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Agricultural Outlook Forum

Presented: February 17, 2006

NATURAL RESOURCE ISSUES IN CHINA: WIND AND WATER EROSION

Mark Majerus
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Natural Resource Issues in China: Wind and Water Erosion

Mark Majerus, Manager
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Bridger, Montana

Bio: Since 1975, Mark Majerus has been stationed at the USDA-NRCS Plant Materials Center near Bridger, Montana, serving as Manager since 1998. The Plant Materials Center works to develop native plants to solve conservation problems in Montana and Wyoming, helping to make seed and plants commercially available for soil stabilization, wildlife habitat, livestock grazing, wind break/shelterbelts, etc. Since 1993, Majerus has traveled to China six times and Outer Mongolia four times to consult on seed collection, plant evaluation, and seed production. Prior to his current position he was a Research Associate with the Reclamation Research Unit of Montana State University-Bozeman conducting reclamation research on coal strip mines of southeastern Montana. Majerus was raised on a farm/ranch in central Montana and attended the University of Montana-Missoula receiving a Bachelors degree (1970) and a Masters degree (1972) in Forestry/Range Ecology.

Speech: The grassland steppe of northern China and Mongolia have experienced centuries of heavy use, both in the form of year-round grazing and crop production. The semi-arid environment, with frequent violent wind and moisture events, is experiencing extensive dust storms and heavy sediments in the major waterways. The northern provinces of Xinjiang, Ningxia, Gansu, and Qinghai, along with the Autonomous Region of Inner Mongolia have been impacted the most. Dust storms not only impact northern China, but dust clouds of China origin regularly find their way to Korea and Japan and on occasion have reached Canada and the continental United States. Scientists with the Institute of Desert Research in Lanzhou, Gansu province reported soil losses in Inner Mongolia of 109-642 tons/acre off of cropland during the winter and spring months. Also wind erosion losses from grasslands plowed for new cropland was 220-1,700 tons/acre.

In 1994 the Chinese central government required that all cropland lost to urban expansion and development must be offset with new cropland. This new cropland was usually developed by plowing up native grasslands, sites that were often marginal for crop production in terms of soil quality and climate. Some of the fastest growing coastal provinces often paid northern and inland provinces to plow up new cropland to meet the offset requirements. This policy resulted in a 22% increase in cropland in Inner Mongolia alone. Years of year-round grazing has taken its toll on the grasslands of northern China, particularly in close proximity of rural villages. Many grasslands have changed from a diverse mix of perennial grasses, forbs, and shrubs to low producing annual grasses and weeds. Historically herders living in remote areas or in small rural villages had access to the same general area month after month, year after year requiring that they graze or cut forage from the same limited area and the only means of increasing income was to increase animal numbers. This downward trend in grassland health has forced the Chinese government to take serious action. Chinese scientists are fully aware of the impact of continuous grazing on perennial forage grasses, as exhibited by the forage/root display at the Inner Mongolia Agriculture University-Huhehot. Much research is presently under way to evaluate the response of the grassland steppe of northern China to deferred or controlled grazing, and in some cases, the complete removal of all grazing animals. On the Ordos Plateau of south-central Inner Mongolia the

primary livestock is cashmere goats. These goats were herded, but general had access to most of this region. As of 2002 all grazing livestock are confined to pens and corrals, requiring that all forage be purchased or hand harvested from government approved areas. In one location willow trees, planted in the late 1980's were allowed to be pruned for goat fodder. Each family was allowed to prune a certain number of trees. The cashmere wool industry is very important to the economy of this region. The Lands' End Clothing Company purchases most of their cashmere clothing from the factory in Dongsheng. Herders in that area now report that the quality of the wool is declining because of the required confinement.

The Chinese government has numerous reclamation projects; attempting to stabilize highly-erodible lands. One of the primary origins of dust storms is the sand dunes of the Gobi Desert. Pole plantings of cottonwood and willows are being used to stabilize dunes in southern Inner Mongolia. Three meter long poles are driven one meter into the sand and periodically watered through the growing season. Japanese volunteers come each year to this one particular area to assist with the greening and stabilization of these sandy sites. The reclamation efforts are concentrated near existing roadways because of the need for access of watering trucks and work crews. In other areas perennial shrubs such as shrubby sweetvetch, standing milkvetch, sagebrush, kochia, and ceretoides (equivalent to our winterfat) are seeded to disturbed or eroding sites, often by airplane. Trees and large shrubs are hand transplanted to vast areas, often with hand-constructed terracing or spot leveling to prepare planting sites. Sea buckthorn, juniper, cottonwood, and pine are the most popular species. In most areas of the semi-arid grasslands these trees will require supplemental irrigation for survival.

One of the largest projects to reverse the trend of deteriorating grasslands is the removal of herders and their animals from thousands of hectares of grassland steppes of northern China. Many of these herders have been relocated to small dairies. Each family provided with a small house (usually brick) valued at about \$5,000 USD and at least two milking cows. They have the option of purchasing up to 3 more cows. They are provided with a communal milking facility and communal grassland for grazing and haying. The Chinese government purchases the milk and trucks it to distribution and processing centers. The former herders often establish gardens to supplement income and their diet. In the eastern portion of Inner Mongolia grazing animals has been reduced by 50%, from 2 million animals to about 1 million. This has resulted in a major decrease in the number of sheep and goats and an increase in the number of dairy cattle. Quality dairy animals have been imported from Canada, the US, and Australia. Throughout China there is a major "Drink Milk" campaign, with billboards, newspaper and magazine spreads, and kiosk advertisements. In areas where grazing is still allowed, people involved in animal husbandry are under close scrutiny by District Managers oversee all grazing and forage harvesting. Although animals are still accompanied by herders, they are further confined to controlled paddock grazing units. Some systems have up to eight paddocks, with at least one paddock saved exclusively for fall and winter use. Other paddocks are saved for forage harvesting only. In areas using paddock grazing, all grazing is restricted from April through June. This three month period of restricted grazing allows native plants to initiated early season growth without grazing or clipping pressure, but livestock animals must be fed during this time periods, often at a financial burden to the herder. The majority of forage harvesting is done on native grassland sites, employing small farming equipment or done entirely by hand. Most of these native sites yield less than 1 ton of forage per acre.

