FINDING OF REVIEW STUDY ON AGRICULTURE AND LIVESTOCK FARMING IN ROD KOHI, D.I.KHAN

DRAFT REPORT

SUBMITTED TO

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1 INTRODUCTION

1.1 Background to the study

Since 1997, In Pakistan Inter-Cooperation (IC) has been mandated by Swiss Development Cooperation (SDC) to implement, on its behalf, the so-called Sustainable Land Use Mandate. Preparations are on the way to the transformation from the SDC concept for Sustainable Land Use (SLU) in the mountain area of northern Pakistan (1996) to a more comprehensive 'SDC concept for the management of Renewable Natural Resources'. The geographical focus of the present SDC-SLU concept comprises whole of NWFP, Azad Jamu and Kashmir and the northern areas. The majority of the field activities, under SDC, are in progress in northern parts of the province. Presently, the SDC extended its cooperation to southern part of the NWFP.

1.2 About the target area

Dera Ismail Khan (D.I.Khan) is the southern most Division of the North West Frontier Province (NWFP) comprising of districts D.I.Khan and Tank. The District D.I.Khan spread over 9,005 square km area and has a height of 255 m from sea level. There are three tehsils in D.I.Khan, viz. D.I.Khan, Paharpur and Kulachi. Previously, Tank was a tehsil of D.I.Khan but now declared as a separate district. Major part of the district D.I.Khan is level plain, has its boundaries with Bannu on north, Punjab on east and south and tribal areas on west. River Indus is situated on the eastern side that delineates Punjab and NWFP. The area is relatively dry with limited potential for increased productivity. Inefficient and sub-optimal use of rainwater has proved to be the limiting factors for the small farmers that intercepted hill torrents during Monsoon bringing down water along with silt particles under a system called Rod-kohi. These torrents are usually uncontrolled and mostly unpredictable, causing losses to human, property, crops, and livestock.

1.3 The background study

An orientation to D.I.Khan, Tank and North Waziristan was done in June 2000. The report pointed out a number of issues related to farming system as well as soil and water management. The same was followed by a fact-finding mission in October-November 2000 with the objectives to identify and analyze problems and potentials of the farming

systems, water and soil management, as well as to develop hypothesis to be tested out through possible interventions in subsequent studies. A poverty study was conducted by SDC-IC in August-September 2001. It confirmed an extreme level of poverty attributed to natural, social and political factors.

Description and presentation of the social and relatively speaking, political dimensions were studied in previous studies conducted by the SDC-IC in 2000 and 2001. A need was felt to study technical aspects addressed rain-fed agriculture in order to provide basis for a comprehensive project proposal in future. This brought the SDC-IC to a conclusion that information needed to be collected:

(a) through conducting review survey in region collecting base-line information from growers on the existing rain-fed agricultural practices and livestock management

(b) through conducting experiments at farmers' field in region for knowing potentials of modern practices over tradition with improvement in crops and livestock production

1.4 Objectives and terms of reference

Keeping in view, the above mentioned background and rationale, the objectives of the study were set: to collect base-line information from growers of the region regarding practices adopting for crops and livestock production, to observe performance of the different improved lines/varieties of crops and trees for food and food supply under drought and to improve existing feed intake of the existing material. Detail terms of reference of the study are given below.

A. To investigate the success rate of updated production practices in crop growth and livestock management for future adoption in the Rod-Kohi, D.I.Khan. This will include:

- ...ic practices in kharif crops for increasing productivity
- ...l trials for the drought tolerant fodder species
- ...esting of the appropriate interventions for upgrading the feeding ...rops residues in livestock feeding

Acco... ...xisting situation of crop production and livestock management in of the fa... ...of D.I.Khan so as to identify and analyze the problems of low ...d suggest solutions. This will include:

(i) Farm size, cropping intensity and livestock herd dynamics of the regions

(ii) Existing practices in technology in crop production and livestock management

(iii) Estimates per unit farm out put (Crop and Livestock) and its utilization

(iv) Estimate availability of values of by-products of local Oil extraction plants and Chishma sugar mill D.I.Khan for feeding.

C. Suggest recommendations for future intervention to enhance production of the crops and livestock in Rod-kohi area of D.I.Khan.

2 Methodology

Based on information reflected in objectives of the study, a detailed questionnaire in consultation with SDC-IC was designed. Sample of the questionnaire is appended (Annex-I). To extract the required information from farmers, three teams were designated each for upper, middle and lower streams of the sector. Each team consisted of a graduate student from Faculty of Crop Production Sciences, NWFP Agricultural University Peshawar, a female Livestock Assistant from the Department of Livestock and Dairy Development NWFP, Peshawar and a local activist from the target region.

Area map was studied and decided to sample all most all villages of the Draban Zam i.e. upper, middle and lower streams of the sector through a random sampling of 5% households per village with a maximum of 20 households per village. One-ay workshop was organized by the SDC-IC on January 08, 2002 to explain study's objectives, selection of villages and households of the area, adoption of methodology for extracting information on the pre-defined questionnaire and structuring teams' coordination for finalizing the task.

2.1 Review study

A pre test survey was organized on January 13-15, 2002, the information was discussed in a meeting on 15.01.2002 and21.01.2002. The questionnaire was re-structured as per suggestion of groups inserting Urdu translation on questions. Time frame of the survey was scheduled in two phases i.e. first in mid February and second in early March 2002 and villagers were informed accordingly for comparison of their problems regarding crops and livestock production. The designated teams visited each individual household

in a village. The team first explained objective of the visit and thereafter asked the required information. Female team member separately interviewed the women of the selected houses. Special attention was paid to interview male and females of the same household in each village. Details regarding villages visited during the survey, number of household per village, and sampling done per village is given in Table-1. Data regarding each question of the questionnaire was entered in the computer and analyzed with a Statistical Package for Social Sciences (SPSS). Means and percentages were computed and their relationship between different parameters was studied.

Table 1. Villages, households and sampling list in the upper, middle and lower streams of Draban Zam, D.I.Khan

Village name	Stream	Households	Sampling
Kotta Alladad	Upper	025	02
Gara Mehrban	Upper	040	02
Ghandi Esab	Upper	048	02
Gara Jat	Upper	028	02
Gara Ghulam Siddique	Upper	028	02
Gara Dasti	Upper	028	03
Kot Shahnawaz	Upper	070	03
Kikri	Upper	028	03
Jalalabad	Upper	010	01
Gara Sheikh	Upper	012	01
Gara Mir Alam	Middle	215	11
Gara Isa Khan	Middle	050	02
Gara Alam Khan	Middle	040	02
Mochiwal	Middle	070	06
Gandi Umer Khan	Lower	609	25
Gara Ramzi	Lower	072	03
Jhok Abdullah	Lower	017	01
Gara Murid Shah	Lower	012	01
Charoya	Lower	010	01
Kiyara fateh Mohammad	Lower	081	04
Tilokar	Lower	012	02
Dholka	Lower	091	05
Khokar Sharqi	Lower	011	01
Zaman Tilokar	Lower	021	01
Khiyara Basharat	Lower	017	02

3 FINDINGS OF THE REVIEW STUDY

3.1 Land holding and farm size

According to this survey report, majorities of farmers were found landowners irrespective of the fact that their land is productive. Farmers in the region were categorized as those

having land less than the substance limits of 5 hectares, followed by increasing the landholding 100 times. Percent farmers with respect to their total land holding are given in Table 2.

Table 2. The landholding details of the farmers in Draban Zam, D.I.Khan

	Percentage			
Farm size [Ha]	Lower	Middle	Upper	Total
Less than 05	08.1	05.3	04.5	06.6
05 to 10	18.1	15.5	22.8	18.7
10 to 20	50.6	47.5	22.7	43.3
20 to 40	15.1	15.8	27.3	17.7
40 and above	08.1	15.9	22.7	13.7
Total	100	100	100	100

According to the data (Table 2), majority of the farmers have 10-20 hectares land in the region as well as in lower and middle streams of the area. On the basis of total land, 6.6% household (HH) have less than five hectares land, 18.7% HH have five to ten hectares, 43.3% HH have ten to twenty hectares, 17.7% HH have twenty to forty hectares and 13.7% HH have greater than forty hectares land in whole of Draban Zam, D.I.Khan.

On the basis of individual streams, it was observed that 8.1%, 5.3%, and 4.5% HH have less than five hectares land unit in lower, middle and upper streams of the area respectively, 18.1%, 15.5% and 22.8% HH have five to ten hectares land unit, 50.6%, 47.5% and 22.7% HH have ten to twenty hectares land, 15.1%, 15.8% and 27.3% HH have twenty to forty hectares and 8.1%, 15.9% and 22.7% HH have greater than forty hectares land units. The data show that about 95% HH in the region as well as in fractions of the region i.e. lower, middle and upper streams have farm size of equal or greater than the substance limits. Small landholding was observed greater in lower than middle and upper streams of the region. Likewise, the big landlords with 40 or greater than 40 hectares land were found less in the lower steam than middle and upper streams. This was due to the 1962 and 1973 land reforms wherein the big farmers lost land while the land less farmers received small pieces of the land.

Total land is cultivated land plus the fallow fraction. The uncultivated land is not of interest to this study. The total cultivated land explained in Table 2 is partly the land owned by the growers and/or tenant that has been leased from the landlords or growers on traditional terms and conditions. Details of the owned and tenant land are provided in Table 3.

Table 3. Owned and tenant landholding data in Draban Zam, D.I.Khan

Farm size [Ha]	Percentage							
	Owns land				Tenants land			
	Lower	Middle	Upper	Total	Lower	Middle	Upper	Total
No land	18.4	31.4	31.8	24.4	18.4	10.5	09.1	14.4
Less than 05	36.4	21.2	40.7	34.6	16.2	15.8	04.5	13.2
05 to 10	28.5	26.2	04.6	22.3	20.6	31.5	22.9	23.2
10 to 20	12.2	10.6	04.7	09.9	32.6	21.1	31.8	30.2
20 to 40	00.0	05.3	13.7	04.4	08.2	15.8	27.2	14.5
40 and above	04.5	05.3	04.5	04.4	04.0	05.3	04.5	04.5

According to the survey data (Table 3), about 25% HH do not have their own land in the region. Further details revealed that 18.4%, 31.4% and 31.8% HH have no land of their own in lower, middle and upper streams of the region. The highest ratio of the owned land was less than 5 hectares in the total region and individual streams of the region. Thereafter, increasing the land holding from 5 acres to 40 hectares or above, the HH percentage decreased in the region as well as in all segments of the region. Information regarding tenant land revealed that 14.4% HH have no tenant land in the region which is reported 18.4%, 31.4% and 31.8% HH in each lower, middle and upper stream of the area, respectively. The highest tenant land of 10 to 20 hectares is reported in the lower and upper streams while 5 to 10 hectares in the middle stream.

3.2 Land utilization and cropping pattern

Survey data revealed that grain crops cultivation dominated the whole area as well as fractions of the areas i.e. lower, middle and upper streams in Draban Zam of D.I.Khan. Vegetable cultivation is reported in 0% HH of the entire area as well as in villages of the three streams of the area. In addition to perennial trees and bushes, weeds of main crops and uneconomic parts of the major crops are the main feed supply source as fodder in the entire region. About less than 1% of the total cultivated land is reported for fodder cultivation in the region. The tendency of fodder cultivation was reported 18.9% for the entire region of which 22.4% is in the lower stream villages, 26.3% in the middle stream villages and 04.5% in the upper stream villages of the total farm area. The chances of Rod-water are generally high in upper stream compared to that of middle and lower streams. Therefore, crops and their weeds generally assumed enough to fulfil fodder requirement of the animals in upper stream. Nevertheless, trees and shrubs growth was also observed relatively better in the middle and particularly in the upper stream of the area compared to that of the lower. Trees for fodder has been extensively consumed. Nevertheless, further cultivation has not been reported since the last 15

years. Populations of human as well as animals have been increased; it is advisable that new species – particularly drought resistant – should be tested for high quality fodder supply under drought.

