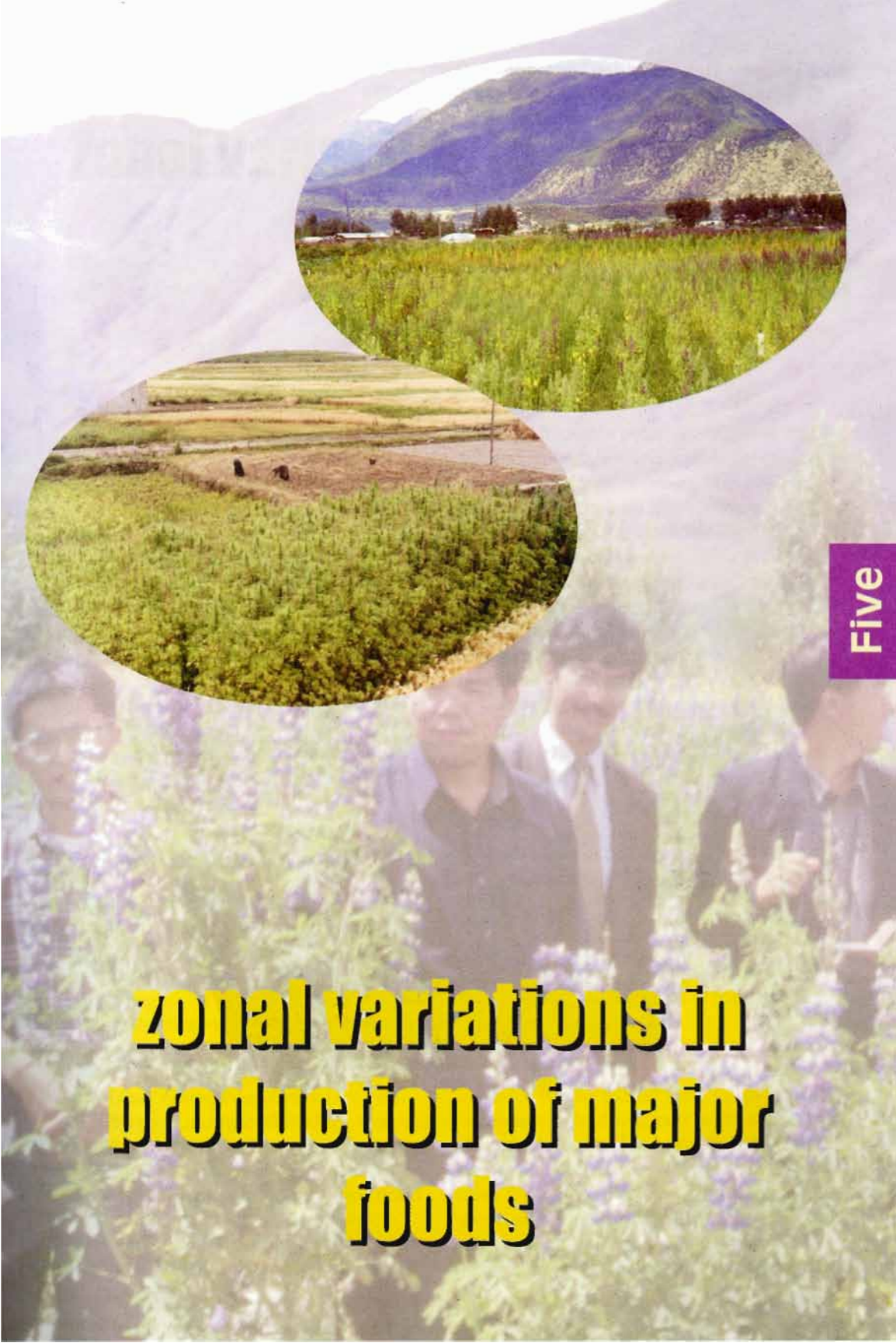

Five

zonal variations in production of major foods

Background: New crops for Tibet: the Andean legume Lupin being tested in Tibet- crop flowering at an experimental station TAAAS team its propspects assess
- *Tej Partap*

Top Inset: New crops for Tibet: the Andean grain chenopod
- *Tej Partap*

Bottom inset: Farmland near village
- *Nyima Tashi*

Crop production in Central Tibet - Nyima Tashi

Chapter 5
Zonal Variations in Production of Major Foods

The area differentiation law of natural conditions controls the spatial variation of environmental conditions and land resources on which food production depends. As a result of this, types, quality, and quantity of food, which together determine food availability, have distinct patterns of zonal variation and spatial dynamics. In order to distribute food properly, balance regional food-supply gaps, and ensure that all people have adequate access to food, it is important that zonal variation and spatial dynamics of food production should be understood in light of changes in population and food consumption, so as to promote better food flow and food trade between areas and regions.

This chapter analysed the zonal variation and spatial dynamics in production of food to understand its pattern, the cause of its formation, and its changing scenarios, by using GIS.

Methodology

Over time, the regional or zonal distribution and spatial dynamics of food production and supply have changed. The area that used to be called the 'Yalong Food Grain Bowl of Tibet' (Qiongjie County and Nedong County) is no longer so. Now the three counties along the Nyachu River (Shigtse, Bailang, and Gyangtse) are the most important food grain producers and are known as the 'Nyachu Food Grain Bowl of Tibet'. Pastoral livestock production used to be the most important source of livestock products, but now crop-livestock mixed farming is showing greater prosperity. Vegetable production started just 12 years ago but with application of greenhouses and plastic-film technology, many kinds of vegetables are available in Lhasa and other urban areas, and even in some rural areas. With development of 12 food-grain production bases, promotion of crop-livestock mixed farming, and expansion of greenhouse vegetable production, the regional distribution patterns of food production will further change and form new patterns. There are a few studies on this issue that focus on food grain production (Crop Science Society of Tibet 1987 1990; Wang Xianming 1996), livestock production (Hu Songjie 1995; Yu Yungui 1994), and agricultural development (Hu Songjie 1995). The changing regional patterns of food production in Tibet have been analysed in the past (Dang Anrong 1997; Yu Xiubo 1999). However, no research has been done regarding zonal/regional patterns of food production and supply in Tibet itself.

All data related to food production were collected for the period from 1985-97, and databases were developed at the county administrative level in both attribute format and spatial format. Two of these databases were linked together by Arc/Infor GIS software, and thematic maps (ArcView GIS) were composed to present the information in spatial format. Data were further aggregated

and presented on the basis of food production systems/zones and administrative prefectures. Figure 5.1 shows the procedure for mapping. Zonal variations of a particular aspect, such as spatial variation of per capita production of cereals or total production of cereals, were presented with the latest data to see which area produced the most food items. The spatial dynamics were presented by growth rate of a particular food item, and also in terms of changes in percentages and deducted value; principally this effort was aimed at understanding where food availability has increased or declined most.

