

RESEARCH ARTICLE

Collecting Plant Genetic Resources from Remote and Isolated Marwah-Warwan Valley of Jammu and Kashmir, India

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Abstract

Marwah-Warwan is an isolated remote valley falling in the Kishtwar district of Jammu Kashmir, India. Considered one of the great wildernesses in the inner Himalayas, the valley is located in the south-east of Jammu & Kashmir sandwiched between the Anantnag district of Kashmir in the west and Suru Valley of Kargil district of Ladakh in the east separated by lofty mountains. There are a total of 27 villages in the valley and several of these villages are still not connected by road. An exploration and germplasm collection programme was undertaken by ICAR-NBPGR in this region and 82 germplasm accessions of diverse agri-horticultural crops belonging to 27 genera and 30 (15 cultivated and 15 wild) species were collected from 24 sites ranging between 33°36' to 33°56' N latitude, 75°26' to 75°48' E longitude with an altitudinal range of 2159 - 3529 m MSL. The germplasm collected included that of cereals, pseudocereals, minor millets, grain legumes, minor fruits/nuts and medicinal plants. The collected germplasm has been submitted for conservation in the National Gene Bank (NGB) which has negligible representation of crop genetic resources from this region. Besides, these collections assume importance especially when the area is increasingly being exposed to the outside world with the construction of roads and other developmental activities, posing a challenge to local agro-biodiversity. Cultivation of paddy, barley and several minor crops has already started vanishing from the system. This article highlights information on the germplasm collected, cultivation practices, genetic erosion and future exploration potential in the region.

Keywords: Exploration, Germplasm collection, Inner Himalayas, Marwah-Warwan Valley.

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Introduction

Marwah-Warwan situated in the Inner Himalayas is an isolated remote valley falling in Kishtwar district of Jammu and Kashmir, India. Located in the south-east of Jammu and Kashmir, Kishtwar district is flanked by lofty Himalayan mountains from all sides and surrounded by districts of Anantnag and Doda and Kargil, Ladakh and touching the northern boundaries of Himachal Pradesh state. Kishtwar proper is the main town of the district connected by a 110 km road with the Srinagar-Jammu national highway at Batote hill station. Kishtwar is also connected with Kashmir valley by Daksum Anantnag - Synthan top (33°34', 75°30', 3793 m MSL) - Chatroo road. The main town of Kishtwar branches off into three main valleys, namely Paddar Valley, Chatroo Valley and Marwah-Warwan Valley. Warwan and Marwah are two separate sub-districts or tehsils among 11 in the district, each one is constituted of about a dozen thinly populated villages. Inshan village is the tehsil HQ of Warwan while Nowapachi village is the tehsil HQ of Marwah. Marwah-Warwan (local "Madeaw-Wardwan") regarded as one of the remotest places in Jammu and Kashmir is a long narrow valley more than 50 km long stretching from village Sukhnai Warwan

in the north to village Hanzal Marwah in the south and on an average less than half a km wide sandwiched between Kashmir valley and Chatroo valley in the west and Suru valley of Ladakh in the east separated by lofty mountains. The valley is drained by Warwan River flowing from Warwan in the north to Marwah in the south with several streams/nallahs flowing into it from both sides of the valley forming the Maru or Marusudhar River as it enters Marwah tehsil. It is considered the largest tributary of the river Chenab meeting it at Bhanderkoot just above Kishtwar town. Renai *nallah* is one of the several prominent *nallahs* flowing southwest of the valley bordering the north side of Kishtwar National Park meeting the Maru River at village Qaderna. Mineral springs of hot water (local "Tatapani") and cold water (local "Shifapani") are located on the banks of this *nallah*. In the higher altitudes of the Kishtwar National Park famous for snow leopards, extensive alpine scrub and meadows, open rocks and glaciers are present. These meadows present a picturesque serene view during the peak blooming period of June-July with colorful flowering plants such as Himalayan cinquefoil (*Potentilla astrosanguinea* Lodd.), *Myosotis alpestris* F.W. Schmidt. etc. On the banks of the *nallahs*/streams in lower catchment areas, one can see lush green forests of fir [*Abies pindrow* (Royle ex D. Don) Royle], deodar [*Cedrus deodara* (Roxb.) G. Don], kail/blue pine (*Pinus wallichiana* A. B. Jacks.), spruce [*Picea smithiana* (Wall.) Boiss.] and Himalayan yew (*Taxus wallichiana* Zucc.).

