Forage Kochia–Uzbekistan's Desert Alfalfa

Forage kochia germplasm from Uzbekistan may increase fall and winter grazing and habitat for livestock and wildlife on western rangelands.

By B. L. Waldron, R. D. Harrison, A. Rabbimov, T. C. Mukimov, S. Y. Yusupov, and G. Tursvnova

Introduction

Forage kochia is often referred to as the "alfalfa of the desert" by Uzbek sheepherders and is one of their preferred rangeland forages. In the United States, the use of forage kochia for fall and winter livestock grazing is on the increase in the semiarid intermountain area. Past use of this perennial semishrub was mainly by public land agencies for rangeland restoration projects, including soil erosion control, greenstripping, and fire prevention, and to suppress invasive annual weeds, such as cheatgrass and halogeton. In fact, some scientists and range managers feel that forage kochia is the best plant to combat cheatgrass invasion and suppress wildfires on western rangelands.[1] Forage kochia has also been used for wildlife habitat and could be a "lifesaver" in maintaining mule deer herds as wildfire, large sagebrush die-offs, noxious weed invasion, and urbanization continue to reduce habitat and winter ranges.

The most recent interest, however, stems largely from ranchers and farmers who want to improve the forage quantity and quality on private depleted rangelands that are traditionally used for wintering livestock (Fig. 1). Recent research by the USDA, Utah State University, and the University of Wyoming have verified that forage kochia for fall/winter grazing has potential to improve the sustainability of the ranching industry in the West.[2,3] In response to the recent interest and requests from ranchers and rangeland resource managers, the USDA, Agriculture Research Service (USDA-ARS), initiated a forage kochia research program that included an evaluation of its adaptation and germplasm collection trips to Kazakhstan and Uzbekistan (Fig. 2).

Figure 1. Cattle winter grazing on forage kochia at the Salt Wells Cattle Company, Box Elder County, Utah.

USDA Forage Kochia Breeding Program

In 1998, the USDA-ARS Forage and Range Research Laboratory (FRRL) in Logan, Utah, initiated the forage kochia breeding and genetics program to develop taller, more productive forage kochia types. This was in response to desire for larger-statured types that provided improved live-

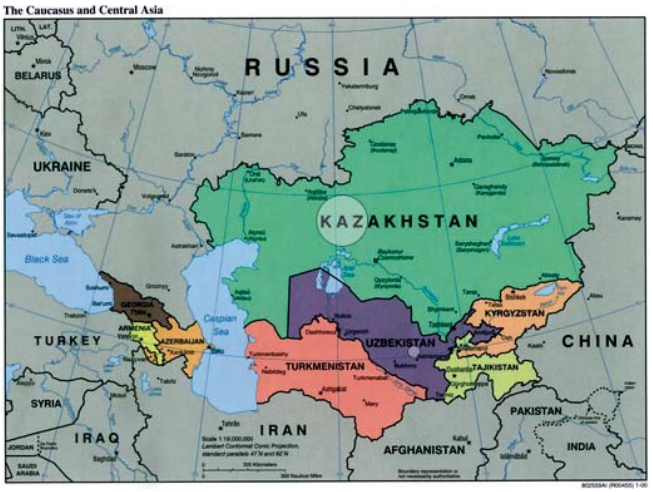

Figure 2. The Caucasus and central Asia region. Circles in Uzbekistan and Kazakhstan show the general areas of forage kochia collection and exchange.

stock and wildlife winter grazing and better game bird and small-mammal habitat.

As part of the research project, they completed a 3-year study that investigated the adaptability and the potential invasiveness of forage kochia. They found that forage kochia was widely adapted to the semidesert and desert ecosystems of the western rangelands and was not an aggressive invader in closed perennial plant communities.[4] It has been reported to encroach into alkali slick spots and dry lake beds where some sensitive species may exist.[4]

In view of the little variation in the stature and height of "Immigrant," a relatively low-growing forage kochia and the only released cultivar in the United States, FRRL scientists organized a forage kochia germplasm collection trip in 1999 to the Aral Sea region of Kazakhstan. This trip was made by USDA scientists in cooperation with the N. I. Vavilov Institute of Plant Industry (St Petersburg, Russia), the

Figure 3. United States Department of Agriculture and Uzbek scientists collect seed from a "Sahro" forage kochia plant that stands nearly 5 feet tall. Insert shows Sahro evaluation field in northern Utah.

