

SUSTAINABLE GRASSLAND PRODUCTION SYSTEMS IN SOUTHERN CHINA: AN EXAMPLE FROM GUIZHOU PROVINCE

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ABSTRACT

In this paper the large production potential existing in the Southern Grassland of China is described together with an introduction of the results achieved and the problems encountered in the course of development. The Guizhou Integrated Grassland Development Project implemented by the Gansu Grassland Ecological Research Institute is a project designed to tap the production potential and address the problems. Through the project, a set of key techniques suitable for establishing sown pastures under the local conditions, optimised management models for strengthening technical inputs under the constraint of a reasonable level of capital input, and an effective extension network which guarantees the transfer of research results from experimental stations to demonstration farms and farm households are obtained. A widespread adoption of the results from the project would be an important way towards the establishment of sustainable pasture-livestock production systems in the south of China.

KEYWORDS

the south of China, Guizhou, sustainable agriculture, pasture-livestock production system

INTRODUCTION

Traditionally China is a country of agriculture. With its 133 million hectares of farmland (7% of the world total) it supports 22% of the world population. Although this must be acknowledged as a significant achievement in its long-term agricultural development, the serious consequences brought about by a neglect in the development strategy of grassland resources have shadowed, to some extent, the bright picture of China's agriculture.

At the present time the output of grain production accounts for 70% of the total value of China's agricultural production and the livestock sector only makes up 20%. Within the livestock sector the predominant industries of pork and poultry, which are big feed-grain consumers, produce more than 80% of the total volume of meat consumed in China. The proportion of meat supplied by grazing industries, mainly beef and mutton, is less than 10% of the total meat production (Cai Shengling and He Renrui, 1993). The underdevelopment of grazing industries has led to a serious shortage in domestic supplies of milk, wool and hides and increased imports of these products which have had a lion's share of the markets of milk and textile raw materials in China's big cities.

In recent years the area of farmlands in China decreased by 333.3 thousand hectares each year, while the population and the demand for food grain increased by 14 million people and 9 million tonnes respectively. Obviously, the population pressure and the continuously increasing demand for food grain will be the major obstacle in the course of rapid development of China's national economy viewed in the perspective of a relatively long period (Cao Bingyun and Yao Junhu, 1996). It also indicates that the heavy grain consumers of pork and poultry industries have been faced with enormous difficulties in their further development

The total area of grasslands in China is about 400 million hectares which, according to their geographical distribution, climatic conditions, vegetation features and economic potentials, are zoned

into three types: the Northern Grassland, the Coastal Grassland along the Chinese coast and the Southern Grassland in the hilly countries of south provinces of China (Li Yutang, 1993). The area of the Northern Grassland is estimated as 313 million hectares, while that of the Southern Grassland-some 67 million hectares.

Traditionally the Northern Grassland has been utilised as grazing lands for cattle, sheep, goats and other grazing livestock and has been overgrazed as a consequence of increased population pressure and irrational grazing schemes. The area of deterioration has reached 70 million hectares and the trend is continuing at a rate of 3 million hectares per year. The average productivity of the Northern Grassland is only 5 kilograms of mutton per hectare, that is, only one third of the world average (Li Fei and Dong Suocheng, 1996).

In the face of the serious situation of China's grain production and the decline of the traditional grazing industries in the north, the exploitation and utilisation of the Southern Grassland as pasture resources for livestock production would open an important way for the wanted sustainable development of China's agriculture.

BOOM OF ANIMAL HUSBANDRY ON SOUTHERN GRASSLAND

The Southern Grassland implies the grasslands is comprised of among mountains and hills in 15 provinces to the south of the Qinling Mountain Range and the Huaihe River, with a total area, including the Coastal Grassland in the south, of 74 million hectares, out of which about 40 million hectares can be utilised for livestock production. On the Yunnan-Guizhou Plateau the area of utilisable grassland is 9.46 times as large as that of local farmlands (Ren Jizhou, 1995), while in the east and the south, where population density is high and intensive agriculture prevails, the area of utilisable grassland still makes up about 20-40% of the local agricultural land resources (Ren jizhou and Shen Yuying, 1993).

