Plant Germplasm Collection Report

Collection of Forage and Turf Germplasm from the Tibetan Plateau Region of Gansu and Sichuan Provinces in the People's Republic of China

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COUNTRY VISITED/DATES: People's Republic of China (P.R.C.)
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SUMMARY: The objective of our trip was to make seed collections of grass, forb, and legume germplasm with Chinese scientists in the unique, remote area of the Tibetan Plateau in Gansu and Sichuan Provinces of P.R.C. for improving deteriorated rangelands and for low-maintenance turf applications in the western U.S. and western P.R.C. Plant germplasm from the Tibetan Plateau is poorly represented in genebanks of both the U.S. and P.R.C., and has the potential to expand existing germplasm for tolerance to grazing and low temperatures. Our main Chinese collaborators were Dr. Gu Anlin (germplasm specialist from the Grassland Research Institute in Huhehot, Inner Mongolia) and Dr. Yi Jin (plant physiologist from Inner Mongolia Agricultural University in Huhehot, Inner Mongolia). Our team was one of ten U.S. teams selected for participation in the joint USDA and Chinese Ministry of Agriculture Scientific and Technical Exchange Program. Our trip was cooperatively funded through the U.S. Germplasm Exploration Fund, the Scientific and Technical Exchange Program, and the Chinese National Science Foundation.

We began our collection trip in Lanzhou and proceeded south and west in the high-cold meadows, shrublands, and marshes in southwestern Gansu Province. From there our team proceeded to the Roergai marshlands in northwestern Sichuan Province, and meadow and mountain sites in western Sichuan. Our travel route included the counties and towns of Xiahe, Hezuo, Luqu, and Maqu in Gansu Province and Roergai, Hongyuan, Maerkang, Dafu, Luhuo, Ganzi, Litang, Kangding, and Chengdu in Sichuan Province. We traveled a total of 4,000 km on

our collection trip. We also gave lectures concerning U.S. rangelands and the importance of germplasm collection and improvement, Tibetan rangelands and livestock production, and ranch planning and new management technologies at training workshops in Hongyuan and Kangding in Sichuan Province.

In Chengdu all seed was cleaned, weighed, and equally divided with our Chinese cooperators. A collection list containing the Latin name, Chinese-character name, collection location, and seed weight was prepared. In Beijing approvals were obtained from officials at the Chinese Academy of Agricultural Sciences, the Chinese Ministry of Agriculture, and the Chinese Plant Quarantine and Inspection Service for exporting our seed to the U.S. These approvals were difficult for our collaborators to obtain because of the unique, special status that plant germplasm from the Tibetan Plateau has. Out of a total of 181 collections made, we were allowed to export 173 collections to the U.S.

Our seed collections were delivered to USDA-APHIS inspectors at the San Francisco International Airport and sent by overnight express mail to the USDA Plant Germplasm Quarantine Center in Beltsville, MD for processing. The collections were fumigated, sent by overnight express mail, and arrived in Logan only six days after their arrival in the U.S. The seed collections were given final cleaning in Logan and were sent to the Plant Introduction Station in Pullman, WA, where they will be incorporated into the National Plant Germplasm System. These collections are available for research to all scientists and will be evaluated in breeding programs at Logan for their potential use as forage on semiarid rangelands and irrigated pastures, and for low-maintenance turf applications.

RECOMMENDATIONS: The condition of the Tibetan Plateau rangeland that we visited varied considerably. Some areas were in good condition and properly managed. Other areas were severely overgrazed with greatly reduced species diversity. Many weedy species and rodents have invaded these overgrazed areas, and serious soil erosion is taking place. The Chinese Provincial and Central Governments must take measures to reduce the overstocking of these overgrazed areas. There is an urgent need for additional germplasm collection trips in other areas of the Tibetan Plateau to ensure that plant germplasm from this vast, unique area of the world is preserved and available for future generations.

Currently, China is undertaking a major effort to economically develop and improve western P.R.C., and seed production and conditioning of important forage and turf species is currently a high priority. As a result, considerable opportunities exist for developing collaborative interactions with key Chinese institutes to collect, evaluate, and commercially produce seed of economically important plant species for range, pasture, and turf applications. Consequently, this is an ideal time for U.S. scientists to pursue collaborative germplasm collection and research opportunities in the P.R.C. The collected germplasm will fill an existing gap and make important additions to the genebanks in both the U.S. and P.R.C. These collected materials will be an important source of germplasm for improvement of forage production efficiency, turf applications, and conservation purposes in both countries.

