Rangeland Resources and Livelihoods in the Dimaluo Valley, Gongshan County, Yunnan, China

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1. Introduction

This paper reports on the findings of field surveys and research in Dimaluo village, Gongshan county, in NW Yunnan. The research on which this paper is based covered a wide range of topics, such as household economics, biodiversity, and indigenous technical practices and knowledge relating to livestock and rangeland management.[1] By combining the main results of these separate surveys, this paper presents an overview of how the inhabitants of Dimaluo make their livelihoods, their interactions with natural resources, and the current challenges they face.

Most of the inhabitants of Dimaluo are of the Nu national minority, an ethnic group that is indigenous to Northwest Yunnan and one of the earliest inhabitants of the Nujiang (Salween River) valley. Previous field work based research in Nu communities has been very limited. The livestock raising customs of Gongshan's Nu people has at least 100 years' history. Cattle and sheep in particular have important roles in Nu culture and livelihoods. Through an analysis of local livelihoods and resource dynamics, it is found that animal husbandry has close interactions with both agriculture and forestry.

Dimaluo's villagers are now well integrated into market economies, for cash is needed to pay for school fees and to purchase other basic necessities. In this new and changing context, the villagers are also facing new challenges. Some fodder resources, including alpine pastures, are showing signs of degradation, and as livestock numbers increase more strain is put on winter and spring fodder resources and on household labour. The paper notes that while there is much consensus between technicians and villagers over the problems faced, approaches to solutions differ. Some technologies demonstrated in the village in the past have not been taken up by villagers, while indigenous knowledge relevant to solutions to current problems has not yet been applied. The paper ends by suggesting participatory dialogue between technicians and villagers as an effective way to enhance the livelihoods of Dimaluo's villagers.

2. The Setting

2. 1 Gongshan County

Gongshan is located in the Northwest corner of Yunnan, between 98° 08' - 98° 56' latitude and 27° 29' - 28° 23' longitude. To the west it borders Myanmar (Burma), to the north it borders Chawo county in Xizang (Tibet), and to the east shares borders with Weixi county and Deqin County in Yunnan province. The Nujiang (Salween River), ca. 1200 masl, runs on a roughly north-south line through the county. High mountains rise to either side of the river - Gaoligongshan to the west and Biluoxueshan (Biluo Snow Mountain) to the east (maximum height of 5128 meters above sea level). Over half the land in the county lies on slopes exceeding 35 degrees. Such extreme variations in

1 The main background papers are Song (2000) which gives particularly to household economies and livestock management, Wang et al (2000) which focuses on impacts of livelihood activities on biodiversity, and Wilkes et al (2000) which reports on natural resource trends and livelihoods.

elevation provide a diverse range of topography, landscape and vegetation types within the county. This diversity is also reflected in the county's extremely rich botanical and zoological diversity.

Gongshan is also home to 34,000 people, of whom 94% are members of national minorities. There are 15 ethnic minorities represented in the county. 14% of the total population are Dulong, 18% Nu, 59% Lisu and 5% Tibetan. Among the remainder, Han, Naxi and Bai minorities are significant. The county is also one of the poorer counties in Yunnan Province. In 1999, average net per capita incomes were 744 Yuan (around USD 93). Income is predominantly agriculture based. Prior to the logging ban that was implemented in the county in 1999, forestry was also a major source of income, with animal husbandry also accounting for a significant proportion of total income in the county.

Particularly since the implementation of the logging ban in 1999, the government has put great stress on animal husbandry as an important sector to drive future economic development in Gongshan, and poverty alleviation policies have set targets for the development of numbers of livestock. The county has an overall insufficiency of grain, but natural grasslands are abundant (a total of over 117 thousand hectares). In fact, with the influence of poverty alleviation policies, livestock numbers have grown rapidly and continually since 1995. By the end of 1998, a total of 1145 tons of meat were produced in the county, an increase of 22% over 1997. Table 1 shows the situation of livestock production in the county in the first half of 1999.

Table 1: Livestock development in Gongshan (first half of 1999)

units: head, tons

township	Large livestock						pigs			Goats and sheep		
				Of which: cattle								
	In stall	Marketed or consmed	Meat production	In stall	Marketed or consmed	Meat production	In stall	Marketed or consmed	Meat production	In stall	Marketed or consmed	Meat production
Bingzhongluo	2582	28	3．82	2576	28	3．82	5791	1162	75．46	2322	54	1．01
Pengdang	2578	49	6．68	2434	49	6．68	6207	1090	70．76	5462	156	2．97
Cikai	1215	52	7．10	967	52	7．10	9214	3068	199．2	7262	528	9．84
Puladi	590	27	3．68	489	27	3．68	5612	1844	119．67	6560	1160	21．65
Dulongjiang	625	24	3．27	579	24	3．27	1676	506	32．8	3794	82	1．53
Total	7590	180	24．55	7045	180	24．55	28500	7680	497．9	25400	1980	37

Data provided by county animal husbandry bureau

2.2 Pengdang township

Gongshan county has 5 townships. Pengdang township is located along the banks of the Nujiang River approximately 20 km northeast of the county town. The township has 4 administrative villages: Shanda, Dimaluo, Yonglaga and Maxidang. According to figures provided by the county statistical bureau, in 1999 the township had a total of 5747 people, and an average per capita arable land area of 2.99 mu (0.2 hectares). Average grain output was 246 Kg per capita and average net per capita income was 710 Yuan. The whole township had 2558 head of large livestock and 6045 pigs and 5965 goats or sheep.

From the comparison of the four townships in Table 1 one can see that in terms of numbers of livestock in stall, Pengdang township is second only to Bingzhongluo township. Moreover, within Pengdang township, Dimaluo is a key livestock raising village. Almost two thirds of the large livestock and one third of the sheep and goats in Pengdang township are raised in Dimaluo. Within Gongshan county, the Nu are relatively concentrated in Bingzhongluo and Pengdang townships. Thus, through a case study of Dimaluo village, one can understand the Nu people's use and management of rangeland resources, and their social and economic livelihood, as well as understanding some of the current challenges faced by agro-pastoralists of all nationalities in the county.

3. Dimaluo Village

Dimaluo Administrative Village is located in Pengdang Township at a distance of 35 km from Gongshan's county town. Dimaluo lies on the western slope of Biluoxueshan, bordering Deqin Tibetan Autonomous County to the northeast and Weixi Lisu Autonomous County to the southeast. The total area of the administrative village is 338 km^2 (Wang 2000). Dimaluo takes its name from the Dimaluo River. 'Dima' is the location of the headwaters of the river, while 'luo' in Nu language means valley (Wang 2000). The administrative village covers the majority of the Dimaluo River valley, which runs parallel to the Nujiang River, from which it is separated by a high mountain ridge. There are 13 natural villages or hamlets within the administrative village. The lower villages are located at around 1700 masl, while other villages are located at 1800-2700 masl. Most villages are separated from the neighbouring village by gullies that contain tributary streams of the Dimaluo river. The village's arable land is situated at 1500-2700 masl, mostly on slopes exceeding 35 degrees. At higher elevations are pine, mixed deciduous wood and bamboo forests, and at higher altitudes still are larch (*tiesha*) forests and alpine rangelands, which lie at an altitude of over 3000 masl. Access to the rangelands requires crossing passes of almost 4000 masl. At even higher altitudes to the east of the Dimaluo valley is Biluo Snow Mountain, which has been proposed as a national level nature reserve.

In 1999 the 13 hamlets in the valley contained 1944 villagers in 424 households. 70% of the inhabitants are Nu, 25% Tibetan and 5% Lisu, the latter being concentrated in two hamlets. The original inhabitants of Dimaluo were Nu. Many Tibetans arrived in Dimaluo in the first half of the twentieth century from Deqin, probably around the same time as the Lisu inhabitants. Table 2 provides selected details on each hamlet and the administrative village as a whole.

In 1997, a road passable to 1 ton trucks was constructed by villagers from the township seat as far as Dimaluo hamlet where the Administrative Village Office is located. A weekly market spontaneously grew up at Dimaluo where outside traders sell clothing and other manufactured products, and villagers can sell their produce – especially mushrooms and medicinal plants in season. In early 2000, Dimaluo Village office was connected to electricity, and it is planned to connect to several natural villages by the end of 2000.

3.1 Village economy

Average per capita availability of grain for consumption (*renjun kouliang*) in 1999 was 180 Kg, which is about 85% of the average for the township, and is well below the official poverty line as measured in terms of grain availability set by the provincial government. Among the reasons for this is that average per capita arable land area in Dimaluo is around 1.75 *mu* (0.117 ha.), much lower than the average for the township as a whole (2.99 *mu* or 0.2 ha.). Average net per capita income (including the imputed value of agricultural produce) in 1999 was 813 Yuan (ca. USD 100), or 116% of the average for the township. However, allowing for the particularities of the Chinese statistical reporting system, an alternative estimate for net per capita cash incomes is closer to 490 Yuan (ca. USD 61) (see Wilkes et al 2000).

In terms of production structure, according to official statistics, in 1999 agriculture contributed on average 44% (min: 38.2%, max: 52.9%) of the total income of Dimaluo villagers. The remainder was due to collection of NTFPs (natural village average of 6%, min: 1.6%, max: 25%), forestry (average 18%, min: 12.6%, max: 30%) and animal husbandry (average 16.7%, min: 10.3%, max: 40%), with smaller contributions from transportation, petty trade and other cash generating activities. Income in Chinese statistical reports includes the imputed value of crops produced, and thus does not represent cash income levels. The income reported from agriculture is mostly imputed value since grain is mostly either self-consumed or used as fodder, and rarely sold. In fact most households have to purchase grain (rice) for their own consumption needs. If one discounts the imputed value of agricultural output, animal husbandry accounts for a much greater proportion of cash incomes.

