ANIMAL HUSBANDRY AND WATERSHED MANAGEMENT IN HIMALAYA-HENGDUAN REGION

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INTRODUCTION

The Himalaya-Hengduan region situated in the south-western part of China is the largest mountain region in the world. The Himalaya range known as 'The Roof of the World', has numerous sharp pinnacles and rugged peaks. Mount Qomolangma (Mount Everest) is the highest peak in the world.

The Himalaya region includes the valleys of Yarlungzangbo, Nu Jiang, Lancang Jiang, Jin Sha Jiang, Ya Long Jiang, and Dadu He, and Yarlungzangbo River is the lowest region.

The natural landscape of the southern Himalaya differs from the northern slopes and the valleys between the Thanlawkyaw and the Nigang between are the gorges of Nu Jiang, Lancang Jiang and Jinsha Jiang. The range rise to 5000-7000m and the climate is mild.

At the source of Himalaya, the valley, topography is gentle with good vegetation and fertile soil. There sheep and yak are the principal pastures on the plateau, [illegible] and lacustrine flats. The precipitation remains good with dense vegetation is not good for livestock farming. Gorges alternate with depressions on river courses. The elevation is not high and farming occurs in the depressions. The climate is good for farming, particularly in the main urban centers and areas of concentrated population. The region is rich in agricultural by-products, for example, [illegible]

ANIMAL HUSBANDRY

Types and Characteristics of Animal Husbandry

The Himalaya-Hengduan region, with complex prevailing conditions, is rich in natural resources and domestic animals. It is a typical region for mountain animal husbandry studies as it has a vertical distribution of the various types: sheep, goats, horses, donkeys, swine, yak, cattle, buffalo and [illegible].

Animal husbandry production is restricted by the natural conditions due to the [illegible] resources from [illegible]

[illegible] Animal Husbandry. The [illegible] consists of various types of [illegible] the most [illegible] are alpine [illegible] and the [illegible]

Alpine animal husbandry. The elevation for this form is the highest in the region, as most parts are over 4500 m, including areas at the top of the Himalaya, the source of Yarlungzangbo river and the northern part of the Hengduan range. The cold climate is not suitable for farming, so the rangelands are not cultivated, creating a pastoral region. The domestic animals reared, such as yak, sheep and goat, are native breeds with a great capacity of survival in this environment. The management of animal husbandry is extensive and most animals are free-range grazers.

Owing to the variations in natural

ANIMAL HUSBANDRY AND GRASSLAND RESOURCES

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The Himalaya region includes the valleys of Yarlungzangbo, Pum-Qu, Luo-Qu, Ma-Jia Zang Bu, and Lang-Qin Zang Bu. The Yarlungzangbo river is the worlds highest.

The natural landscape of the southern Himalayan slopes differs from the northern slopes and the physical phenomena vary within short distances.

The Hengduan ranges situated to the east of the Himalaya are oriented north to south. The range includes the Boshula, the Thaniantaweng, and the Nigjing. In between are the gorges of Nu-Jiang, Lancung-Jiang, and Jinsha-Jiang. Peaks on the range rise to 5500-7000m and the climate is moist.

At the source of Himalaya-Hengduan valleys, topography is gentle with good vegetation and light erosion. Tibetan sheep and yak find excellent pastures on the plateaus, mountains, and lacustrine flats. The precipitous mountain zone with sparse vegetation is not good for livestock farming. Gorges alternate with depressions on river courses. The elevation is not high and terracing occurs in the depressions. The climate is good for farming, particularly in the main urban centers and areas of concentrated population. The region is rich in agricultural by-products, for example fodder.

ANIMAL HUSBANDRY

Types and Charactersitics of Animal Husbandry

The Himalaya-Hengduan region, with complex prevailing conditions, is rich in natural resources and domestic animals. It is a typical region for mountain animal husbandry studies as it has a vertical distribution of the various types: sheep, goat, horses, donkeys, swine, yak, cattle, buffalo and zebu.

Animal husbandry production is restricted by the natural conditions due to the changes in rising elevations (See Table 1).

Range lands and Animal Husbandry: The region is composed of various types of rangeland. The main types are alpine meadow, mountain shrub, mountain sparse wood, and mountain desert.

