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LAND RESOURCE MANAGEMENT FOR FOOD SECURITY IN QUETTA VALLEY, BALOCHISTAN

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ABSTRACT

Land with a high economic potential for irrigation: It's a small part of the land that is irrigated by tube wells. The soils are well suited for intensive cultivation of vegetables and fruits (apples, apricots, peaches, grapes, etc. under irrigation. Land with a moderate to poor economic potential for irrigation/dry farming comprises medium to moderately textured soils, moderately fine textured gravelly soils, and some soils with salinity and sodicity problems. Some parts where water does not completely satisfy crop requirements, or which is not suitable for crop growth are dry farmed. Saline-sodic areas: Mostly occupying the northern and southern parts of the district are deep to very deep, moderately well-drained, gypsiferous, saline-sodic fine-textured soils occurring on the level and nearly level position in the piedmont basins. This soil is uncultivated and provides poor grazing. Agricultural unproductive land: It comprises bad land, gullied land, rough, broken, gravelly, and stony land. These lands are unsuitable for any agricultural development. The physical and socio-economic conditions, including lack of moisture, very rocky and very gravelly nature of soils, irregular relief, isolation, and lack of infrastructure, are the limitations that restrict the use of about two-thirds of the area to the grazing, even if irrigation water is made available. Soil erosion, disturbances of the hydrological cycle, and industrialization/urbanization of good soil are great problems in the area. By proper management, agricultural production can be increased.

***Keywords*:** Land, Resources, Food security, Quetta

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1. INTRODUCTION

Baluchistan's total area is 347,190km^{2,} and different kinds of soil are present at different landforms, each with its own unique set of characteristics, agricultural potential, development possibilities, and management requirements. Recognition of soil as a critical variable in the planning and implementation of land resources development programs is vitally important for agricultural development. Knowledge about the soil conditions and appreciation of the soil differences is, thus, essential for all those charged with the task of agricultural development to ensure its sustainability, both for resource conservation, environmental protection, and food security (Wang et al., 2007; Sharif et al., 2019).

Structurally Balochistan makes up a part of the Iran Anatolian folded zone, consisting of sedimentary strata. The Geosyncline was gradually filled up with a thick mass of sediments, mostly of marine nature, and consequently attained the configuration of a flat, featureless aggradation of the coastal plain (Torbehbar & Liseroudi, 2015). Later on, the Himalayan orogeny began, and the sedimentary strata of the Tethys Sea were compressed as a whole. Under the continued orogenic pressure, folds and faults appeared in the strata throughout the geosyncline, resulting in the land surface becoming corrugated, indented, and doomed. Rows of rugged rocky ridges emerged out of its watery embryos separated by deep and narrow valleys, many of which were flooded by lakes. By the middle Pleistocene, the rocks were deformed nearly to the extent that they are today. The rocks exposed in the area are mainly sedimentary and are rich in fossils belonging to the Jurassic, cretaceous, tertiary, and Pleistocene periods (Burg et al., 2013; Adnan, 2018).

The climate condition of the area is classified as arid subtropical continental highland characterized by low rainfall, low humidity, dry winds, severe winter, and mild summer. The winter season in the area ends in March, after which the summer starts. Temperatures rise rapidly, and the atmosphere pressure diminishes (Khan et al., 2021; Hina & Saleem, 2019). Currently, the conditions have become favorable for the eastern depression of the monsoon. The area receives its precipitation due to the monsoon in summer and western disturbances in winter. The summer precipitation is in the form of rain, which is generally flashy. Winter precipitation is received as snow and rain, the lateral generally as drizzle. The precipitation is higher in winter than in summer. Long dry spells are common (Kumbhar et al., 2019; Ashraf et al., 2021). The farming of dry wheat and Jowar farming is liable to fail

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except during years of favorable rainfall. Quetta, the north-western parts of Balochistan, receives the bulk of its rainfall between December and March peaking in January and February, and in most years, tailing off rapidly as April progresses (Abbas et al., 2018).