Marwah-Warwan is biodiversity rich fertile valley with agriculture as the mainstay of almost entire population. The people are simple and hospitable and majority of them speak *Kashmiri* with a localized accent. Interestingly, although Marwah-Warwan is the part of district Kishtwar of Jammu Province, the only motorable road to this area is from district Anantnag of Kashmir Province through Marghan Top. Alternatively, people have to cross arduous hilly tracts through villages of Tellar, Hanzal and then Dachhan tehsil areas by foot to reach main town of Kishtwar. The area remains cut off for 4-5 months in a year from rest of the country due to heavy winter snowfall. Earlier during the years 2013, 2015 and 2018, systematic expeditions were conducted by ICAR-NBPGR in Chatroo Valley, Padder Valley and Kishtwar main including some areas of Dachhan, Surror, Sarthal, Thakraie, Bhonjwa and Drabshala and valuable germplasm of cereals, pseudocereals, millets, pulses, vegetables etc. has been collected and conserved in the National Gene Bank (Sultan *et al.*, 2019b). Since Marwah-Warwan part of Kishtwar district was not yet explored by ICAR-NBPGR and there is almost negligible representation of crop genetic diversity in the National Gene Bank from this region, the present exploration and germplasm collection programme was undertaken systematically to collect the available genetic diversity from this unexplored place, especially at a time when the area is being increasingly opened up to outside

world for tourism and other developmental activities, posing a challenge to local agro-biodiversity.

Materials and Methods

Exploration and germplasm collection programme approved under National Exploration Plan 2022-23 was undertaken in Marwah-Warwan Valley of Jammu and Kashmir, India during September 2023. The villages Mulwarwan and Inshan of Warwan tehsil were the entry points into the valley through the Marghan mountain pass (33°44'N, 75°29'E, 3702 m MSL). Before exploration, information on the region's flora, agriculture etc. was gathered from available literature and other sources, for example, Govt. agencies, NGOs etc. and analyzed with the specific aim of better planning of the exploration. Scientists of Rice Research Station, SKUAST-K, Khudwani, Anantnag (J&K), High Altitude Maize Research Station, SKUAST-K, Sagam, Kokernag, Anantnag (J&K) and High Altitude Research Station, SKUAST-K, Larnoo, Kokernag, Anantnag (J&K) were also consulted in this regard. Standard procedures of germplasm exploration and collection developed by ICAR-NBPGR, New Delhi (Tyagi *et al.*, 2016) were followed. The main sources for collection 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. The germplasm of wild species was collected from roadsides, alongside farmer's fields, grasslands, hill slopes and from rock crevices. The samples were collected in the form of seeds, fruits, bulbs, corms, rhizomes, tubers, etc. based on their mode of propagation. At each collection site a passport data sheet was filled as per standard format (Moss and Guarino, 1995) including data from hand-held GPS system on latitude, longitude and altitude of the place of collection. For recording ethno-botanical information, discussions were held with local knowledgeable farmers and elderly people. Each collection was assigned a unique collector number. One set of the collected materials was deposited in National Gene Bank, ICAR-NBPGR, New Delhi for conservation, while another set of majority of the collections were retained for characterization and multiplication.

Results and Discussion

Marwah-Warwan Valley is an isolated remote place with almost entire population directly or indirectly involved with the agriculture and allied sectors (Fig. 1). It is mostly a mono cropped zone with low production and productivity and the people are largely practising subsistence farming. Maize, wheat, potato and common beans are the main crops. "Ambri" apple plants are also grown at places in the area. These crops are essentially cultivated using organic and traditional eco-friendly farming methods with very

limited use of modern agricultural inputs and still based on local cultivars, human labour, animal power and indigenous implements. Potatoes and other such vegetables are traditionally stored in deep pits covered with soil for winter use. Marwah tehsil is comparatively bigger in area, more populated and richer in vegetation than Warwan tehsil. The two tehsils are about 30 kms apart and Hajika nallah near Sarkund village separate the two. While moving from Warwan to Marwah, countless wild walnut trees can be seen growing on both sides of the road. Wherever sizable population of these walnut trees is present, local people refer to the place as “Doonkhal” (“Doon” is local name for walnut). Similarly, the place with larger population of *Sambucus wightiana* Wall. (local “Gonji”) is referred to as “Gonjikhhal”. The entire valley is guarded by lofty mountains on all sides, and it is this isolation that has probably protected and preserved local agro-biodiversity for a long time. However, according to locals, during last decade there has been tremendous loss of biodiversity especially of useful medicinal herbs in the valley. Earlier medicinal plants grew more commonly and livestock used to graze these herbs. The consumption of different products from such livestock led to healthier lifestyle free from modern day ailments in local population. Several important medicinal herbs still grow in the higher reaches of the valley which are overharvested now for commercial purposes. During present exploration in the area, the authors have observed alien invasive weeds such as *Xanthium spinosum* L. growing abundantly along tracks. Such invasive alien species pose a significant threat to the local biodiversity in general. The authors have earlier reported this weed growing in several other places of Kishtwar district as well (Sultan *et al.*, 2019b). In fact, species which are listed to be of immediate concern in the Kishtwar district include *Parthenium hysterophorus* L., *Xanthium spinosum* L., *Cirsium arvense* (L.) Scop. and *Anthemis cotula* L. (Bhutyal *et al.*, 2014). Since Marwah-Warwan valley is now being increasingly opened up for the outside world and developmental activities including construction of roads etc. have been initiated, the erosion of the local