Alpine animal husbandry: The elevation for this form is the highest in the region, as most parts are over 4500 m, including areas at the top of the Himalaya, the source of Yarlungzangbo river and the northern part of the Hengduan range. The cold climate is not suitable for farming, so the rangelands are not cultivated, creating a pastoral region. The domestic animals reared, such as yak, sheep and goat, are native breeds with a great capacity of survival in this environment. The management of animal husbandry is extensive and most animals are free-range grazers.

Owing to the variances in natural

conditions between the western and eastern parts, alpine animal husbandry is sub-divided into three parts.

In the east Himalaya and northern part of Hengduan, the altitude is lower, annual precipitation is about 650mm, the precipiation is 300-350 mm, vegetation is mainly steppe, and sheep form 40-60% of the total animal population.

In the far western end of the Himalaya, climate is arid, precipitation is less than 100 mm, vegetation is mainly desert, and goats form 45% of the total livestock population.

Plateau lake-basin area: This form is practised at the second floor of vertical distribution, generally at an elevation of 4200-4500 m. The climate is not too cold, and vast natural grasslands exist. Animal husbandry is the main component of the economy. The area is self-sufficient in animal products. Some cold-resistant crops, i.e. highland barley (naked barley), are planted in some areas.

Species of livestock are more numerous and include sheep, goat, yak, cattle, hybrids, horses, donkeys and swine. Sheep form 60% of the total animal population. The management of animal husbandry is extensive. Herdsmen are settled and most animals penned.

Plateau-valley area: The elevation is generally between 3000-4000 m, where the warmth is good for farming. Forests, rangeland and cropland are distributed across the slopes of the mountains. Agriculture plays an important role in the economy, and the areas are self sufficient in agricultural products, particularly supplementary fodder. Animals are mainly cattle and goats.

Low elevation-gorge area: In the south-eastern parts of Hengduan and southern slopes of the east-Himalaya, altitude is lower than 2000m, climate is hot and

Table 1. Vertical Distribution of Animal Husbandry

Altitude	Topography	Climate	The Type of Rangeland	Type of Economy	Main Animal
>4500m	Alpine Plateau	Cold Sub-humid	Alpine meadow and Alpine steppe	Pastoral regions	Yak and sheep
3500 - 4500	Plateau Valley	Cool Semi-arid	Mountain Steppe and Mountain shrub	Semi-pastoral regions	Sheep, Yak and Cattle
2500 - 3500m	Valley	Warm Semi-arid	Mountain shrub	Semi-agricultural regions	Cattle, Goat and Swine
<2500 m	Valley	Hot. Humid, Semi-arid	Mountain sparse wood	Agricultural regions	Buffalo and Swine

humid, agriculture is developed, and the crops grown include rice, wheat and maize. Animal husbandry is a part of the agricultural ecosystem. In addition to cattle and goats, there is a large number of other animals living in the tropics and sub-tropics. For example buffalo and zebu. Cattle form 25-30% of the total animal population.

DEVELOPMENT OF ANIMAL HUSBANDRY AND THE MANAGEMENT OF VALLEYS

Direction of the Development of Animal Husbandry

Because the region has wide rangelands, rich farming by-products, a high population of domestic animals and a long history of animal husbandry, it is expected to continue as a prime area for animal husbandry. General development direction will be towards a stable base for animal husbandry. Management will change gradually from extensive to intensive.

Animal husbandry practices are expected to concentrate on oxen, which are an important division of animal husbandry in the region. The oxen population is 40% of the total livestock. The ox species are yak, hybrids, cattle, buffalo and zebu. These animals adapt to various environments and form a good foundation for animal husbandry development in the future. The beef/milk ox population will be increased, and programmes for the improvement of meat/milk ox, draught animals, and wool stocks will be initiated.

Sheep: Sheep development is important in a division which invariably produces large quantities of wool and mutton, and sheepskin. Sheep will be developed for wool and mutton, and goats for wool, milk and skins.

Transportation is difficult in the region. For short distances horses that suit the mountain environment are required. Other animals, and poultry, should also be developed to maximize available resources.