Since the period reported in Table 2, the logging ban was implemented throughout Gongshan county and income from forestry will show a significant decrease in the 2001 statistical report. NTFP collection shows strong seasonality and is not a stable income source. Markets are volatile and stocks of some wild mushrooms and medicinal plants are depleting (see Wang 2000 and Wilkes et al 2000). Thus, animal husbandry is what most villagers and local officials look to for stable economic growth, and for security against other future economic shocks. At the end of 1998, there were 1597 head of large livestock in the village (of which 1366 were cattle or yak), 1200 goats and 577 sheep. The whole village produced 8250 kg of milk in 1998 and 18,150 kg of meat.

Most field research reported in this paper was conducted in Mulandang and Caidang hamlets. From Table 2 one can see that in terms of its reliance on animal husbandry

Mulandang hamlet is average within the administrative village, while Caidang is relatively more reliant on animal husbandry.

3.2 Land use and vegetation

The Dimaluo valley is characterized by the wide range in altitude. This presents a wide variation in climatic conditions. These climate belts are roughly consistent with different land uses as summarized in Table 3. Since animal husbandry is a main economic activity in Dimaluo, the characteristics of rangelands are summarized in detail in section 5 below.

Table 3: Land use patterns in Dimaluo

Altitude (masl)	Place name	Main vegetation types	Land use	Notes
1500	Dimaluo village	Secondary pine forest, shuidonggua, grassy slopes, agricultural crops	Residence, arable land, cash crop trees, winter grazing and raising livestock in pens	Common crops include corn, buckwheat, potato and wheat. Common cash crop trees include plum, apple, peach, walnut.
1800-2000	Mulandang Village			
2000-2700	Caidang Village			
2700-2900	Tamumian pasture	Grassy slopes and pine forest	Grazing (May – Sept)	Seasonal habitation
2900-3200		Bushes and shrubs, bamboo, fern		
3200-3700		Larch forest, xuezhu bamboo below forest canopy		
3700 (western slope) – 3900 – 3700 (eastern slope)	Eastern slope is Jiuta pasture; western slope is Siwalongba pasture	Alpine grassland, rhodedendron		

In the following sections we will see how this village economy, and the animal husbandry sector in particular, operates at the household level, and how in the course of managing livestock and rangeland resources the villagers interact with natural resources in the valley.

Table 2: Introduction to Dimaluo Administrative Village (1999 figures)

Hamlet name	Meaning of place name*	Main ethnic group	Households	Population	Total gross income (Yuan)	Contribution to gross income（%）			Pc grain availability (Kg)	P.c. net income (Yuan)
						NTFP collection	Forestry	Animal husbandry		
Tongda	Flat place at the foot	Lisu	32	143	194454	7.8	17.7	13.4	189	802
Pula	'Leave the living' (according to legend, all the old people died in an epidemic)	Nu	39	159	188643	3.2	19.2	15.2	174	689
Longpo	Clear bamboo to establish settlement	Tibetan	28	137	184640	4.3	18.9	14.0	174	800
Gekedang	Flat area like a canoe	Nu	29	162	228187	3.3	12.6	31.7	173	836
Caidang	Gradual slope below a flat area	Tibetan, Nu	30	134	181276	8.3	21.6	40.0	162	796
Mulandang	Swidden land area	Tibetan	29	143	189675	7.9	23.6	14.0	167	777
Baihan	High corner	Tibetan	65	332	420812	5.2	17.8	19.8	143	749
Congni	Tail of the lake	Tibetan	33	140	242518	5.3	16.2	19.9	227	1025
Shiyonggong	Place with lots of squash	Tibetan, Nu	37	138	215006	6.0	21.9	17.2	201	922
Qingmatang	Place for growing paddy	Tibetan	19	69	100086	25.0	21.4	12.4	199	857
Mulou	Under the shady slope	Nu	29	130	192950	7.6	22.2	10.3	205	879
Wangqingwang	Next to the little river	Nu	33	153	152869	3.3	30.0	12.1	129	591
Puta	?	Tibetan	21	104	180269	1.6	27.4	26.2	196	1028
Total or average			424	1944		6.0	18.0	16.7	180	813

Source: Village statistical report (2000), except column two which is from Gongshan Dimingzhi
Note: Income figures include the imputed value of agricultural produce.

4．Livestock and livelihoods in Dimaluo

4．1 Historical development of livestock raising

According to interviews with elderly villagers, the history of raising cattle, sheep, horses, donkeys and mules in Dimaluo spans over 100 years, or three generations. The development of livestock is said to be linked to the migration of Tibetans to Dimaluo from neighbouring Deqin (on the other side of Biluo Snow Mountain). One hundred years ago, Caidang only had 3-4 households, and Mulandang hamlet only 6 hosueholds, all living quite dispersed. All inhabitants were indigenous Nu people. Then, only wealthy households raised cattle and sheep. Before Liberation in the early 1950s, 3-4 Tibetan households moved to Dimaluo from Deqin, bringing with them the techniques and methods of raising livestock. Now there are about 30 Tibetan households in these hamlets, and because of intermarriage with the indigenous Nu people, the lifestyle of the two ethnic groups is now basically similar. Thus contemporary Nu animal husbandry management practices are the result of interaction between Nu and Tibetan technical knowledge.

From interviews with villagers, the development of livestock raising in Dimaluo can be divided into 4 stages:

Stage 1: 100 years ago to the eve of Liberation in the early 1950s. In this period only a few wealthier households raised horses, cattle and sheep and their numbers were very limited, while natural grasslands were abundant. The present location of hamlets was then surrounded by abundant grass and forest of good quality. The style of livestock management was a mixture of semi-nomadic and free range: seasonally the livestock would be allowed to roam, and those whose conditions allowed would add some supplementary fodder and salt, especially in the winter. One reason for the slow growth of livestock numbers in this period was the lack of capital with which to buy livestock.

Stage 2: Early 1950s – 1958: This was the first period of rapid development of livestock numbers. In the 1950s, land reform was implemented and both agriculture and animal husbandry developed. In the cooperativization movement, oxen were purchased at a low price by the cooperatives but were still raised by the cooperative members individually. Other livestock and poultry were retained by villagers as private property. At the same time, the government began to provide technical support. Given local resource endowments, Dimaluo's villagers depended on animal husbandry for their development.

Stage 3: 1958 to 1978: This was a slow period in animal husbandry development. Mainly for political reasons, the government required that all livestock be sequestered by the state. Villagers were only given the rights to manage livestock, while ownership and use rights remained with the collective. The villagers were sent to graze cattle according to the allocation of labour tasks by the collective, but because of management and technical reasons, livestock mortality was high. Especially after the Cultural Revolution in 1966, with the slogan of 'cutting off the tail of capitalism', livestock and poultry raised by villagers, as well as their vegetable and fodder plots, were seen as signs of capitalism,

and these activities were limited. It was forbidden to raise plow oxen. This was a great blow for animal husbandry. Private property was not allowed, including private housing, and all private houses were burned. Food was to be eaten collectively, labour was collectively arranged and housing was public.

Stage 4: 1982 to today: From 1982, animal husbandry entered a period of rapid growth. With the implementation of the household production responsibility system, villagers' incentives to invest labour and other inputs in production was renewed. Livestock were allocated or auctioned to individuals and ownership rights were given to villagers so that villagers could allocate resources as they saw fit. In 1985 unified procurement by the state of livestock products was abolished and prices set according to market supply and demand. Based on the local comparative advantage in resources and traditional Nu knowledge of animal husbandry, animal husbandry once again became a main activity and cattle, sheep, horses and mules became common.

Especially since 1995, livestock raising came to be seen by local governments as a key economic activity, and Dimaluo was declared to be one of the key villages for animal husbandry development in Gongshan county. This also brought many boosts to animal husbandry development in Dimaluo. Figure 2 shows the trend in livestock numbers over the 13 years between 1986 and 1999.

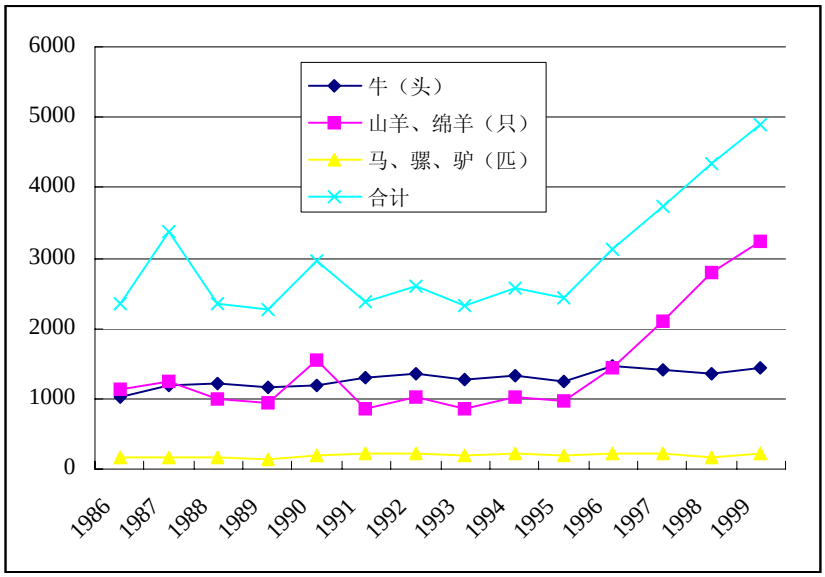


Figure 2: Trends in Livestock Numbers in Dimaluo, 1986-1999

Unfortunately separate data are not available for yak and cattle, and sheep and goats. Nevertheless, from the figure we can see that in the 13 years covered by the data, numbers of cattle (and yak) have increased gradually, at an average rate of 32 head of cattle per year. Before 1995, numbers of sheep and goats were roughly around 1000 head, but after 1995 there was a rapid increase in numbers for 4 consecutive years. Horses, donkeys and mules have also seen a gradual rise from 165 in 1986 to 220 in 1999.