The population of the area according to the 1998 census is 759941. The average density of the population is 286.4 persons per square kilometer, but the population is not distributed uniformly over the area. This is the concentration of population in urban areas and areas which are under cultivation. The urban proportion of the area is 74.4. While the proportion ratio in rural areas is 25.6. The male and female population is 412064 and 347877 giving a sex ratio of 118.5. The average household size is 8.5. Most of the population of the district is Pathan except for Quetta City, which contains a heterogeneous population (Lehri et al., 2021: Bandyopadhyay et al., 2020; Arif et al., 2023).

In general view, the area can be divided into different land resource zones to highlight the regional situation regarding soil conditions, moisture availability, land use constraints and specific management needed for agricultural development, agriculturally unproductive land. Therefore, the current study aims to assess the land resources of the study area to provide better opportunities to the community to boost their socio- economic condition. Moreover, study identifies the inherited capacity of a land unit to support a specific land use without deterioration.

2. MATERIALS AND METHODS

2.1. Data Collection

The study area occupies a central position in the mountainous landscape of Balochistan Province. Long and narrow Quetta and Kuchlak valleys intersect the mountains, which are situated between 4,300 to 5200 feet above sea level. The Quetta district is surrounded by Murdar range in the southeast, which is connected, in the northeast with Zarghun range of mountains. Takatu range lies immediately north of Quetta, while to the west and south Chiltan ranges it. The mountains range in elevation from 5000 to 11400 feet. Quetta is the district, divisional and provincial headquarters as well as the main commercial city of Balochistan. In the east of the Quetta district lies the Sibi and Ziarat districts, in the north Pishin district, in the south Mastung district, and in the west Killa Abdullah district and Afghanistan. The total area is 2653km^2. It lies between latitudes 29°-46' to 30°-26' North and longitudes 66°-14' to 67°-16' East (Dawood et al., 2021). Fig. 1 shows map of the study area adopted from Pakistan Bureau of Statistics (Pakistan Bureau of Statistics, 2017).

