Sustainability and socio-economic impacts of plant resources utilization in Valley Lalku, District Swat, Pakistan

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Research

Abstract

Background: Plants provide a variety of useful products such as food, wood for construction purposes, secondary metabolites with a huge range of commercial uses and raw materials for modern day pharmaceutical industry. These utilities place plants at the top of natural resources chart both ecologically and economically due to their prominent role in supporting the livelihood of man. In addition to this, common folk also benefit from sales and marketing of plants and plant products. Although these people-plant interactions play a vital role in poverty alleviation it is unfortunate that existing methods of plant resource utilization are unscientific, ill planned and lavish. These poor practices of resource overuse in developing countries have led to deforestation and removal of vegetation cover. Hence well-planned conservation centric studies are need of the day.

Methods: Present study was designed to document plant resources utilization and their socio-economic impacts in montane temperate ecosystems of Lalku valley, District Swat. The study aimed at documentation of ethnic knowledge regarding the medicinally and socio-economically important plant species in the locality. Data on plant resources was collected by using standardized surveys and purpose specific questionnaires.

Results: The study revealed that various ethnic groups of the locality were using 112 plants belonging to 63 families for multiples utilities. During survey it was found that the livelihood of rural populations was highly dependent upon these natural resources which provided a range of suitable products including timber, fuelwood, crude medicines, fruits and many other beneficial aspects for daily life.

Conclusion: This research work concluded that people plant interactions in these montane temperate ecosystems are of huge value for the local folk ranging from wild edibles, timber, fuelwood and medicine as majority of the people belong to low-income classes. It was also noticed that plant resource utilization was heterogeneous which may lead to disastrous ecological consequences in years come. Hence, these plant resources are under the pressure of over collection on large scale.

Moreover, the benefits obtained from the plant trade of commercially important plants are not sharing equally among the population, therefore there is a lack of interest in sustainable harvesting and sensible management. This has led to reduction in population density of valuable plant species. Current study will provide a baseline of information for future studies in this regard and will enable conservation biologists to lay down proper conservation strategies.

Keywords: Plant resources, Sustainable harvesting, Socio-economic impacts.

Background

People-plant interactions date back to prehistoric times and since the very early days man is utilizing plants for a variety of purposes including their use as food, medicine and for shelter. Sustainability is the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations (CBD, 1992). The Convention on Biological Diversity (CBD) was held in Rio de Janeiro in 1992 as a result of a common concern about the substantial reduction in biodiversity due to anthropogenic stresses. The signatories of the convention put forth that they had governing rights over their natural resources, and they will be part of the conservation drive for natural resources and biodiversity on sustainable basis. These nations are now legally bound to ensure concrete steps for sustainable use of natural resources and conservation of natural resources. To provide legality for sustainable utilization and conservation of their biological resources the contracting parties are bound to these international agreements for approval of these decisions regarding natural resources to national law to ensure protection of biodiversity. This is a very encouraging story but unfortunately there is still a want for uniform universal framework and over exploitation of natural resources and deforestation are still big issues in developing countries. Since the very beginning, plants are providing a variety of useful products to humanity, ranging from timber and fuelwood to cutting edge pharmaceutical products as well as food. This gives the kingdom Plantae a position of high valued natural resource ecologically, commercially and as support for livelihood opportunities to common folk. People-plant interactions provide opportunities to people of rural areas who are living below the poverty line and their role in poverty reduction in such localities can never be overlooked. Moreover, human societies are also dependent numerous indirect benefits yielded by people-plant interactions such as water retention, control of soil erosion and locking carbon into a wide range of organic compounds (Balslev, 2011); most of these services are provided by wild plants (Bastian, 2013). Due to tremendous increase in human population during the last few decades, have put these natural resources under huge anthropogenic stresses which is telling upon the direct and indirect services provided by the lant resources. As estimated that, the world population will consume 50% more food and 45% more energy, (United Nations., 2012). Manifold rise in deforestation rates and uncontrolled expansion of urban zones are causing a rapid decline in species richness and species composition of plant communities across the globe. (Boza, 1993). Throughout the world in general and especially in tropical rain forests the anthropogenic stresses have destroyed, altered and modified the natural ecosystems (Altieri *et al*. 1987; Rudel and Roper. 1997). In northern areas of Pakistan, the montane temperate ecosystems are facing a big threat due to fuelwood and timber extraction on unprecedented scales (Siddiqui *et al*. 1999). This deforestation has led to loss of biodiversity on regional and global level which has is causing climate change and has induced permanent changes in land use (Tinker *et al*. 1996). This change is a major challenge for the conservation of nature according to Svenning & Sandel (2013) and associated changes in seasonal variation, temperature and precipitation represent a profound threat for biodiversity (Bastian., 2013). The effects of climate change and anthropogenic activities are intimately related and possess the ability to set new limits for environmental resilience and supply abilities (Pasztor & Schroeder. 2012). The use of wild plants as cure for diseases is common in many regions of the globe (Shinwari, 2010). All over the world, especially in developing countries people depend heavily on plant natural resources. Wild plants are utilized as food, medicine, fuel, construction materials etc. (Pimentel and Pimentel, 2008). Around 50, 000 to 70, 000 plant species are known to have medicinal and other uses across the world (Schippmann *et al*. 2006). In developing countries, a considerable chunk of population is engaged in medicinal lant collection, use and their sale for generating income (Iqbal, 1993; Walter, 2001). However, with human population explosion and increase in global medicinal plant trade has put a tremendous pressure on wild medicinal plants. Many wild species are decreasing due to over-exploitation and improper collection methods. Some agencies are required to convey the wild species for cultivation systems (Bah, 2002; Lambert *et al*. 1997); WHO, IUCN and WWF 1993). Alam and Ali (2009) reported that pressures such as deforestation, over exploitation, high demand, atmospheric pollution and lack of proper training are translating into loss of biodiversity in Pakistan. Jones *et al.* (2002) have recorded a rise in consumption of medicinal plants and mushrooms due to economic and cultural reasons in the developing countries. According to careful estimates, by year 2050 the total volume of global medicinal plant trade may reach up to 5 trillion US dollars due to increased demand to herbal medicine (Lang, 2008; Shinwari, 2010). According to Ilyas *et al*. (2012), deforestation, over grazing and over exploitation of plants are contributing to reduction in forest cover of montane temperate forests of district Swat. The result of uncontrolled deforestation and over exploitation is the loss of various valuable species which may become endangered in years to come

(Al-Yemeni *et al*. 2010; Sher *et al*. 2011). A study reported 500 families to be engaged in medicinal plant collection and trade with a volume of 5000 tons of medicinal plants collected per Anum (Chaudhry *et al*., 2000). Improper methods of collection, grazing pressure, fuelwood extraction and deforestation are contributing in declining population density of medicinal plants in northern Pakistan (Raziq *et al*. 2010; Sher *et al*. 2010). Conservation through trade/use is an important strategy to provide incentives for the species conservation and habitats protection by turning them into income generating sources (Wild & Mutebi, 1996). Present study is aimed at assessing the medicinally valuable species most commonly used by the local community and also the extent to which these are exploited for different practices i.e., medicinally valuable, fuel wood and other uses both legally and illegally. Secondly after analyzing the preferences of local people what steps should be suggested to cope with the fuel wood demand and hence decrease the pressure on fuel wood species and forest of the area which is one of main cause of decline of medicinal plants. This study will also contribute in preservation of valuable information regarding medicinally valuable species other economically important forest resources.

