AGRICULTURAL POTENTIAL OF THE SOILS OF SHARKUL WATERSHED AREA, DISTRICT MANSEHRA

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Abstract

Semi- detailed soil survey of the Sharkul Watershed area was carried out during the period from July 26th to August, 14th , 2002. European Union funded the operational costs and Pakistan Forest Institute executed the task with the technical assistance of soil survey of Pakistan. On the basis of their agricultural development potential, nine land capability classes were recognized in the area. It has been estimated that in the arable part of the area about 349 hectares (20.6 %) consist of class II (good) dry-farmed land. About 469 hectares (27.6 %) of the land consist of class III land, having moderate general potential in which about 29 hectares (1.7 %) are under irrigated farming and the remaining about 440 hectares (25.9 %) are used mainly for dry farming. About 436 hectares (25.7 %) of the land is consisting of class IV (poor) dry farmed cum forest/range land. In the non arable remaining part of the study area, about 144 hectares (8.5 %) comprises as class V (good) forest cum poor dry farmed/grazing land and about 99 hectares (5.8 %) falls under class VI (moderate) forest cum poor dry farmed / grazing land, while about 189 hectares (11.2 %) of the land have moderate general potential far range land combined with low potential for forestry/rainfed farming, while about 14 ha (0.6 %) area is under built up.

Introduction

The Sharkul Watershed area extends over about 1700 hectares. It is an umbrella like small valley called Konash valley and is situated at the northerly edge of district Mansehra towards Battagram. It lies between 34° 06' 38" N to 34° 09' 10" N latitude and 73° 36' E to 73° 39' E longitude. The famous silk route leading to Gilgit and China is passing through its heart. The main objective of the study is to generate and exchange information of soils, water and forest resources and to identify options to enhance resources management that would be technically feasible, economically viable and socially acceptable. The area has a complex history of organic disturbances with many erosional and depositional cycles, which has transformed it into different types of geo forms and landscapes. Its central part consists of loess plain, eroded at places and

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surrounded by mountains which have converted it into a beautiful cup-shaped valley. Its elevation ranges from about 2110 meters in the north to 1677 meters in the south. Major parts of the area consist of irregular oriented mountain ridges, which are intervened by vales occurring at short distances. The higher ridges are dominantly aligned in the north and the southwest direction, while the lower one generally has an east-west direction. As a whole the project area forms part of Tarbela Watershed (Nizami, 1976). The mountainous ridges are composed of mainly fine grained rocks i.e. micaceous and siliceous schists in their north, west and southern part and coarse grained rocks i.e. granites, gneises and schists in east and south-eastern parts.

The area represents three major landforms (i) mountainous ridges (occurring in the north, west and southern parts) (ii) dissected piedmont plains (occurring at the foot of the mountains in the middle and south eastern parts) and (iii) loess plain (occurring in the central lower parts surrounded by high mountains). (Ali et al., 2002)

The study area has a humid, temperate climate with an average annual precipitation of more than 1100 mm with warm summer and cold winter (Gul,M 2000). The local climatic conditions however, change with elevation as well as with the slope direction. In the higher elevation, the northern and northeastern aspects are cooler with more precipitation than lower elevation and southern and southwestern aspects (Table 1). The land in the plains is mainly used for rainfed farming along with some patchy irrigated farming, while that of the ridge slopes is used differently i.e. for forestry at higher elevations and for rainfed farming or grazing combined with forestry at middle and lower elevations (Ahmad, 1951).

The land capability classification or soil potential assessment is a system in which grading of land is made according to its suitability for common agricultural use on sustained basis including production of common agricultural crops, forestry and range. To classify the land for its capability the geology, climate, hydrology, vegetation and other related characteristics, which affect its use and management are thoroughly considered. In other words this classification is based on the relative degree or severity of limitation of the soils for its agricultural use. The soils having no or minor limitation are placed under the highest class i.e. class I for arable use and V for forestry or grazing, while the other classes have progressively increasing limitation. The first four classes (I to IV) are meant for arable use and the last four ones (V to VIII) for non-arable use i.e. forestry or range/grazing. It is necessary first to indicate whether a soil is classified for irrigated or non-irrigated cultivation. Prefix "ir', 'd', 't' or 'g' is used with the class numeral which represent irrigated cropping, dry farming, timber wood production or grazing respectively. On the basis of the kind of limitations/hazard, the land capability classes I to VIII are further sub divided into *land capability subclasses.* The soils having the same degree and the same kind of limitation for agricultural use are grouped together and placed under the same subclass. The kind of limitation is denoted by affixing their specific small letter symbols with the relevant subclass. In case where more than one limitation is involved, the symbol representing the severest or the most important one is used.

