

DYNAMICS OF HIGHLAND AGRICULTURE IN LHASA DISTRICT, TIBET

A Case Study



Liu Yanhua

ICIMOD OCCASIONAL PAPER NO. 22

Kathmandu, NEPAL
October 1992

ICIMOD Occasional Papers

- No. 1 **EROSION AND SEDIMENTATION PROCESSES IN THE NEPALESE HIMALAYA**
Brian Carson (1985)
- No. 2 **INTEGRATED RURAL DEVELOPMENT PROJECTS IN NEPAL: A REVIEW**
Bharat B. Pradhan (1985)
- No. 3 **SUSTAINING UPLAND RESOURCES: PEOPLE'S PARTICIPATION IN WATERSHED MANAGEMENT**
Anis Dani and J.G. Campbell (1986)
- No. 4 **DECENTRALIZED ENERGY PLANNING AND MANAGEMENT FOR THE HINDU KUSH-HIMALAYA**
Deepak Bajracharya (1986)
- No. 5 **GLACIAL LAKE OUTBURST FLOODS AND RISK ENGINEERING IN THE HIMALAYA**
Jack D. Ives (1986)
- No. 6 **OPERATIONAL EXPERIENCES IN FOREST MANAGEMENT DEVELOPMENT IN THE HILLS OF NEPAL**
G.B. Applegate and D.A. Gilmour (1987)
- No. 7 **FORESTRY-FARMING LINKAGES IN THE MOUNTAINS**
T.B.S. Mahat (1987)
- No. 8 **ROAD CONSTRUCTION IN THE NEPAL HIMALAYA: THE EXPERIENCE FROM THE LAMOSANGU-JIRI PROJECT**
Urs Schaffner (1987)
- No. 9 **MOUNTAIN ENVIRONMENTAL MANAGEMENT IN THE ARUN RIVER BASIN OF NEPAL**
John R. Dunsmore (1988)
- No. 10 **HILL AGRICULTURE AND THE WIDER MARKETING ECONOMY: TRANSFORMATION PROCESSES AND EXPERIENCE OF THE BAGMATI ZONE IN NEPAL**
Mahesh Banskota (1989)
- No. 11 **HIGHLAND-LOWLAND INTERACTIONS IN THE GANGES BRAHMAPUTRA RIVER BASIN: A REVIEW OF PUBLISHED LITERATURE**
L.A. Bruijnzeel and C.N. Bremmer (1989)
- No. 12 **MICRO-LEVEL ENVIRONMENTAL MANAGEMENT OBSERVATIONS ON PUBLIC AND PRIVATE RESPONSES IN KAKANI PANCHAYAT, NEPAL**
Saroj K. Basnyet (1989)
- No. 13 **MOUNTAIN ENVIRONMENTAL MANAGEMENT: NYEMO COUNTY (TIBET), CHINA**
Zhang Rongsu (1989)
- No. 14 **NATURAL RESOURCE MANAGEMENT IN THE MOUNTAIN ENVIRONMENT: EXPERIENCES FROM DOON VALLEY, INDIA**
J. Bandyopadhyay (1989)
- No. 15 **LANDSLIDE MANAGEMENT IN THE MOUNTAIN AREAS OF CHINA**
Li Tianchi (1990)
- No. 16 **MINI- AND MICRO-HYDROPOWER IN NEPAL**
Jean-Marion Aitken, G. Cromwell, and G. Wishart (1991)
- No. 17 **AGROFORESTRY IN MOUNTAIN AREAS OF THE HINDU KUSH-HIMALAYAN REGION**
Jeannette Denholm (1991)
- No. 18 **HYDROLOGICAL ASPECTS OF THE HIMALAYAN REGION**
Donald Alford (1992)
- No. 19 **SUSTAINABILITY OF THE ENVIRONMENTAL RESOURCE BASE AND DEVELOPMENT PRIORITIES OF A MOUNTAIN COMMUNITY: BHARDEO, NEPAL**
Kk Panday (1992)
- No. 20 **SEABUCKTHORN: A MULTIPURPOSE PLANT SPECIES FOR FRAGILE MOUNTAINS**
Lu Rongsen (1992)
- No. 21 **THE LAND, THE FARMER, AND THE FUTURE: A SOIL FERTILITY MANAGEMENT STRATEGY FOR NEPAL**
Brian Carson (1992)

The imbalance between population and resource availability is a worldwide phenomenon, especially in those countries where the bulk of the population is engaged in agriculture. The problem is more acute in the fragile mountain areas where resources are very limited and population growth is rapid. The pressure on the land is increasing and the population is further concentrated by the migration of people from the rural areas to the towns and cities.

The increasing gap between the demand and supply of food and other necessities has become a major concern for the mountain areas. The International Centre for Integrated Mountain Development (ICIMOD) is working towards the sustainable development of the mountain areas.

This constitutes the background to the long-term work programme of the Mountain Farming Systems Division of ICIMOD. The programme is directed towards identification, assessment, and development of sustainable mountain agriculture. Accordingly, through the synthesis of both past and present field studies, the factors and processes contributing to sustainability are being identified to facilitate identification and application of sustainability-promoting options.

As part of Mountain Farming Systems' work, the present paper reports on the results of a study on highland agriculture in Lhasa district of Tibet (China). As part of the study, the authors visited the area and conducted field studies. The study was characterized by high mountain agriculture, mainly in the form of terrace farming. The purpose of the study was to review past experiences, to identify the basic changes in the mountain areas, and to provide a basis for the development of sustainable mountain agriculture.

This review attempts to review a number of variables by which the mountain areas are being transformed. The variables are: population, land use, and agricultural production. The changes in population, land use, and agricultural production are reviewed in terms of their impact on the mountain areas.

Dynamics of Highland Agriculture in Lhasa District, Tibet

Liu Yanhua

ICIMOD OCCASIONAL PAPER No. 22

Published by
 International Centre for Integrated Mountain Development
 Kathmandu, Nepal

The views and interpretations expressed in this paper are those of the author. They are not attributable to the International Centre for Integrated Mountain Development (ICIMOD) and do not imply the expression of any opinion concerning the legal status of any country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries.

Copyright © 1992

International Centre for Integrated Mountain Development

All rights reserved

Cover photograph: (clockwise from top right)

1. Cattle in the courtyard of a farm house
2. Highland maize
3. Stored bedding material
4. Degraded upland pasture

(All Courtesy of N.S. Jodha)

Published by

International Centre for Integrated Mountain Development
G.P.O. Box 3226,
Kathmandu, Nepal

ISBN 92-9115-063-0

Typesetting at ICIMOD Publications' Unit

Printed at Nepal Lithographing Co.
Lazimpat plaza, Lazimpat, Kathmandu.
Phone:- 415564

The views and interpretations in this paper are those of the author. They are not attributable to the International Centre for Integrated Mountain Development (ICIMOD) and do not imply the expression of any opinion concerning the legal status of any country, territory, city or area of its authorities, or concerning the delimitation of its frontiers or boundaries.

Foreword

The imbalance between population and resource availability is a major problem faced by most of the developing countries, especially in those countries where the bulk of the population depends upon agriculture. The problem is more acute in the fragile resource zones where the natural resource base offers very limited intensification possibilities and population pressure grows unabated. The pressure created by the human population is further accentuated by the growing numbers of livestock that compete for land and which contributes to the overexploitation of land resources.

The increasing gap between the demand and supply of land resources and their products is the final consequence of the emerging situation. Remediation of the above crisis calls for a closer examination and understanding of the overall dynamics of resource use in the concerned areas.

This constitutes the background to the long-term work programme of the Mountain Farming Systems' Division at ICIMOD. The programme is directed towards identification, assessment, and adoption of sustainability options for mountain agriculture. Accordingly, through the synthesis of both past studies and fresh field studies, the factors and processes contributing to sustainability and unsustainability are analysed to facilitate identification and application of sustainability-promoting options.

Prepared as part of Mountain Farming Systems' work, the present paper focusses on the dynamics of highland agriculture in Lhasa district of Tibet (China). As per the broad typologies focussed on by ICIMOD studies, Lhasa district represents an area characterised by high mountain agro-pastoral farming systems. The purpose of the paper is to review past experiences, to identify the basic changes, and to raise questions concerning the future development of the region in order to sensitise policy-makers, planners, researchers, and technicians to further considerations of sustainable agricultural development in mountain areas.

This review attempts to answer a number of questions by analysing data collected during the period from 1958 to 1984. The questions are: what have been the changes in the agricultural sector? what have been the changes in the population structure? what factors contributed to these changes? what are the interactions between agriculture and population? what are the constraints to development? and what lessons can be learned from past experiences?

The paper addresses the above questions using time series secondary data as well as information from the author's own studies in the area. The dynamics of the highland agro-pastoral system are studied with a focus on changes over time and interactions among the human population, livestock, and the fragile resource base. The paper alerts policy-makers to the emerging unsustainability of current resource use systems and production patterns in Lhasa district. It may be added that Lhasa is one of several similar agro-ecosystems in the Hindu-Kush Himalayas where the immediate attention of decision-makers is needed in order to reverse the emerging trends of unsustainability.

