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Central Inner Mongolia

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This chapter covers research on the grasslands of central Inner Mongolia carried out at two institutions: the Grassland Research Institute of the Chinese Academy of Agriculture Sciences, and the Department of Grassland Science of the Inner Mongolia College of Agriculture and Animal Husbandry, both of which are located in Hohhot, the capital of Inner Mongolia (Liu and Zhao, 1983; Liu et al., 1990). Research in this region carried out by scholars from Inner Mongolia University and the Chinese Academy of Sciences Institute of Botany is covered Chapter 4.

The Grassland Research Institute, established in 1963, employs about 260 technicians and 42 senior scientists, organized in 10 divisions and two field research stations. During the past 20 years, these scholars have conducted 48 research projects, 16 as collaborative projects with other institutions. The Inner Mongolia College, founded in 1952, houses nine departments with 210 professors and associate professors, and a total of 700 faculty members. Scientists at the college have carried out grassland surveys, conducted research on the dynamics and stability of the Inner Mongolian grassland ecosystem, and provided advice on the use and development of Inner Mongolian grasslands.

Dr. Wang Zhigang, a graduate of the Inner Mongolia College of Agriculture and Animal Husbandry and recipient of a Ph.D. from Cambridge University in grassland ecology, describes recent research at his alma mater and in the Grassland Research Institute of the Chinese Academy of Agricultural Sciences, both located in Hohhot, the capital of the Inner Mongolia Autonomous Region. Most work at these two institutions has focused on applied topics, such as the breeding and cultivation of forage grasses, and on grassland protection, production, and management.

SURVEYS OF GRASSLAND RESOURCES

The total land surface of China is 9.6 million km^2, of which 4.0 million km^2 (more than 40%) are grasslands, and of these 3.3 million km^2 lie in the northern temperate zone. A survey of China's grasslands, begun in the early 1970s, seeks to establish the types and grades of grasslands as well as their distribution, productivity, diversity, and the carrying capacities of natural and degraded areas (*Keyan chengguo huibian* [1988] 3:1).

Because most of China's grasslands are located in frontier and mountainous regions where public transportation and communication are poorly developed, remote sensing technology has proved particularly useful. Since the early 1980s, large-scale surveys of grassland areas have identified vegetation types, soil types, topography, climate, and water systems on the basis of color, grain, and other features of remotely sensed imagery obtained from a Multispectral Scanner (MSS) or other remote-sensing device (Wu, 1988). Similarly, the distribution and aboveground biomass of some species can be estimated from reflection patterns on remote satellite photographs. Recently, remote sensing technology has been used to monitor trends over an area of 280,000 km^2 in 18 counties of Inner Mongolia, Hebei, and Beijing. Results of this survey show that each year about 4.7 million hectares of grasslands in the northern temperate steppe region have deteriorated, while the numbers of livestock have exceeded carrying capacities in many regions (Li Bo, 1990).

HERBAGE RESOURCES AND FORAGE GRASS BREEDING

Accurate information on current herbage resources is essential for any program of restoring and managing grazing lands. As a result of overgrazing, the grasslands of Inner Mongolia have been seriously degraded and the primary production of most areas is well below their potential (Jiang, 1988; Liu, 1990). Methods of grassland restoration and management include reducing stocking rates and introducing improved breeds of forage species. First, however, information on current herbage resources is needed. The earliest studies of wild forage species in Inner Mongolia were conducted by Wang (1955) of Nanjing Agriculture University. Beginning in 1952, Wang investigated economic and biological characteristics of 12 wild forage species in Xilingele League. In 1962, Professor Xu Linren of the Mongolia College of Agriculture and Animal Husbandry described the classification, distribution, and biological, ecological and economic characteristics of 23 major forage species (Xu, 1962). Between 1973 and 1983, the Grassland Research Institute conducted similar investigations in Xilingele League, the Xinjiang Autonomous Region, and Guizhou and Hainan provinces (Chen et al., 1985).