Similarly, we can also trace the history of the development of livestock from household interviews, asking villagers to recount their family's history of livestock raising, as summarized in Table 4).

Table 4 Family histories of livestock raising

Villager name	When family started raising and numbers	Pre-Liberation	1958-1978	1982	1998
Luo Wenju	Over 100 years ago Numbers not known	Cattle: 2 head Sheep: 4 head	Sequestered by state	Cattle: 4 head Sheep: 7 head Goats: 1 head Horses: 2 head	Cattle: 11 head Goats: 70 head Sheep: 78 head Horses: 3 head
Hu Zhengping	100 years ago Numbers not known	Cattle: 3 head	Sequestered by state	Cattle: 1 head Sheep: 2 head	Cattle: 15 head Yak: 25 head Sheep: 9 head Horse: 1 head
Xiao Wensheng	100 years ago Numbers not known	Cattle: 11 head	Sequestered by state	Cattle: 8 head	Cattle: 8 head Sheep: 25 head Horses: 1 head
Xiao Jianwen	50 years ago Numbers not known	Not known	Sequestered by state	Cattle: 1 head Sheep: 1 head	Cattle: 13 head Sheep: 50 head Horses: 4
Ye Li	1982 Numbers not known				Cattle: 2 Sheep 40
Yang Xingde	1982 Numbers not known				Cattle: 17

Taking Mulandang hamlet as a case (see Table 5), we asked about the distribution of livestock among households.

Table 5: Livestock possession in Mulandang hamlet (2000)

Cattle possession	**Number of households (n=28)**	**Sheep possession**	**Number of households (n=28)**
0	3	0	22
1-4	12	1-5	1
5-10	12	5-10	1
>10	1	>10	4

Source: Song (2000)

From Table 5 we can see that of the 28 households in Mulandang hamlet, only 3 households have no cattle. One is an elderly man, Xiao Wenxiu whose wife is paralysed and who are looked after by their daughter. The other two are poor households in the hamlet who have no capital and labour. Six households raise sheep. Many who no longer raise sheep did raise them at some time in the past, but because of lack of labour or capital gradually ceased to raise sheep. For example, Xiao Wensheng in 1998 had 25 sheep but by July 2000 he had no sheep because his household had insufficient labour with which to manage and graze them (he had bought a truck for his son to drive to earn

cash income). But almost all villagers without sheep said that if they had sufficient capital and labour they would raise sheep.

From this review of trends in livestock numbers in Dimaluo, we can see that it is primarily cattle (including yak) and sheep (including goats) that villagers prize for their development. This is due to the traditional habits of the Nu people, and to the uses and relative values of different types of livestock and their products (see section 4.4).

4. 2 Livestock feeding practices and management

The Nu people of Dimaluo use a combination of free-range grazing and semi-stall feeding for cattle, sheep and horses. There are major differences between the practices adopted in summer and in winter, with the latter being predominantly stall-based and the former free-range. Feeding techniques are passed between generations or learned from neighbours.

Summer grazing: In April, the villagers take the cattle, sheep and horses up the mountain to the pasture. Between April and May they graze in the middle-elevation pasture and in June start to proceed to the alpien pasture where they graze until the end of October. Livestock mostly feed on fresh grass and are also fed salt (about 10 Kg per head of cattle).

After milking cows around 7 in the morning, the lead cattle leads the other cattle onto the pasture to eat grass until around 7 in the evening, after which they return to the hut on the pasture themselves. They are then milked again, and then rest near the hut. On the alpine meadows calves need special care. Each cow has a calf each year, mostly born in March or April. After feeding on milk for two weeks, calves are then fed a watery gruel made of maize or eat grass, and are limited to drinking milk twice a day. Only after one month are the calves allowed to drink milk freely. Before that they are fed by the villagers. At one year, the calves eat grass and need no special care. Mostly a cow will produce milk for 7 months of the year, and stop producing in the winter between December and April.

Sheep and horses do not need special attention. For the whole summer they are left to graze freely. But sheep will not return to the hut on the pasture by themselves and so need someone to look after them. Households that lack labour rarely raise sheep or only raise a few sheep. Healthy sheep give birth twice a year. Sheep give borth msotly to one lamb, while goats give brith to two, hence the rapid growth of numbers of these ruminants.

Gazing in the summer months is mostly done by each family separately. Households with many cattle and sheep allocated one able bodied member of the household to take the livestock up to the alpine pasture and to tend them throughout the summer, milking and producing butter. Only in November do they follow the livestock back to lower elevations. Both men and women can tend livestock on the alpine pasture, but it is mostly men. Households with few livestock, or households that have insufficient labour sometimes jointly graze their livestock with one household providing one labour power to graze the livestock together. The other households then provide that household with butter or with remuneration in cash.

Winter feeding: In November the livestock are driven down the mountain where they stay until April. They are let out to graze in the daytime (unless it has snowed) and kept in a stall at night. When it does not snow cattle are fed once a day and calves twice. When it snows they are kept in the stall and all cattle are fed twice a day. For feed, villagers store winter grass and supplement this with fodder, mainly grass, barley, maize, wheat, turnip, potato and salt. But because grass fodder is short in winter, there is often insufficient fodder to meet the needs of livestock, and many livestock grow thin and frail over the winter months. If a cow calves, in addition to increasing fodder, sometimes the cow is fed chicken meat. In march and April when the cattle are to be driven up the mountain, villagers will feed them chicken if they are able, while those with few chickens are only able to feed chicken to cows that have calved in order to ensure their nutritional intake. In winter, feeding cattle is mainly women's work apart from feeding livestock, before April and after October women shear sheep with which to weave blankets.

The common division of labour between men and women in the household is depicted in the table below.

From the table we can see that in a year, men are mostly responsible for feeding and grazing, and only in households with little male labour will women stay in the alpine meadow for the summer months. Planting, carrying manure, feeding pigs and other livestock in winter are all women's work. The division of labour between men and women is quite clear, and both undertake important tasks. Feeding techniques are passed down equally to men and women of the younger generation. But the amount of labour available to a household has a great impact on its ability to earn cash income. Older people live with their sons and women marry patrilocally, so households without sons need to invite a son-in-law to come to live with them.

Table 6 Annual production activities and division of labour

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Div of labour
Feed cattle, sheep	√	√	√	√								√	F
Carry manure	√	√										√	F
Carry fuel wood	√	√										√	M, F
Dig land			√	√									Mostly F
Birthing cattle, sheep			√	√									M
Shear sheep			√	√							√	√	F
Weave blankets	√	√	√	√	√	√	√	√	√	√	√	√	F
Herd livestock to alpine meadow				√	√	√	√	√	√	√			Mostly M
Milking				√	√	√	√	√	√	√			M, F
Butter making				√	√	√	√	√	√	√			M, F
Maize fields					Planting	Weeding	Weeding	Weeding	Weeding	harvest			Mostly F
Feeding pigs	√	√	√	√	√	√	√	√	√	√	√	√	F

4.3 Animal health and veterinary services

Apart from feeding techniques, disease prevention and treatment is also important. Pengdang township animal husbandry station has two staff, and 3 of the four administrative villages in the township have a para vet. Dimaluo has one para vet, who is mainly supposed to be responsible for seasonal vaccinations. But because the hamlets can only be reached by foot, while vaccination would require 1 day in each of the 13 hamlets, so to complete vaccination would require almost one month. In summer the livestock are mostly on the alpine pasture, which is far and where the livestock are dispersed so this work is rarely done effectively. In addition the subsidy payment for the para vet is considered low, and there are no extra funds for purchase of medicines, so the villagers' needs and demands for veterinary services go unmet. We also heard that in the past a vet had used one needle to vaccinate livestock in all hamlets leading to a widespread epidemic and high mortality. So some villagers now are unwillling to vaccinate their

livestock.

Villagers say that the township vets have not come to the village for several years. In the past there were two para vets in the village but neither of them provides services any more. Animal morbidity is common, but medicines or other treatment is rarely provided. Hence villagers either ask the medicinal doctor to provide treatment or purchase medicines themselves from the township or county, but often with little success. A common illness occurs among yak purchased from Deqin. Peng Enguang, the herbalist in Mulandang hamlet, says that these yak often fight, after which they develop some form of 'heart disease', which he also surmised may be some form of maladaption to the local environment. Despite injections with penicillin and so on, these yak die. Sheep also commonly develop two forms of illness - 'eye illness' (eyes bloat then go blind after which the sheep gradually die) and 'joint pains' (sheep cannot stand and gradually die) – which commonly lead to death.