National Academic Center for Agricultural Research of the Ministry of Science and Higher Education of the Republic of Kazakhstan, and the USDA-ARS International Programs and resulted in over 200 forage kochia collections (Forage Kochia Germplasm Collection Expedition to Russia and Kazakhstan—Plant Germplasm Collection Report, available at http://www.usu.edu/forage/kazakhstan.htm). These collections have been evaluated in the United States, and a representative core subset has been transferred to the USDA National Plant Germplasm System for maintenance and future use.

Further review of literature and communications indicated that scientists in Uzbekistan had developed and used several different forage kochia varieties during the Soviet era. Scientists from the Uzbek Research Institute of Karakul Sheep Breeding and Ecology of Deserts visiting the Forage and Range Research Lab in Logan, Utah, described forage kochia types that stood nearly 5 feet tall and yielded 1,400 pounds per acre on less than 12 inches of precipitation per year (Fig. 3). Subsequent contacts were made with the Uzbek Research Institute, and a germplasm exchange was arranged to take place in Uzbekistan.

Uzbekistan's Forage Kochia Program

The germplasm collections and exchange took place in October 2002 at areas near Samarkand, Uzbekistan. The purpose of the expedition included the following: 1) to exchange seed of the US cultivar Immigrant forage kochia for Uzbek varieties of forage kochia representing subspecies *villosissima, canescens,* and *virescens*; 2) to arrange for cooperative studies comparing the performance of Immigrant and the Uzbek forage kochia varieties; and 3) to expand and develop contacts for germplasm exchange and related agricultural research with scientists and administrators associated with the Uzbek Research Institute of Karakul Sheep Breeding and Ecology of Deserts at Samarkand, Uzbekistan.

Uzbek Research Institute of Karakul Sheep Breeding and Ecology of Deserts

Uzbekistan is a landlocked central Asian country the size of California and is bordered by Afghanistan, Kazakhstan, Tajikistan, and Turkmenistan. Uzbekistan leads the world in Karakul sheep production in both quality and quantity. Karakul sheep are well adapted to Uzbekistan's rangelands and are raised primarily for exportation of high-quality pelts used in clothing. They also account for 20% of the nation's total meat production and are valuable for wool and milk. All told, Karakul sheep are a primary source of income for over 2 million people living in the country's desert rangelands.[5]

Uzbek scientists have tried to reclaim the production potential and reverse the desertification process caused by centuries of intensive grazing of the country's vast desert and semidesert rangeland. One of their research emphases has been the development and testing of key plant species for use in range rehabilitation programs.[6] The Uzbek Research

Uzbek Research Stations

Karnab Experiment Station

The Karnab station is used to investigate and develop plant materials for rangeland restoration programs. It is located near the town of Karnab in the territory of the agricultural enterprise "Razzok Jahangirov," Nurabad providence, Samarkand region, and 93 miles northwest of Samarkand (lat 39'40"N, long 65'47"E). The station represents the sagebrush-ephemeral desert rangelands of the foothills of Uzbekistan. The elevation is 1,600 feet, and the site is characterized by an average annual air temperature of 58.3°F and annual precipitation of 6.5 inches. The majority of the precipitation is received during November to May. The soil surface texture is a silty clay loam and is classified as gray brown loamy with an occasional gypsum horizon.[6] Rangeland species evaluated at the station included forage kochia, haloxylon, four-winged saltbush, camphorosma, salsola, calligonum, and halothamnus. The current dominant native species in the nearby ecosystem included diffuse sagebrush, camel thorn, and bulbous blue grass (Table 2). Other plants found locally included cheatgrass, sedge, foxtail barley, spring grass, and locoweed.

Nurata Experiment Station

The Nurata experiment station is located near the city of Nurata in the Navoi region about 186 miles northwest of Samarkand (lat 40'28"N, long 65'42"E). The station represents the semidesert foothill rangelands of Uzbekistan. The elevation is 2,132 feet with an average annual air temperature of 59.7°F and annual precipitation of 9 inches. The majority of the precipitation occurs during November to May. The soil is classified as a sierozem and ranges from a fine sandy loam to a sandy textured surface.[6] Native species in the ecosystem, which consisted mainly of diffuse sagebrush and bulbous bluegrass, were similar to those found around the Karnab experiment station. Species in the research plots, which were established in 1986, were similar to those at Karnab.