Farmers of the region generally cultivated land once a year by growing either Rabi (Winter) or Kharif (Summer) crops on a piece of land. This reflects that mono cropping-pattern is in practice in the whole of Rod Kohi area in D.I.Khan. Survey data further confirmed that most of the land remained fallow in the entire region due to severe drought in the last 5 years (Table 4).

Table 4. Fallow land [%] during Rabi and Kharif season in the last 5 years in Draban Zam, D.I.Khan

Fallow land of the total Farm	Rabi season				Kharif season			
	Lower	Middle	Upper	Total	Lower	Middle	Upper	Total
80%	26.5	31.8	40.7	30.9	12.2	0.00	04.5	07.7
100%	73.5	68.2	59.3	69.1	87.8	100	94.5	93.3

Table 4 shows that 31% HH reported 80% of their land fallow in the last five years for rabi season on total area basis as well as in different villages of the three segments i.e. lower, middle and upper of the area. Approximately 69% HH were reported for absolute failure of cultivation on their farms due to drought or not having water from the hill torrents. Severe drought in the area was the only reason for leaving such a huge land fraction uncultivated. As compared to winter season, summer was much affected by drought stress. During summer, a tiny fraction of the farm was reported under cultivation that ranges from 0.0 to 7.0% of the total land holding. Nevertheless, more than 90% land was reported uncultivated in the region as well as in the different streams of the region.

Table 5. 100% fallow land during Rabi and Kharif in Draban Zam, D.I.Khan [1996-2001]

Fallow land [100%]	Rabi season				Kharif season			
	Lower	Middle	Upper	Total	Lower	Middle	Upper	Total
1996-97	30.6	57.9	68.2	45.6	36.7	42.1	54.5	42.2
1997-98	69.4	52.6	54.5	62.2	83.7	68.4	86.4	81.1
1998-99	98.0	78.9	68.2	86.7	87.8	89.5	77.3	85.6
1999-00	95.9	89.5	68.2	87.8	89.9	94.7	81.8	88.9
2000-01	91.8	84.2	50.0	80.0	93.9	94.7	45.5	82.2

Table 5 shows 100% fallow land reported in the last five years from the house holds survey conducted in the Draban Zam area, D.I.Khan with its percent distribution in the

different fractions i.e. lower, middle and upper parts of the stream. It could be seen from the table that the intensity of drought increased from 1996 onwards till 2001. This increasing drought from 1996 to 2001 increased the amount of 100% fallow land both in winter as well as in the summer season not only in the entire region but also in the individual streams of the region. Year 1996-97 was relatively the best year among the last five years duration having some of the land fraction under cultivation. Thereafter, each year the increasing drought adversely affected the crop cultivation, which increased the fallow land area in the entire region. Effect of absolute crop failure is reported less in the upper than middle and lower streams of the region. Water resources in the region are either the natural rainfall or flood from the hill torrents. Natural rainfall is almost equally distributed in the region and received with equal opportunity in the three streams. However, the floodwater is received in a specified period with an opportunity first to enter in the upper streams than middle and lastly in lower stream of the region. If the quantity and/or duration of water supply are limited, the upper stream has advantage to irrigate their land. When the amount is surplus, the middle households has a chance to get their share or otherwise. The lower stream is always on chance with hope to have sufficient water from the flood or natural precipitation during the crop growth season.

Wheat is the leading crop of the area followed by gram or chickpea. Rape seed/mustard is also cultivated either sole or mostly mixed with wheat and gram. Melon is the crop of interest with highest return in the form of cash if the climate favors. Sorghum is mainly planted mixed with millets but harvested the spikes of each crop separately at maturity. The stalks are either allowed to stay in fields and grazed through animal or in very few cases they are cut and fed under cut and carry system. The existing cropping patterns are mainly based on traditional system of subsistence farming with lack of market information and improvement in the existing production pattern. Depending upon the availability of water during the crops sowing season, major emphasis was recorded for melon cultivation at priority, thereafter, for wheat and sorghum. Mustard and guar is of the interest to farmers having no other option to plant a species due the soil moisture limitation or insufficient fodder for the animals in the season. The main crop rotation of the region is provided in Figure 1.

RABI AND KHARIF CROP ROTATION

Rabi Crops

Sowing		Harvesting		
Oct.	Nov.	March	April	May
Mustard (*Euroca sativa*)		Mustard		
Gram (*Cicer arietinum*)			Gram	
Wheat (*Ttriticum aestivum*)				Wheat

Zaid Rabi Crops

Sowing		Harvesting	
Feb.	March	April	May
Melon sole Melon with Sorghum		Melon	Sorghum fodder

Kharif Crops

Sowing		Harvesting	
Jun.	July.	Sep.	Oct.
Sorghum (*Sorghum spp.*) mix with Millets (*Pennisetum spp.)*			Sorghum Millets

Figure 1. The major crop rotation in Draban Zam, D.I.Khan

The survey reported that both sole and mix cropping is in practice in the entire area. Wheat, gram and to some extent, mustard are the winter season crops that are planted as sole crops in almost all villages of the three streams. Gram – mustard; gram – barley; Mustard – Guar; and gram – wheat are the mostly adopted inter cropping pattern in winter season. Melon – sorghum; melon – millets and melon with sorghum and millets are mainly intercropped if water is available for cultivation in spring season mostly through precipitation or floods in the area. Sorghum and millets are the main dominating summer crops of the area and are planted mix in a single field in all the three streams of the region. Guar plantation is at the least priority as a source of fodder in the households having livestock.

Data regarding intercropping revealed that 78.9% HH are practicing intercropping on their farms in the entire region of that 87.8%, 68.4% and 68.2% HH are in lower, middle and upper streams of the area. The rest of the growers were reported for sole cropping of wheat, gram and mustard. Details of inter-cropping on percent HH basis along with the crop species are given in the Table 6.

Table 6. The households [%] using intercropping on their farm in the Draban Zam, D.I.Khan

	Percentage			
Species	Lower	Middle	Upper	Total
Gram+Barley/Sorghum+Millets	02.0	-	-	01.1
Gram+Mustard/Sorghum+Millets	26.5	-	18.2	18.9
Sorghum+Millets	59.1	42.1	45.5	52.2
Mustard+barley	-	26.3	-	05.6
Mustard+Wheat	-	-	04.5	01.1
No inter cropping	12.2	31.6	31.8	21.1

Table 6 shows that sorghum and millets are the leading crops cultivated mix in all most all villages of the three streams. Gram mixed with mustard is the next common combination in both lower and upper streams villages of the area. Barley as a fodder is generally mixed with mustard or gram and is found in the middle stream region.

Legume inter cropping with cereal is the best option and had never tried in the region. Cultivation of mung and mash with sorghum/millets or lentils with wheat and barley might have better opportunities to increase farm income and production. Research work is required to test and screened short duration varieties particularly of mash and lentils for the area along with their production technology that could be acceptable to the growers of the area.

3.2.1 Choice of crops

Water is the only limiting factor of the area and hence, vegetable production is either not in practice or reported to have been in cultivation in the near past. Cultivation of green fodder is the only option for 20-25% HH of lower and middle stream villages of the area in which animals are the significant source in contributing family income. Cultivation of grain crops both for family consumption and source of income is in practice and are cultivated since many years. The percent household categorized on the basis of landholding (Table 2) when regressed with %HH optioned for the crops cultivation (Table 7) showed a linear relationship (Figure 2).

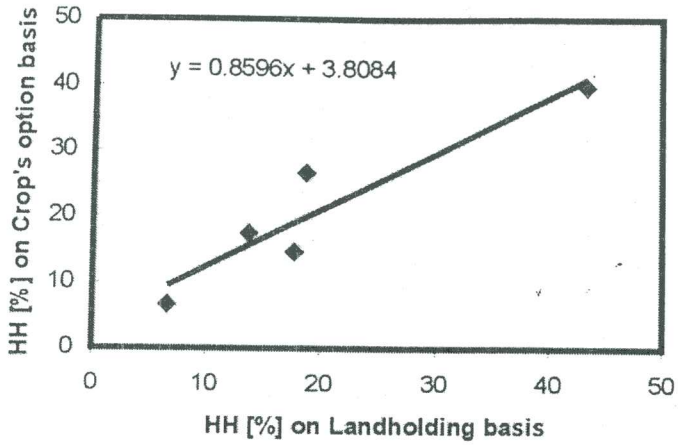


Figure 2. Relationship between households [%] on the basis of landholding and option for the selection of crops at farms.

Response of the percent HH for the grain crops' cultivation is provided in Table 7.

Table 7. Growers' option/interest planting grain crops in Draban Zam, D.I.Khan

	Percentage			
Farm size [Ha]	Lower	Middle	Upper	Total
Less than 05	06.5	05.0	09.4	06.6
05 to 10	26.2	31.7	22.6	26.6
10 to 20	44.7	03.7	31.8	39.8
20 to 40	14.1	10.3	18.1	14.6
40 and above	08.5	16.0	18.1	12.4

It is evident from the above table that increasing the landholding of the region as well as of the individual streams of the area increased interest/options for grain cultivation and improvement. Household with landholding of 05-20 hectares showed the highest interest for grain crops cultivation and improvement.

Option of cultivating non-traditional crops were warmly well commed by the 95% HH of the area subject to the condition if they were provided with the information regarding production technology and their utilization. Safflower, sesame, lentils, mash, mung, groundnuts and several other species are famous for drought stress resistant and needs to be tested for growth and development in the area if not for seed perhaps for the better quality fodder option in the area.

3.3 Agronomic practices

The Draban Zam farming system is traditional, survival oriented and complex. Despite larger landholding, agronomic practices and farm production is of substance level that mainly attributed to severe drought conditions in the region. Land remains fallow

throughout out the years(s) and ploughed when sufficient water supply is ensured either through natural rainfall or floods. Prolonged droughts, inadequate crop production practices, primitive local crops' species/varieties and their seed quality, migration of the people to nearby irrigated areas, livestock and livestock production sale constitute the substance and unique farming system in the region.

3.3.1 Field capacity and water for irrigation

Seedbed preparation is a basic sign of the land preparation for cultivation in a region. Unlike other regions of the province, fields in Rod-Kohi area are mostly flat and bigger in size. Seedbed preparation absolutely depends on water availability in the crop growth season. Rainfall during whole of the year is quite limited. Moon-soon is the main contributor of agricultural crop production in the area and is generally expected in June and July each year. Floodwater from hill torrent and Kala-pani – the perennial water streams – mainly originated from the springs are the irrigation sources other than the natural precipitation in the entire region. As per physical information gathered in the region, the response of percent households of the region regarding water availability months and amount is provided in Figure 3.