Table 7 Livestock mortality (selected households) 1998 – July 1999

Interviewee	1998				1999		
	Cattle	Sheep	Pigs	Horses	Cattle	Sheep	Pigs
Hu Zhengping	6 (3 cows, 3 calves)	0	0	0	0	0	0
Xiao Wensheng	2 calves				1		1
Gao Changyong	0	26	0	0	2	5	2(1 large, 1 small)
Gao Xianrong	unknown	30	unknown	unknown	Unknown	Unknown	Unknown
Luo Wenfa	4 calves					Ill; bought 118 Yuan of medicine.	4piglets
Xiao Jianwen	0	10	8	1	0	7	0
Ye Li	3	0	0	0	0	10(6 large, 4 small)	3
Yang Qingzhong	5	0	0	0	0	0	0
Chen Guorong	2	0	2	0	0	0	0

4．4 Utilization of livestock products

The Nu people highly prize their cattle, sheep and horses. Possession of livestock is one of the most important indicators of wealth in these communities. The various uses of these animals also reflect their traditional customs, culture and social life.

4.4.1 Uses of cattle and yak

(1) Milk and butter production: After procuring milk, it is left to one side for three days and then poured into a 1 meter high wooden tube. Using a stick it is then beaten 500 times and then a kettle of boiled water is poured in and beaten another 500 times, by the end of which butter floats to the top of the tube. The butter is finally scooped out by hand. The remaining yoghurt is also highly nutritious, tasty, thirst quenching and energizing. If too much yoghurt is left in the butter tube, then it can be boiled and strained using muslin cloth and pressed into solid squares which can be eaten raw or roasted and stored for a long time to be used for entertaining guests. The remaining water left in the butter tube is also nutritious and is fed to the pigs. Butter produced in this way is a main source of cash income for villagers ,and is also a basic necessity in their lives. It is drunk as butter tea every morning. A traditional food used for entertaining guests, ‘xiala’ or meat stewed in wine, requires that chicken is first fried in butter and then boiled in wine. Butter is mostly sold when a household has more butter than it needs for its own consumption. Households with few cattle and insufficient butter for their own needs buy butter from neighbours. Butter can also be bartered or used for exchange. For example, if one wishes to mate one’s cow with the yak bull of another villager one would have to pay more than 100 Yuan, but to mate with the yak bull of a relative one needs only to give 2 kilograms of butter. If one invites another villager to graze one’s livestock on the alpine meadow in summer, butter is the most common form of payment.

Yak are preferred to cattle, and one main reason is the difference in milk and butter output levels. Villagers say that on average a cow can produce 2-3 Kg of milk a day (420-630 kg per year). About 10 kg of milk can produce 0.5-1 kg of butter, so one cow can produce about 20-30 kg of butter each year. The same amount of Yak milk, on the other hand, can produce up to 1.5 kg of butter, or 50-90 kg per year, much more than the ordinary cows. This difference is also reflected in the higher price for yak (2300-2400 Yuan for a two year old yak or 4000 Yuan for a full grown bull yak), so many villagers still do not possess yak.

(2) Manure for arable land: Livestock manure is an important product. Villagers in Mulandang hamlet said that chemical fertilizer is expensive and not good to use. They prefer organic manure, and manure is applied to all hillside arable fields. The more that is applied the better the harvest. Also, some of the few less sloped fields can be plowed using cattle, which reduces the human labour input required.

(3) Ritual and social activities: In general villagers in Dimaluo do not sell cattle unless they are old (13-14 years) and weak. Otherwise cattle will only be sold for cash needed in emergencies. Giving gifts of calves is a local custom. For example, villager Peng Enguang has given 4 calves to a poorer household in the village in order to help that household escape poverty. Calves can also be used for gifts for relatives and friends.

Cattle will also be slaughtered for wedding s and funerals in order to provide meat for the guests. In 1998 when Mulandang catholic church was being built, the villagers slaughtered a cow for the opening ceremony

(4) Emergency store of wealth: For the Nu, cattle is a replacement for cash. Historically cattle (along with iron pots) were used as the medium for exchange and accounting. Even today young villagers see cattle as a store of wealth just like a bank account. If a family needs cash urgently, such as when someone is in hospital, as long as that household has cattle, then they will not worry about payment.

4.4.2 Uses of sheep and goats

(1) Shearing for wool: Wool is used for knitting clothes and blankets, which are a local speciality product, and also basic necessities. Wool is sheared, spun, died and woven by the women. Every household has blankets that are used as bedding in winter. Nu blankets have also become a speciality product that are sold outside in the township and county town. Many households sell these blankets. They are also used as gifts for friends and relatives.

In addition to blankets, wool is used for clothing. Nu women's traditional costume includes a knee-length woolen cloth apron, waist wrapping and head scarf all of which are made from either wool or linen. Woolen socks are also common, especially in winter. Apart from their use in keeping feet warm, woolen socks are given as gifts as a sign of affection between young men and women and between husbands and wives. Young girls of 7 or 8 years old learn to card wool blankets and knit socks. By 17 or 18 they can all produce good quality socks.

(2) Store of wealth and medium of exchange: As with cattle, sheep and goats can also be a store for wealth, so generally villagers who are able are all willing to raise sheep and/or goats. The value of sheep is far below that of cattle in the eyes of the Nu, but as long as one ensures normal reproduction rates, villagers who raise sheep are willing to sell them for cash. Sheep are sometimes an important source of cash income, though households with insufficient labour or capital rarely raise sheep. Sheep can also be exchanged in other ways. For example, villager Luo Wenfa grazes 40 sheep for someone else. The original sheep were supplied by their owner else, and Mr Luo is responsible for feeding and tending them. If a sheep dies, he does not have to compensate the owner but for every two lambs born one belongs to the original owner. By July 1999 these sheep had given birth to 10 lambs of which Mr Luo gained 5. He was also given 4-500 Yuan as labour remuneration for raising the sheep. Sheep or lambs can also be given as gifts to frields and relatives.

(3) Ritual and celebration: To be able to slaughter a sheep at New Year is another important reason why Nu people raise sheep. Households with no sheep slaughter a pig to celebrate the new year. Sheep are also slaughtered at weddings and funerals for consumption by the guests.

4.4.3 Uses of horses, mules and donkeys

Horses are mainly used for transporting goods, so their numbers are limited. Villager Yang Lixin said that before the road was connected to Dimaluo village office in 1997, his father was a professional horse caravan leader, specializing in taking people's goods to the township and county town. After the road was built, horses were mainly used for transport within the limits of the village and between the hamlets and the alpine meadow, so some households ceased to raise so many horses. Some villagers also specialize in horse caravans to the Dulongjiang, though this business is now threatened by the completion of a highway from the county town to Dulongjiang.

4．5 Animal husbandry and household economies

Arable land fertilizer is mostly organic manure, though chemical fertilizer is also used. For some villagers, it is hard to purchase chemical fertilizer due to high price. Also some villagers think that chemical fertilizer is not as effective as manure – partly because fields are on steep slopes and chemical inputs are easily washed away. Thus, livestock and agriculture are closely compatible as these two figures show:

Fig. 3 Virtuous cycle of animal husbandry and agriculture

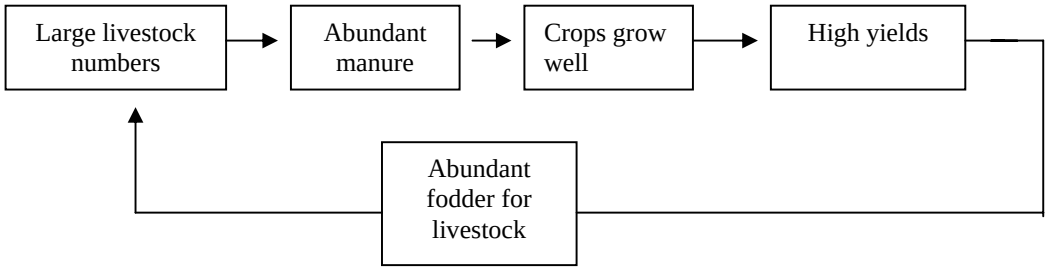
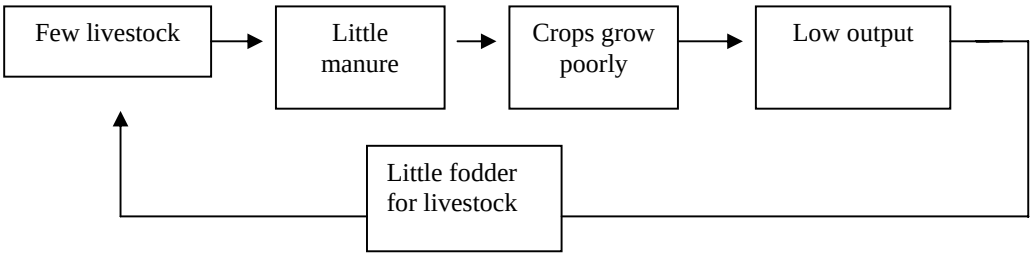


Fig. 4 Vicious cycle of animal husbandry and agriculture



These figures show the importance of livestock raising for agriculture in Dimaluo, and also shows that the two sectors closely interact.

Agriculture and animal husbandry are the keys to household economies in Dimaluo. Most hamlets are located at high elevations of 1800-2600 masl. Only one or two hamlets are at lower altitudes (ca. 1500 masl) near the river. In higher altitude villages, the fields are unirrigated, and mostly used to grow maize, potato, barley, wheat and buckweat. The output of maize is between 3-13 kg per ha, barley can reach 23 kg per ha, wheat between

3-20 kg per ha and buckwheat 3-7 kg per ha. Potato is commonly intercropped with maize, but if not intercropped output can reach 33 kg per ha. Most of these crops are self-consumed or fed to livestock, and rarely sold. With the increase in livestock numbers, some villagers even purchase maize to use as feed. Also, villagers grow many fruit trees (walnut, apple, pear, peach and lacquer), most of which are either eaten by villagers of fed to their livestock. Only walnuts are sold in small amounts.