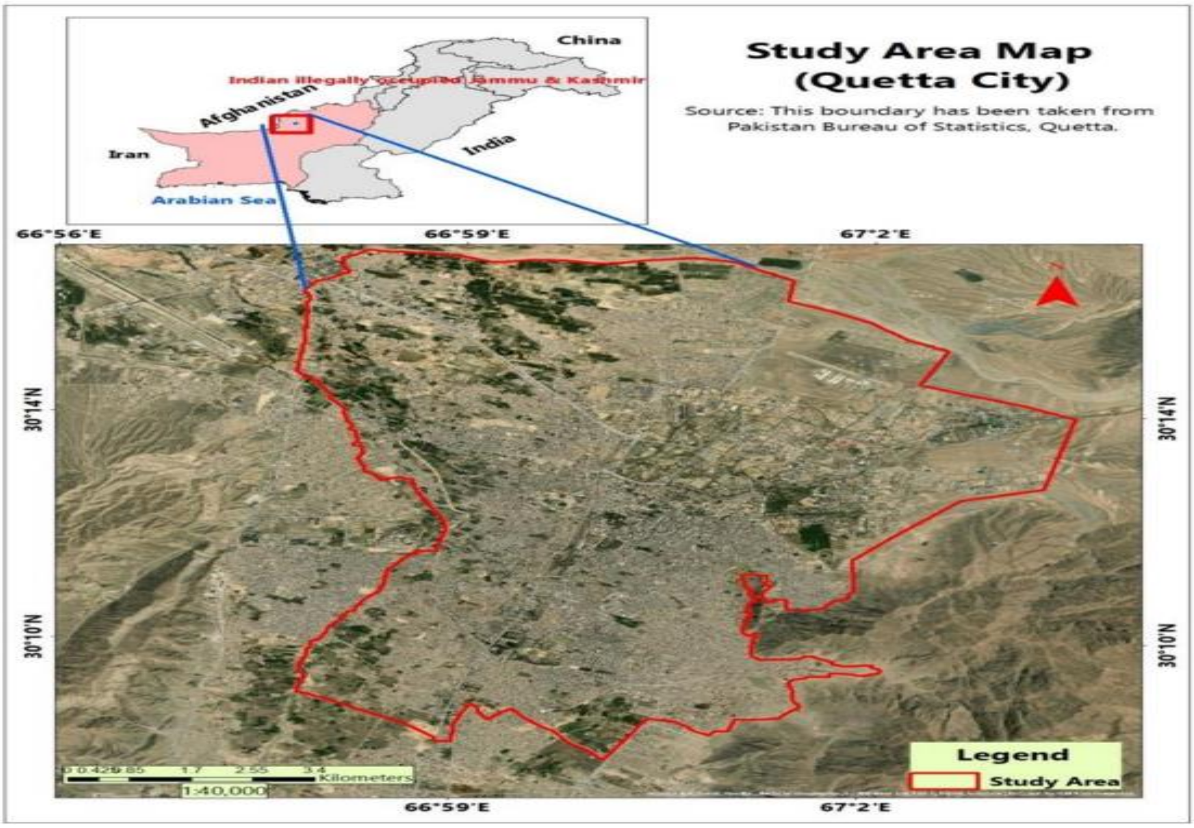

Fig. 1: Map of Quetta showing study location.

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2.2. Soil Sampling

The basic aim of field visits was to collect soil and water samples for proper laboratory testing as well as to gain firsthand knowledge about the field. The Soil sampling was done during Sept-October from Quetta district. About 50 soil samples were collected from the study area. In order to ensure accuracy, triplicate samples were taken from each sampling side. The soil samples have been taken in a random manner. Auger (6 feet length) has been used for collection of soil samples. The soil samples have been taken from 0-6, 6-12- and 12-18-inches depth. About 500g soil sample was taken from each sampling side. The samples were taken in polythene bags. In CIMR Laboratory samples were air dried, grinded and passed through 2a 2mm sieve. The soil was kept in Plastic jars and numbered accordingly. Toposheets and GPS were used for location identification. Fig. 2 shows research methodology prepared by researchers.

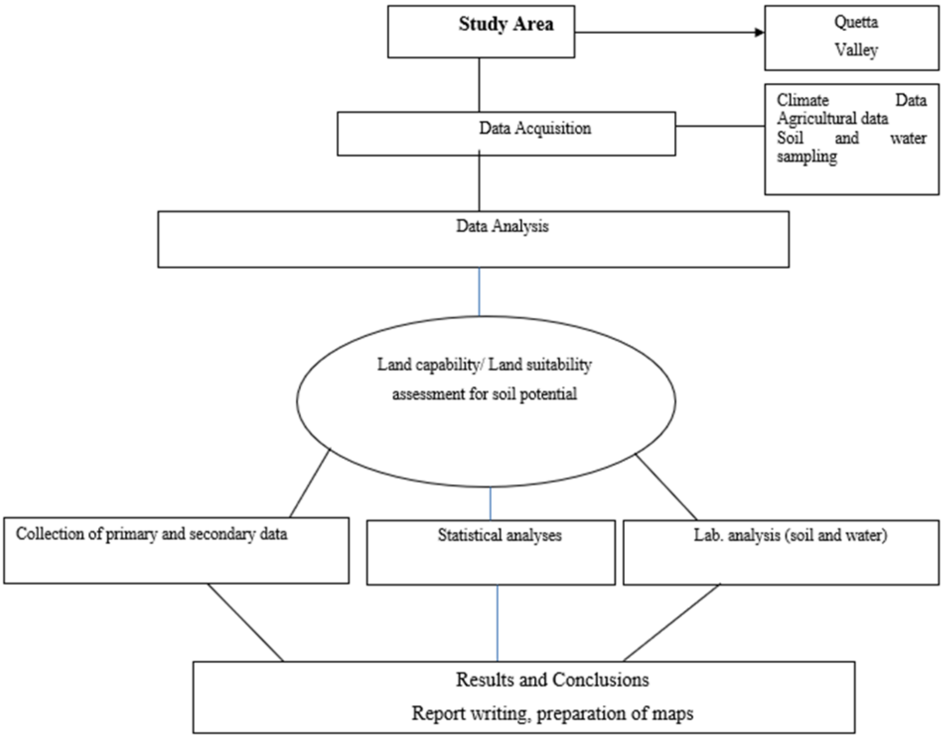

Fig. 2: Flow chart of research methodology.

