GRASSLANDS

# LEADING THE FIELD IN GRASSLAND AGRICULTURAL SUCCESS

Lanzhou University researchers have led the development of sustainable grassland agricultural systems, contributing to the assessment and restoration of degraded grasslands.

## THEORY AND APPLICATION OF GRASSLAND AGRICULTURE

The grassland agro-ecosystem theory established by Ren Jizhou and his colleagues at the College of Pastoral Agricultural Science and Technology (CPAST) at Lanzhou University (LZU) has transformed China's long-held 'grain-oriented' farmland agriculture into a 'grain- grass-balanced' approach, and improved national food security.

The theory categorizes four production levels of grassland agro- ecosystem: pre-plant production, plant production, animal production, and post-biological production. It considers the relationship between land and forage crops, grassland and livestock, and the forage livestock system and socioeconomic activities.

Applying the theories, CPAST and other researchers established the grassland agricultural system model for the grain and forage system in the Loess Plateau, the mountain-oasis-desert coupled system (MODS) in Gansu Province's Hexi Corridor, and the forage-livestock coupled 'Qinglong Model' in southwest China's karst areas. The theories and models also led to one of the most ambitious simulations mapping global vegetation distribution. The CPAST team modelled 10 ecosystems and 42 types of vegetation covering all the world's regions, except Antarctica.

Livestock in Qinghai-Tibetan Plateau face extreme conditions and lack of legume forage. CPAST researchers, led by Nan Zhibiao, have cultivated three new cultivars of common vetch (*Vicia sativa*), a legume species known for its cold tolerance, and for seeds that are an important protein source for livestock in alpine pastoral areas. The new cultivars, named Lanjian 1, Lanjian 2 and Lanjian 3, will help preserve the grassland and make valuable farming animals stronger.

CPAST also established 10 of the 18 seed testing rules of China for grass and forage plants, and a technical system for germplasm innovation of stress tolerance in grass and cereal crops, leading to six new lines of alfalfa, ryegrass and barley. Researchers have cultivated a new cultivar, called Tenggeli, of *Cleistogenes songorica*, a grass species that can survive in Gobi desert conditions where the annual rainfall is as low as 100 mm. Meanwhile, two new sheep lines, suitable for pen feeding, were bred. These results marked the beginning of desert ecosystem restoration projects, such as erosion prevention, and greening initiatives in urban and mining areas of arid and semi-arid regions.

### CPAST research directions

**CPAST's main focuses for research, teaching and demonstration are:** Exploration and utilization of grass and forage germplasm resources, including their stress physiology and molecular biology; breeding and seed research; grass and forage protection; and the interactions between microbes and forage/grass, and between forage/grass and livestock;

Management of cultivated grassland/turf, including combination selection of various grass/forage; cultivation of grass/forage with high quality and high yield; rotation between grass/forage and crop; design, construction and management of lawn and turf playground; development of forage/grass resources and livestock product safety; and molecular nutrition and biotechnology for ruminants;

Coupling and management of grassland agro-ecosystem, including grassland succession and classification under global climate change; structure, function, evolution and regulation, as well as economic characteristics of grassland agro-ecosystem; management and remote sensing; grazing management, improvement and ecological restoration; natural disaster prediction of grassland resources; and decision-making behaviours of farmers in pastoral and farming areas, as well as relevant production, economic development, and policies for grassland ecology.

A grassland agricultural model for the Loess Plateau was designed, including a new annual planting pattern that rotated cultivation of legumes, such as alfalfa, alongside traditional grain crops, such as wheat and maize. This improved the efficiency of water use and reduced run-off during harvest periods, supporting both livestock and grain production.







## GRASSLAND DEGRADATION AND ITS MANAGEMENT

CPAST researchers revealed the mechanisms underlying grassland degradation and restoration, and proposed a theory and method for evaluating grassland health. These approaches were widely applied in northern China, providing theoretical and technical support for transforming China's grassland utilization from a "livestock oriented" model to one that emphasizes the balance between production and ecology, and prioritizes ecology.

Their contribution includes the establishment of a comprehensive index to evaluate grassland health by assessing condition, vigour, organization and resilience (CVOR). Associated calculation models were developed, and the index system has already been applied to evaluate desert grassland conditions in China.

CPAST researchers proposed the system of rationalising use of grassland in typical eco-regions. A sustainable development model of system coupling was put forward, suitable for pastoral, agricultural, semi-agricultural and semi-pastoral areas in northern China. It features storing food in grass and forage, ensuring China's food safety and ecological protection. The model has been demonstrated at some sites, and is now being extended more broadly.

CPAST also pioneered the research on pastoral plant diseases in China, proposing an integrated technical system for controlling diseases in grassland, and developed a comprehensive and sequential classification system for grassland types around the world. A system for meteorological disaster warning and assessment was also established. These inform recommendations for the optimum carrying capacity of livestock, and the mode of rotational grazing in major pastoral areas of grasslands.

### CPAST in numbers

15 field stations in key ecological areas, including the Tibetan Plateau and the Loess Plateau, and so forth

More than 130 faculty members including:
- 2 members of the Chinese Academy of Engineering
- 1 recipient of the National Science Fund for Distinguished Young Scholars
- 2 recipient s of the Excellent Young Scientists Fund of the National Natural Science Foundation of China
- 2 distinguished scholars of Thousand and Ten Thousand Talent Project of China
- 1 leading talent of Science and Technology Entrepreneurship under the Ten Thousands Talent Plan of China

A CPAST group has developed several transgenic lines of forage plants with enhanced resistance to drought, salinity and nutrient deficiency, as well as greater symbiotic nitrogen-fixing ability, using key genes relevant to stress-tolerance from *Zygophyllum xanthoxylum*, a desert shrub.

## SEEDING SUCCESS

The discipline of grassland agriculture at LZU was established in early 1998 and the college was founded in 2002.

CPAST has many research and communication platforms, such as the State Key Laboratory of Grassland Agro-ecosystems (the only one in grassland science), the International Joint Research Center of Grassland Agro-ecology, and the China Grassland Industry Development Strategy Research Center. Research projects completed by CPAST have led to four national science and technology progress awards, and one international science and technology cooperation award. Research result transformation bases are distributed at 38 enterprises and research institutions in 23 provinces of China.

CPAST also created the educational framework of grassland sciences in China under the leadership of Ren and Nan, and was the only winner of the special prize of national teaching achievement. The grassland sciences discipline was ranked first in the third and fourth round of national discipline evaluation, respectively. The discipline was selected as a "Double first-class discipline" in 2017, a government-led initiative to develop elite universities and research disciplines. ■