Zonal Variations and Spatial Dynamics of Per Capita Calorie and Protein Availability

Per capita calorie and protein availability in each county were calculated and maps of distribution composed. The growth rates of per capita calorie and per capita protein availability for 1985-97 were calculated and mapped. All data of both availability and

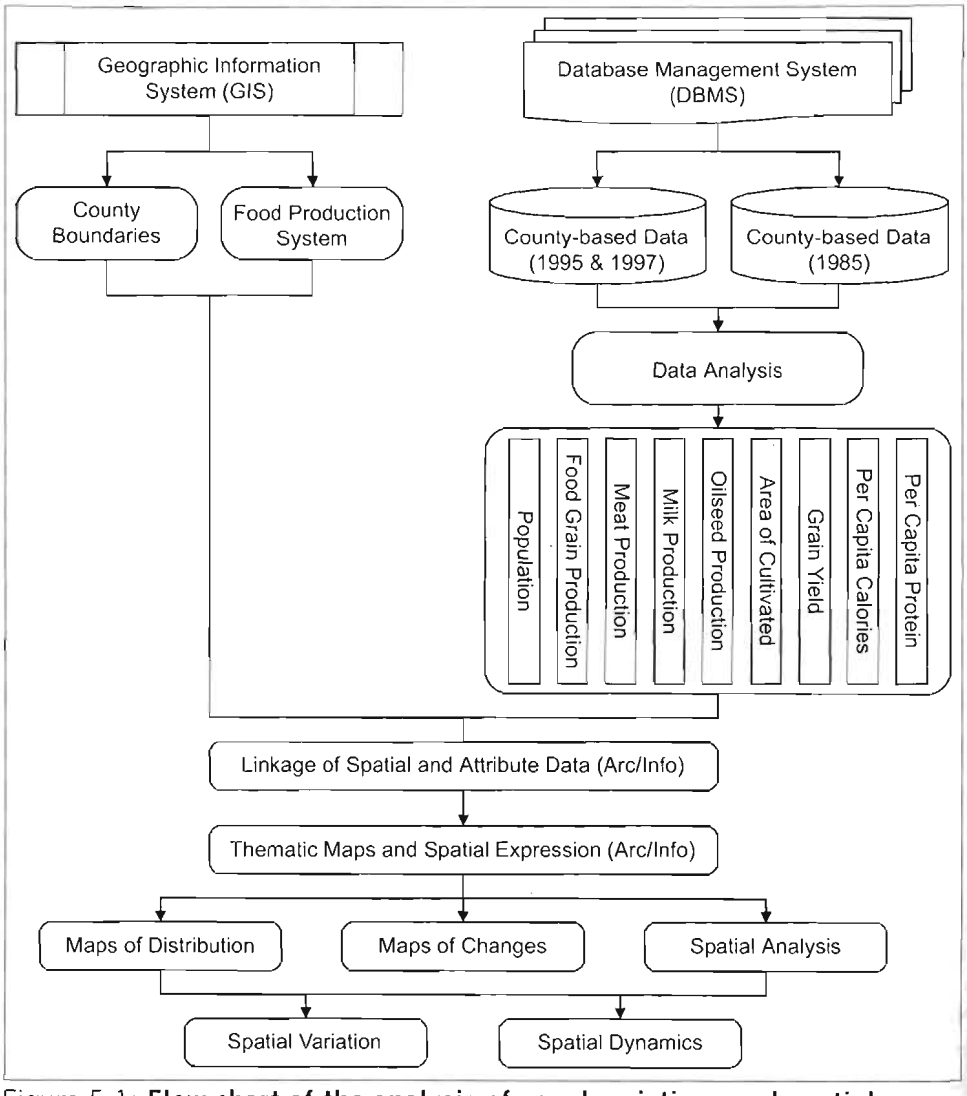

Figure 5.1: **Flow chart of the analysis of zonal variations and spatial dynamics of food production**

growth were aggregated on the bases of food-production systems and prefectures. Based on these calculations and mapping, the following characteristics of zonal variations and spatial dynamics of per capita calorie and protein availability were suggested.

There are great zonal variations in per capita calorie and protein availability

There is a huge gap of per capita calorie and protein availability among the counties (Figures 5.2 and 5.3). Gyantse County of Shigatse Prefecture boasts the highest availability of per capita calories with 10,618 kcal day^{-1} In Geji County of Ali Prefecture, only 545 kcal day^{-1} of calories per capita are available. The gap of per capita protein availability between the highest and lowest is 217.9g day^{-1}. Some counties produced over than 247g day^{-1} of protein per capita while others produce less than 30g day^{-1}.

Comparing prefectures, the average calorie production per capita in Lhasa is about 5495 kcal day^{-1}, whereas in Naqu Prefecture it about 680 kcal day^{-1}. The gap of per capita protein production is also large. Comparing food-production systems, there are also distinct gaps between per capita calorie and protein availability (Table 5.1).

In general, there is a severe deficit of calories in north and north-western Tibet, whereas the river valleys of the Nyachu River in central Tibet have sufficient production of calories and protein. In Naqu Prefecture, Ali Prefecture, and some counties of Changdu Prefecture, the availability of per capita calories and protein falls below basic calorie and protein requirements (2,500 kcal day^{-1} calorie and 100g day^{-1} protein). The Nyachu river valleys and Lhasa river valley have achieved per capita calorie and protein production above 6,000 kcal day^{-1} and 200g day^{-1}, respectively. In general, there are surplus calories in prefectures that are dominated by crop production, whereas areas that are predominantly pastoral often have deficits of calories but enough protein. This is

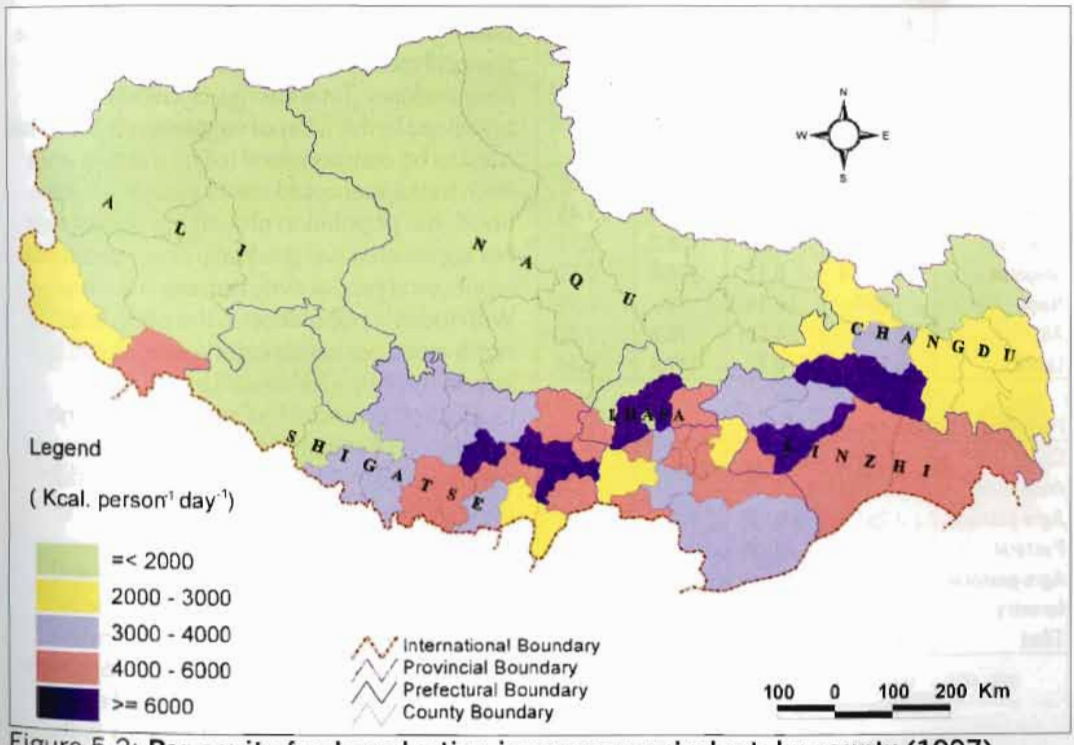

Figure 5.2: **Per capita food production in energy equivalent, by county (1997)**