biodiversity is inevitable. First time concerted efforts have been made by ICAR-NBPGR in an organized way to survey and explore almost all the villages of the region falling in the altitudinal range of 2159 - 3529 MSL, 33°36' - 33°56' N latitude and 75°26' - 75°48' E longitude for collection of crop genetic resources. The exploration has yielded a total of 82 germplasm accessions (Table 1) from 24 different collection sites (Table 2) of following crops:

Cereals

Maize and wheat are the main cereal crops grown in the region. According to locals barley and paddy were also commonly cultivated earlier but these crops especially paddy has now been almost abandoned. During the present exploration programme seven (07) accessions of maize (*Zea mays* L.), six (06) accessions of wheat (*Triticum aestivum* L.), four (04) accessions of naked barley (*Hordeum vulgare* L.) and two (02) accessions of paddy (*Oryza sativa* L.) were collected. Maize landraces collected were short with small cobs having yellow or white grains. Wheat also has small plants with short spikes (Fig. 2A). One of the accessions collected from Warwan area (SHEIKH-1251) has small reddish grains in contrast to the straw- colored grains of other accessions. Naked barley is cultivated as in neighboring Ladakh. This is quite interesting as in other parts of Kishtwar district hulled barley is cultivated instead and authors have collected several accessions of hulled barley (local “Jau”) earlier (Sultan *et al.*, 2019b). According to elderly farmers of Warwan area, their forefathers have originally brought barley and wheat seed from Ladakh which is being cultivated up to this day. The two paddy accessions collected were awned with dull white and bold grains (Fig.2C). Earlier, paddy was commonly cultivated, largely in the fields located on the banks of nallahs/streams especially in Marwah area, but now as the water level in the river/nallahs has significantly fallen below, badly affecting paddy field irrigation, the farmers have discontinued paddy cultivation. Paddy cultivation still has the potential to be revived once electricity supply reaches the area and lift irrigation pumps get installed.

Pseudocereals

Nine (09) accessions of Tartary buckwheat [*Fagopyrum tataricum* (L.) Gaertn.], two (02) accessions of grain amaranth (*Amaranthus caudatus* L.) and two accessions of grain chenopod (*Chenopodium album* L.) were collected during present exploration. Earlier, these crops were more commonly cultivated but now farmers are increasingly losing interest in these valuable and climate resilient crops. Interestingly, in the entire Warwan-Marwah region only bitter buckwheat [*Fagopyrum tataricum* (L.) Gaertn.] is cultivated and we have not seen sweet buckwheat (*Fagopyrum esculentum* Moench) being cultivated anywhere. It seems due to harsh climate and isolated conditions, the farmers of this region have preferred and selected bitter buckwheat for

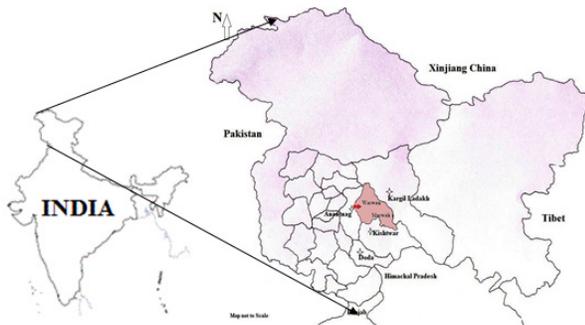


Fig. 1: Map of UT of Jammu & Kashmir. Shaded portion within Kishtwar district is the study area of Marwah-Warwan (arrow mark in red color denotes the Marghan Top entry point into the area)