Institute of Karakul Sheep Breeding and Ecology of Deserts was established in Samarkand in 1930 to support the Karakul sheep industry and provide information about improved forages. The institute has 15 scientific departments that focus on 3 main research efforts: 1) selection, breeding, and reproduction of Karakul sheep; 2) production and processing of Karakul pelts; and 3) evaluation and development of improved forages. The institute currently maintains close association with the International Center for Agricultural Research in Dry Areas (ICARDA) in Aleppo, Syria. Collaborative research with ICARDA includes replicated, on-farm evaluations of sheep performance and reproduction as associated with different rangeland conditions (Fig. 4). Forage kochia has been extensively evaluated at the institute and has proven to be one of the most successful plant materials for improvement of semiarid rangelands.

Figure 4. The institute conducts cooperative research with the International Center for Agricultural Research in the Dry Areas on the correlation between sheep performance and rangeland condition. Here an institute scientist and technician examine a ewe in the study.

Forage Kochia Germplasm of Uzbekistan

During the germplasm expedition, Uzbek scientists shared information about forage kochia use, classification, ecology, biology, and genetics. Forage kochia, the Uzbek "alfalfa of the desert," is a highly preferred forage for sheep, goats, and cattle on Uzbek semiarid rangelands. From discussions and the translated reports, it was discovered that the institute classifies forage kochia into 3 types or subspecies: 1) sandy ecotype—spp. *villosissima,* originating from Kazakhstan and characterized as being more gray and pubescent and the least preferred by livestock; 2) stony ecotype—spp. *canescens,* originating from Kirghizia and characterized as being highly variable; and 3) clay ecotype—spp. *virescens,* originating from Uzbekistan and characterized as being the most glabrous and preferred by livestock. However, some scientists in Uzbekistan and the United States have adopted Balyan's classification, in which he combined spp. *villosissima* and *canescens* into the spp. *Grisea*.[7]

Figure 5. United States Department of Agriculture and Uzbek scientists collect wild forage kochia seed that has been protected from grazing by camel thorn. A herd of Karakul sheep grazes in the background.

Table 1. Forage kochia (*Kochia prostrata*) varieties obtained in exchange between the USDA and the Uzbek Research Institute

Variety (subspecies)	Description
Otavny (*canescens*)	Otavny was developed using mass selection in stony ecotypes collected from foothill regions of Kirgizia. It is characterized as having both upright and semi-upright forms growing to a height of 2.5–3.0 feet and is especially noted for its regrowth ability after harvest. It is commonly grazed or harvested in June and allowed to regrow and grazed again during the fall and winter. Forage yields of 1,500 pounds per acre, and crude protein levels of 12%–16% have been reported. It is adapted to semisaline soils on sagebrush-ephemeral sites receiving 6–8 inches annual precipitation. Seed of Otavny was collected from 2-y-old spaced plants in a research nursery at the Karnab Experiment Station. It is later maturing at this site, and only a small amount of viable seed was obtained.
Karnabchulsky (*canescens*)	Karnabchulsky is described as a pasture-type forage kochia that is very palatable and grazing tolerant. It is known to be long-lived (12–15 y) and very drought tolerant with a deep-penetrating root (19–26 feet). Forage yields of 1,107–1,348 pounds per acre and protein levels of 13%–15% have been reported. It is adapted to sagebrush-ephemeral desert regions that have a mean annual precipitation of 4–8 inches. Karnabchulsky is reported to be mainly tetraploid (4x = 36) with some hexaploid off-types (6x = 54). We could not determine its origin. Seed was collected from a seed increase field established in 1986 at the Nurata experiment station.
Sahro (*villosissima*)	Sahro is also described as a grazing-tolerant, palatable pasture type. It was developed using mass selection within a Kizilkum population of sandy ecotype. Shoots and leaves are very pubescent, and it is known for its prolonged vegetative period and semi-upright stature reaching heights of 2.1–2.5 feet. Yields of 1,340–1,518 pounds per acre (13%–15% protein) have been reported. It is adapted to sagebrush-ephemeral rangelands but is also suitable for sandy deserts receiving 3–5 inches of annual precipitation. Seed was collected from a seed increase field established in 1986 at the Nurata experiment station.
Pustinny (*virescens*)	Pustinny was developed using repeated mass selection. It is mostly diploid with a large number of tetraploid off-types. Of all the Uzbekistan kochia, Pustinny is the most like Immigrant, with the exception that it is mostly yellowed stemmed versus red stemmed. While it is leafy, the leaves are smaller and more glaborous than the other Uzbekistan kochia. It is reported to be disease and pest resistant and to produce typical yields of 1,045–1,268 pounds per acre, with protein levels of 11%–13%. The institute reports suggest that it is adapted to desert and semidesert areas receiving 6–14 inches of annual precipitation. Seed was collected from a seed increase field established in 1986 at the Nurata experiment station prior to our arrival, suggesting that it may not be as late maturing as Immigrant.
Malguzarsky (*virescens*)	We believe this is the Malguzarsky-88 reported in some literature and that it was an original type used in Uzbekistan before 1972. Most likely, Otavny, Sahro, Karnabchulsky, and Pustinny were all developed as improved types, probably using 1 or more cycles of mass selection, as replacements for Malguzarsky. Malguzarsky is a diploid (2x = 18), and we believe that Pustinny may have been developed from selections within Malguzarsky. Seed was collected prior to our arrival from an old foothill planting in the Malguzarski region.
Wildland (*virescens*)	A wildland germplasm collection was made at a semidesert foothill area along the main highway between Samarkand and Tashkent, near Shzud-Amigdalis in the Jizzah region (Dzhizak city, lat 40'07"N, long 66'08"E). The soil surface texture is silt loam and is a typical serozem. The area receives an estimated 20 inches of annual precipitation per year. The average annual temperature is 57.2°F, and the elevation was about 2,788 feet. The rangeland was overgrazed, and the few unprotected forage kochia plants were heavily utilized. The plant community was comprised mainly of sagebrush species, bulbous bluegrass, and camel thorn. Tall wheatgrass was also found in a protected area. Seed was obtained from plants protected from grazing. This collection was predominantly yellow stemmed but also contained red-stemmed plants.