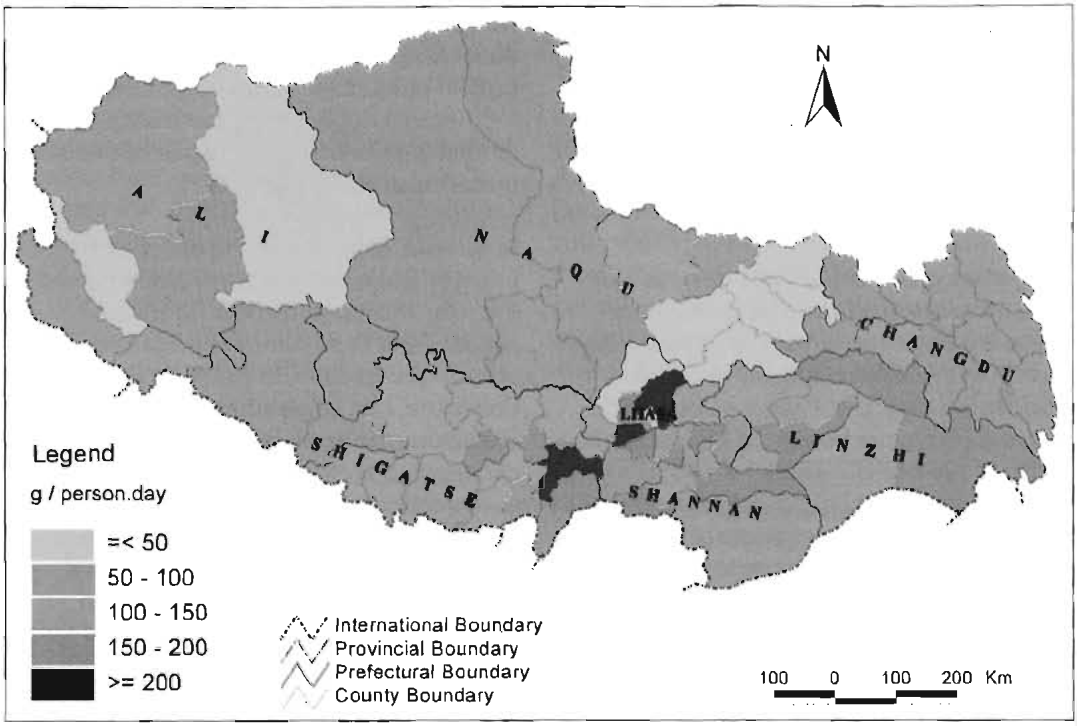

Figure 5.3: **Per capita food production in protein equivalent, by county (1997)**

Table 5.1: **Total per capita calorie and protein supply and its growth rate (%)**

	Per capita energy		Per capita protein	
	Calories	Growth rate (%)	Protein	Growth rate (%)
Prefectures				
Lhasa	5,495.2	2.82	139	2.55
Changdu	2,314.3	(-0.15)	84.8	1.45
Shannan	4,744.4	1.26	138.2	2.12
Shigatse	4,614.4	0.12	126.8	0.62
Nagu	680	(-5.15)	59	(-2.18)
Ali	1,590	(-4.29)	78.8	(-2.31)
Linzhi	5,256.4	0.12	147.4	0.40
Food-Production Systems				
Crop-dominated	6,204.3	2.64	155.9	2.48
Agro-pastoral	3,255.9	(-0.18)	105	0.95
Pastoral	1,114.2	(-4.79)	67.2	(-2.19)
Agro-pastoral-forestry	4,449.4	0.09	130.9	0.69
Tibet	3,527.8	(-0.75)	110.6	0.38

attributed to variation in biophysical conditions between the crop-dominated and pastoral areas. Biophysical productivity in the pastoral areas is often confined by low temperatures. Total energy, or calories, produced in the form of vegetation is low. This used to be compensated for by the vast area each individual could use to sustain a livelihood, but population growth has meant that per capita area has gradually decreased while biophysical productivity remains the same. With today's population in the north and north-west, per capita calorie availability is low. In the crop-dominated areas, the production potential has increased through expansion of cultivated land and increases in per unit crop yield; thus biophysical production has increased.

Although there is a shortage of calorie and protein availability in the north and north-west, there is no food inadequacy. Herders and nomads sell and barter animals and non-food livestock products such as wool and leather for cereals, receiving calories in the

form of cereals in return. It is hard to estimate how many calories are obtained in this way, but during the household survey in Damshong County and Naqu, over 76% of calories and 56% of protein in the diet were estimated to come from cereals. Most herders and nomads said that they could not bear a shortage of tsampa, although they had plenty of meat and milk. Large amounts of cereals from other areas are traded for livestock products. However, food security for nomads is fragile and depends on barter and exchange. Overgrazing of the rangeland puts livestock production at risk and threatens the supply of products for barter. Also natural disasters are a problem. Crop farmers can recover in one season if there is total loss of a crop, but nomads suffer for much longer if there is a devastating loss of livestock.

There has been a decline of calorie production in the north and north-west, while in the centre and south it is increasing.

For the last 13 years, per capita calorie production in most of the north and north-west has declined or stagnated, while in the majority of counties in central and southern Tibet it has increased substantially (Figure 5.4).

Per capita protein production has followed the same pattern (Figure 5.5). Table 5.1 indicates that the growth rates of per capita calorie availability in Naqu and Ali prefectures are -5.2 and -4.3%, respectively. They have decreased significantly within the last 13 years. Per capita protein availability has also followed the same pattern. In central and southern Tibet, both per capita calories and protein have increased. In pastoral areas and in the two prefectures where pastoral farming predominates, both per capita calorie and protein availability have declined, while in crop-dominated areas or counties where cropping is the major agricultural sector, they have increased. In addition, per capita calorie production is decreasing, but per capita protein production is increasing. Over 60% of counties have decreased per capita calorie production, whereas per capita protein production has increased in over two-thirds of them.