Management Methods: In the region, rich in grasslands, animal husbandry has had a long history. However use of natural resources has been irrational, with excessive use of grassland which has damaged the development of animal husbandry and valley management. The following suggestions are made:

The full rangelands should be used during the warm periods (summer and autumn), and protected during the cold winter and spring. The animal carrying capacity of the rangelands is seasonally unbalanced. An estimate is that the animal carrying capacity during the cold season is 40% less than in warm seasons. Analysis indicates that in periods of warm weather alpine meadow (40% of rangelands) is utilized.

The rangelands of alpine meadow are the best of the high mountain lands and have palatable and nutritious grasses, with a high content of crude protein (16%). Alpine meadow in warm seasons when the climate is cooler and water sources plentiful, are ideal. Additionally, the root systems of the herbage are concentrated within the surface layer of the springy soil, that is resistant to erosion. This rangeleand, with altitudes generally of 3600-4800 m, and sometimes 4700-5200 m has a climate that is cold and stormy in winter and spring, preventing grazing. A rational plan is required to increase the animal population and grazing time during the warm seasons.

Lake-basin meadow is also found in the region. Topography is low-lying and surrounded by hills, climate is not too cold during winter, and the yield from grasses is high. It is suitable for the grazing of animals during the cold season. 70% of the animal population graze here during winter and spring. A 5-7 month grazing season has resulted in overgrazing causing damage to pastures and soil. A grazing plan must be developed to decrease animal grazing times.

Degraded rangeland can be improved by cultivating artificial grassland. In the region, most herbage is too short to cut and stores of hay are insufficient for winter feed - only 0.5-1 kg being stored per animal. To achieve a stable system of fodder production, with rational use of natural rangeland, the improvement of degraded rangeland, the cultivation of aritifical grasslands, and the increase of fodder production during winter and

spring should be energetically persued. Irrigating, applying fertilizer and sowing seed can all raise the productivity of rangelands. After improving rangelands, yields at 4000m elevation are 300-400 kgs hay per Mu, 7-10 times greater than the yields of degraded rangeland, and 3-5 times greater than natural rangeland yields.

Also shrubby rangeland can be grazed. Shrubby rangelands situated on gentle slopes can generally be grazed leaving time available to sow herbage. Shrubs growing on steep slopes and banks should be not grazed in order to avoid soil erosion.

In the foothills of the river sides in the Himalaya (4200 m) and the Hengduan (3500 m), there are large areas of steppe rangelands which have been exploited, thus creating serious soil erosion and threatening valley bottom croplands. Exploited rangelands, especially slopes exceeding 25°, should return to animal husbandry activities in order to enhance vegetation growth and to preserve both soil and water. In addition, the land should be cultivated with herbage. Stall-feeding of stock should be prolonged to reduce free range grazing. Agricultural by-products and fodder should be increased.

Efficient animal production: Creating efficient animal production is an important link in animal husbandry management. In the region, animal breeding levels, including breed selection from native and imported breeds, should be enhanced. Correct breed selection and improvement can raise productivity by 30%. Seasonal animal husbandry must be developed to decrease usage of the rangelands in the cold seasons. Measures that eliminate inefficient animals thereby structurally improving animal groupings can increase animal productivity. For example, in a countryside area the rate of inefficient animal elimination has been raised to 18% from 13%. Total animal production has not decreased but animal grazing has been reduced by 10%, thus protecting the rangelands.

Rational distribution of husbandry to suit local conditions: The interdependent relationships between various ecological factors and the comprehensive characterstics of production should be considered when using rangeland resources in harmony with the need to preserve ecological balances for the future. The region is sub-divided into four management districts.

Southern slopes of the Himalaya and the Southern part of the Hengduan: This district includes the southern slopes of the middle-east Himalaya and the south-eastern sections of the Hengduan. The climate is hot and humid, rich in precipitation, the forest resources are plentiful, natural conditions provide good farming of two or three crops per year, and natural rangelands mainly consist of alpine and sub-alpine throughout the forest belt.

Although the livestock population is low, its origin is complex. The main groups of domestic animals are goat, sheep, cattle, buffalo, and zebu. Many are the best breeds of the country. With regard to the prevailing ecological conditions and animal species, animal husbandry should be directed mainly towards meat/milk and draught animals. The main animal groups that require development are cattle, buffalo, goat and pig. Rearing methods should rely mainly on stall-feeding, with limited summer grazing.

