韓草誌(J. Korean Grassl. Sci.) 12卷 特別號 : 23~29, 1992

Factors Required to Sustain Grassland Farming Systems and Forage Supply in Winter Cold Zones in China

T. Zhu, Y. Zu, L. Fu and H. Gao

中國의 冬季寒冷地域에 있어서 草地開發과 粗飼料 供給의 活性化에 必要한 要因

T. Zhu, Y. Zu, L. Fu and H. Gao

적 요

중국의 동계한냉지역에 있어서 조사료와 가축생산에 대한 문제점을 조명해 보고 초지농업에 대해 고찰해 보았다. 이 지역에서는 동계기간중 기후적 요인(특히 저온)이 초지의 생산성을 제한시키는 주요 요인이 되고 있는데, 이는 계절간 목초의 균등생산과 동계기간중 원활한 사초공급의 어려움을 보여주고 있다. 본고에서는 중국 동계한냉지역에 있어서 현재와 미래의 초지농업에 대해 상세히 기술하였다.

Ⅰ. INTRODUCTION

The total area of grasslands of China is about 3.8 million km^2, where grows about 3000 forage plants and supports about 330 million domestic herbivores. In recent years, it produces about 340 thousands of draught animals (LiYutang 1990), 1 million beef cattle, 10 million meat sheep, 80 million kg wools and hairs and 1 million animal skins each year. It is a main production base of meat, milk, wools and skins in China.

But about 2.8 million km^2 area of grasslands is distributed in winter cold zones where the avarage temperature in January is lower than −8℃. In these zone, rainfall and temperature is low. Development of grasslands farming is limited by climatic factors, especially the hard winter conditions. It is very important to ensure forage supply in winter and improve the feed management for the development of grassland farming in winter cold zones.

Ⅱ. EFFECT OF COLD ON THE GRASSLAND PRODUCTION SYSTEM IN WINTER COLD ZONES IN CHINA

1. Effect of cold on forage supply

Winter cold zones of China is mainly located in the arid and semi-arid ecological weak region (Dall 1986). The forage production is greatly limited by short sustained time of accumulation temperature (≧10℃) (Numata 1979) and the low rainfall in growing stage. During the long winter periods, forage plants grow into the withered and yellow stage, when plants parts, such as, stems and leaves, are broken and even blown away by strong winter wind. The litter is covered by thick winter snow. These results in further decrease of forage production (Table 1). (Li Bo 1991). It is indicated that the seasonal unballance of forage supply in winter cold zone is mainly due to the seasonal unballance of forage production.

Institute of Grasslands Science of Northeast Normal University, ChangChum 130024, China.

Table 1. Grassland production in growing and withered-yellow stage

Type of grasslands	Grasslands production in growing stage (g DM/m)	Grasslands production in withered-yellow stage (g DM/m)	Decrease of production (%)
Northeast meadow	225	113.0	50
Grasslands in north China	105	46.2	56
Northwest desert grasslands	45	13.5	70
Alpine-arctic meadow in Tibetan plateau	120	45.6	62