Animal husbandry is a main source of cash income for the villagers. There are livestock markets at the village office in Dimaluo hamlet, at Pengdang township and Gongshan county town. Table 8 summarizes some of the prices for livestock products in 1998-9 as reported by villagers in interviews.

Table 8: Prices of livestock products in Dimaluo

Butter: 12 Yuan/kg	Adult goats (20 kg): 280 Yuan each
Wool blankets: 120-350 Yuan each depending on quality	Adult sheep: 350 Yuan each
Adult cows: 7-800 Yuan (of which villagers count around 200 Yuan as costs); or up to 1500 Yuan if sold to a Hui Muslim restaurant in the county town	Full grown pigs: up to 500 Yuan each
	Chickens: 5 Yuan / kg

Villagers say that before 1992, they mostly ate maize, buckwheat, wheat and barley and often lacked grain so had to rely of government relief. In those days, livestock were few and cash income sources were few. Because of a lack of manure, crop outputs were low. After 1992, villagers began to increase their numbers of livestock, their income increased and villagers were able to purchase rice. The main staple foods of villagers include rice (often purchased), maize, buckwheat, wheat and barley. Many of these grains are also used as livestock fodder. With the increase in the numbers of livestock, organic manure is mostly sufficient and output levels have increased. Also, as cash incomes have increased and villagers begun to eat purchased rice, the competition between livestock and humans for grain has lessened. Consumption of pork and poultry, and yoghurt have increased, increasing villagers intake of proteins. Thus, development of the livestock sector has increased villagers' living standards in many ways.

Additional cash income sources include wage labour in local mines or quarries, timber transport (before the logging ban in 1999) and transport. In households with abundant labour, households members below 40 years old often do wage labour outside the village, leaving the over 40s and school children at home to take care of agriculture and livestock. But wage labour is a somewhat unstable income source and sometimes work opportunities are hard to find. Having land and livestock, most villagers see wage labour as a supplementary income source rather than as an essential livelihood activity.

From this one can see that although income sources are diverse, livestock raising is still a main and stable livelihood activity and is essential to villagers' livelihoods. Household economics in Dimaluo mainly concern the mutual compatibility of agricultural cultivation with livestock husbandry. The key to agriculture is the ability to apply organic manure, while the key to livestock husbandry is the ability to provide sufficient fodder in the winter-spring months, which mainly depends on agricultural output. The main constraints on livestock development are the lack of capital and (for some) the lack of labour with which to procure sufficient winter fodder. The main constraints on agriculture are the lack of capital with which to purchase modern production inputs and the lack of livestock to provide sufficient organic manure.

One caveat to the above, however, is that most villagers, even those with larger herds, think that their herds have not developed to a scale appropriate for large-scale selling of livestock. Also, yak butter and wool blankets are mostly self-consumed, and only surplus is sold. And many villagers think that the market price for sheep in the county town is too low and are unable to compete with cheaper prices for livestock imported from neighbouring counties, so rarely sell sheep there. For some households with many sheep, this is mainly for wool, and only secondarily for animal sale.

5. Rangeland resources and management

In this section we look at how the villagers and their livestock interact with natural resources – and rangeland resources in particular – in the course of making their livelihoods.

5.1 Rangeland resources

The total area of grazing land in Dimaluo is over 11,000 ha., of which 7733 ha. is alpine rangeland, 1133 ha. is low altitude rangeland and 2133 ha. mid-altitude rangeland (County Animal Husbandry Bureau, pers comm). For distribution of grazing lands in Dimaluo see Map 1 and Transect 1. There are over 10 areas of alpine grazing land in Dimaluo. These grazing lands are at 3200-3900 masl, in primary (*Abies*) forest and in slightly lower valleys, where grass is dominant. In addition, each hamlet has a second rangeland at 2700-2900 masl nearer the village, which are used in spring each year. Fern growth in these lower altitude grasslands is very common, which limits the amount of fodder resources available in the spring rangelands. Winter grazing occurs in scattered grasslands around each hamlet and in fallow fields, but in some hamlets these meadows are said to provide insufficient fodder for wintering. Additional winter fodder is provided by the dried stalks of crops and legumes harvested from the fields in October.

In 1987, the county agricultural zoning office undertook a systematic survey of grass resources in the county (CAZO 1987). Based on the 1987 survey, this section reports on the main eco-types and population types found in the Dimaluo valley. Transect 1 summarizes this information in another form. The main rangeland eco-types are: mountain undergrowth, forest rangeland, grass rangeland and sparse forest rangeland. Each of these eco-types has variant sub-types depending on factors such as altitude, climate, soil type and so on. The 1987 survey also identified several classes within each sub-type based on the different dominant species of grasses and other plants.

● **Mountain Undergrowth:** Mountain undergrowth consists mainly of bushes, shrubs and grass, with a ground coverage rate of 10-30%, representing regenerated secondary forest after deforestation. Along the river it can be found in isolated patches, while on the mountain slopes it can be found in large tracts. Current land uses are commonly combinations of forestry (e.g. household fuel wood and timber forest) and livestock grazing. At lower altitudes, this type of ecosystem will be interspersed with arable fields.

Mid-altitude mountain undergrowth type: This type of rangeland is distributed between 1500 and 2500 masl, either in discrete patches or dispersed in valleys on slopes of around 37 degrees. As a rangeland resource, the survey found that at mid-altitude ranges, average fodder biomass output is 6.4 kg/ha., a low level of fodder biomass output. Grasses account for half of the biomass, and fern for around 8%, with smaller contributions from legumes, and other families. Of the total biomass only 17.5% was graded in the survey as excellent quality fodder grass, 10% was good quality, and 49% average quality. Based on the different dominant species within this type of grazing land, the survey identified 6 sub-types, some of which are likely to be present in Dimaluo:

(a) Schitzaechgrium delavayi + Eragrostis pilosa + Imperata cylina + ferns
(b) Imperata cylina + Eragrostis japonica + Eulalia speciosa (debeaux) kuntze + ferns
(c) Imperata cylina + Arthraxon hispicus (thum) makino + Negraulia regnaudiana (kunth) keng + fern
(d) Imperata cylina + ferns
(e) ferns - Imperata cylina
(f) Arthraxon hispicus (thum) makino + Imperata cylina + Phragmitas communis trin - ferns

Sub-alpine mountainous undergrowth type: Occurring at altitudes of between 2777 masl to over 3000 masl, on slopes of around 33%, this type of undergrowth provides on average an edible fodder biomass output of 22 kg per ha. Over half of the biomass is grass of average quality. The most common sub-types are:

(a) Primula agienania Balf. et Forrest + Potentilla sp + 'niumaocao'
(b) Artemisia tangutica pamp + Potentilla sp – Carex sp - Fragaria ananssa Duchesne
(c) Sindarandinaria nitida (mitford) nakai

● **Forest Rangeland:** Forest rangeland refers to secondary forest regrowth following the felling of forest or abandonment of arable land. Forest rangeland can be found within the forest, or in the buffer zones around such forest or between discrete patches of forest. Land uses include forestry-grazing, arable-grazing, and forestry-arable-grazing. Forest rangeland can be found mostly between 1500 and 3200 meters. The 1987 survey identified 25 different sub-types of forest rangeland. Of those identified as being distributed in the Dimaluo valley are:

Mid-altitude forest rangeland:

- Found near Wangqiwang hamlet on slopes between 20-48 degrees, at an average altitude of 1800 meters. The dominant species is Yunnan Pine (Pinus Yunnanensis Franch), with dominant undergrowth grass species of Themeda eriandra japonica, Schitzaechgrium delavayi, Imperata cylina, Eulalia speciosa (debeaux) kuntze and fern varieties. In general around 20% of the biomass provides excellent fodder species and a further 35% provides good fodder species.

- Found on the east slope (39 degree average slope) of the Dimaluo River at an average altitude of 1925 masl is the combination: weeds + Imperata cylina + Arthraxon hispicus (thum) makino. Over 40% of the biomass is grass and 25% fern. Excellent fodder species account for 20% of the total biomass, good fodder species for a further 20%, and average quality species for 27%. Biomass output per ha. is 27.6 kg. The total area surveyed in 1987 was 1290 ha. of which 929 ha. could be used, giving a total usable output of 1,154,127 Kg and a theoretical capacity of 121.6 cattle units.

Alpine forest rangeland:

Alpine forest rangeland can be found near the mountain tops on the west side of the Dimaluo valley, such as near Alulaka and Congni hamlets, at altitudes of 1983-3020 masl. On average, such rangeland consists of 39% grass, 31% fern. Excellent fodder species account for only 13% of biomass, good species for 13%,

and average quality for 42%. Low and poor quality species account for over 30% of total biomass. The usable fodder output per ha is around 13 kg. Specific classes present in Dimaluo are:

(a) Imperata cylina + fern + Recanthus pedumcularis (excellent fodder = 25%, average = 50%, below average = 22%; average output = 21 kg/ha.)

(b) On the mountain top above Congni at 1983 masl can be found the class: Schitzaechgrium delavayi, + Imperata cylina – fern. The 1987 survey identified a usable area of 255 ha. with a total output of 453,798 kg, and a theoretical capacity of 478 cattle units. Output per ha was 18.6 kg, and of the total biomass 70% was grass, and 16% was fern. Excellent and good fodder species accounted for 30% of total biomass, average species for 54%, and below average and poor for only 17%.