Valley of the Yarlungzangbo (mid-section), and the central Hengduan: The elevation of this area is high, annual precipitation is low, 400 - 650mm, and one crop only per year is cultivated. It is rich in grazing rangelands and agricultural by-products. The area is developing mixed activities, farming, forestry and animal husbandry.

It is a transition district varying from agricultural to pastoral areas. Animal husbandry should be focussed on milk and meat producing cattle, and also sheep and horses should be suitably utilized.

The district is important for the development of seasonal animal. husbandry. The animal population should be controlled to prevent overgrazing and to protect the ecological balances.

Northern Section of Hengduan Range: In the northern part of the Hengduan,

topography slopes gently, elevation is higher, growing period of grass is short, and farming/cultivation is minimal. Animal husbandry development depends mainly upon the availability of natural rangelands. Rangelands where the animals are reared and grazed are mainly alpine meadow. Livestock development should be concerned with yak and sheep. Cold season rangeland grazing should be controlled to prevent the degeneration of the rangelands.

Plateau lake-basin of the Himalaya: This includes vast plateau with the lake-basins of the northern slopes of the Himalaya. Elevation is generally 4300-4500m, climate is semi-arid and arid, annual precipitation is 230-410mm, and only cold-resistant crops can grow. Rangeland vegetation is alpine steppe. The natural conditions and characteristics of the resources are good for sheep rearing.

The rangeland has been overgrazed and is degenerated. In order to increase stall-feeding and decrease free range animal grazing, artificial grass and fodder crops should be grown.

EXPLOITATION OF THE MARSHLANDS AND MARSH MEADOWS AND RATIONAL USE OF THE GRASSLAND RESOURCES IN RUOERGAI REGION

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INTRODUCTION

Ruoergai region, (32°20'-34°10' N 102° 15'-103 50'E) belongs to Ruoergai and Hongyuan counties of Aba Tibet Autonomous Prefecture, Sichuan. The grassland here, distributed over a large area of plentiful water and luxuriant grass, is an important base for the plateau animal husbandry. The marshlands and marsh meadows (informally called by the local people and including marsh vegetation and marsh meadows, as well as some joined meadows) have also been developed well and play an important role in the region, covering an area about 30 million ha (including part of the adjacent Aba county) and accounting for 10.59 % of the total area and 14.66% of the total grass-land area of the three counties. The major plants of the marshlands and marsh meadows are the Carex and Kobreasia of the Cyperaceae. A lot of surface water accumulates seasonally, so the areas are not easily accessible and have low useful value. Attention is now focussed on how to improve and use the marshlands and marsh meadows. This paper, based on the many-year vegetation surveys of the region, presents suggestions for the exploitation of the marshlands and marsh meadows, and the utilisation of the pasture resources of the region.

CHARACTERISTICS OF THE NATURAL ENVIRONMENT OF RUOERGAI REGION

Landform characteristies

Ruoergai region is a part of the Yellow River source on the north of the Bayankela Mountains, which belong to the east margin of the Qinghai-Tibet Plateau. Based on the structure, it belongs to the Ruoergai-Jingchuan Synelinovium in the Western Sichuan geosynecline, running from northeast to southwest. The rock layers mainly consist of sandstone, plate, phyllite and flag limestone of the Triassic period. The rock formation is covered with the Quaternary sediments made by the alluvial, diluvial, slope and iceborne deposits. There are few rocks without earth cover.

Based on the vast plane formed in the peneplain stage during the middle Triassic period, the basic outline of the region's plateau landform was formed with the strong uplift of the Qinghai-Tibet Plateau during the end of the Triassic period and the beginning of the Quaternary period. The edges of the plateau became warped because of the intermittent and different uplifts of the neotectonic movement. On the plateau there are wide valleys and gently sloping hills. It is a hill - like plateau, the south part being a little higher than north part. It is surrounded by the mountains: the Mountain land is in the north; Min Mountains are in the east and Qionghai mountains are in the south. Those mountains are often 4000 m high. In the middle of the plateau, there are valleys with wide floors and low hills. The relative height between the hill tops and valley bottoms is over 50-200 m. The Black River and White River run through the region from south to north and empty into the Yellow River. Those river valleys are open and several kilometers wide; in some places they are more than 20 kilometers wide. Many well-developed meanders, river forks and oxbow lakes are spread all over the region.