These studies have provided useful information on the introduction and domestication of wild species. For example, four years of data on 20 wild forage species planted by the Grassland Research Institute at a field station in Xilinhot in 1976, shows that only three species—*Roegneria turczaninovii, Aneurolepidium chinense,* and *Elymus sibiricus* L.—survived the cold winter and produced a high, stable, aboveground biomass (Wu-yun-gao-wa, 1984). Many wild forage species, although established, have produced low and unstable yields, whereas others have produced high yields but have been unable to survive the extremely cold winter followed by dry spring or summer. In 1978, scientists at the Grassland Research Institute developed a new variety *Medicago sativa-falcata,* by crossing *Medicago sativa* (2n = 32) with *Medicago falcata* L. (2n = 16,32) (Chen, 1984). The new variety has produced a consistently good yield of high-quality forage, demonstrated a survival rate of 92% through winter temperatures as low as –40°C, and adapted well to a variety of environmental conditions.

CULTIVATION OF FORAGE GRASSES AND HERBAGE CROPS

It is believed that overgrazing has caused a decline in the variety and productivity of palatable species (Chen et al., 1984). Much research has focused on methods for restoring degraded grasslands or establishing artificial grasslands in arid and desert regions. Ma et al. (1989) have studied interseeding as a method for improving degraded steppe and abandoned land. Beginning in 1975, the Grassland Research Institute attempted to establish artificial grasslands in Damao Banner on the Wulanchabu Plateau (Dong et al., 1988). This project included experiments on the selection of regional forage species, timing and methods of sowing, interseeding of legume and grass species, rotation farming systems, and control of insect pests and plant diseases. In the course of nine years, this project resulted in the creation of 807 hectares of artificial grassland.

Research of this type increased in late 1970s, although fundamental problems have persisted: Results obtained in one region have not been applicable in other regions where environmental conditions differ. Different studies have used different experimental protocols. Poor control of seed exchange and use of unlabeled or incorrectly labeled seeds have been common in some remote areas (Chen and Wu, 1988).

In 1978 the Grassland Research Institute began controlled experiments to test the performance of 39 common forage species under different conditions. These experiments were conducted at 25 sites in 13 provinces or autonomous regions, from Tibet in the southwest to Heilongjiang in the northeast. The experimental sites were selected to cover a wide range of environmental conditions: latitudes from 26°36'N to 40°56'N and longitudes from 91°61'E to 124°48'E; elevations from 148 to 421 m; annual mean temperatures from –2.4 to 15°C; maximum temperatures from 19.2 to 40.2°C; minimum temperatures from –40 to –42°C; annual precipitation from 200 to 1300 mm; soils from light chestnut in the north to yellow earth in the south; and soil pH from 5.5 to 8.5. After five years, the study areas were divided into four zones and 14 subzones, and species adapted to various zones were selected (Dong and Jia, 1988).

GRASSLAND PRODUCTION AND RANGE MANAGEMENT

It is believed that China's grassland has deteriorated severely as a consequence of overexploitation and mismanagement, but it is unclear what the causes and extent of grassland deterioration are, or what measures might be taken to control or reverse this process?

Zhao-na-sheng et al. (1988) investigated the extent and analyzed the causes of grassland deterioration in China. They collected data on grassland production and dynamics, animal husbandry, and herding economy over three decades (1950s to 1980s), established mathematical models, and used these models to predict trends in grassland development up to the year 2000. Their studies show that herbage production in China's grasslands is declining; that the main cause is overgrazing; and that to restore production, the number of livestock must not exceed the carrying capacity of grassland. They have estimated the carrying capacities of grasslands for different regions and conclude that, to develop animal husbandry in these regions, it would be better to improve the quality rather than increase the quantity of livestock. In particular, they recommend reducing the growth rate of the livestock population and changing the current herd structure by increasing the percentage of females. Finally, they have estimated that by the year 2000, the loses due to grassland deterioration will be 10 *yuan*/km^2 per year.