E.F. Tacke
Director General
ICIMOD

Acknowledgements

Years of work, travel, and interaction with people within Lhasa and in Tibet have made it possible for the author to gather information about Lhasa through personal observation and through a number of secondary sources. The author wishes to thank all those people in Tibet and China who helped him to complete his task. However, it was at ICIMOD that this paper was planned as part of the Mountain Farming Systems' long-term programme on Sustainable Mountain Agriculture.

Physical and Environmental Features

Land Use

Economic Situation

II. Agricultural Development

Historical Changes in Agricultural Development

Agricultural Commodities

Development of Crop Production

Development of Animal Husbandry

Labour Force

III. Technological Changes

Systems

IV. Interaction of Agriculture and Population

Agricultural Production and Supply

Handing over of Animals

Changes in Average Livelihoods

Productivity of Labour

V. Lessons from Past Experiences

Indicators of Change and Causes of Change

Sustainability Assessment

Issues in Development

Shortage of Manpower

Lack of Continued Support

Inadequate Communication

Conclusion

Annex

References

	Page
I. Study Area Background	1
Introduction	1
Physical and Environmental Features	1
Land Use	3
Economic Situation	5
II. Agricultural Development	9
Historical Changes in Agricultural Development	9
Agricultural Components	10
<i>Development of Crop Production</i>	11
<i>Development of Animal Husbandry</i>	13
<i>Labour Force</i>	21
III. Population Changes	22
Population	22
IV. Interaction of Agriculture and Population	25
Agricultural Production and Supply	25
Relationship of Elements	28
<i>Changes in Average Landholdings</i>	31
Productivity of Labour	33
V. Lessons from Past Experiences	36
Indicators of Change and Causes of Change	36
Sustainability Assessment	37
Issues in Development	38
<i>Shortage of Manpower</i>	38
<i>Lack of Continued Support</i>	39
<i>Inadequate Communication</i>	39
Conclusions	39
Annex	42
References	43

	Page
Table 1: Proportion of the Value of Crop Production and Animal Husbandry in the Gross Output Value of Agriculture (%)	10
Table 2: Productivity of Major Crops in Lhasa District (ton/ha) (1958-1984)	12
Table 3: Area (proportion) under Different Crops (ha)	13
Table 4: Livestock Pattern (1958-1984)	16
Table 5: Distribution Pattern of Increased Livestock (1958-1984)	17
Table 6: Livestock Structure (1958)	17
Table 7: Livestock Structure (1984)	18
Table 8: Livestock Density (1984)	20
Table 9: The Rural Population and Labour Force (1958 - 1984)	20
Table 10: Distribution of the Rural Population (1984)	23
Table 11: Distribution of Farm Labourers and Herdsmen	23
Table 12: Grain Availability (1952-1984)	25
Table 13: Estimation of Crop Production and Per Capita Grain Availability (1990-2020)	27
Table 14: Land Cultivated Per Capita, Crop Production Per Capita, and Productivity	29
Table 15: Animal Husbandry Products (1984)	30
Table 16: Average Landholding (1958 - 1984)	31
Table 17: Ratio of Population to Arable Land (1984)	32
Table 18: Rural Population - Arable Land Ratio (1958-1984)	32
Table 19: Comparison of Livestock - Rural Population - Grassland (1958 - 1984)	33
Table 20: Productivity of Labourers in Terms of Crop Production (1958 - 1984)	33
Table 21: Productivity of Labourer in Animal Husbandry (1958 - 1984)	35
Table 22: Agriculture-Population Interaction: Indicators of Change and Causative Factors (1958-1984)	36

List of Figures

	Page
Figure 1: Location of Lhasa District in the Hindu Kush-Himalayan Region	2
Figure 2: Graphs Depicting Different Climates	4
Figure 3: Topographical Features of Lhasa District	5
Figure 4: Land Cover and Land Use in Lhasa District	6
Figure 5: Percentage of Output Value from Agriculture to the Gross Output Value in Lhasa District	8
Figure 6: Crop Production Distribution Pattern (1958)	14
Figure 7: Crop Production Distribution Pattern (1984)	15
Figure 8: Livestock Distribution Pattern (1984)	19
Figure 9: Grain Production and Its Incrementation in Lhasa District (1958-1984)	26
Figure 10: Numbers of Livestock and Sheep Units Per Capita for the Rural Population	34

I. Study Area Background

Introduction

In most developing mountain areas, agricultural production, broadly speaking, is the main activity on which people depend for their livelihood. The population is closely affected by agricultural development which is closely related to the environmental conditions. The recent rapid population growth in mountain areas has resulted in increased competition for limited resources and, consequently, pressure on the physical, economic, and social environment. The paper deals with Lhasa District in Tibet as the focal area and discusses agricultural development, population growth, and their interactions.

This paper is a part of the long-term Mountain Farming Systems' programme at ICIMOD, focussing on the development of sustainable mountain agriculture in the Hindu Kush-Himalayan Region (Jodha et al. 1992). As per the broad typologies focussed on by ICIMOD studies, Lhasa District represents an area characterised by high mountain agro-pastoral farming systems. The purpose of the paper is to review past experiences, to identify the basic changes, and to raise some questions in the context of future development of the region in order to sensitise policy-makers, planners, researchers, and technicians to further considerations of sustainable agricultural development in mountain areas.

The former administrative area of Lhasa District covered 12 counties and Lhasa City. In 1984, during organisation of the new administrative area, four counties, namely Moto, Milin, Linzhi, and Gongbujiangda were formed out of it. The Lhasa District discussed in the paper is not the former but the new administrative area.

This review attempts to answer a number of questions by analysing data collected from the period from 1958 to 1984.

1. What have been the changes in the agricultural sector?
2. What have been the changes in population structure?

3. What factors contributed to these changes?
4. What are the interactions between agriculture and population?
5. What are the constraints to development?
6. What lessons can be learned from past experiences?

Physical and Environmental Features

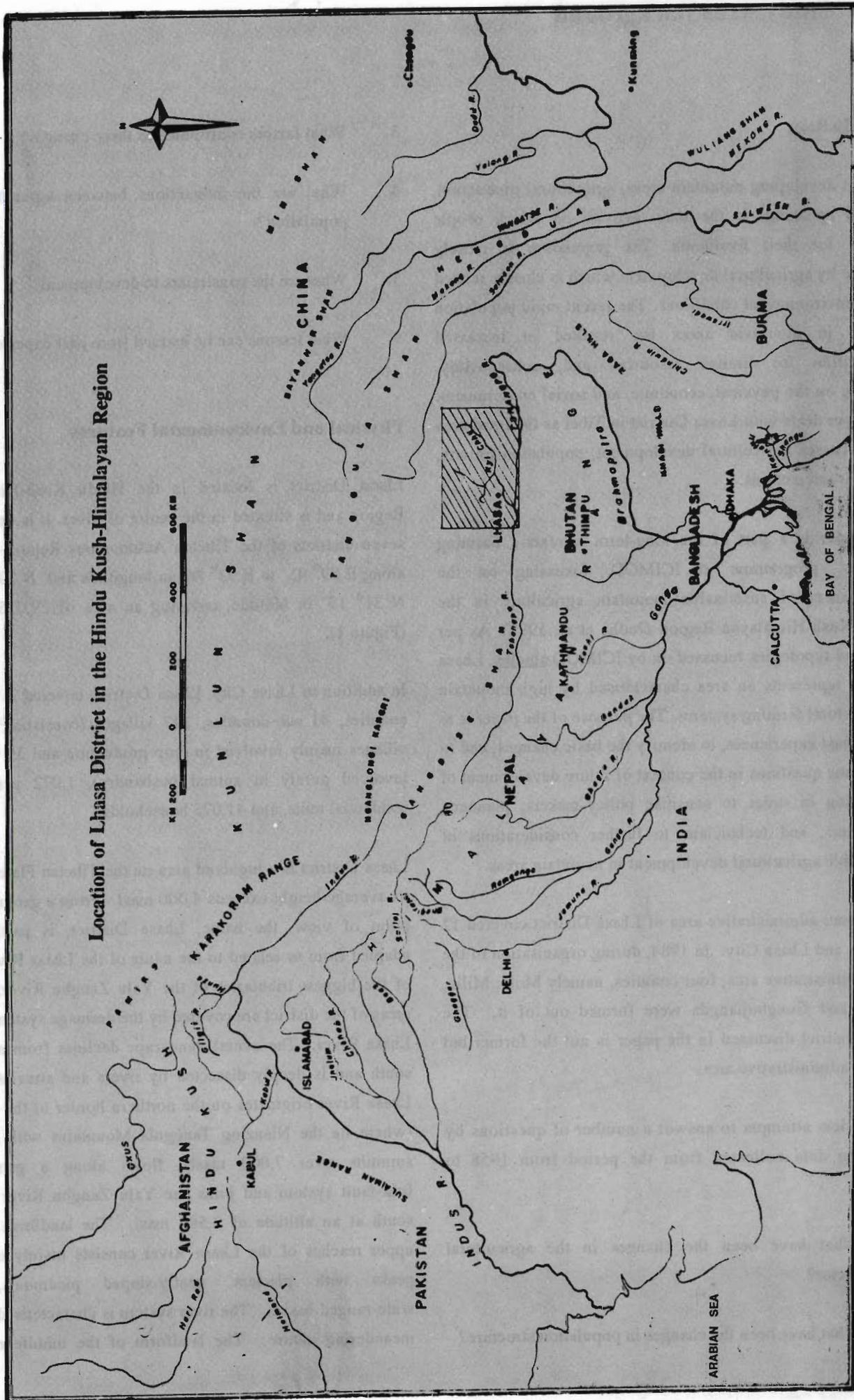
Lhasa District is located in the Hindu Kush-Himalayan Region and is situated in the centre of Tibet. It is one of the seven districts of the Tibetan Autonomous Region and lies along E 89° 45' to E 93° 26' in longitude and N 29° 08' to N 31° 15' in latitude, covering an area of 29,025 sq.km. (Figure 1).