The gently sloping hills, broad valleys and meandering rivers are useful for collecting and keeping water in the region. The Quaternary sediments widely distributed in the valleys and especially, the silt and light clay of the lake facies deposits, have poor permeability and have formed a layer which easily prevents water from

permeating the terrene. The accumulated water on the surface has provided the conditions for the development of the marshlands and marsh meadows.

Climate characteristics

Ruoergai region belongs to the frigid climatic zone of the Qinghai-Tibet Plateau. The main characteristics are frigid, humid, and long frost season, with relatively large precipitation and much drizzling rain. The major climatic factors of Ruoergai and Hongyan counties are shown in Table 1.

Table 1: Major climatic factors of the two counties (1957-1974)

Counties	Annual mean precipitation (mm)	Annual mean temperature °C	Annual mean relative humidity (%)	Annual accumulated temperature (°C)
Ruoergai	641.9	0.69	68	306.9
Hongyuan	700.3	1.1	72	322.0

Water is the main influence, on the formation of the marshlands and marsh meadows, and precipitation is the major source of water of the area. Table 1 shows that precipitation in the Ruoergai region is relatively high. The climatic data between 1957-1974 also indicate that in the region, the precipitation from May to September each year accounts for 80% of the total annual rainfall. Overcast and rainy days are many, and continuous rain can last as long as 25 days a month. Due to such rainfall density, and soil permeability, the surface runoff is small. The annual mean evaporation is only 450 mm, which is smaller than the precipitation of Ruoergai region. The surplus water is drained away by surface runoff and underground streams.

Heat not only influences plant growth, but also the decomposition and accumulation of the organic remains. It can promote the development of the marshlands and marsh meadows if the accumulation of the organic remains is faster than decomposition. Generally speaking, when the temperature is below 5° C, the activity of micro organisms is very weak. In the region there are 7 months a year when the mean temperature is less than 5° C. Under such a long and low temperature period, the docomposition of the organic remains is greatly inhibited (by microorganisms) and peat accumulateds in large quantities.

To sum up, precipitation is higher than the evaporation capacity and the extended, low temperatures create favourable conditions for the formation and development of the marshlands and marsh meadows, as well as deeply influencing the composition of the region's vegetation types.

Hydrological characteristics

The discharge of the Black River and White River, running through the region, is large but stable year after year. The two flow in the same valley. The rivers' valleys are relatively wide and flat, without terraces. Particularly in the middle and lower reaches, there is little difference between hill slopes and valley floors. The rivers therefore, are so meandering in many places and flow so slowly with a specific drop of only 0.002-0.003 %, providing the marshlands and marsh meadows with plentiful water by permeation.

It is the underground water that greatly influences the marshlands and marsh meadows. The underground water mainly consists of the slope underground water, alluvial underground water, and crack underground water. The slope and alluvial underground waters are usually found at the foot of the hills and spill out onto the surface, but this varies greatly. In winter (after November) the water is frozen and stored in its solid state. When the warm season comes, it melts and flows into the areas. However the discharge of crack water is great and stable, and usually converges into streams. The streams flow into the marshlands and trunk rivers. The different underground waters are highly influential on the formation and development of the marshlands and marsh meadows.

Vegetation characteristics

Due to the effect of the frigid and wet environment, the growth of some forest species has been inhibited. The small-size coniferous forests of *Picea asperata, P. wilsonii, P. purpurea, and Abies faxoniana* are scattered on the north-facing slopes. In addition, scrub is also usually distributed on the north-facing slopes, as well as on the river banks. The major plants are *Salix spp; Spiraea alpina, Sibiraea angustata, Lonicera thibetica, Rhododendron nitidum, Potentilla frunticosa and Hippophae rhamnoides.*

Besides the small-size coniferous forests and scrubs meadows and marsh vegetation is widely distributed. The meadow vegetation mainly consists of *Clinelymus nutans, Roegneria nutans, Koeleria litwiniwii, K. cristata, Poa pratensis, P. pachyantham Festuca ovina, Agrostis scgneideri, Deschampsia caespitosa; Kobresia setcwanensis, K. humilis and Potentilla anserina, P. bifurca, Anemone rivalaris, A. geum, A. trullifolia var,. Linearis, Anaphalis flavescens, Polygonum viviparum, Leontopodium logifolium.* The marsh vegetation is mainly composed of *Carex muliensis, C. atrofusce, Cremanthodium lineare, C. plantagineum, Caltha scaposa, Sanguisorba filliformis, Chamaesium paradox, Potamogeton pusillus, Mengathens trifcliata, Utricularia vulgais, Batrachium trichohyllum* and so on.