Symbol	Limitation or hazard represented
e	*Erosion* hazard
r	Unfavourable *relief*, causing difficulty in irrigation or management
w	Excessive *wetting* due to impeded drainage or flooding/ pounding problem
s	Unfavourable *soil* characteristics; being too gravelly/stony, sandy, clayey, relatively shallow/inadequate rooting depth etc
a	*Salinity* and/or *sodicity* problem
c	*Climatic* limitation; too low/high temperatures or too low/erratic rainfall; the latter is used only for land that is not irrigated.

(Brinkman,1969).

Materials and methods

The data required for assessment of the potential of the soils in the area were collected during the course of semi-detailed soil survey. During the field studies, the aerial photos and top sheet (1:50,000 scale) were jointly used to select transact across the area and representative sites with respect to landform, slope, land use/ vegetation for observation, keeping in view the accessibility factor. The soils and related feature i.e. land forms, relief, slope/topography, presence of rocks/stones, erosion, drainage, land use/vegetation were studied, noted on the proforma and marked on the base map (Fraser 1958). Soil layers (soil profile) characteristics were studied by auguring to a depth of about 150 cm or to the bedrock if it occurred within that depth. However, some deep soils cut studies of the profile were made for their full exposition from top to bottom. One hundred and sixty four field observations were made according to complexity of different landforms and frequency of soil variations encountered.

The soil profile characteristics studied included:

- Kind and thickness of different layers/horizons

- Study of each soil horizon for: -
  - matrix and mottles colour.
  - texture- proportion of sand, silt and clay (see Annexure-2)
  - structure- arrangement of soil particles
  - consistence
  - type, volume and size of rock fragments
  - number of pores per square centimeter, size and shape of pores
  - lime content.
  - root distribution and size
  - boundaries of joining horizons and its shape
- Depth of each horizon
- Drainage conditions

On the basis of similarity in certain above mentioned diagnostic characteristics, observed with field and verified from laboratory analytical data, the soils were classified into six taxonomic units, called as “Soil Series”, each of which was recognized with a specific name. Six pits, one in each Soil Series were excavated to a depth of 150 cm or to the bedrock if encountered at shallower depths, which were studied for each horizon and characteristics in detail, described and recorded in a field data form. Hydraulic conductivity of each Soil Series was determined at the pit site in triplicate using inverse auger hole method (Mutraja, 1996).

Twenty-five soil samples collected from the pits of six soil series were analyzed in laboratory for the requisite determinations (Table 3). After getting these results, soils series were regrouped/ reviewed on the basis of soil parent material, soil horizon characteristics and laboratory determinations, etc. Careful photo interpretation of the area was done with the help of stereoscope and observation points marked on the base map and their recorded information were transferred to it to refine the soil mapping units. Informations of observation points were extrapolated to the un-surveyed areas, similar in respect of parent material (Anon.,1976), slope, vegetation cover, land use, etc. Consequently, total ten soil mapping units were compositioned and delineated on the base map to obtain the Physiography and Soils map (Zink,1989), “Present Soil Erosion Status” and “Present Land Use” maps. The informations collected for these maps during the field operation were used to update the unit boundary lines of these maps. All these three maps were re-interpreted by their superimposition to produce ***“Land Capability”*** map. In all, nine land capability mapping units were recognized. Each unit is named in terms of its general agricultural potential and represented by specific map symbol, which are delineated on the accompanying land capability map.

This map was digitized and reproduced in colour paper print by computer using Geographical Information System (GIS) software.