The Guyan Farm (Hebei province), about 5 hours north of Beijing, is a major agriculture area with a large milk/cheese processing facility and associated dairies. The government controlled area is utilized as a research facility for the China Agriculture University and other government entities such as China Science and Technology, Bureau of Planning and Economic Development, China Grass Seed Company, and Bureau of Agriculture. At the Guyan farm they have established several large fields of US and

Canadian forage grasses for potential seed and forage production. They are also producing corn harvested as silage. The corn is punch-planted through starch-base plastic strips, which aid in weed control and moisture retention. Annual forages such as oats and winter peas are being evaluated. They are still learning the techniques of producing seed and forage under cultivated conditions. The fields we visited were past due for both seed and/or forage harvesting. The available farming equipment was being upgraded, but was still quite antiquated by US standards. New potato production equipment had been purchased from Denmark, with income generated by a contract to grow potatoes for the McDonalds franchise in China.

The Grassland Research Institute (GRI) in Huhhot, Inner Mongolia has been involved in grassland research for several years, but in 2003 received a substantial increase in funding to upgrade their facilities and equipment. The once meager facilities have now been upgraded to include a large greenhouse, tissue culture lab, seed cleaning facility (with 3-screen mill, indent cylinder cleaner, and gravity table) (manufactured in Huhhot), and a large equipment storage shed housing new, yet to be used, John Deere combine (made in NE China), two Truax and two Brillion drills (made in USA), and traveling sprinklers (made in Canada). The GRI, starting in 2004, has initiated research on seed production of releases from the Inner Mongolia Agriculture University forage breeding program and expanded their reseeding trials on deteriorated grasslands and other disturbances in grassland ecosystems.

Between Huhhot and Xilinhot, Inner Mongolia is the newly developed Experimental Center for Forage Seed Production Demonstration. With an investment of 20,000,000 yuan (\$2.5 million USD) the research facility has established large seed production fields of alfalfa, Mongolian wheatgrass, and Siberian wildrye. Water wells have been developed to feed four center pivot irrigation systems. Seeds strippers designed and constructed by an Agriculture Engineering facility in Huhhot are used to harvest the seed which is shipped to Huhhot for cleaning by the same engineering company which is also designing and constructing experimental seed cleaning equipment. At the Experimental Seed Production Center they are also evaluating cultivars of US and Canadian forages for potential seed production and use in grassland renovation.

The grasslands of north central China and Mongolia and the rangelands of the northern Great Plains and Intermountain Basin are very similar, both in terms of climate and species composition. Areas between the 40th and 50th parallels on opposite sides of the world are amazingly similar. Climax vegetation of both areas is composed of the same species or very similar functioning species. Prairie junegrass (*Koeleria*) is common to both areas, as are the needlegrasses (*Stipa* and *Nassella*). Western wheatgrass (*Pascopyrum smithii*) of the US is very similar in appearance and function to Chinese wildrye (*Leymus chinense*).

The similarities of the grassland ecosystems of north-central China and the western United States have prompted the Chinese and Mongolian scientists and government officials to seek advice on grassland management and renovation from US Government and University scientists. They have established cooperative working relations with the USDA-NRCS Plant Materials Centers in Montana, North Dakota, and Idaho, and the USDA-ARS Forage and Range Research Lab in Logan, UT. Beginning in 1989 the Grassland Research Institute (GRI) (a division of the Chinese Academy of Agriculture Sciences) in Huhhot, Inner Mongolia sent a scientist, Gu Anlin, for a one-year detail to the Plant Materials Center in Bridger, Montana. She was sent to learn about the Plant Materials approach to collecting, evaluating and the eventual release of forage and reclamation plants. While in the United States she was exposed to range renovation research, seed production of native species, and the dissemination of research information to farmers and ranchers. At that time in China many new

cultivars of forage species were being developed, but they never got past the lab and experimental plots at the University level. We continue to work with GRI and Gu Anlin. She led a China/US seed collection expedition to the Himalayan Highlands in 2001 and is presently working to get authorization for a cooperative seed collection in eastern Inner Mongolia proposed for the fall of 2006. After her detail to the US in 1989-90 she was instrumental in establishing research plots at four locations in Inner Mongolia (Huhehot, Zhaohe, Dalad Qi, and Linhe) in 1991 looking at Chinese and US cultivars of forage and reclamation species. Similar plots were established in the United States in Bridger, Montana, Aberdeen, Idaho and Pullman, Washington.

In 2004 Dr. Mao Peisheng, professor and Director of the Seed Analysis Lab at the Chinese Agriculture University-Beijing spend six months at the Bridger PMC to learn about the seed production industry in the United States. He learned about seed production techniques and the seed certification process. He visited the Montana and Wyoming seed analysis labs, as well as seed cleaning plants and commercial seed growers. He witnessed, first hand, the field inspection process and was involved in determining seed harvest readiness of at least 15 species of grasses, forbs, and shrubs. While at the Bridger PMC he conducted a study of seed moisture as it correlated to seed maturity and harvest readiness.

Chinese and Mongolian scientist have made several visits to research institutions of western United States, usually flying in to Salt Lake City and first visiting the USDA-ARS Forage and Range Research Lab in Logan, UT and then traveling to the Aberdeen, ID PMC, then proceeding through Yellowstone National Park ending up at the Bridger, MT PMC. The Chinese scientist have been introduced to plant breeding, seed production, range renovation, seed collection and evaluation of native plants, seed certification, grazing management, pasture and hay production. In the fall of 2004 Dr. Doug Johnson and I gave seminars on seed production and the USDA approach to developing native forage and reclamation plants to graduate students at the China Agricultural University-Beijing, Inner Mongolian Agricultural University-Huhehot, and the Guyan Farm.