The Southern Grassland is climatically featured by the monsoons from the Pacific and the Indian Oceans, with a high annual rainfall more than 800 mm (as high as 2000 mm in some regions). In most of the regions where the grassland is distributed the average temperature in January is above 0°C and the annual accumulated temperature (°C) is more than 5000 °C (Figure 1) (Zhang Zihe, 1984). Thus, compared to the regions in the world located at the same latitude (most of them are deserts), the Southern Grassland enjoys unique advantages for growing a wide range of pasture species and raising herbivorous animals.

The Southern Grassland has undergone a booming development since the early 1980s, facilitated by a series of development projects and the establishment of a group of pasture seed producing bases, pasture seed testing centres and pasture-livestock experimental stations. The implemented projects include 6 international joint research projects and more than 30 integrated development projects of crop, forest, livestock and fish-farming industries with the grassland as the project focus. Aerial sowing has also been adopted in regions where the conditions are suitable for pasture establishment. Since the effort has been focused on the establishment of sown pastures and their intensive management, the area of sown pastures in the south and the south-west of China has been increasing at a rate of 66.7 thousand

hectares per year through the last 10 years and the accumulated figure had reached 575.3 thousand hectares by the end of 1987, accounting for 1.05% of the local natural grassland (Huang Wenxiou, 1991). This boom in grassland development plus the rich resources of by-products of local crop production, in turn, has led to a rapid increase in the number of livestock raised in the south provinces of China. In 1993 the region's year-end stock was 58.14 million head for cattle and 40.70 million for sheep (goats), implying that the Southern Grassland, with its pasture resources and locally produced crop by-products, supports almost half of the total grazing livestock population in China. The three provinces of Sichuan, Yunnan and Henan, where crop production is dominant in the local agriculture, have become larger producers of cattle and sheep (goats) than the traditional livestock producing provinces, such as Inner Mongolia, Xingjiang, Qinghai and Gansu. However, in a perspective of long-term sustainable development, the rapid growth of the local livestock sector has brought about some serious problems which must be addressed in the near future.

PROBLEMS FACED BY ANIMAL HUSBANDRY ON SOUTHERN GRASSLAND

The south, the south-west in particular, is classified as the major region of karst landforms in China, with a total area more than 500 thousand square kilometres. This type of landform is characterised by complicated topography, steep slopes, thin soil profile, poor soil nutrients, slow succession and fast reversed succession of vegetation, serious soil erosion caused by run-off and the fragility of the local ecosystems in general. The strategy for the exploitation of the local grassland resources and the establishment of a steady pasture-livestock production system must be based on the concept of "ecological agriculture", that is, to achieve the integrated ecological-social-economic benefit through promoting agricultural productivity while protecting the environment and maintaining the sustainability of the resources. This important issue, however, has not yet been seriously addressed since it has just recently emerged into the focus of attention.

In comparison to the extensive management style prevailing in regions of the Northern Grassland, the model of management adopted for the Southern Grassland can be described as a "primitively intensive one". The major shortcomings of such a primitive manner of management are that there have been intensive inputs of capital and labour, while the need for intensive inflows of technology, information and management knowledge has been neglected. Thus, the established pasture-livestock system is an odd result of intensive capital inputs under extensive management and, there would be no doubt, such a system can neither be sustainable, nor be capable of achieving the expected goals of economic development. This problem has affected the strategy of development for the whole Southern Grassland.

Another problem which arose during the recent boom of animal husbandry in the Southern Grassland is the lack of a system of technical extension services. Although a series of research programmes have been conducted in various ecological zones of the Southern Grassland to address the key technical issues related to the establishment of a sustainable pasture-livestock system and thereby some important results have been obtained and applied to an extent in practice through demonstration, the lack of planning and strengthened measures for providing extension services, assessed on the whole, has hindered the research results from being transformed into actual productivity. For example, the technical problems about how to decrease costs, simplify key techniques, increase vegetation stability for establishing sown pastures and maintaining the

established artificial plant community have been solved through the above mentioned research programmes, but in reality these problems are still serious obstacles preventing the Southern Grassland from building a higher level of development.