Results and Discussion

In order to assess the Agricultural potential of the soil accurately, information about soils, topography, climate and present land use are prerequisites. The information regarding the soils of the area collected during the field observations revealed that the soils varied in characteristics mainly due to differences in physiography, parent material and land use types. The soils of the re-deposited loess plain having generally level to gently sloping (0.5-5.0 %) physiographic position occur in the central part of the survey area. They are characteristically very deep (>150 cm), well-drained (Anon., 1990) and dominantly silty clay loams to silty clays in texture (Table 2). The soils lying comparatively in depression parts have distinct mottles and darker colour, while those on the higher parts within this unit have brighter colour. The organic matter content in general is high (2.8 %). These soils possess weak to moderate structure. It has a moderate potential under dry farming. The soils on mountain slopes are formed mainly from residual and colluvial gravelly/ cherty materials. The amount of organic matter and thickness of the soil is generally greater on cooler or wetter aspects and varies from low (1.8 %) (where they are shallow and cultivated) to high (2.8 %) (where soil is deep and under the forest cover). These soils occur on moderately sloping to very steep surfaces (5-60 %) and are partly modified by terracing. They vary in depth from very shallow to deep (<25-150 cm) and are well to excessively drained with massive/ weak to moderate structure. A very minor part close to the water channels or on the foot slopes are developed in mixed alluvium, which is moderately deep to deep (50-150 cm), moderately well drained and cherty very fine sandy loams in texture. The soils of the piedmont plains are formed mainly from the piedmont alluvium derived from the adjacent mountains, mainly occupies gently sloping to sloping position (2-10 %), except those soils where they have been transformed into terraces for cultivation. They are generally moderately deep to deep (50-150 cm), well drained, dark yellowish brown to dark brown (Munsell,1951), gravelly and chennery loams to silty clay loams in textures, moderate to high organic matter content (2.8-4.1 %), weak to moderate structure and have an almost neutral reaction.

Interpretation of the relevant remote sensing data (air photos) followed by field observation and assessment of other related land characteristics like soils, topography, climate, vegetation, land use, etc. resulted into nine land capability units (Fig. 1), which are described as follow. (Ali et al., 2002)

Land capability mapping unit 1: land with a high general potential for dry farming (dIIc)

The land under this unit represents nearly level to gently sloping (0.5-5 %) parts of re-worked loess plain. Soils are deep to very deep (150+ cm), well drained , dark yellowish brown to dark brown, silty clay loam to silty clay (Table 2) with high organic matter content (2.8 %). It has minor limitations of being clayey soils, slow permeability, and slight water erosion. The unit has high potential for rainfed farming of both summer and winter crops. Its present agricultural production is however, below its potential due to uncertain weather condition, and out dated traditional management. With modern management, use of fertilizer and improved crop varieties, crop yield can be increased.

Land capability mapping unit 2: land with a moderate general potential for irrigated farming (irIIIe)

This unit represents nearly level to gently sloping (0.5-5 %) parts occurring in the low laying parts of mountain slopes and in the piedmont plains along water channels on terracets. Soils are moderately deep to deep (50-150 cm), well drained to excessively drained, dark brown to greyish dark brown, cherty very fine sandy loams to gravely loams with moderate to high organic matter content (1.8-4.1 %). With modern management, including bench terracing, establishment and maintenance of structure for safe distribution of irrigation water and with proper choice of crop cover system such as to grow suitable and economical crops, legumes, proper crop rotation and agro-forestry (Anon., 1993), this land could produce high yields. Development and maintenance costs, however, would be high and will restrict the net productivity of the land.

Land capability mapping unit 3: land with a moderate general potential for rainfed farming combined with poor potential for forest/range (dIIIe, gVIe, tVIIe)

This unit refers to the sloping sides of the mountain ridges that have been terraced for cultivation and consists of mainly moderately deep to deep (50-150 cm) but partly shallow (<50 cm), moderately well drained, brown to dark brown, cherty very fine sandy loam soils with high organic matter content (4.1 %) in their top soils. They are traditionally used for rainfed cultivation of both summer and winter crops. At present, the crop yields are low to moderate due to moderate degree of erosion by water, low capacity to hold moisture due to somewhat sandy soil texture. Main part of this land has a moderate potential (dIIIe) for rainfed cultivation while a significant part of it has a low potential for forestry and range land (tVIIe). With modern management, including improvement of terraces by leveling and raising of terrace embankments, provision of grass water ways and proper water disposal structure to control excessive run-off and a proper crop cover during rainy season to check water erosion, selection of draught resistant crops, this land can give moderate to high crop yields. The small patches having poor to moderate potential for forestry and range land could not be separated due to small scale of mapping.