The Study area

District Swat is a famous mountainous region situated in the north of Pakistan with a total area of 5337 square kilometers. Due to its geographical location, district Swat consists of thick forests, glaciers, green meadows and plain areas with rich diversity of flora and fauna. Most parts of the area possess different types of plants used for medicinal and other purposes. According to 2017 census Report, the total population of district Swat was 23, 09570. About 497,969 acres area of Swat valley is under forest cover dominated by *Pinus*, *Cedrus* and other coniferous species. Forests are the natural beauty of Swat valley including the investigated area Lalku valley. Lalku is situated in the north-west of District Swat of Malakand Division. Its distance is about 50 km from the Mingora city of Swat and lies between latitudes 36-40 to 35-12 North longitudes 72.50 to 70.30 East in the District. The elevation of Lalku valley is 1500m to 3000m from the sea level. The study area was divided into two main parts, lower Lalku and Upper Lalku. The total area is approximately 15091 ha, distributed in different elevation ranges. In general, about 81% area lies between an elevation range of 1500m-2500m while 19% between 2500m-3000m. The soil is clay sandy type and stony at high elevation. Geologically the rocks are amphibolite, mica, schist, quartz, granite, pegmatite and ultramafic. Land sliding is common due to glacial action in the upper zone. Lalku valley has diverse vegetation, but upper part of the valley exhibits more diverse vegetation due to its high altitude and favorable climatic conditions. The area is rich in forests which occur at elevation between 1500m-3000m (Figure 1). In the lower zone *Pinus roxburghii* is the dominant species. The other species found are *Senegalia modesta*, *Celtis caucasica*, *Diospyros lotus*, *Ficus carica*, *Morus alba*, *Olea ferruginea*, *Ailanthus altissimia*, *Robinia* and *Eucalyptus* species. The Coniferous forests are located at altitude of about 2500m and above which have dominated the north side. They are dominated by *Pinus wallichiana*, *Abies pindrow*, *Picea smithiana*, and *Taxus wallichiana.* Southern hills are covered with *Quercus incana*, Q*uercus dilatata* and other *Quercus* species. Several other trees such as *Juglans regia*, *Zizyphus vulgaris*, *Salix* sp., *Morus* and *Populus* species are common. Some bushes like *Rubus*, *Buxus, Parritiopsis, Daphne* etc. are also frequently found.

Materials and Methods

The current study was designed to document the sustainable utilization and socio-economic impact of plants resources in Lalku valley, District Swat during 2018. Prior to investigating the plant resources, topo-sheet, map and other general information regarding the research area were obtained from the Forest Department of the District.

For data collection following tools were utilized:

1. Semi-structured interviews
2. Field surveys
3. Questionnaires

The semi-structured interviews had both the open and semi-open questions to extract as much information as possible. Several surveys were conducted in the research area during different months of the year (1st in April and May 2nd June and July and 3rd in August and September) for recording the relevant data. The data was also collected from local people through questionnaires. A total of 250 respondents were interviewed and most of the information was collected from aged and experienced people in the area because they had sufficient information regarding the plant resources and associated problems however participants from young generation were also included. The questionnaires for interview consisted of a master sheet and two pages. Master sheet carried basic information such as name of interviewee, date, location, interviewee role in collection/use, names of species/products. For further information from each participant a separate two pages were filled in summarized form regarding all the qualitative and quantitative data of different types of plants collected by these people. The data was also obtained regarding how the raw materials are extracted and which type of pre and post processing steps are performed for commercial purposes and other uses. Information about the costs and benefits, where and to whom the plants materials are sold and means of transport, and the limiting factors in the trade were also investigated. The obtained data was properly tabulated in MS-Excel spreadsheets. Multiple data sheets were prepared from the

questionnaires in separate folders for further analysis. During field survey the plants were collected, and fully dried specimens were mounted on herbarium sheets with scotch tape. Plants were identified with the help of available literature (Nasir and Ali, 1971-91, Stewart, 1972). Nomenclature was confirmed from National Herbarium, NARC, Islamabad. A set of voucher specimens was deposited to Botany Department Jahanzeb College, Saidu Sharif Swat.

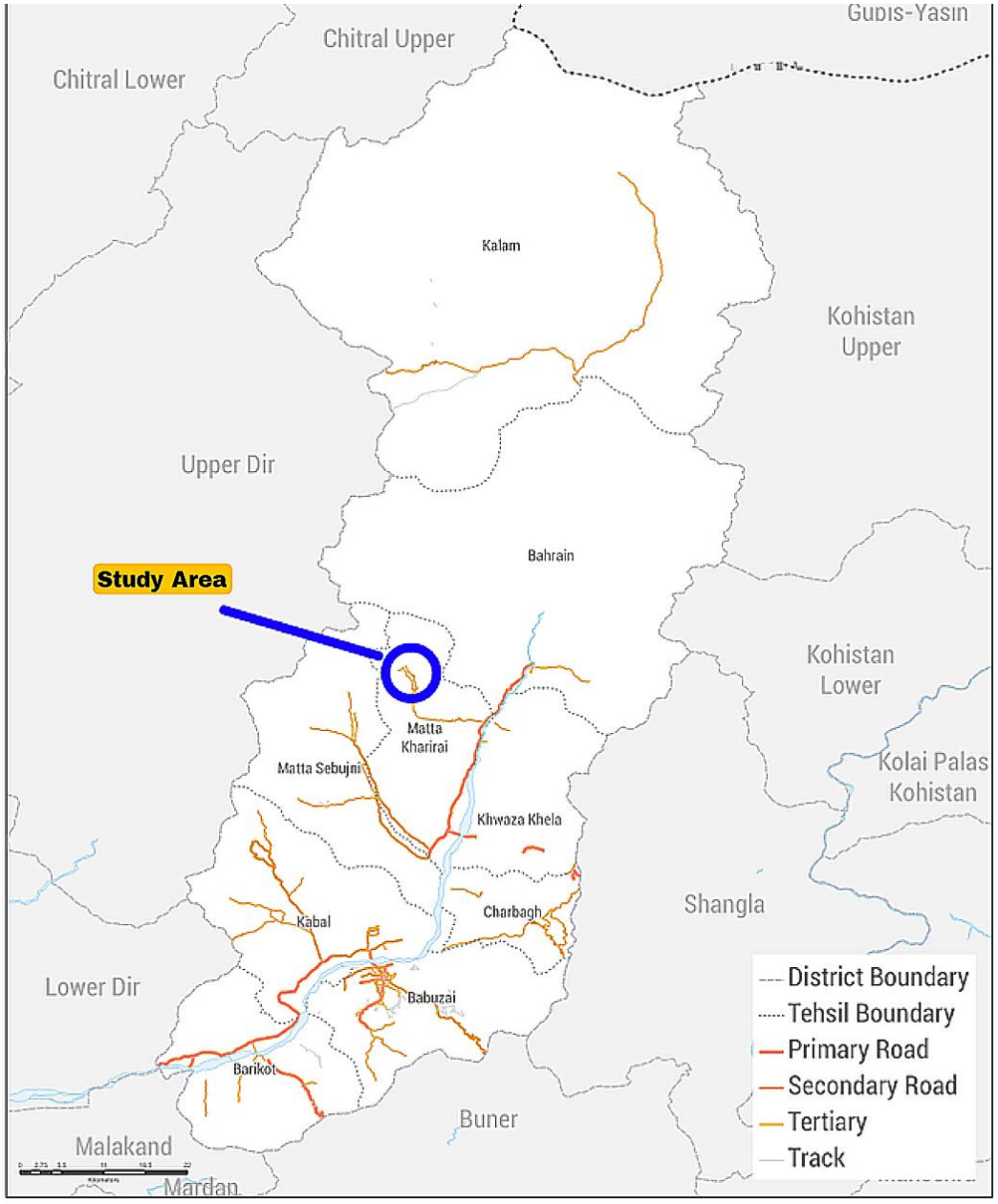

Figure 1. Map showing studied site Lalku valley, Swat, Pakistan

Results

Timber

Many gymnosperm trees having hard woody stems and durable timber were extensively used in the study area for multiple uses such as construction material, for making furniture, for making hunting tools, for floor toppings, as main beam for roofs etc. These trees included *Pinus wallichiana, Abies pindrow, Pinus roxburghii, Morus alba,Cedrus deodara, Juglans regia, Melia azedarach, Morus nigra, Olea ferruginea, Alnus nitida, Platanus orientalis* and *Diospyros lotus.* The wood of all these species was found to be appreciated both regionally and across the country. The *Cedrus deodara* was preferable species for flooring, as roof beams, pillars and furniture as it is considered to be extremely hard and durable wood and also resistant to termites. It was mostly imported from other valleys of the District to the study area. *Pinus wallichiana, Picea smithiana* and *Abies pindrow* were utilized in making of different things such as house constructions, furniture, cloth cupboards, wooden bridges,