Acknowledgments: The success of our trip can be directly attributable to the hard work and dedication of many people in the U.S., and especially in P.R.C., who were involved in all phases of our trip. It is impossible to name all of these people, but without their hard work our trip could not have taken place. Nevertheless we wish to particularly thank Dr. Gu Anlin from the Grassland Research Institute in Inner Mongolia and Dr. Yi Jin from Inner Mongolia Agricultural University, Mr. Kevin Connors from USDA-ARS in Logan, Dr. Karen Williams from USDA-ARS in Beltsville, and Ms. Alma Bowman from USDA-FAS in Beltsville for their critical assistance.

Technical Report and Trip Details

Background: Of China's total land area of 960 million hectares, 400 million hectares, or about 41.7 % of the country, are classified as rangeland. Geographically, 42 % of China's rangelands are located in the Tibetan Plateau Region, 37 % are found in the temperate steppe of northern China (Inner Mongolia and Xinjiang), and 21 % are found in southern and eastern China. The arid rangelands of China, which includes the grazing lands across northern China and the Qinghai-Tibetan Plateau, encompasses about 311 million hectares (3.1 million km^2), or about 32 % of China's total land area (Table 1). This is an enormous land area, equivalent to about 4.5 times the area of the state of Texas.

Table 1. Rangelands of northern and western P.R.C. by province or region

Province/ Region	Area (million ha)	Total rangeland (million ha)	% of region in rangeland	Useable (million ha)	%
Inner Mongolia	118.3	86.7	73.3	68.0	78.4
Tibet	120.0	84.0	70.0	67.2	80.0
Xinjiang	160.0	57.3	35.8	48.0	83.7
Qinghai	72.1	38.6	53.5	33.5	86.8
Gansu	45.0	16.1	35.8	9.7	60.2
Sichuan	23.6	13.9	58.8	--	--
Heilongjiang	45.4	7.5	16.5	4.8	64.0
Ningxia	5.2	3.0	57.7	2.6	86.6
Liaoning	14.6	2.0	13.7	--	--
Jilin	18.7	1.9	10.2	1.3	68.4
Total	622.9	311.0	49.9		
China (total)	960.0	400.0	41.7		

Adapted from *Grasslands and Grassland Sciences in Northern China.* 1992.

The rangelands of China display highly distinctive species, ecological processes, and evolutionary phenomena, and a number of these rangeland areas are included in the World Wildlife Fund's Global 200 ecoregion priority list (Olson and Dinerstein 1997). These ecoregions include the Tibetan Plateau Steppe, the Middle Asian Mountain Temperate Forest and

Steppe in Xinjiang, and the Daurian Steppe in northeastern Inner Mongolia. In addition, the Sichuan-Yunnan Temperate Forests Ecoregion on the southeastern edge of the Tibetan Plateau contains extensive rangelands and forest grazing lands. The Tibetan Plateau, with 85 % of its area lying above 3,000 m, is the highest and most imposing such area on earth. Some 2.5 million km^2 in size, the Tibetan Plateau is about one-third of the continental U.S.

Climatic changes on the Tibetan Plateau have greatly affected the vegetation. Analyses of pollen from various parts of the Plateau have revealed several cycles between warm and humid climates and cold and dry climates since the Pliocene (Schaller 1998). In post-glacial times, during the Holocene, there were three wet and four dry periods in the past 10,000 years on the Tibetan Plateau. The past 3,000 years have become both drier and colder. Much of the Plateau has had a forest-steppe or steppe vegetation since the Pliocene that has favored the spread and survival of plains ungulates. Less than 1 % of the Tibetan Plateau is under crop cultivation. In the eastern part of the Plateau, cropland is concentrated in the lower valleys, and in western Tibet is located along the valley and tributaries of the Yarlung Tsangpo. The upper limit of cultivation is as low as 3,300 m in some parts of the eastern Plateau, but can reach 4,400 m in western Tibet.