Land capability mapping unit 4: land with a moderate general potential for rainfed farming (dIIIe)

This unit occurs on sloping faces in the dissected piedmont plains. The side slopes are mostly terraced to preserve erosion and mass movement. The soils are mainly moderately deep (50-100 cm) but partly shallow (<50 cm) at some parts. They are gravelly/cherty coarse loamy to medium loamy in texture and traditionally used for rainfed cultivation of both summer and winter crops. The small patches along the water streams are used for irrigated cropping by diverting the stream flow to the terracets/fields. The land is faced with moderate to severe degree of limitations including water erosion, gravelly/sandy nature of soils, relief and too low winter temperature. This land has moderate to low potential for summer and winter crops. With good management including improvement of terraces by leveling and raising of terrace embankments, by improvement of water ways structure to control excessive run off, use of suitable fertilizer and by selection of drought resistant crops, this land can give moderate to high crop yields.

Land capability mapping unit 5: land with a moderate general potential for rainfed farming (dIIIs)

The land under this unit represents mostly gently sloping to sloping (2-10 %) and partly nearly level to level parts, (0.2-1.0 %) in the piedmont plain. Soils are mainly moderately deep to deep/very deep(50- >150 cm), cherty loams to cherty very fine sandy loams and silty clay loams to silty clay containing low to high organic matter content (1.8-4.1 %). They are mainly used for rainfed cultivation of both summer and winter crops. They are also used for vegetables and orchards. Main limitations are uncertain weather condition, slight water erosion due to gentle topography, somewhat rapid permeability and low water holding capacity due to sandy/chennary texture and restricted range of suitable crops. Part of limitation can be removed at relatively high cost, part can not and require special management or selection of suitable crops for attaining high productivity. With modern management including improving of terraces by leveling, proper crop cover during rainy season, use of fertilizers and biocides and selection of drought resistant and improved varieties of crops adapted to the local ecological conditions etc, this land can give moderate to high crop yields.

Land capability mapping unit 6: land with a low general potential for rainfed farming combined with forestry/range (dIVs-t/gVIIe)

The land under this unit represents steep to very steep (30-60 %) mountains surfaces that have mostly shallow to very shallow (<25-50 cm), part moderately deep (50-100 cm) soils with cherty fine sandy loam texture and relatively moderate to high organic matter content (2.32-4.1 %). Main limitations are water erosion, shallow rooting depth and erratic precipitation. The land has a low potential (dVIs) for rainfed cultivation of both summer and winter crops. The unit includes significant part of land having low potential for forestry and range development. At present the land has thin to moderate scattered forest with somewhat depleted vegetation cover consisting of mainly shrubs and grasses with scatter trees. Due to high susceptibility to erosion, provision of proper water disposal structures, grass water- ways and proper crop cover in the rainy season are urgently needed. With improved management, crop yields can be increased significantly by selection of drought resistant crop varieties and to control the cutting of young trees/bushes and controlled grazing.

Land capability mapping unit 7: land with a high potential for forestry combined with low potential for rainfed farming (tVe/dIVs)

This mapping unit covers steep to very steep mountains surfaces (30-60 %) mainly used for forest, except some patchy dry farmed spots or rangeland. The aspect orientation (northern aspect) of the mountain is ecologically suitable for afforestation with mainly coniferous trees. The unit consists mainly shallow to very shallow (<25-50 cm), partly moderately deep (50-100 cm), cherty very fine sandy loams soils containing moderate organic matter content (2.32 %). The land could be used for rainfed cultivation but due to its low potential, cost of development and maintenance would be relatively high, restricting the better return. The land is best suited for afforestation with conifers. The main problem exist presently is moderate erosion which can be controlled effectively through plantation. Major part of this land is currently under thick coniferous forests used for timber wood and fuel wood. A significant part is also used for rainfed cultivation combined with grazing of livestock. The land needs to be replanted with suitable trees in naked patches of land where required. The small patches for rainfed forming (dIVs) having poor potential could not be separated due to small map scale.