In addition to Lhasa City, Lhasa District, covered in 1984, 8 counties, 41 sub-counties, 197 villages (consisting of 158 villages mainly involved in crop production and 39 villages involved purely in animal husbandry), 1,072 permanent residential units, and 41,075 households.

Lhasa District is a highland area on the Tibetan Plateau, and its average height exceeds 4,000 masl. From a geographical point of view, the name, Lhasa District, is particularly adapted from or related to the name of the Lhasa River, one of the biggest tributaries of the Yalu Zangbu River. Most areas of the district are covered by the drainage system of the Lhasa River. The overall landscape declines from north to south and is deeply dissected by rivers and streams. The Lhasa River originates on the northern border of the district (where lie the Nianzing Tanggula Mountains with several summits over 7,000 masl), flows along a geological fold-fault system and joins the Yalu Zangbu River in the south at an altitude of 3,580 masl. The landform of the upper reaches of the Lhasa River consists mainly of high peaks with glaciers, gently-sloped piedmonts, and wide-ranged basins. The river system is characterised by its meandering nature. The landform of the middle reaches

FIGURE 1

Location of Lhasa District in the Hindu Kush-Himalayan Region



(from Lhumzhub to Maizhu) of the Lhasa River is deeply dissected and the valleys are mostly V-shaped. Several old alluvial terraces (but very narrow) remain on the steep slopes of the valleys. In the lower reaches of the Lhasa River, broader valleys, both along the main river and along its tributaries, are distributed and alluvial plains, extending from six to eight kilometres in width, are formed. Old plateau surfaces, dispersed by dissected valleys, remain separately on the ridges of the Lhasa Valley.

The climate in Lhasa District is semi-arid and temperate (Zhang Rongzu et al. 1982), dominated by a highland monsoon pattern. According to the records of several climate stations (Figure 2), the mean annual temperature ranges between 1 to 8°C and the mean annual precipitation varies from 300 to 700mm. The "Golden Season", as the local people refer to it, is the period from June to September when the temperature is higher (8 to 16°C) and the rainfall is heavier (200 - 600mm, accounting for 80 per cent of the mean annual precipitation). The other seasons are generally a dry-windy spring, short autumns, and long cold winters. The climate in Lhasa District is characterised by vertical differences caused by the enormous variation in elevation between high ridges and valleys. According to former studies, it is recognised that the mean annual temperature decreases 0.57°C for every increase of 100m in elevation (Gao Youxi et al. 1984), and the mean annual precipitation increases by 15mm for every increase of 100m in elevation below 4,800 masl (Liu Yanhua et al. 1983). These differences influence the development of vegetation, soil, and land use patterns considerably.

Land Use

According to the official records, agricultural land occupied 92.6 per cent of the total land in Lhasa District. Out of the total agricultural land, 283.6 sq. km. were used for crop production and 26,600 sq. km. were used for animal husbandry.

Crop production and animal husbandry are the major land use activities in Lhasa District. Distinct differences in land use patterns occur as one moves upwards from the valley basins to the hills/mountains. Regarding agroclimatic

differences, two vertical zones, a cropland zone (below 4,200 masl) and a pastureland zone (between 4,200 and 5,400 masl) are identifiable.

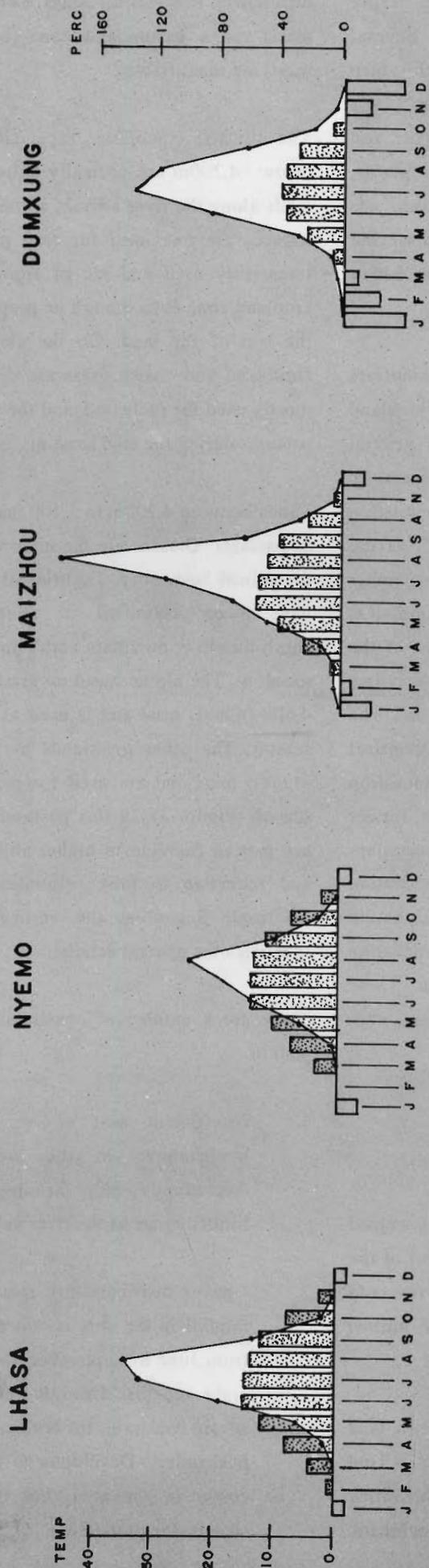
The climatic conditions, especially temperatures, in areas below 4,200m are normally suitable for crops. Therefore, lands along the river's bank, alluvial-diluvial fans, and river terraces are reclaimed for crop production. Croplands are intensively used and are of significant importance in the cropland zone even though its proportionate area is less than the rest of the land. On the slopes, semi-arid temperate shrubland and coarse grass are distributed. The shrubs are mostly used for fuelwood, and the coarse grasses are used as pastures during the cold season.

Lands between 4,200m to 5,400 masl are predominantly used as pastures. Grasses are the main valuable natural resources for animal husbandry. Traditionally, four types of grassland have been classified : alpine meadow, subalpine shrub-meadow, mountain shrub and coarse grasses, and wet meadow. The alpine meadow grassland is distributed above 4,600 (4,800) masl and is used as pasture during the warm season. The other grasslands are distributed below 4,600 (4,800) masl and are used for pasturing during the winter season (Figure 3). In this pastureland zone, a shifting land use pattern (moving to higher altitudes in the warm season and retreating to lower altitudes in the cold season) is practised. Regarding the vertical distribution, Figure 4 illustrates the general details.

There are a number of constraints confining the land use pattern.