GUIZHOU INTEGRATED DEVELOPMENT PROJECT FOR SUSTAINABLE GRASSLAND PRODUCTION SYSTEM: PROJECT OUTLINE AND RESULTS

Guizhou province is located on the Yunnan-Guizhou Plateau in the south-west of China. The local topography on mountain tops above the altitude of 1500 m features erosion-formed open rolling flats with rich pasture resources. The total area of native grassland is about 19 million hectares, out of which 15 million hectares are usable for grazing. The local climatic conditions are also favourable to pasture-livestock production with an annual rainfall above 1000 mm and a monthly average temperature above 10°C.

Since 1983 the Gansu Grassland Ecological Research Institute (GGERI) has conducted a long-term research and extension programme assigned by the Ministry of Agriculture of China in the central part of the Yunnan-Guizhou Plateau. The programme was given high priority by the Ministry through the successive five-year plans, that is, the 6th (1981-1985), 7th (1986-1990), 8th (1991-1995) and 9th (1996-2000) five-year plans for nation-wide research and development activities. The programme was combined with the implementation of an internationally sponsored poverty alleviation project and a UNDP grassland development project after 1989 and hence it was turned into the current shape as an integrated research-development project. Correspondingly, the project sites for research, demonstration and extension have been expanded from the north-west of Guizhou province (Weining county) into the central and south parts of the province (Qingzhen and Dushan counties) and Qujing county in the east of neighbouring Yunnan province. The major results from the integrated research-development project consist of three aspects: a) research on techniques of pasture establishment and management, b) a system study for establishing improved pasture-livestock production systems and c) the establishment of an extension system for facilitating the transfer of research results from experimental stations to farms.

The following results have been obtained from research seeking techniques suitable to pasture establishment and management under the local conditions:

- 1) 14 pasture species have been selected through tests under grazing conditions, which have the merits of high yield, fine nutrient and palatable quality, strong ability in competition with weeds, relatively high growth rate in early spring and late autumn and a long duration of more than 10 years for utilisation (Jiang Wenlan et al., 1996c).
- 2) A low-cost technique for improving native natural grassland or establishing sown pastures through establishing sheep flocks at certain locations (the technique of "sheep night penning") was developed for the specific geological conditions of the mountainous countries with karst landforms. Without tillage, the technique can help in clearing native vegetation, improving soil fertility, increasing pasture yield and decreasing run-off and soil erosion. Compared to the traditional method of tillage, the forage yield from the sown pastures established through this technique can be increased by 32% while the cost is decreased by 80% (Jiang Wenlan et al., 1996d).
- 3) Instead of using pesticides, a clean technique for controlling grubs in sown pastures through establishing sheep flocks and

adjusting grazing intensity was tested and recommended for extension. It is a simple application and can control up to 84-93% of the pest with a low cost of only 108 Yuan per hectare, which is 10-34% cost of chemical control. Also, the technique improves soil fertility, stimulates re-growth of pasture and increases the yield (Yuan Qinghua, 1995a, 1995b, 1996).

- 4) Through a series of investigations on the deterioration processes and circumstances of the local sown pastures and analyses of the invader plants regarding their types, numbers, invading processes and conditions, some effective measures have been determined for preventing sown pastures from degradation, and for adjusting legume-grass ratios and maintaining the stability of the established plant community (Wang Gang et al., 1995a, 1995b, 1995c).

The study into seeking improved pasture-livestock production systems had its objective to effectively utilise limited capital, promptly extend research results to farms, and exploit maximum production potential of local natural resources while protecting the ecological environment from damage.

A two-stage analysis approach was adopted to improve a) the allocation of grassland resources on the base of an ecological zonation and b) the intensified inflows of information, technology, managerial skills and labour under the constraint of a reasonable level of capital input. Both theoretical analyses and actual experiments on farms were employed in the designing of sheep, dairy and beef production systems with special attention given to the vertical and horizontal links within the individual systems. It was shown that the three improved production systems of sheep, dairy cows and beef cattle increased production per hectare of pasture by 124.5, 117.5 and 264 APU, respectively, which were 694.6, 3638.3 and 1596.7 Yuan at the prices of 1995. The pasture cover of the pastures under utilisation was kept within the ranges of 1000-2000, 1000-2200, 1500-3000 kilograms of dry matter per hectare, indicating that the optimised systems did not cause deterioration of the pastures while they achieved the above mentioned economic returns (Jiang Wenlan, 1995; Jiang Wenlan et al., 1996a, 1996b). This result means that the optimised systems can lead to a dynamic equilibrium between pastures and livestock and hence the sustainability of the pasture-livestock production system.