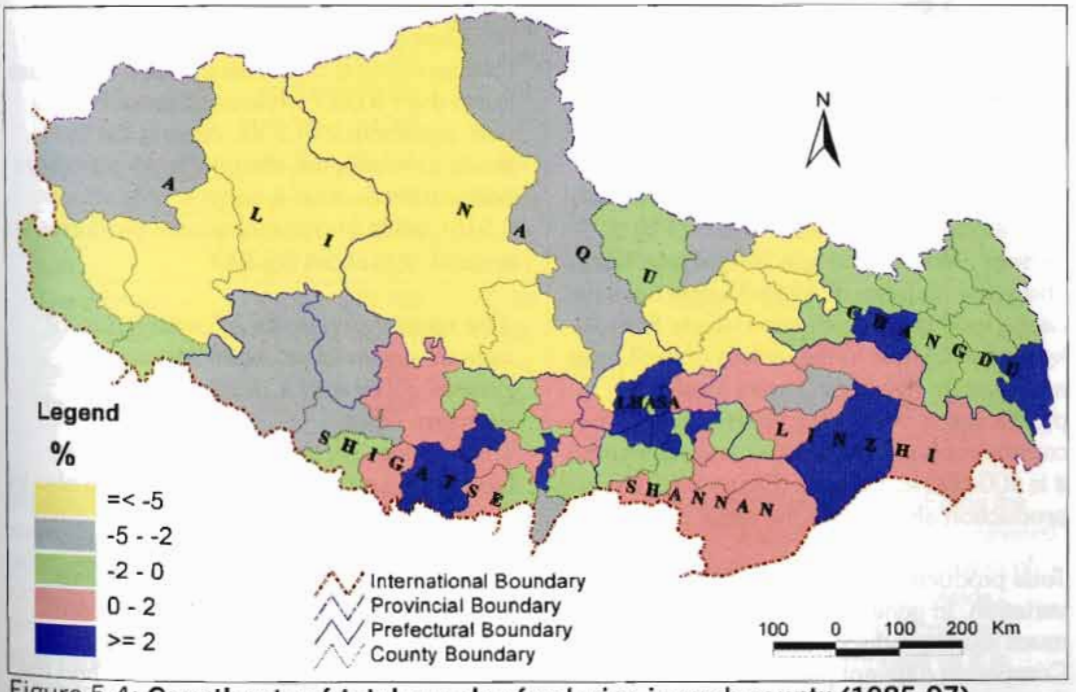

Figure 5.4: **Growth rate of total supply of calories in each county (1985-97)**

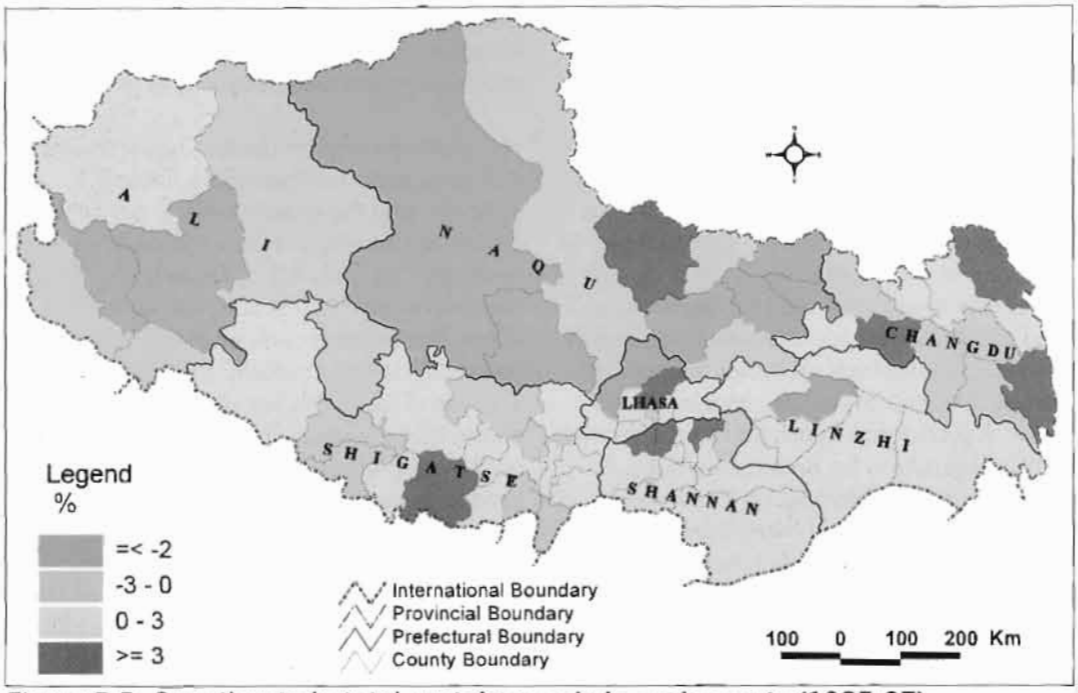

Figure 5.5: **Growth rate in total protein supply in each county (1985-97)**

Zonal Variations and Spatial Dynamics of Per Capita Production of Cereals

There is a great zonal variation in production of cereals. Per capita production is low in north-western Tibet and high in central Tibet.

Biophysical conditions and the level of socioeconomic development affect production of food grain crops. Per capita production of cereals ranges from 0 to 863 kg person^{-1}. Most counties in Naqu Prefecture and some counties in Ali Prefecture have per capita food grain production of less than 50 kg person^{-1}, while in the valleys of the Lhasa and Nyachu rivers, per capita food grain production is over 600 kg person^{-1}. In some counties of Linzhi and Shannan prefectures, it is 400-600 kg person^{-1} (Figure 5.6). Oilseed production also follows the same pattern.

Total production of cereals also has great variation. In general, north-western Tibet has much lower production than central Tibet. Comparing different prefectures, Shigatse is the major producer of food grain and oilseed, and Naqu Prefecture produces the least (Table 5.2).

The gap between the highest food grain producer and the lowest is tremendous. The total production of cereals in Naqu Prefecture is less than 3,000t while in Shigatse Prefecture, it is about 284,200t. Among the food-production systems, the total food grain from pastoral production systems is only about 4,515t, while in crop-dominated production systems, it is about 85,390t.

The spatial dynamics of production of cereals are evident as an increase in central Tibet and a decline in north-western Tibet.

There is not only great spatial variation of food grain and oilseed production, but also in the speed of the development of food grain and oilseed production between counties, prefectures, and food-production systems. Figure 5.7 shows the growth rate of food production in each county. Table 5.3 indicates that, for the last decade, Lhasa had the highest growth of both food grain and oilseed