Based on last 5 years average, the information collected through interviewing farmers, it was observed that water from all three sources i.e. rainfall, flood from hill torrents, and water from spring is mainly available in the months from January to March and thereafter, from Jun to September. No water availability is reported in the region in survey conducted during the month of April and May (Fig. 3). Water availability is though reported by 49% HH in the lower stream villages for the month of January, 45% for February, and 10% for March but this water availbility is quite insufficient for agronomic practices to bring the land at field capacity. Water availability in Jun, July and Sep. is reported sufficient to raise crops in the lower stream villages by 63.3%, 63.3% and 16.3% household interviewed in the region. However, 18%, 33% and 16% replied for insufficient water in Jun, July and Sep. A bit forward from the lower stream, response of middle stream villages not mimicked with that reported for water quantity especially in Jun and July. In middle stream region of the area, 11%, 53% and 47% households responded for the water availability in Jan to Mar, however, the quantity of water is not usually enough to raise crops. Water availability in the month of Jun to Sep is reported enough to raise crops by 42%, 47% and 16% households of the area. For the upper stream segment, 14% reported for insufficient water in Feb and March. Nevertheless, 82%, 86 and 27% households were of the opinion that water in the month of Jun, July

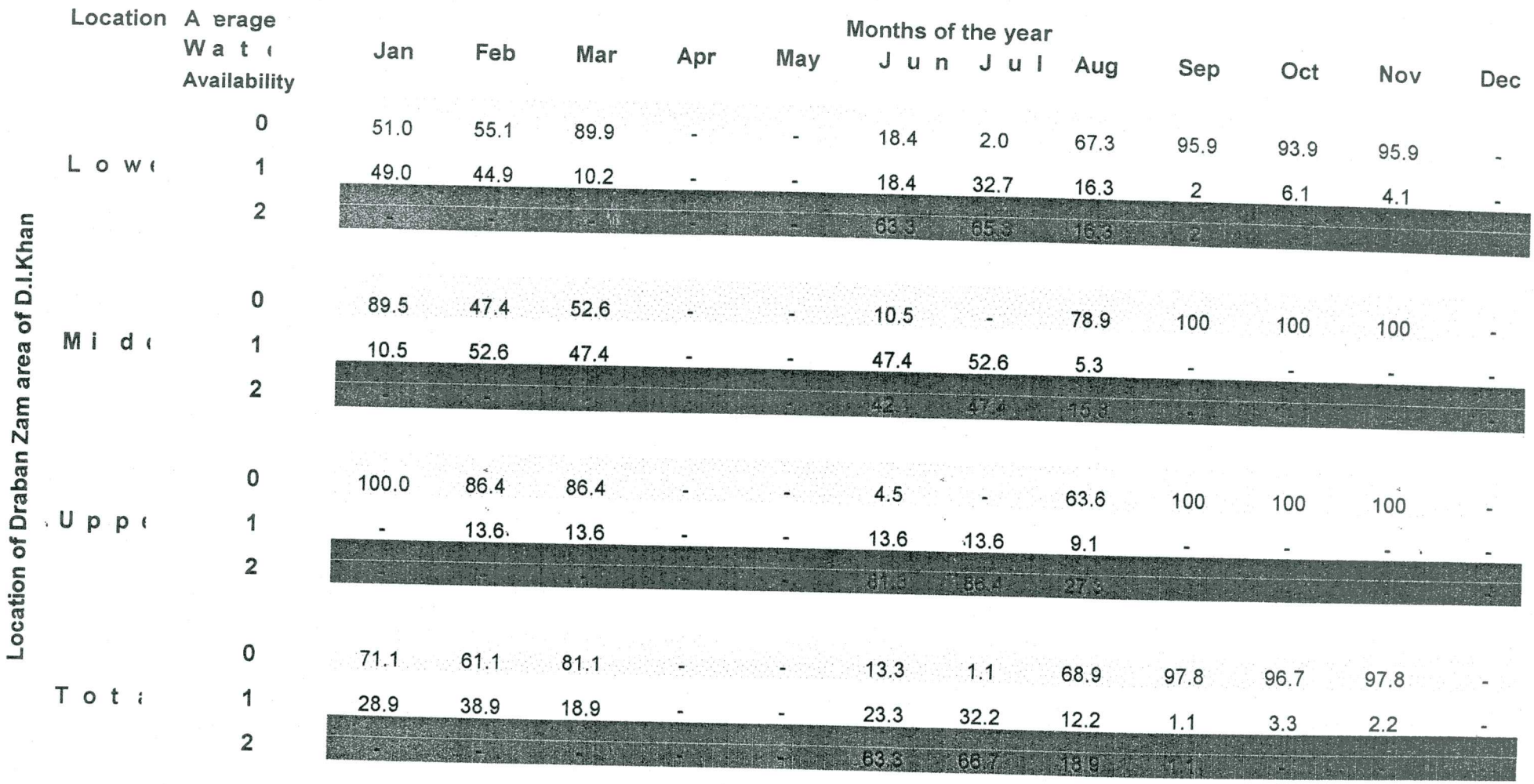


Figure 3. Responses of the households [%] regarding water availability through rainfall and other sources in different months of the year (5 year's average estimate)

and Sep. is enough to plow the land and raise the crops at their farm. On total area basis, 29%, 39% and 19% replied for insufficient water availability in the month of Jan, Feb and March. About 63%, 67% and 19% showed their willingness to have sufficient water in Jun, July and Sep for crop growth and development.

Compared to lower and middle stream villages, the total water availability is reported by relatively higher household percentages. The natural rainfall is suppose to be equally distributed in the region, however, water from other sources i.e. *Kala Pani* and flood water from hill torrents first enter in the upper stream villages and is consumed by every growers as per demand. Thereafter, the water quantity – if surplus from the growers of the upper stream – is allowed to flow for consumption by middle stream villagers. The lower stream villagers are always kept on chance to have the irrigation facility for their fields when water is either not controlled or consumed by the upper and middle stream growers. Information regarding Rod water storage depth in fields and its expected month of storage is provided in the following Tables 8 and 9 respectively.

Table 8. Rod water storage depth [Cm] in Draban Zam, D.I.Khan

	Percent households			
Water depth	Lower	Middle	Upper	Total
000 Cm	04.1	-	18.2	06.7
060 Cm	44.9	42.1	59.1	47.7
120 Cm	51.0	52.6	18.2	43.4
150 Cm	-	05.3	04.5	02.2

Table 8 shows that the majority of HH in lower (45%), middle (42% and upper (59%) part of the Draban Zam area stored approximately 60cm water depth in the fields which accounts for 48% HH of the total area. Water harvesting depth of 120cm is reported for 51%, 53% and 18% HH in the lower, middle and upper stream villages of the area. The maximum 150cm of the water storage depth is reported in the uppers stream villages by 05% HH surveyed. The source of water flow is mainly from upper to middle and thereafter to lower stream villages. The storage of water depth [Acre inches/m area] is the intention of the growers to have good crop of the season. From discussion with growers, one can conclude that they are absolutely illiterate regarding field capacity and water utilization for the crop production. The grower's intention was observed for maximum water store in fields, which make the fields saturated and hence a good crop is expected after cultivation at field capacity stage. Here the study regarding field water holding capacity is desired to be estimated and thereafter the growers should be educated that extra water use at the fields is of no use but rather adversely affects fertility of the fields through leaching nutrients. Based on information collected from the

survey, it was noticed that farmers have not supplied any kind of fertilizer/farm yard manure to their fields for so many years (indefinite period). The crops have been raised mainly through irrigation. Some of the growers intentionally over flooded their fields with the objectives that they will plant winter crops (Wheat and Gram) on that particular field.

Study is needed to teach the growers that:

- water storage to be consumed by the winter season crops is full of risks through drought stress in winter if occurs
- is it possible to have more income/production from a field if not planted at water availability but rather with delay the next season
- each field has an optimum water holding capacity, beyond that extra water storage on field not only delay planting of the season but also adds in leaching nutrients from the soil and helps in erosion of the top fertile soil layers of that field
- the optimum utilization of water enables the fellow growers to cultivate their land which helps in the area's climate change through establishing water cycle and this will have a positive impact of the crops growth of the entire region

June, July and August are the months when water is frequently available (Table 9) and stored as well as consumed mainly for crop cultivation and bringing fields to proper *Vattar* condition (Field capacity) before plowing it and making the seedbed ready for sowing.

Table 9. Rod water storage month for cultivation in Draban Zam, D.I.Khan

	Percent households			
Months of the year	Lower	Middle	Upper	Total
Nil	04.1	-	18.2	06.7
Jun-July	32.7	63.2	18.2	35.6
July	08.2	-	-	04.4
July-August	53.1	38.8	83.6	52.2
September	02.0	-	-	01.1

The harvested water from either source is collected for planting crops of summer or winter season. From the survey data collected in the entire region based on sampled households, the tendency of 71.1% HH was estimated for cultivation of summer crops and 22.2% HH for winter crops in addition to the 6.7% HH with out of reach to water supply at their fields. Further bifurcation of the total region into lower, middle and upper stream villages revealed that 61.2%, 94.7% and 72.7% HH opt for summer and 34.7%,

05.3% and 09.1% HH for winter crops cultivation, respectively. Effect of the stored water on crops is reported the best by 63.3% HH, which accounts for 63.3%, 52.6% and 72.7% HH in each lower, middle and upper stream of the area. About 25.6% HH remarked with good effect of the harvested water on crops in the area that further splits in 28.6%, 36.8% and09.1% HH in each lower, middle and upper streams of the area. A very mild response of 4.4% HH reported with remarks of poor effect on total area basis and 4.1% of lowers and 10.5% in the middle region of the area. This data further confirms that the upper stream villages have an access for plenty of water to store in their fields and hence responded with the highest (72.7%) percentage for the best effect of water on the crops.

3.3.2 Seedbed preparation

Good seedbed preparation is the initial operation to have optimum production from a land. Fine seedbed preparations not only improve soil water holding capacity but also facilitate the process of seed germination and thereafter, growth and development of the emerged seedling. Plowing implements, methods and frequency of the plowing in a field is to be taken in consideration with respect to soil type and ecological conditions of a region. Rod Kohi area has distinguishing features for crop production for example acute shortage of water for crop growth, unpredictable rainfall in the season, soil having maximum silt, planting fields not on regular intervals, and single crop production system e.g. growing either summer or winter crop on a field.

The frequent visits confirmed that fields remain fallow for an indefinite period if there is drought in the area. On water availability, the land is plowed and prepared for cultivation. Plowing of a piece of land is subjected to the amount of water received. Source of the irrigation water has been explained earlier in section 3.3.1. On receipt of the sufficient water quantity (mostly flood water), the entire field is plowed and prepared for sowing either rabi or kharif crops. Otherwise, if sufficient rainfall is received during the planting months, the total water of the different fields are harvested in one field or fraction of a field and that particular section of the field is prepared to cultivate at proper *Vatter*. The seedbed preparation is reported either through deep plowing (*Raja Hall*) or the routine usual plowing using cultivator with tractor/hall with pair of bullocks. The routine plowing is further practiced as straight plowing – i.e. in single lines along the field length – or cross plowing – i.e. in two directions; first along the field length and then subsequently along the field width – (Table 10).

