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RESEARCH ARTICLE

# Collecting Plant Genetic Resources from Gurez, An Underexplored Remote Valley of Jammu & Kashmir State of India

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For the first time, systematic exploration and germplasm collection trips were conducted across Gurez Valley, a remote locality near Line of Control with Pakistan in Bandipore district of Jammu and Kashmir during 2015 and 2017. Almost all the villages up to Chakvali (Tulail) were surveyed. A total of 68 accessions belonging to 28 species including 34 accessions of wild germplasm were collected from altitudinal variation of 2403-3491 meters above sea level. *Fagopyrum tataricum* subsp. *potanini* and *Crataegus pseudoheterophylla* were collected for the first time, besides good variability in wheat, maize and common bean. Other significant collections included common and tartary buckwheat, hull-less barley, field pea, black cumin, caraway, and wild germplasm of *Allium stracheyi*, *Elymus* spp., *Hippophae rhamnoides* subsp. *turkestanica* and *Malus baccata*. Once a common crop, proso millet was seen cultivated only by a lone aged farmer in the entire tract, thus becoming almost an extinct crop in that area. This paper highlights information on the germplasm collected/observed, cultivation practices, genetic erosion and future exploration potential.

**Key Words: Exploration, Germplasm collection, Gurez valley, Plant genetic resources**

## Introduction

Gurez, known as 'Crown of Kashmir' and hailed as one of the nine virgin valleys of Asia, extending between 34°30′-34°41′ N latitude and 74°37′-74°46′ E longitude, is a picturesque, fertile cleft carved out of the high Himalayas at an average altitude of about 2400 meter above sea level by Kishanganga river in the Indian state of Jammu & Kashmir. It is located 123 km in the north-east direction from Srinagar and 86 km from Bandipore, the district headquarters of this valley. Gurez is surrounded on its north by Ladakh, south by Bandipore, southeast by Ganderbal and on the west by Kupwara with its peripheries touching Line of Control (LoC) that divide India and Pakistan (Fig. 1). It was a vital stopover on the famous ancient Silk Route connecting Kashmir to Kashgar, an oasis city in Xinjiang province of China. It was also a major path for migration as well as introduction of plant genetic resources between Europe and East Asia. Three main areas recognized in Gurez valley are: 1) Kanzalwan/ Bagtore area, a small steep semicircular region about 11 km in length 2) Dawar area, regarded as Gurez main is approximately 16 km in length comprised of several villages from Badwan to Chorwan including main town of Dawar and 3) Tulail area, a steep valley more than 110 km long extending from famous Habba Khatoon mountain in the east of Gurez main to Kaobal Gali alongside LoC. These areas are around 1-2 kms in width. Chakvali is the last village in Tulail area in the eastern side, after which the valley narrows down leading to mountain pass (Kaobal Gali) to glaciated Mushkoh Valley near Drass (Ladakh). Mighty Kishanganga river drains the entire area between Kaobal Gali in east and Kanzalwan in west and more than three dozen villages with a population somewhere between 30,000 to 35,000 are thus located alongside Kishenganga River (called Neelam in PoK), an important tributary of mighty Jhelum River with its origin in Kishansar Lake and merging into Jhelum River near Muzaffarabad in PoK. Gurez Valley is the homeland of the rare Dard tribe in India, which was a part of ancient civilization of Dardistan. Dawar, in fact was the old capital of Dardistan. The language of Dard tribe is Shin, also known as Sheena, Sina, Shinaki and Brokpa. Shina speaking populations are predominant in Gurez valley besides in neighbouring Drass, Da, Hanu, Beema, Darchik and Garkon areas of

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Ladakh. They practice subsistence farming and eke out a living from harsh mountain terrains.

While moving from Bandipore to Gurez, one has to cross tough Razdan Pass at about 3600m MSL that remains cut off from rest of the country for at least five months a year due to heavy snowfall. Harsh conditions together with physical barriers limit human settlements and intensive agricultural activities. The soils are sandy clay loam type, highly acidic (pH 5.45) with high organic carbon content (1.2%) and average NPK content are 250.8, 27.0 and 235.2 kg/ha, respectively. Out of an estimated 1100 ha area of land under cultivation, only half is irrigated. Potato occupies about 45% of the area; while other important crops are maize, wheat, common bean, fodder crops and vegetables (Badri *et al*., 2014).

