ICIMOD

MOUNTAIN FARMING SYSTEMS

Discussion Paper Series

METHODS OF RAISING THE PRODUCTION LEVEL OF GRASSLANDS IN THE HIGH-FRIGID PASTORAL AREAS

SUE DAXUE

MFS Series No. 11

1990

International Centre for Integrated Mountain Development

METHODS OF RAISING THE PRODUCTION LEVEL OF GRASSLANDS IN THE HIGH-FRIGID PASTORAL AREAS

Sue Daxue

MFS Series No. 11

Sue Daxue is associated with the Commission for the Integrated Survey of Natural Resources of the Chinese Academy of Sciences

---

September, 1990

International Centre for Integrated Mountain Development (ICIMOD)

Kathmandu, Nepal

PREFACE

ICIMOD's approach to problem-oriented research involves both knowledge reviews and field studies. The focused reviews and field studies conducted by the Mountain Farming Systems' Division cover various aspects of agricultural development. Since early 1988, a series of 'state of the art' reviews of agricultural policies and programmes were sponsored by ICIMOD in different countries of the HKH Region. The purpose of these studies and the subsequent National Workshops in different countries was to understand some of the constraints and prospects of mountain area development. These exercises were also aimed at acquiring comparative perspectives of development approaches and strategies in different countries.

This paper was a part of this series of studies, commissioned by ICIMOD, and was also presented at the Workshop on "Agricultural Development Experiences in West Sichuan and Xizang, China", held by ICIMOD in October 1988, in Chengdu, China. The paper analyses the problems of low fodder productivity and low output of livestock products from high-frigid pastoral areas in Tibet; it makes recommendations for improvement through technical and management changes.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

Damxung County, Tibet is situated at 29.31-31.4° N and 90.4-91.54° E at elevations exceeding 4,200 m. Animal husbandry is the main activity, and it is totally dependent upon natural pastures without carrying out any forest or grassland plantation. The animal husbandry system is similar to that carried out on the high-frigid pastoral areas (comprising of approximately 100 million ha) of the Qinghai Tibetan Plateau and in other areas of the high Himalayas. This paper analyses the characteristics and problems of grassland agriculture in Damxung County and suggests methods for improving productivity in the high-frigid pastoral areas.

Characteristics of Grassland Agriculture

Quality of Natural Pastures

The total area of Damxung County is 9957.33 km^2. Out of the total area, 6823.59 km^2, or 69 per cent, is natural grassland. Of this, 90.37 per cent or 6166.62 km^2 is usable. As the basis of livestock husbandry, natural pastures are the most important natural resources, and animals are grazed on them all the year round.

The pasturelands are distributed throughout an area between 4,200 to 5,200 m.a.s.l. High elevations with a semi-arid and sub-frigid climate, with little temperature accumulation and a short frost-free season, are the features of this area. The records of the County Meteorological Station, for the areas over 4,260 m.a.s.l. over a 16 year period, show the amassed temperature for temperatures over 0° C as 1,428.7° C, the absolute frost free period as less than ten days, and the periods of growth as short (grass sprouts in early May and withers in early September); this results in short grass with four months of green growth and eight months of withering. The annual precipitation is 220-480 mm, and 70 per cent is concentrated in June, July, and August. During this period, it is fairly hot with few clouds. Radiation reaches 173.3 Kcal/cm^2, and there is a wide differentiation in daily temperature. This helps in the growth of fodder grasses and in the accumulation of nutrients, since strong ultraviolet rays help synthesize protein.

Restricted by the above conditions, the pastures produce a high quality of grass but the yields are low. An analysis of the nutrient composition of nearly a hundred mixed grass samples collected on different pastures in August, 1985[1], showed that Damxung grasslands contain high protein, nitrogen-free extract (NFE), fat and lysine in protein, but with low crude fibre with a high digestion coefficient. Obviously, this quality is higher than that of grasses from typical steppes in the temperate zone and even higher than that of grasses from secondary rangeland in the sub-tropical zone (Table 1).

The average hay yield from different pastures throughout the County is 480 kg/ha annum. One point five hectares of grassland are required for every head of sheep. The grass yield and stocking capacity are lower, by approximately 50-100 per cent, than those of grasslands in the typical steppe land of the temperate zone of China. However, the grass has a high nutrient content and is easy to digest, making it suitable for livestock. Yaks can gain from 0.4 to 1 Kg per day during the green grass period. However, low grass yield results in low stocking capacity and low productivity.

---

1. Su Daxue et al. *A Survey of Grassland Resources in Damxung County*. Beijing: CAS, 1985.

Table 1. Comparison of the Nutrient Composition of Three Types of Grassland

Nutrient / Grassland	CP (%)	C Fat (%)	C Fibre (%)	NFE (%)	Lysine ppm
Damxung Grassland	10-13	2.5-5	22-28	40-49	0.5-0.7
Temperate Typical Steppeland in Inner Mongolia	6-8	2-4	25-38	38-45	0.2-0.45
Subtropical Secondary Rangeland in Guizhou	3-6	1-1.5	35-42	30-42	0.1-0.32

Note:

Calculated by K. Nehring's formula of nutritive ratio, the nitrogen-carbon ratio of pastures of different kinds in Damxung is generally 1:4.9-1:7.6, which shows that they are N-C type and are high-nutrient grasslands, suitable for grazing livestock.

Sufficiency and Insufficiency of Seasonal Pastures

Damxung is divided by the Nyaingen Tanglha Mountain. To its south, rainfall averages 480 mm per annum and meadows yield more grass than areas to the north of the mountain where the annual precipitation is 230 mm. Here, on the high-frigid steppes, coverage and grass yield are low.

Pasture types, stocking capacity, and utilisation obviously show more differentiation vertically than horizontally; elevation is the determining factor. There are no summers and the winters are long. According to the season, pastures are rotation-grazed. In the warm season (from June to September), animals are grazed on the mildly cold high-frigid meadows. In the cold season (from October to May), grazing takes place on the sheltered and sunny side of the high-frigid steppes and on the warm strath and boggy meadows with elevations below 4,600-4,700 m. Pastures around the villages and at lower elevations are used to graze old, weak, and sick animals all the year round as well as for lambing and breeding (See Fig. 1).