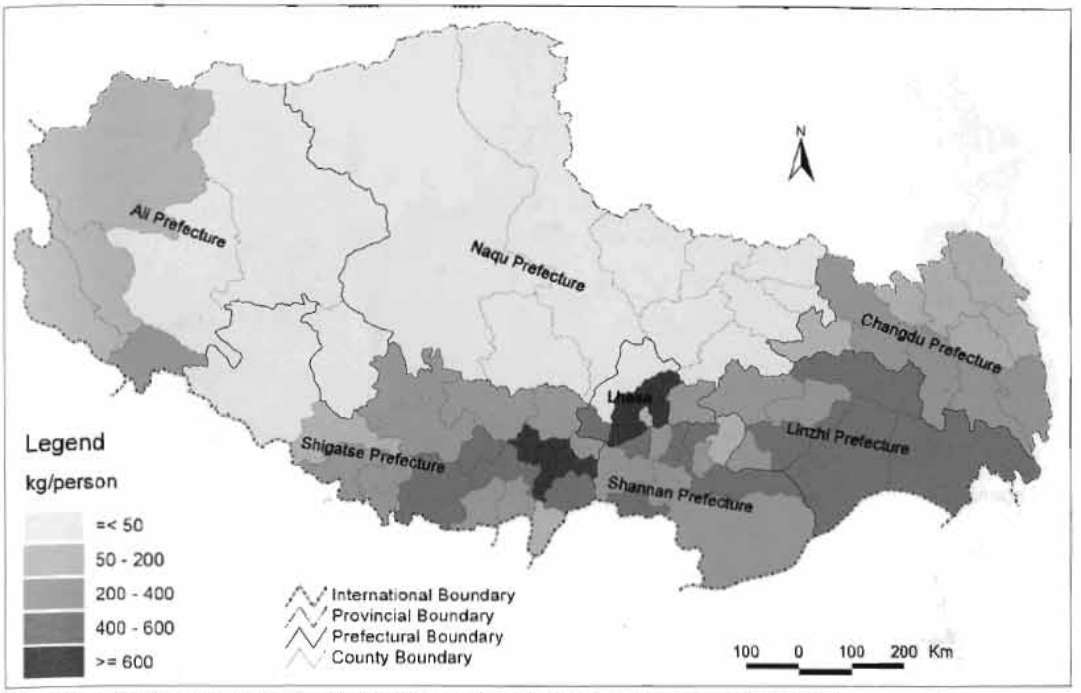

Figure 5.6: **Per capita food grain production in each county (1997)**

Table 5.2: **Regional differences in total production of cereals and rape seed**

Food production system or prefecture	Cereals (t)				Rape seed (t)			
	1995	1985	Increase (decrease)	Growth rate (%)	1995	1985	Increase (decrease)	Growth rate (%)
Lhasa	135,165	84,706	50,459	4.79	9,581	2,360	7,221	25.17
Changdu	100,200	79,460	20,740	2.44	502	424	78	3.18
Shannan	125,318	84,785	40,533	3.83	4,873	3,197	1,676	7.47
Shigatse	284,207	204,555	79,652	2.77	16,527	7,675	8,852	15.28
Nagu	2,747	4,998	-(2,250)	-(1.97)	12	/	/	/
Ali	5,171	4,798	373	-(0.77)	16	/	/	/
Linzhi	6,4771	44,306	20,464	4.06	2,063	810	1,253	96.17
Crop-dominated	85,389	87,120	-(1,730)	-(0.31)	23,946	9,252	14,694	17.89
Agro-pastoral	71,516	69,127	2,389	0.21	7,505	4,364	3,141	8.38
Pastoral	4,514	4,900	-(385)	-(0.61)	12	/	/	/
Agro-pastoral-forestry	26,196	25,586	609	0.19	2113	850	1,262	72.60

production at rates of 4.8 and 25.2%, respectively. In Naqu and Ali prefectures, production of cereals has decreased slightly at rates of -2 and -0.8%, respectively. In general, there has been growth in both food grain and oilseed production. Both pastoral areas and crop-dominated areas have decreased food grain production during the last 13 years. The decline in crop-dominated areas was mainly attributed to limitation of cropland expansion and per unit yields, while, in pastoral areas, it was attributed more to shrinking of the cropland as it is converted into pastoral land.

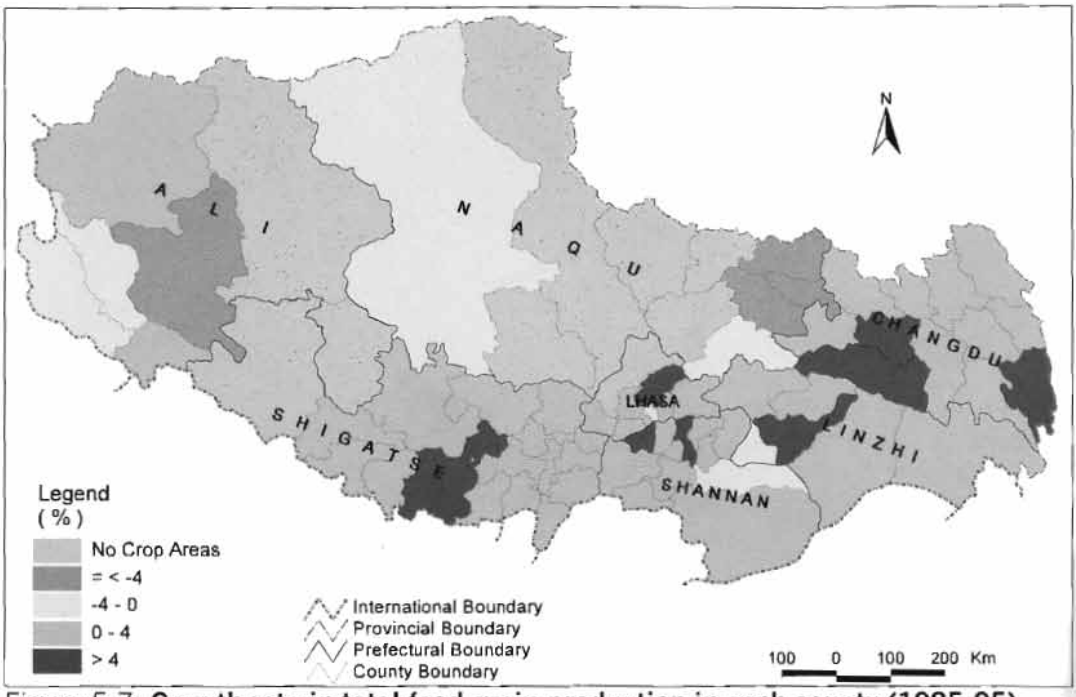

Figure 5.7: **Growth rate in total food grain production in each county (1985-95)**

Table 5.3: **Regional differences of total area and per unit yield of cereals**

Food production system of prefecture	Area of cereals cultivated (ha)				Per unit yield of cerals (t/ha^{-1})			
	1995	1985	Increase (decrease)	Growth rate (%)	1995	1985	Increase (decrease)	Growth rate (%)
Lhasa	31,745	29,640	2,105	0.17	4	2	1	4.45
Changdu	43,809	41,040	2,769	0.56	2	1	0	1.65
Shannan	25,732	27,353	(-1,620)	(-0.56)	4	3	1	5.19
Shigatse	64,709	67,353	(-2,644)	(-0.14)	4	3	1	4.06
Nagu	3,255	3,486	(-230)	(-0.49)	0	1	-0	(-3.74)
Ali	1,972	2,133	(-160)	(-0.88)	2	2	0	1.51
Linzhi	16,392	15,726	665	0.57	3	2	1	3.66
Crop-dominated	85,389	87,120	(-1,730)	(-0.31)	4	3	1	4.97
Agro-pastoral	71,516	69,127	2,389	0.21	2	2	0	2.00
Pastoral	4,514	4,900	(-385)	(-0.61)	1	1	-0	(-2.32)
Agro-pastoral-forestry	26,196	25,586	609	0.19	3	2	1	3.79

Zonal variations in food grain production were attributed to changes in cropland area, while the spatial dynamics were attributed to changes in per unit crop yields.

Spatial dynamics of per unit yield (Figure 5.8) and spatial dynamics of total production of food grain (Figure 5.9), by and large follow the same pattern. There is a similarity in the distribution of growth rate of total food grain production and growth rate of per unit yield. This means that changes in total production of cereals are mainly attributed to changes in per unit yield. The contribution from the area of cultivated land is small because there has not been much scope for increasing this. However, zonal variations of food grain production are mainly attributed to the area of cultivated land.