Table 10. Plowing types with number generally in practice by growers [%] in Draban Zam, D.I.Khan

		Rabi (Winter) Crops											
		Lower			Middle			Upper			Total		
Species	No	DP	SP	CP	DP	SP	CP	DP	SP	CP	DP	SP	CP
	0	42.9	44.9	28.6	63.2	31.6	73.7	54.5	36.4	31.8	50.0	40.0	38.9
Wheat	1	57.1	40.8	57.1	36.8	68.4	26.3	45.5	63.6	59.1	50.0	52.2	51.1
	2	-	14.2	14.3	-	-	-	-	-	09.1	-	07.8	10.0
Gram	0	42.9	38.8	32.7	66.7	31.6	70.6	41.2	36.4	11.1	47.6	36.7	35.7
	1	55.1	46.9	59.2	33.3	68.4	29.4	58.8	63.6	72.2	51.2	55.6	56.0
	2	02.0	14.3	08.1	-	-	-	-	-	16.7	01.2	07.8	08.3
	0	100	04.1	95.9	100	05.3	94.7	100	04.5	100	100	04.4	96.7
Mustard	1	-	93.9	04.1	-	94.7	05.3	-	95.5	-	-	94.4	03.3
	2	-	02.0	-	-	-	-	-	-	-	-	01.1	-
		Kharif (Summer) crops											
Melon	0	95.9	24.5	59.2	100	68.4	94.7	100	72.7	95.5	97.8	45.6	75.6
	1	04.1	71.4	38.7	-	31.6	05.3	-	27.3	04.5	02.2	52.2	22.2
	2	-	04.1	04.1	-	-	-	-	-	-	-	02.2	02.2
	0	100	18.4	98.0	100	26.3	100	100	40.9	95.5	100	25.6	97.8
Guar	1	-	76.6	02.0	-	73.7	-	-	50.0	04.5	-	71.1	02.2
	2	-	02.0	-	-	-	-	-	09.1	-	-	03.1	-
	0	95.9	02.0	85.7	78.9	-	89.5	81.8	-	86.4	88.9	01.1	86.7
Millets &	1	04.1	91.8	14.3	21.1	100	10.5	18.2	100	13.6	11.1	95.6	13.3
Sorghum	2	-	06.1	-	-	-	-	-	-	-	-	03.3	-

DP = Plowing land deep with a Raja Hall
SP = Plowing land lengthwise in one direction with plow or cultivator
CP = Plowing land first lengthwise then widthwise with a cultivator

Plowing is a laborious, time-consuming job and also costly for the poor growers, the survey confirms that crop to be planted at afield has strong relationship with method of seedbed preparation in the region. In Rod Kohi area, fields remain fallow for a relatively longer period of time due to drought stress. This makes the soil more compacts due to its clayey nature. The farmers need to teach that deep plowing before irrigating a field allows that field to absorb more water, enhance water supply for a relatively longer period for the crop growths, decrease run-off (erosion) and leaching of the nutrients from soil through controlling percolation of water. Cross plowing during seedbed preparation provides fine seedbed for the establishment of seedling and ensures maximum germination in addition to that of decreasing weeds population and breaking hard sub surface of the filed. The majority of HH adopting straight plowing, which reflects poor germination of seedling and hence considerable decrease in yields through insufficient plant stand at harvest.

a. Wheat (*Triticum aestivum*)

Deep plowing - relatively costly than the normal plowing – for wheat is reported for 51% HH in total area basis and about 57%, 36% and 45% HH in each of the individual streams i.e. lower, middle and upper, respectively. The 100% response was reported for single deep plowing practice. Deep plowing is mainly practiced for wheat at the sowing season (Sep.–Oct.) when field is at field capacity and ready for cultivation. Straight plowing is reported for 52% HH in the region with 41%, 68% and 64% HH in each of the lower, middle and upper streams, respectively. The 8% HH plow the fields two times and also in the month of October. Cross plowing is reported for 51% HH of the region and is 51%, 26% and 59% HH in each lower, middle and upper streams, respectively. The 10% HH plowed field two times but also in the month of October when field is in *vattar* state.

b. Gram (*Cicer aritinum*)

Deep plowing for gram crop is reported for 51% HH of the area, which is 55%, 33% and 58% HH for each lower, middle and upper streams, respectively. A single deep plowing is in practice. Deep plowing is mainly practiced at gram sowing season (Sep.–Oct.) when field is physically ready to sow. 56% HH of which 55%, 68% and 64% HH are in each lower, middle and upper streams report straight plowing, respectively. The plowing number is reported twice by 8%HH of the area in the month of Sep.-Oct. Cross plowing is reported for 56% HH of the region and 59%, 29% and 72% HH in each lower, middle and upper streams, respectively. Cross plowing in practiced twice by 8% HH and in the month of Sep.-Oct. when field is ready to cultivate.

c. Mustard (*Eruca sativa*)

Deep plowing for mustard is reported by 0% HH. It is due to low priority crop of the region. Straight plowing is done once by 94% HH of the area and 94%, 95% and 96% HH in each individual streams i.e. lower, middle and upper, respectively. Majority of the grower plow land in Aug.-Sep. Cross plowing is reported by 3% HH of the area and 4% HH in lower stream only. Land is mainly plowed in the month of Aug.-Sep.

d. Melon (*Cucumis sativus*)

Plowing for melon crop is subjected to water availability in spring season. Deep plowing for melon is reported for 2% households of the area and 4% HH of the lower stream only.

It is mostly done in the month of Feb-Mar. Straight plowing is reported for 52% HH of area and 71%, 32% and 27% HH of each lower, middle and upper streams of the area, respectively. Only 2% HH plow the land twice but in the month of Feb-Mar. Cross plowing is reported for 22% HH of the region and 39%, 5% and 5% HH of each lower, middle and upper streams of the area, respectively. A maximum of 2% HH do plowing twice in the month of March.

e. Guar (*Field vetch*)

Deep plowing for guar is reported nil due to its least priority crop (21%) of the region and is reported to be remained in cultivation by only 16 in lower and 10% in upper streams. Straight plowing is reported for 71% HH of the region and 76%, 74% and 50% HH of each lower, middle and upper streams of the area, respectively. Only 3% HH reported to plow the land two times in July. 2% HH of the area and 2% and 5% HH in lower and upper stream villages report cross plowing. The maximum households plow the land in July.

f. Sorghum and Millets (*Sorghum and Pennisetum spp.*)

Sorghum and millets are planted mixed. 11% HH of the total area and 4%, 21% and 18% HH in each lower, middle and upper streams respectively of the area reported single deep plowing for sorghum and millets. Deep plowing is done on the day of sowing. 96% HH of the region and are 92%, 100% and 100% HH in each lower, middle and upper streams report straight plowing, respectively. Only 3% HH reported to plow land twice in Jun-July-Aug. Cross plowing is reported by 13% HH of the region and 14%, 11% and 14% HH in each of the lower, middle and upper streams, respectively.

Through this survey, it was estimated that 51.1% growers prepare the seedbed through animals in the entire region that estimated 55.1%, 57.9% and 36.4% HH in lower, middle and upper parts of the area. 43.3% use tractor and estimated 38.8%, 42.1% and 54.5% HH in lower, middle and upper parts of the area, respectively. The rest of the growers were of the idea of using both animals and tractors based on their availability. Seedbed is prepared by engaging male (88%) member of the family in the area. For each lower, middle and upper section of the region, an estimate of 84%, 95 and 96% respectively was reported for the male engagement and the rest including female and children in the process of seedbed preparation.

3.3.3 Fertilizer and farm yard manure application

General trend of the growers is not to apply any kind of fertilizer to their crops either in rabi or kharif season. It was observed that farmers have no idea/information regarding fertilizer and their types or ever applied to crops in their life. Their general view is that their soils are rich with nutrients and produced bumper crops only and only if irrigation water is made available to their fields. Nevertheless, according to their perceptions the torrent water brings silt with and is highly rich with nutrients for the crop growth and production. Livestock dung is mainly dried, stored and used as fuel in 90% families in all the upper, middle and lower stream villages of the Draban Zam. Fresh dung is the only source of supplying nutrients to fields having material for grazing and the animal allowed grazing freely in it during the whole day. This is usually practiced when economic fraction of the main crop is harvested (e.g. sorghum and millets) or the crop is in extravagant growth (e.g. wheat/gram) at vegetative stage with fear to abate grain yield at maturity. Rest of the sheep, goats and livestock along with family garbage is mainly stored in front of their houses and applied to the fields during seedbed preparation of special interest crops i.e. mainly Melon and Wheat. Soil samples have been collected from different fields of the area and analyzed for major nutrients N, P and P along with organic matter. The details are provided in Table 11. A deficiency for N and P is found in all most all the three streams with highest in upper and middle than lower streams of the area.

Table 11. Nutrient status of the soil analyzed in lower, middle and upper stream villages of the Draban Zam, D.I.Khan

Location	PH	K [mg kg^{-1}]	P [mg kg^{-1}]	N [%]	Org. M [%]
Gandi U. Khan	8.3/8.2	168.5/112	0.164/0.065	0.051/0.039	0.862/0.690
Gara Mir Alam	8.1/8.1	136/162	1.295/0.244	0.049/0.046	1.035/0.690
Gandi Esab	8.2/8.3	112/092	0.244/0.064	0.041/0.025	0.690/0.517

Fertilizer trials on the basis of the above analysis would be carried out to study and to demonstrate nutrient deficiency particularly of N and P that has been reported quite low and especially in middle and upper streams of the area.

3.3.4 Sowing method, seed rate & source, sowing time and variety

The only improved agronomic practice observed in the area was that almost all growers sow crops in rows. Wheat is planted 10-15cm in rows and is almost half of the recommended distance for wheat. Gram planted 20-25cm distances in rows, mustard 25-30cm, guar 25 and sorghum with millets in 20-25cm in rows (Table 12).

Table 12. Response of [%] households regarding sowing method, seed rate and seed purchasing source of the crops planted in Draban Zam, D.I.Khan

Species	Sowing method	Lower	Middle	Upper	Total
Wheat	10cm in row	79.6	94.7	100	87.8
	15cm in row	20.4	05.3	-	12.2
Gram	15cm in row	85.7	94.7	90.9	88.6
	20cm in row	14.3	05.3	09.1	11.1
Mustard	25cm in row	91.8	68.4	50.0	76.7
	30cm in row	08.2	31.6	50.0	23.3
Melon	25cm in row	-	-	-	-
Guar	20cm in row	12.0	-	08.0	18.0
	30cm in row	04.0	-	02.0	03.0
Sorghum &	20cm in row	10.2	15.8	09.1	11.1
Millets	25cm in row	89.8	84.2	90.9	88.9
Seed rate					
Wheat	40-60 Kg ha^{-1}	02.0	10.6	-	03.3
	60-80 Kg ha^{-1}	08.1	31.6	27.2	17.8
	80-100 Kg ha^{-1}	20.4	15.8	36.4	23.3
	>100 Kg ha^{-1}	67.3	36.9	27.2	52.2
Gram	10-40 Kg ha^{-1}	04.1	26.3	31.8	15.6
	40-60 Kg ha^{-1}	77.5	36.8	54.5	62.2
	60-80 Kg ha^{-1}	16.3	38.6	13.6	20.0
	>80 Kg ha^{-1}	02.0	-	-	01.1
Mustard	04-06 Kg ha^{-1}	34.6	57.9	45.4	42.3
	06-08 Kg ha^{-1}	06.1	-	-	03.3
	08-10 Kg ha^{-1}	59.2	42.1	54.5	54.4
Melon	-	-	-	-	-
Guar	15-20 Kg ha^{-1}	24.5	-	81.8	81.2
	20-40 Kg ha^{-1}	02.0	-	18.2	17.8
Sorghum & Millets	06-10 Kg ha^{-1}	55.1	84.2	68.2	64.4
	10-15 Kg ha^{-1}	44.9	15.8	31.8	36.6
Seed purchasing source					
Wheat	Own stock	49.0	68.4	63.6	56.7
	Fellow grower	04.1	-	-	02.2
	Local market	46.9	26.3	27.3	37.8
	Govt. farm	-	-	-	-
Gram	Own stock	59.2	73.7	77.3	66.7
	Fellow grower	02.0	-	-	01.1
	Local market	38.8	26.3	22.7	32.2
	Govt. farm	-	-	-	-
Mustard	Own stock	85.7	78.9	81.8	83.3
	Fellow grower	02.0	-	-	01.1
	Local market	12.2	21.1	18.2	15.6
	Govt. farm	-	-	-	-
Melon	-	-	-	-	-
Guar	Own stock	40.8	15.8	22.7	31.1
	Fellow grower	-	-	-	-
	Local market	02.0	-	04.5	02.2
	Govt. farm	-	-	-	-
Sorghum & Millets	Own stock	59.2	73.7	72.7	65.6
	Fellow grower	02.0	-	-	01.1
	Local market	38.8	26.3	27.3	33.3
	Govt. farm	-	-	-	-

Table 13. Response of the households [%] regarding sowing time, crop variety in cultivation and labor distribution for Agricultural operation in Draban Zam, D.I.Khan