Cold season pastures in Damxung have to support animals for eight months of the year, whereas warm season pastures are only grazed for four months. Thus, the ratio of cold season grassland to warm season grassland should be 2:1. However, there is a serious shortage of cold season pastures, due to the fact that there are only 196,300 ha of available cold season pastureland in the County, while there are 420,400 ha of warm season grasslands, comprising 68 per cent of the total available grassland. In reality, therefore, the ratio of cold season grassland to warm season grassland is approximately 1:2, and this is just the reverse of what is ideally required.

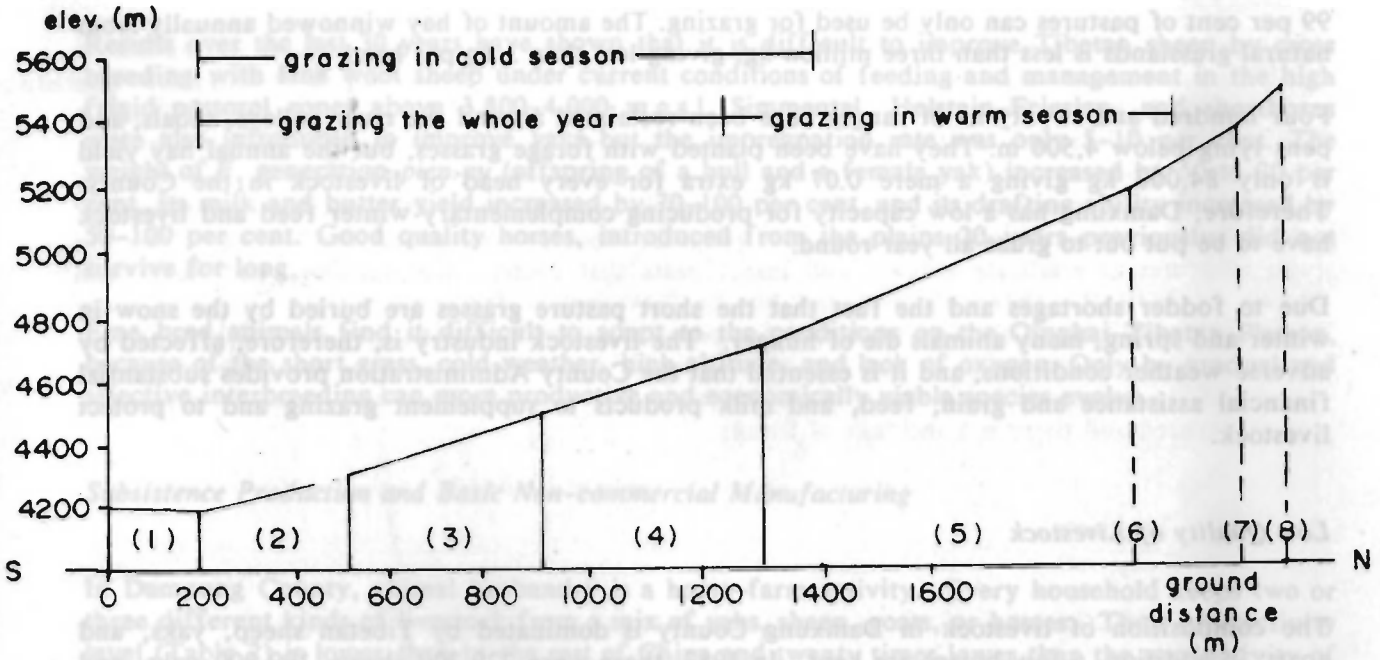

Fig. 1 Vertical Distribution Difference of Damxung Grasslands

Notes:

1. River.
2. Strath and boggy meadows.
3. High-frigid steppe.
4. High-frigid steppe.
5. High-frigid meadow.
6. Scattered mattress vegetation in the high mountains.
7. Running rock banks in the high mountains.
8. Snow line.

At low elevations, the grass yield from cold season pastures is a little higher than that from warm season pastures. When calculated according to the actual stocking capacity of the ranges, pastures that are used, both during the cold season and the rest of the year, have a carrying capacity of 210,036 head of sheep, whereas the carrying capacity of warm season pastures is 9,904 less. Consequently, at the end of Autumn, when the herds are moved from the warm to the cold pastures, the utilisation balance can only be maintained by reducing livestock by 31.6 per cent.

Fodder Shortages and Frequent Disasters

The high-frigid meadows are widely dispersed throughout the country and are the largest in terms of acreage. However, their grasses are short (only from 2-10 cm tall) and vegetation is rare, particularly on the high-frigid steppes. Coverage varies from 15 to 45 per cent, and the high-frigid marshes are almost inaccessible in autumn, and are not fit for mowing. Throughout the whole County there are only 5,425 ha of strath and boggy meadows suitable for swathing for winter fodder. This accounts for only 0.88 per cent of the pasturelands, and more than

99 per cent of pastures can only be used for grazing. The amount of hay winnowed annually from natural grasslands is less than three million kg, giving less than 3 kg per head.

Four hundred and twenty ha of ranges have been reclaimed around the river valleys, shoals, and pens lying below 4,500 m. They have been planted with forage grasses, but the annual hay yield is only 84,000 kg giving a mere 0.07 kg extra for every head of livestock in the County. Therefore, Damxung has a low capacity for producing complementary winter feed and livestock have to be put out to graze all year round.

Due to fodder shortages and the fact that the short pasture grasses are buried by the snow in winter and spring, many animals die of hunger. The livestock industry is, therefore, affected by adverse weather conditions, and it is essential that the County Administration provides substantial financial assistance and grain, feed, and milk products to supplement grazing and to protect livestock.

Low Quality of Livestock

The composition of livestock in Damxung County is dominated by Tibetan sheep, yaks, and goats; in addition, a few horses are kept. In 1987, there were 229,300 sheep, 199,900 yaks, and 88,700 goats. These were all indigenous species and of low quality. However, they are well adapted to the adverse ecological conditions, such as high elevation, freezing climate, lack of oxygen, and short grass, and are multipurpose breeds. For example, yaks produce milk, butter, wool, down, and meat and in addition are used as pack animals or for riding; sheep produce wool, milk, and meat and can also be used as pack animals; and goats also produce wool, down, meat, milk, and butter. However, they mature late and their productivity is low. Late maturity results in a slow turnover rate.

Yaks produce, on an average, per head, per year, 200 kg of milk, 0.4-0.5 kg of yak's hair, and 0.5 kg of yak's down. A castrated adult yak can carry loads of from 50-75 kg and travel 15-20 km per day; its dressed weight is from 80-175 kg and its dressing percentage from 45-52 per cent. Yaks mature at 6 years. From a ram, the average amount of wool produced annually is from 0.2 to 1.13 kg and from a ewe 0.96 to 0.24 kg. The length of the wool is 14 cm (from 10.8 to 17.4 cm), and the ewe gives milk for 90 days a year producing 0.15 kg per day.