While coniferous and broad leaved forests are present in Gurez and Tulail proper, vegetation is rather sparse and dotted mostly with moraines, boulders and slopes of varying steepness at higher elevations. Diverse topography, unique environment and varying habitats resulted in rich biodiversity with unique flora and fauna having good assemblage of rare medicinal plants, crop wild relatives, minor fruits and wild edible plants. Dad and Khan (2011) have reported that 26 plants under 21 genera and 14 families from alpine grasslands in Gurez valley are used as wild edibles by pastorals, nomads and other indigenous communities while Singh and Bedi (2017) described 42 wild edible species from this region. It is a home of endangered animals such as snow leopard, hangul deer, barking deer, musk deer, black bear, *markhor* and ibex.

This area has not been systematically explored for plant genetic resources, and only a meagre germplasm holding exists in the National Gene Bank (NGB) of ICAR-NBPGR, New Delhi, which was collected under National Agricultural Technology Project (1999-2004). Thus, extensive exploration trips were undertaken after a gap of more than a decade for collecting germplasm of different agri-horticultural crops from the region.

## Materials and Methods

During the 2015 and 2017, expeditions were conducted across Gurez Valley covering the Gurez main and Tulail, and nearly all villages were surveyed. Prior to that information on region's flora, agriculture and results from previous collecting missions were gathered and analyzed with the specific aim of better planning of these explorations. Scientists of High Mountain Agricultural Research and Extension Station, Gurez, SKUAST (Kashmir) were also consulted in this regard. The main sources of germplasm samples of cultivated crops were farmer's fields or the threshing yards/farm stores in case the crop had already been harvested. In general, random sampling was followed for field collection and farm stored material whereas small samples were bulked in case of wild species. In a few cases samples were also collected from seed sellers, which made it possible to find out and collect old traditional material. The germplasm of wild species was collected from roadsides, on the sides of farmer's fields, grasslands and from rock crevices. At each collecting site a passport data sheet was filled in as per standard format (Moss and Guarino, 1995) using data from a hand-held GPS system that included latitude, longitude and altitude of the place of collection. In addition to the data recorded directly by the collecting team, further information was amassed through several interviews with local people. Each collection was assigned a unique collector number. The collected materials were deposited in the NGB. Important herbarium voucher specimens were deposited in the National Herbarium of Cultivated Plants (NHCP), ICAR-NBPGR, New Delhi.

## Results and Discussion

All 68 germplasm samples belonging to 28 species were collected from 19 sites across Gurez and Tulail valleys at altitudes ranging from 2403-3491 meters above sea level (Table 1). This included 34 accessions of cultivated plants and 34 accessions of CWRs.

The agricultural activities start generally in the month of May as soon as the snow melts away. Due to very cold, harsh and long spell winter only *Kharif* crop system is followed. Potato, maize and common beans are cultivated everywhere both in Gurez and Tulail valleys, and their mixed cropping was commonly observed. Synthetic fertilizers are either not used or used at a very limited scale; therefore agricultural produce thus obtained is mostly organic. More than 0.1 million quintals of potatoes are produced annually from this area. We have observed a striking case of sustainable agriculture production system through mixed cropping of proso millet, maize, wheat, French bean, potato and other vegetables in some parts of Tulail (Fig. 2E). This area is treasure-trove for many crop wild relatives including minor fruits and vegetables. Besides, countless number of economically important species belonging to forages,