Land capability mapping unit 8: land with a moderate potential for forestry combined with low potential for range/rainfed farming (tVIe/ gVIIe/dIVs)

This land unit refers to moderate to steep surfaces (30-60 %) of the mountain ridges which are mainly used for forest/range, but some scattered dry farmed cultivation is also practiced where soil depth permits. It consists mainly shallow (25-50 cm) but partly moderately deep (50-100 cm), gravelly/cherty coarse loamy to medium loamy soil having relatively high organic matter content (4.1 %). The land is faced with severe degree of limitations including erosion by water, low capacity to hold water and nutrients due to shallow rooting depth and erratic precipitation. At present the land has a moderately thick forest and somewhat depleted vegetation cover consisting of mainly shrubs and grasses with scattered trees. Major part has probably been ruined of its tree cover by cutting and over grazing. The land needs to be replanted with suitable tree species. With improved management practices including restrictions on felling the young trees/bushes, controlled grazing, re-seedling of bare spots with climatically adapted shrubs/grasses and tree species, erosion control by plugging gully heads and provision of grass water ways, use of farmyard manure, this unit could be developed as moderate to good forest cum range land.

Land capability mapping unit 9: land with a moderate general potential for development as range land combined with low potential for forestry/rainfed farming (gVIe/tVIIe/dIVs)

This unit represents very steep to steep (30- >60 %) parts of the mountain ridges that have shallow to very shallow soils (<25-50 cm) and bare rock surfaces not suitable for cultivation or forestry except those parts which has been conserved from erosion. The land has very severe limitations of soil erosion by water, scanty soil cover, restricted rooting depth, and very low capacity to hold water and nutrients and erratic precipitation. At present the land has a thin cover of forest with depleted vegetation consisting of mainly shrubs and grasses with few scattered trees. Some parts of the land is also used for rainfed cultivation but its potential is poor. It provides moderate grazing to the livestock for a relatively short period. Over cutting and over grazing have been the major factors depleting the vegetation cover. With improved management practices including restriction on feeling trees/bushes, controlled grazing, re-seedling of bare spots with climatically adapted shrub/grasses, control of soil erosion by plugging gully heads and provision of grass water ways and use of small doses of fertilizers etc. the land could be improved to serve as a moderate to high range land (Anwar 1971).

Recommendations

The recommendations given below related to the specific land use, land management, soil and forest degradation control measures needed to increase agricultural production and ensure conservation of the land resources (Morgan, 1996) for their sustained agricultural use on scientific lines. These are based on the general information collected through field investigation, analyses and interpretation of the land resources data, information collected from the farmers of the project area, project technical staff and our past experience in similar areas. These are classified according to the major kinds of land use i.e. arable land (agricultural land/cultivated land) forest land and range land, as follows.

(a) **For arable land:**

i) Leveling of benches and strengthening/raising of field embankments for uniform spreading and effective control of irrigation and high run off water after rain.

ii) Improvement of the irrigation structure by regularizing water supplies through weir controlled channels in the irrigated land.

iii) Improvement/ extension of irrigation system through construction of dams on potentially suitable sites, where feasible.

iv) Practicing tillage across the contour on sloping terraces for proper control of irrigation water and over flow just after rain showers.

v) Use of recommended amounts of fertilizer, biocides, improved quality seed and growth of suitable crops for the area.

vi) Adopt proper crop rotation, which maintain soil fertility, break pest disease, weed cycles and protect soil from erosion.

vii) Provision of proper crop covers system (including that of peanut, potato and legumes) for sloping land during rainy season. This will not only increase the nitrogen quantity, but will also control/decrease the rate of soil erosion by heavy runoff.

viii) Planting of suitable forest/orchard trees and shrubs/bushes along field embankments to protect soil from erosion and generate extra income.

ix) Growing of green manure crops such as berseem before or after harvesting of main crop in order to conserve the fertility and soil moisture.

x) Provision of grass waterways and construction/maintenance of water drop structures on relatively steep arable land to reduce the velocity of runoff. As such soil material is trapped and sediments free water is partly infiltrated into the ground and partly run down at a safe speed.

xi) Protection of streams from erosion/cutting by lining with stones, planting with trees and controlling/diverting the water, where required.

xii) Establishment of fruit processing/packing and vegetable oil industries to encourage growing of orchards and oilseed crops.