Note: The National Plant Germplasm System classifies *Kochia prostrata* as *Bassia prostrata*. However, this classification has not been recognized in Uzbekistan. Variety descriptions taken from unpublished report by Dr A. Rabbimov titled "Ecological and Biological Peculiarities and Achievements in the Selection of *Kochia prostrata* (L.) Schrad in Uzbekistan."

From the expedition, 6 Uzbek forage kochia germplasms/varieties were obtained. They included Otavny grown at the Karnab Experiment Station; Sahro, Karnabchulsky, and Pustinny from the Nurata Experiment Station; Malguzarsky from the mountains in the Malguzarski region; and a wildland collection from the Jizzah region between Samarkand and Tashkent (Fig. 5). A description of each variety is found in Table 1.

The Karnab station was established to investigate and develop the most suitable and desirable plant materials for rangeland restoration programs. It is located near the town of Karnab, about 93 miles northwest of Samarkand, and represents the sagebrush and short-lived grass desert rangelands of the foothills of Uzbekistan. The Nurata experiment station is located near the city of Nurata, where Alexander the Great had a major fortress. It is in the Navoi region, about 186 miles northwest of Samarkand, and represents the semi-desert foothill rangelands of Uzbekistan. The dominant native species in the area surrounding both stations included diffuse sagebrush, camel thorn, and bulbous blue grass (Fig. 6; Table 2).

From our observations, grazing of livestock, mainly Karakul sheep, was uncontrolled and unsystematic. The majority of the rangeland was in a low state of health. In heavily grazed areas near villages (Fig. 7), many of the desirable species had been replaced by the poisonous plant peganum and other undesirable species. Near Karnab, we observed haloxylon strips planted as windbreaks and a large forage kochia planting. Both had been seriously abused from firewood cutting and unrestricted grazing. Near this area, the sky was silhouetted with miles of concrete fence posts that had their wire illegally removed from them. Their presence indicated that an extensive grazing management system had once been implemented but now is gone.

Figure 6. Most rangeland that we observed was predominantly diffuse sagebrush (plant being eaten by donkey) with an understory of bulbous bluegrass and moderate amounts of camel thorn (green plant in background).