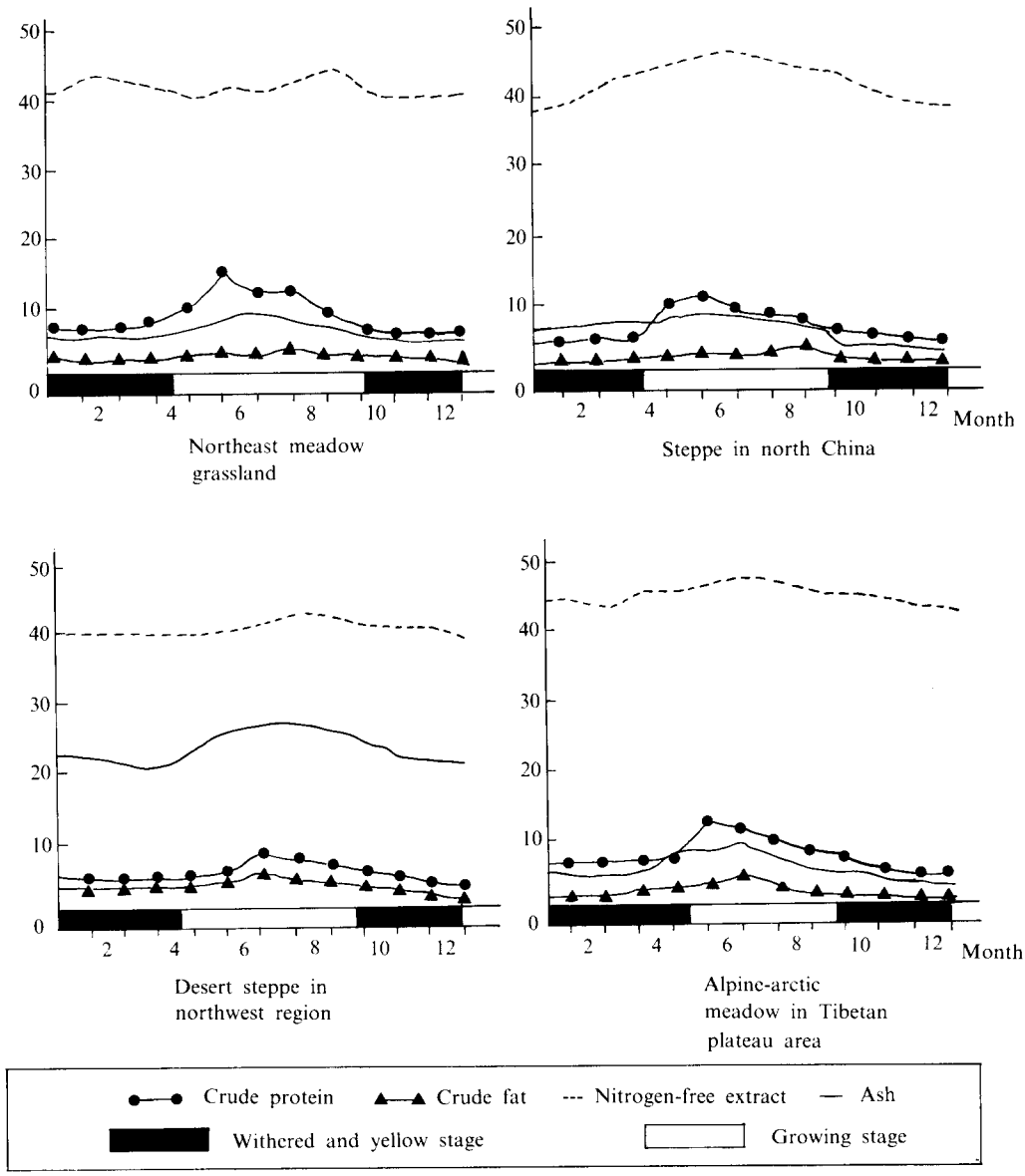

Fig. 1. Forage nutrition changes (% of dry matter) in growing and withered-yellow stage

In winter cold zones of China, the cold affect not only the forage production, but the forage quality. It shows in Fig. 1 that the content of crude protein, crude fat, nitrogen-free extract and ash of forages in the withered and yellow stage is much lower than that of forages in the growing stage. (Zhu TingCheng 1985). It makes the seasonal unballance of forage supply of grassland production system in winter cold zone more serious.

2. Effect of cold on the animal production

Effect of cold on the animal production is mainly reflected in the increased metabolic energy requirement of animals in cold condition. For example, in Northeast China, extra 1.3 MJ metabolic energy is required per day for every 1℃ temperature decrease for the beef cattle of 300 kg body weight when environment temperature is lower than 5℃; 32.6 MJ extra metabolic energy is required per day when environment temperature is decreased to −20℃ for their mainteinance, i.e., extra 4kg forages of good quality is required. Therefore, in winter, increased animal feed requirement and decreased grasslands production further aggravate the seasonal unballance of forage supply.