**Table 1. Plant Genetic Resources collected from Gurez Valley of Jammu & Kashmir, India**

| S.No. | Species | Common name | Local name | No. of accessions collected | Remarks |
|---|---|---|---|---|---|
| **Cereals** | | | | | |
| 1 | *Triticum aestivum* | Wheat | Ghoom/ Kanak | 07 | Vary in seed size and color |
| 2 | *Zea mays* | Maize | Makai | 06 | |
| 3 | *Hordeum vulgare* | Barley | Yeao | 01 | |
| 4 | *Elymus dahuricus* | Dahurian wild-rye | | 03 | |
| 5 | *Elymus nutans* | | | 01 | |
| 6 | *Elymus semicostatus* | | | 04 | Two distinct forms collected |
| 7 | *Elymus longearistatus* | | | 01 | |
| **Pseudocereals** | | | | | |
| 8 | *Fagopyrum esculentum* | Sweet buckwheat | Mure/Mori | 01 | |
| 9 | *Fagopyrum tataricum* | Bitter buckwheat | Barve/Chuti | 01 | |
| 10 | *Fagopyrum tataricum* subsp. *potanini* | Bitter buckwheat | Barve | 01 | Comes up spontaneously, not intentionally cultivated |
| 11 | *Amaranthus hypochondriacus* | Amaranth | Ganhar | 01 | |
| 12 | *Chenopodium album* | Chenopod | | 01 | |
| **Millets** | | | | | |
| 13 | *Panicum miliaceum* | Proso millet | Woondu | 01 | |
| **Grain legumes** | | | | | |
| 14 | *Phaseolus vulgaris* | Frenchbean | Rajma | 13 | |
| 15 | *Pisum sativum* var. *arvense* | Pea | Kakun | 02 | Three types seen – pink striped, green-striped, blackish |
| **Oil seeds** | | | | | |
| 16 | *Brassica rapa* subsp. *oleifera* | Turnip rape | Tilagogol | 02 | Comes up as field weed |
| **Vegetables** | | | | | |
| 17 | *Allium stracheyi* | Jamboo | Jangli Pran | 02 | |
| **Fruits** | | | | | |
| 18 | *Malus baccata* | Wild apple | Chirkupalle | 02 | Fruit size and shape variable; >100 yrs old trees found; propagated through suckers apart from seeds |
| **Minor fruits** | | | | | |
| 19 | *Crataegus songarica* | Hawthorn | Shunt | 01 | Almost thorn less type |
| 20 | *Hippophae rhamnoides* subsp. *turkestanica* | Seabuckthorn | Ghurve (Pup) | 02 | Found in many places like Barnoie, Kaspath, Old Tulail, Neru, Zuagi |
| **Forages legumes** | | | | | |
| 21 | *Medicago falcata* | Lucerne | | 01 | |
| 22 | *Medicago sativa* | Lucerne | | 01 | |
| **Spices & condiments** | | | | | |
| 23 | *Bunium persicum* | Black cumin | Zeera/Hawui | 05 | |
| 24 | *Carum carvi* | Carum | Kral-e-Zeur | 03 | |
| **Medicinal & aromatic plants** | | | | | |
| 25 | *Aconitum violaceum* var. *robustum* | Violet Monkshood | Bishmool | 01 | |
| 26 | *Angelica glauca* | Smooth Angelica | Chora | 01 | |
| 27 | *Cichorium intybus* | Chicory | Kasni hund | 01 | |
| 28 | *Hyoscyamus niger* | Henbane | Bajarbang | 01 | |
| 29 | *Saussurea costus* | Kuth | Koth | 01 | |

ornamentals, medicinal and aromatic plants also occur in this area.

### *Cereals, Millets and Pseudocereals*

Maize is the main cereal crop; local landraces are short in stature, with small cobs having variation in grain size and color (yellow, orange or white) coupled with good taste. At Neru village, authors found a type of maize subjected to popping at ambient temperature (Fig. 2A). Maize with white kernels was informed to be tastier than rest of the types. Wheat is the second important cereal cultivated up to 3050 m MSL (in Chakvali),


**Fig. 1. Map of Jammu & Kashmir state. Boundary of the study area in Bandipore district is marked in red color**

however mostly in Tulail tehsil. Like maize, here also plants are shorter in stature with short spikes; both awned and awnless forms depicting variation in grain color and shape were collected. Threshing of harvested wheat was done by traditional method of trampling with bullocks and horses (the practice locally called as '*Khal*') and indigenous implements are still in use (Fig. 2D). Cultivation of barley is limited in this tract; hull-less type having seeds with reddish tinge is an interesting collection (Fig. 2B).