An adult sheep weighs an average 38.5 kg (from 36-40 kg), its packing 10 kg, and it travels from 15 to 20 km per day. Its carcase weighs around 17-18 kg; the dressing percentage being 46-48 per cent. It is fully mature at three years.

Goats produce on average 0.2 to 0.4 kg of wool and 0.05-0.15 kg of down per year, and 0.8 to 1.0 kg of butter.

The low productivity of native breeds in addition to their late maturation lead to low productivity and poor economic results. From the late 1950s, efforts have been made to introduce breeds of sheep that produce fine and semi-fine wool such as the Sinkiang Merino, Tsigai, Border Leicester, and Romney Marsh. This was done gradually in an attempt to improve the native Tibetan sheep. The first filial generation (F_1) of Tsigai and Tibetan cross-breeds is livelier and its wool yield increased by 50 to 70 per cent over that of local breeds. However, it has lower viability. The second filial generation (F_2) of Tibetan and fine wool sheep cross-breeds, introduced into Aba (Ngawa) Prefecture close to Tibet, had a reduced wool yield and even suffered from loss of hair. Obviously, its adaptability and resistance had lowered. The third filial generation (F_3) of cross-breeds not only loses hair but often does not have any hair at all and cannot survive.

Results over the last 30 years have shown that it is difficult to improve Tibetan sheep by cross breeding with fine wool sheep under current conditions of feeding and management in the high frigid pastoral zones above 3,800-4,000 m.a.s.l. Simmental, Holstein-Friesian, and shorthorns were also introduced to improve yaks but the impregnation rate was only 5-10 per cent. The weight of F_1 generation *pien nu* (offspring of a bull and a female yak) increased by 50 to 70 per cent, its milk and butter yield increased by 70-100 per cent, and its drafting ability increased by 50-100 per cent. Good quality horses, introduced from the plains 20 years previously, did not survive for long.

Fine bred animals find it difficult to adapt to the conditions on the Qinghai-Tibetan Plateau, because of the short grass, cold weather, high altitude, and lack of oxygen. Only by gradual and selective interbreeding can more productive and economically viable species evolve.

Subsistence Production and Basic Non-commercial Manufacturing

In Damxung County, animal husbandry is a home-farm activity. Every household keeps two or three different kinds of livestock from a mix of yaks, sheep, goats, or horses. Their productivity level (Table 2) is lower than in the rest of China and twenty times lower than the productivity of herds from countries where modern pastoral techniques are practised.

Table 2. 1980-1985 Productivity Level of Animals in Damxung

Stock	Mean Rate of Livestock Free-Grazing (%)	Average Output of Animal Products per 100 head (kg)		
		Meat	Butter	Wool and Down
Yak	8.25	781.11	16.16	96.89
Sheep	21.60	260.93	18.29	108.0
Goats	20.29	-	-	37.75

Livestock are an important means of subsistence and of productivity. Every family operates self-sufficiently and keeps a small workshop where sheep and yak wool are woven into tents. Cheese and butter are also manufactured on a household basis and hides are tanned by individual families. The products that are not used by the family are sold. The amount of surplus for sale is not very high - for beef and mutton it is 10 per cent, for butter 9 per cent, and for wool (the highest of all) 60-70 per cent.

From autumn to early spring every year (September/October to February/March), the herdsmen transport their products and salt by yak to southern Tibet where they barter these items for grain, utensils, and articles for daily usage. The area is rich in salt and this barter-exchange process is locally known as the "salt-grain exchange" and is one of the major marketing methods for animal products.

The herdsmen are illiterate but extremely religious. Both these factors lead to an unwillingness on their part to adopt improved practices of animal husbandry. It is only 30 years since the prevalence of the feudal system and people are not readily receptive to science and technology. The number of livestock kept is seen as the basic criterion by which to judge a family's wealth. There is a tendency to want to raise more animals than one's neighbours without any consideration for the economic viability of the stock kept. They refuse to slaughter lambs and calves for economic purposes because of a religious ideology that proscribes killing. They are even reluctant to eradicate rodents and insect pests that destroy the pastures, and have been known to bury the chemicals provided by the Government for such purposes. Since every household owns a lot of animals which are permitted to graze freely (the amount of livestock that graze freely accounts for 8-10 per cent of the total), and which are never slaughtered but are simply left to wander off and die of old age, unless they are killed by wild beasts, the pastures are overgrazed and there is a shortage of forage.

Analysis of Problems

Increase in Herding Population and Livestock Population and the Consequent Pressure on Pasturelands

The population figures for the herding population of Damxung County from 1952 to 1984 show that, over the past 32 years, the population of herders rose from 17,363 to 27,711, an increase of about 60 per cent (Fig. 2).

To support their families, herdsmen use the milk, meat, butter, and wool from their animals and exchange some surplus for grain and daily necessities. They raise both replacement and draft animals for their products, in order to meet their basic needs. The grazing capacity of pastures in Damxung, however, has reached saturation point. The per capita occupancy rate is 20 sheep units; in 1953 it was 19.97 , in 1958 it was 20.29, and in 1984 it was 20.27. Over 32 years, there has been very little change, except during the "Cultural Revolution" when livestock figures increased a little.

Since per capita occupancy changed negligibly, and the quality and productivity of livestock did not improve, the population increase naturally led to a growth in the total number of livestock. The grazing stock on Damxung pastures rose from 797,600 sheep units to 1,184,000 sheep units from 1952 to 1984; an increase of 48.6 per cent (Fig. 2). From 1959 onwards there has been critical overstocking of animals in the area and overgrazing of the pasturelands.

According to a survey conducted in 1985, the Damxung pastures have the capacity to support 581,700 sheep units, but they actually support 1,184,300 sheep units, representing an overstocking figure of 103.5 per cent. The per sheep unit occupancy of pastureland fell from 0.77 ha in 1952 and 0.75 ha in 1958 to 0.53 in the 70s and 0.52 in the 80s. In 1985, it was calculated that to maintain regular production, without supplementary feed, each sheep unit should have at least 1.5 ha of grassland. In South Australia, for example, where precipitation is almost the same as that of Damxung County, there was grave degeneration in the state of the pastures in the 1920s. By the 1950s-60s productivity was restored and per unit occupancy regulated at 4 ha per sheep unit. In the U.S.A. also, before the 1930s, overstocking was high, and this led to the degeneration and desertification of pastures. In 1934, the Taylor Grazing Law was introduced, restricting the utilisation rate to 50 per cent, and this resulted in the restoration of the grasslands.