(b) **For forest land:**

i) Proper institutional arrangements to protect the existing forest trees from their illegal/ pre-mature cutting of young trees, burning and browsing of young shoots by animals.

ii) Discourage shifting cultivation (clear land for cultivation).

iii) Afforestation of open areas with suitable tree species useable for timber and firewood, use of small doses of nitrogen and phosphatic fertilizers to accelerate the tree growth.

iv) Plugging of gully heads and gully formation by regulating the water runoff through properly designed grass waterways.

(c) For range land:

i) Restrictions on over grazing are grazing large animals as cattle, horses and ponies, which result in significant erosion scarring and soil loss.

ii) Proper institutional arrangements for effective control on grazing, introduction of rotational grazing where practical; discouragement of grazing on hill peaks and steep slopes.

iii) Fencing of gullies, bare rocks and landslides to reduce their further erosion and allow vegetation regeneration.

iv) Plugging of gully heads and control of gully formation by regulating the water run-off through properly designed grass waterways.

v) Reseeding of relatively bare parts with suitable species of shrub, grasses and trees in order to provide forage, protection against erosion, use of small doses of nitrogen and phosphatic fertilizers to accelerate the growth, if feasible.

vi) Establishment of recreational sites for summer resort and tourism development.

Table 1. Climatic data calculated for the period 1999-2001 at Hilkot Watershed.

Month	Precipitation (mm)	Relative Humidity (%)	Temperature (C°)		
			Max.	Min.	Mean
January	89	56	9.0	1.1	5.1
February	59	58	10.9	2.5	6.7
March	140	56	15.5	5.3	10.4
April	56	52	22.5	10.7	16.6
May	62	51	26.4	15.0	20.7
June	132	56	28.6	16.6	22.6
July	184	68	25.4	17.8	21.6
August	137	71	25.3	16.9	21.1
September	144	67	23.4	15.5	19.6
October	18	57	22.4	11.8	17.1

November	62	56	18.5	6.7	12.6
December	28	50	12.6	4.2	8.4
Total	1111	698			
Average	93	58	20.0	10.3	15.2

(Source: Meteorological Station of Hilkot Watershed)

Table 2. General Textural classes of soils

Texture	Range in Particles Size distribution		
	Sand	Silt	Clay
Sand	+85	-15	-10
Loamy Sand	70-90	-30	-15
Sandy Loam	43-85	-50	-20
Fine Sandy Loam	43-85	-50	-20
Very Fine Sandy Loam	43-85	-50	-20
Loam	23-52	28-50	7-27
Silt Loam	20-50	50-80	12-27
Sandy Clay Loam	45-80	0-28	20-35
Clay Loam	20-45	15-53	27-40
Silty Clay Loam	-20	40-73	27-40
Sily Clay	-20	40-60	40-60
Sandy Clay	45-65	0-20	35-55
Clay	-45	-40	+40

Table 3. Analytical data of Nakholai Soil Series

Lab. No.	Hori-zon	Depth (cm)	Soil Particle (%)			Texture	$CaCO_3$ %	Org. mat. %	N %	CEC (meq/ 100g)	pH	Ece x10[3] (dSm^{-1})	Soluble ions (meq/l)						P (ppm)	K (ppm)	O.C %
			Sand	Silt	Clay								CO_3	HCO_3	Cl	SO_4	Ca+Mg	Na			
1	Ap	0-7	50	35	15	Loam	0	4.1	0.66	17.8	5.9	1.20	0	2.0	2.0	8.0	11.0	1.0	15.2	132	2.4
2	Bw1	7-20	48	34	18	Loam	0	2.3	0.58	19.8	6.0	1.20	0	2.0	2.5	6.0	10.0	1.0	12.0	110	1.8
3	Bw2	20-45	47	33	20	Loam	0	1.1	0.36	20.0	6.0	0.92	0	2.0	4.0	3.2	8.0	1.2	10.0	58	0.64
4	Cw1	45-68	61	25	14	Sandy loam	0	1.2	0.24	18.5	6.4	0.45	0	0.7	0.3	3.5	4.0	0.5	9.4	38	0.70
5	Cw2	68-73	86	10	4	Loamy sand	0	0.2	0.24	16.8	6.7	0.26	0	1.0	0.2	1.4	2.2	0.4	6.2	30	0.12