Authors were able to spot cultivation of proso millet only at one place (Sheikhpora, in Tulail). Plants of this easy-to-cook and tasty millet were only 30-40 cm tall, probably had cold tolerance trait. The aged farmer informed that his emotional bond with this traditional crop persuaded him to continue its cultivation, which was otherwise discontinued from cultivation in the entire Gurez and Tulail area, owing to low productivity and availability of better alternatives. Cultivation of another traditional crop buckwheat, according to the locals has also declined drastically. *Fagopyrum tataricum* subsp. *potanini*, a wild progenitor of tartary buckwheat having characteristic wavy seeds has been first time collected from the region from Izmarg, where it occurs as field weed (Fig 2F). In the nearby Bakhtoor village, red-husked grain amaranth was being cultivated at a small scale as medicinal plant (not as pseudocereal). Its roasted grains are given with honey to patients suffering from paralysis. Another pseudocereal of Himalayas, *Chenopodium album* occurs here only as field weed, and not cultivated for food purpose.

Germplasm of wild relatives of wheat and barley belonging to the genus *Elymus* (4 spp.) have been collected for the first time from this area. Foxtail millet progenitor *Setaria viridis* and grain amaranth relatives *Amaranthus hybridus* and *Amaranthus retroflexus* were seen common weeds in the surveyed areas. Besides, *Setaria pumila* and *Elymus caninus* were observed to a lesser extent.

### *Grain Legumes*

Field peas and common beans are the two important grain legumes cultivated, with the latter being more common. Field peas are usually intercropped with maize; however we found it as a sole crop in large scale at Neru in Tulail. The variability collected in common beans especially is interesting and diverse, differing in grain size and color (Fig. 2G). Yellow grain types are comparatively more common in the region despite the fact that red grain types are preferred more by consumers. Scarlet runner bean (*Phaseolus coccineus*) is usually found cultivated in home gardens/backyards.

### *Vegetables and Oilseeds*

*Allium stracheyi* with 20-25 cm long shoots having flat leaves and pale yellow inflorescences is locally called as


**Fig. 2. Maize genotype subjected to popping at ambient temperature (A), interesting naked barley with reddish tinge (B), characteristic and picturesque fields near village Chakvali (Tulail) showing wheat and potato crops (C), indigenous traditional tools used in processing of threshed wheat (D), a small field in Sheikhpora (Tulail) showing multicrop farming (E), *Fagopyrum tataricum* subsp. *potanini* growing in a field in Izmarg (seeds in inset) (F), French bean variability collected (G) and impact of the Kishanganga hydro-electric power project dam–submerging prime agricultural land near Dawar (Gurez) (H).**

'Jangli pran' and the locals collect it from wild and dry it for use in dishes in place of onion. Good populations of this species were found on both sides of Razdan Pass in rocky crevices. *Brassica rapa* subsp. *oleifera* with smaller leaves has been observed as a weed in crop fields. Both the red and normal skinned potatoes cultivated here are hardy in texture, superior in quality, and with long storage life without sprouting. In this regard, registering the produce under the tag of Geographic Indication and promoting domestic exchange and export of this high-value commodity would help enhancing the livelihoods of local people. Some high value household vegetables such as local turnip, radish (*muli*) and *Brassica oleracea* var. *sabellica* (haak; *kram*) are often protected from browsing by domestic animals through upright wooden planks. It is a common practice that storage of potatoes and some other vegetables are achieved through their deep burial in earthen pits at the beginning of winter. Such storage pits dug out in open land to store vegetables especially potatoes, cabbage, turnip etc. for winter season use are locally called as *deas*.

### *Fruits and Nuts*

Variability for fruit size in *Hippophae rhamnoides* subsp. *turkestanica* Rousi has been collected from Tulail area. Locally this plant is called 'ghurve' while its ripe fruits are called 'pup'. According to the locals the fruits are only eaten by crows and occasionally by children, and there is no commercial utilization of fruit unlike in Leh areas. The fruits are also used to cure liver ailments. Temperate fruits such as apple, European pear, quince and sour cherry were found cultivated in village premises. Good variability in *Malus baccata* in terms of fruit size, leaf size and suckering habit was observed. Walnut abundantly grows wild in the forests especially in Gurez area, but nuts are very hard to crack with very low kernel recovery. However, elite walnut selections with thin shell and good kernel recovery were commonly found in backyards. This tract has bountiful wealth of minor fruits such as *Rubus saxatilis*, *Chenopodium foliosum*, *Viburnum foetens*, *Prunus cornuta*, *Prunus armeniacus*, *Fragaria nubicola*, *Corylus jacquemontii* (chamdai) and species of *Cotoneaster* and *Ribes*, indicating the need for future explorations for these species.