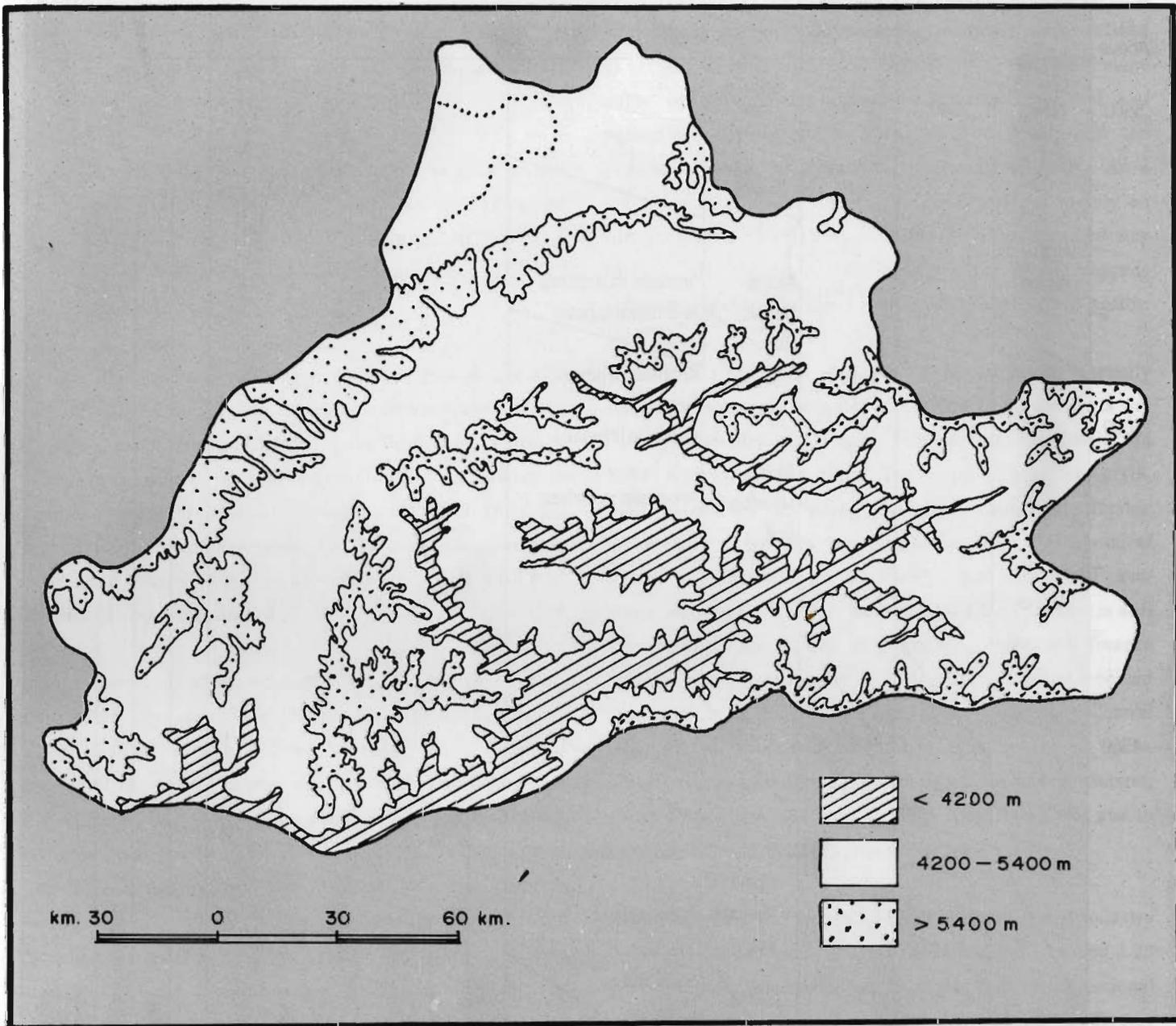
1. Insufficient heat - Due to the high elevation, temperatures in the area are relatively low. Accordingly, crop farming is only possible in the limited range of the river valleys below 4,200m.
2. Uneven distribution of rainfall - Due to the fact that rainfall in the area is concentrated during the period from June to September, the drought period lasts for eight months. Drought, especially in spring, is a severe constraint for both crop production and animal husbandry. Development of irrigation systems is costly in the area, but it is the basic need for sustainable production.

FIGURE 2: GRAPHS DEPICTING DIFFERENT CLIMATES



ALT. (m)	3648.7	3809.4	3824.0	4200.0
LAT.	29° 40'	29° 26'	29° 53'	30° 29'
LONG.	91° 08'	90° 10'	91° 47'	90° 06'
P̄ (mm)	448.1	324.2	542.1	480.9
T̄ (°C)	7.7°c	5.3°c	5.4°c	1.3°c
Exp. (mm)	2205.6	2268.2	2147.5	1920.2
Rec. (year)	1951-1980	1973-1980	1978-1980	1962-1980

Figure 3: Topographical Features of Lhasa District



3. Rugged topography - The mountain areas of Lhasa District are heavily dissected. The physical environment is very fragile; characterised by steep slopes, shallow soil layers, and scattered vegetation cover. In general, the thickness of the mountain soil is only about 10 to 15 cm. Once the soil erodes, it is hard to rehabilitate it.

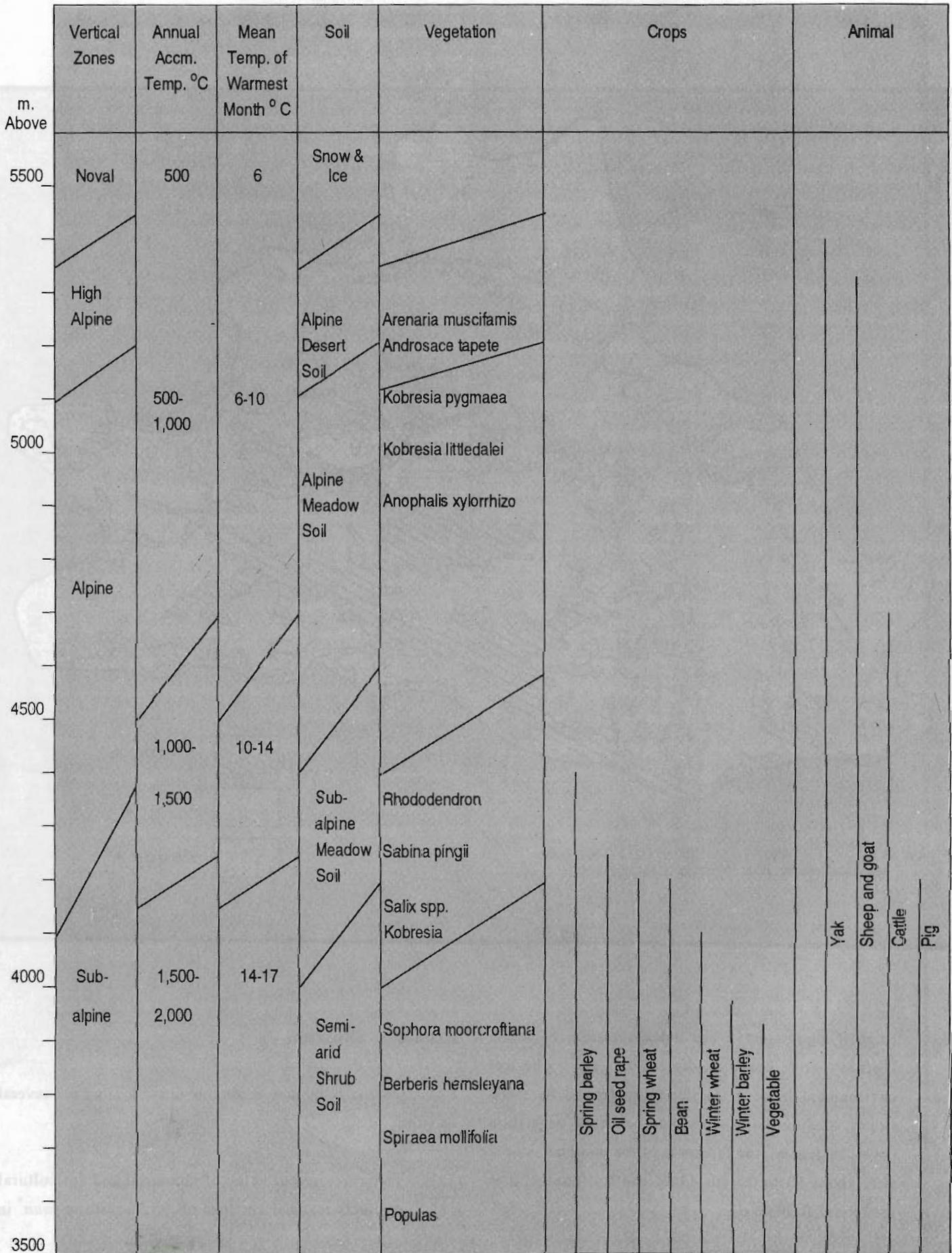
Economic Situation

Lhasa District is the key economic area of Tibet for several reasons.

1. The gross output value of industrial and agricultural products reached a record of 95.36 million *yuan** in

* In 1984 there were 4.5 *yuan* to one U.S. dollar.

Figure 4: Land Cover and Land Use in Lhasa District



1984 (at 1980 constant prices), accounting for 11.81 per cent of that of the Tibetan Autonomous Region as a whole, although the area of Lhasa District is only 2.42 per cent of the total area of Tibet.

2. The productive capabilities, in the context of technology, productivity, and management, are higher than average for Tibet.
3. The economy has developed faster (the gross output value of industrial and agricultural products increased 4.31 times from 1958 to 1984) than that of Tibet as a whole, which increased 3.16 times from 1958 to 1984.

Besides the environmental aspects, other factors are also equally important for the economic development of the district. Firstly, Lhasa District is the historical centre of Tibet, both politically and economically. According to historical records, regional exploitation started from the second or third century when the *Tu Fan* Kingdom was established. Since then, the central or key role of Lhasa District has been maintained.

Many technological innovations were created in or were introduced first into this district and from here were extended to other areas of Tibet. Secondly, Lhasa District is located at the hub of communications and is well-linked to the Sichuan and Qinghai provinces. Commercialisation, however, has partly stimulated economic development. Thirdly, Lhasa City, the capital of the Tibetan Autonomous Region, is located within the district. Because of this it has 37 per cent of the total population, resulting in mass consumption and creating a big demand for products. On the one hand, the citizens, who receive allowances for working in a remote region, have sufficient purchasing ability, and, on the other hand, the produce, particularly the basic food items, are in short supply. Until recently, the demand was greater than the supply.