Most of the Tibetan Plateau consists of rangelands that are floristically distinctive (Schaller 1998). The rangelands of the Tibetan Plateau can be divided into six major regions: (1) the Qaidam Desert; (2) the high-cold, or alpine, meadow of eastern Qinghai, western Sichuan, and Tibet; (3) a xeric shrubland and steppe along the valleys of the Yarlung Tsangpo in southern Tibet; (4) the high-cold, or alpine steppe in the southern Chang Tang of Tibet and Qinghai; (5) the high-cold desert, or desert steppe in the northern Chang Tang of Tibet and western Qinghai; and (6) the desert mountains in northwest Tibet (Chang 1981, Schaller 1998). Within each region numerous distinct plant communities are found.

The Tibetan Plateau vegetation and its floral elements have prominent differences compared to the subtropical mountain forest vegetation in southeastern Tibet and adjoining regions (Chang 1981). The Plateau contains species with affinities towards both Sino-Himalayan elements and the Central Asiatic element. Endemic species are relatively abundant on the Tibetan Plateau and comprise about 1,200 species, which is about one-quarter of the total number of Tibetan species. Many of the dominants are endemic species. *Stipa purpurea* is a dominant whose center of importance is on the Plateau. Dominants of some of the drier valleys of the Tibetan Plateau, such as *Aristida triseta, Orinus thoroldii,* and *Trikeria hookeri*, are also endemics of the Plateau. Dominants of the steppe shrublands (*Sophora moorcroftiana, Caragana versicolor,* and *Ceratostigma griffithii*) and some important companion species (*Artemisia wellbyi, Astragalus malcolmii*) are also endemics of the Tibetan Plateau. *Ceratoides compacta* is a dominant species of high-cold desert vegetation and is considered a unique species that was formed during the uplift of the Tibetan Plateau (Chang 1981).

Areas of the Tibetan Plateau are climatic analogs of the Intermountain Region of the U.S. The Plateau is a vast, expansive area that has arid rangelands, deserts, high mountains, saline soils and lakes, and fertile valleys very similar to those of the western U.S. The specific collection area for our trip included the high-cold meadows, shrublands, and marshes in southwestern

Gansu Province; the Roergei marshlands in northwestern Sichuan Province; and high-cold meadow and mountain sites in western Sichuan Province.

Funding: Proposals for funding were submitted to the USDA Germplasm Exploration Fund and to the Research and Scientific Exchanges Division in the Office of International Cooperation and Development of the USDA Foreign Agricultural Service (USDA-FAS-OICD). Both proposals were selected for funding, and approval was given to use any remaining USDA funds to support reciprocal germplasm-related visits to the U.S. by P.R.C. collaborators. The proposal to OICD was instrumental in facilitating cooperation within the Ministry of Agriculture and approvals for germplasm export because the exchange program is an integral part of the U.S.-P.R.C. Scientific and Technical Exchange Agreement between USDA and the P.R.C. Ministry of Agriculture. Additional funds from the Chinese National Science Foundation were used to support a portion of the expenses of participating Chinese scientists.

Objectives: The main objective of our trip was to collect important grass genera in the Tibetan Plateau Region of P.R.C. including: *Agrostis, Dactylis, Elymus, Festuca, Pennisetum,* and *Roegneria*. Representative collections were also sought of the following grass genera: *Bromus, Deschampsia, Poa,* and *Stipa*. In addition, we were interested in making collections of legume species in the following genera: *Hedysarum, Lotus, Medicago, Trifolium,* and *Vicia.* Characters of particular interest were those associated with forage production under adverse environmental conditions, arid low-maintenance turf applications, irrigated pasture species, and plants for fall and winter forage production on western rangelands in the U.S.

Prior to our trip, very few accessions of forage grasses and legumes from the Tibetan Plateau were stored and available in the U.S. National Plant Germplasm System (NPGS) or genebanks in P.R.C. Collections of grass and legume accessions from this unique part of the world were needed to: 1) provide critical germplasm for forage turf improvement programs in the U.S. and P.R.C. for tolerance to low temperatures, grazing, soil salinity, and drought, 2) better represent the genetic diversity of important forage species from this unique part of the world in the NPGS, and 3) ensure preservation of this important germplasm for future use in both the U.S. and P.R.C. Timely collection and evaluation of forage and turf germplasm resources from this area was required before overgrazing and development severely reduced the diversity of this germplasm.