pulpit, chairs, reading desk, eaves, wooden boxes and other furniture tools in which *Pinus wallichiana* was highly utilized as compared to *Abies pindrow* and *Picea smithiana*. Other two species *Melia azedarach* and *Juglans regia* were used for making of tribal chairs, rustic chairs, bed's legs. *Morus alba* and *Morus nigra* were also utilized for making of bed feet. *Olea ferruginea* were used in roof beams, house pillars, handles, graves, eaves, bowls, wooden utensils or crockery, curving tools and abstinence or walking sticks etc. *Diospyros lotus* wood was also used as pillar purpose in mundane houses and bed's legs. *Platanus orientalis* were also utilized in local furniture purposes and pulpits.

The harvesting practices used unsustainable and there was no forestation program in the study area. Hence very poor regeneration potential was observed owing to the fact that most of the tree species belong to very slow growing categories and were extracted on large scale. Wood of these tree species was also found on sale on local timber shops. The timber extraction on mega scale may lead to extreme consequences in years to come. (Table 1 and Figure 2)

Table 1. Plants use categories for timber

Scientific name	Family name	Local name	Part used
Alnus nitida (Spach) Endle.	Betulaceae	Greray	Stem, wood
Diospyros lotus L.	Ebenaceae	Toor amlok	Stem, wood
Juglans regia L.	Juglandaceae	Ghoz	Stem, wood
Melia azedarach L.	Meliaceae	Tora shandai	Stem, wood
Morus alba L.	Moraceae	Spin toot	Stem, wood
Morus nigra L.	Moraceae	Toor toot	Stem, wood
Olea ferruginea Royle	Oleaceae	Khona	Stem, wood
Abies pindrow Royle	Pinaceae	Achar	Stem, wood
Cedrus deodara (Roxb.) G. Don	Pinaceae	Ranzra/ diar	Stem, wood
Picea smithiana (Wall.) Boiss.	Pinaceae	Mangazai	Stem, wood
Pinus wallichiana A.B. Jacks.	Pinaceae	Srup/ peoch	Stem, wood
Platanus orientalis L.	Platanaceae	Chinar	Stem, wood

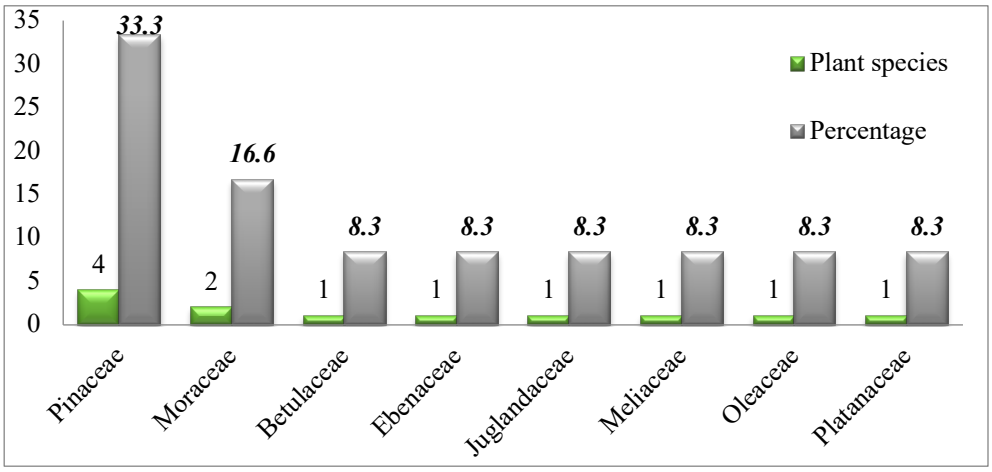

Figure 2. Percentage and number of plant families used as timber

Fuel

The forests in the study area were reported to be under high pressure as they were extensively used as fuel along with timber. Due to lack of alternative sources of fuel most of these species utilized as timber, were also targeted as fuel source by the local community. The important species consumed as fuel were *Abies pindrow, Pinus roxburghii*, *Pinus wallichiana*, *Melia azedarach*, *Ailanthus altissima*, *Alnus nitida, Salix* sp., *Quercus* sp., *Ziziphus sativa*, *Olea ferruginea*, *Ficus* sp., *Morus* sp., *Berberis* sp., *Debregeasia saeneb* and *Indigofera heterantha*. This uncontrolled fuelwood extraction has threatened the very existence of many valuable species such as *Pinus roxburghii*, *Cedrus deodara*, *Pinus wallichiana*, *Diospyros lotus*, *Juglans regia*, *Olea ferruginea*, *Salix* sp., *Quercus* sp. and some other species which are over-exploited due to complete dependency of the local community on forests resources. Rapid deforestation has also led to soil erosion and land sliding is of common occurrence and few sites. The shad loving species were also affected with the unjustified removal of forests from the area. According to a survey about 15000kg to 20000kg wood was utilized as fuel by each household annually. (Table 2)

Table 2. Plants used as fuel purposes

Scientific name	Family name	Local name	Part used
Pistacia chinensis subsp. *integerrima* (J.L Stewart ex Brandis) Rech. f.	Anacardiaceae	Shnai	WP
Berberis jaeschkeana C.K. Schneid.	Berberidaceae	Spin kwaray	Shoot
Berberis vulgaris L.	Berberidaceae	Toor kwaray	Shoot
Alnus nitida (Spach) Endl.	Betulaceae	Geray	WP
Celtis australis L.	Cannabaceae	Tagha	WP
Sambucus wightiana Wall. ex Wight & Arn.	Viburnaceae	Benakai	WP
Diosporus lotus L.	Ebenaceae	Tor Amlok	WP
Indigofera heterantha Wall.	Fabaceae	Ghwareja	WP
Quercus dilitata Royle	Fagaceae	Banj	WP
Quercus incana Roxb., Hort. Beng	Fagaceae	Banj	WP
Juglans regia L.	Juglandaceae	Ghoz	WP
Melia azedarach L.	Meliaceae	Tora shandai	WP
Ficus carica L.	Moraceae	Inzar	WP
Ficus palmata Forssk.	Moraceae	Inzar	WP
Morus alba L.	Moraceae	Spin Tootan	WP
Morus laevigata Wall. ex Brandis	Moraceae	Shah toot	WP
Morus nigra L.	Moraceae	Tour toot	WP
Olea ferroginea Royle	Oleaceae	Khona	WP
Abies pindrow Royle	Pinaceae	Achar	WP
Picea smithiana (Wall.) Boiss	Pinaceae	Mangazai	WP
Pinus roxburghii Sarg..	Pinaceae	Nakhtar	WP
Pinus wallichiana A.B. Jacks.	Pinaceae	Srup	WP
Platanus orientalis L.	Platanaceae	Chinar	WP
Ziziphus jujuba Mill..	Rhamnaceae	Elani	WP
Ziziphus oxyphylla Edgew.	Rhamnaceae	Markanai	WP
Populus alba L.	Salicaceae	Sperdar	WP
Populus nigra L.	Salicaceae	Sperdar	WP
Salix alba L.	Salicaceae	Wala	WP
Salix babylonica L.	Salicaceae	Wala	WP
Ailanthus altissima (Mill.) Swing.	Simaroubaceae	Spina shandai	WP
Debregeasia saeneb (Forssk.) Hepper & J.R.I Wood	Urticaceae	Ajlai	WP

Where, WP, whole plant

Medicinal uses

According to the local community, medicinal plants had the similar position as that of modern pharmaceuticals. All over the world of about 53,000 plant species are used for different medicinal purposes (Hamilton, 2004). In various developed countries the local people depend upon plants for their medicinal value. Plants and their constituents still provide a base in the formation of various modern drugs in modern pharmaceutical industries (Strithik *et al*. 2009). The current study demonstrated that majority of the local folk in the study area relies on plant resources and have sufficient traditional knowledge about their medicinal uses. During the survey about 50 plant species belonging to 35 families were studied which were highly medicinal and the local community used them for different medicinal purposes. In this regard mostly elder persons were interviewed as they have more knowledge about medicinal plants. These plants were used for the treatment of numerous ailments in traditional system of medicines. The highest number of plants were found to be used for stomachache (11 species), hepatitis, chough and chest problems (08 species). The least number of 02 species were recognized as diuretic, purgative, diarrhea, wounds, hypertension and vomiting. While One species was recognized as anti-inflammatory, anti-cancerous, sedative, narcotic, typhoid, epilepsy, leucorrhea, rheumatism, snake bite, and tuberculosis.