Meadow vegetation and marsh vegetation is widely distributed over large areas. The meadows have many types and various species, which are luxuriant and grow relatively high. This is the most distinguishing feature of the natural vegetation of the region.

The natural factors of Ruoergai region, such as the land - form, climate and hydrology, create favourable environmental conditions for the formation and development of the marshlands and marsh meadows. Due to the high elevation and severe climate, plantation and forestry have been inhibited, but meadow vegetation and marsh vegetation has been widely developed in the region. Therefore, the pasture land of the region is vast and productive for animal husbandry. The pasture land can produce more than 100 kilograms per mu and sometimes even 1000 kilograms, of dry grasses. The rich meadow vegetation provides animal husbandry with liberal resources. Thus animal husbandry has become the basic production in Ruoergai region.

Drainage of the marshlands and marsh meadows

With the development of the animal husbandry, the pasture lands are in great demand. In order to expand pasture land and the problem of the use and improvement of the marshlands and marsh meadows has been raised. The excessive water is the key factor. Thus, based on the many-year vegetation surveys in the region, the marshlands and marsh should be drained. There have however, been different opinions about it.

Drainage of the marshlands and marsh meadows will destroy the balance of the hydrological cycle.

Due to the environmental conditions in Ruoergai region such as high elevation and harsh climate, the main vegetation there is meadow and bushland, as well as large areas of marshland and marsh meadow. The interception of water and the transportation of vapour in the hydrological cycle is largely done by these vegetation types. Although the marshlands and marsh meadows are smaller than meadows, they have a higher water content and larger water-storage capacity, and in some places they are even covered with water. Therefore, through evapo-transpiration they play an important role in the transportation of vapour into the air, maintenance of the hydrological cycle, and stabilization of the atmospheric and soil humidity and the ground water level in the region.

Based on the climatic data, the annual precipitation of Ruoergai region is 50-80 mm more than that of Shiqu and Seda counties which are at the same latitude. The atmospheric circulation is the main influence on precipitation levels. One of the reasons for the large amount of precipitation in the region is that the marshlands and marsh meadows transport a lot of vapour into the air. During our surveys, it was found that Ruoergai region

has developed a large area of meadow vegetation and not grassland vegetation, especially the quantity and growth of *the Gramineae*, as well as the grass yield of the various pasture lands there, are better than those of Shiqu, Seda and Ganzhi counties. The forests on the north-facing slopes are multilayer forests, where growth and natural regeneration is also better than that in Ganzhi county; even the soil of the so-called dry grassland is wet below 5 mm. Besides the influence of latitude, elevation and atmospheric circulation the large area of the marshlands and marsh meadows is important to stabilize the atmospheric and soil humidity of the region.

If the marshlands and marsh meadows are drained dry, the natural reservoir of the region will be destroyed, vapour reduced, ground water level will drop, and the so-called arid grassland become real arid grassland. Futhermore, due to the fall in the ground water level, some sand dune pastures developed from the sand sediments of the ancient rivers, will be affected.

If the marshlands and marsh meadows are drained over a large area, the environment of the region will tend to be arid; and meadows will gradually evolve into grassland vegetation. Thus the productivity of the pasturelands will be reduced and the development of animal husbandry will be inhibited.

It is difficult to plant trees on the plateau and forests cannot be used to regulate the environmental water balance. Due to the harsh natural environment of the pastoral areas, and an elevation beyond the tree line in many places, it is difficult for trees to grow there and very difficult to plant trees. Therefore, it is unrealistic to use forests to regulate climate and maintain the hydrological balance of natural ecology. Forests cannot replace the marshlands and marsh meadows in the natural ecological equilibrium of the region. Drainage of the marshlands and marsh meadows is not the key to increasing the animal husbandry production of the region. It is severely cold in Ruoergai region with a long winter and short spring, summer and autumn.