During the summer of 2004 Dr. Tumenjargel Dagvanamdal a botany professor from the Mongolian Agricultural University was sent to the US to learn about seed production and the seed certification process. During her five month stay she visited the USDA-ARS Forage and Range Research Lab in Logan, UT, USDA-NRCS Plant Materials Centers in Aberdeen, ID and Bridger, MT, the USFS Shrub Sciences Lab in Provo, UT, and the USDA Plant Introduction Station in Pullman, WA. Another Mongolian scientist was detailed, at the same time, to New Mexico State University to review rangeland management practices in the desert southwest. Both of these details were financed by the 'Green Gold' project, a Swiss project looking to help increasing the forage base in Mongolia. The Green Gold project is proposing to finance up to six Mongolian students to come to Universities in the western United States for Masters and Doctorate degrees in range and pastureland management, plant breeding, and seed physiology.

Mongolian animal husbandry and agriculture is primarily nomadic herding of grazing animals (sheep, goats, cattle, camels and horses) and some harvesting of native hay. Family groups may move up to four times per year, relocating to historic grazing areas of their ancestors. Since the breakup of the Soviet Union in 1990, Mongolians have been struggling to regain control of their natural resources, especially their native forage. Problems that exist in Mongolia include high concentrations of animals in close proximity of villages and larger urban areas, weeds in abandoned cropland, mining disturbances, and the impact of several years of drought and harsh winters.

Seed collection of native forage species was initiated in 1994 as a cooperative venture between USDA-ARS Germplasm Collection Fund (Dr. Doug Johnson) and the Research Institute of Animal Husbandry

in Ulaanbaatar, Mongolia (Dr. Sodnomdarjaa Jigjidsuren). Subsequent collection expeditions in 1996 and 1998 complimented the initial collection trip, getting representative collections from all the major grassland and forest steppes of Mongolia. Once representative seeds of the primary forage plants of Mongolia were assembled, initial evaluation plots were established at three sites Turgen (central), Batsumber (northern), and Buyant (far west). USDA-ARS and USDA-NRCS assisted in the design and establishment of these test plots and provided seed of US plant materials for comparison to native Mongolian collections. Over 700 accessions of 164 species or more were seeded at each site. Financial support for this Initial Evaluation process was provided through a PL-480 Food for Progress grant from the US Embassy in Mongolia. The superior performing collections are being advanced to the seed production phase at a new Experiment Station site at Bornuur north of Ulaanbaatar. The seed increase phase is being financed with US Embassy Wheat Monetization money, awarded to the Grazers and Haymakers Association (Non-profit Organization) who, in turn, is working with the Research Institute of Animal Husbandry. Throughout the collection and evaluation process Dr. Jigjidsuren and associates have assembled a book picturing and describing all of the major native forage plant of Mongolia, the text being both in English and Mongolian. Dr. Jigjidsuren has just completed a Herders Guide outlining grazing management principles and species identification.

In summary, the approach to solving erosion problems in China and to some extent in Mongolia, involves the complete removal of grazing animals from critical areas, the overall reduction in the number of grazing livestock, the establishment of controlled grazing paddocks, the relocation of herders to communal dairies, the collection and evaluation of native forage plants for grassland renovation, evaluation of pasture and hay forages, evaluation of seed production potential, and consulting with US scientists from universities and government research agencies.

Natural Resource Issues in China: Wind and Water Erosion

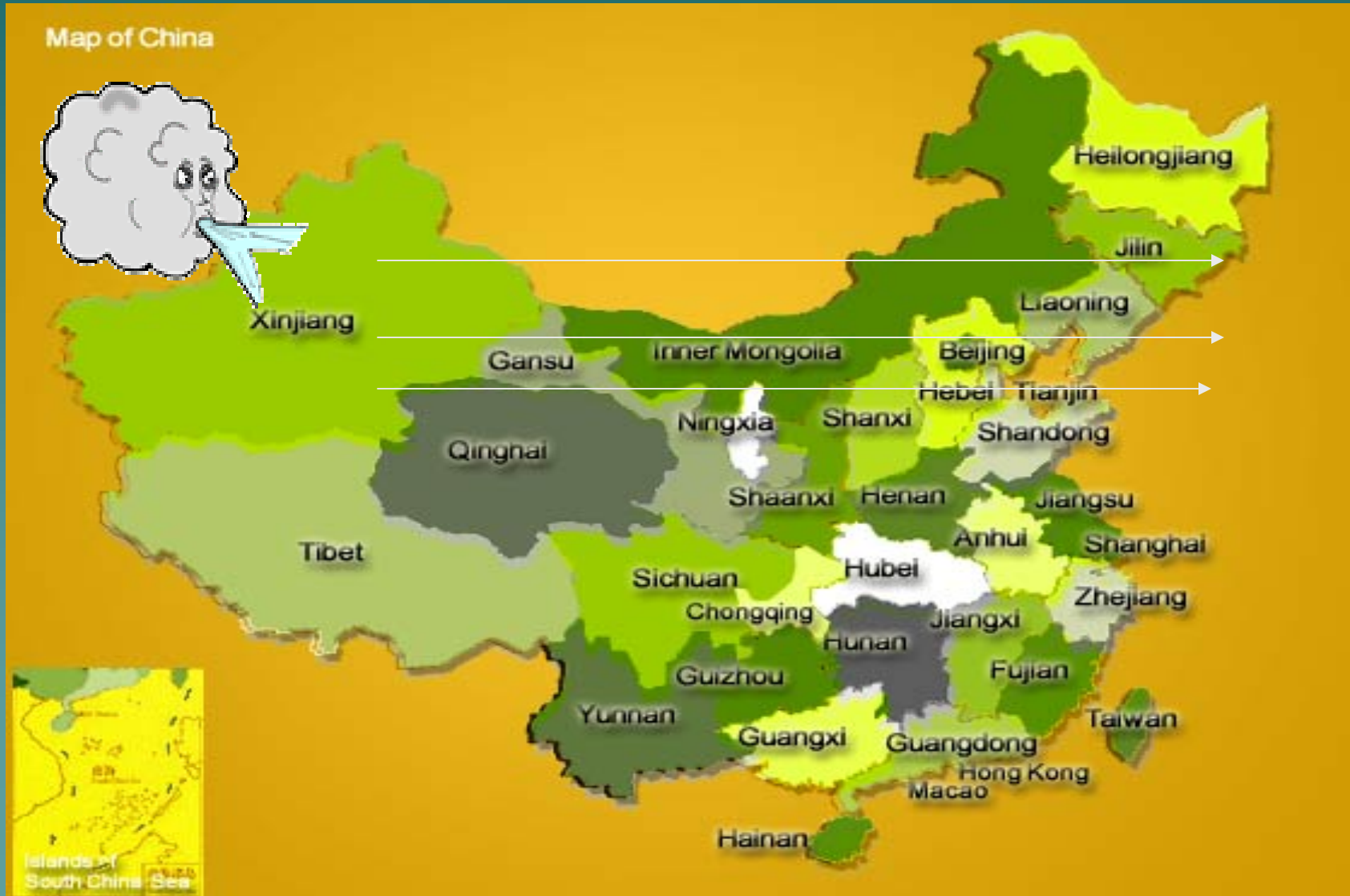
An aerial photograph of the Great Wall of China, showing a section with a prominent watchtower on the left. The wall curves across a dense, green forested mountain range. The sky is clear and blue.