Studies of this type have focused on the biological, economic, and sociological causes of grassland degradation. Few have described the problem as a function of the flow of energy and matter through the grassland ecosystem. Ren et al. (1978) analyzed the energy flow in grassland production through six stages: solar energy → plant biomass → available forage → forage intake by animals → digestible nutrient → animal biomass. They conclude that in order to maximize grassland and animal productivity it is necessary to improve energy conversion efficiency at each stage. Cai (1982) has also studied energy flows in grassland ecosystems. He points out that in grassland ecosystems, unlike agroecosystems, inputs and outputs of energy and matter are low. Generally, the amount of forage intake by animals should not exceed 40-50% of the aboveground biomass. In some parts of Inner Mongolia, however, the amount of forage consumed is well above this level, resulting in unwelcome changes in species composition, decline in productivity, and even desertification. To restore the natural function of their grassland ecosystems, the Chinese must either reduce the number of livestock or supply additional energy and materials to these systems.

Grassland Protection

Chinese scholars, many of whom have studied the protection of crops against pests and diseases, have neglected the protection of grasslands. As a result, we know little about the occurrence and distribution of plant diseases and insect pests in the Inner Mongolia grassland.

Mice are a major grassland pest. They consume forage and damage soil, thereby hastening the process of degradation. Controlling mice requires vast amounts of money, manpower, and materials. Use of poison bait has been a common method of killing mice. In 1975, China used 100 million kg of poisoned cereal for mice control. The method was costly, and the poison often killed birds and other animals that prey on mice or other pests. Dong and Hou (1984) experimented with granulated grass bait as a substitute for cereal bait, and showed that the grass bait was economical, safe for birds and other animals, and effective in controlling several mice species—*Microtus brandti* Radde, *Citellus danricus* Pallas, *Ochotoma curzoniae* Hodgson, and *Meriones unguiculatus* Milne-Edwards.

The Grassland Research Institute also investigated the occurrence and distribution of diseases of more than 50 forage species in 17 counties of Inner Mongolia, Gansu, and Ningxia. Hou and Bai (1984) identified 180 diseases and 90 pathogens, including 64 species and 29 genera. This study has provided useful information for seed quarantine, disease control, and breeding of disease-resistant species.

Grassland Machinery

During the past decade, Chinese scientists and engineers have developed some grassland machinery. The 9 YL-306 forage granulator, FD-1.5 windmill generator, and 9 CXB-1.75 loosener, all developed at the Grassland Research Institute, have been used widely and have performed well in Inner Mongolia. Ma (1985, 1986) has shown that shallow plowing and soil loosening can improve degraded grasslands and increase forage yield. The 9 CXB-1.75 loosener combines the loosening of soil, breaking of clods, application of fertilizer, and planting in one operation.

Grassland Farming Systems

There is no agreement on the relative merits of rotation versus continuous grazing. From 1985 to 1988, Zhang et al. (1989) compared the effects of rotation and continuous seasonal grazing on grassland vegetation, soil characteristics, and production of livestock in Wulanchabu. They found that rotation grazing resulted in greater vegetation coverage, higher-quality herbage with higher protein and fat content and less fiber, and higher liveweight gain of sheep. They also found that under rotation grazing, sheep spent two hours less each day foraging. Since Osuji (cf. Zhang et al., 1989) has shown that sheep expend 0.54 kcal during each eating hour for every kilogram of body weight gain, rotation grazing must result in less energy loss than continuous grazing.

DYNAMICS AND ECOLOGICAL STABILITY OF GRASSLAND COMMUNITY

Ecological studies of populations and communities in grassland habitats, which began in the West in the 1920s and have increased in recent years, have been neglected in China. The few studies of this type carried out in China have focused on factors that control the stability and fluctuation of grassland communities.

Since 1959 the Department of Grassland Science of the Inner Mongolia College of Agriculture and Animal Husbandry has been conducting research on the dynamics and stability of desert steppe communities on the Wulanchabu Plateau. The *Stipa klemenzii*-dominated desert steppe community in this region exhibits remarkable fluctuation in aboveground biomass with a periodicity of about 13 years (Li Dexin, 1990). Annual fluctuations are a response primarily to changes in precipitation, especially the amount of spring rain, which in turn influences the soil water content (Li and Gao, 1985). These results explain the geographic distribution of desert steppe species such as *S. klemenzii* and *S. breviflora*. Li and Gao have shown that the aboveground biomass of *Stipa breviflora*-dominated steppe communities was higher in the medium or lightly grazed areas than in the heavily grazed or ungrazed areas. Li (1989) has suggested that under medium and light grazing the community reached equilibrium and became ecologically stable.

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