The growth of grass is different in different seasons; and quantity and quality of forage available vary. Between April and September the grass productivity is high and rich in nutrients. The plentiful regenerated grass is of a fine quality. Between October and March grass productivity and nutrients decrease sharply because of the cold weather. Also, because of the bitter cold and strong winds, the winter and spring pasturelands require good environmental conditions, and are generally distributed on the leeward, south-facing river terraces and on the foot of the hill. Those areas are very limited. During summer and autumn with the temperature rise, the pasture land is more than enough. The pasture areas in winter and spring are not proportional to those in summer and autumn, which causes a disequilibrium.

In winter and spring the pasturelands are over used, but during summer and autumn they are not effectively used. Ineffective use is also a limiting factor in animal husbandry development in the region. The drainage of the marshlands and marsh meadows is not the key to resolving the disequilibrium between forage supply and pastureland use in animal husbandry production. Since the marshlands and marsh meadows are wide spread in the broad valleys, with bitterly cold and strong winds in winter and spring, they are not suitable to be used as the winter and spring pasture. They are also not suitable for mowing, because the grass layer of the Cyperaceae is short and productivity is low. The best time for mowing grass is the rainy season, but it is difficult to dry and store the grass collected.

On the low-temperature terrain of the region it is not easy for the plant residues and the organic matters in the soil to decompose. After the drainage of the marshlands and marsh meadows, though the hydrothermal conditions could be improved to some extent, peat decomposition will still be limited. The mineral nutrients released by the decomposed peat hardly meet the demands of the growth of fine grasses, making it difficult for them to invade the region naturally. Good results will be hard to get even if the region is seeded with fine grasses.

If deep tillage and seeding are used to speed up vegetation regeneration,

substrates should be added to the deep peat layer. If the drained marshlands and marsh meadows are not deeply tilled in time, these areas will be covered with water again and there will be no way for the vegetation to regenerate.

It is difficult to drain the marshlands and marsh meadows using common methods. Their relief is generally high, and the river bed runs almost flat. Some central areas are submerged or covered with many deep pools. The peat is generally one meter thick but can be as thick as several metres. The water -absorbing capacity of peat is very strong, making it very difficult to drain the areas with rich peat, leaving aside the landform conditions. If drainage is carried out under the specific drop less than 0.003% of the rivers, the drainage quota must be raised and complex engineering and machines would be needed. The common drainage methods such as digging pitches, and burying water-storage tanks can do nothing. The relations between drainage and the water requirement of the plants should also be considered. It would also be inhibiting to raise the drainage quota.

To exploit the marshlands and marsh meadows, it would not be good to drain the areas if only to increase the pasturelands to meet the demands of animal husbandry production. But multi-purpose use of the rich peat is another possibility. There are other problems that must be considered, such as the reserves of the peat resources, and the economic benefits of exploitation. Furthermore, the exploitation of the areas needs not only the latest in technology and equipment, but also a labour force, energy, and some public utilities, such as a food supply, transportation and housing.

SUGGESTIONS FOR THE RATIONAL USE OF THE PASTURELAND RESOURCES

As stated above, the limiting factors for animal husbandry production in the region are the different levels of forage supply in different seasons and the disequilibrium between winter-spring and summer-autumn pasture areas and uses. The latter is the major reason that animal husbandry has been unstable for so long. In order to obtain high and stable production, the use, improvement and construction of the pasturelands must be centered on the problem of disequilibrium. To resolve the problem, different methods should be used on different kinds of pasturelands. The pasturelands of Ruoergai region can be roughly divided into hilly pastureland, valley pastureland and the marshlands and marsh meadows, based on the landform characteristics. Some ideas for using and improving the three pastureland types are discussed below.