2006 Agricultural Outlook Forum
Washington D.C.

Mark Majerus

USDA-NRCS Plant Materials Program

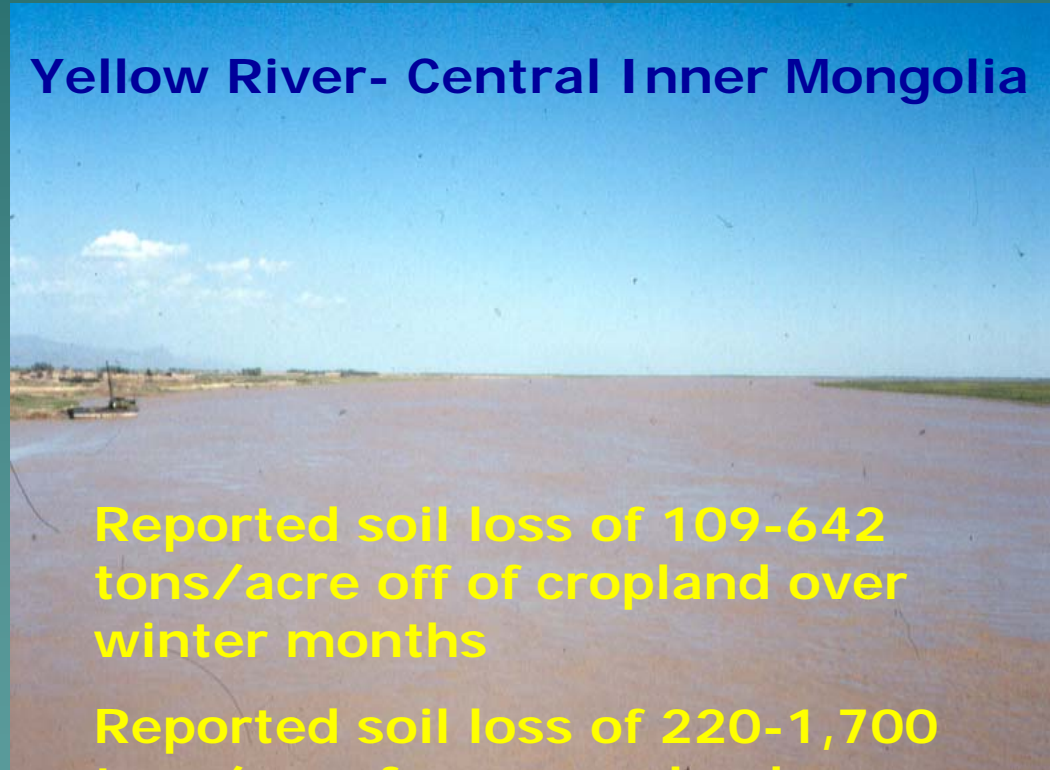
Wind Erosion Across North China



Wind and Water Erosion Inner Mongolia



Yellow River- Central Inner Mongolia



Reported soil loss of 109-642 tons/acre off of cropland over winter months

Reported soil loss of 220-1,700 tons/acre from grasslands plowed for crops

Institute of Desert Research- Lanzhou (1997)



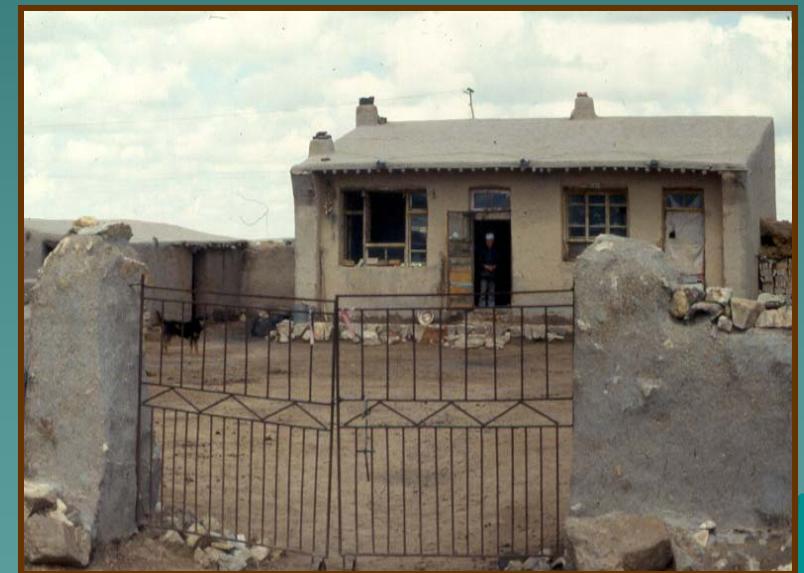


In 1994 Central Government required that all cropland lost to development be offset with new cropland.