Table 1: Plant Genetic Resources (PGR) collected from Marwah-Warwan valley in Kishtwar district of Jammu & Kashmir, India

| S No. | Crop | Species | Local name | No. of accessions | Traits |
|--|-----------------------|--|-----------------------|-------------------|---|
| <i>Cereals</i> | | | | | |
| 1 | Maize | <i>Zea mays</i> L. | Maki | 07 | Shorter plants and cobs |
| 2 | Wheat | <i>Triticum aestivum</i> L. | Kanak | 06 | Shorter plants and spikes |
| 3 | Barley | <i>Hordeum vulgare</i> L. | Grim/Vishki | 04 | Naked greenish |
| 4 | Rice | <i>Oryza sativa</i> L. | Madeaw Dhani | 02 | Awne d, bold dull white grains |
| 5 | Wild rye | <i>Elymus semicostatus</i> (Steud.) Melderis | | 02 | |
| 6 | Wild rye | <i>Elymus caninus</i> L. | | 01 | |
| 7 | Wild rye | <i>Elymus nutans</i> Griseb. | | 01 | |
| <i>Pseudocereals</i> | | | | | |
| 8 | Buckwheat | <i>Fagopyrum tataricum</i> (L.) Gaertn. | Trumba/Dhruv | 09 | Lesser seed shattering |
| 9 | Grain amaranth | <i>Amaranthus caudatus</i> L. | Seoul | 02 | |
| 10 | Grain chenopod | <i>Chenopodium album</i> L. | Kankudroo | 02 | |
| <i>Millets</i> | | | | | |
| 11 | Foxtail millet | <i>Setaria italica</i> (L.) P. Beauvois | Shol | 04 | Primitive features, seed shedding |
| 12 | Finger millet | <i>Eleusine coracana</i> Gaertn. | Kudroo | 03 | |
| 13 | Proso millet | <i>Panicum miliaceum</i> L. | Anne | 02 | |
| <i>Grain legumes</i> | | | | | |
| 14 | Common bean | <i>Phaseolus vulgaris</i> L. | Madeaw-Wardwan rajma | 12 | Medium sized, reddish grains common |
| 15 | Soybean | <i>Glycine max</i> (L.) Merr. | Muthi | 03 | One acc. with smaller brownish grains |
| <i>Fruits and nuts</i> | | | | | |
| 16 | Sea buckthorn | <i>Hippophae rhamnoides</i> subsp. <i>turkestanica</i> Rousi | Kandi phall | 01 | Plants less thorny |
| 17 | Hawthorn | <i>Crataegus songarica</i> K. Koch | Reng/Khring | 02 | One acc. thornless |
| 18 | Himalayan viburnum | <i>Viburnum grandiflorum</i> Wall. ex DC. | Kulma | 02 | |
| 19 | Hip rose | <i>Rosa canina</i> L. | Gulab | 02 | |
| 20 | Hip rose | <i>Rosa macrophylla</i> Lindl. | Gulab | 01 | |
| 21 | Stone bramble | <i>Rubus saxatilis</i> L. | Chanch | 01 | Fruits shiny red and tasty |
| 22 | Himalayan bird cherry | <i>Prunus cornuta</i> (Wall. ex Royle) Steud. | Zanbi dach | 01 | |
| 23 | Hazelnut | <i>Corylus jacquemontii</i> Decne. | Jangli badam/ Virvoin | 01 | |
| <i>Medicinal & aromatic plants</i> | | | | | |
| 24 | Yams | <i>Dioscorea deltoidea</i> Wall. ex Griseb. | Kinns/Discorea | 03 | |
| 25 | Henbane | <i>Hyoscyamus niger</i> L. | Bajarbangh | 03 | |
| 26 | Indian costus | <i>Saussurea costus</i> (Falc.) Lipsch. | Kuth | 01 | |
| 27 | Himalayan yew | <i>Taxus wallichiana</i> Zucc. | Postul phall | 01 | The aril of the berries is edible and has medicinal value |

| Other crops | | | | | |
|-------------|------------------|--------------------------------|---------------|----|----------------|
| 28 | Tomato | <i>Solanum lycopersicum</i> L. | Tamatar | 01 | Smaller fruits |
| 29 | Mountain spinach | <i>Atriplex hortensis</i> L. | Wust-e- haakh | 01 | |
| 30 | Sunflower | <i>Helianthus annuus</i> L. | Gul-e-aftab | 01 | |