The local people were mostly illiterate, and the rearing of livestock was a common practice in the area, therefore they had good knowledge of medicinal plants used to cure livestock diseases. (Table 3 and Figure 3)

Table 3. Plants categories based on diseases treated

Therapeutic class	Total species	Scientific name	Part used
Asthma	6	*Achyranthes aspera* L.	Roots
		Datura stramonium L.	Seeds
		Foeniculum vulgare Mill.	Fruit, young shoot
		Mentha spicata L.	Shoot
		Paeonia emodi Wall ex Royle	Whole
		Solanum virginianum L.	Seeds, whole
Anti-inflammation	1	*Atropa belladonna* L.	Shoot
Anti-cancer	1	*Sinopodophyllum hexandrum* (Royle) T.S. Ying	Leaves, fruit
Bronchioles	3	*Datura stramonium* L.	Seeds
		Papaver somniferum L.	Capsules
		Viola serpens Wall.	Whole
Backache	6	*Aconitum heterophyllum* L.	Root
		Atropa belladonna L.	Shoot
		Berberis lycium Royle	Bark of root
		Clesmatis grata Wall.	Shoot
		Olea ferruginea Royle	Seeds, oils
		Tulipa clusiana Redou.	Bulb
Blood purification	5	*Ajuga bracteosa* Wall. ex Benth.	Whole
		Fumaria indica (Hausskn.) Pugsley	Root
		Iris germanica L.	Oils of rhizomes
		Lippia obovata	Whole plant
		Melia azedarach L.	Seeds, bark, leaves
Coolant	3	*Berberis lycium* Royle	Bark of root
		Fumaria indica (Hausskn.) Pugsley	Root
		Teucrium tomentosum B. Heyne ex Benth.	Whole
Constipation	4	*Linum usitatissimum* L.	Seeds
		Foeniculum vulgare Mill.	Fruit, young shoot
		Lepidium sativum L.	Seeds
		Trichodesma indicum (L.) R. Br.	Whole
Cough and chest problems	8	*Achyranthes aspera* L.	Roots
		Berberis lycium Royle	Bark of root
		Datura stramonium L.	Seeds
		Ficus carica L.	Fruit
		Papaver somniferum L.	Capsule
		Plantago lanceolata L.	Seeds
		Solanum virginianum L.	Seeds
		Viola serpens Wall.	Whole
Carminative	3	*Cuscuta reflexa* Roxb.	Shoot
		Foeniculum vulgare Mill.	Fruit, young shoot
		Trichodesma indicum (L.) R.Br.	Whole
Diabetes	6	*Achillea mellifolium* L.	Flowers
		Ajuga bracteosa Wall. ex Benth.	Whole
		Dicliptera bupleuroides Nees	Leaves
		Hedera nepalensis K.Koch	Shoot
		Pistacia integerrima J.L. Stewart ex Brandis	Pods, bark
		Zanthoxylum armatum DC.	Seeds
Diuretic	2	*Clesmatis grata* Wall.	Shoot
		Trigonella foenum-graecum L.	Seeds, leaves

Therapeutic class	Total species	Scientific name	Part used
Dysentery	4	*Alisma plantago-aquatica* L.	Leaves
		Linum usitatissimum L.	Seeds, shoot
		Origanum vulgare L.	Root, flower
		Rumex dentatus L.	Leaves, root
Diarrhea	2	*Acorus calamus* L.	Rhizomes
		Celosia argentea L.	Young shoot
Dysentery	1	*Alisma plantago-aquatica* L.	Leaves
Epilepsy	1	*Arisaemia flavum* (Forssk.) Schott	Rhizome
Expectorant	3	*Arisaemia flavum* (Forssk.) Schott	Rhizome
		Mentha longifolia (L.) Huds.	Shoot
		Papaver somniferum L.	Capsules
Fever	6	*Aconitum napellus* L.	Root
		Aconitum napellus L.	Latex, leaves
		Berberis lycium Royle	Bark of root
		Clesmatis grata Wall.	Shoot
		Papaver somniferum L.	Capsule
		Trigonella foenum-graecum L.	Seeds
Headache	3	*Artemisia scoparia* Waldst. & Kit.	Leaves, Seeds
		Cannabis sativa L.	Leaves, Seeds
		Skimmia laureola Franch.	Leaves
Hepatitis	8	*Artemisia vulgaris* L.	Whole
		Berberis lycium Royle	Bark of root
		Cuscuta reflexa Roxb.	Whole
		Fumaria indica (Hausskn.) Pugsley	Root
		Pistacia integerrima J.L.Stewart ex Brandis	Legume
		Rumex dentatus L.	Leaves
		Teucrium tomentosum B. Heyne ex Benth.	Whole
		Zanthoxylum armatum DC.	Seeds
Hypertension	2	*Linum usitatissimum* L.	Seeds, shoot
		Paeonia emodi Wall ex Royle	Whole
Kidney problems	5	*Berberis lycium* Royle	Bark of root
		Curcuma longa L.	Bark
		Ficus carica L.	Fruit
		Olea ferruginea Royle	Seeds, oils
		Tribulus terrestris L.	Seeds
Leucorrhea	1	*Celosia argentea* L.	Young shoot
Laxative	6	*Lepidium sativum* L.	Seeds
		Linum usitatissimum L.	Seeds, shoot
		Myrsine africana L.	Seeds
		Ricinis communis L.	Seeds
		Rumex dentatus L.	Leaves, root
		Trigonella foenum-graecum L.	Seeds
Narcotic	1	*Cannabis sativa* L.	Seeds, Leaves
Ophthalmic	3	*Celosia argentea* L.	Young shoot
		Olea ferruginea Royle	Seeds, oils
		Trichodesma indicum(L.) R.Br.	Whole
Piles	3	*Ficus carica* L.	Fruit
		Lippia obovata	Whole plant
		Melia azedarach L.	Seeds, bark, leaves
Purgative	2	*Clesmatis gata* Wall.	Shoot