Logistical Arrangements: Dr. Gu Anlin from the Grassland Research Institute in Huhehot, Inner Mongolia was the overall coordinator of our trip. Dr. Gu conferred with grassland scientists in each province concerning the best areas to make collections and the best collecting routes. Although we had originally proposed to collect in Qinghai Province, lack of precipitation during the spring and summer months prior to our collection, resulted in limited seed availability there. We also had hoped to make collections in Yunnan Province; however, in making the detailed plans for our trip, it become obvious that time was too short to accomplish collections in this province. As a result, we focused our collection efforts in Gansu and Sichuan Provinces.

Dr. Gu obtained the required travel clearances and collecting permits from the P.R.C. Central Government, Gansu Province, and Sichuan Province, and arranged transportation, lodging, and

other logistics for the collecting trip. A pre-trip reconnaissance of the proposed collecting area was made by Daniel Miller one month prior to our trip to finalize the most productive collection route. Travel within the collection area in Gansu and Sichuan Provinces was with vehicles furnished by Gansu Agricultural University and the Grassland Institute of Sichuan Province, respectively. Local officials from the Bureau of Animal Husbandry in Gansu and Sichuan Provinces served as guides in the collection areas. We brought along the necessary collecting equipment and supplies including seed envelopes, global positioning system (GPS), portable seed threshing apparatus, and other miscellaneous supplies. Prior to our trip, Dr. Karen Williams made arrangements for the necessary permits from USDA Animal and Plant Health Inspection Service (APHIS) and alerted APHIS officials in San Francisco concerning importation of our seed into the U.S.

Trip Details:

16-18 August (U.S. to Beijing to Lanzhou)

Doug Johnson, Dan Miller, and Larry Holzworth arrived in Beijing on Aug. 17 and the next day flew to Lanzhou where they were met by P.R.C. collaborators including Dr. Gu Anlin from the Grassland Research Institute in Huhehot, Inner Mongolia; Dr. Yi Jin from Inner Mongolia Agricultural University; and Dr. He Yi from the Animal Nutrition Institute of Gansu Province in Lanzhou. We also met with Dr. Li Yangchun, taxonomist at Gansu Agricultural College in Lanzhou, who was instrumental in planning and arranging the logistics for our trip in Gansu Province. Unfortuantely, Dr. Li was unable to accompany us because of problems with a detached retina in one of his eyes.

19-21 August (Lanzhou to Xiahe)

Obtained 15-passenger minivan from Gansu Agricultural University and purchased provisions for our trip. Left Lanzhou and drove about five hours to Xiahe. Conducted a training session for the procedures to make germplasm collections and made first collections near Labrang Monastery (third largest Tibetan monastery) just outside of Xiahe. Made additional seed collections in vicinity of Xiahe. Met staff of Xiahe County Animal Husbandry Bureau (Director Ma Long Xi, Technician Shen Weizhong, Technician Ma Shengxiang). Drove south of Xiahe to Sangke Meadow Preserve where seed collections were made. Collected *Brachypodium sylvaticum*, a grass with soft leaves and short rhizomes, which may have potential as a turf. (14 seed collections)

22-23 August (Xiahe to Luqu)

Met staff of Xiahe County Grassland Station (Director Ma Long Xi). Traveled to He Tsao City (capital city of South Gansu Prefecture). Met staff of Gannam Prefecture Grassland Station (Director Shu Mao, Deputy Director Yang Bao Tian, Technician Ma Shu, Technician Xing Yiu Zhang) and examined herbarium specimens. On way to Luqu drove through heavily grazed areas with high densities of yak. Also drove through pasture areas reserved for winter use. Collected in winter pasture areas on road to Henan Mongol. (21 seed collections; 1 collection with no viable seed when threshed)