Table 2: Geographical coordinates of collection sites of crops species/CWR collected in Marwah-Warwan valley in Kishtwar district of Jammu & Kashmir, India

| S. No. | Collection site/Area/ Village | Latitude | Longitude | Altitude (m) | Crop/CWR collected |
|--------|--|----------|-----------|--------------|---|
| 1 | Dhobpathar, 5 kms ahead of Gawran | 33°43' | 75°26' | 2729 | <i>Rosa canina</i> |
| 2 | Upper Batinallah, 3 kms before Marghan Top | 33°46' | 75°31' | 3529 | <i>Elymus nutans</i> |
| 3 | Nadibalan Warwan | 33°46' | 75°32' | 3366 | <i>Rubus saxatilis</i> |
| 4 | Lower Nadibalan Warwan | 33°46' | 75°32' | 3285 | <i>Elymus caninus</i> |
| 5 | Uuriwan Warwan | 33°48' | 75°33' | 2503 | <i>Triticum aestivum</i> |
| 6 | Afti Warwan | 33°51' | 75°32' | 2586 | <i>Hippophae rhamnoides</i> ssp. <i>turkistanica</i> , <i>Rosa canina</i> , <i>Saussurea costus</i> |
| 7 | ChoiDraman Warwan | 33°51' | 75°32' | 2559 | <i>Triticum aestivum</i> (2 acc.), <i>Phaseolus vulgaris</i> , <i>Fagopyrum tataricum</i> |
| 8 | Basmuna Warwan | 33°50' | 75°29' | 2689 | <i>Phaseolus vulgaris</i> , <i>Triticum aestivum</i> , <i>Fagopyrum tataricum</i> , <i>Rosa macrophylla</i> , <i>Zea mays</i> |
| 9 | Upper Basmuna Warwan | 33°50' | 75°29' | 2704 | <i>Solanum lycopersicum</i> , <i>Atriplex hortensis</i> , <i>Triticum aestivum</i> |
| 10 | Gumri Warwan | 33°55' | 75°31' | 2768 | <i>Hyoscyamus niger</i> (2 acc.), <i>Fagopyrum tataricum</i> |
| 11 | Rikenwas Warwan | 33°56' | 75°31' | 2775 | <i>Fagopyrum tataricum</i> |
| 12 | Barayan Warwan | 33°50' | 75°32' | 2571 | <i>Phaseolus vulgaris</i> , <i>Hordeum vulgare</i> , <i>Triticum aestivum</i> , <i>Fagopyrum tataricum</i> |
| 13 | Sarkund Marwah | 33°42' | 75°38' | 2327 | <i>Dioscorea deltoidea</i> , <i>Viburnum grandiflorum</i> , <i>Zea mays</i> , <i>Prunus cornuta</i> |
| 14 | Qaderna Marwah | 33°38' | 75°43' | 2221 | <i>Elymus semicostatus</i> , <i>Crataegus songarica</i> , <i>Setaria italica</i> , <i>Hordeum vulgare</i> , <i>Fagopyrum tataricum</i> , <i>Oryza sativa</i> , <i>Eleusine coracana</i> (2 acc.), <i>Glycine max</i> (2 acc.), <i>Panicum miliaceum</i> , <i>Phaseolus vulgaris</i> , <i>Zea mays</i> |
| 15 | AstanGam Marwah | 33°40' | 75°42' | 2159 | <i>Setaria italica</i> , <i>Phaseolus vulgaris</i> , <i>Zea mays</i> , <i>Amaranthus caudatus</i> |
| 16 | Satarwagen Yuordo Marwah | 33°40' | 75°42' | 2346 | <i>Chenopodium album</i> , <i>Fagopyrum tataricum</i> , <i>Amaranthus caudatus</i> , <i>Hordeum vulgare</i> , <i>Phaseolus vulgaris</i> |
| 17 | Chanjier Marwah | 33°37' | 75°42' | 2184 | <i>Zea mays</i> , <i>Glycine max</i> , <i>Phaseolus vulgaris</i> , <i>Hordeum vulgare</i> , <i>Chenopodium album</i> , <i>Oryza sativa</i> , <i>Setaria italica</i> , <i>Elusine coracana</i> , <i>Fagopyrum tataricum</i> |
| 18 | One km before Teller Marwah | 33°36' | 75°43' | 2198 | <i>Crataegus songarica</i> |
| 19 | Teller Marwah | 33°36' | 75°43' | 2202 | <i>Zea mays</i> , <i>Phaseolus vulgaris</i> , <i>Viburnum grandiflorum</i> , <i>Dioscorea deltoidea</i> , <i>Corylus jacquemontii</i> , <i>Taxus wallichiana</i> |
| 20 | Hynan Marwah | 33°37' | 75°42' | 2182 | <i>Zea mays</i> , <i>Phaseolus vulgaris</i> , <i>Dioscorea deltoidea</i> |
| 21 | Yurodo Marwah | 33°39' | 75°43' | 2174 | <i>Helianthus annuus</i> |

| | | | | | |
|----|----------------------------------|--------|--------|------|---|
| 22 | Three kms ahead of Yurodo Marwah | 33°39' | 75°44' | 2318 | <i>Elymus semicostatus</i> |
| 23 | Anyar Marwah | 33°39' | 75°47' | 2337 | <i>Hyoscyamus niger, Phaseolus vulgaris</i> |
| 24 | Zaban Renaie Marwah | 33°39' | 75°48' | 2378 | <i>Setaria italica, Panicum miliaceum, Fagopyrum tataricum, Phaseolus vulgaris</i> (2 acc.) |