● **Alpine Grass Rangeland:** Grass rangelands are characterized by lower than 10% coverage of bushes, shrubs and trees. Most such areas exhibit little human interference and land use is mostly restricted to grazing. Within Dimaluo, Alpine grasslands can be found at Caidang, Alulaka, Siwalong, Qingpo and on the east slopes of Biluo Snow Mountain, at an average altitude of 2318 masl (average slope 29%), where sunlight and rainfall are suited to the growth of grass. On average, grass accounts for 45% of the biomass and fern for only 7%. Average output per ha is 72.7 Kg (min 10.7 kg, max: 213.7 kg), thus making alpine meadows an excellent grazing resource. According to the 1987 survey, low quality grasses account for 10% of total biomass, average quality for 45%, and good and excellent quality species for 43%. Depending on topography, altitude, soil quality, climatic factors and the ecological factors, the survey identified several classes within the Dimaluo area:

- Found at Alulaka on the flatter areas (slope 23 degrees) at the top of the mountain at an altitude of 2620 masl: Carex nubigena D. Don + Arthraxon hispicus (thum) makino + Alena fatua r. (wild barley) – fern - dipsacus japonicus. 39% of biomass is grass, 10% Dipsacus sp., 16% Cyperus sp., and fern 4%. Excellent fodder constitutes 23% of biomass, good fodder 30%, average 41%, and poor quality fodder only 5%. Average output per ha was 42.8 Kg. The 1987 survey identified in Alulaka 648 ha which yields an effective output of 2,182,383 Kg, and had a theoretical capacity of 230 cattle units. However, already by 1987, the survey found that grazing was over concentrated and parts of the pasture had already been over grazed.
- Found at Qingbo pasture above Baihan hamlet on 28 degree slope at 3368 masl: weeds + Carex sp. + Carex pachyrrhiza Franch
- Found at Siwalongba pasture on 21 degree slope at 3263 masl: fern + ‘xuemancao’ + Fagopyrun sp. + Prunella asiatica nakai
- Found in the upstream area of the Siwalongba pasture at around 3570 masl on a 22% slope: Potentilla sp + Spenceria ramalana Trimen + weeds
- Found on Biluo Snow Mountain at high altitude (ca 3862): ‘niumaocao’ + Juncus reusomelas Royle + Potentilla sp

Of these classes of alpine grass pastures, on average excellent species accounted for 12% of total biomass, good species for 40% and average for 40% while poor species were only 6-7% of the total. Grasses account for 28% and ferns for only 4%. In 1987 utilization levels were reported to be low and the report suggested that it should be utilized seasonally.

● **Sparse Forest Rangeland:** Sparse forest rangeland consists of tall trees, bushes and grass, where canopy coverage provided by the trees and bushes is around 10%. It is essentially a transitory type in the process of forest regeneration, and consequently is associated with arable and forestry land uses. Mostly found at 1740-2017 masl on slopes of 30-43 degrees, the following classes were found in the Dimaluo valley:

- Found at Congni at an average altitude of 1880 masl: Imperata cylina + Schitzaechgrium delavayi + Eragrostis nigra Nees – fern. The total area identified was 3524 ha, with a usable area of 2183 ha. with an average output of 56.7 Kg/ha. Thus the theoretical capacity of the area identified was 676 cattle units. Of total biomass 59% was grass and 18% fern. Excellent fodder species accounted for 5%, good fodder for 34%, average fodder 39% and poor fodder 20%. Because of low slope and good rainfall this was classified as ‘average quality’ rangeland, best used for grazing and grass cutting.

5.2 Interactions between rangeland and forest ecosystem dynamics

It can be seen clearly from the description of rangeland resource types that rangeland resources are closely related to forest undergrowth and succession stages of regenerating forest. Thus the dynamics of forest ecosystems in Dimaluo are closely related to the dynamics of rangeland and fodder resources.

According to interviews with elderly villagers, before Liberation, much of the Dimaluo valley was forest. This is partially confirmed by data from the 1987 rangelands survey, in which many of the rangeland types identified at mid-altitudes represented stages in forest regeneration. Forest cover, especially at altitudes below 2700 masl, has gradually decreased for several reasons: clearance for agricultural land and medicinal plant plantations, fuel wood collection and procurement of house construction timber. With the rapid increase of livestock numbers since the mid-1990s, grazing and trampling of young saplings has reportedly had additional impacts on forest regeneration (Wang et al. 2000).

From discussions about the environment in the Dimaluo valley with villagers, it was found that large areas of forest had been cleared in the past, particularly at higher elevations on the west side of the Dimaluo River, near Alulaka, Puta and Longpo natural villages. These areas are marked on Map 1 as fern forest. Visually, when viewed from the east slope of the valley, the lack of trees and large tracts of fern forest near the top of the east slope is striking. According to villagers, these areas were cleared during the 1960s to create arable fields and to grow medicinal plants. The appearance of fern forests confirms that these areas were once forest, as the appearance of ferns indicates a stage in the regeneration of these forests. In visits to other villages, it was also found that large areas that once had been forest existed. For example, in Tongda hamlet, the head of the valley which had once been natural forest is now covered with *muxiang* (a medicinal plant tree) which was planted in the 1960s. Another area of poor quality secondary forest to the southeast of the village was pointed out as areas that had been cleared to create fields in the 1960s. In the Caidang-Mulandang area, a large area of what is now arable fields and scrub was said to have been cleared in the 1960s to create fields. In summary, the areas impacted tend to lie above or below residential areas, but not far from these residential areas. These areas are now largely fern forest.

Historically, forest clearance was driven by agricultural policies in the cooperative period (ca 1958-1970). In particular, clearance of forest to create medicinal plant plantations was actively pursued in the late 1950s-early 1960s and again in the 1980s. For example, Li et al (1991) record that:

> In June 1959, the county commercial bureau sent people to Alulaka in Dimaluo Village (2912 masl) to create a medicinal plant base and plant medicinal plants. Danggui and Muxiang seeds were bought from Lijiang. “The forest there was thick and the soil fertile.” At that time, each of the hamlets in Dimaluo sent two people to the base to learn. After building a house, “we gradually cut down the forest and planted medicinal plants on the flat areas of land. With the support of the masses, within 1 month we had cleared 16 *mu* [just over 1 ha] of land…we planted 4 *mu* of *danggui* and 12 *mu* of *muxiang*…and through that one period of training the villagers of each village in Dimaluo learned how to grow *danggui*…the next year

> we cleared more land…and had more than 20 people managing 20 *mu* of medicinal plant crops." In addition, because the subsidy from the state was not enough to provide for food needs, so everyone put in effort to clear fields and grow potatoes, vegetables, carrots, buckwheat and so on". In 1961 the three technicians turned the medicinal plant base over to the villagers to manage. "Several years later, Dimaluo village sold over 5000 kg of *danggui* and *muxiang* to the county commercial bureau". In the second half of 1961, medicinal plant production was promoted to other townships in the county.

Wang et al (2000) also suggests that some areas of forest were cut down in response to tenure insecurity induced by the introduction of the household responsibility system in 1980. Also around that time, two villages moved their location. In 1979, a landslide destroyed Mulandang natural village, and the surviving inhabitants moved to new houses higher up the hill. The resulting mud and silt flows led to the loss of many hectares of prime agricultural land on the east bank of the river near Congni. Half of Congni's villagers moved to what is now Puta (also called *xinqiandui*, or 'newly moved production team') on the higher slopes of the west side of the river. These large scale movements increased demand for housing construction materials and for clearance of new arable fields closer to the new locations of residences in both natural villages, resulting in localized but severe deforestation. Villagers reported that food insecurity is still one pressure for increasing land area, but in 1998 burning of swidden was banned and villagers are now under pressure not to increase arable land area. Other causes of deforestation in Dimaluo include fuel wood and house construction timber procurement (see Wang 2000 and Wilkes et al 2000 for details).

Overall, much of the grass and other fodder types available at lower altitudes in the Dimaluo valley are the result of previous deforestation and gradual growth of secondary forest. Of concern to the villagers today are the large tracts of fern forest that grow near each village. As fern is largely inedible to livestock, this reduces the amount of fodder available near at lower altitudes in the winter and spring months. Thus we see that forest ecosystem dynamics and fodder resources have close interactions.

5.3 Rangeland management

The total area of grazing land in Dimaluo is over 11,000 ha., of which 7733 ha. is alpine rangeland (CAZO 1987). Given that Alpine pastures give higher yields of grass that many of the other rangeland types found in Dimaluo, animal husbandry development in Dimaluo depends on the use of natural alpine pastures. Villagers identify more than 10 large and small alpine pastures around Dimaluo. These alpine pastures are distributed above each village at an elevation of around 3200 –3900 masl. The nearest is 10 hours' walk from the village and the furthest can only be reached in 3 days. Traditionally, the Nu practice rotational grazing on different pastures, leaving the same pasture patch ungrazed for one year in order to ensure the sustainable supply of grass and maintain output and quality levels. But nowadays, with the increase in numbers of livestock, degradation of the alpine pastures is occurring in some places. These alpine pastures are the second home to the villagers, since they live there tending their livestock between June and the end of October of each year.

Apart from alpine pastures, each village also has a pasture located closer (1-2 hours) to the village at lower elevations of around 2700-2900 masl. These middle level pastures are used between April and May each year.

Also, rangelands are distributed dispersed around the villages, on the hilltops above villages and in the gullies that separate hamlets, and livestock are also grazed in the arable fields after harvest. These rangelands are used between November and April each year. Because of the increase in numbers of livestock, and increases in population, arable land area and residential areas, these rangelands have been encroached upon in some places so that rangeland resources close to some hamlets are insufficient.