Therapeutic class	Total species	Scientific name	Part used
		Origanum vulgare L.	Root, flower
Rheumatism	1	*Tulipa clusiana* Redou.	Bb
Skin problems	5	*Ajuga bracteosa* Wall. ex Benth.	WP
		Berberis lycium Royle	Ba of root
		Dicliptera bupleuroides Nees	L
		Plantago lanceolata L.	Sd
		Sinopodophyllum hexandrum (Royle) T.S.Ying	Fr, L
Snack bite	1	*Arisaemia flavum* (Forssk.) Schott	Rh
Sedative	1	*Delphinium roylei* Mun.	Fl, L
Stomachache	11	*Achyranthes aspera* L.	R
		Acorus calamus L.	Rh
		Acorus calamus L.	R
		Alisma plantago-aquatica	L
		Berberis lycium Royle	Ba of root
		Curcuma longa L.	Ba
		Delphinium roylei Mun.	Fl
		Mentha arvensis L.	S
		Plantago lanceolata L.	Sd
		Rumex dentatus L.	L, R
		Viola serpens Wall.	WP
Typhoid	1	*Berberis lycium* Royle	Ba of root
Throat problems	3	*Curcuma longa* L.	Ba
		Morus alba L.	Fr
		Morus nigra L.	Fr
Tuberculosis	1	*Datura stramonium* L.	Sd
Urinary problems	6	*Achyranthes aspera* L.	R
		Berberis lycium Royle	Ba of root
		Curcuma longa L.	Ba
		Olea ferruginea Royle	Sd, Oils
		Tribulus terrestris L.	Sd
		Trigonella foenum-graecum L.	Sd
Vermicide	5	*Cuscuta reflexa* Roxb.	S
		Delphinium roylei Mun.	L, Fl
		Fumaria indica (Hausskn.) Pugsley	R
		Melia azedarach L.	Sd, Ba, L
		Myrsine africana L.	Sd
Vomiting	2	*Foeniculum vulgare* Mill.	Fr, YS
		Mentha arvensis L.	S
Wound	2	*Curcuma longa* L.	Ba
		Berberis lycium Royle	Ba of root

Where: Ba, bark; Fr, fruit; Fl, flower; Bb, bulb; L, leaves; R, root; Rh, rhizome; S, stem; WP, whole plant; YS, young shoot; Sd, seeds

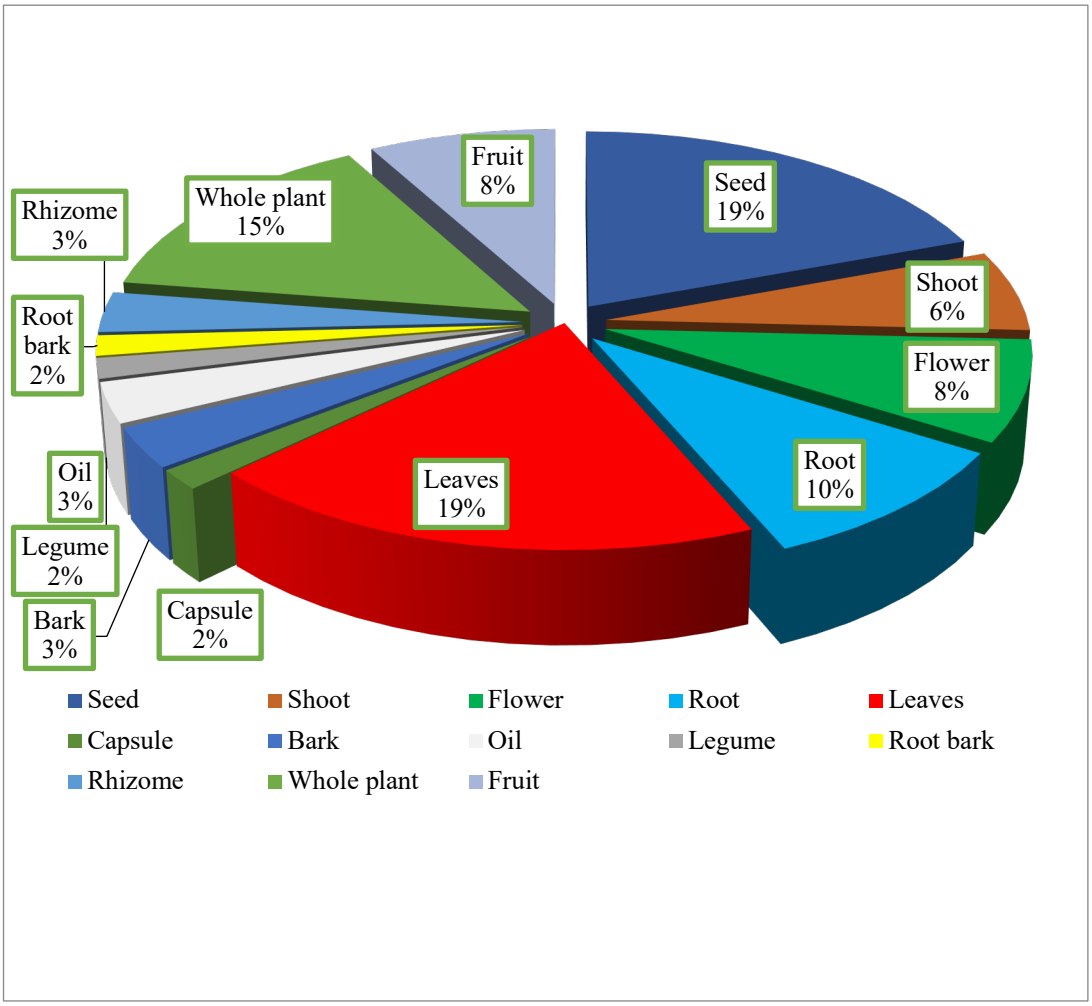

Figure 3. Percentage of part(s) of medicinal plants used

Fruits

Several fruits are used as a diet by rural population. Some of these fruits were high quality natural sources of starch, oil and protein. The utilization of these kinds of fruits played a significant role in health maintenance due to their high nutritional value. Some of the local fruits are components of fruit trade at local and national markets. The important fruits known from the wild, consumed and traded included *Juglans regia*, *Diospyros lotus*, *Diospyros kaki, Prunus persica*, *Morus alba, Morus nigra*, *Morus laevigata*, *Ficus carica*, *Punica granatum*, *Olea ferruginea*, *Rubus fruticosus*, *Fragaria vesca*, *Viburnum grandiflorum* and *Ziziphus vulgaris.*

However, their productivity had highly decreased from the last few decades. The main market for the sale is Mingora fruit market from where they reach to other parts of the country. The fruits harvesting from the wild is one of the important economic activities for poor people of the local community (Table 4).

Table 4. Wild fruits consumed by local people in the area.

Scientific name	**Family**	**Local name**	**Life form**
Viburnum grandiflorum Wall ex DC.	Viburnacae	Ghoz meva	Shrub
Diospyros lotus L.	Ebenaceae	Tor amlok	Tree
Diospyrus kaki L.	Ebenaceae	Sor amlok	Tree
Juglans regia L.	Juglandaceae	Ghoz	Tree
Punica granatum L.	Lythraceae	Narsaway	Tree
Ficus carica L.	Moraceae	Inzar	Tree
Morus alba L.	Moraceae	Spin toot	Tree
Morus leavigata Wall. ex Brand.	Moraceae	Shah toot	Tree
Morus nigra L.	Moraceae	Tor toot	Tree

Olea ferruginea Royle	Oleaceae	Khona	Tree
Ziziphus vulgaris L.	Rhamnaceae	Markhanai	Tree
Fragaria vesca L.	Rosaceae	Da zmake toot	Herb
Prunus persica (L.) Batsch	Rosaceae	Shaltalo	Tree
Rubus fruticosus L.	Rosaceae	Karwara	Shrub

Thatch

In the study area, the local folk from low-income classes used different plants for thatching their houses. The prominent species used for thatch included *Pinus wallichiana*, *Cedrus deodara*, *Isodon rugosus*, *Arenaria griffithi*, *Dodonea viscosa*, *Indigofera* spp., *Pinus roxburghii*, *Picea smithiana*, *Sambucus wightiana*, *Debregaesia salicifolia*, *Cannabis sativa* and *Salix* spp.

In the study area a total of 13 plant species belonging to 10 families were used for thatching purposes. These species were also contributed considerably to the local people to earn money. Locals collect these species to be sold regionally and also transported to other parts of the Swat valley. This has led to over exploitation of these plant species and turning them into vulnerable, threatened and rare ones.