24-25 August (Luqu to Maqu in Gansu Province)
Met officials of Luqu County Grassland Station (Director Sang Ji Jia, Deputy Director Ma Yuming) and examined herbarium sheets. Visited revegetated area with bad pica problems. Made collections in reserved pastures. On way to Maqu drove through severely overgrazed areas with high densities of weedy species (*Happlopapus* and *Pedicularis*), also saw gold mining trenches dug on mountain slopes with trenches not backfilled, and fenced privatized pastures. Met staff of Maqu Grassland Station (Director Yang Junming), and also met Professor Du (plant ecologist from Lanzhou Agricultural University) who was working with Oxfam, a non-government organization headquartered in Hong Kong. Director Yang accompanied us to the mountains north of Maqu and to sand dune areas along Yellow River where we made productive collections. Visited overgrazed area with poisonous plant (*Ligularia*). (17 seed collections)

26-29 August (Maqu to Zoige in Gansu to Roergai to Hongyuan in Sichuan Province)
Drove to Zoige through beautiful mountain areas. Saw wetland reserve, which had very severe overgrazing by large numbers of yak and sheep. Changed vehicles, finalized herbarium specimens with Dr. He Yi. Met staff of Roergai County Animal Husbandry Bureau (Director Ya Sigang) and Roergai County Grassland Station (Director Yu Bole). Drove to Hongyuan along White River. Met Hongyuan County Party Secretary (Rinzin Dorji) and staff of Sichuan Grassland Research Institute (Director Dr. Ze Bai). Made diverse collections. Doug Johnson, Larry Holzworth, and Daniel Miller lectured (interpreted by Dr. Gu Anlin) to 60 animal husbandry specialists from the local counties who were in Hongyuan for training course. Topics discussed were U.S. rangelands and the importance of germplasm collection and improvement, Tibetan rangelands and livestock production, and ranch planning and new management technologies. Observed introduction garden where saw *Phleum* from Australia, which could not produce seed (probably because of photoperiod differences); also observed reed canary grass from Wisconsin. Inspected seed production fields of the Sichuan Grassland Research Institute for Chuan Cao #1 and #2 of *Elymus sibiricus*. Lectures and field visit were filmed by television crew for showing on local, provincial, and national television. (30 seed collections)

30-31 August (Hongyuan to Maerkang to Dunba in Sichuan Province)
Sichuan Grassland Research Institute will be given 50,000 ha near the junction of the road to Abu for management for ecotourism. Drove through spectacular mountain scenery; descended in altitude with vegetation changing to a shrub-tree dominated community. Observed many beautiful rock houses along the way. Observed many areas where Chinese Government was not permitting Chinese farmers to farm anymore because of erosive, steep slopes. Government is giving payments to farmers for three years to plant a permanent crop (trees or perennial forage); many Chinese farmers will lose use of traditional farmland. Met staff of Jin Chuan County Animal Husbandry Bureau (Director Wang Chengde, Deputy Director Pi Lei). At county border met by Prefecture Director of Animal Husbandry (Jiang Chu) and other county officials. Passed the confluence of the Dadu River, a tributary of the Yangtze River. (18 seed collections)

1-3 September (Dunba to Dafu to Ganzi to Luhuo in Sichuan Province)
Changed vehicles (originally used as a UNICEF van) and driver. Observed spectacular mountain scenery. At Dafu County border met by county officials and staff of Animal Husbandry Bureau

(Director Liu Shi Shen, Office Manager Dorji). Visited traditional rock house in Dafu; also visited new tourist hotel being built in Dafu. Made collections of *Guldenstaedtia*, possibly a good grazing legume. Crossed a 3,650 m elevation pass and could see mountains up to 5,500 m in elevation. Met staff of Ganzi Prefecture Animal Husbandry Bureau (Director Jiang Chu and Grassland Station of Ganzi Prefecture (Director Peng Yang Dong). Met Ganzi County Party Secretary (Li Jin Chuan) and staff of Ganzi County Animal Husbandry (Director Du Qiang Xu). Heavy rain in Luhuo County so cleaned seed. Met Governor of Luhuo County (Gong Jian Zhong) and Party Secretary (Yang Zhi Gui) and staff of Animal Husbandry Bureau (Director Yan Xio Jui). (34 seed collections)