Table 9: Rangeland management institutions in Dimaluo

Rangeland	Location	Distance from village	Tenure	Timing of use	Management/ Access
Alpine pasture	In primary forest or valleys and cols, ca. 3000-4000 masl	The nearest is 10 hours, the furthest 3 days	De jure: Gongshan county De facto: Pasture surrounding a house belongs to the house owner	June- end October	Customary law: pasture near a house belongs to the house owner who has exclusive rights to use but can confer use rights to others; free access in other areas
Mid-altitude pasture	Pasture above villages, 2700-2900 masl	1-2 hours	Village collective	April-end May	Customary law: pasture near a house belongs to the house owner who has exclusive rights to use but can confer use rights to others; free access in other areas
Pasture around villages	Pasture and grassy slopes and gulleys near village, arable land after harvest (1800-2600 masl)	Next to village, half hour	Village collective	November - April	

All villagers interviewed said that there is an unwritten customary regulation for the management of pastures. The regulation stipulates that the grassy or forested slopes next to each hamlet belong to that hamlet collectively, and on these rangelands members of that hamlet can freely graze theier livestock. There is no designated person to manage the pasture. The alpine pasture, on the other hand is formally owned by Gongshan county, but villagers are freely allowed to graze livestock there. According to local custom, specific pastures are used by between one to three hamlets. Within a particular pasture area, according to local custom, once a hut has been built in one part of the pasture, the

area around that hut can only be used by the family that built the hut. Thus, the areas surrounding huts on the alpine meadows becomes de facto owned by individual families. Sometimes, several families come to an agreement to jointly graze their livestock on the same area of the alpine pasture. Nu culture emphasizes the virtue of helping others and families being united rather than conflicting. If someone violates this custom, they will be disdained by others. So no known conflicts have occurred between neighbouring households on the alpine pasture. Rather, people observe the customary law and respect other people's rights. The middle-elevation pasture is the collective property of the hamlets (formerly production teams), and their utilization follows the same rules as the alpine pasture.

The three types of rangeland and their management are summarized in Table 9.

5．4 The sustainability of animal husbandry and the environment

Animal husbandry has had both beneficial and adverse impacts on the environment in Dimaluo. With the proposal to designate Biluo Snow mountain a nature reserve, some external stakeholders are more concerned with the impacts villagers have on wild plant and animal populations and the disturbance of wild animal habitats and migration routes by livestock grazing on alpine pastures(see Wang et al 2000 and Wilkes et al 2000). Fuel wood collection, house roofing material procurement, hunting and NTFP collection have all been identified as threats to biodiversity in the area (Wang et al 2000, Song 2000, Wilkes et al 2000). Villagers, on the other hand are more concerned with the sustainability of fodder resources.

5.4.1 Degradation of Alpine pastures

The main environmental trend which villagers are concerned with in regard to animal husbandry development is alpine pasture degradation. Over-concentrated grazing in some pastures had already been noted in the 1987 grassland survey (CAZO 1987). Villagers report that the quality of many alpine pastures is declining. This degradation has two forms: the widespread appearance of non-edible plants and the loss of plant cover. The most notable indicator of degradation is the appearance of a non-edible plant known locally as *Tudahuang* (*Rhumex nepalensis*). Villagers report that this weed has become particularly common since around 1993. In some pastures between 40% and 80% of pasture area is covered in *Tudahuang*.

Rapid assessments were made of the availability of edible fodder plants, the proportion of edible versus non-edible fodder plants and their respective biomass in sample plots in a small. Visits to Penggong Pasture discovered that in localized areas within the pasture (especially within 20-30 meters of the access road) there area *Rasa* shrubs (visually estimated to be 2-5 plants per 10 m^2) and *Potentialla spp* (ca. 3-15 plants per m^2). *Rasa* has thorns and are relatively inedible to livestock while the reproductive ability of the plant is strong. *Potentilla spp* is a very strong reproducer and after invading pasture competes for nutrition and water with other fodder plants, and is a main indicator of the degradation of alpine and sub-alpine pastures here. All the alpine and sub-alpine pasture residential locations (herders' huts on the pasture) visited are surrounded by *Rhumex nepalensis* at a density of ca 3-6 plants per m^2. In some areas the soil coverage of this

plant reaches 70-90%, in which case these areas have basically lost any value as fodder pasture. Overall, rotational or mobile grazing patterns have not led to pasture degradation, but in localized areas there has been over grazing.

In Siwalongba pasture, together with a local herdsman areas were selected which he thought were 'good quality' alpine pasture and 10 sample plots (each of 2 m^2) were randomly selected to observe soil coverage, biomass, dominant species and per centage of weed coverage (see Table 10). From the table, it can be seen that even in areas where local villagers think the pasture quality is good, degradation is present to different degrees.

Table 10: Alpine Pasture Grassland Quality Survey Results (Siwalongba pasture)

Plot No.	Coverage （%）	biomass （kg）	Dominant species	Weeds (%）
1	80	0.45	禾草	10
2	90	0.48	禾草	8
3	60	0.40	禾草+委陵菜	20
4	65	0.38	禾草+委陵菜	20
5	30	0.16	委陵菜	60
6	70	0.45	禾草	10
7	15	0.40	土大黄	70
8	40	0.40	禾草+土大黄	50
9	〈10	0.10	委陵菜	70
10	50	0.20	委陵菜+土大黄+禾草	30~40

The sampling found that an average of 35% (min: 8, max: 70) of the total biomass of the pasture is accounted for by inedible fodder plants, notably *Tudahuang (Rhumex nepalensis)*, and three other less frequent types. Within the pasture, the distribution of inedible plants is notably uneven. *Tudahuang* is concentrated on the edges of the pasture close to the habitations of herders. The density and biomass of *Tudahuang* increases with closeness to these habitations, and in some cases, 100% of biomass in their immediate vicinity is *Tudahuang*. This strongly suggests that degradation of pasture quality is closely related to interference by livestock, and that this interference is related to grazing practices.

Degradation is also evidenced by the loss of plant cover in some areas. The main causes of loss of plant cover appear to be pig grazing on alpine pastures and over-concentrated grazing in specific localities within pastures. During the assessment in Siwalongba pasture, it was quite clear that much of the decrease in plant cover on the pasture was the direct result of rutting by pigs. Interviews with villagers suggested that the main reason why pigs are grazed on alpine meadows is lack of fodder sources in the summer months in the vicinity of the villages. In fact, it is likely that fodder biomass exists but that labour is insufficient to collect sufficient fodder. The relative insufficiency of fodder is also related to the numbers of pigs being raised. The village statistics suggest that a quarter of pigs raised are sold within the year. Interview data suggest that many pigs are raised for

2-3 years successively. The sale ratios of other livestock are also low (sheep 20% and cattle 5%), though the reasons differ. These latter livestock are raised primarily for their by-products – wool, butter etc. The purpose of raising is not to sell for meat or to sell lives animals. At present most households are in the process of building their herd sizes. Since many households only have small numbers of cattle, in order to ensure a constant supply of milk, they refrain from selling cattle.

Over-concentrated grazing, on the other hand, appears to be a result of grazing practices and the current institutional arrangements governing rangeland use and management. At present each pasture is de jure the property of Gongshan county, but the county agencies play no role in its annual use. De facto, each pasture is used by one or more natural village. But natural villages as an organization play no actual role in the actual use of pasture. In practice, individual houses are built on the pasture and the surrounding pasture is recognized by all to belong to that household. This arrangement has contributed to over-concentrated grazing leading to localized degradation. The lack of any significant role for any institution above the household level also precludes the establishment of rotational grazing arrangements.

Thus, overall this rapid and rough assessment of the extent, distribution and causes of degradation of alpine pastures suggests that current livestock numbers do not exceed the carrying capacity of pastures in Dimaluo. Yet despite the room for increase in herd sizes, degradation has already occurred in some localized areas.

5.4.2 Lack of winter-spring fodder

Livestock winter in and near the hamlets, and only return to the alpine pastures in May each year. The lack of winter and spring fodder sources is said by villagers to be a main constraint on livestock health and further development of livestock numbers. In winter, livestock are grazed near the hamlets in daytime and kept in stalls at night or when it snows. During this period, some villagers say that their cattle can only eat half full, and have to be fed supplementary fodder once a day (or twice if it has snowed). But for many households, fodder is insufficient to maintain the health growth of their livestock, and weak and thin livestock and livestock morbidity and mortality are common in March and April each year.

A main source of winter fodder is crop by-products (such as maize or legume stalks) that are dried and stored after harvest in October. Households with alternative incomes with which to purchase rice for human consumption also feed grain (maize, buckwehat and so on) to livestock in winter. However, for many households agricultural by-products are insufficient to provide all the fodder needed for winter and spring. This is partly a result of low agricultural output levels. Arable fields in Dimaluo lie on steep slopes at relatively high altitudes. Since the early 1990s, plastic sheeting has become increasingly used to raise temperatures and output. New high yielding varieties have also become widespread but must be grown in combination with chemical fertilizers. Many households, however, are unable to afford plastic sheeting and chemical fertilizer. According to the village statistical report for 1999, average grain output per ha. is around 6.3 kg. Villagers say that in the absence of plastic sheeting and chemical fertilizer, sloping land produces around

3.3 kg per ha, while with these inputs output can reach 13.3 kg. Therefore, increasing the application of modern inputs (e.g. through provision of credit) could almost double output per hectare. HYVs are also unsuited to the higher altitude fields where frost falls several weeks before maize has ripened.