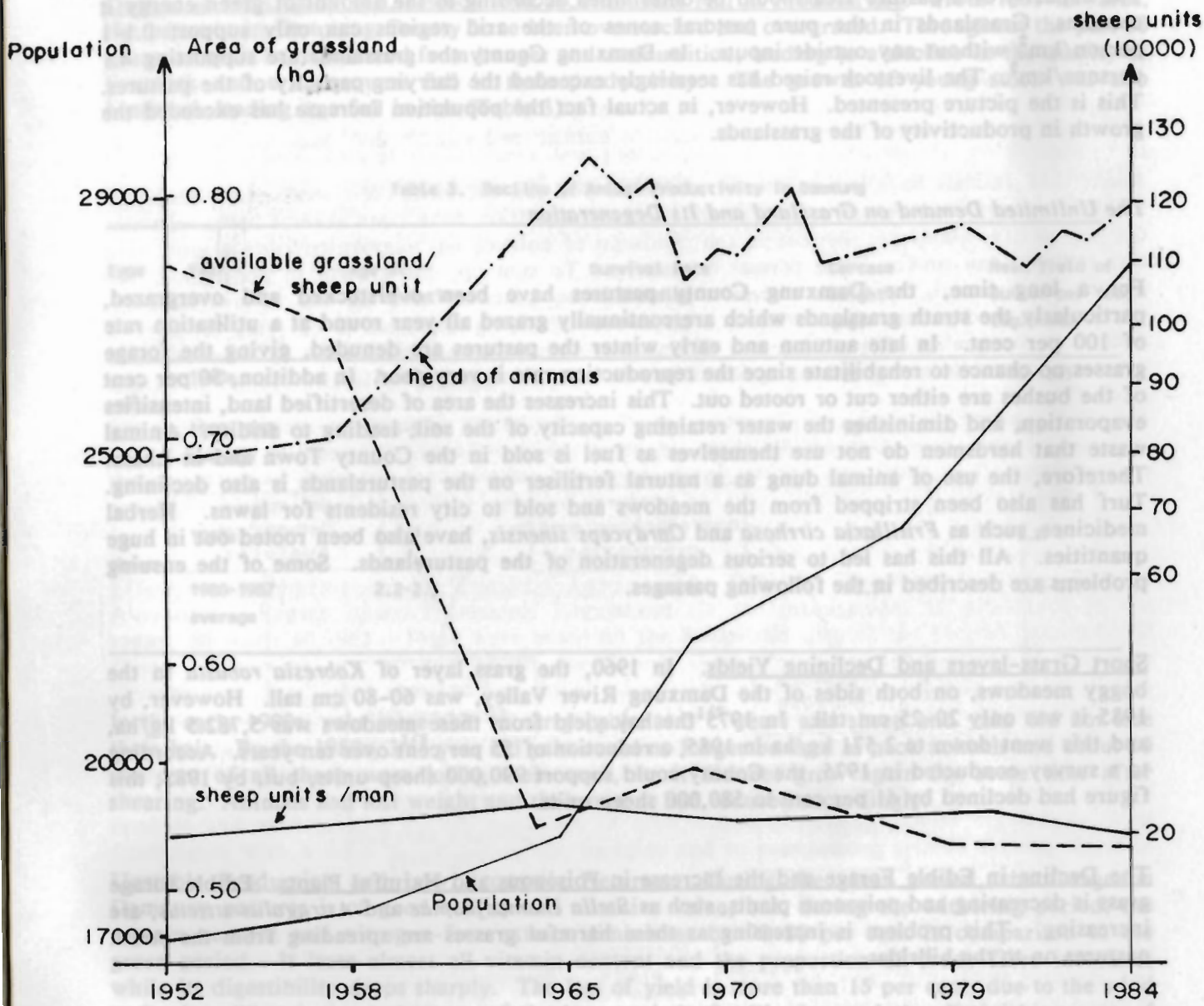

Fig. 2 Change Curve of Stock-raising Population and Animals in Damxung County from 1952-1984

The capacity of a pasture area should be determined according to the amount of green energy it contains. Grasslands in the pure pastoral zones of the arid regions can only support 0.1-1 person/km^2 without any outside inputs. In Damxung County the grasslands are supporting 4.1 persons/km^2. The livestock raised has seemingly exceeded the carrying capacity of the pastures. This is the picture presented. However, in actual fact the population increase has exceeded the growth in productivity of the grasslands.

The Unlimited Demand on Grassland and Its Degeneration

For a long time, the Damxung County pastures have been overstocked and overgrazed, particularly the strath grasslands which are continually grazed all year round at a utilisation rate of 100 per cent. In late autumn and early winter the pastures are denuded, giving the forage grasses no chance to rehabilitate since the reproduction rate is very poor. In addition, 50 per cent of the bushes are either cut or rooted out. This increases the area of desertified land, intensifies evaporation, and diminishes the water retaining capacity of the soil, leading to aridity. Animal waste that herdsmen do not use themselves as fuel is sold in the County Town and in Lhasa. Therefore, the use of animal dung as a natural fertiliser on the pasturelands is also declining. Turf has also been stripped from the meadows and sold to city residents for lawns. Herbal medicines, such as *Fritillaria cirrhosa* and *Cordyceps sinensis*, have also been rooted out in huge quantities. All this has led to serious degeneration of the pasturelands. Some of the ensuing problems are described in the following passages.

Short Grass-layers and Declining Yields. In 1960, the grass layer of *Kobresia robusta* in the boggy meadows, on both sides of the Damxung River Valley, was 60-80 cm tall. However, by 1985 it was only 20-25 cm tall. In 1975 the hay yield from these meadows was 5,782.5 kg/ha, and this went down to 2,571 kg/ha in 1985, a reduction of 55 per cent over ten years. According to a survey conducted in 1975, the County could support 990,000 sheep units, but, by 1985, this figure had declined by 41 per cent to 580,000 sheep units.

The Decline in Edible Forage and the Increase in Poisonous and Harmful Plants. Edible forage grass is decreasing and poisonous plants, such as *Stella chamaejasmae* and *Astragalus strictus*, are increasing. This problem is increasing as these harmful grasses are spreading from the strath pastures on to the hillsides.