Species	Sowing time	Lower	Middle	Upper	Total
	Sep-Oct	51.0	05.3	18.2	31.2
Wheat	Oct-Nov	36.7	94.7	81.8	68.8
	Nov-Dec	02.0	-	-	01.1
	Aug-Sep	04.1	42.1	54.5	24.4
Gram	Sep-Oct	85.6	52.7	45.5	68.8
	Oct-Nov	10.3	05.2	-	06.8
	Aug	16.3	36.8	22.7	22.2
Mustard	Aug-Sep	24.5	15.8	18.2	21.1
	Sep-Oct	59.2	47.4	54.1	53.3
Melon	Feb-Mar	-	-	-	-
Guar	July	93.9	100	100	96.7
Sorghum &	Jun-July	69.4	68.4	77.3	71.1
Millets	July	22.4	15.8	09.1	17.8
	July-Aug	08.2	15.8	13.6	11.1
Varieties of the crops in cultivation					
	Farmi (Improved)	02.0	-	-	01.1
Wheat	Ratti (Local)	53.1	52.6	63.6	55.5
	Mixed	44.9	47.4	36.4	43.4
	Kala (Local)	53.0	84.2	90.9	68.9
Gram	Kala/farmi	18.4	15.8	09.1	15.6
	Kala/Lalri	28.6	-	-	15.6
Mustard	Local	100.0	100.0	100.0	100.0
Melon	Lulachiwal	90.0	88.0	92.0	89.0
	Bukhara	10.0	12.0	08.0	11.0
Guar	Local	100.0	100.0	100.0	100.0
Sorghum & Millets	Local	100.0	100.0	100.0	100.0
Labor engagement as field worker					
Sowing	Male	85.7	100	100	91.2
	Male + Children	14.3	-	-	08.8
	Male	16.3	26.3	13.6	18.7
Weeding	Female	72.5	73.5	86.4	75.8
	Female + Children	10.2	10.2	-	05.5
	Male + Children	-	-	04.5	2.2
Harvesting	Male + Female	77.6	52.6	86.4	73.6
	All Family	22.4	47.4	09.1	24.2
	Male	76.9	94.7	95.5	85.7
Threshing	Male + Children	04.1	05.3	04.5	04.4
	All Family	16.3	-	-	09.9
Cleaning etc.	Female	100.0	100.0	100.0	100.0

Melon is planted mix with sorghum and millets. As melon is short duration crop, its cultivation based on water availability in the fields. Mixing melon with sorghum and millets provides addition forage from a field. Cultivation of sorghum mixed with millets is a general trend of all most all the growers of the region. However, the only solid reason reported was that the area is very thin populated and bird losses to millets are high in the area. To avoid bird losses of millets, the crop is mixed with sorghum to confused birds. A variety of ranges are reported for seed rates used for the different crops in the area.

Majority of growers used lower seed rates than the recommended for all most all crops species (Table 12). It was observed that seed used for cultivation is mainly from the own previously harvested stock not especially separated during threshing or procured for future cultivation or borrowed from the local area fellow growers. Judgment for the quality, purity and viability is mostly found lacking with the remarks that the growers have no idea about it. Sowing is manly done subject to the water availability to the field. Majorities of the growers sow their crop if water is sufficient to bring the field at field capacity states in the area (Table 13).

Better resistance against drought enable the growers to plant local type of all most all crops with maximum household number in all the three streams of the area. The other solid reason could be that the growers' excess is rather easy having local types for planting at the time of sowing.

Local types have been observed with high infestation rates of insect and disease attacks in the area. Screening different varieties of the main crops against insect attack and disease resistance with better performance under drought should be done on top priority. Identification of sorghum/millets with high yield and resistance against smut is required. Similarly, gram selection against blight disease is to be identified for general cultivation in the region.

Male is the dominant field staff reported for sowing, irrigation and harvesting crops in almost all the three streams. Female is reported dominant for weeding, cleaning and grain storage the farm produce.

3.3.5 Weeding and crop protection measures

Wheat and gram is the only crops of the region that are manually weeded twice during the vegetative growth and development. Any other crop protection measures were not reported for the control of weeds, insects, pest and disease if observed/appeared in the region. Wheat rust and smut is common in the area and improved variety needs to be identified for cultivation that is susceptible to diseases than the local one. Wheat grazing is practiced if the crop shows strong vegetative growth. Grazing wheat in vegetative growth controls crop's vegetative development and subsequently increases seed production. Gram blight and pod borer attach is common in all villages of the area. No effective control measures are adopted and even available for control of the disease. From field survey, 50-80% blight attach is reported in the region. A small damage of

cutworms, cater pillars, and aphids are also observed. Grazing is practiced once during the crop vegetative development. In addition to control further disease spreading, grazing allow crop to develop new shoots and branches that add in increasing grain yield at harvest. Smut is reported at a relatively high scale in sorghum. The crop is infested by 50% to 70% with damaged heads. Screening of the maximum available entries against insect and disease attack with better performance under drought for quantity and quality is to be carried out. The specified variety needs to be identified to growers for future cultivation in the region.

The common weeds found in the area with local names are:

walvaree, Jawan and lewoo and are mostly found in wheat crop. Besides that some of the otheer frequently found weeds are chamber, tarar, doma etc.

3.3.6 Yield estimation and utilization

The unmanaged seedbed preparation in addition to using the substandard seed quality i.e. seed viability and purity as well as the unpredictable drought in area are the sole causes of poor plant stand and hence reflected greater variability in production of different fields within region as well as among different villages of the area. Households' response regarding yield of major rabi and kharif crops with expected average dry matter production is provided in Table 14-17.

Table 14. Growers' responses regarding wheat yield and dry matter production [kg ha^{-1}] in Draban Zam, D.I.Khan

Yield range (kg ha^{-1})	Households responses [%]							
	Lower		Middle		Upper		Total	
	Seed	DM	Seed	DM	Seed	DM	Seed	DM
<1000	08.2	10.2	57.9	73.7	50.0	54.5	28.9	34.4
1000-1200	36.7	34.7	31.6	15.8	27.3	31.8	33.3	30.0
1200-1400	46.9	46.9	10.5	10.5	22.7	13.6	33.3	31.1
1400-1600	08.2	08.2	-	-	-	-	04.4	04.4

Wheat grain yield is reported in the range of 1000 to1600kg ha^{-1} in the area. Approximately 29% HH are getting wheat seed yield less than 1000kg ha^{-1}. Similarly, 33% HH are reported in the range of 1000-1200kg ha^{-1}, with further 33% in the range of 1200-1400kg ha^{-1}. A very small fraction of 4% HH of area reported for maximum of 1400-1600 kg ha^{-1} wheat production. HH classification at each location basis showed that highest growers' population (47% HH) are getting yield in the range of 1200-1400kg ha^{-1}, followed by 37% HH with 1000-1200kg ha^{-1}. The highest seed yield from 1400 to 1600kg

ha^{-1} is reported for 8% HH in lower stream villages. Nevertheless, in middle stream 58% HH responded for having less than 1000kg seed production ha^{-1}. Thereafter, increasing yield considerably decrease percent HH in the area. In upper stream villages, about half of the HH received less than 1000kg ha^{-1} grain of wheat and the rest one fourths 1000-1200 and 1200-1400 kg ha^{-1} respectively. Seed production on average is reflected greater in lower than middle and upper streams. Wheat dry matter is the main fodder source of the entire region and reported with equal share of seed yield. Response of growers regarding dry matter production almost mimicked seed yield in area as well as in the three locations of the area. It was further observed that 91% HH of the area consumed wheat for self-utilization, which estimated 94% HH in lower, 95% HH in middle and 82% HH in the upper streams of the area. The rest of growers utilized wheat both for selling and for their own consumption. Wheat straw is consumed by 100% HH as a source of fodder by themselves. The lowest yield of the area is mainly due to poor plant stand and could be improved through demonstrating production technology at the farm to the growers of the area. Besides identification for a good variety of shorter height, seed treatment and proper storage would be surely helps in increasing unit production in the area.

Melon is an indeterminate crop and always planted on chance if water is made available in the season. Lack of farmer's education, un-frequent cultivation of the crop and always mixed planting with out any seed ratio along with sorghum and millets not enable growers of the area to provide an estimates for yield and production. Dry matter of the melon is reported mainly for fuel utilization in the area. Guar being fodder cops is not frequently planted in the entire region. However, its cultivation is reported at least priority and planted when there is no other option/alternative. Guar dry matter production is reported from 1000 to 1500kg ha^{-1} and is mostly consumed as fodder by 5.5% HH in the area, which is approximately 8.1% HH in lower and 4.5% HH in upper streams of the area. Mulch application to melon – particularly of mustard biomass that is mainly remained surplus in the area – could be one of the best options to spread on fields when the melon seedling germinates. Besides extending water supply duration through effective utilization of water, it will control evaporation losses of the field and helps in improving quality and quantity of melon.

Table 15. Growers' responses regarding gram yield and dry matter production [kg ha^{-1}] in Draban Zam, D.I.Khan

Yield range (kg ha^{-1})	Households responses [%]							
	Lower		Middle		Upper		Total	
	Seed	DM	Seed	DM	Seed	DM	Seed	DM
300	14.3	22.4	26.3	52.6	54.5	54.5	26.6	36.7
400	53.1	49.0	52.6	31.6	18.2	27.3	44.4	40.0
500	-	28.6	05.3	15.8	-	18.2	01.1	23.3
600	32.7	-	15.8	-	27.3	-	27.8	-

Gram seed yield is reported from minimum 300 to maximum 600kg ha^{-1} (Table 15) in the entire region. About 44% HH were reported for 400kg ha^{-1} gram seed production in the area. Only 27% HH replied having 300kg ha^{-1} seed yield of gram and 28% HH with maximum of 600kg ha^{-1} seed yield. A small response of about 1% HH is receiving yield of 500 kg ha^{-1}. On individual location basis, maximum of 53% HH are receiving average seed yield of 400kg ha^{-1} in lower stream and 33% HH about 600kg ha^{-1}. In middle stream, the highest (53% HH) were reported for average yield of 400kg ha^{-1}, followed by 26% HH with 300 kg ha^{-1}. In upper stream villages, the highest 55% HH have the average yield of 300kg ha^{-1}, followed by 27% HH with 400kg ha^{-1}. Gram dry matter has equal importance to provide feed for animals in the area. About 40% HH optioned for having 400kg ha^{-1} dry matter yield, 37% HH about 300kg ha^{-1} and 23% HH about 500kg ha^{-1} in the region. For the consumption of gram seed, it is reported that 28% HH sell the produce of which 37% HH are in lower and 32% in upper streams. 48% HH reported for partly selling and partly self-utilization in the area. On location basis, it comes to 39% HH in lower, 84% HH in middle and 36% HH in upper streams who are partly selling their production. The rest of the HH are reported for self-consumption of the total production of gram. Lowest gram seed production in the area was due to very poor and non-active nodulation, blight disease and borer attack. A suitable variety if identified with the character having relative resistance to blight disease could surely improve the existing production. Borer if controlled at pods formation stage will also adds in minimum 10-15% production in the region. Introduction of inoculums also helps in increasing production.