In addition to constraints on winter-spring fodder supply arising from output levels, some households face labour constraints at the critical time for harvesting agricultural by-products. After grain has been harvested, stalks are left to dry in the field and should then be harvested before the rains in late October arrive. However, some households are unable to cope with the multiples demands on labour at this time of year, so their stores of fodder are limited. A further constraint is presented by the growth of fern forests near many hamlets. From villagers' perspectives, fern forests have little use. New sprouts are used as pig fodder in the spring, and in the autumn (ca. September) fern biomass can be cut and composted before adding it to livestock pens as bedding. But from a negative impact point of view, the increasing area and density of fern forests means that large areas of land relatively close to villages, where livestock are grazed between October and May, are not grazable, or yield relatively low amounts of edible fodder biomass. Seeking alternative fodder sources increases the opportunity costs for villagers.

From the demand side, causes of fodder shortage also arise from the relatively long period of grazing in low altitude areas (September 25 – May 20) and from the high numbers of livestock requiring fodder during the winter months, as livestock sale ratios are low.

6. Current challenges and ways ahead

It is clear from the preceding sections that some aspects of animal husbandry in Dimaluo are still little understood. To date, our surveys have given little attention to the differences between sheep and goats and cattle and yak. Pig raising has almost received no attention, despite its ubiquity and the impact of pigs on household labour resources and on the alpine pastures. Previous surveys in Dimaluo have also been concentrated in Nu and Tibetan-Nu populated hamlets. Villagers suggest, however, that the Nu, Tibetans and Lisu have different levels of skill and knowledge about livestock raising. Ethnic differences have not been focused on to date.

Nevertheless, through the three surveys on which this paper is based, a number of problems and opportunities – both technical and institutional options - have been identified, either as defined by villagers, officials and technicians or by researchers from different disciplinary backgrounds. Many problems have been mentioned in the preceding sections of this paper, and rather than reproduce in detail the range of options that have been suggested, this section focuses on characterizing the development processes already underway in Dimaluo, how they are perceived by various stakeholders and how the problems and options suggested reveal the different ways in which different stakeholders perceive the future of animal husbandry development and rangeland management in Dimaluo.

6.1 Villagers' pursuit of development

For villagers, animal husbandry is a major and relatively stable source of cash income. Cash income is essential for investments in production, human capital (education), payment of taxes and for many households purchase of grain for consumption. Beyond this, animal husbandry also provides the means of maintaining social relationships through gift giving, barter exchange and providing materials for clothing and signifying intimate relationships, among other things. The possibilities for utilizing a variety of rangeland resources at different elevations in the Dimaluo valley also make animal husbandry a way of life. While a significant number of villagers spend almost half of each year living on the alpine pastures, others have to cope with labour inputs in agricultural and other tasks in the absence of some of their family members.

In the second half of the 1990s, forestry was also an important productive sector, and many villagers were involved in felling and transporting timber in the logging concessions in Gongshan, while others sold timber and other tree products to purchasing agents or processing plants. Since the implementation of the logging ban in 1999 these income sources have almost disappeared. Widespread popularizing of the laws against hunting, the disappearance of some wild medicinal plants and mushrooms and the proposal to designate Biluo Snow Mountain a nature reserve all put pressure on villagers' attempts to diversify their cash income sources.

In this developing context, the majority of villagers are looking to animal husbandry to replace this lost income. There is strong and widespread interest in increasing the proportion of yak in their herds, mainly for the non-meat products such as butter that yak provide. But at the same time as wishing to increase their numbers of livestock, many villagers are concerned with the availability and sustainability of fodder resources. Villagers have tried to dig out the *Tudahuang* that infests some parts of the alpine meadows but with no success. The government is also promoting the conversion of sloped farming land to forest or grassland uses, and villagers are interested in the possibility of planting abandoned fields with high yielding grass types. The lack of winter and spring fodder is a constraint for many villagers. Until they have solved the supply of fodder at these times of year, it will be difficult for many households to increase livestock numbers.

A small number of villagers see their potential development as lying in marketing and trade in livestock. Gongshan county town imports 6-700 cattle each year from neighbouring Weixi county, and some Dimaluo villagers with access to capital see the potential for competing in this market. However, most villagers see the value of livestock as lying in products such as butter and wool rather than in sale of live animals.

6.2 Government support for development

Given the abundance of natural pasture in Dimaluo, the local government has designated Dimaluo as a 'key livestock production village' within the county. Particularly since the implementation of the logging ban in 1999, the government hopes that animal husbandry as an economic activity can replace lost income and government revenue from forestry. The current poverty alleviation plan for the county has also set targets for the development of livestock. In order to contribute to the achievement of these goals, the County Animal Husbandry Five Year Plan for 2000-2005 includes the following objectives: change in herd structure (decrease in pig numbers, increases in sheep, goats and cattle), increases in sale ratios of livestock as measured in terms of increases in meat production and sale, and in monetary value of livestock products. Specific plans for Pengdang township include establishment of a livestock market place. We can see from this that animal husbandry is largely conceived of in terms of sale of livestock for meat products, a view that we have seen is not shared by all villagers.

The County Animal Husbandry Bureau (AHB) is charged with ensuring the achievement of the goals in the five year plan. The AHB conceives of its activities in terms of six components: 'seed stock, fodder, fodder resource management, prevention, monitoring and training'. 'Seed stock' refers to the provision of yak or other new breeds of livestock to villagers. 'Fodder' refers to improving fodder supplies, such as through demonstration and extension of silage fodder storage technology. 'Management' includes management of alpine pasture resources. 'Prevention' includes training of staff in disease prevention methods and provision of medicines. 'Training' includes training in management of herds so as to realize optimal economic yields and introduce planning of fodder resource use. We can see from this that overall there is much complementarity with the issues of concern to villagers. However, in implementation, the six components are often divorced from each other and – even more strikingly – considered in isolation from the integrated complex of factors that comprises villagers' livelihoods.

For example, the AHB recognizes that winter-spring fodder shortages are a constraint on the maintenance and development of herds in Dimaluo. However, they see the problem largely as lying in villagers' attitudes, which they see as characterized by a 'lack of fodder planning'. According to the AHB technicians, fodder planning should be achieved not only through management of fodder supply, but also by management of livestock demand for fodder through increasing sales of live animals prior to the winter season. In recent years they have also attempted to demonstrate and extend silage fodder storage techniques to overcome this seasonal constraint. However, the 'demonstration' in Dimaluo showed that 0.1 hectare of maize field could provide material for one silage urn. Harvesting and processing within the time limit required for successful conversion into silage fodder required the demonstration household to employ 5 people for 3 days, and in the end the silage produced was enough to feed one cow for two weeks. No villagers have gone on to use the technology. For villagers, the silage fodder technology was appraised by considering a wide range of factors, including availability of labour, land use, impact on grain availability as well as effective fodder supply.

The AHB also plans to plant grasslands using a mixture of exotic seeds that has been

proved successful elsewhere in Yunnan. However, as the case study in this volume by Richard and Xie shows, this also must take account of labour resources if it is to be adopted by villagers.

6.3 Participatory technology development

The preceding two sections indicated that there is consensus between villagers and technicians on the importance of animal husbandry and on some of the problems faced. In the past, however, some technology extension efforts have failed due to their inappropriateness to villagers' capital and labour conditions. Underlying these experiences appears to be the general lack of understanding of villagers' livelihoods by technicians. The surveys which this paper has drawn upon have gone some way towards providing an understanding of local livelihoods and resource dynamics. The technicians' framework for understanding essential components of animal husbandry management – as indicated by the 6 components listed above - while advantageous for management of a technical service bureau, may not be appropriate for identifying problems and developing solutions that enhance local livelihoods. As has been shown in this paper, animal husbandry has close interactions with both agriculture and forest, as well as playing a role in complex and diverse household economies.

One way beyond the current impasse of needs going unmet and technology going unadopted may be to engage villagers, technicians and external researchers in a joint process of identifying key issues to work on and in sharing and developing new knowledge, techniques and technologies that are appropriate to local livelihoods. Such an approach could draw on participatory technology development methodologies that have been applied to other sectors and issues in China and elsewhere (Salas and Tillmann forthcoming and van Veldhuizen et al. 1997). The following example gives an idea of how such an approach may be developed.

In section 5.4.2 it was noted that fern forests have grown up over the last 20 or more years in many places that were deforested in the past. Many of these areas lie close to hamlets at low and mid-altitudes. During one of the surveys on which this paper is based, the following indigenous knowledge of fern succession was documented:

> Dimaluo has two hamlets composed mostly of Lisu people. The Lisu are known locally for their preference for engaging in swidden agriculture. Since 1998, burning to create new swidden has been illegal. In order to continue to open new arable land, the Lisu have had to resort to other techniques. Nu and Tibetan villagers observed that the Lisu used the following technique. In the first year, when the fern is newly sprouted around May, cut it down. Cut it again two weeks later and again two weeks after that (mid-June). Grass will begin to appear. If this procedure is repeated three years in a row, then a good quality field can be created. Another variant heard from one villager is where the fern is burned in situ after cutting three times.

Several Nu and Tibetan villagers expressed their interest in applying this technique to the conversion of fern forest to grassland by seeding with grass each year. Experimental plots

could be designed to try out different methods, timings, and use different grass seeds – including exotic seeds such as those identified by the Animal Husbandry Bureau and endemic seeds such as those identified in the 1987 grassland resource survey.

Apart from a focus on technical interventions, a participatory approach could be adapted to consider the redesign of social institutions, particularly in relation to management of forest and pasture resources, the provision of veterinary services and marketing.

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