Degeneration of Cold Season Pastures. Pasturelands are becoming more and more arid, and the waters that heretofore collected on the marshy meadows are decreasing or have completely disappeared. The water level of the Nam Lake has decreased by one metre and its total area, too, is decreasing. The cold pastures at lower elevations are becoming more and more arid, and their coverage is diminishing. These meadows are evolving into drought-enduring *Stipa purpurea* steppes, and their distribution boundary has risen by 100 m and their snow line by 50-100 m. For example, there is now a flood alluvial fan-shaped grassland to the north of Damxung Airport which was once a cold-season pasture consisting mainly of *Carex spp.* In the early 1960s, it had a coverage of from 60-80 per cent but now it is a high-frigid steppe of *Stipa purpurea* and weeds with a coverage of 45-50 per cent. Soil fertility is falling and there is an obvious decrease in organic content as well as in nitrogen and phosphorus. A 1985 Survey determined that there was a degeneration in cold season pastures throughout the country. Seriously degenerated pastures totalled 46,447 ha or 7.69 per cent of all usable grasslands.

Decline in the Quality of Livestock with a Consequent Fall in Productivity. From 1959 onwards, the pastures in Damxung County have been overstocked and overgrazed. Throughout the past 30 years, animals have suffered from hunger and malnutrition, leading to a decline in the quality of livestock and a consequent fall in their productivity. The growth of young stock was also hindered, leading to a fall in size (Table 3).

Table 3. Decline of Animal Productivity in Damxung

Type	Year	Age at First Mating	Survival Rate of Breeding Animals (%)	Carcase Weight (kg)	Mean Yield of Butter per Year (kg/head)
yak	1960s	2.5-3	> 60	125	10-12.5
	1980-1987 average	4.5-5.5	32	95	4.3
sheep	1960s	1.6-2	> 75	17.5	0.8-1
	1980-1987 average	2.2-2.5	60.24	13.5	0.5-0.7

In the early 1900s, yaks were able to carry packs at $3^{1/2}$ years and sheep and yaks did not lose their hair. By the 1980s, $3^{1/2}$ year old yaks could no longer be used as pack animals and about 10 per cent of all sheep were losing their wool, or it did not grow again for some time after shearing. Animals had lost weight and their output had reduced accordingly.

Unstable Production and Low Economic Returns. During the green period, the forage on Damxung pastures is of good quality and nutritive value, but, during the withering period, the protein content and nitrogen-free extract diminishes by 70-80 per cent in comparison to the green period. It loses almost all vitamin content and the proportion of crude fibre increases, while its digestibility drops sharply. The loss of yield is more than 15 per cent, due to the wind and rain. What is more, because of the long period of withering and the diminishing area of winter grazing land, animals go hungry and when winter comes have to rely upon their own muscle and fat to survive. After winter/spring, the loss in weight for different types of livestock is: yaks 20-30 kg, sheep 5-7.5 kg, and goats 3-4 kg. Over a 20 year period, the loss of condition during the winter/spring period was 4.6 times the amount of meat sold throughout the County as a whole.

Livestock die when they are too weak and thin. From 1970 to 1979, the average death rate for adult animals was 8.42 per cent peaking at 15 per cent. Especially during the Cultural Revolution, there was a lot of emphasis on the number of animals kept; during that time the number of animals dying annually was greater than the number of livestock allowed to free-graze (see previous section on Subsistence Production and Basic Non-Commercial Manufacturing). Since 1982, with gradual management reforms, the number of animals "put out to grass" has once more superseded the number of adult animals dying from hunger. However, due to overstocking and lack of forage, the average death rate from 1980 to 1987 was still about 80 per cent. A lot of animals died in winter and in spring and production was unstable.

Figure 2 shows the rise and fall in the amount of livestock over 20 years after the animal population reached its peak in 1967. In the early 1960s, the forage was good enough to support healthy stock with supplemental feed. In the 1980s, there was a severe shortage of forage grass. In order to reduce the deathrate, the animals were fed grain as a supplement. The amount of supplement given was greater than 500 metric tons per year, and this was also given along with milk and butter. In 1986, the total expenditure on animal feed was 250,000[2] *yuan*.

Weak, thin animals have less resistance to disease and this increases their weakness. Since the 1960s, expenses on veterinary services and disease prevention have risen several times. Besides the loss in life, therefore, the loss in the condition of animals has augmented costs a great deal and reduced the profits from animal husbandry. To sum up, the growth in population, the growth in livestock, and the excessive demands on pastures have all led to overstocking, overgrazing, and pasture degeneration, with an accompanying reduction in carrying capacity, a decline in the quality of livestock, and diminished output. As a result, livestock numbers have again begun to rise and grassland agriculture is once more bogged down in an irreversible vicious circle (Fig. 3).