Since 1985 the GGERI has made great efforts in Guizhou province to establish a multi-ownership economic-technical complex which combines activities of research, demonstration and extension into a network through which technical inputs flow from experimental stations to demonstration farms and further to individual farm households. The demonstration sites established have had a total area of more than 2000 hectares, with a stocking rate of 7.5 head of sheep per hectare and 2.5-3.3 kilograms of clean wool per head. The network has covered the counties of Weining, Qingzhen and Dushan in Guizhou province and Qujing county in Yunnan province. More than 2000 farm households have benefited directly from the project with an increased income as high as 6-10 times the level before the project.

CONCLUSIONS AND DISCUSSIONS

The results from the Guizhou Integrated Grassland Development Project indicate that the exploitation of production potential in the Southern Grassland can bring about significant economic and ecological benefits when suitable research results are transferred to and adopted in local production systems. For example, if only the technique of "sheep night penning" is adopted at a rate of 2% a year

in the karst mountainous counties, containing more than 2 million hectares of native grasslands, within 10 years 0.4 million hectares of sown pastures, which is 7.3 times larger than the existing area, would be established and would bring about a total net economic benefit of 820 million Yuan during the 10-year period. Meanwhile, with this technique, run-off can be decreased by 55% in the established pastures, and soil erosion by 99% in comparison to the cases with tillage. The indices of soil fertility and vegetative composition of the native grasslands can also be improved by the technique: the soil organic matter content can be increased by 2.6-4.0%, effective nitrogen by 31-71 ppm, effective phosphorus by 4.3-13.8 ppm, effective potassium by 86-422 ppm.; the native shrub species with low feed value can be replaced by quality forages such as rye-grass, white clover and others, with a proportion of the latter as high as 95-100% in the established sown pastures and a forage yield of 11000 kilograms of dry matter or more per hectare (Jiang Wenlan et al, 1996d).

The research results from and the production practices through the project also indicate that even though the established sown pastures showed a strong trend of degradation due to the instability caused by the force of natural succession towards a sub-climax of the vegetation (Jiang Wenlan et al., 1996a), a high degree of sustainability of the established pasture-livestock production system and a significant level of economic returns can still be achieved by adopting adequate technology and optimised management tactics.

The above conclusions are important to the poverty-stricken mountainous regions of Guizhou province, where farmlands for food grain production are relatively scarce even through rich grassland resources exist. Therefore, the establishment of sustainable pasture-livestock production systems would provide the local farm households with an important source of income and hence a way for eliminating of poverty.

In a long-term perspective of exploiting the grassland resources the strategy for further development needs to be oriented to the establishment of a complete grassland production system which includes not only the existing pasture and livestock production, but also up-stream and down-stream industries, such as tourism and processing enterprises (Ren Jizhou and Shen Yuying, 1993). There exist certain ecological-economic zones in the south of China, where the conditions are suitable for establishing such a four-component production system and, through the system, achieving a much higher overall productivity and a more efficient use of the grassland resources.

Another consideration concerning a rational use of natural resources is to realise system coupling between different production systems (Ren Jizhou and Shen Yuying, 1993). The traditional way in China of utilising grasslands, farmlands and forests is to separate them into different management regimes isolated from each other, and thus exchanges of energy and materials between the systems are hindered. In the mountainous regions of south China the topography, climate conditions and land types usually vary significantly within a short distance, forming many ecological-economic sub-systems. Therefore, the concept of coupling between these sub-systems may be easier to be adopted there than in the north of China and it would greatly increase overall productivity and economic returns. This direction could be regarded as an important aspect of modernisation of agriculture in China and, obviously, the Southern Grassland possesses large potential in this direction.

It is estimated that the livestock production in the Southern Grassland

can be increased by 170 million sheep units in the near future (Li Fei and Dong Suocheng, 1996). Including the existing 390 million sheep units, the total number of herbivorous livestock will be 560 million sheep units, accounting for more than 50% of the populations of cattle, sheep and goats in China. Thus, the Southern Grassland would become the major livestock production base in China.

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Figure 1
The equal value lines with 800 mm precipitation and 5000°C accumulated temperature in China.