2.3. Laboratory Analyses

Soil pH was measured of soil saturated paste by using a pH meter. There should be no free water on the surface. Paste should be mixed properly and slip on a spatula. Regarding Electrical conductivity, Soil saturation extract was taken of the saturated paste using suction pump. Electrical conductivity was measured using a Conductivity meter. The calcium carbonate was estimated by titration (acid-base titration). Finally, the texture analysis was carried out through Sieve analyses.

2.4. Data Analysis

Data analysis consisted of various steps. Data was collected from different institutions/organizations by using questionnaires, Interviews of local community, satellite data was classified. The data of soil and water was analyzed in the laboratory and statistical analysis was run. Finally, reports and maps preparations using GIS/RS techniques were prepared.

3. RESULTS AND DISCUSSION

3.1. About 400 Meters North (M.B.12½º) of Furlong stone¾ on Quetta-Chaman Road

pH of this site is in the range of 8.0 to 8.25 while EC from 0.5 to 1.28, Organic Matter 039 to 0.45. The texture is Silty clay. No salinity sodicity problem, while organic matter is deficient. The calcium carbonate is very high in the soil profile. The soil texture is silty clay, hard, compact surface, agricultural activities are very difficult.

3.2. (M.B.295°) of Milestone Reading Pishin 1 Mile on Pishin- Saranan Road

pH of this site is in the range of 8.6 to 8.9 while EC from 35.2 to 41.8, Organic Matter 039 to 0.0.60. The texture is Silty clay. salinity sodicity problem, while organic matter is deficient. The calcium carbonate level is very

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high in the soil profile. The texture is silty clay, hard, compact surface, agricultural activities are very difficult. This side needs reclamation.

3.3. (M.B.180°) of New Radio Station Quetta-Chamman Road

pH of this site is in the range of 8.1 to 8.35 while EC from 0.74 to 150, Organic Matter 0.18 to 0.39. The texture is Silty clay to silty clay loam. No salinity sodicity problem, while organic matter is deficient. Calcium carbonate is very high in the profile. Texture is silty clay, hard compact surface, working very difficult

3.4. About 500 Meters East of the Sariab Agricultural Research Station Across the Railway Line

pH of this site is in the range of 8.0 to 8.3 while EC from 0.45 to 3.25, Organic Matter 0.27 to 0.36. The texture is Silty clay to silty clay loam. No salinity sodicity problem, while organic matter is deficient. Calcium carbonate is very high in the profile. Texture is silty clay, hard compact surface, working very difficult.

3.5. Located on Baleli- Gaza- band Road

pH of this site is in the range of 8.35 to 8.65 while EC from 36.3 to 66.0, Organic Matter 0.12 to 0.60. Texture is Silty clay. salinity sodicity problem, while organic matter is deficient. Calcium carbonate is very high in the profile. Texture is silty clay, hard compact surface, working very difficult. This side needs reclamation.

3.6. Panjpai 52 Miles on Baleli-Gaza Band Road

pH of this site is in the range of 8.00 to 8.95 while EC from 4.80 to 27.50, Organic Matter 0.12 to 0.30. Texture is Silty clay loam. salinity sodicity problem, while organic matter is deficient. Calcium carbonate is very high in the profile. Texture is silty clay, hard compact surface, working very difficult. This side needs reclamation.

3.7. About one Mile north-east of Milestone 39/2 on Quetta-Chamman Road

pH of this site is in the range of 8.20 to 6.00 while EC from 15.0 to 55.0, Organic Matter 0.12 to 0.63. Texture is Silty clay. High salinity sodicity problem, while organic matter is deficient. Calcium carbonate is very high in the profile. Texture is silty clay, hard compact surface, working very difficult. This side needs reclamation.

3.8. Gulistan 6 miles on Gulistan-Gaza Band Road

pH of this site is in the range of 9.75 to 10.00 while EC from 1.40 to 6.5, Organic Matter 0.18. The texture is Silty clay loam. salinity sodicity problem, while organic matter is deficient. Calcium carbonate is very high in the profile. Texture is silty clay, hard compact surface, working very difficult. This side needs reclamation.

3.9. 12 Miles on Quetta-Chaman Road

pH of this site is in the range of 8.60 to 8.90 while EC from 5.60 to 35.2, Organic Matter 0.21 to0.51. Texture is Silty clay. Slight salinity sodicity problem, while organic matter is deficient. Calcium carbonate is very high in the profile. Texture is silty clay, hard compact surface, working very difficult. This side needs reclamation.