Table 16. Growers' responses regarding mustard yield and dry matter production [kg ha^{-1}] in Draban Zam, D.I.Khan

Yield range (kg ha^{-1})	Households responses [%]							
	Lower		Middle		Upper		Total	
	Seed	DM	Seed	DM	Seed	DM	Seed	DM
300	75.5	-	100	-	100	-	86.6	-
400	18.4	-	-	-	-	-	10.0	-
500	06.1	91.8	-	100	-	100	03.4	95.6
>600	-	08.2	-	-	-	-	-	04.4

Mustard seed yield is reported from minimum 300 to maximum 600kg ha^{-1} (Table 16). A sum of 86% HH are of the opinion having average yield of 300kg ha^{-1}. 10% HH reported having 400kg ha^{-1} seed of mustard crop and a very few (3% HH) of an average 500kg ha^{-1}. Dry matter of mustard has no significant importance and therefore not properly responded. The major consumption of mustard dry matter in the area is either source of fuel or material used in roofs (temporary shelters). The maximum of 76% HH are getting seed yield of 300kg ha^{-1} in lower stream of the area, 100% HH in the middle and likewise in upper streams with a production of 300kg ha^{-1}. Only 18% HH are reported for 400kg ha^{-1}. The 6% HH in lower replied to have 500kg ha^{-1} seed of mustard which is the maximum production of the area. 35%, 05% and 27% HH of the lower, middle and upper streams reported for total dispose off the production and about 33%, 84% and 18% HH opted for both selling and self-consumption. The rest of the HH of the area consumed the production at their won. Aphids are the only insects found causing considerable losses in production. Controlling aphids through spray of chemicals or resistance variety will surely increase production.

Table 17. Growers' responses regarding sorghum/millets yield and dry matter production [kg ha^{-1}] in Draban Zam, D.I.Khan

Yield range (kg ha^{-1})	Households responses [%]							
	Lower		Middle		Upper		Total	
	Seed	DM	Seed	DM	Seed	DM	Seed	DM
<600	24.5	-	73.7	-	68.2	-	45.6	-
600-800	40.8	-	21.1	-	27.3	-	33.3	-
800-1000	20.4	-	05.3	-	-	-	12.2	-
1000-1200	14.3	04.1	-	-	-	-	08.9	02.2
3000-5000	-	77.6	-	94.7	-	95.5	-	85.6
>5000	-	18.4	-	05.3	-	04.5	-	12.2

Sorghum and millets is the only successful crop of kharif in the area and planted by almost all growers of the area. Grain yield for sorghum/millets is up to 600kg ha^{-1} by the highest (46%) HH in the area followed by 33%, 12% and 9% HH with an average production of 600-800, 800-1000 and 1000-1200 kg ha^{-1}, respectively. On individual location basis, 25% HH are getting yield of less than 600kg ha^{-1}, 41% from 600 to 800, 20% HH from 800 to 1200 and 14% approximately 1000-1200 kg ha^{-1} in lower stream region. In middle stream, about 74% HH are getting less than 600kg ha^{-1}, 21% HH from 600 to 800kg ha^{-1} and 5% HH above 800kg ha^{-1}. In upper stream of the region 68% HH reported for less than 600kg ha^{-1}seed yield and 27% HH in the range of 600 to 800 kg ha^{-1}. An almost equal trend of self-consumption of the sorghum/millets seed was

collected from the maximum HH in all the three parts of the region. Open-air field dry matter of sorghum and millets was reported in the range of 3000 to 5000kg ha^{-1} by the majority of HH in all the three parts of the region, which is mainly consumed as a source of fodder. Experiments are needed to be carried out for screening different varieties that have resistance to smut disease and borer attack. Further studies of mixing optimum ratio of sorghum and millet seed rates will improve seed production of the unit land. A suitable combination of legume (Guar) with sorghum or millets might improve fodder quality and N status of the soil in the area.

It is interesting to note that maximum HH reported for the maximum seed production of wheat, gram and sorghum/millets crops are in the lower stream villages as compared to that of the middle and upper stream villages. Despite, chances of early water availability with maximum capacity to store it are high in upper and middle streams than the lower stream villages. Several reasons could be possible for the low productivity at upper than the lower stream villages. The maximum water storage at upper stream might delays sowing of crops in season by bringing field at optimum capacity state, which might have an adverse effect on productivity. High water quantity stored at a field may causes leaching of nutrients from soil or helps in erosion of the top fertile layer of the fields. Excessive water storage might accelerate losses of water through establishing relatively higher capillary movements in fields and enhance rate of evaporation from that particular field.

3.3.7 Post harvest information

Tractors in all the three streams of the area mainly used for threshing. About 26% HH do wheat threshing by animals 7% HH by tractor and the rest using both animals and tractors in the area. Tractors are reported for 67%, 57% and 86% HH in lower, middle and upper streams of the area. Data regarding quantity of the average produces sold revealed that a very small %HH have the opportunity. An estimate for 12% HH is calculated in lower and 14% in upper stream to sell wheat grains which was about 10% HH of the region. The average wheat price is reported in the range of rupees 7-9 per kilo. Straw is sold by 4% HH in area of which 4% HH are from lower and 5.5% HH from upper streams. Price for straw is reported Rs. 1.70 to 2.50/kg. Both seed and straw of wheat are mainly sold at farm. Gram seed selling is reported by 54% HH in the area of that were 51%, 58% and 59% HH in lower, middle and upper streams, respectively. A strong variation in gram seed price is reported that ranges from Rs. 6 to 24 per kg. Gram seeds are mainly disposed off at farm in all the three streams. It was further reported that price

4 LIVESTOCK PRODUCTION AND MANAGEMENT

4.1 Livestock number and species distribution

The average number of livestock per HH is summarized in Table 18 and the relative proportion of different species in the large animal population (excluding poultry) is illustrated in Figure 4. Livestock population in the Rod Kohi Area was predominantly composed of cattle (3.62 /HH, 28.39%) and goats (4.52/HH, 35.45%). Few, negligible number of HH in all the three locations kept buffaloes that did not reflect the general trend and indicated individual preference of farmer for this specie. Generally, buffaloes due to their high feed and water requirements, intensive feeding and low tolerance to high summer temperature are not suitable to the Rod Kohi Area and explain their lowest number reported in Table 18.

Table 18. Average number of livestock and poultry per household

Location	Buffalo	Cattle	Sheep	Goats	Equine	Camel	Poultry	Total LSU
Lower	0.10	3.63	2.43	4.69	0.00	1.14	3.53	5.46
Middle	0.04	2.81	1.14	3.95	1.00	1.00	2.52	4.36
Upper	0.25	4.45	1.75	4.70	2.00	1.50	2.40	5.23
Mean	0.13	3.62	1.98	4.52	1.00	1.31	3.04	5.11

LSU= Livestock Units

It is interesting to note that the number of goats exceeded sheep (4.62 Vs 1.98 per HH) and this trend is in line with the change in species composition of small ruminants reported earlier in the province (Zaman, 2001). There are several reasons for goat preference over sheep and a specific question in this regard was asked during the study. Goats as browser are better suited to the current status of grazing lands that predominantly supply bushes and trees as main grazing source. Goats are more profitable as they provide milk, kid crop, and hairs while sheep contribute only lambs and wool. Generally sheep are not kept for milk purposes in the study area. Equine (donkeys and horses) and camel are kept for transportation of on-farm agricultural produce including forages and crop residues etc. Camel was the preferred animal for transportation as shown by their greater number than equines (10.27 Vs 6.74%). Camels are not only better converters of poor herbage of trees and bushes available in the area with minimum requirement for drinking water but are also commonly used for transporting wood over long distance.

Figure 4. Percent distribution of large animal species

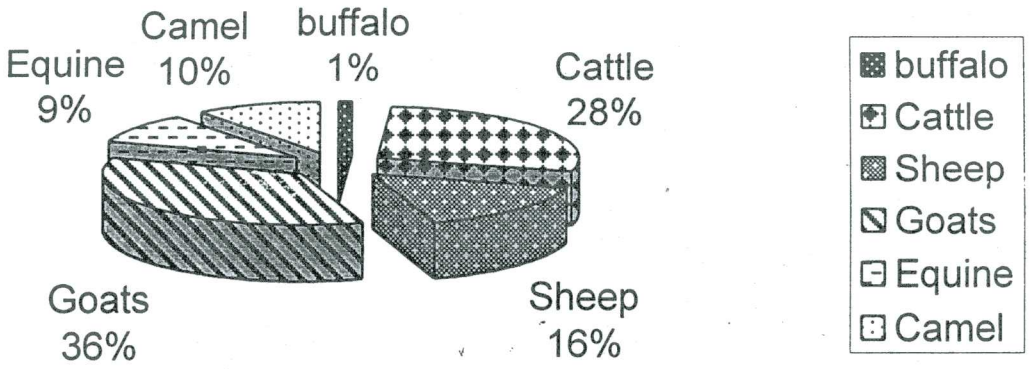
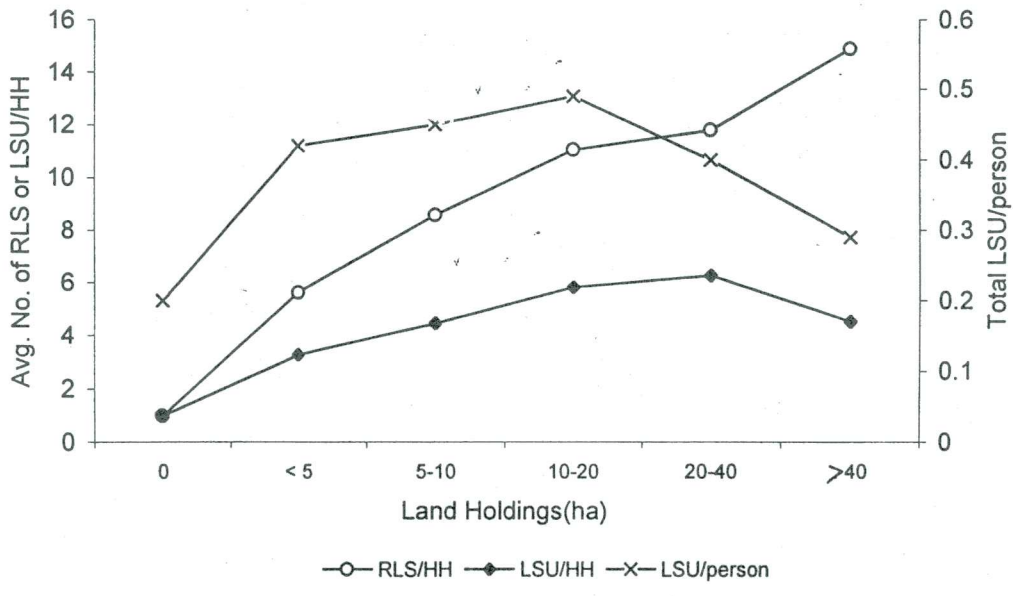


Figure 5 Relationship of livestock and land holdings



Small number of poultry varying from 2 to 4 per HH is kept as scavenger that supply eggs and meat for household consumption. Heavy death toll due to contagious diseases is a major constraint in expanding poultry number.

The numbers of livestock and poultry were converted to livestock units (LSU) for comparison among the three locations. LSU per HH in the lower, middle and upper streams were 5.46, 4.36 and 5.23, respectively, suggesting higher livestock density in the lower and upper than middle streams. However when the LSU were calculated per HH member in the three locations, the number in lower stream exceeded the other two locations. Average LSU per person was 0.49, 0.36 and 0.36 in the lower, middle and upper streams, respectively. The high number lower stream may iead to assume that in lieu of less cropping of land due to shortage of Rod water in lower stream, population dependency on livestock as an alternate source of livelihood may be relatively increased.

4.2 Relationship of livestock population with Land holding and Land ownership

Ruminant livestock for their feed supply mainly depend on agricultural crops. This aspect of livestock and crop integration was examined for Rod Kohi Area through relationship of the two variables. Land holdings were classified in to 6 categories and the percent distribution of different species of ruminant livestock were calculated and reported in Table 19.