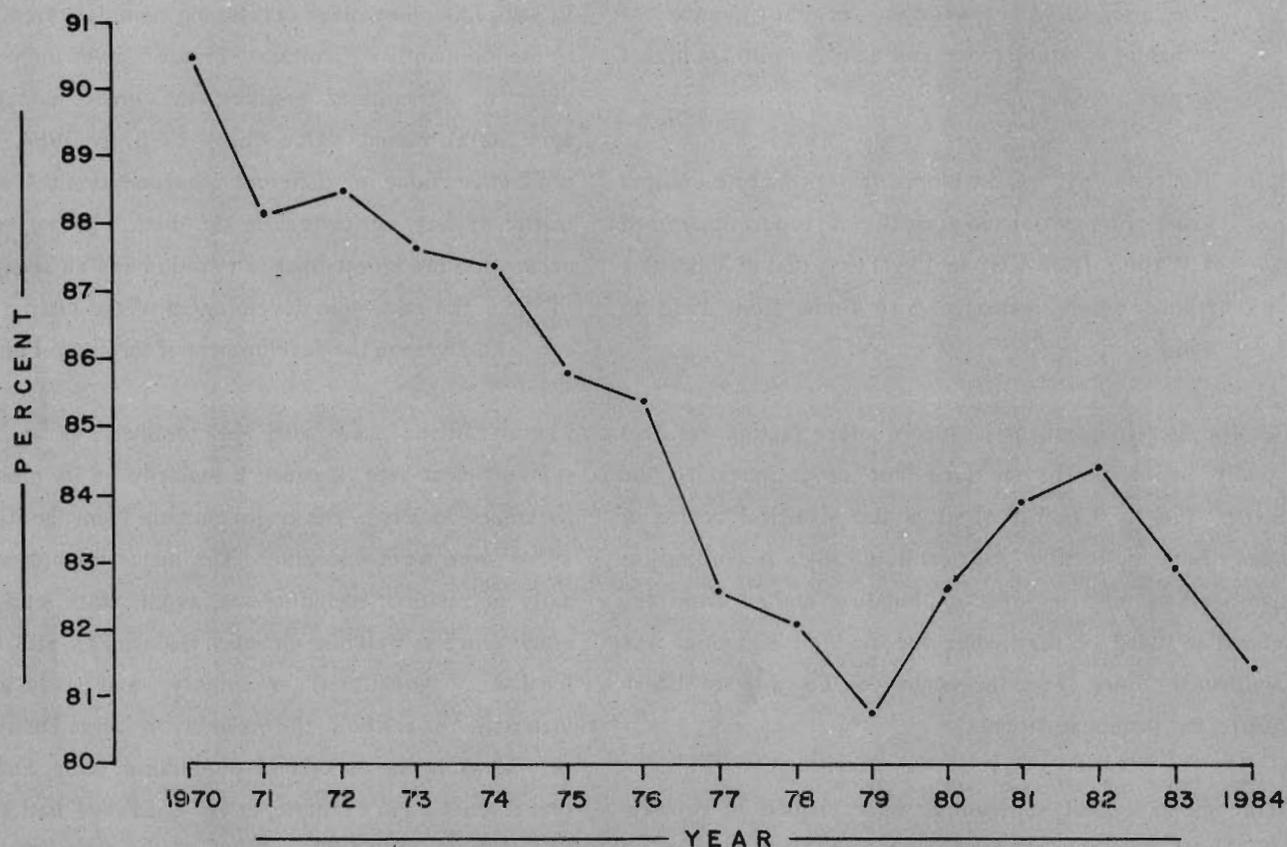
This situation could have acted as an incentive to produce more and could have become an important factor in economic development.

Although Lhasa District is the key economic area of Tibet, it is, still, like many other developing mountain areas, defined as predominantly agricultural. Figure 5 gives the percentage value of agricultural produce, the gross industrial and agricultural output value from 1970 to 1984, and the productive value of different components in 1984. As a matter of fact, agriculture in the district is not merely an occupation but an established tradition and an accepted way of life. The economic development of the district depends substantially upon the development of the agricultural sector.

Lhasa District can also be defined as a partially self-sufficient area, because a majority of its products are consumed locally. The major outputs from the district (in 1984) were wool and hide. The major imports are grain, daily necessities (including tea, sugar, cloth, etc), durable goods (such as watches, bicycles, radios, TVs, etc), chemical fertilisers, agricultural machinery, and industrial raw materials. As a whole, the economy of Lhasa District is still very weak in the aspects of production, trade, and finance (net revenue). For example, in 1984, Lhasa District received an amount of 51.79 million *yuan* from the Central Government, accounting for 54.31 per cent of its gross industrial and agricultural output value. From this amount, about 20 per cent was used for importing food grain and to support agricultural development.

Regarding the gross output value of agriculture and industry (GOVAI) per land area (1984), Lhasa District recorded 3.28 thousand *yuan* per km²; about four per cent of the national average of China. Regarding GOVAI per capita, the figures for Lhasa District were about 330 *yuan* (1984), 37.4 per cent of China's average. The above comparisons indicate, to a great extent, that the economic situation is behind the remainder of country.

Figure 5: Percentage of Output Value from Agriculture to the Gross Output Value in Lhasa District



Contribution from Different Sectors in 1984
(at 1980 constant prices)

(yuan x 10⁴)

	Value	Per cent
1. Agriculture: crop production	3033.20	39.0
2. Animal husbandry	3101.50	39.9
3. Forestry	52.16	0.7
4. Fisheries	6.54	..
5. Sidelines	1587.42	20.4
Total	7780.82	100.0

Source: Compiled by the author

II. Agricultural Development

Historical Changes in Agricultural Development

From the 1950s onwards, the agricultural pattern of Lhasa District has undergone remarkable changes. The process of change can be intrinsically related to the social transformation. It is widely accepted that four periods can be clearly identified in terms of policy, land ownership, institutions, and production.

Slavery was still prevalent in Lhasa District until 1959. Serf owners controlled every means of production, including cultivated lands, livestock, grassland, and production tools. Seventy per cent of the produce of serfs and slaves was handed over to feudal lords who represented only five per cent of the total population. At that time, agricultural development was very slow.

The period from 1959 to 1965 was characterised by democratic reforms. The most significant change was that, in reallocation of land ownership, slaves became farmers and were given their own land to cultivate. Grasslands became common property. The new policy (declared in 1961 in relation to the documents concerning "policies in rural areas" and "policies in pastoral areas") encouraged land reclamation and agricultural development. The documents declared that there would be no taxes for five years on newly reclaimed land.

In the pastoral areas, the Government provided more and more subsidies to improve the quality of grasslands, to improve management technology, and to control diseases. Meanwhile, the price of livestock products increased. In 1961, the Lhasa Institute of Agricultural Sciences was established. Efforts were expended to introduce and propagate seeds, improve cultivation techniques and irrigation facilities, plant fodder, and so on. As a result, the cultivated land in Lhasa District expanded quickly, livestock numbers increased notably, and the gross value of the

agricultural output increased by 56 per cent (equivalent to a 6.6% increase per annum).

The period from 1966 to 1976 was the period when the "cultural revolution" enveloped the entire country. In Lhasa District, the administrative structure was urged to change into the "people's common" system.

The institutional change led to a shift from individual ownership of land and means of production to public ownership for planned and unified management. The new policies in agriculture over-evaluated past experiences and laid a stress on grain as the only crop and 'cutting off sideline production' regardless of environmental and farming conditions. Agricultural production was guided more by administrative cadres than farmers. This seriously damaged the enthusiasm of the farmers and caused great harm to agricultural development. During this period, the gross output value, however, increased by 41 per cent, with a growth rate of 3.5 per cent per annum, mostly because of technological progress. But the impact of interfering with traditional agriculture was quite evident. Complaints regarding shortages of meat and barley were prevalent.

At the end of 1976, although the "cultural revolution" was over, the negative impact continued for some years. In 1979, when agricultural production fell a great deal because of natural disasters, the weaknesses of the former policies became evident. Agricultural development was in need of readjustment. In 1980, and again in 1982, new policies emphasising a market economy were formulated. The "Responsibility System"* restored the right to use land and make decisions to the farmers. The increased price of agricultural products encouraged farmers to improve production. Farmers were exempted from agricultural taxes (extending until the year 2000) and the financial subsidy granted by the Central Government was increased. Under these policies, crop production patterns were gradually

* The "Responsibility System" also known as the "Production Responsibility System" is a managerial system in which the duties and rights of production units and individuals in the production process are clearly defined within the enterprise itself. Payment is task-based and contracted on an output - related basis.

readjusted, the slaughter rate for livestock increased, and 'sideline' activities became one of the important components of agriculture. The gross output value of agricultural production increased by 36 per cent from 1977 to 1984, leading to a 3.9 per cent increase per annum. However, it has been observed that, since the 1980s, the traditional manner of cultivation has been rehabilitated, agricultural mechanisation rejected, and increasing emphasis is now given to the improvement in agricultural technologies in close association with the farmers rather than imposing technologies as in the past.

Agricultural Components

With regards to the main components of agriculture in Lhasa District, five sectors, namely, crop production, forestry, animal husbandry, sideline activities, and fisheries, are covered. However, their development patterns and levels are different (CAS 1980).

Animal husbandry and crop production constitute the principal agricultural sector (Cheng Hong et al. 1984). The total production value of these two dominates the entire agricultural sector (Table 1). The production of these two sectors is dependant on land. The mean production value of croplands was 418 *yuan* (at constant 1980 prices) per ha in 1958 and 1,100 *yuan* per ha in 1984. The mean production value of grasslands was 3.9 *yuan* per ha in 1958 and 7 *yuan* in 1984.