Analytical data of Sharkul Soil Series

Lab. No.	Hori-zon	Depth (cm)	Soil Particle (%)			Texture	$CaCO_3$ %	Org. mat. %	N %	CEC (meq/ 100g)	pH	Ece x10[3] (dSm^{-1})	Soluble ions (meq/l)						P (ppm)	K (ppm)	O.C %
			Sand	Silt	Clay								CO_3	HCO_3	Cl	SO_4	Ca+Mg	Na			
6	Ap	0-10	76	20	4	Loamy Sand	0	2.32	0.55	18.4	5.8	1.0	0	0.8	4.0	5.2	9.5	0.5	20.4	76	1.35
7	Cw1	10-26	68	28	4	Sandy loam	0	1.90	0.42	16.0	6.2	1.02	0	1.0	1.0	8.2	9.0	1.2	16.2	30	1.10
8	Cw2	26-72	65	30	5	Sandy loam	0	0.8	0.20	16.0	6.2	0.3	0	1.2	0.5	1.3	2.8	0.2	9.8	24	0.50
9	Cr	72-100	57	37	6	Sandy loam	0	0.6	0.20	13.0	6.8	0.29	0	1.2	0.5	0.3	2.4	0.5	6.6	26	0.35

Analytical data of Banser Soil Series

Lab. No.	Hori-zon	Depth (cm)	Soil Particle (%)			Texture	Ca CO_3 %	Org. mat. %	N %	CEC (meq/ 100g)	pH	Ece x10^3 (dSm^{-1})	Soluble ions (meq/l)						P (ppm)	K (ppm)	O.C %
			Sand	Silt	Clay								CO_3	HCO_3	Cl	SO_4	Ca+Mg	Na			
10	A	0-6	63	31	6	Sandy loam	0	1.8	0.32	16.5	5.0	0.83	0	2.0	1.4	4.9	6.8	1.5	8.8	15 2	1.05
11	Cw1	6-28	65	30	5	Sandy loam	0	0.4	0.24	13.8	5.9	0.28	0	1.2	0.8	0.8	2.2	0.4	6.8	32	0.23
12	Cw2	28-41	65	30	5	Sandy loam	0	0.22	0.08	13.2	6.3	0.18	0	0.8	0.3	0.7	1.4	0.4	4.2	20	0.13

Analytical data of Dosera Soil Series

Lab. No.	Hori-zon	Depth (cm)	Soil Particle (%)			Texture	Ca CO_3 %	Org. mat. %	N %	CEC (meq/ 100g)	pH	Ece x10^3 (dSm^{-1})	Soluble ions (meq/l)						P (ppm)	K (ppm)	O.C %
			Sand	Silt	Clay								CO_3	HCO_3	Cl	SO_4	Ca+Mg	Na			
13	Ap	0-9	25	64	11	Silt loam	0	2.8	0.58	19.5	5.9	1.6	0	1.2	2.8	12.0	8.1	7.9	16.8	76	1.63
14	Bt1	9-20	24	60	16	Silt loam	0	1.9	0.42	19.0	6.0	1.2	0	1.4	3.1	7.5	3.8	8.2	14.2	40	1.10
15	Bt2	20-32	19	52	29	Silty clay loam	0	0.9	0.24	23.5	6.5	0.72	0	1.8	2.1	3.3	3.0	4.2	14.0	40	0.52
16	Bt3	32-60	18	52	30	Silty clay loam	0	0.4	0.22	23.0	6.8	0.49	0	1.8	2.0	1.1	2.5	2.4	9.2	32	0.23
17	Bt4	60-105	11	62	27	Silty clay loam	0	0.22	0.20	23.0	7.0	0.35	0	2.0	1.0	0.5	2.0	1.5	4.8	30	0.12
18	Bt5	105-150	10	62	28	Silty clay loam	0	0.08	0.08	22.0	6.6	0.30	0	2.0	0.5	0.5	1.5	1.5	4.0	28	0.05