The people of the study area made different products from above mentioned plants used for such as wooden lodge, cabins, baskets, mundane houses, cages, brooms, spade, axes handles and farriers. (Table 5)

Table 5. Thatch species of Lalku Valley, Swat

Scientific name	**Family**	**Local name**	**Part used**
Cannabis sativa L.	Cannabaceae	Bhang	Whole
Sambucus wightiana Wall. ex Wight & Arn.	Viburnaceae	Benakai	Whole
Arenaria griffithii Boiss.	Caryophyllaceae	Kinar	Whole
Indigofera tinctoria L.	Fabaceae	Ghoreja	Whole
Plectranthus rugosus Wall.	Lamiaceae	Sperkay/ barotus	Whole
Cedrus deodara (Roxb.) G. Don	Pinaceae	Diar/ ranzra	Whole
Picea smithiana (Wall.) Boiss	Pinaceae	Mangazai	Whole
Pinus roxburghii Sarg.	Pinaceae	Nakhtar	Whole
Pinus wallichiana A.B. Jacks.	Pinaceae	Srup/ peoch	Whole
Ziziphus mauritiana Lam.	Rhamnaceae	Beer/ karkana	Whole
Salix babylonica L.	Salicaceae	Wala	Whole
Dodonea viscosa Jacq.	Sapindaceae	Ghoraskay	Whole
Debregeasia salicifolia (D. Don.) Rendl.	Urticaceae	Ajlai	Whole

Plant species used as brooms

There were 7 Plant species belonging to 6 families used for broom making. *Arisitida cynantha*, *Artemisia scoparia*, *Saccharum griffithii*, *Indigofera heterantha*, *Isodon rugosus*, *Pinus roxburghii*, *Pinus wallichiana* leaves are mostly used in homes, water-mills and guest rooms for sweeping and cleaning. (Table 6)

Table 6. Species uses as brooms in Lalku valley, Swat

Scientific name	**Family**	**Local name**	**Life form**
Artemisia vulgaris L.	Asteraceae	Tarkha	Herb
Indigofera heterantha Wall.	Fabaceae	Ghoreja	Tree
Plectranthus rugosus Wall.	Lamiaceae	Sperkay/ barotus	Shrub
Pinus roxburghii Sarg.	Pinaceae	Nakhtar	Tree
Pinus wallichiana A.B. Jacks.	Pinaceae	Srup/ peoch	Tree
Aristida purpurea Nutt.	Poaceae	Mashkanray	Herb
Saccharum griffithii (Munro ex Boiss.) Hack.	Poaceae	Kahay	Herb

Honeybee flora

Bees are social insects that collect various types of pollens and nectars from different flowers and produce honey and waxes. These social insects live in big colonies by making hives. Honeybees pollinate numerous flowers of plants that are their natural inborn habitat. The study area was also composed of about 05 species belonged to 03 families which used as a feeder for honeybees. *Origanum vulgare*, *Micromeria biflora*, *Isodon rugosus*, *Ziziphus jujuba* and *Senegalia modesta* were regarded as the best species for production of honey in the zone but *Senegalia modesta* were very rarely found in the region. (Table 7)

Table 7. Honeybee flora of Lalku valley, Swat

Scientific name	Family	Local name	Life form
Sengalia modesta (Wall.) P.J.H. Hurter	Fabaceae	Palosa	Tree
Micromeria biflora (Buch.-Ham. ex D. Don) Benth.	Lamiaceae	Naray shamakay	Herb
Origanum vulgare L.	Lamiaceae	Shamakay	Herb
Plectranthus rugosus Wall.	Lamiaceae	Speerkay	Shrub
Ziziphus mauritiana Lam.	Rhamnaceae	Karkana	Shrub

Multipurpose plants

In the study area some plants were extensively used due to their multipurpose utilities. These plants and their parts were used for different purposes such as food, timber, medicines, fuel wood, fiber source, fodder, for improving soil fertility, raising fences etc. Some trees provide us many types of fruits, food, wood, fences & hedges and other eatable parts, shadow, insect killer products. Some of these plants are known to increase the soil fertility and enhance soil stability. Many plants provide shelter to nitrogen fixing bacteria which in turn provide with nitrites and nitrates; leading to appropriate nitrogen levels to facilitate the vegetative growth of plants. The young green leaves also were the best source of calcium, iron, folic acid, magnesium, biotin, chlorophyll, and niacin. Such mineral rich foliage is of huge value for man as they can be utilized as medicine either in raw form or in slightly processed form. Moreover, some plants were aromatic and were used for various purposes like in pharmaceuticals, as condiments, perfume making and for medicinal purposes. Current study documented 17 species belonging to 10 families with multiple uses. *Pinaceae* was the leading family in this regard because many species of this family were used for different outcomes such as timber, fuel wood, medicinal, thatching and other traditional purposes. (Table 8 and Figure 4)

Table 8. Multipurpose plant species of Lalku, Valley District Swat.

Scientific name	Family	Local name	Use categories
Abies pindrow Royle	Pinaceae	Achar	Tim, fuel,
Cedrus deodara (Roxb.) G. Don	Pinaceae	Ranzra/ Diar	Tim, Fue, Tha, Med
Celtis australis L.	Cannabaceae	Tagha	Tim, Fue, Tha,
Diospyros lotus L.	Ebenaceae	Tor amlok	Tim, Fue, Med, income source
Juglans regia L.	Juglandaceae	Ghoz	Tim, Fue, Fru,
Melia azedarach L.	Meliaceae	Tora shandai	Tim, Med, Fue, Fod
Morus alba L.	Moraceae	Spin toot	Tim, Fru, Med, Fue, Too, Fod
Morus leavigata Wall. ex Brand.	Moraceae	Shah Toot	Tim, Fru, Fue, Med, Too, Fod
Morus nigra L.	Moraceae	Tor Toot	Med, Too, Tim, Fru, Fue, Fod
Olea europa subsp. cuspidata (Wall. & G. Don) Cif.	Oleaceae	Khona	Fru, Tim, Fue, Fod
Olea ferruginea Royle	Oleaceae	Khona	Tim, Fue, Fru, Fod
Picea smithiana (Wall.) Boiss	Pinaceae	Mangazai	Tim, Fue,
Pinus roxburghii Sarg.	Pinaceae	Nakhtar	Fue, Tha, Bro
Pinus wallichiana A.B. Jacks.	Pinaceae	Peoch, Srup	Tim, Fuel, Bro
Pistacia integerrima J.L. Stewart ex Brand.	Anacardiaceae	Shnai	Med, Fue, source of income
Platanus orientalis L.	Platanaceae	Chinar	Tim, Fuel, Too
Taxus wallichiana Zucc.	Taxaceae	Banrya	Tim, Fue, Med