4-7 September (Luhuo to Dafu to Yajang to Litang in Sichuan Province)
Visited Tagong Monastery, second largest monastery behind monastery in Lhasa. Met officials of Luhuo County (Governor Gong Jian Zhong, Party Secretary Yang Zhi Gui) and Animal Husbandry Bureau (Yan Xio Jui). Received sustained heavy rain. High mountain road above 3,650 m elevation on way from Yajang to Litang. Cleaned seed in conference room of Litang County Grassland Station. Met staff of Litang County Animal Husbandry Bureau (Director Xau Ye and Deputy Director). Visited plant introduction trials at Litang County Grassland Station (best species included *Lolium perenne*, *Elymus sibiricus*, *Dactylis glomerata*, *Medicago sativa* from Gansu, *Astragalus adsurgens*, and *Trifolium pratense*). Three large, plastic-covered greenhouses were being constructed for tree nursery species and field-scale plantings of oats and barley were being evaluated at the Litang County Grassland Station. Met staff of Daocheng County. Visited dune stabilization demonstration area south of Litang; oats were being used as a cover crop to permanently establish *Lolium perenne* and *Elymus nutans*. Met officials of Litang County (Governor Sonam Tsering, Deputy Governor Zen Yen Zaixi), staff of Animal Husbandry Bureau (Director Zhu Zhu, Deputy Director Xiu Ye), military leader of Litang, and Living Budha (Luo Qubi). Hard rains received on way to Batang. West of Litang observed riparian areas where gold dredging was occurring with drastic disturbance; no attempt was made to contour or revegetate the dredgings. Observed severely overgrazed areas with thousands of yak west of Litang. Visited area with "range wars" over grazing rights. Collected with military leader armed with a machine gun for security. (31 seed collections with 1 collection with no viable seed after threshing)

8-9 September (Litang to Yajang to Kangding in Sichuan Province)
Met staff of Animal Husbandry Bureau of Ganzi Prefecture (Director Ho Jianping, Deputy Director Tan Yeng, Deputy Director Qing Cheng Jie). Also met staff of Institute of Research for Animal Husbandry for Ganzi Prefecture (Director Duo Ga, Deputy Director Ding Xiaotao, Office Director Zhou Guang Ming). Cleaned seed in hotel at Yajang. In Kangding, Doug Johnson, Larry Holzworth, and Daniel Miller gave lectures concerning U.S. rangelands and the importance of germplasm collection and improvement, Tibetan rangelands and livestock production, and ranch planning and new management technologies to 80 persons representing staff, trainees from local counties, and students from the Institute (interpreted by Dr. Yi Jin and Deputy Director Ding). Made collections of 2-m tall orchardgrass. (18 seed collections)

10-11 September (Kangding to Chengdu in Sichuan Province)
At hotel in Chengdu cleaned seed, divided seed into equal amounts for U.S. and P.R.C. sides, went through taxonomic keys and verified species names, and prepared species lists with the field collection numbers, Chinese common names, Latin names, and seed amounts. Visited headquarters of the Grassland Research Institute of Sichuan Province where a major grant from the Chinese Government was being used to construct facilities for seed conditioning and seed storage for forage species of *Bromus*, *Elymus*, *Roegneria*, and *Brachypodium*.

12 September (Chengdu to Beijing)
Seed cleaning and cataloging was completed at the hotel. Our team flew from Chengdu to Beijing.

13-16 September (Beijing)
After returning to Beijing, species lists were finalized. Dr. Gu Anlin and Dr. Xu Zhu (Director of the Grassland Research Institute in Huhehot) worked to obtain approvals for exporting our seed collections back to the U.S. This required considerable negotiation with officials in the Ministry of Agriculture and the Chinese Academy of Agricultural Sciences because of the unique status of germplasm from the Tibetan Plateau. After several days of intense negotiation, approval for seed export was given for a total of 173 collections with approval withheld on only 8 collections. Seed packets were delivered to the Beijing Animal and Plant Quarantine Service for issuance of a Phytosanitary Certificate. It was necessary to obtain a special approval from USDA-APHIS in Beltsville indicating that USDA-APHIS officials were aware of potential soil and insect contamination in the seed collections, and that the seed could be released for export to the U.S. Doug Johnson sent an email to Dr. Allan Stoner at the USDA-ARS Germplasm Resources Laboratory in Beltsville, MD, who arranged to have the necessary authorization faxed to Beijing.