Resulted in 22% increase in cropland in Inner Mongolia alone. Often on marginal land.





**Historically
herding with overnight
corralling and some
native hay harvest**

Impact of continuous grazing on plant health



Years of Year-Round Grazing is Taking its Toll



Removal & confinement of all grazing animals Ordos Plateau

- ◆ Total confinement of livestock
- ◆ Limited forage available
- ◆ Pruning of willow trees—each family so many hectares
- ◆ Quality of cashmere wool diminishing
- ◆ Five year trial period



Stabilization of Sand Dunes East Edge of Gobi Desert



- ◆ 3 meter poles buried 1 meter
- ◆ Cottonwood/willow
- ◆ Watered 2-3 times during growing season
- ◆ Japanese volunteers each year



Shrub & Tree Establishment on Highly Erodable Areas-Mostly by Hand



shrubby sweetvetch



juniper for stabilization projects

Caragana
Ceretoides
Kochia
Artemisia



standing milkvetch



sea buckthorn

Relocation of herder to Dairies

Small (usually brick) house (\$5,000 value)
2 dairy cows (with potential to buy up to 3 more)
Communal milking barn
Communal grazing land and native hayland

Got Milk ?



**Eastern Inner Mongolia
Xilinhot—Hailar—Huhehot**

**Animal reduction- from 2 million
to 1 million 2002-2004**

**Major 'Drink Milk' campaign
throughout China**

Controlled Grazing Systems

- ◆ All grazing restricted April through June
- ◆ Up to 8 paddocks
- ◆ One paddock save for winter use only
- ◆ Strictly enforced by District Manager





**Haying of
native grass
stands where
grazing is
restricted or
controlled**



Meadow brome-Canada



Peas/Oats for forage

Guyan Farm

Seed Production Trials

Potential for forage and grazing



Timothy-Canada



Corn silage



Potato Production for McDonalds
Danish equipment

China Agriculture- In process of upgrading equipment



Still in use



Seed cleaning facility



New greenhouse & tissue culture lab

Grassland Research Institute- Huhehot, Inner Mongolia

2 Truax Drills (made in USA)

2 Brillion Drills (made in USA)

John Deere Combine-(made in NE China)
seed cleaning equipment (built in Huhehot)

Irrigation sprinklers (made in Canada)