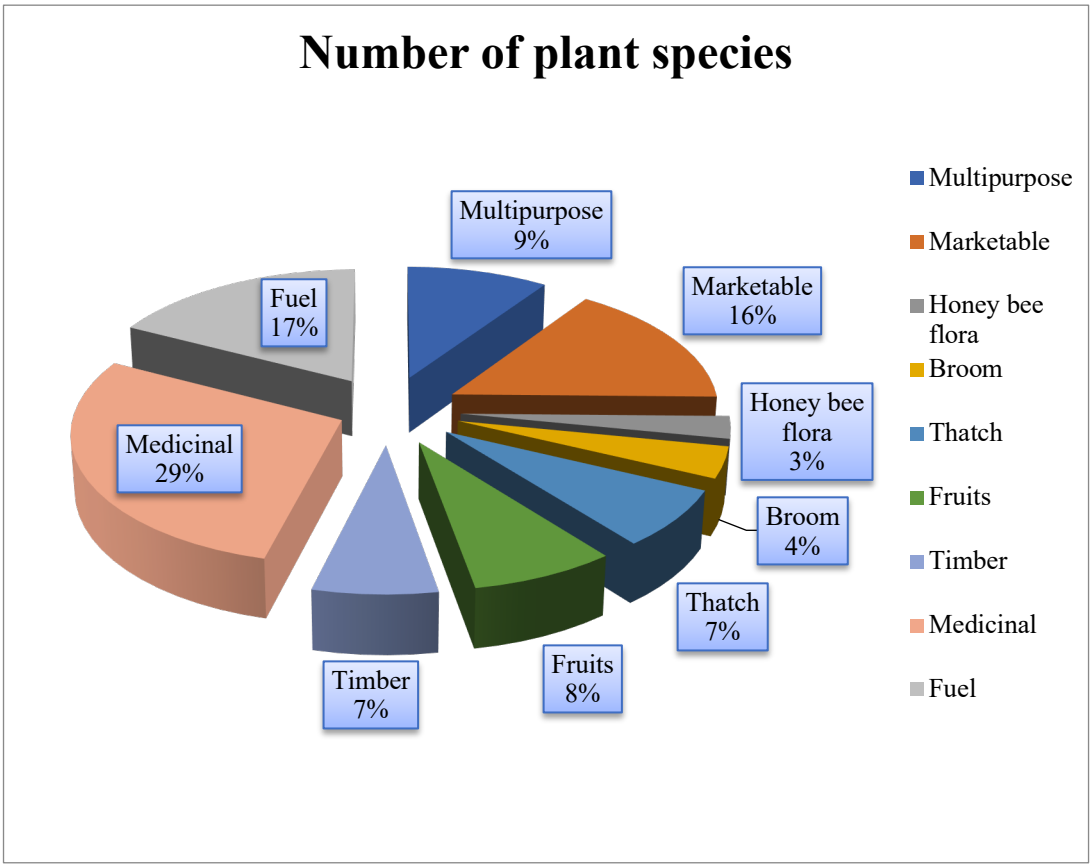

Figure 4. Pie-chart representing percentage of various plant categories.

Ritual and tool making species

The leaves and wood of some species are harvested for traditional and religious ornaments which are highly attractive when processed into decoration pieces. These species included *Platanus orientalis*, *Olea europaea* subsp. *cuspidata*, *Thuja orientalis*, *Celtis australis*, *Ficus carica*, *Iris germanica*, and *Narcissus tazetta. Pinus* spp leaves were used in mosques for carpet purpose. *Skimmia laureola* was another important plant as its leaves are considered a talisman against evil eyes. The leaves of Cupressaceae were used as page markers in Holy Quran. *Saccharum folifolium* and *Saccharum griffithii* were also utilized in making of palettes, cribs, baskets, decoration pieces, cages, and agricultural tools. *Platanus orientalis* wood was also used in making of pulpits in the mosques. *Olea* sp. and *Morus* sp. wood was also famous for making of gun's handles, sleeves, arms etc.

Plants used for oil extraction

During surveys 6 plants were found to be used for extraction of oil. These oils were used for different purposes in daily life. The important plants species were *Brassica campestris, Olea ferruginea, Lablab purpureus, Iris germanica, Helianthus annuus,* and *Ricinus communis.* Brassica or mustard oil was used as hair tonic, massage for babies and for old aged people and also cooking purpose. *Ricinus communis* oil was used to ease constipation. *Iris germanica* oil was used as blood purifier. Olive oil was also used for hair and massage of pains. Olive oil was also reported to be used in preparing local delicacies. *Helianthus annuus* oil was used in cooking purposes.

Level of traded plants and sustainability

The study showed that the poor households not only gathered their plants resources for timber, fuel, medicinal and multipurpose but also for sale to improve their income. They were collecting both medicinal herbs and important species for commercial purposes. The study confirmed that the trade is heterogeneous and traded species reach to the market through a chain of agents and middlemen. The medicinal species and fruit having commercial value are generally sold in the fresh form but their sale in dried form was also common. The demand for the sale is increasing but surprisingly, the local community particularly collectors have very smaller share in the total trade. The trade at the local and national levels is not usually through legal ways. The trade is, therefore, difficult to quantify. Furthermore, the harvesting practices were usually destructive and were reported on unsustainable bases as they are still primitive and have caused a severe reduction in the

populations of highly valuable plant species. The prices of the transported material were very low as compared to the national and international markets. The main reasons behind low price were the collection procedures, timing and poor processing methods. A total of 28 economically valuable plant species were identified in the study area. Marketable part(s) and their market prices are given in the table. (Table 9 and Figure 5)

Table 9. Marketable plant species of Lalku Valley, Swat.

Scientific name	**Family**	**Common name**	**Marketable part(s)**	**Price in Pakistani (Rs.)**
Abies pindrow Royle	Achar	Pinaceae	Timber wood	2000/Small beams
Pistacia chinensis subsp. *integerrima* (J.L. Stewart ex Brandis) Rech. f.	Amaranthaceae	Shnai	Dried insect galls	750/kg
Achillea millefolium L.	Asteraceae	Aqar qarha	Dried herb	6000/kg
Berberis lycium Royle	Berberidaceae	Spin kwaray	Bark of root	80/kg
Berberis vulgaris L.	Berberidaceae	Toor kwaray	Bark of bark	90/kg
Sinopodophyllum hexandrum (Royle) T.S.Ying	Berberidaceae	Kakora	Dried rhizome	270-320/kg
Valeriana officinalis L.	Caprifoliaceae	Mushk-e- bala	Dried rhizome	300-360/kg
Diospyros lotus L.	Ebenaceae	Tor amlok	Dried fruit	50/kg
Lablab purpureus (L.) Swe.	Fabaceae	Lobya	Dried seeds	120/kg
Quercus incana Roxb.	Fabaceae	Banj	Fuel wood	440/kg
Robinia pseudoacacia L.	Fabaceae	Kikar	Fuel wood	400/kg
Juglans regia L.	Juglandaceae	Ghoz	Dried fruit	1350/kg
Punica granatum L.	Lythraceae	Narsaway	Rind of fruit	80/kg
Morchella conica Pers.	Morchellaceae	Cut Gujai	Dried fruiting body	16000/kg
Morchella elata Fr.	Morchellaceae	Zyara Gujai	Dried fruiting body	11000/kg
Morchella esculenta Fr.	Morchellaceae	Spina Gujai	Fresh whole fruiting body	20000/kg
Morchella vulgaris (Pers.) Gray	Morchellaceae	Gujai	Dried whole fruiting body	18000/kg
Olea ferruginea Royle	Oleaceae	Khona	Fuel wood	430/kg
Paeonia emodi Wall ex Royle	Paeoniaceae	Mamekh	Dried herb	380/kg
Papaver somniferum L.	Papaveraceae	Qashqash	Dried capsule	300/kg
Cedrus deodara (Roxb.) G.Don	Pinaceae	Diar/ Ranzra	Timber wood	8500/ Beam
Pinus wallichiana A.B. Jacks.	Pinaceae	Peoch/ srup	Timber wood	6000/ Beam
Myrsine africana L.	Primulaceae	Marorang	Dried fruit	600/kg
Aconitum napellus L.	Ranunculaceae	Da ghra zahar	Dried rhizome	450/kg
Skimmia laureola Franch.	Rutaceae	Nazar panra	Fresh leaves	30/Small bundle
Zanthoxylum armatum DC.	Rutaceae	Dambara	Dried fruit	180/kg
Ailanthus altissima (Mill.) Swin.	Simaroubaceae	Spina shandai	Fuel wood	410/kg
Viola serpens Wall.	Violaceae	Banafsha	Dried flower	2600/kg