Ⅲ. MAIN PROBLEMS AND PRESENT DEVELOPMENT OF GRASSLANDS FARMING IN WINTER COLD ZONES IN CHINA

Main problems of grasslands farming in winter cold zones in China as follows:

1. Irritional grasslands resources protection

The large area of grasslands are deteriorated because of overuse of grasslands over long periods of time and irritional activities of mankind, such as, using grasses and shrubs as fuels, digging the drug plants (Zhu Ting Cheng, 1989).

2. Imperfect management system

As it is indicated above, main bases of animal production of China are located in winter cold zones, animals have to grow through the long periods of cold winter season of about 4~5 months. Because of the over amount of livestock kept and inadequated feed supply in winter, basic enery requirement of the livestock can not be met, resulting in the malnutrition and even death of livestock. Good economic effect can be got by fattening animals by barn feeding immediately after autumn, when animals are in good growth state. But traditional irritional time of barn feeding (started in mid winter when animals are in the maintaining growth periods) with inadequated forage supply, effect of barn feeding is always getting half the result with twice the effort.

3. Inadequated grain feed supply

China has great population. Only small amount of grains can be used as feeds (Table 2) (FAO, 1990). Therefore development of animal husbandry can not depend on the grain production. Only way to solve the problem of seasonal unballance between forage supply and animal requirement in winter cold zones is to exploit and utilize other feed resouces of non-grain.

Table 2. Allotment of grains in China and other countries

	Ratio of grain used for different purposes (%)			Compound feed per capita (kg) in 1986
	Edible	Feed	Seeds	
World avarage	42.3	42.9	5.0	142
China	75.7	15.6	8.3	5
U.S.A.	23.0	74.6	2.4	435

4. Bring the grasslands under cultivation

Large area of grasslands of high productivity has been brought under cultivation during past few decades. But only about 1 % total area of crop land grow feed crops in cropping system. The problem of shortage of forage supply become even more serious. In recent years, Chinese government has taken a series of measures to strengthen the development of grasslands farming in winter cold zones.

5. Grasslands construction and development of new forage cultivars

In recent years, about 6.3 million hectare fenced grasslands and 6 million hectare artificial grasslands have been developed in China. China has successfully developed the technique to oversow forage plants in grassland by airplane, such as, oversowing *Calligonum mongolicum* in the steppe of Innermongotia; *Kochia prostrata* in the Gobi desert steppe of Xingjiang, *Astragalus adsurgens* in the alpine meadow area with elevation of over 3,000 m in Tibetan plateau.

China also pays attention to the research on the selection and breeding on new forage cultivars adapted to the cold zone with high yield and quality. Some forage cultivars adapted to different ecological zones have been successfully developed and used for the establishment of pasture in great area, such as, alfalfa, *Astragalus adsurgens,* smooth brome and feed triticale adapted to the condition of alpine-arctic region (Table 3), etc. Successful development of polyear cultivar of *Zea mays* L. has increased the efficiency of straw utilization. The stems and leaves of this cultivar are still green, fresh and have higher nutritive value after their seeds have been harvested.

Table 3. Characteristics of feed triticale bred in China.

	Yield kg/ha		Content of C.P.	Lysine	Hardiness	Cultivar
	D.M	G.M	%	%		
Feed triticale	9,545	42,258	13.8	0.51	dry cold disease	H 1890: High cold resistance, seeds yield: 200 kg/ha, late-maturing WOH 830: Hardiness, early-maturing H 1881: Cold, disease resistant spring variety

6. Exploitation of other feed resources

China is rich in feed resources. For example, cereal straw production is highest in the world. About 20 million tons oil cakes (soybean cake, peanut cake, cotton seed cake and rape seed cake) are produced each year. In recent years, a series of measures have been taken of exploit these valuable resources.