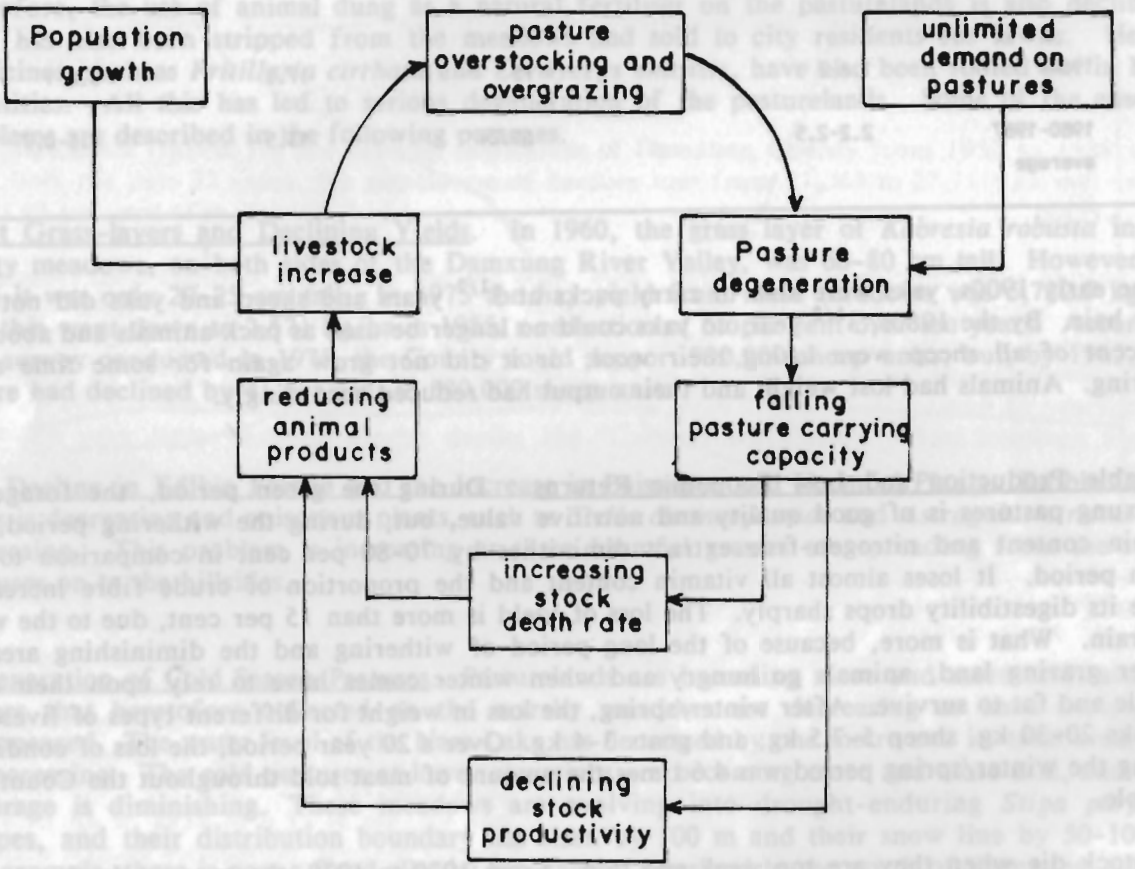

Fig. 3 Uncontrolled Production Cycle of Grassland Agriculture

---

2. There were 3.20 *yuan* to a U.S. dollar in 1986.

Methods of Raising Productivity

There are a number of factors contributing to the overstocking and degeneration of pastures, decline in the quality of livestock, and unstable productivity with poor economic returns. These include the adverse natural environment, low productivity of the pasturelands, poor quality and breed of livestock, mismanagement of pasturelands, backward mores (in terms of herding systems), and outmoded religious beliefs. In order to improve the management of livestock farming and bring about economic progress, a number of measures are necessary in order to remove the constraints.

Improving Pasture Management

The most important constraint is the scarcity of forage, especially in winter and spring. Although it is difficult to ameliorate an adverse environment, especially on cold, high altitude pastures, there is a lot of potential for restoring the productivity of the grasslands and improving the economic returns from the present pastures.

Effective Implementation of Grassland Laws. The People's Government of the Tibetan Autonomous Region issued Provisional Regulations for the management of grasslands in the region on April 10,1985. These were based on the Rangeland Law of the Peoples' Republic of China. According to these regulations, the County Government and its district and township governments distributed rights to individual households, or a collection of herding households, regulating the number of livestock for the use of cold season pastures. Grassland use certificates were issued by the County Government for this purpose. Herdsmen had the right to manage the pastures themselves over quite a long period of time and no party was permitted to infringe upon these rights. Villagers' Committees were set up for cold season pastures in order to control random and rush grazing or advanced use of cold season pastures. These regulations were formulated with a view to protecting the pastures and to establishing a more rational form of management.

Given the autonomy to use cold season pastures, herdsmen became more conscious of judicious use, and began to take advantage of warm season grassland by prolonging the period of usage in an attempt to reduce grazing pressure on cold pastures. Since the right to use the pastures was protected by law, the herdsmen built fences and took steps to destroy poisonous and harmful weeds and rodents. Thus, the trend towards degeneration was to some extent controlled.

Maintaining a Balance between Livestock Numbers and the Output of Forage. The Government of the Tibetan Autonomous Region commissioned a one year detailed survey of grassland resources in Damxung County in 1985 (see Footnote 1, page 1). The survey examined the acreage, major types of forage, and nutritive value of all the pastures in the County. In addition, it noted the grassland types, their carrying capacity, proportion of cold pastures to warm pastures, and the differences in their carrying capacity. Based on the findings of the Survey, grassland management groups, at all levels below County level, assessed the appropriate stocking rate for every type of grassland. Initially, the number of animals that could be raised was based on the grass yield of pastures during the period of lowest output.

In such a way, unrestrained increases in the size of herds was checked in order to balance the amount of forage available with the number of animals to be fed. A grassland grazing and grassland protection fees are now charged if animals in excess of the specific carrying capacity of a pasture are grazed in that location. The money so raised is used by the management group to protect and improve the grasslands.

Strengthening of Grassland Protection and Supervision. The administrative bodies under the County Government, including management groups and herdsmen, have intensified their efforts to protect and supervise the pasturelands according to the provisions laid down in the Grassland Law and Regulations. Destruction of vegetation, either by cutting down shrubs or digging up medicinal herbs, is prohibited. Both users and managers alike are entitled to report destructive behaviour so that appropriate fines or economic sanctions can be imposed upon violators. The fines so collected are used for the improvement of pastures. However, certain constraints have been encountered. There is a lot of covert felling and digging up of plants. It is suggested that a "policy" body should be established for the grasslands, like the one established in the Inner Mongolian Autonomous Region, to supervise and implement the Grassland Law and Regulations.

Establishment of a Grassland Protection Zone. The strath, boggy meadows of *kobresia robusta* and *Blysmus Sincocompressus* occupy an important position in the context of pastoralism, because they constitute one of the most important winter and spring grazing grounds, having the highest productivity, longest grazing period, smoothest terrain, and lowest elevation; in addition they constitute one of the few high cold pasturelands on the Qinghai-Tibetan Plateau that can be mowed. Among all the natural pasturelands in China, this type of pasture is of substantial economic value.

In order to protect forage resources, preserve the ecosystem, and prevent further degeneration, it is recommended that a 3-6 km^2 protection zone of sagebrush and valsoid spike grass be established in suitable places on both sides of the Damxung River Valley. This can be implemented either at County or at State Government level.

Adoption of Various Technical and Economic Measures to Improve Animal Husbandry

For herdsmen, the number of animals they keep is an indication of their wealth. To satisfy their daily needs they barter surplus milk, meat, wool, and fur for grain and daily necessities. They are usually unwilling to cull out and sell farm animals, however, and this results in there being approximately 8.6 per cent of all animals that are old and unproductive. In 1978, pack animals (yaks and sheep) accounted for 25 per cent of the total herd composition if converted into sheep units. From 8-10 per cent of all animals are left to free graze until they die of old age, because religious tradition prohibits their slaughter.