Analytical data of Ahl Soil Series

Lab. No.	Hori-zon	Depth (cm)	Soil Particle (%)			Texture	$CaCO_3$ %	Org. mat. %	N %	CEC (meq/100g)	pH	Ece x10^3 (dSm^{-1})	Soluble ions (meq/l)						P (ppm)	K (ppm)	O.C %
			Sand	Silt	Clay								CO_3	HCO_3	Cl	SO_4	Ca+Mg	Na			
19	Ap	0-9	61	24	15	Sandy loam	0	2.1	0.42	20.8	5.2	1.3	0	1.3	1.3	10.4	8.5	4.5	16.5	64	1.20
20	C	9-40	61	22	17	Sandy loam	0	1.8	0.25	19.5	5.8	0.6	0	1.4	1.5	3.1	4.2	1.8	12.8	34	1.05

Analytical data of Girari Soil Series

Lab. No.	Hori-zon	Depth (cm)	Soil Particle (%)			Texture	$CaCO_3$ %	Org. mat. %	N %	CEC (meq/100g)	pH	Ece x10^3 (dSm^{-1})	Soluble ions (meq/l)						P (ppm)	K (ppm)	O.C %
			Sand	Silt	Clay								CO_3	HCO_3	Cl	SO_4	Ca+Mg	Na			
21	Ap	0-12	40	28	32	Clay loam	0	1.3	.5	16.8	6.6	.45	0	.80	3.0	0.7	4.0	0.5	18.4	56	0.81
22	Bw1	12-25	38	30	32	Clay loam	0	.72	.42	14.0	6.8	.25	0	.76	1.5	0.2	2.3	0.2	16.2	32	0.42
23	Bw2	25-47	36	34	30	Clay loam	0	.55	.20	13.2	6.8	.20	0	.90	0.6	0.5	1.8	0.2	13.0	28	0.32
24	Cw1	47-80	15	50	35	Silty clay loam	0	.49	.14	12.0	7.0	.20	0	1.00	0.4	0.6	1.7	0.3	9.8	20	0.30
25	Cw2	80+	18	50	32	Silty clay loam	0	.39	.08	13.0	7.2	.15	0	1.14	0.07	0.3	1.3	0.2	6.4	24	0.22

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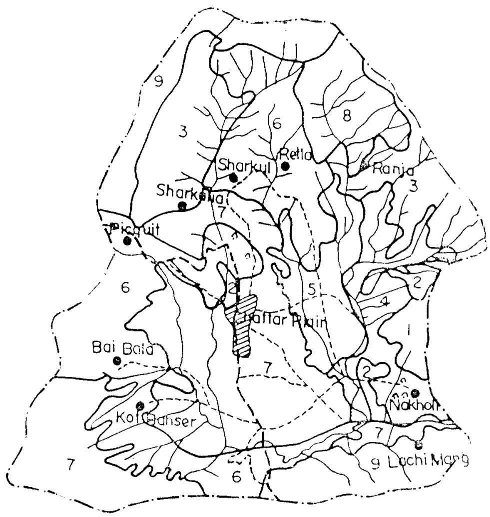
SHARKUL WATERSHED
LAND CAPABILITY

N

SCALE: 1: 50000



MAPPING UNITS

1. Good dry farmed land (dIIe)
2. Moderate Irrigated land (irIIIe)
3. Moderate dry farmed land cum poor forest/range land (dIIIe-gVIe-tVIIe)
4. Moderate dry farmed land (dIIIe)
5. Moderate dry farmed land(dIIIs)
6. Poor dry farmed cum forest/range land (dIVs-t/gVIIe)
7. Good forest cum poor dry farmed land (tVe-dIVs)
8. Moderate forest cum poor grazing/dry farmed land (tVIe-gVIIe-dIVs)
9. Moderated range cum poor forest/dry farmed land (gVIe-tVIIe-dIVs)

Fig. No. 1

CONVENTIONAL SIGNS

- Area boundary
- Mapping unite boundary
- Metalled road
- Karakoram highway
- Drainage ways
- Built -up area
- Village
- Grave yard