### *Spices and Condiments*

Gurez has been famous for good production of kala zeera [*Bunium persicum* (Boiss.) B. Fedtsch]; a valuable seed spice and wild plant genetic resource having potential to support livelihood of thousands of local people. Its fruit size varies slightly from place to place. The fruits of this species and *Carum carvi* are collected from the wild by local people, sold and used as a spice. Hot decoction of their fruits is used to cure various digestive and abdominal ailments (Kapahi *et al*., 1993). Both these species have been over harvested which may be one of the reasons for their declining populations and production in the area.

### *Medicinal and Aromatic Plants*

Representative samples of medicinal plants such as *Aconitum violaceum* var. *robustum*, *Angelica glauca*, *Cichorium intybus*, *Hyoscyamus niger* and *Saussurea costus* were collected. Other medicinal plants observed growing in the region include *Podophyllum hexandrum*, *Heracleum candicans*, *Origanum vulgare*, *Atropa acuminata*, *Achillea millefolium*, *Hypericum perforatum*, *Artemisia maritima*, *Dioscorea deltoidea* and *Lepidium apetalum*. *Lepidium apetalum* was found in Neru area and was earlier found by the authors cultivated locally in Zanskar (Ladakh) as "Amchi" medicine. State government forest nursery near Izmarg is involved in field conservation of several of these medicinal plants.

### *Other Crops*

While one accession each of *Medicago falcata* and *Medicago sativa* have been collected from road side, well protected by concertina wire (razor wire) fences, other forage species – *Trifolium repens*, *Trifolium pretense*, *Lotus corniculatus*, *Medicago lupulina*, *Dactylis glomerata* and *Lolium* spp. were found growing at many places. Hops was observed as semi-wild throughout the surveyed areas. Other economic species found are *Salix* spp., *Trigonella emodii*, *Rosa macrophylla* and *Rosa webbiana*.

### *General Observations*

The lifeline of Gurez and Tulail valleys is the motorable road passing through dangerous Razdan Pass, which remains blocked for nearly six months a year due to heavy snowfall, therefore the area remains physically isolated from rest of the country for half a year. Probably this isolation has protected and preserved the biodiversity and cultural identity of Gurez. Agricultural practices here are sustainable and eco-friendly, as they are still based on local cultivars, human labour, animal power and indigenous implements. Though, different kinds of cultivars are available here, they are not known by distinct

landrace names unlike other parts of the country. Genetic diversity that has been increasingly lost in traditional crops like proso millet and buckwheat in these areas is not due to the reason that older generations failed to pass on their knowledge or values to the younger generation but because of the reluctance of young generation to adapt to their wisdom to meet the food, nutritional and livelihood security.

Browsing by domestic animals is a serious threat to the survival of wild germplasm, particularly CWR. For this reason, we could find their good population amidst concertina wire fences prevalent in the entire area established for defense purpose, which are otherwise amenable to browsing. Besides, the valley is on the verge of being submerged by the dam of 330 MW Kishanganga hydro-electric power project. The main town of Dawar and nearby villages have been badly affected (Fig. 2H) and hundreds of acres of land has already been submerged. The impact on overall ecology and biodiversity is going to be massive. This necessitates an urgent need to further explore and rescue the potential germplasm before it is lost forever.

## Conclusion

Maximum collections in French bean (13), followed by wheat (7), maize (6), *Bunium persicum* (5) and *Elymus semicostatus* (4) indicate that this area is rich in diversity of these crops. Rich species and genetic diversity in minor fruits, medicinal and aromatic plants, forages and wild ornamentals indicate the need for continued collecting missions. Unprecedented threat of submergence of prime agricultural land by the construction of dam for hydro-electric power project together with construction of more roads and browsing will continue to be major factors affecting genetic erosion and loss of local biodiversity. Reluctance of younger generation to carry forward the legacy of elders has contributed greatly towards loss of traditional crops. Community support initiatives are required to preserve them *in situ* (on farm), through the sharing of knowledge, publicity and cooperation with scientific researchers and governmental organizations.

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