Therefore, 35-40 per cent of the total composition of livestock are pack animals and animals put out to grass, and this results in a slow turnover and poor profits. The Grassland Group of the Qinghai-Tibet Study Team, from the Academia Sinica in the town of Jiagenduo, in Damxung, assessed the amount of forage consumed by castrated and old animals at 26.57 per cent of the total grass yield. In the period from 1972-75, the culling rate was 8.1 per cent and the selling rate 1 per cent; this did not give a picture of profitable returns from animal husbandry.

Keeping old animals is uneconomical. An old, castrated animal produces 0.75 kg of wool and down a year, and this is worth 2.5 *yuan*. However, it consumes 365 kg of hay and forage, and this is worth 73 *yuan* a year; the ratio of income to cost of forage is thus 1:29. The income earned from a pack animal for a long distance haulage averages 0.1 *yuan* a day, only a thirtieth of the cost of the feed it consumes. When the weight of the animal reaches 70 per cent of its adult weight, the rate of return of forage/feed reaches a peak and then declines gradually with age. The conversion efficiency of feed for a 7 year old sheep is 9 times lower than that for a 10 month old sheep. The amount of feed consumed by a 9 year old sheep is 1.8 times that of a 5 year old one, but the conversion efficiency of the former to the latter is 1:1.8. It is, therefore, obvious that the older the stock, the more uneconomical it becomes.

In 1985, the Animal Husbandry Department of the Tibetan Institute of Agriculture and Animal Husbandry carried out a survey in Damxung County. It was calculated that a castrated sheep slaughtered at one and a half years brought in 2.82 times the income of a sheep slaughtered at the age of three and a half. A one and a half year old sheep only consumes a third or a quarter of the amount of feed that a three and a half year old consumes. Based on this, it can be seen that selective culling and a reduction in the number of castrated and pack animals kept will more than double the profits accruing from animal husbandry.

Commencing in 1980, Damxung County began to concentrate on culling animals by setting an age limit to animals to be culled or to be permitted to free graze, in order to bring about a speedier turnover. The age limit for culling was set at 8-9 years for yaks, 12 years for female yaks, 5 years for castrated yaks, 6 years for ewes, and 2-3 years for castrated sheep. These measures increased the proportion of animals culled from 10.5 per cent in 1978 to 15.49 per cent in 1986. Efforts should be made to raise the proportion to over 25 per cent.

Improving Herd Composition by Increasing the Proportion of Females. The criteria for a good herd composition are outlined below.

- The species of animals kept should be rangeland species that can adjust to the climatic conditions. There should also be a balance between the number of animals kept and the fodder yield of the pastures grazed. This will vary according to the differential productivity of cold and warm season pastures. For instance, the carrying capacity of warm season pastures is 30 per cent greater than that of cold season pastures, and the forage grass from warm pastures is too short to mow for winter storage. Hence, to make optimum use of warm pastures, enough animals should be bred during the warm season.

- Herds should be kept that meet both economic and social needs. The people of Damxung live in compact, closely-knit communities. Their needs are mostly for butter and meat, whereas the State wants wool. However, since the State cannot bring in sufficient butter and meat to barter for wool, due to transportation difficulties, Damxung County should give priority to milk and meat production.

In line with the above, the proportion of dams, of the right age, should be increased in order to augment milk production and produce enough offspring to take advantage of the warm pastures. In 1978, the proportion of such dams was only 29.27 per cent for yaks, 30.5 per cent for sheep, and 36.35 per cent for goats. From 1980, the proportion of breeding dams began to increase and has since risen each year. From 1980-1987, the mean annual proportion of breeding dams was 37.24 per cent for yaks, 45.71 per cent for sheep, and 47.60 per cent for goats. This has resulted in an increase in butter production by 5 per cent, an increase in the proportion of culled animals

from 8 per cent to 15-20 per cent, and a doubling in the amount of mutton and beef produced. The survival rate of newborns has shown a remarkable increase and the mortality rate of adult animals has decreased sharply. Efforts to improve herd compositions continue with the aim of improving the proportion of dams to 45 per cent for yaks and 55 per cent for sheep and goats.

The Promotion of Seasonal Animal Husbandry in order to Produce Fatter Lambs. Seasonal animal husbandry is a technique that can correct the imbalance in the productivity of cold and warm season pastures. By optimum use of warm season pastures, lambs and calves can be fattened for market in a short time. This serves to not only increase economic returns but also to reduce the pressure on cold season pastures. During recent years, the County has experimented with different techniques for fattening, slaughtering, and marketing yearlings. Three month old lambs, raised on warm season pastures had a carcase weight of 10.19 kg when slaughtered, i.e. 75 per cent of the weight of an adult (13.5 kg), but the lambs were fattened at a much lower cost. Even better results can be achieved by following the criteria described above for a good herd composition. It is necessary to bring the lambing season forward by one or two months, and this should not be difficult. However, due to religious influence, herdsmen believe it inhuman to slaughter yearlings and this means that the practice has not, as yet, been widely accepted.

Planting Forage Grass for Animal Feed and for the Regeneration of Pasturelands. Under the adverse climatic conditions and due to the rugged terrain, it has been difficult to replant pastures or to establish new ones. However, it is possible to take advantage of micro-climates in certain localities to plant forage grasses such as highland barley and oats. In addition, certain plants, such as *Urtica spp* and *Datura sp*, which are either rejected by animals in summer or which are poisonous in the green state, can be mowed and stored for winter because they often lose their poisonous content when dry. By employing such strategies, 1.5 million kg of feed is stored for winter each year. However, there are still improvements to be made.

Crossbreeding to Increase Productivity. As described above, it is difficult to improve the livestock in Damxung County. However, the F_1 generation of fine wool and Tibetan cross-breeds can be used to increase the output of wool and meat, and the F_1 generation of *pien nu* can be used to raise milk production and draft performance. Economic cross-breeding, however, is only possible on a small-scale and should in any case be controlled in respect of quantity.

Strengthening of Veterinary Services and Disease Prevention. Damxung's veterinary services and epidemic prevention programme has been improving gradually since 1959. Cattle plague and anthrax have now been eliminated. The current problems include internal and external parasites such as liver rot, mange, and warbles. These affect the health of the stock as well as the quantity and quality of animal products. For example, 70-80 per cent of the yak hides originating in Damxung have holes caused by cattle grub. Currently, the County offers antihelmintic treatment for all animals in spring and autumn each year.