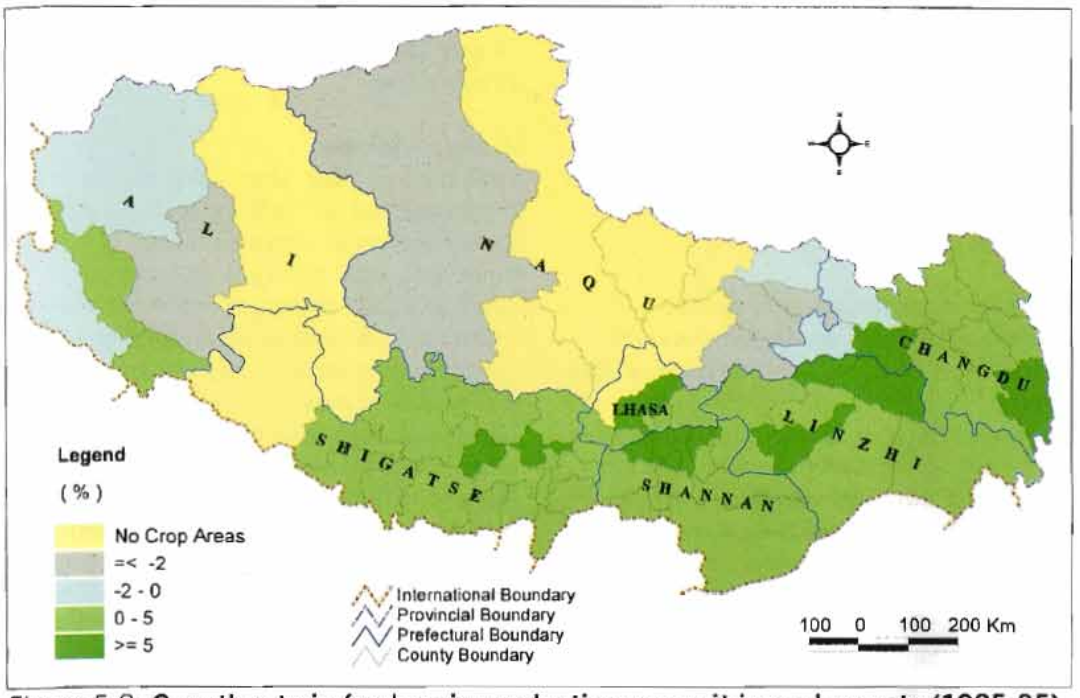

Figure 5.8: **Growth rate in food grain production per unit in each county (1985-95)**

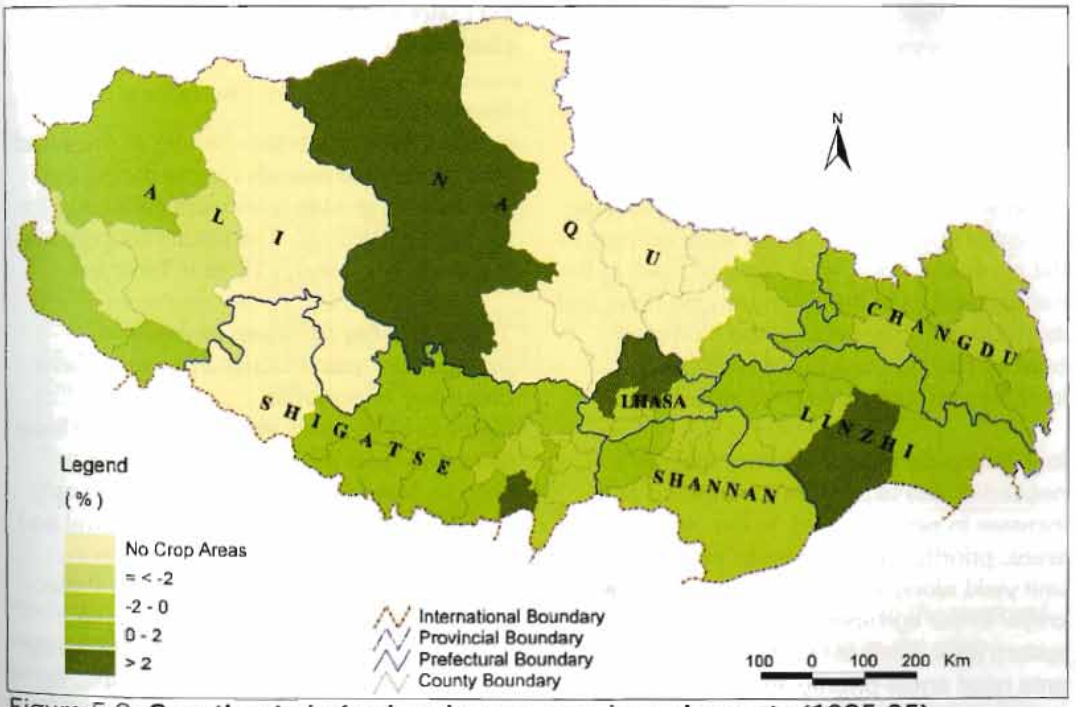

Figure 5.9: **Growth rate in food grain crop area in each county (1985-95)**

Moreover, both the increase in per unit yield and growth of sown area of food grain crops have contributed to the increase in total food grain production . Prefectures such as Lhasa and farming systems such as the agro-pastoral system have increased production of cereals by increasing both per unit yield and the sown area of crops (Table 5.3).

Both zonal variations and spatial dynamics of total oilseed production result from changes in sown area of rape seed.

Total production of oilseed is mainly affected by the area of rape seed cropping and per unit yield. Both zonal variations and spatial dynamics of oilseed production were mainly influenced by changes in sown area of rape seed, although per unit yield of rape seed also effected the total production of oilseed. Therefore, improvement in the per unit yield of rape seed, while increasing the sown area, will yield the greatest further increase in total production of oilseed.

To sum up, there is zonal variation of per capita and total production of cereals and oilseed. This variation also has spatial dynamics. It changes over time with changes in cropland area and per unit yield. In general, food grain and oilseed production in central and southern Tibet is much greater than in north and north-western Tibet. It is increasing in central and southern Tibet, and declining in the north and north-west. Central Tibet, in the middle reaches of the Yalongzangpo River and its tributaries, may become the food grain bowl of Tibet in the future if crop yields increase and sown area is maintained.

In the crop-dominated system, focus is needed on the expansion of cropland and increase in per unit yield. In the agro-pastoral areas, priority can be given to increasing per unit yield along with increasing sown areas of crops. In the agro-pastoral-forestry mixed system zone, both per unit yield and sown area need equal priority. In the pastoral system, cropland area will have to be increased wherever possible.

Zonal variations and spatial dynamics of per capita meat and milk production

Zonal variations

In all parts of Tibet, almost every household produces meat and milk for its members. The great variation in carrying capacity of rangeland, area of rangeland, biophysical conditions, and socioeconomic development of counties and regions means that there is corresponding variation of meat and milk production. In most counties in the north and north-west, per capita meat production is more than 60 kg; in central parts, it is less than 30 kg (Figure 5.10). Per capita milk production also follows the same pattern.

Comparing prefectures, in 1995, Linzhi Prefecture produced the least meat at 4690t, while Changdu Prefecture produced the most at about 30,000t. Ali Prefecture produced the least milk at around 6,140t yr^{-1}, while Shigatse Prefecture produced the most at about 40,000t yr^{-1}. Among the food-production systems, the agro-pastoral system zone is the major producer of both meat and milk (Table 5.4).

Spatial dynamics

In order to examine the changes in meat and milk production in each county during the last decade, growth rates were calculated for the period 1985-97. The results are presented in Figures 5.11 and 5.12, and Table 5.4.

There is a big increase in meat production, particularly in areas where cropping is possible.

Figure 5.11 suggests that most counties have increased meat production in the past decade. Meat production decreased in only 11 out of 74 counties. In most of central and southern Tibet, total meat production increased by more than 3%. Shannan Prefecture has seen the largest increase in meat production at a growth rate of 15.2%, while in Ali Prefecture the change was -0.4%. By and large, areas where cropping is possible recorded larger increases in meat production.