17 September (Beijing to U.S.)
Larry Holzworth and Doug Johnson returned to the U.S. (Daniel Miller returned on Sept. 14), and seed collections were delivered to APHIS officials at the San Francisco International Airport. The seed collections were sent by APHIS officials by FedEx to the USDA Plant Germplasm Quarantine Center in Beltsville, MD, for processing and fumigation. Within six days, the processed seed was returned by FedEx to Logan, UT, where it was given a final cleaning. Passport data were put into electronic form, and both the cleaned seed and passport data were sent to the USDA-ARS Plant Introduction Station at Pullman, WA.

Benefits to U.S. Agriculture: Collections will expand existing germplasm for tolerance to low temperatures, grazing, soil salinity, drought, and other stresses imposed under differing environmental conditions. These accessions are of benefit to forage improvement programs to enhance forage production under adverse environmental conditions (especially drought and low temperatures), arid low-maintenance turf applications, irrigated pasture species, and plants for fall and winter forage production on western rangelands in the U.S. Collected germplasm from the Tibetan Plateau Region is critical for improving rangeland productivity on deteriorated rangelands and for arid turf applications in the western U.S. Ecotypic diversity of grass and legume germplasm from the Tibetan Plateau is potentially extensive because forages have been

utilized in this area for thousands of years and likely genetically modified by natural selection.

Grass and legume accessions will be used in ongoing USDA-ARS research programs at Logan, UT, to: 1) develop improved grass and legume germplasm for use on western rangeland with emphasis on cold and drought tolerance, late fall and early winter forage production, arid turf applications, and irrigated pastures; 2) introgress desirable traits into Triticeae accessions well adapted to western rangelands, arid turf applications, and irrigated pastures; and 3) conduct cytogenetic and molecular studies of genomic and phylogenetic relationships among genera and species of the Triticeae. Besides their importance as forage and turf species, many of these species hold potential for utilization in biotechnology applications for improving insect and disease resistance and drought and salinity tolerance of important crop species. Incorporation of collected germplasm into the U.S. National Plant Germplasm System will allow use by scientists in the U.S. and throughout the world, and ensure preservation of this unique germplasm.

Benefits to P.R.C.: Forage grass and legume germplasm from the Tibetan Plateau will add important germplasm to the Chinese Genebank, which has only limited representation from this unique region. Conservation of this indigenous germplasm is important because overgrazing and exploitation threaten the existence of these unique germplasm pools. These collections will assist Chinese forage scientists in making important germplasm available for breeding and improvement programs, and eventually lead to improved forage cultivars in P.R.C. The germplasm collections will be evaluated by scientists at the Grassland Research Institute for their potential in revegetation of overgrazed, deteriorated P.R.C. rangelands. Species from the Tibetan Plateau have not been systematically examined for their potential in reclaiming these difficult areas. In addition, some species have potential for low-maintenance turf applications in P.R.C. Evaluation of the germplasm in both the U.S. and P.R.C. will expand the knowledge base of these important species and allow a more thorough assessment of these unique germplasm resources. The close interactions with botanists, forage scientists, and staff from the Grassland Research Institute, local research institutes, and provincial Bureaus of Animal Husbandry will provide opportunities for strengthened professional ties between U.S. and P.R.C. scientists.

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Species list and number of collections of each species brought back to the U.S. from the Tibetan Plateau Region of Gansu and Sichuan Provinces in P.R.C. during 2000.

Astragalus melilotoides	1
Achnatherum duthiei	2
Achnatherum jacquemontii	4
Agrostis hugoniana	1
Agrostis inaequiglumis	5
Agrostis limprichtii	4
Andropogon yunnanensis	2
Brachypodium sylvaticum	6
Bromus himalaicus	7
Bromus sinensis	4
Calamagrostis emodensis	1
Cymbopogon distans	2
Dactylis glomerata	2
Deschampsia caespitosa	7
Duthiea brachypodia	3
Elymus cylindricus	1
Elymus dahuricus	2
Elymus nutans	15
Elymus sibiricus	6
Elymus tangutorum	10
Eragrostis nigra	2
Festuca ovina	6
Festuca polycolea	2
Festuca rubra	5
Festuca sinensis	2
Gueldenstaedtia diversifolia	3
Helictotrichon altius	1
Helictotrichon tibeticum	1
Lotus corniculatus	1
Medicago sativa	1
Melica spp.	1
Melilotus officinalis	1
Melissitus ruthenicus	2
Microstegium vimineum	1
Pennisetum flaccidum	2
Phalaris spp.	1
Poa pratensis	8
Poa psilolepis	3
Poa sphondylodes	1
Poa spp.	3
Ptilagrostis dichotoma	2
Roegneria melanthera	3
Roegneria nutans	14
Roegneria varia	3
Roegneria spp.	3
Stipa aliena	3
Stipa capillacea	3
Stipa krylovii	1
Stipa przewalskyi	2
Stipa roborowskyi	1
Stipa spp.	2
Trifolium repens	1
Tripogon chinensis	1
Vicia angustifolia	2
Total	**173**