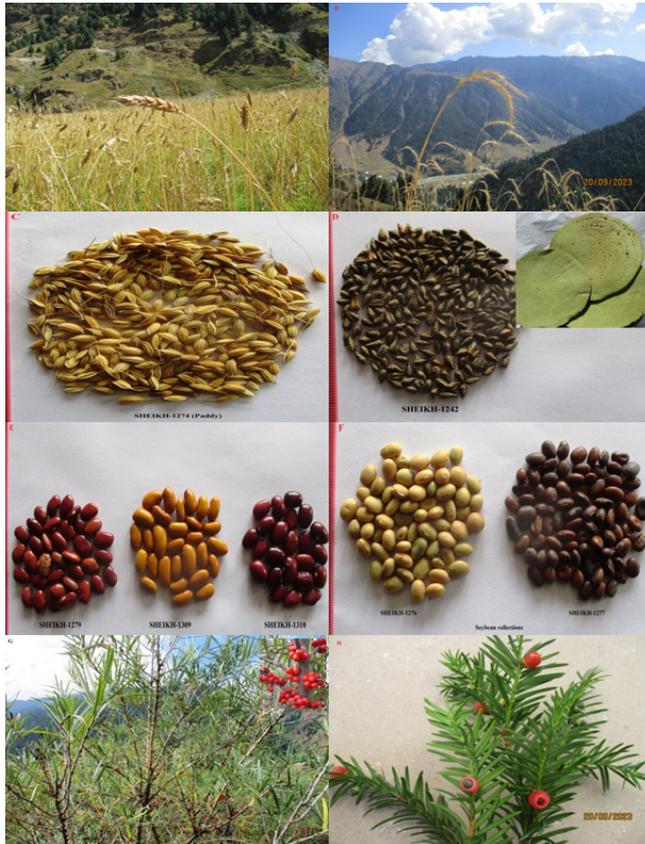


Fig 2: A characteristic wheat field in Warwan area (A), *Elymus nutans* collected at the entrance of Warwan valley near Marghan Top (B), Paddy (Local "Madeaw Dhani") collected from Marwah area (C), Buckwheat (*Fagopyrum tataricum*) collection SHEIKH-1242, in the inset buckwheat pancake (Local "Dhull") prepared on a stone pan (D), Some variable common bean and soybean collections (E and F), Seabuckthorn (*Hippophae rhamnoides* subsp. *turkestanica*) population growing at Afiti Warwan (G) and Himalayan yew (*Taxus wallichiana*) collected near Teller Marwah (H)

cultivation; it is considered to be healthier containing greater amount of rutin and having higher antioxidant activity than common or sweet buckwheat. It has been reported that rutin content in *Fagopyrum tataricum* is almost 100 times higher than that of *Fagopyrum esculentum* (Kitabayashi *et al.*, 1995). In other areas of Kishtwar *Fagopyrum esculentum* is cultivated besides *Fagopyrum tataricum*. Interestingly, lesser seed shattering was observed by us during buckwheat harvesting in farmer fields in Warwan areas. The buckwheat flour dough is fermented overnight before being made into pancakes on a stone pan. The resultant sourness in the dough according to the locals neutralizes the bitterness in

pancakes to some extent. These pancakes are locally called as "Dhull" and are eaten with honey or sugar (Fig 2D).

Millet

Four (04) accessions of foxtail millet [*Setaria italica* (L.) P. Beauvois], three (03) accessions of finger millet (*Eleusine coracana* Gaertn.) and two (02) accessions of proso millet (*Panicum miliaceum* L.) have been collected mostly from Marwah areas. Earlier these crops were cultivated commonly and consumed in the form of porridge but now younger generation has lost interest in these crops which are now unfortunately vanishing from the system. Elderly people fondly mention these crops and their nutritional worth. Primitive form of *Setaria italica* is being cultivated more commonly than other two minor millets and is used as animal feed and fodder (Fig. 3 B and C). Its grains are boiled in water and then fed to the cattle and as per locals it then increases milk yield. The millet is characteristically threshed by trampling with bullocks. According to locals, in earlier times it was cooked and eaten like rice. This primitive type of foxtail millet has earlier been collected by us from Padder area of Kishtwar where it is locally known as "Sallan"; its roasted grains are ground and used as satu there (Sultan *et al.*, 2019b). Seed shedding is a problem with it, besides morphologically it is closer to *Setaria viridis* (L.) P. Beauv., the wild relative of foxtail millet.