Rational use of the valley pastureland and establishment of artificial forage-bases:

The valley pastureland is the largest and most valuable of the Ruoergai region. It is mainly distributed in the valleys, on the terraces along river banks and on the flat and gentle hills. The relief of the valley pastureland is relatively high, soil is thick and fertile, and humidity is moderate. The drainage conditions and aeration of the soil are good. Besides natural precipitation, there is plentiful underground water in this area. Because the environmental conditions of the valley pastureland are better than those of the other two, the grass species are many and various. The dominant plants are the Gramineae. This pastureland has been unevenly used in the past. Some places have been overgrazed, particularly on some leeward and gentle south-facing slopes and valley bottoms, the areas along each side of roads and rivers, and the residential areas nearby, but the remote areas and some northern slopes have not been fully and rationally used. Some plots of pasture have even degenerated. The valley pastureland is predominant in the region and has a great influence on animal husbandry development.

The residential areas are distributed over the valley pastureland. In order to use and construct the valley pastureland rationally, attention must be paid to the lay-out of the residential areas. The pasture should be divided for rotational grazing. Its grazing capacity has to be controlled and grazing technologies improved to make full and rational use of it. The degenerated pastures should be raked and scarified in time to improve soil aeration. In the meantime, irrigation, fertilization and reseeding of fine grazing grasses should be applied to

change the composition of the grass population and increase yield. While improving the degenerated pastures, plans should be made to till the soil deeply and establish some artificial forage bases. The valley pastureland has many advantageous conditions for the establishment of artificial forage bases, such as its large area, relatively flat relief, fine drainage possibilities, and moderate humidity.

The artificial River Daba Pasture (about 10,000 mu) in Ruoergai county has been established by the deep tillage method and can produce 1968 kilograms per mu, which is about 10 times more than that of the pasture prior to deep tillage. Deep tillage, reseeding and the establishment of artificial forage bases are not only useful methods to improve the degenerated pastures, but are also effective in resolving the shortage of the winter fodder.

The Hilly Pasturelands and Artificial Reseeding

Strict control of the grazing capacity of the hilly pastureland and transformation of the sandy grazing pastures; The hilly pastureland is located on the low mountains, the upper parts of the plateau hills, and the watersheds of small and large rivers. Drainage of this pastureland is good and the source of water is mainly the natural rainfall, so the soil is generally moderate or a little dry. Because of the freezing and melting interractions, the physical weathering is serious and soil layer is thin and contains much gravel.

The major plants of the areas are the mosophilic perennial grasses, and among them there are a few xerophilous and mesophilic grasses. Because of the relatively steep slope of the hilly pastureland, its thin soil layer, and rough soil structure, if it is over grazed the grass cover can easily be destroyed, the soil is liable to be eroded, and the destroyed vegetation is very difficult to recover. Especially on some hills made from sand sediments of the ancient river courses, once the vegetation is over-nibbled and trampled by animals, the sand dunes become exposed and become sand drift under wind erosion. At present, although this hilly pastureland is not large and has little influence on the animal production, it should be transformed in time to prevent the movement of the drift and extinction of this kind of pastureland. The land should also be rationally grazed and the grazing capacity controlled, to keep the grass cover from being destroyed. The hilly and sandy pasturelands which are already without vegetation and seriously degenerated should be closed to grazing, and be artificially reseeded to speed up vegetation recover.

Maintenance of the hydrological cycle and limited drainage of marshlands and marsh meadows

Although the marshlands and marsh meadows have a little value for animal husbandry production, they have a great effect on the hydrological cycle balance of the region.

The main grasses of the marshlands and marsh meadows are the hydrophilous Cyperaccac which need few mineral nutrients. With sufficient water, the grasses turn green earlier than those in other areas. They are soft, tender and palatable for animals. But after spring, with the increasing precipitation and temperature, parasites grow fast and infect the animals. After summer the grasses become rough and indigestible. Anyhow the surface water cuts off the area from people and animals. Therefore, the marshlands and marsh meadows have a little useful value, except for their influence on regulating the climate of the region. It is better to select some uplands and low terraces in lake basins and wide valleys to drain within limits and control the ground water level properly.

The vegetation of the region is on the transition zones from forest to meadow and from meadow to grassland. The natural ecosystem formed on the transition zones is generally fragile and unstable. The destroyed forests easily evolve into meadows, and the degenerated meadows evolve into grasslands. Once this takes place, it is difficult to reverse. Therefore, when considering the use of existing pastures, attention must be paid to the influence on the environment. The opinions in this papers remain to be further deliberated and confirmed.