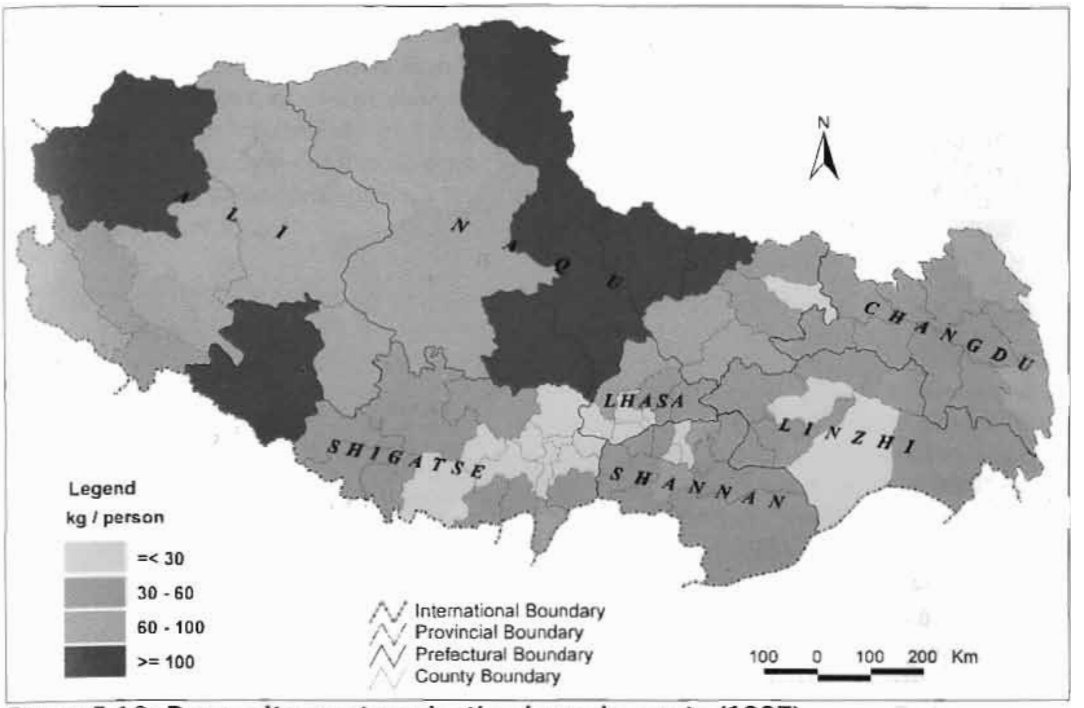

Figure 5.10: **Per capita meat production in each county (1997)**

Table 5.4: **Regional differences in total meat and milk production**

Food production system or prefecture	Meat production				Milk production			
	1995	1985	Increase (decrease)	Growth rate (%)	1995	1985	Increase (decrease)	Growth rate (%)
Lhasa	10,173	6,908	3,264	6.35	13,181	12,819	361	2.75
Changdu	29,910	15,044	14,866	10.91	39,204	43,050	(-3,846)	(-0.98)
Shannan	13,209	5,301	7,907	15.22	30,881	28,365	2,516	0.99
Shigatse	17,269	9,454	7,815	8.79	39,854	28,858	10,996	4.05
Nagu	29,553	22,660	6,892	2.48	30,128	48,445	(-18,316)	(-3.01)
Ali	5,547	6,130	(-582)	(-0.35)	6,142	6,166	-23	(-0.05)
Linzhi	4,694	2,679	2,014	6.15	16,515	9,886	6,628	6.34
Crop-dominated	17,987	8,288	9,699	11.82	8,477	3,757	4,719	16.49
Agro-pastoral	42,311	22,051	20,259	9.70	27,246	12,512	14,734	16.01
Pastoral	38,820	32,172	6,647	1.90	18,393	18,965	(-572)	(-1.86)
Agro-pastoral-forestry	11,239	5,667	5,572	7.30	5,986	2,741	3,245	10.43

Production in the crop-dominated zone increased by 11.8%, and in the agro-pastoral area by 9.7%. In the pastoral system zone, meat production increased by 1.9% in the last decade.

Milk production is declining in the pastoral zone, while it is increasing in the crop-dominated zone.

Figure 5.12 shows that milk production has decreased at a rate of more than 2% in most