3.10. Along Gaza-band Panjpai Road

pH of this site is in the range of 7.80 to 8.15 while EC from 0.9 to 6.0, Organic Matter 0.22 to0.39. The texture is Silty clay loam. Slight salinity problem after 18-inch depth, while organic matter is deficient. Calcium carbonate is very high in the profile. Texture is silty clay, hard compact surface, working very difficult. This side needs reclamation.

3.11. Killi Rahim Gul Situated on Baleli-Gaza band Road

pH of this site is in the range of 8.70 to 8.90 while EC from 42.4 to 91.5, Organic Matter 0.2 to 0.50. The texture is Silty clay. salinity sodicity problem, while organic matter is deficient. Calcium carbonate is very high in the profile. Texture is silty clay, hard compact surface, working very difficult. This side needs reclamation.

3.12. Pishine 1 Mile on Pishine-Band Khushdil Khan Road

pH of this site is in the range of 8.25 to 8.40 while EC from 0.35 to 0.70, Organic Matter .0.10 to 0.24. The texture is Silty loam. No salinity sodicity problem while organic matter is deficient. Calcium carbonate is very high in the profile.

3.13. Killi Raja on Quetta-Samungli Road

pH of this site is in the range of 6.70 to 7.95 while EC from 1.65 to 3.50, Organic Matter .0.30 to 3.57. Surface soil is acidic. This may be due to continuous erosion. The texture is Silty Clay loam. No salinity sodicity problem while organic matter is on the surface is satisfactory. Calcium carbonate is very high in the profile.

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3.14. Kille Rahim Gul Situated on Baleli-Gaza band Road

pH of this site is in the range of 8.35 to 8.80 while EC from 15.0 to 132.0, Organic Matter 0.1 to 0.30. The texture is Silty clay to clay loam loam. salinity sodicity problem, while organic matter is deficient. Calcium carbonate is very high in the profile. Surface, hard compact surface, working very difficult. This side needs reclamation.

3.15. Agriculture Research Station Sariab, Quetta

pH of this site is in the range of 8.15 to 8.30 while EC from 0.6 to 0.85, Organic Matter .0.20 to 0.45. The texture is Silty clay. No salinity sodicity problem while organic matter is deficient. Calcium carbonate is very high in the profile.

3.16. Sariab Railway Station at a high Lying Gravelly Terrace

pH of this site is in the range of 8.0 to 8.15 while EC from 0.3 to 0.65, Organic Matter .0.24 to 0.45. The texture is Silty clay. No salinity sodicity problem while organic matter is deficient. Calcium carbonate is very high in the profile.

3.17. Main Gate of Balochistan Textiles Mills Sariab, Quetta

At this site pH ranges from 7.8 to 8.9, EC is from 0.96 to 34.4, and Organic Matter is from 0.10 to 0.27. The texture is Sandy loam. No salinity sodicity problem up to 18-inch depth afterward, pH and EC increasing. While the organic matter is deficient. Calcium carbonate has a very high profile.

The data in Fig. 3 revealed that calcium carbonate in the study area is very high; more than 87% of the area is under this. While 6% of the area has low calcium carbonate and 7% moderate. Calcium carbonate is a cementing agent that binds soil particles together through physio-chemical mechanisms and presumably creates a stable soil structure. This creates problems, especially with nitrogen and phosphorus fertilizer fixation.