Straw ammoniation

500 million tons crop straws have been produced each year in China when calculated by grain/straw= 1 for wheat and rice, grain/straw=0.5 for maize and sorghum. It is about 50 times of annual hay production (about 10 million tons grasses hay maked each year) (Wang Suzhen 1991). At present, techniques of straw ammoniation has been adopted in most winter cold zones of China. Digestibility and protein content of straw is greatly increased after it is ammoniated (Table 4). With rough calculation, 7 tons concentrated feeds can be saved with 1 ton ammonia input for straw ammoniation. Where

Table 4. Characteristics of ammoniated wheat straw

	Increase of eating rate	Daily intake increase of cattle	Increase of digestibility of O.M.	Increase of C.P.	Cow daily live weight gain increase	Increase of milk production
Ammoniated wheat straw	43 %	0.76kg	15 %	6.5 %	209 %	24.8 %

concentrated feed level of animal ration is low, 1 ton concentrated feed can be saved with 4 tons ammoniated straw.

Silage making

Silage making is one of good ways to solve the problems of seasonal unballance of forage supply in winter cold zones, especially in high elevation region of south China where hay making is very difficulty due to cold and wet climate. There are great variety of materials which can be used for silage making: A): Grasses from semi-artificial and artificial pasture. B): Feed crops, such as, silage corn: late sowing, cutting before frost's descent when seeds is in milk stage, nutrition value is high and good silage can be made. C): By-products of agriculture, such as straw, sweet potato and peanut sprout.

Hay making and storage

At present, main winter forage of animal is hay in winter cold zone. Herdsmen have got a wealth of experiences in hay making, such as: cutting time, haymaking and hay storage methods, etc.. Hay maked with yang-cao (*Leymus chinensis*) have high nutrition value, and good palatability, which has been exported to Japan and other countries in Southeast Asia (Zhu TingCheng, 1981).

Exploitment of other feed resources

China has great amount of different protein feed resources. Only four kinds of oil cakes (soybean, peanut, cotton seed and rape seed cake), annual production reach to about 20 million tons. Traditionally, most of these cakes have been used as manure, good resources has been wasted. Research results indicated that these cakes can be directly used as animal feeds under the scientific feeding and management even it is not detoxication treated. Recently, great amount of oil cakes and distiller' grains have been used as protein supplement for the fattening of pigs and beef cattle.

Works on the exploitation of trididitional chinese medicine feeds using the stems and leaves of *Elcutherococcus senticosus, Panax ginseng* is in development stage, which may contain some unknown factors which are good for animal health and can promote animal growth.

7. Developing feed industry and improving feeding management

Although feed industry develop lately in China, it has had great development in recent years. At present, there are about 14 thousand plants of feed processing, and annual production of the processed feed is about 20 million tons (Wang Suzhen, 1991). In Recent years, single pattern of grasslands utilization, grazing animals on grasslands throughout the year, has been changed, stocking rate is determined for warm and cold season seperately according to the seasonal production of grasslands. Further increase the herdsmen's settlement in winter and time of barn feeding in winter cold zones. At the same time, measures have been taken to speed up the turnover time of livestock and increase the ratio of female animals in population of livestock kept in winter.

China has also taken some measures to improve

the environment condition of livestock growth in winter cold zone such as: construction of stock shed. Good result has been achieved for the construction of plastics shed especially (Table 5).

Table 5. Winter temperature condition and feeding effect of plastics shed in northeast grassland zone

Livestock	Temperature ℃	Month						Optimum temperature ℃	Daily gain g/d	Feeding periods days
		Dec.		Jan.		Feb.				
		Inside shed	Outside shed	Inside shed	Outside shed	Inside shed	Outside shed			
Beef cattle	Max.	7.0	−5.1	−0.4	−2.7	1.1	−3.0	5−21	492.8	90
	Mini.	−5.1	−24.1	−9.1	−26.5	−4.0	−22.5			
Sheep	Max.	5.0	0.4	4.5	−2.2	3.7	−15	7−24	60.7	90
	Mini.	−3.5	−26.7	−7.0	−28.1	−2.5	−24.1			

Ⅳ. PROSPECT FOR THE DEVELOPMENT OF GRASSLANDS FARMING IN WINTER COLD AREA IN CHINA

It is estimated by forecast analysis of development made by Chinese Ministry of Agriculture that the meat consumed per capita will increase from present 20 kg to 25 kg and milk from 3 kg to 15 kg in 2000 in China. It means that the meat production must reach to 31.25 million tons and milk production to 18.75 million tons in 2000 in China in order to meet the requirement of people. Under the conditions of great population and shortage of arable lands in China, grasslands production systems in winter cold zones of about 30% of total area of China will face a great challenge in the next century as the main base of animal production in China.