'Sideline' activities are another component of agriculture. In Lhasa District, six kinds of activity are included in this category: 1) temporary employment for construction and

transportation; 2) collecting fuelwood, cow dung, turf, and fodder and selling them; 3) small-scale side occupations such as charcoal-making, brick-making, and firing quicklime; 4) small-scale processing and handicrafts, e.g., extracting oil, weaving rugs, and knitting woollen goods and as employed craftsmen; 5) hunting; and 6) collecting medicinal plants. These activities used to be organised by the collectives but are now carried out by households.

Production from 'sidelines' is an important source of farmers' income, but it was restricted until the end of the "cultural revolution". Rapid development in this field took place in 1980 and in 1984 its production value reached 15.87 million *yuan* (2.8 times that of 1980), accounting for 20.29 per cent of the gross agricultural product. In the past, its proportions were only 2.3 per cent (in 1960), 6.9 per cent (in 1970), and 8.1 per cent (in 1980), but, recently, 'sideline activities' have started to absorb more and more labourers in off-farm employment.

In Lhasa District there is a lack of natural forests. The temperature conditions below 4,000m are suitable only for certain kinds of trees, provided there is appropriate irrigation and management. Before the 1950s, there were trees such as poplar, willow, pine, and cypress surrounding the temples and yards of the serf-owners. In 1964, a nursery for stock was established and several species were introduced into the district. "Beijing Poplar" grew well and was planted along roads, irrigation channels, river banks, and surrounding crop fields. Several "*Lin Ka*" (small plots of trees) were planted and protected. The new trees partly made up for the shortage of firewood and, what was more important, encouraged the development of forest products. Because of weaknesses in forestry management, extension of the forest area appeared

Table 1: Proportion of the Value of Crop Production and Animal Husbandry in the Gross Output Value of Agriculture (%)

	1958	1960	1965	1970	1975	1980	1984
Crop production	41.5	43.0	49.0	44.2	48.6	49.0	38.98
Animal husbandry	56.8	54.6	47.8	48.1	43.7	40.4	39.86
Percentage output to gross value	98.3	97.6	96.8	92.3	92.3	89.4	78.84

difficult. Up to 1984, trees were grown only on an area of 100 ha. The timber production potential of these trees has not yet been exploited. At present, the output from forestry consists mostly of fruit; namely, apples, peaches, pears, and walnuts. The fruit trees are distributed throughout the lower reaches of the Lhasa Valley. In 1984, about 100 tons of fresh fruit and three tons of dried fruit were harvested. Fruit production has great potential for the future but requires relatively high investment and meticulous management.

Fish farming was not the tradition in Lhasa District because the Tibetans were not used to eating fish. Fishing started only in 1960 when a fishing team was organised. Because of the limited fishing resources, the contribution of the fisheries has been extremely marginal (less than one per cent).

Development of Crop Production

Crop production in Lhasa District is severely limited by the climatic conditions and terrain. Single yield cropping is predominant below 4,200 masl, where the mean annual temperature ranges from 5°C to 8.2°C, and the mean annual precipitation is between 300mm to 700mm. The cultivated land, distributed throughout sheltered valleys and on gently sloping terraces, was 27,430 ha (1984), occupying 17 per cent of the valley area or 0.9 per cent of the total land in the district. Dry farming crops consist mainly of winter wheat, spring wheat, highland barley, pulses, buckwheat, rape, potatoes, and some vegetables.

Crop production is an important sector of the district economy. From 1958 to 1984 the grain crop increased 3.2 times (from 21.85 thousand tons in 1958 to 70.14 thousand tons in 1984) and oil seed production increased nearly three times (from 602 tons to 1,792 tons). Vegetable production has recently become an important part of crop production. How have these changes come about? What has caused the increase? Reviewing previous implementation patterns could be helpful in answering the above questions.

Firstly, the arable land of Lhasa District increased from about 25 thousand ha in 1958 to 28 thousand ha in 1984, representing an increment of more than 100 ha per annum. However, the increases were rather uneven. The arable land increased from 1958 to 1967 (from about 25 thousand ha to

28 thousand ha), reached a high level from 1968 to 1979 (about 29.0 thousand ha), and fell to about 28 thousand ha in the 1980s. Three distinct periods of cropland changes are recognised. During the first period (1958-1967), the arable land expanded from the valley plains to the alluvial-diluvial fans and gentle terraces. The reclaimed lands are generally large and fertile, but the new lands lack irrigation. During the second period (1968-1979), because of a mistaken stress on "grain production as the key link", the reclamation shifted to marginal lands such as steep slopes, high altitude areas, and gravel terraces. The result of this has been very low crop productivity, clearly suggesting that available labour could have been better utilised in other activities. At the beginning of the third period (after 1980), with the introduction of the "Production Responsibility System" and other measures of economic reform in Tibet, croplands decreased considerably. Low-yielding lands were generally neglected. The area of cultivated land decreased to the level prevalent at the end of the first period. The changing pattern of arable lands in Lhasa District indicates that a rational increase in arable land took place during the first period and it fluctuated and stabilised in the second and third periods.

Secondly, the growth in yield per unit area also influences the growth of crop production. Table 2 records the productivity of the major crops in Lhasa District. As a whole, the productivity of crops has risen markedly but not uniformly. Among the major crops, wheat is the most productive crop and has had the highest increase (3.28% per annum). Barley and other cereals (mainly buckwheat) have had lower rates of growth (2.74-2.92% per annum).

Pulses and oilseeds are traditional crops in the district, but the rate of growth in their production was comparatively low and unstable.

Thirdly, changes in cropping patterns contributed to the increase of crop production. Table 3 indicates the cropping patterns in terms of sown area and proportion for different crops in Lhasa District over several years. Some unique features that can be identified are listed in the following passage.

1. Grain cultivation accounts for an overwhelming proportion of croplands. However, its share of cultivated land is on the decline.

Table 2: Productivity of Major Crops in Lhasa District (ton/ha) (1958-1984)

Year	Barley	Wheat	Pulses	Other cereals	Oilseed	Vegetables
1958	0.98	1.04	0.94	0.87	0.45	-
1960	1.12	1.15	1.09	1.07	0.54	-
1965	1.69	1.71	1.66	1.57	0.77	-
1970	1.40	1.67	1.45	1.51	0.64	-
1975	1.85	2.35	1.702	2.51	1.04	-
1978	2.20	3.24	2.11	2.22	0.81	-
1980	2.34	3.61	2.20	2.24	1.09	9.88
1982	2.46	3.02	2.19	2.25	0.91	8.12
1984	2.86	3.41	1.56	2.38	1.05	16.33
Annual growth rate	2.92	3.28	1.66	2.74	2.33	-

2. Among the grains, barley is the preferred crop. Wheat replaced pulses to become the second most important crop because of its higher productivity. The area and the proportion of land under pulses and other cereal crops have decreased.

3. From 1958 to 1984 there were fluctuations in the size of areas under different crops. Production management, technological improvements, crop productivity, and people's preferences influenced these changes.

4. There has been little change in the cropping pattern of oilseed.

5. Vegetable production is increasing.

When comparing the increases (the figure for 1984 divided by that for 1958) in production, cultivated land, and land productivity of different crops, some features can be identified. The significant components contributing to the growth in crop production were barley and wheat, which have not only had rapid increases in production but have also occupied the major share in both cultivated land and gross output.

Barley is the staple foodgrain of the local people and is the traditional priority in food production. In general, the increase in barley production has been influenced more by productivity-raising issues than by expansion of cultivated lands. In the case of wheat production, a positive change occurred after 1972, i.e., a highly productive crop was sown on a larger proportion of land. At the beginning of the 1960s, a newly-developed species called "*Fei Mai*" (Heine Hvede) was introduced. The productivity of "*Fei Mai*" reached 10 tons per ha in several places, where it had been cultivated on an experimental basis, in the following years. This species was adopted extensively. After 1972, land cultivated with wheat increased rapidly (from 3,600 ha to 10,790 ha in 1979). Meanwhile, production rose from 5,820 tons/annum in 1972 to 34,920 tons/annum in 1978. Wheat production exceeded barley production and became the priority crop from 1977 to 1980. After the shocks of drought and disease in 1979 (Lin Dawu et al. 1985), wheat production readjusted to a lower level. Its production in terms of cultivated area and productivity stabilised gradually after 1981.