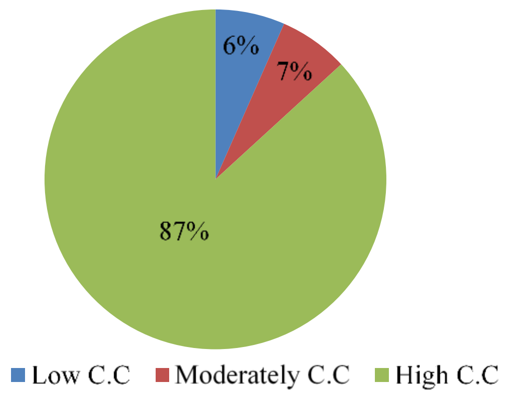

Fig. 3: Graphical representation of calcium carbonate

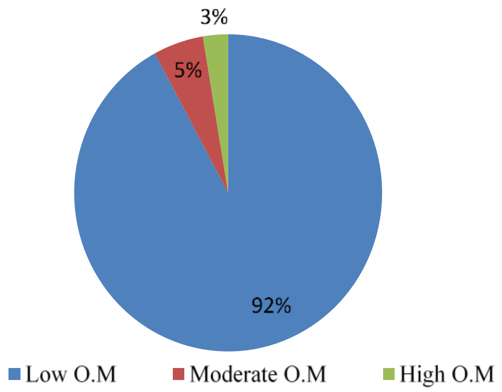

Fig. 4: Organic matter in Quetta

Organic matter in the study area is very low 92% of the area (Fig. 4). 5% moderate and only 3% sufficient. Needs more plant cover in the area. Table 1 revealed the range of organic matter in the soil. It was categorized as low, medium and high. Soil in the study area contains adequate organic matter more than 1.29%. Whereas 0.86-1.29% and less than 0.86% was categorized as moderate and low organic matter in the soil. The data given in Fig. 5 shows that 53% of the area is under salinity, 38% non-saline and the rest with slight salinity. Table 2 shows various ranges of salinity and EC. Among all ranges, more than 9, 4.8-8.9, 2.4-4.45, 1.2-2.4 and less than 1.2 were categorized as very strong, strong, moderate, slight and no salinity respectively.

Table 1: Soil organic matter and range

Sr. No	Soil Organic Matter (OM)	O.M-Range (%)
1	Low	<0.86
2	Marginal	0.86-1.29
3	Adequate	>1.29

Table 2: Degree of salinity and EC range

S.NO	Degree of Salinity	EC-Range (ds/m)
1	Non	<1.2
2	Slight	1.2-2.4
3	Moderate	2.4-4.45
4	Strong	4.5-8.9
5	Very strong	>9

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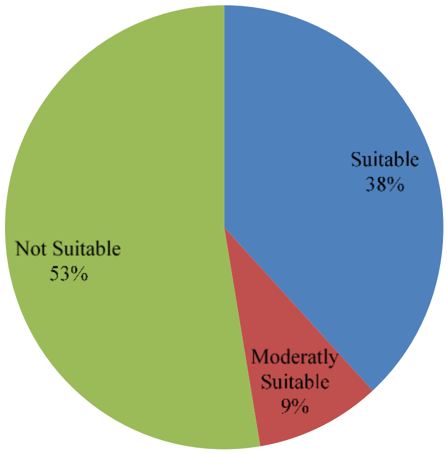

Fig. 5: EC in the Quetta.

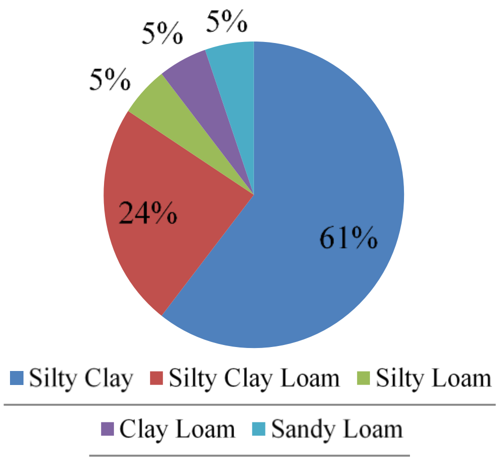

Fig. 6: Soil texture of Quetta valley

Table 3: Classification of pH

Classification	pH-Range
Strongly Acidic	4-5.5
Moderate Acidic	5.5-6.5
Slightly Acidic	6.5-7.0
Slightly Alkaline	7.0-7.5
Moderate Alkaline	7.5-8.5
Strongly Alkaline	>8.5

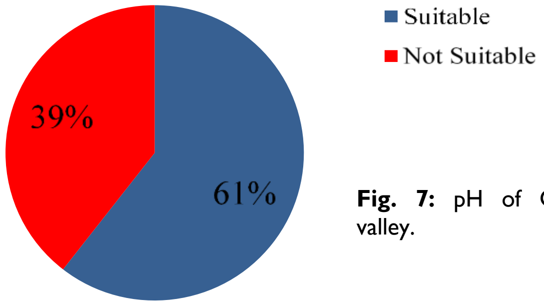

Fig. 7: pH of Quetta valley.