Table 19 Average number of ruminant livestock per household classified on land holdings (values in parenthesis are percent of total with in each species)

Land Holdings	Buffalo	Cattle	Sheep	Goats	Total
Landless	00	1.0 (3.6%)	00	00	1.00 (1.0%)
< 5 ha	00	3.75 (13.5%)	1.25 (5.6%)	2.13 (4.2%)	5.63 (4.9%)
5 to 10 ha	0.27 (58.3%)	4.27 (15.4%)	1.19 (17.4%)	4.38(28.0%)	8.58 (24.2%)
10 to 20 ha	0.02 (16.7%)	5.68 (20.4%)	2.19 (38.2%)	4.97 (37.8%)	11.06 (37.2%)
20 to 40 ha	0.01 (8.3%)	6.69 (24.1%)	2.80 (23.6%)	4.13 (15.2%)	11.80 (19.2%)
> 40 ha	0.22 (16.7%)	6.40 (23.0%)	3.00 (15.2%)	6.67 (14.7%)	14.89 (14.5%)

Changes in the livestock farm size with increasing land holdings are illustrated in Figure 5. The number of RLS progressively increased with increasing land holdings suggesting that supply of crop based animal feed may be a driving force for keeping more ruminant livestock. The number of LSU per HH, that include all livestock species including poultry, increased at a slower rate (as evident from slope of the line) with increasing

landholdings up to 40 ha and thereafter declined with further increase in holdings beyond 40 ha. Similarly the relationship of LSU per person with farm size was not linear. LSU per person sharply increased up to 0.5 ha followed by little change up to 40 ha and then abruptly declined with further increase in landholding. Such curvilinear relationship of livestock units and land holdings could be linked to more emphasis of big landholders on agricultural crops and other off farm activities including shift towards keeping small ruminants. Nevertheless the number of HH having more than 20 ha are relatively small (<16%) and the HH having own land averaged 4%. For majority of the households, livestock farming continue to be a back up support activity closely integrated with land cultivation. Livestock farm size classified on the basis of land ownership showed that tenants had higher numbers (6.26 LSU/HH) than land owners or owner- cum- tenants (4.86 and 4.75 LSU/HH, respectively).

4.3 Present livestock performance and breed potential

The livestock breeds throughout the Rod Kohi area were of local type that resulted from continued inbreeding over a long period. No crossbred cattle with imported blood or improved non-indigenous breeds of sheep and goats were observed during visit to different villages at the time of the review study. Cattle breeds were phenotypically close to Dhanni and Lohani. Both the breeds are primarily draught type and the reason for farmers' preference for these breeds is that bulls are still significant source of agriculture power in the Rod Kohi farming system. Overall 51% HH depend on animals, 43% use tractors and 6% HH reported using both tractor and animals for land cultivation.

Dhanni and Lohani bulls kept for draught purpose are also used for breeding. More than 70% farmers reported such dual purpose use of bull. Since artificial Insemination services are not available to local farmers, continuous use of these bulls for breeding explain the predominance of these two cattle breeds in the Rod Kohi area.

Being draught breed, the milk producing potential of both the breed is low, 1.5 to 4.5 liter/day in Dhanni and 2 to 3 liter/day in Lohani cows. The current milk yield of cows in Rod Kohi area is much below the breed potential. Most of the HH (87%) reported daily milk yield varying from a minimum of 0.5 lit to a maximum of 2 liter per cow. Despite low milk yield, lactation period in cows remained longer and lactation periods of 6 to 8 months and 9 to 12 months were reported by 47% and 45% HH, respectively. Only small number of HH (8%) experienced lactation period of 3 to 5 months. However, due to difficulty in conceiving, long dry period of more than two years were frequently

reported. Keeping dry unproductive cows is not only uneconomical but also add to pressure on dwindling feed resources in the area. Malnutrition is a major factor limiting productive and reproductive performance of the local cows as prioritized by 97.4% HH during the survey. In most cases, evidences for severe mineral deficiency in farm animals were observed that affected both health and productivity of the animals. Improvement of nutrition through application of appropriate strategies should be the key intervention in solving livestock problems in the Rod Kohi area.

Both sheep and goats were of local Damani breed specific to D.I.Khan and adjoining areas and farmers were reluctant to keep other breeds. Pervious experience in the area has shown that improved breed of goats brought from other parts of Pakistan, could not thrive in the harsh environment of Rod Kohi with poor feed supply especially of the grazing land.

The local breeds of sheep and goats do not perform well and their performance remained much below the breed potential. Damani sheep is famous as "poor man cow" with a daily milk yield of 0.80 to 1.5 liter as against an average yield of not more than 0.5 liter under Rod Kohi farming system. In most cases the milk production is so low that ewes are never milked and left to nursing lambs. Annual wool yield also averaged 0.7 Kg as against breed potential of 1.15 Kg. Similarly Damani goats although indigenous to the area have current performance below the desired level. Damani goat is a milk and meat breed with a milk yield 1.1 to 1.4 liter/day. Whereas farmers reported milk yield varying from a minimum of 0.25 lit to a maximum of 1.0 liter/day.

There appear to be two reasons for such suboptimum performance of sheep and goats in the area. Firstly poor nutrition and secondly continuous inbreeding over a long period that resulted in genetic erosion of this valuable breed and if not checked will ultimately threat extinction of the breed. Apart from nutrition improvement, implementation of selective breeding should be the key solution. Village based schemes to select superior genotypes with in the indigenous population of Damani sheep and goats in D.I. Khan and purchase of these with providing loans will have more impact on genetic improvement. However, this would require farmers participation for establishing breeding centers for cattle, sheep and goats through community based organizations. These centers will provide breeding services of progeny tested males for breed improvement. Cross breeding of local cattle with exotic dairy breeds and importing improved breeds of sheep and goats from other areas is unrealistic to the farming conditions in Rod Kohi. Instead emphasis should be given to genetic enhancement of

local breeds as suggested above together with general improvement in animal management including nutrition.

Farmers' awareness on selecting breeding bull, ram or buck was very low. Almost 100 % HH had no choice criterion for selecting a breeding male and availed what so ever was available at the time of service. Such indiscriminate breeding further add to deterioration of animal genetic.

4.4 Availability and utilization of feed resources

Major feed resources in Rod Kohi area include grazing, crop residues, fodder and concentrate. As evident from the health, productive and reproductive performance of farm animals, these local feed resources are inadequate to meet the requirements of large population of livestock. Farmers have evolved different systems of livestock feeding integrated with grain crops including seasonal migration to irrigated areas in attempt to fill the feed gap. Several strategies specific to each feed resource are suggested for improving feed supply and utilization.

4.4.1 Fodder

Fodder cultivation is not a common practice of Rod Kohi farmers. Only 0.75 % of the cultivable land is spared for growing fodder (Table 20)

Table 20. Utilization of land for fodder cultivation

Location	Average Cultivatable Land/HH (ha)	Fodder land/HH (ha)	Fodder land %
Lower Stream	325	4.04	1.24
Middle Stream	299	2.90	1.00
Upper Stream	396	00	00
Mean	335	2.31	0.75

Fodder cultivation was reported by farmers in lower and middle streams and those in upper stream did not report. Further categorization of fodder land in Table 21 revealed that landowners were not interested in growing fodder and the activity was limited to tenants and tenant-cum owner.

mostly at a growth stage of 40 to 60 days. This was practiced more in middle (79%HH) and upper (77%HH) than lower stream (31%HH). On the other hand both gram and wheat crops were grazed to a large extent in lower (65%HH) than the middle and upper locations (16% and 14% HH, respectively). Initial cut of barley is also utilized as fodders under cut and carry system. Weeds removed from grain crops also contribute to forage supply for the animals. Quite large number of HH (70%) in all the three locations partly depended on weeds as fodder source.

4.4.2 Crop Residues

Dried and mature plant material left after removing grain part serves as a major feed source for ruminant livestock. These constitute wheat straw, sorghum stover, millet stover, gram straw and rape pods/straw in Rod Kohi and are stall fed to animals round the year. Wheat straw is stored as heap covered with soil in the field called "Pala" while sorghum/millet stovers are stored as stacks in side or out side the house compound. Gram straw is generally stored inside room. Due to sever drought over the last five years, farmers could not adequately grow grain crops and were always short of straw and stovers for their animals. Consequently many farmers (more than 50%HH) purchased these from outside and the price per kg vary from Rs.1.0 during wheat threshing to Rs. 3.0 during off-season. Purchased 1000 kg wheat straw will be hardly sufficient to feed 3 cows and two bulls in an HH for one month and for other with less animals it will last little longer. This would mean the farmer has to continue buying straw for his animals round the year if own source is not adequate and would cost him a lot of money. Some farmers did report that they had to sell sheep and goats to buy straw for large animals especially for bulls. In contrast to wheat straw, most of the farmers has enough sorghum and millet stovers from their own source and few (17%HH) bought from outside. Not all the sorghum/millet stovers are harvested, stored and stall fed to animals. About 50% of the respondents reported they after removing grain part from sorghum /millet, leave the plants standing in the field for animal grazing. The reason being that it saves labour of harvesting, transportation and storage. Since this result in enormous wastage of the plant material as feed, it should be discontinued through awareness creation among the farmers. During stall feeding stovers are either chopped or fed as whole plant. Chopping minimize wastage and was found practiced by 60% HH. Chopping is done with a hand cutter or through manual chopper jointly operated by several neighbors around. Whole, unchopped stovers were fed by 39% HH and the refused stalks that make a significant proportion were either used as fuel or disposed as

Table 21. Land use pattern for fodder cultivation classified on land ownership

Category	Average Cultivatable Land/HH (ha)	Fodder land/HH (ha)	Fodder land %
Tenant	277	2.00	0.70
Land Owner	452	0	0
Land Owner-Cum-Tenant	332	3.91	1.20
Mean	354	1.97	0.63

There are several reasons for sparing less land to fodder. Farmers have priority for growing grain crops on the limited land that could be cropped. Less than 20% of the cultivatable land could be cultivated due to low and erratic rainfall and inadequate Rod water. Therefore, farmers use maximum land for grain crops. Secondly, landowners have low preference for fodder because of the low share than tenant they receive in fodder. Owner: tenant ratio for fodder varies from 1:3 to 1:7 as compared with 3:2 to 2:2 for grains. Thus tenants are forced by landowners to cultivate grain and not fodder. Considerable number of HH (46%) reported buying green fodder while 25% HH were growing own fodder. Fodders are purchased as bundles (2-3 kg weight) from nearby irrigated area or field of standing crop is purchased. The price varies and settled through negotiation. One kanal of sorghum field would cost Rs 1000 to 1200.

Fodder production in the area is century old. Farmers have no choice for quality seeds, do not practice legume intercropping, and never tried new fodder varieties. Traditionally barley is grown as rabi and sorghum/millet as kharif fodders. Many farmers in Rod Kohi are not quite familiar with guar as a suitable legume, commonly grown in other arid regions of Pakistan. Similarly, mung and mash as suitable legumes for intercropping with sorghum/millet were never reported by any farmer. In fact they did not know that legumes increases fodder quality and improve soil fertility.

Drought resistant high yielding fodder varieties need to be tested in Rod Kohi farming system together with legume intercropping. This shall require conducting adaptability trials followed by propagation of suitable varieties on farmer's field as demonstration plots. Making quality seeds available to farmers on reasonable price shall prove instrumental in increasing fodder yield.

Lack of green fodder is a major constraint for increasing livestock production and the problem in Rod Kohi is as sever as found in other neighboring arid regions such as Lachi Tehsil (Kohat). About 30% of the HH did not feed fodder to their animals. Farmers through experience have evolved grazing standing grain crops that reportedly benefit both crop yield and livestock nutrition. Overall 52% HH practiced grazing gram crop

rubbish. Under conditions of severe feed shortage in Rod Kohi, such wastage of feed resource is unjustified and farmers should be made aware of this aspect.