Seed stripper
manufactured in Huhehot

Experimental Center for Forage Seed Production Demonstration-Inner Mongolia

20,000,000 Yuan investment

Agropyron mongolicum

Elymus sibiricus

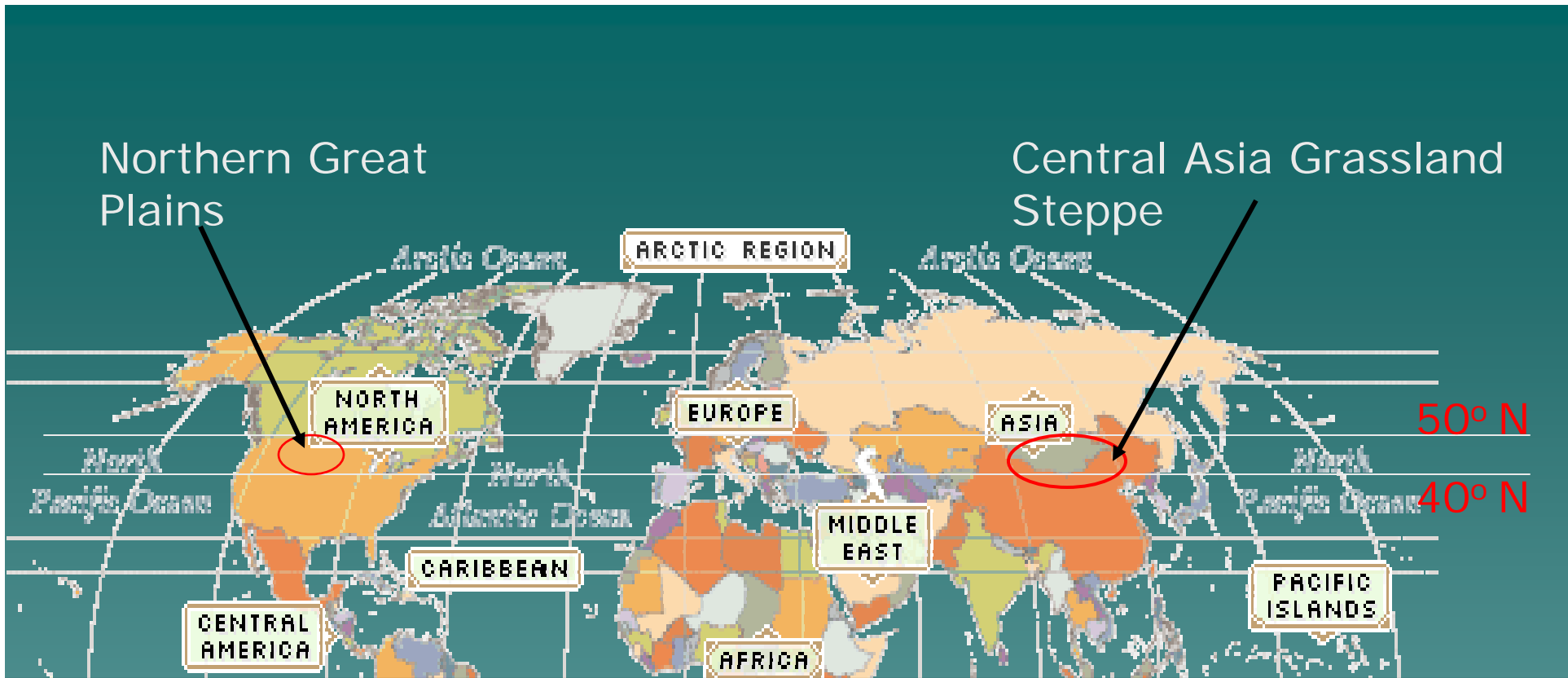
Medicago sativa

Seed production utilizing center pivot irrigation



Testing of U.S./Canadian forage cultivars





USDA-NRCS Plant Materials Centers

Bridger, Montana

Bismarck, North Dakota

Aberdeen, Idaho

USDA-ARS Forage & Range Research

Logan, Utah



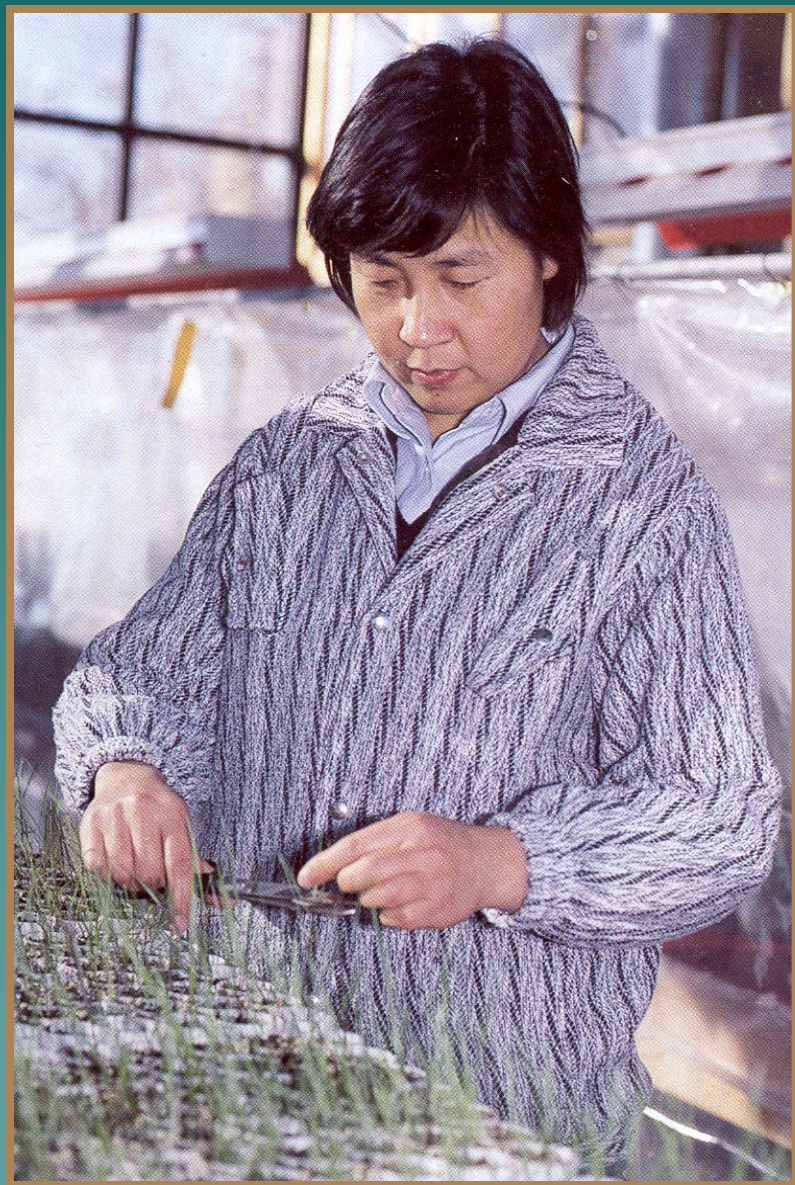
LOCATION & SERVICE AREAS OF PLANT MATERIALS CENTERS



Serving the northern
great plains and
Intermountain basin

In cooperation with
Soil & Water
Conservation
Districts

**Scientist Exchange with Grassland Research Institute (GRI)
Chinese Academy of Agricultural Sciences (CAAS)**



Gu Anlin

At Bridger PMC for one year (4/89—4/90)

To learn USDA-NRCS Plant Materials Program approach to developing native plants for conservation use

Leader on ARS/NRCS seed collection trip to Himalayan Highlands (Tibetan Plateau) (2001)



Initiated Plant Materials Trials 1991 U.S. and China Cultivars



In cooperation with Grassland
Research Institute

Huhehot-cropland

Zhaohe-semi-arid steppe

Dalad Qi-sandy

Linhe-saline irrigated



Dr. Mao Peisheng

China Agricultural University-Beijing

Professor and Director Forage Seed Lab

6 month exchange at Bridger PMC to learn about seed production and U.S. seed industry (5/04-10/04)

Conducted Seed Moisture/Harvest Readiness Study while at PMC





Tours of PMC and conservation practices in Montana & Wyoming for Chinese and Mongolian scientist and government officials

Lectures to graduate students at China Agriculture University-Beijing and Inner Mongolia Agriculture University-Huhehot



Etheridge Seed Farm-Powell, WY



Dr. Tumenjargal Dagvanamdal

Mongolian Agricultural University

Ulaanbaatar, Outer Mongolia

Professor of Botany & Medicinal
Plants

5 month exchange to:

USDA-NRCS Plant Materials Centers (Bridger, MT-Aberdeen, ID)