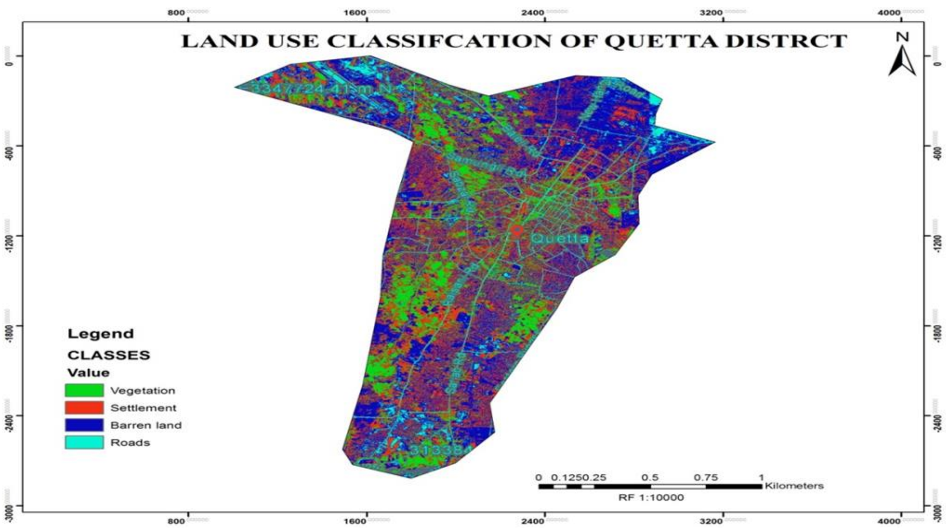

Fig. 8: Land use classification of Quetta District.

Fig. 6 showed that 61% of the area has Silty clay texture, 24% is silty clay loam and 5% silt loam, clay loam and sandy loam each. A major part of the area is under heavy texture on which workability is very difficult. Fig. 6 showed that 61% of the area is free from salinity and 39% is under sodicity problem. Which needs reclamation measures. Fig. 7 shows soil texture of Quetta for agricultural activities. The finding reveals that 61% of the soil texture is suitable for farming. Table 3 showed various ranges of pH. Among all ranges, more than 8.5, 7.5-8.5, 7.0-7.5, 6.5-7.0, 5.5-6.5, and 4-5.5 were categorized as strongly alkaline, moderate alkaline, slightly alkaline, moderately acidic, and strongly acidic, respectively.

Image processing showed that vegetation cover is not prominent (Fig. 8), while barren land is more dominant.

Settlement is also scattered. Land use according to the soil potential is as follows. Level to very gently undulating, well-drained loams, silt loams, and very fine sandy loams. Present land use is mainly wheat, barley, maize, fodders, vegetables, and orchards of apples, apricots, plums, peaches, and grapes under tubewells. No limitation. It needs intensive irrigated cropping; emphasis on high-value crops; use of balanced fertilizers (Neris et al., 2012; Ahmad et al., 2019; Agha et al., 2020).

Level to nearly level, well drained, loamy and fine silty, moderately deep over coarse soils. Mainly wheat, barley, maize, fodders, vegetables and orchards of apple, apricots, plums, peaches and grape under tubewells somewhat shallow depth to gravels. Frequent light irrigation, split application of fertilizers (Liu et al., 2010; Younas et al., 2022).