Bio-Engineering Measures. Some of the bio-engineering measures taken are described below.

Extending Grassland Fences: The County has 12,000 ha of fenced grassland, most of which are *Tsaokoulun*, a kind of man-made pasture enclosed on strath, cold season grassland. These measures were introduced 10 years ago. They prevent random and rush grazing and advance use of cold

pastures. Despite their success, many of them have been destroyed since the 1980s because of mismanagement. However, following the introduction of the right to use cold season pastures, many herdsmen have voluntarily re-built these fences with State subsidies.

Wintering Sheds: The winters are so cold in Damxung County that a yak of 250 kg will lose 87.8 Kcal of heat energy if it travels one kilometre. The strong winds on the plateau mean that the heat dissipation rate for conductive convection is 31 per cent of the body total. To offset this hazard, wintering and windsheds should be built to reduce heat loss and improve the survival rate of newborns.

Eradication of Pests: Insects and rodents have rendered a lot of harm to grasslands in Damxung, especially in the case of cold season pastures. Many pastures have been destroyed by these pests. The State, in the past few years, has provided tens of thousands (*yuan*) to buy insecticides and drugs to kill rodents. These have been made available to herdsmen free of charge. However, herdsmen are reluctant to exterminate these pests and as a result they have begun to proliferate once more.

Establishment of Cold Storage Facilities. The last 20 days of September are the best time for slaughtering. However, due to lack of cold storage facilities, slaughtering has to be postponed until November when the temperature drops to 0°C. The time lag between the end of September to November results in a loss of condition of up to 15 kg in yaks and 5 kg in sheep. In Shantang District, they have two slaughtering dates; one in early and the other in late November. The carcase weight of the late-slaughtered animals is usually 10 to 15 per cent less than the carcases of those slaughtered earlier.

This is reason enough to argue for the establishment of cold storage facilities that can use electricity that is heat or water-generated. With such facilities, meat production will increase by 10-15 per cent. In addition, it will reduce consumption of cold season pastures by 150,000-200,000 sheep units for 1-1.5 months.

Establishment of Small Manufacturing Units. Currently, animal products are crudely processed. The animal husbandry is of a self-sufficient, subsistence type and marketing is based on simple barter transactions. The County is located on the Qinghai-Tibet Highway and the Sino-Nepal Highway also passes through. It would be profitable to take advantage of the access to transportation links and set up small manufacturing units, such as fur and leather manufacturing factories and slaughterhouses, as long as a supply of electricity can be guaranteed.

Development of Transportation Facilities in Order to Lessen Reliance on Pack Animals. The traditional "salt-grain exchange" barter system between pastoral and agricultural areas is a primitive method of marketing. In recent years, the State has stepped up its purchase of animal products and supplies of grain to pastoral areas. Both State and private transportation has improved but further improvements are necessary if the reliance on uneconomic pack-animal transportation is to decrease.

Organisational Structure

Promotion of Science and Technology. The State has exempted the County from animal husbandry taxes in order to help the sector develop. It has also introduced science and technology for animal husbandry by setting up a pasture station for grassland management; a veterinary centre for the prevention and cure of animal diseases and epidemics; and a stock-breeding station for raising, selecting, and improving yak breeds. It will also introduce fine wool sheep for cross-breeding and experimental purposes. A farm machinery workshop and a hydro-electricity station, that is experimenting in wind and solar power, have been established. There is also a meteorological station and a number of commercial outlets for the purchase of animal products and the sale of items for everyday use.

Establishment of Grassland Management Committees. A Grassland Management Station was set up in Damxung County and management committees were formed at the district and township levels. These committees are responsible for grassland management. They ensure that grassland laws and regulations are adhered to; conduct propaganda and education campaigns on pastoral science and technology and on grassland laws and regulations; assess and plan the use of pastoral resources; lease pastures; and administrate rewards and punishments for optimum and improper use respectively, together with other concerned officials.

Marketing of Animal Products. The County's commercial departments and animal product purchasing stations are responsible for making essential inputs available to the herdsmen and for allocating manufacturing inputs and purchasing products. The commercial purchasing stations, however, do not accept the meat of yearlings or even buy it as sub-standard mutton. In this way, a constraint is imposed upon the dissemination of fattened lamb production techniques.

Damxung's main occupation is animal husbandry. The Standing Committee of the County People's Congress is responsible for legislation concerning animal husbandry, and the County Government and the Animal Husbandry Bureau direct the management of production. Guidance is given to the herdsmen through town councils and village communities.

All the herdsmen in Damxung are Tibetan. At present, family planning measures have not been accepted except by State cadres at the County and town administrative level. The increase in population is a major constraint on development. Persistent efforts should be made to popularise family planning and education should be encouraged in order to reduce the effects of religious taboos and superstition.

ICIMOD is the first international centre in the field of mountain development. Founded out of widespread recognition of environmental degradation of mountain habitats and the increasing proverty of mountain communities, ICIMOD is concerned with the search for more effective development responses to promote the sustained well being of mountain people.

The Centre was established in 1983, and commenced professional activities in 1984. Though international in its concerns, ICIMOD focuses on the specific, complex, and practical problems of the Hindu Kush-Himalayan Region which covers all or part of eight Sovereign States.

ICIMOD serves as a multidisciplinary documentation centre on integrated mountain development; a focal point for the mobilisation, conduct, and coordination of applied and problem-solving research activities; a focal point for training on integrated mountain development, with special emphasis on the assessment of training needs, the development of relevant training materials based directly on field case studies; and a consultative centre providing expert services on mountain development and resource management.

Mountain Farming Systems constitutes one of the four thematic research and development programmes at ICIMOD. The programme deals with agriculture defined broadly to cover all land-based activities (cropping, horticulture, forestry, livestock farming, etc) and their support systems. Currently the major focus of the programme is on the factors and processes contributing to the sustainability/unsustainability of mountain agriculture. This is carried out by examining (through both knowledge reviews and field studies) the sensitivity of public and private interventions to specific mountain conditions. The explicit consideration of the latter conditions can alone assure a mountain perspective to public policies and programmes in the agricultural sector.

Director: Dr. E.F. Tacke Deputy Director: Dr. R.P. Yadav

International Centre for Integrated Mountain Development

G.P.O. Box 3226, Kathmandu, Nepal

Telex : 2439 ICIMOD NP Cable : ICIMOD NEPAL

Telephone : (977-1) 525313 Fax : (977-1) 524509