Both straw and stovers are mostly fed to large ruminants. Sheep and goats are generally not stall fed if any with cut tree forage or grass hay. Gram straw is mostly fed to camels and the price is one and half time higher than wheat straw. Although nutritive value of gram straw is much higher than wheat straw, it is never fed to cattle. Farmers believe that it causes impaction (blockage of gastro-intestinal tract) when fed in large quantity to cattle. However, partial feeding of gram straw, mixed with wheat straw is more beneficial than feeding wheat straw alone but not known to farmers.

Rape stalks are highly lignified and less digestible. Animals do not eat and are used as fuel or used in construction of kacha roof. The potential of upgrading rape stalk as animal feed through chemical treatment needs investigation.

4.4.3 Up-grading feeding value of crop residues

From the above analysis, it is clear that crop residues constitute an important feed source for livestock in Rod Kohi farming system. However, crop residues are considered poor quality feed because they are deficient in protein and energy, highly lignified and thus less digestible and serve as gut filler. Performance of animals subsisting on crop residue always suffers. The feeding value of crop residues can be effectively increased through urea treatment. The technique is already proven and used in arid regions of several countries including Pakistan. The feasibility of this technique under Rod Kohi farming system needs to be explored. If found acceptable, should then be multiplied with consistent technical back up. Initially, the straw treatment should be done with limited farmers, one in each of the three locations using limited quantity of straw (100 kg) for the treatment. Feeding of the treated straw to animals, preferably lactating cows should be accompanied with data recording in the form of changes in feed consumption and daily milk yield. A group of farmers in the village should be involved throughout the process of treating straw and monitoring animal responses.

4.4 .4 Grazing

Livestock in Rod Kohi area heavily depend on grazing natural vegetation and 91% HH practiced grazing of their livestock. Communal grazing is not common unlike other areas

of the province. Majority of the HH (81%) practiced self-herding, having own arrangement for grazing mostly involving children (Table 22). Group herding was reported by 10% HH, in which two or more HH graze their animals turn by turn. Mixed species herding was common and reported by 81% HH. All species of farm animals' cattle, sheep, goats, equine and camel are taken in a group for grazing. Individual specie herding was done by only 10% HH.

Grazing take place round the year in the same field in the vicinity of habitation and on average travel 2 to 3 Km using 5 to 7 hours daily. In most cases fallow land is grazed with sparse vegetation. After harvesting crops, stubbles are also grazed by animals. Generally the grazing land give a barren look with no or little grass cover for most of the time of year. Few species of shrubs and trees that had naturally survived the harsh arid conditions of the area serve as the only sources of grazing herbage. Shrubs include Acacia nilotica, Ziziphus nummularia, Capparis aphyla and Prospis sp. Among the avialble tree the moct common species are Acacia modesta, Ziziphus mauritinia, Kagal and Salvadora oleioides. These are mostly browsed by small ruminants, especially goats and camels. While goats benefit from the shrubs and tree due to their browsing habit, sheep generally suffer for want of grasses and this was one of the reasons that farmer preferred keeping goats over sheep. Tree leaves are also lopped and brought home for stall feeding of small ruminants especially young ones and camel as reported by 52%HH. The remaining 48% HH did not stall-feed tree leaves. Despite that the current density of tree is highly scarce, people continue cutting trees for wood without replacing with new plantation and there is no control over this. Intervention of the Forest Department in the area was not visible. For want of money, farmers are forced to sell tree in their field. A 40 kg load of freshly cut wood is sold for Rs. 22.00 and when dried may fetch double price. Village broker buy the wood, stores in one place and then later sell out in other areas. Farmers are not aware of the environmental consequences and future impact of depleting natural green resources on the aridity of the area. Since poverty is apparently the main driving force behind such practices, creating alternate income generating activities shall be the sustainable solution to improve the livelihood and protect environment. Increasing income from agriculture and livestock through environment friendly strategies should be the future hope in this respect.

At the time of conducting the review study, huge nomadic flocks of sheep and goats belonging to Afghan powindhas were seen passing through the Rod Kohi area. Where they stay in transit and further add to deterioration of the already depleted Rod Kohi

grazing lands. Past efforts of the habitants have failed to prevent or restrict this pressure and need government intervention.

Feeding value of the local grazing land vegetation is unknown that make difficult to assess the feed situation in relation to nutrients requirement of animals and formulate effective program of feed improvement. Representative samples of all the feed resources in all the three streams during different seasons need to be analyzed for important nutrients.

The existing trees should be replaced with high fodder yielding species with the help of Forest Department. Adaptability of exotic species of acacia needs to be explored. Grafting of Ziziphus mauritinia with improved fodder type should be initiated on mass scale through farmers' training on grafting technique. Similarly new drought resistant fodder bushes such as Atriplex species appear relevant to the area and could be planted on field boundaries or other suitable places.

Shortage of drinking water for grazing animals is a great problem. Animals travel long distance in search of drinking water. Inadequate drinking water causes impaction leading to death of the animals and was commonly reported by farmers. Drinking water ponds at suitable places in grazing areas should be reserved for animals.

4.4.5 Concentrates

Concentrates are expensive part of animal ration and are generally not affordable by poor resource farmers. More than 70% HH could not feed concentrates to their animals simply due to high cost and low milk yield that could not justify input cost. The remaining 30% HH used cereal grains, mustard seed cake, cotton seed cake, wheat bran and dried bread as supplement in varying quantity. Draught bulls and milking cows were the preferred animals for concentrate feeding. Farmers purchased concentrate ingredients from local market at a cost varying from Rs. 6 to 12 per Kg. Small quantity of home saved bread and wheat bran are also used. Due to high price, these feed ingredients are not fed in adequate quantity and their daily allowance never exceed 1 kg per animal with a minimum scale as low as 250 g/cow or bull.

Alternate feed supplement such as Molasses Multinutrient Blocks (MMB) is highly relevant to the feed situation in Rod Kohi. The success of feeding MMB in arid zones of Pakistan such as Balochistan has been already demonstrated. Molasses is used as main ingredients that could be procured from Chishma Sugar Mill, D.I. Khan. The other

ingredients such as urea, lime, salt, Dicalcium phosphate and wheat bran are available in the local market. MMB technology is highly compatible to existing farm conditions. Feeding of MMB do not require special arrangement. The blocks are placed in side the feed trough and allowed to be licked freely by animals. The animal slowly consumes all the critical nutrients in the blocks that stimulate digestion and increase feed utilization. The resultant response is increase in milk production, improved health and fertility in the animal. The cost of block weighing 3 kg if prepared by farmers is estimated Rs. 15.00 and is sufficient for a cow for about 10 days. As the livestock in Rod Kohi area suffer from mineral deficiencies, MMB will be highly useful in correcting this problem.

It is suggested that local farmers should be demonstrated preparation of MMB on their farms. Initially three farmers, one in each location, should be selected for the demonstration. A group of farmers in each case should be included in the process of demonstration. The blocks after two days when it get hard, should be offered to milking cows and changes in daily milk production be recorded. In case farmers' response is positive, more farmers may be given training on preparation of MMB. It is worth mentioning that preparation of MMB can be used as on-farm income generating activity by local farmers. However they would require project loan to buy ingredients and return the amount after sale of the blocks.

4.5 Migration of Livestock Farmers

Due to feed shrtage in Rod Kohi, livestock farmers along with their animals migrate to irrigated area of D.I.Khan such as CBRC area where they do agricultural related activities and keep their livestock fed adequately. Overall 85% HH reported practicing such migration. Generally migration is done twice a year. They mostly start leaving during the end of April or early May and return back after 2 months stay before the rainy season. Second time migration start during October/November and return before the next expected rainy season in March.

Majority of the migratory HH (74%) takes both small and large ruminant livestock with them. Few HH (6.6%) preferred taking cows only while 3.3% HH were accompanied with small ruminants (sheep and goats) only. The period of stay vary from one month to 4 months and most of the HH (45%) stayed 2 months or 3 months (21%HH). Migration gets more frequent if there are no rains.

Several problems are faced by farmers during migration with lack of residential accommodation and social insecurity as priority problems. Some of the farmers use the influence of their landowners (Khans) to make their migratory stay socially secure and facilitated.

4.6 Prevalent Diseases

The incidence of infectious diseases in cattle, sheep, goats and poultry is considerably high causes death toll and great economic losses to the farmers. There are three major infectious diseases of cattle, Foot and Mouth Disease (FMD), Haemorrhagic Septicaemia (HS) and Black Quarter (BQ) that attack the animals in the form of outbreaks during winter and summer after rainy seasons. HS and BQ cause 100% mortality. Veterinary treatment is very expensive costing more than Rs. 500.00 per time and the local treatment is not effective to save the animals. FMD do not cause death of the animals but the animals suffer for long time with severe drop in their performance. Local treatment of applying inexpensive antiseptics is effective in healing the lesions of the disease. But the animal's working capacity in case of bulls and milk yield in cows remain suppressed and the farmers have ultimately to dispose the animal. These diseases can be successfully prevented through vaccination twice a year that would cost Rs. 5.00 per animal, but the farmers have no knowledge of preventive measures and never told about this.

Small ruminants (sheep and goats) are frequently attacked by Enterotoxaemia (ETT), Pleuro-pneumonia (PP) and FMD. These disease being infectious in nature are readily transmitted among the animals and occur in both winter and summer. Death toll from the former two diseases peak to 70%. No veterinary treatment is used and local treatment is also not effective in most cases. Vaccination is never done rather not known to prevent the attack of these diseases in sheep and goats.

Heavy uncontrolled losses occur in poultry due to Newcastle Disease (NCD) that may occur at any time of the year with more attacks during winter. The affected birds never survive. Fowl Pox, coryza and coccidiosis are other diseases that frequently attack birds causing mortality varying from 30 to 50%. Treatment if given is all based on local herbal medicines. Some farmers that have accessibility to veterinary hospital/dispensaries did vaccinate their birds against NCD on payment but it did not prove effective in preventing the disease. This could be due to lack of precautions during storage and vaccination that require cold conditions and proper dilution for effective immunity.

Other systemic diseases that are not infectious in nature and therefore do not transfer from one animal to other but are of great economic importance. Among these of particular significance are warble fly infection, gastro-intestinal worms, ticks, haemoglobinurea and paralysis syndrome. Warble fly infection is very common and the infected cattle, sheep and goats develop holes in skin causing great damages. The sale value of the warble fly infected animals is reduced to half of the original price, no matter if it is sold to a farmer or butcher. The farmers do not know that the causal agent is a fly that attack animals during summer, lay eggs that develop to larvae and penetrate skin and can be effectively controlled and prevented by spraying a suitable insecticide at the right time. The farmers have their own suppositious explanations as to the cause of this problem and accordingly treat the animals, that are not effective. Other skin problems include eczema and ticks that are treated with local insecticides and drugs. However, if farmers are made aware of the causal factor of warble fly infection, they could adapt similar approach for controlling the problem.

Haemoglobinurea and paralysis syndrome in milking cattle and sometime in bulls and small ruminants were reported by farmers. These are caused by mineral deficiencies , especially phosphorus. Pica (eating abnormal non dietary things), a sign of mineral deficiency was frequently reported by farmers in all farm animals. Farmers through experience have identified suitable treatment of the malady by feeding ash of camel head for seven days. Although bones are rich source of calcium and phosphorus, required for treating the deficiency, but restriction to this specific source make the treatment difficult. Alternately, dicalcium phosphate powder is easily available in local market or ash of any dead animal bones can be used to correct the mineral deficiency. However, this require farmer education.

Other problems such as impaction (blockage of gastrointestinal tract) due to inadequate drinking water when animals consume large quantity of dry roughages, diarrhea, fever and rheumatism that are caused by faulty management also frequently occur in farm animals and treated using local approaches.

In summary, local farmers have no proper knowledge of livestock diseases. They have developed their own perceptions of treatment that are mostly myth oriented and are not always effective rather add to animal suffering.