Grain legumes

Of all the crops collected during our present exploration programme, maximum number of accessions (12) have been collected in common beans indicating their common cultivation in the region. The common bean landraces in Jammu and Kashmir are frequently named according to the area of production and every region claims to produce unique and tasty common beans. Similarly, common beans produced in Marwah-Warwan are known as Marwah-Warwan rajma (Madeaw-Wardwan rajma) and are believed to be superior in quality and taste. The common beans produced here are often reddish colored with medium sized grains (Fig. 2E) in contrast to other regions of Kishtwar and in Gurez valley of Kashmir where good variability in size and color has been collected (Sultan *et al.*, 2019a). One accession of short duration elongated yellow grained common bean has been collected from Marwah region (SHEIKH-1309). Three (03) accessions of soybean [*Glycine max* (L.) Merr.] have also been collected during present exploration including one unique small, brown-seeded collection from Qaderna Marwah (SHEIKH-1277) (Fig. 2F).



Fig. 3: A man working in a buckwheat field in Warwan village (A), A man carrying harvested foxtail millet landrace on his back in Marwah village (B), Harvested foxtail millet landrace stacked in front of a typical house before being threshed by trampling with bullocks in remote Zeban Renai village of Marwah (C) and a traditional watermill in Teller Village of Marwah (D)

Fruits and nuts

In Marwah area “Ambri” apple plants with fragrant tasty fruits were found growing in front of several homes. Small populations of sea buckthorn (*Hippophae rhamnoides* subsp. *turkestanica* Rousi) were found growing on sandy stream banks near village Afiti of Warwan (Fig. 2G) and village Qaderna of Marwah. Strangely locals are quite ignorant about this important plant genetic resource; its local name “Kandi phall” apparently indicates the uselessness of the plant. Unlike the plants growing in Ladakh and Telail Gurez, sea buckthorn plants growing in Marwah-Warwan valley are less thorny; one accession of this plant has been collected from Afiti Warwan. The value and importance of sea buckthorn and need for its conservation was highlighted during an interaction meeting with elderly people of Warwan area during the present exploration programme. The locals were informed about the nutritional importance of this minor fruit which in neighboring Ladakh is known by the name of “Leh berry” and is a source of livelihood of many people there. Two accessions each of hawthorn (*Crataegus songarica* K. Koch), Himalayan viburnum (*Viburnum grandiflorum* Wall. ex DC.), hip rose (*Rosa canina* L.), one accession each of *Rosa macrophylla* Lindl., *Rubus saxatilis* L. and *Prunus cornuta* (Wall. ex Royle) Steud. were also collected. One accession of *Crataegus songarica* (SHEIKH-1296) is significantly thorn less with tasty fruits. While moving from Warwan to Marwah, countless plants of wild walnuts (*Juglans regia* L.) were seen growing in the forests at several places. These plants are a source of livelihood for local people who collect their comparatively smaller, harder and difficult to crack nuts and sell them to the contractors

at a meagre price. One accession of hazelnut (*Corylus jacquemontii* Decne.) has been collected near village Teller of Marwah. Small population of dispersed plants can be seen growing here. *Sorbus* L. spp. (local “Muilli”) was also found growing at this place and locals fondly eat its soft tasty fruits. It could not be collected during the present exploration as it was not at suitable stage of collection.

Medicinal and aromatic plants

The area abounds in wealth of medicinal plants mostly growing in higher reaches. These include *Angelica glauca* Edgew., *Viola odorata* L., *Podophyllum hexandrum* Royle, *Atropa belladonna* L., *Rheum emodi* D. Don, *Arnebia benthamii* (Wall. ex G. Don) LM. Johnston, *Picrorhiza kurrooa* Royle ex Benth., *Inula royleana* DC., *Delphinium roylei* Munz, *Jurinea dolomiaea* Boiss. etc. Three (03) accessions each of yams (*Dioscorea deltoidea* Wall. ex Griseb.) and Henbane (*Hyoscyamus niger* L.) and one (01) accession of Indian costus [*Saussurea costus* (Falc.) Lipsch.] have been collected during the present exploration. One accession of *Taxus wallichiana* Zucc. has also been collected some 2 kms ahead of Teller village. Its berries are eaten by locals and are believed to be general tonic, effective against cough. The berries are about 0.9cm long and 0.7cm broad; reddish berry flesh or aril is the edible part while the single stone/seed enclosed within this aril is highly toxic (Fig 2H).