Very gently undulating, somewhat excessively drained, shallow loamy soils over gravel or cherts. Mainly wheat, barley, fodders, vegetables, grapes and figs. Somewhat low water holding capacity, limited depth of root zone. Frequent light irrigation, split application of fertilizers

In the study area, the land is used in a number of different ways. The main factors governing land use are moisture availability, soil conditions, relief and socio-economic circumstances. Grazing, torrent-watered cropping, dry-farmed cropping and irrigated cropping are the four kinds of land use practiced in the area (Abbasi et al., 2010; Naeem et al., 2020). A major part of the area is not cultivated and is predominantly used for grazing. Part is cultivated, under Sailaba, Khushkava or with irrigation. The Khushkava and Sailaba cultivation is practiced primarily to meet local human food requirements. The acreage in crops under Sailaba and Khushkava varies tremendously from year to year due to variations in the amount, intensity and time of the occurrence of the rainfall. Yields also vary greatly, and only in years of exceptionally good rainfall satisfactory crops are produced. The irrigated area is very small, but selectively very important because of the greater variety, larger yields and higher value of the crops grown. The low rainfall, low winter temperature, limited supply of irrigation water, salinity and sodicity, very gravelly nature of soils, steep mountains are the main factors limiting possibilities to increase production. Considerable increases both in crop and forage production are possible by further development of water and modern management (Minhas et al., 2007; Akhtar et al., 2021; Kaleem et al., 2024).

Two cropping seasons are followed in the area: Kharif, the summer season (from mid-April to mid-October), and Rabi, the winter season (from mid-October to mid-April). High temperatures in the presence of water are favorable for plant growth in summer. The main crops of this season are fruits like apples, apricots, plums, peaches, and grapes; vegetables like potatoes, tomatoes, onions, and turnips; melons and watermelons; fodders, and Jowar. Low temperatures, frost, and snowfall restrict the plant growth for most of the crops in winter. The only crops of this season are wheat, barley fodder, and some vegetables (Ezeaku & Iwuanyanwu, 2013; Tian & Quiring, 2019; Jamro et al., 2020).

One of the factors limiting production is the low level of management throughout the area. The use of artificial fertilizers is not known in the area. However, in the irrigated parts, improved crop varieties and fertilizers are rapidly increasing, and the yields are moderate to good. Generally, no systematic cropping system is followed, particularly in drier areas with erratic rainfall. The land is used for the same crop year after year (Adaikwu et al., 2012; Baloch et al., 2023; Baqi et al., 2024).

4. CONCLUSION

The area is now almost bare of protective vegetation, and soil erosion is widespread. Soil conservation and range management practices should, therefore, be adopted. The availability of adequate water is the main factor limiting the proper range development. Ground-water resources are minimal because whatever water is received through precipitation is either lost by run-off or percolates through grave and stony soils into deep strata. In view of the wind speed in the area, windmills may prove to be a cheap device to exploit this water. Some windmills are already working successfully in this area and are providing watering points for herds at a few sites in the rangelands. Grazing is an important land use of the area. The concept of modern range management deals with getting the highest sustained yield of livestock production from rangelands without damaging the soil and water resources. The major part of the area is under salinity sodicity, which should be reclaimed by adding Gypsum and flushing it with good quality water where possible. According to the potential of soil, the area can be put under fish farming, poultry yards, and tourism for the area's socio-economic development. Most of the area is undergrazing, so cattle farming can play a dominant role in eliminating poverty in the area.

Recommendations

- The land is irrigated by tube-wells. The soils are well suited for intensive cultivation of vegetables and fruits (apples, apricots, peaches and grapes etc) under irrigation. With adequate water supply, sufficient doses of balanced fertilizers and use of improved crop varieties, the yields could be increased considerably.
- Irrigation of the land consisting of gravelly or saline-sodic soils would not be economical currently due to the acute shortage of moisture. These soils should only be used for irrigated agriculture if surplus water is available

after completely satisfying the water requirements of the better soils in the area.

- If ample good-quality water is provided, these soils can be reclaimed easily by leaching excess salts. After reclamation and growing of leguminous crops for two to three years, these soils would become highly productive for all the high-value crops of the area. The yield under proper water management and application of balanced fertilizers would be very high.
- The selection of alternative land utilization types should be most appropriate and economical. Besides soil, climate, socio-economic, ecological, and management factors, this depends on other factors also, among which the most important are:

Until experimentation results on individual soil are available, management recommendations covering the area, in general, have to be employed. These include i) the application of balanced fertilizers, ii) use of improved and good quality seed, iii) proper seed rates, spacing, timely sowing and harvesting, iv) the adoption of plant protection measures (weed and pest control), v) soil conservation measures, vi) controlled grazing/felling, and vii) Proper and timely tillage operation.

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