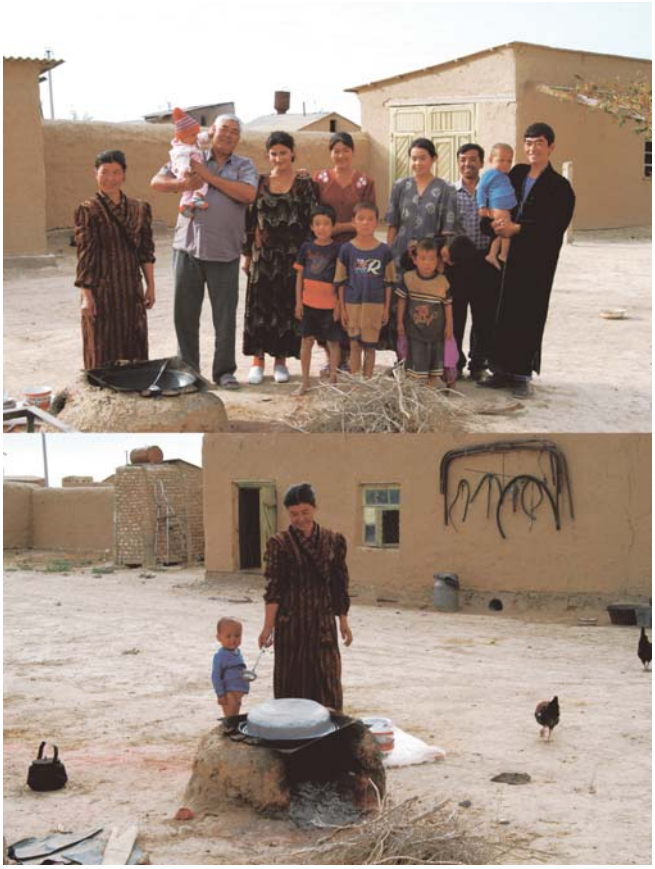

Figure 7. Uzbekistan's rural culture showing traditional clothing, cooking, and adobe structures.

Summary

Uzbek scientists have tested and developed excellent plant materials that are well suited for range reclamation programs. However, Uzbekistan's uncontrolled and unsystematic grazing makes it difficult to successfully use the plant materials to stop desertification processes. The Uzbek Research Institute of Karakul Sheep Breeding and Ecology of Deserts could make a significant contribution by documenting the relationships between rangeland condition and livestock performance. This type of information could assist Uzbek resource managers in implementing sound rangeland management policies and help them attain the full potential of their plant materials.

The USDA and Uzbek scientists were able to exchange seed of US and Uzbekistan forage kochia varieties. Scientists at the Uzbek Research Institute of Karakul Sheep Breeding and Ecology of Deserts and the USDA-ARS FRRL are comparing the forage kochia germplasms in both the United States and Uzbekistan. This coordinated program will have a lasting benefit for both the United States and Uzbekistan.

The Uzbekistan germplasm has been included with the Kazakhstan germplasm in the USDA forage kochia breeding program. Initial research is encouraging that breeding and selection, within these germplasms, will result in more productive, larger-statured forage kochia cultivars adapted to the

Table 2. Species frequently observed on Uzbekistan's rangeland

Common name	Scientific name
Bulbous bluegrass	*Poa bulbosa*
Camel thorn	*Alhagi pseudalhagi*
Calligonum	*Calligonum microcarpum*
Cheatgrass	*Bromus tectorum*
Diffuse sagebrush	*Artemisia diffusa*
Forage kochia	*Kochia prostrata*
Four-winged saltbush	*Atriplex canescens*
Foxtail barley	*Hordeum murinum spp. leporium*
Halogeton	*Halogeton glomeratus*
Halothamnus	*Halothamnus sp.*
Haloxylon	*Haloxylon aphyllum*
Locoweed	*Astragalus alocepias*
Peganum	*Peganum hazmala*
Salsola	*Salsola orientalis*
Winterfat	*Krascheninnikovia ewersmanniana*
Sedge	*Carex pachystachya*
Spring grass	*Eremopyrum orientale*
Tall wheatgrass	*Thinopyrum ponticum*

Note: The USDA National Plant Germplasm System classifies *K. prostrata* as *Bassia prostrata*. However, this classification has not been recognized in Uzbekistan.

western United States. These future cultivars have a real potential to improve the sustainability of western ranching by further reducing winter feeding costs. They should also be of great value to native ungulates and birds by providing valuable nutritional forage and cover and assisting in suppressing wildfires that are devastating their critical browse communities.

Authors are Research Geneticist, USDA, Agricultural Research Service, Forage and Range Research Lab, Logan, UT 84322-6300 (Waldron); Range Scientist, Utah State University, Logan, UT 84322 (emeritus USDA-NRCS) (Harrison); Specialist for Plant Introduction and Selection, Uzbek Research Institute of Karakul Sheep Breeding and Desert Ecology, Samarkand, Uzbekistan (Rabbimov); Head of Desert Forage Production and Plant Physiology Lab, Uzbek Research Institute of Karakul Sheep Breeding and Desert Ecology, Samarkand, Uzbekistan (Mukimov); General Director, Uzbek Research Institute of Karakul Sheep Breeding and Desert Ecology, Samarkand, Uzbekistan (Yusupov); and Translator, Uzbek Research Institute of Karakul Sheep Breeding and Desert Ecology, Samarkand, Uzbekistan (Tursynova).

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