USDA-FS Shrub Lab, Provo, UT

USDA Plant Introduction Station, Pullman, WA

USDA-ARS Forage & Range Research, Logan, UT

To study seed production, cleaning, and storage techniques

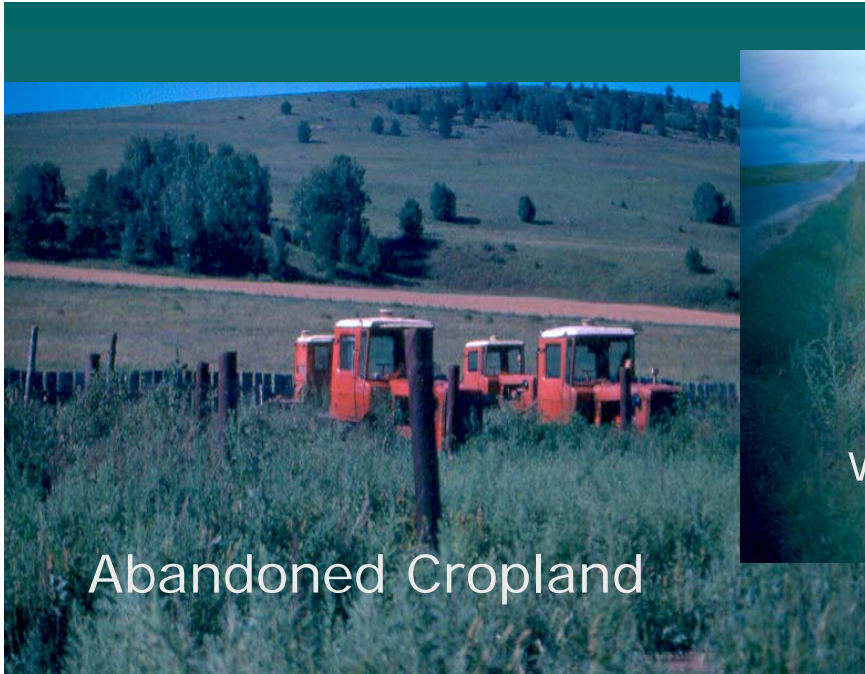
Sponsored by Green-Gold Project (Swiss government)

2005-two scientists to US (seed production/grazing management)

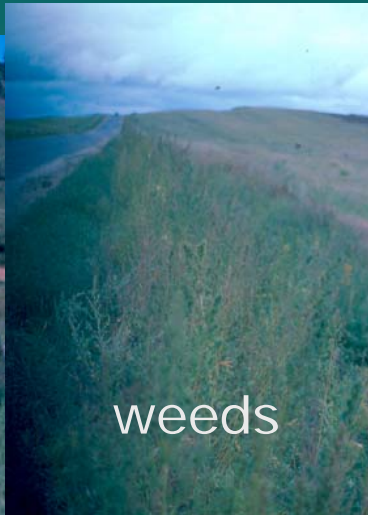
2006-08 up to six graduate students to western U.S. universities

Outer Mongolia—Nomadic Herding Lifestyle





Abandoned Cropland



weeds



Overgrazing near villages



5 years of drought and hard winters

Conservation Issues in Mongolia

Pristine Natural Resource that need protection



high concentrations of animals

Research Institute of Animal Husbandry

Mongolia Agriculture University-Ulaanbaatar, Mongolia

Seed Collections-1994, 1996, 1998 (USDA-ARS Germplasm Collection Fund/Foreign Agriculture Service)

Plant Evaluation-2000-2004, Turgen, Batsumber, Buyant (PL-480)

Seed Increase-2005 Bornuur (Wheat Monitization-US Embassy)





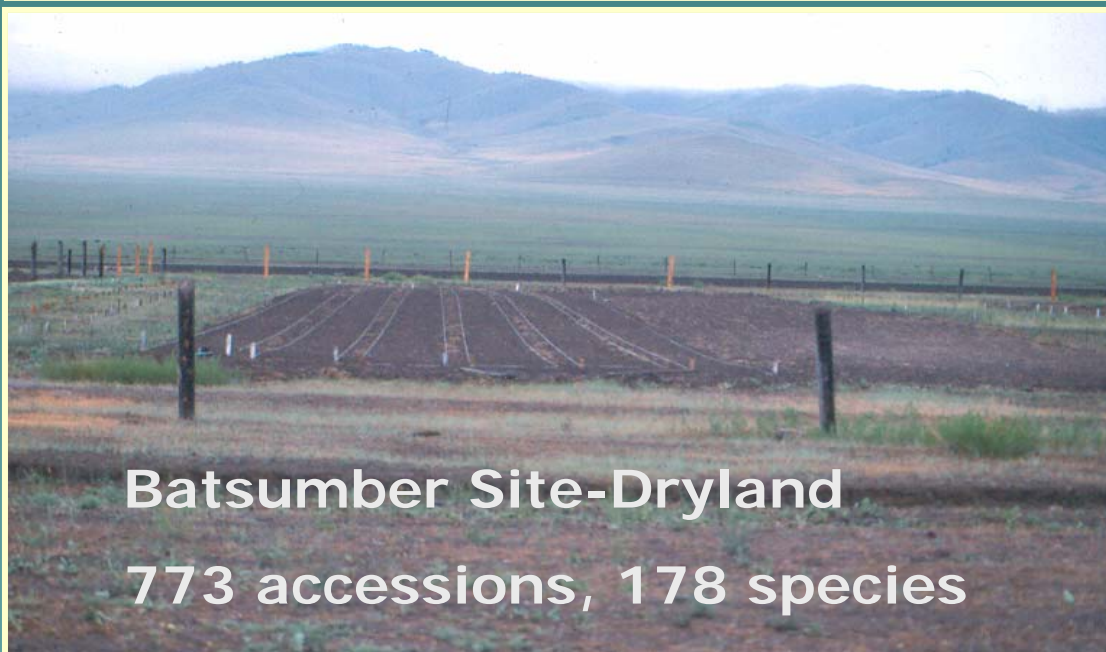
Turgen Site-Irrigated
733 accessions, 164 species