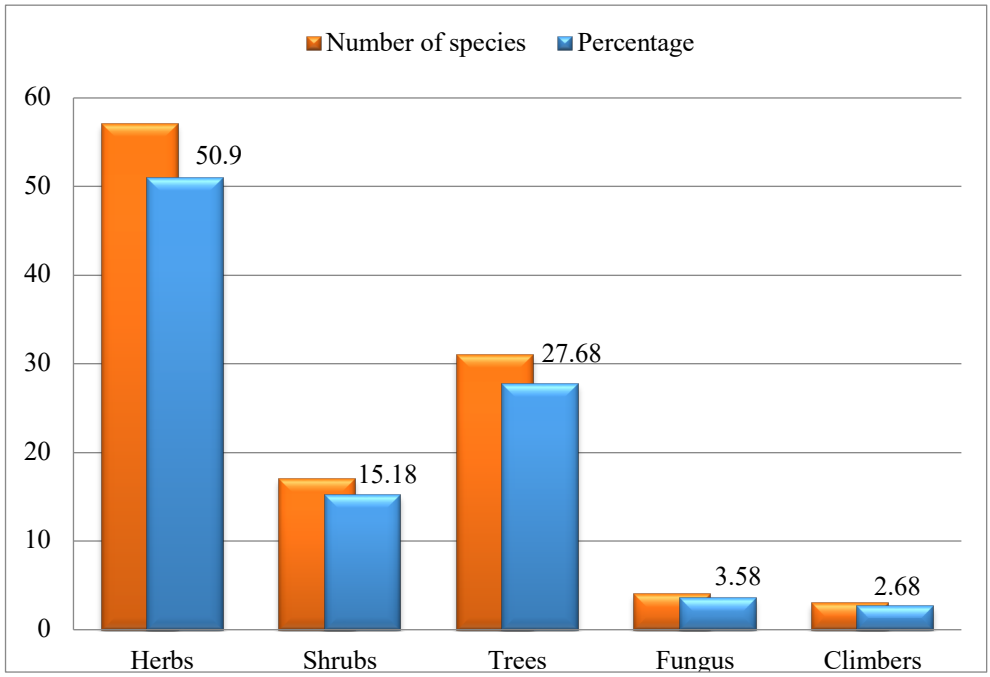

Figure 5. Percentage and number of plant species based on life form.

Discussion

The current study reported a total of 112 plants utilized for various purposes such as medicinal, construction, timber, fuel, thatch, broom and ceremonial purposes. All had a considerable importance for the survival of the livelihoods. These 112 species belong to 63 families most of which were angiosperms (98 species) and 10 species of gymnosperms represented by 4 families while 4 were fungal members belonging to a single family. Among angiosperms, monocots were represented by 5 species while the rest of the 93 species belonged to dicotyledons. The highest number of species were that of Lamiaceae (10 species), while the lowest number of species recorded was 01 species for each family including: Apiaceae, Adoxaceae, Apocynaceae, Amaryllidaceae, Acanthaceae, Alismataceae, Araliaceae, Caryophyllaceae, Cupressaceae, Cuscutaceae, Fumariaceae, Juglandaceae, Boraginaceae, Euphorbiaceae, Liliaceae, Linaceae, Meliaceae, Mimosaceae, Malvaceae, Myrsinaceae, Rubiaceae, Lythraceae, Iridaceae, Myrtaceae, Nitrariaceae, Papilionaceae, Platanaceae, Polygonaceae, Plantaginaceae, Primulaceae, Paeoniaceae, Simaroubaceae, Sapindaceae, Scrophulariaceae, Taxaceae, Urticaceae, Violaceae and Zingiberaceae. The findings suggest that people mostly rely on plants for medicines and use plants as a source of their income. With the advancement of pharmaceutical research, there is increasing exploitation of such resources and traditional medicines are getting rare as reported previously (Sher et al. 2014; Tariq et al. 2021; Rahman et al. 2022a; Alam et al., 2023). In this study, 4 species of *Morchella* including *M. conica*, *M. elata*, *M. esculenta* and *M. vulgaris* were recorded which are considered to have potential therapeutic relevance and use in treating hypertension, diabetes, hyper cholesterol level, cancer etc. However, regardless of their promising therapeutic applications, its use of in ethnomedicine remains relatively uncommon which may be attributed to mushroom poisoning incidents (Hussain et al. 2023). Hence, further pharmacological experiments accompanied by its validation are needed to potentially explore its ethnomedicinal implications.

However, several plants in the area were also utilized in huge quantity particularly for timber, fuel and medicinal purposes (Sher et al. 2022). If the collection, utilization and over-cutting of these plants continues at current pace without sustainable management, it may totally destroy the habitats and life of plants in future. These findings are in line with the work of Hussain, *et al* (2007) who reported that the number of endangered species is increasing due to environmental degradation, overgrazing and over exploitation in the form of medicinal plants extraction and deforestation. The awareness shall be created in the local community to prevent and avoid the collection of endangered and rare species of the area because they are mostly illiterate and have no information about plants collection correctly and at appropriate timing. Therefore, they do not care for their precious plants resources and collect whole plants with roots without any proper harvesting practices and consume the life of species which can be prevented. Our findings are also backed by those reported in FAO (1995) which stated that medicinal plants resources are not scientifically managed and therefore they are disappearing in many parts of the world. Sher *et al.* (2011) reported that the availability of important MAP species is decreasing and the number of rare

and threatened species among MAPs is increasing. They also reported that the gatherers have very little marketing skills and are often not aware of the high market value; as a result, most of collected materials are sold to local middlemen at very low price. It was noticed that this problem is due to the involvement of children and women in collection of plants for medicinal and other purposes in extra time. Women and children usually gather medicinal plants as a part time business in the northern areas of Pakistan (Khan, 1998; Sher et al. 2015; Ullah et al. 2021; Rahman et al. 2022b).

The study also found that because there is no enforcement of laws from government on over-cutting and over-collection. This situation was confirmed by the local community (aged people) that about 30-40 years ago, the area was covered with very thick forests due increase in human population. However, the plants are utilized on unsustainable bases and as a result the population density of several species such as *Pinus wallichiana, Cedrus deodara*, *Taxus fuana* is decreasing. The main factors reducing the valuable species of plants are deforestation, and over-collection for various purposes including commercial harvesting in local markets that leads to climate change which in return affect plants diversity. Sher *et al* (2017) also mentioned that MAPs are traded in urban markets to generate income while Chi *et al.* (2017) reported that a large number of important Medicinal Plants are highly affected by Climate change and human activities.

Conclusions

Several studies have been conducted on medicinal plants and ethno-botanical evaluation in the study area. In the current survey the sustainability and socio-economic importance of plants resources was focused by considering major use categories in the region. During this study it was found that the livelihood of rural populations is highly dependent upon their forests. These natural resources provide a range of suitable products (timber, fuel, traditional medicines, fruits, etc.,) for daily life and also support the livelihood of poor community. Sadly, the benefits obtained from the trade of economically valuable plants are not sharing equally with the local people and therefore, they are not showing interest in sustainable harvesting and sensible management. As a result of which the important plants are decreasing and pressure on the targeted plants is increasing due raised demand. The study also found that legislation is quite ineffective and there is no cultivation and reforestation program. The conservation strategies are also ineffective due to lack of conservation funds.

The present study thus recommends initiating conservation measures with involvement of local communities to rehabilitate the exhausted plant resources in order to conserve and protect important plant resources from overexploitation and over collection. The current study strongly recommends control on overgrazing, overall coordination of government with local community and proper legislation (law enforcement), replacement of destructive harvesting practices by scientific methods through training programs for collectors. Furthermore, legal trade and equitable sharing of benefits could be effective for sustainability and economic development in the area.

Declarations

List of abbreviations: Ba, bark; Fr, fruit; Fl, flower; Bb, bulb; L, leaves; R, root; Rh, rhizome; S, stem; WP, whole plant; YS, young shoot; Sd, seeds

Ethics Approval and consent to participate: Prior verbal consent was obtained from all informants.

Competing interests: The authors declared no conflicting interests.

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Author's contributions: HS and AsA conceived the research idea. HS, AsA designed and conducted the study. HS, IUR, HU and AA analyzed and interpreted the data. AA, ZU and HS drafted the initial manuscript. AA, ZU, RB and HS revised and improved the manuscript. All authors have read and approved the final version of the manuscript.

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