Other crops

Besides common beans, maize and wheat, potato is the fourth common crop grown in both Warwan and Marwah areas. Potatoes cultivated in the area are tasty and both white and red skinned types are grown. One accession

each of tomato (*Solanum lycopersicum* L.) with small attractive fruits and mountain spinach (*Atriplex hortensis* L.) has been collected in Warwan area. Apart from potatoes, vegetable cultivation in the entire area seems to be limited. Interestingly, one accession of sunflower (*Helianthus annuus* L.) has also been collected from Marwah region and according to the farmer, it is being grown from the time of his forefathers but its cultivation has now been stopped.

Besides, these crops wild rye (*Elymus nutans* Griseb.) accession (SHEIKH-1315) has been collected near Margan Top at an altitude of 3529 mMSL (Fig. 2B). Two (02) accessions of *Elymus semicostatus* (Steud.) Melderis and one (01) accession of *Elymus caninus* L. have also been collected during the course of present exploration.

To sum-up, eightytwo (82) germplasm accessions of diverse agri-horticultural crops thus collected belong to 27 (15 cultivated and 12 wild) genera and 30 (15 cultivated and 15 wild) species (Table 1). Maximum number of accessions have been collected in common beans (12), followed by *Fagopyrum tataricum* (09), *Zea mays* (07) and wheat (06) indicating diversity of these crops in the region. Maximum number of accessions of various crops (13) have been collected from Qaderna village area. This crop diversity is of primary importance in the nutritional and livelihood security of the local population. One set of all the 82 collected germplasm accessions has been submitted for conservation in National Gene Bank at ICAR-NBPGR, New Delhi while another set of majority of these accessions has been retained for characterization/maintenance. Genetic diversity of crops, gathered and protected from extinction in the gene banks worldwide is no doubt essential for dealing with changing and more demanding environments. However, it would always be wiser to mobilize and support local communities to preserve crop genetic resources *in situ* (on farm), through the sharing of knowledge, publicity and cooperation with scientific researchers and governmental organizations.

The remote, isolated and picturesque area of Marwah Warwan is surrounded by a difficult terrain which has made development of transportation infrastructure and logistic services difficult. This has badly hampered access to electricity, sanitation and communications services. Entire belt is still devoid of electricity supply with virtually no telecommunication facilities. In almost every household, solar panels have been installed for lighting purposes. Since the area has so far been devoid of electricity supply, traditional watermills still operate in almost every village (Fig. 3D). There are several villages which are still inaccessible and one has to travel several kilometers on foot to reach there. Sukhnai in the north, Teller, Deharna and Hanzal in the south west and Sudhar Renai, Zaban Renai and lastly Metwan on the banks of Renai nallah in the south east, for example, are far from being connected by roads. The geographical isolation has however protected and

preserved local biodiversity. Crops grown here especially common beans and potatoes are in great demand in other parts of Jammu and Kashmir. Now various developmental activities including construction of roads have been initiated in the entire region. Improved transportation will result in economic benefits through tourism and resource extraction, opening up new livelihood opportunities for local people. Local agricultural produce including rajmash, potatoes etc. besides forest produce including valuable herbs and medicinal plants will have easy access to the market. With market demand economic activity will improve; consequently, the cost of living will ease. Careful consideration should, however be given to ensure the sustainable management of these resources. According to locals, during last decade there has been tremendous loss of biodiversity especially of useful medicinal herbs which are highly endangered now. Engagement with stakeholders, particularly those who are most likely to bear the costs of negative external pressures, is also critical in ensuring social, environmental and agricultural sustainability.

Conclusion

The present exploration has yielded 82 germplasm accessions, maximum number of accessions are of common bean (12), followed by *Fagopyrum tataricum* (09), *Zea mays* (07) and wheat (06). As the region has remained largely isolated without modern day facilities like telecommunication, electricity supply, road connectivity, the agriculture system has been truly eco-friendly and sustainable with local crops being superior in taste and nutritional value. This valuable agro-biodiversity is now threatened as the valley is being increasingly opened up for tourism and other developmental related activities. Cultivation of paddy, barley and several minor crops has already started vanishing from the system. Medicinal and aromatic plants now occur only in higher reaches, while just a decade ago these grew within village premises as well. Community support initiatives are required to preserve crop genetic resources *in situ* (on farm), through the sharing of knowledge, publicity and cooperation with scientific researchers and governmental organizations. Rich species and genetic diversity in medicinal and aromatic plants, minor fruits, nuts and wild ornamentals indicate the need for urgent continued collecting missions in the region.

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