Fourthly, the changes in distribution pattern are also an important factor in crop production. Figures 6 and 7 show the gross crop production and production of different crops

Table 3 : Area (proportion) under Different Crops (ha)

Year	Barley	(%)	Wheat	(%)	Pulse	(%)	Other Cereals	(%)	Oil-seeds	(%)	Vegetable	(%)
1958	11,113	(46.3)	3,833	(11.8)	6,347	(26.4)	2,400	(10.0)	1,333	(5.5)	-	-
1960	12,160	(46.8)	3,247	(12.50)	6,433	(24.8)	2,593	(10.0)	1,540	(5.9)	-	-
1965	12,980	(47.2)	3,873	(14.1)	6,467	(23.5)	2,840	(10.3)	1,353	(4.9)	-	-
1970	13,967	(48.6)	4,900	(17.0)	5,700	(19.0)	2,513	(8.8)	1,613	(5.6)	-	-
1975	12,946	(45.6)	8,780	(31.0)	3,260	(11.5)	1,613	(5.7)	1,753	(6.2)	-	-
1978	10,500	(38.2)	10,786	(39.3)	3,433	(12.5)	907	(3.3)	1,833	(6.7)	-	-
1980	10,647	(37.5)	10,640	(37.5)	3,660	(12.9)	780	(2.7)	2,047	(7.2)	633	(2.2)
1982	12,847	(45.8)	7,327	(26.1)	3,960	(14.1)	913	(3.3)	2,067	(7.4)	940	(3.3)
1984	12,407	(45.2)	7,380	(26.9)	4,160	(15.2)	1,273	(4.6)	1,713	(6.3)	493	(1.80)

in each county of Lhasa District. In general, the following can be deduced:

- crop production is increasing rapidly throughout the lower reaches, covering Dagze, Lhasa, Doilung, and Quxu counties in the Lhasa Valley, compared to other parts of the District;
- in counties where the major cultivated lands are below 3,800 masl, the contribution of wheat production is greater than that of barley; and
- vegetable cultivation has become a part of crop production in the areas close to Lhasa City. Vegetable production in Lhasa County is becoming increasingly important. The management of animal husbandry was, and is, characterised mainly by semi-nomadic herding on extensive rangelands.

Development of Animal Husbandry

Animal husbandry is another major land-based activity in Lhasa District. It is not merely an established tradition, but also an important factor in the district economy.

The management of animal husbandry was, and is, characterised mainly by semi-nomadic herding on extensive rangelands. The grasslands in Lhasa District cover about 26,600 square kilometres, accounting for approximately 91.7 per cent of the total area (94 times larger than cultivated lands). The total herds in 1984 numbered 1.46 million head, including 556.8 thousand cattle and yak^{*}; 33.6 thousand horses, mules, and donkeys; 357.5 thousand head of goats; 505.2 thousand sheep; and 8.4 thousand swine. Most animals were raised on the grasslands.

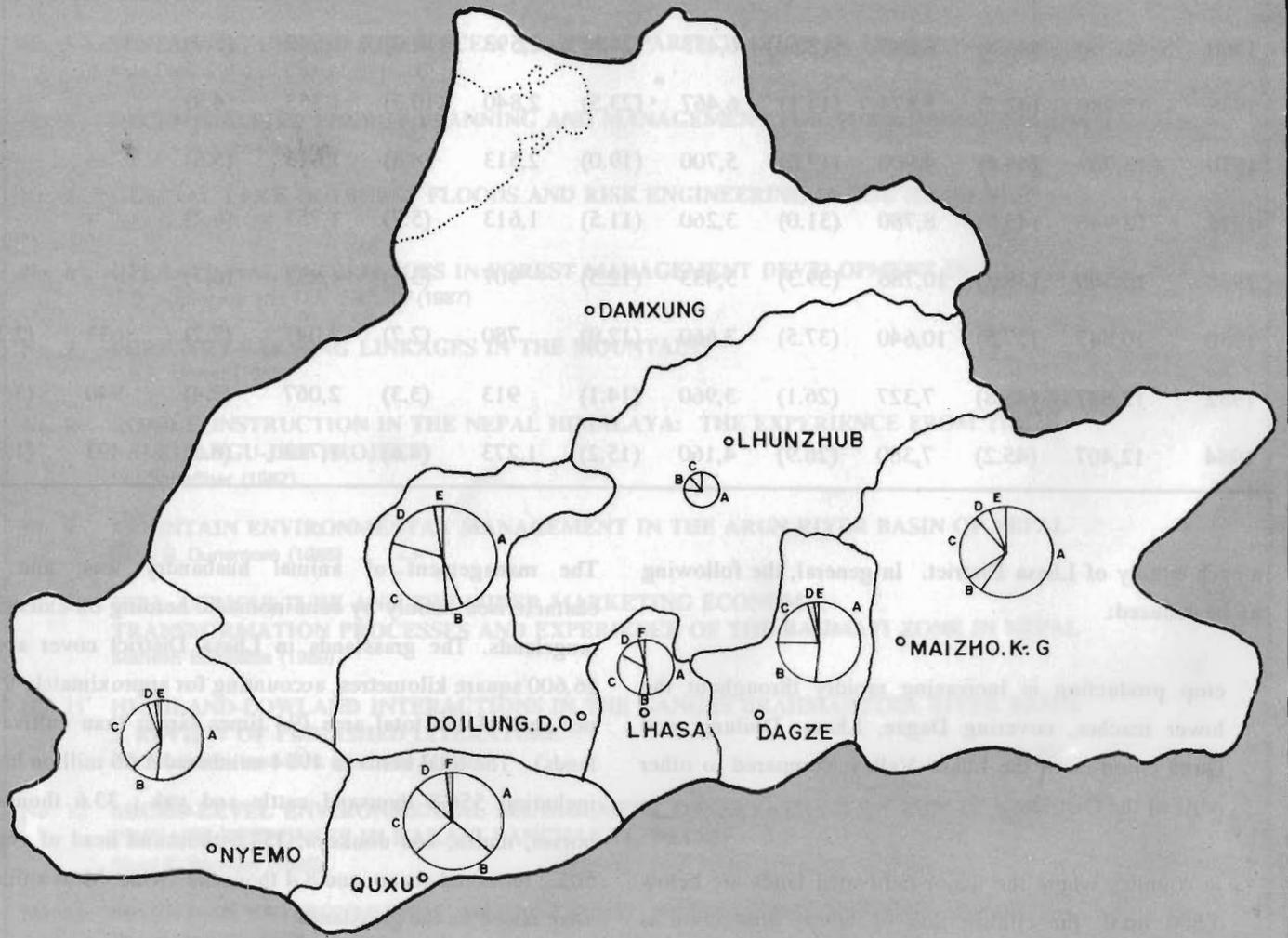
Animal husbandry is prevalent from valley floors to highland areas. Based on the economic importance of animal husbandry to the gross agricultural output value, elevation of the area, and management practices, three types of pastoral system are in operation.

From the Table 4, the following can be deduced.

- The majority, covering 97 per cent, of animals are ruminants (cattle, yak, sheep, goats, etc).
- The numbers of livestock have continued to grow and have decreased in only a few cases.

* The statistics record cattle and yak together. The official data (1984) record the cattle/yak ratio as 23/7.

Figure 6: Crop Production Distribution Pattern (1958)



- A = BARLEY
- B = WHEAT
- C = PULSE
- D = OTHER CEREALS
- E = OILSEED
- F = VEGETABLES

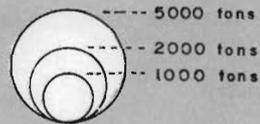
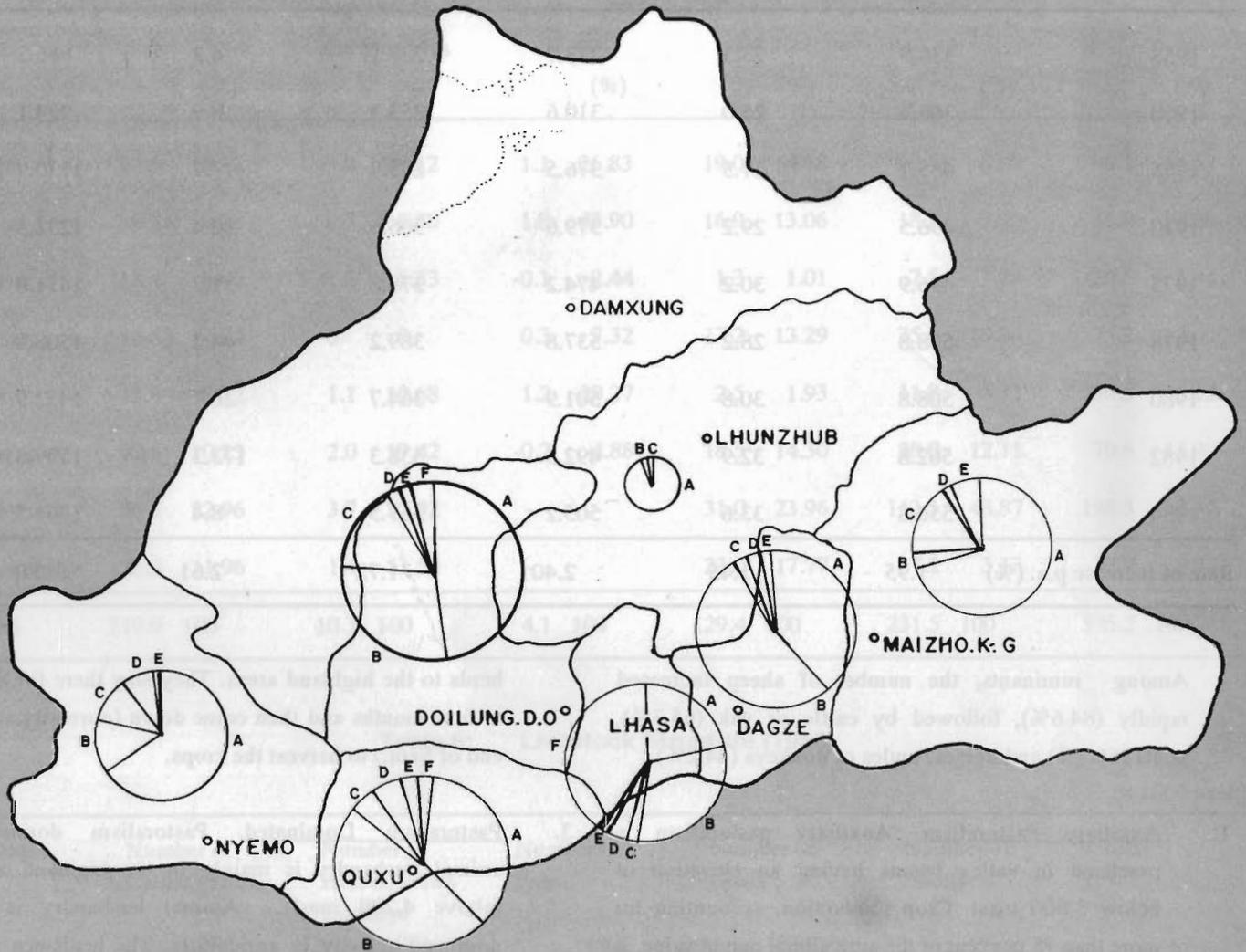