<u>Collections not allowed out of P.R.C.</u>

Astragalus polycladus	1
Hedysarum multijugum	1
Hedysarum tanguticum	2
Medicago archiducis-nicolai	1
Oryzopsis tibetica	3
Total	**8**

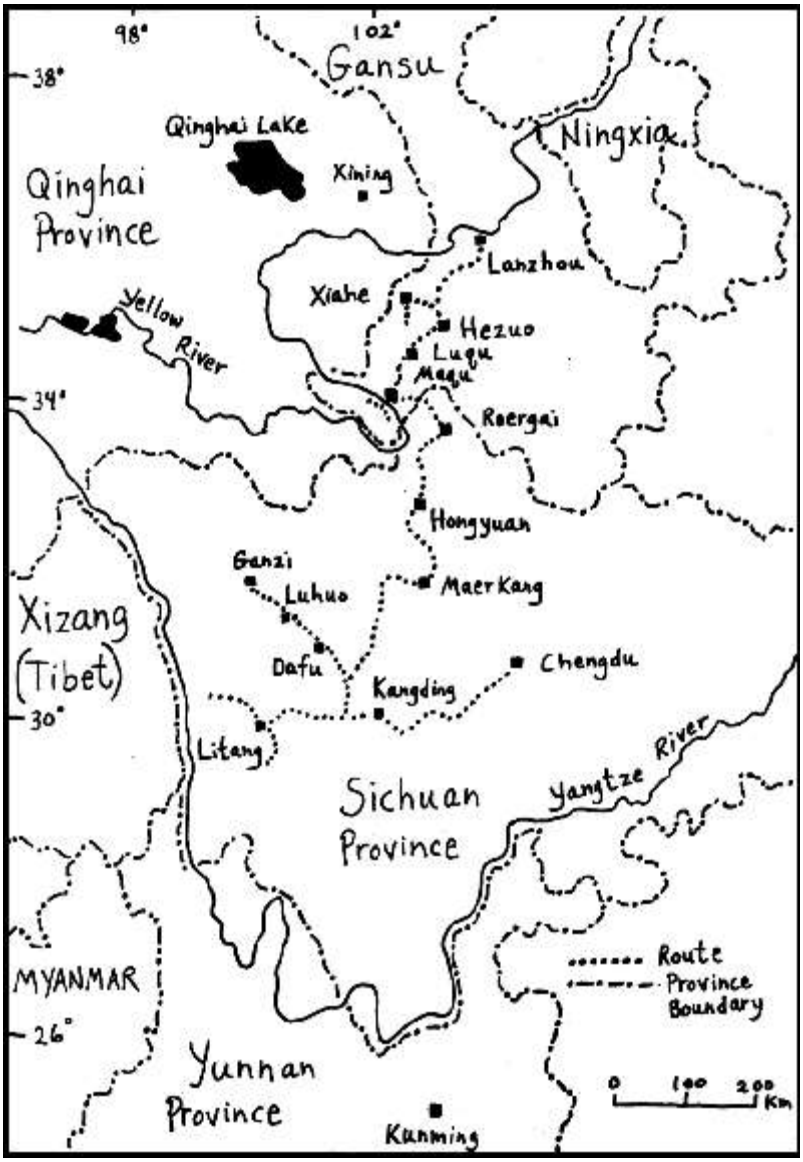

Figure 1. Collection route in the Tibetan Plateau of Gansu and Sichuan Provinces in P.R.C.