Seasonal unballance of forage supply and hard winter conditions are and will be the main limiting factors for the development of grasslands farming in winter cold zones of China. In order to develop the grasslands farming in winter cold zones, China will: Further strengthen the basic construction of grasslands and exploitation of feed resources.

Emphasis will be put on the: improvement of deteriorated grasslands; pasture establishment; fencing and stock shed construction; new protein feed supplement resources exploitation; development of new techniques for the treatment of agricultural by-products (straw, oil cakes, distiller' grain etc.)

1. Speed up the construction of feed processing industry and improve the grasslands management

The production of compound feed, vitamin, antibiotic, enzyme preparation, growth hormone, etc., will take priority to develop first. Measures will be taken to further improve the management of grasslands and animals and develop the optimum management systems in different grasslands zones according to the divisions of ecological region, such as, joining zone between agriculture and animal husbandry and joining zone between forestry and animal husbandry.

2. Strengthen the research and education of grasslands science

More efforts will be made on the research on the development of new forage varieties with high hardiness. Research on the development of optimum

model for grasslands farming in winter cold zones will be focal point to develop as one of major national projects in next several years.

Besides the university education, more effort will be made on the popularization of knowledge of grasslands science and "laws of grasslands" in order to improve the management level of herdsmen and local manager.

There will be a great development for grasslands farming in winter cold zones of China in the next few decades. We wish to develop our grasslands farming cooperatively with the scientists all over the world. We are sure that grasslands farming in Northeast Asia will play greater roles in the agricultural development in next century.

V. SUMMARY

This paper discussed the effect of cold on the forage and animal production and reviewed the main problems and present development of grasslands farming in winter cold zones in China. It is considered that climatic factors, especially cold winter condition, is the main limiting factor of the grasslands production, which cause the seasonal unballance of forage production and forage supply in winter cold zones in China. Present and future development of grasslands farming in winter cold zones are discussed detailly.

(Key words: Grassland farming, winter cold zone, Grassland production system, Limiting factor, Straw amminiation)

VI. REFERENCES

1. Dall. B.E. and C.M. Mckelil. 1986. Use and abuse of chinese deserts and rangelands. Rangelands 8(6):267-271.
2. FAO. Production year book. 1990. Vol, 43 Rome, Italy.
3. Kawanabe Sukeo and TingCheng Zhu. 1991. Degeneration and conservational trial of *Leymus chinensis* grassland in northern China. Journal of Japanese Society of Grasslands Science. Vol. 37. No. 1:91-99.
4. Li Bo, RenJizhou. 1991. The development of grasslands ecology. Research on the developing strategies for the ecological science in China. 319-404. Beijing, China.
5. Li YuTang. 1990. The achievement and perspective of chinese grasslands farming in the past decades. Grassland of China, No. 3:1-5.
6. Numata, M. 1979. Climate and soils in Asian grasslands areas. Ecology of grasslands and bamboolands in the world. Dr W. Junk by publisher. The Hague-Boston-London 35-42.
7. Wang SuZhen and Xie Fan. 1991. The grassland resources and utilization in south China. Acta Agrestia Sinica. Vol. 1. No. 1:1-9.
8. Zhu TingCheng, Li Jiandong and Yang Dian Chen. 1981. A study of the ecology of yang-cao (*Leymus chinensis*) grasslands in northern China. Proceedings of the XIV International Grassland Congress 429-431. Kentucky, U.S.A.
9. Zhu TingCheng, Li Jiandong and Zu Yangang. 1985. Grassland resources and future development of grassland farming in temperate China. Proceedings of XV International Grassland Congress. 33-38. Kyoto, Japan.
10. Zhu TingCheng, Zu Yangang. 1989. Past, present and future use of the pastoral zones of eastern and central Asia. Proceedings of XVI International Grassland Congress. 1725-1729, Nice, France.