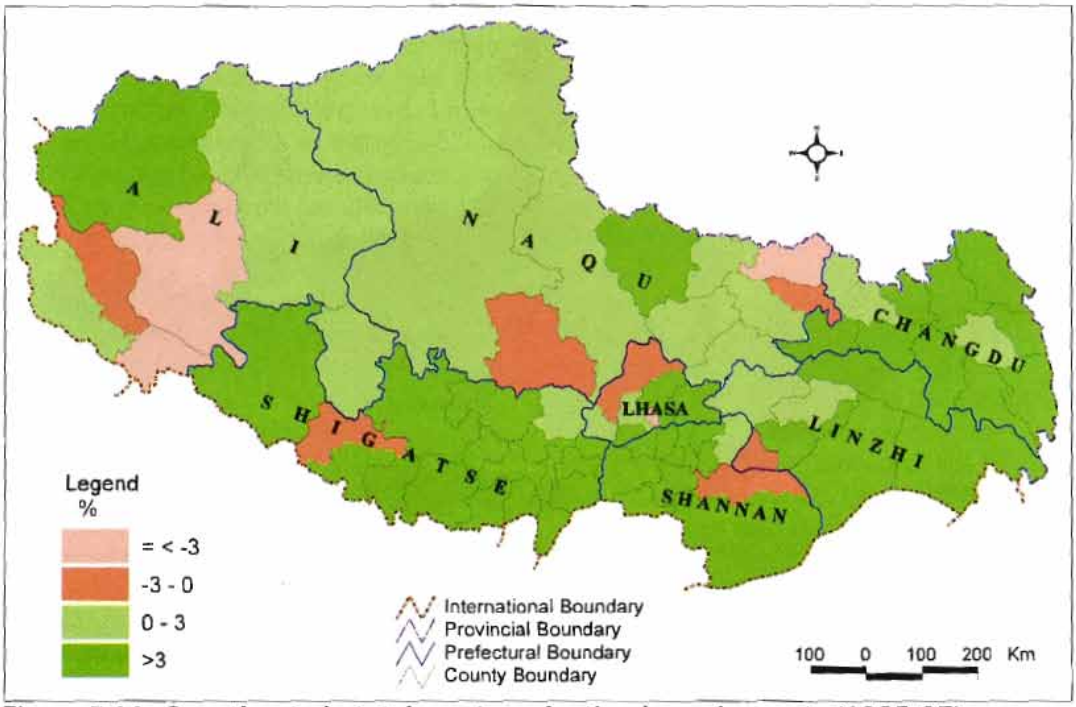

Figure 5.11: **Growth rate in total meat production in each county (1985-97)**

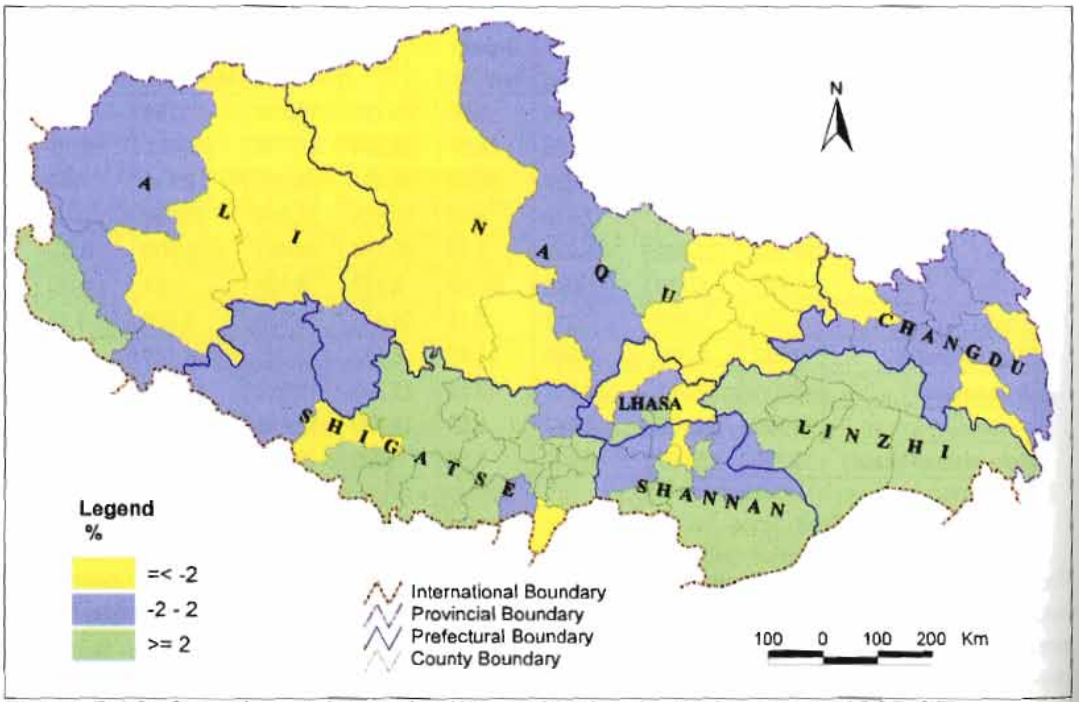

Figure 5.12: **Growth rate in total milk production in each county (1985-95)**

of the north and north-west. In areas where cropping is possible, milk production has increased at a growth rate of more than 2%. Figure 5.12 indicates that milk production in the pastoral system has declined by 1.8%, whereas in both the crop-dominated zone system and the agro-pastoral system it has increased by more than 16%.

Meat and milk production bases are shifting towards central Tibet. Expansion of the crop-livestock farming system is desirable for further increasing both meat and milk production. In the pastoral system, increases in per unit yield of meat and milk production are needed.

The above analysis indicates that in the crop-dominated zone and regions where cropping is possible, both meat and milk production have been increasing, while in the pastoral system, they are declining. This reflects the limitations of further development of livestock not only due to the low carrying capacity of rangeland but also to difficulties in improving the per unit yield. Rangeland-based livestock production may not have much growth in the near future unless there is radical improvement in rangeland production conditions. In the cropping areas, there is great potential for livestock production through using crop straw and agricultural by-products as animal feed, devoting marginal land to forage production, producing forage through promotion of multiple cropping, and developing silage production. In general, there is greater potential for biomass production in the lower river valleys of the cropping areas than in the pastoral system. Livestock production has been increased in cropping areas simply through taking advantage of feed-production potential.

Recent increases in meat and milk production are not attributed to the area of rangeland and improvement of rangeland productivity, but to increases in the number of animals. Most counties have tried to increase livestock numbers and there has been considerable growth (Figure 5.13). Table 5.5 suggests that all prefectures have increased their total numbers of animals in the last decade. However, increasing livestock production by increasing animal numbers may cause serious overgrazing and further deterioration of pastoral land. This may make pastoralism unsustainable. Thus, attention should be paid not only to increasing the per unit yield of rangeland, but also to promoting crop-based livestock production in cropping areas and introducing intensified livestock-raising, such as large-scale pig and poultry-raising, in urban areas.

Table 5.5: **Regional differences in total numbers of animals**

Food production system or prefecture	1995	1985	Increase (decrease)	Growth rate (%)
Lhasa	168,180	152,770	15,410	0.90
Changdu	354,810	346,440	8,370	0.32
Shannan	216,210	198,310	17,900	0.71
Shigatse	563,840	475,390	88,450	1.88
Nagu	689,990	626,100	63,890	0.49
Ali	271,080	253,510	17,570	0.38
Linzhi	62,310	53,090	9,220	1.23
Crop-dominated	379,760	331,320	48,440	1.12
Agro-pastoral	719,990	655,920	64,070	1.10
Pastoral	1,078,670	986,750	91,920	0.48
Agro-pastoral-forestry	148,000	131,620	16,380	1.09

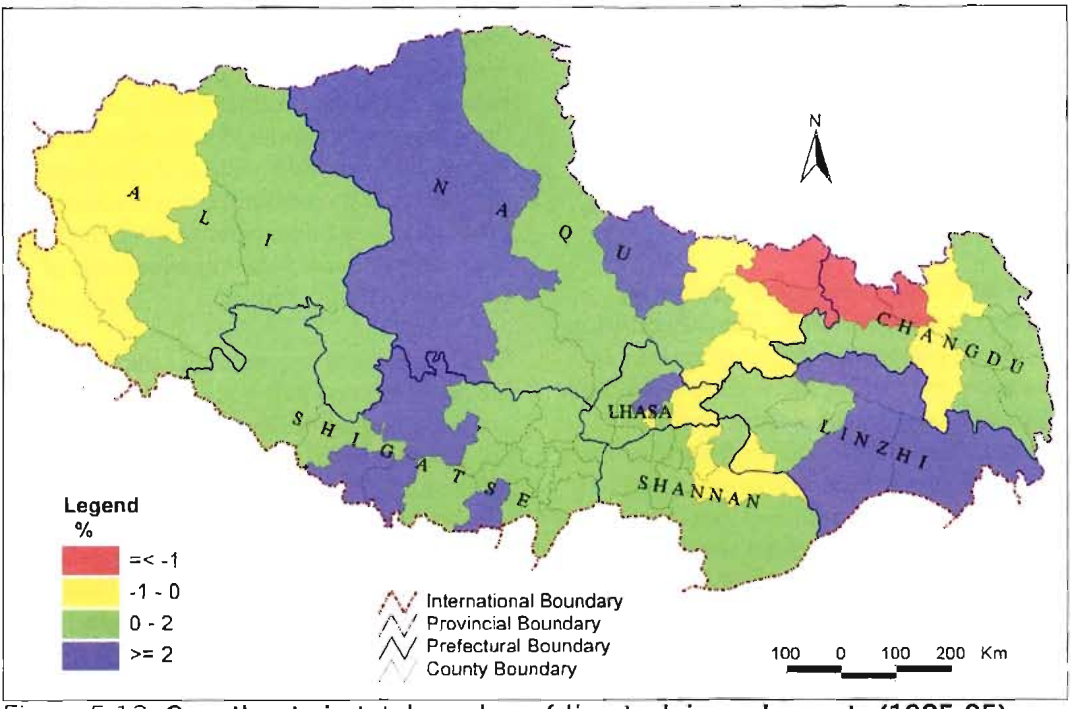

Figure 5.13: **Growth rate in total number of livestock in each county (1985-95)**