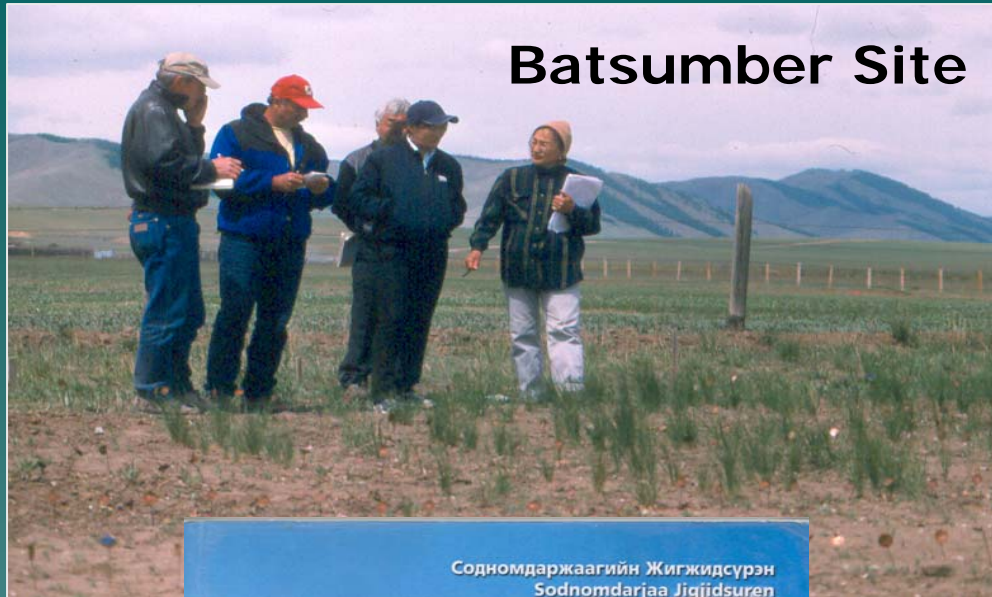
Initial Evaluation

PL-480 Food for Progress
Grant through U.S.
Embassy 2000-2004

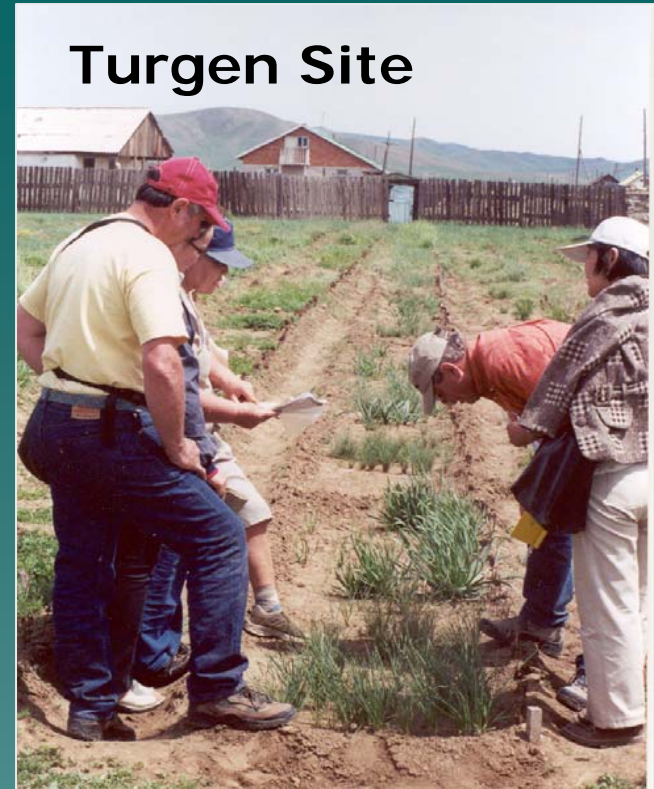
Research Institute of
Animal Husbandry—
Mongolian Agricultural
University



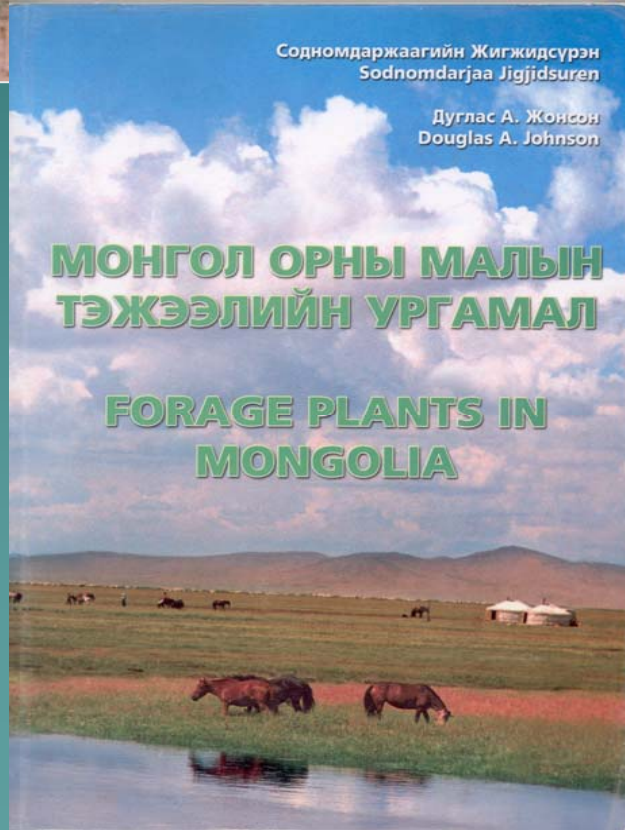
Batsumber Site-Dryland
773 accessions, 178 species



Batsumber Site



Turgen Site



Dr. Jigjidsuren-Project Leader
Research Institute of Animal Husbandry



The Approach to Solving Erosion Problems in China/Mongolia



restricted grazing

reduction of
animal numbers



develop paddock grazing

collecting and testing
native forage and
reclamation species



evaluating species
for potential forage
& seed production

consulting with USDA
scientists