Figure 7: Crop Production Distribution Pattern (1984)



- A = BARLEY
- B = WHEAT
- C = PULSE
- D = OTHER CEREALS
- E = OILSEED
- F = VEGETABLES

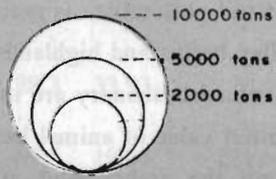


Table 4: Livestock Pattern (1958-1984)

(x 1000 head)

Year	Cattle/ Yak	Horses/Mules and Donkeys	Sheep	Goats	Swine	Total
1958	336.9	23.3	273.7	228.1	4.3	866.3
1960	366.3	25.0	310.6	253.3	8.9	934.1
1965	485.1	27.5	376.5	263.9	17.9	1170.9
1970	496.5	29.2	379.6	306.6	20.4	1232.3
1975	496.9	30.2	474.2	378.8	31.7	1411.8
1978	508.8	28.2	537.8	389.2	44.2	1508.2
1980	508.8	30.8	501.9	364.7	26.7	1432.9
1982	562.8	32.9	492.3	338.3	173.3	1599.6
1984	556.8	33.6	505.2	357.5	8.4	1461.5
Rate of increase p.a. (%)	1.95	1.45	2.40	1.72	2.61	2.0

Among ruminants, the number of sheep increased rapidly (84.6%), followed by cattle or yak (65.3%), goats (56.7%) and horses, mules or donkeys (44.2%).

herds to the highland areas. They stay there for three to four months and then come down (normally at the end of Sept.) to harvest the crops.

1. Auxiliary Pastoralism. Auxiliary pastoralism is practised in valley basins having an elevation of below 3,800 masl. Crop production, accounting for more than 75 per cent of the agricultural output value, is the dominant agricultural component. Livestock, consisting of more cattle than yaks and more goats than sheep, are pastured on fallow lands, basin grasslands, and the surrounding valley slopes close to the farmers' residences. Swine are the prevalent livestock found in this area.
2. Mixed Pastoralism. Mixed pastoralism is practised in areas between the valley basins and highlands. Both crop production and animal husbandry are important in agriculture. The output value of animal husbandry varies depending upon the arable land available, elevation, etc. However, the output value is less than 80 per cent that of agriculture. Seasonal range management is in practice. From the beginning of the warm season in the croplands, the farmers drive their

3. Pastoralism Dominated. Pastoralism dominated animal husbandry is mainly in the highland areas (above 4,200 masl). Animal husbandry is the dominant activity in agriculture. The herdsmen have permanent settlements in relatively low and wind-sheltered places. The surroundings of their homesteads are used as pastures during winter and spring. As the weather becomes warmer (in May), nomadic pasturing begins. Livestock are sent higher and higher until the weather compels them to move down. The nomadic period lasts at least half a year.

As the management of animal husbandry has changed little since the 1950s, the number of livestock can be taken as a traditional indicator of the changes in production. Table 4 shows the livestock pattern from 1958 to 1984 and Table 5 the distribution pattern of livestock between 1958 and 1984.

The changes in livestock structure and distribution are shown in Tables 6 and 7.

Table 5: Distribution Pattern of Increased Livestock (1958-1984)

(base 1000 x) (x1000 head)

County	Increase in Number of Cattle/Horses, Yak		Increase in Number of Pigs, Mules and Donkeys		Increase in Number of Goats		Increase in Number of Sheep		Increase in Number of Total		Total	
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Maize	42.5	19.33	3.0	29.12	1.1	26.83	19.0	14.68	20.5	8.80	86.1	14.47
Dagze	18.2	8.28	0.7	6.80	1.8	43.90	16.9	13.06	18.3	7.90	55.9	9.39
Lhasa	13.4	6.09	-1.6	-15.53	-0.1	-2.44	1.3	1.01	7.5	3.24	20.5	3.44
Doilung	32.6	14.83	0	0	0.3	7.32	17.2	13.29	25.1	10.84	75.2	12.63
Quxu	13.9	6.32	1.1	10.68	1.2	29.27	2.5	1.93	11.8	5.11	30.5	5.12
Nyemo	22.5	10.23	2.0	19.42	-0.2	-4.88	18.5	14.30	28.0	12.11	70.8	11.90
Damxung	50.5	22.96	3.7	35.92	-	-	31.0	23.96	113.1	48.87	198.3	33.32
Lhunzhub	26.3	11.96	1.4	13.59	-	-	23.0	17.77	7.2	3.13	57.9	9.73
Total	219.9	100	10.3	100	4.1	100	129.4	100	231.5	100	595.2	100

Table 6: Livestock Structure (1958)

(x 1000 head)

County	Number of Cattle/Yak		Number of Horses/Mules Donkeys		Number of Pigs		Number of Goats		Number of Sheep		Total	
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Maizho	69.0	45.85	3.0	1.99	0.5	0.33	45.5	30.23	32.5	21.60	150.5	17.37
Dagze	21.2	29.78	2.9	4.07	0.7	0.98	19.8	27.81	26.6	37.36	71.2	8.22
Lhasa	4.6	23.59	2.4	12.31	0.6	3.08	6.2	31.79	5.7	29.23	19.5	2.25
Doilung	21.7	28.89	4.7	6.26	0.8	1.07	23.4	31.16	24.5	32.62	75.1	8.67
Quxu	17.1	28.64	3.5	5.86	1.5	2.51	19.2	32.62	18.4	30.82	59.7	8.67
Nyemo	27.0	32.37	1.5	1.80	0.2	0.24	28.3	33.93	26.40	31.66	83.40	9.63
Damxung	152.3	42.58	4.3	1.20	-	0	69.5	19.43	131.6	36.79	357.7	41.29
Lhunzhub	24.0	48.78	1.0	2.03	-	0	16.2	32.93	8.0	16.26	49.2	5.68
Total	336.9	38.89	23.3	2.69	4.3	0.50	228.1	26.33	273.7	31.59	866.3	100

Table 7: Livestock Structure (1984)

(x 1000 head)

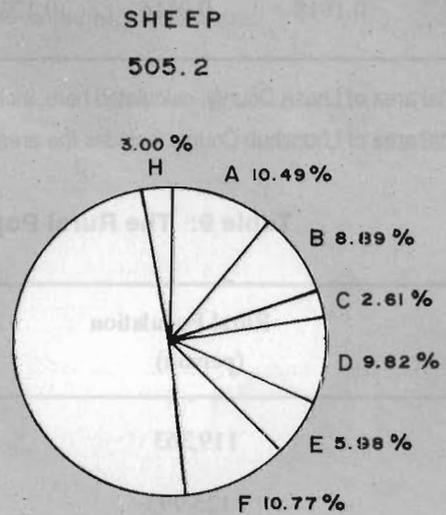
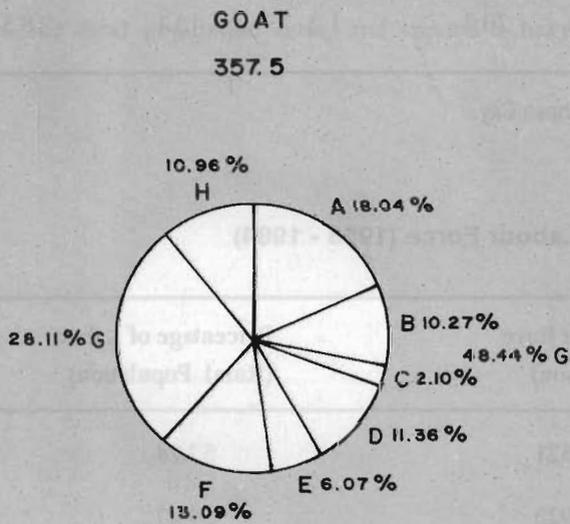
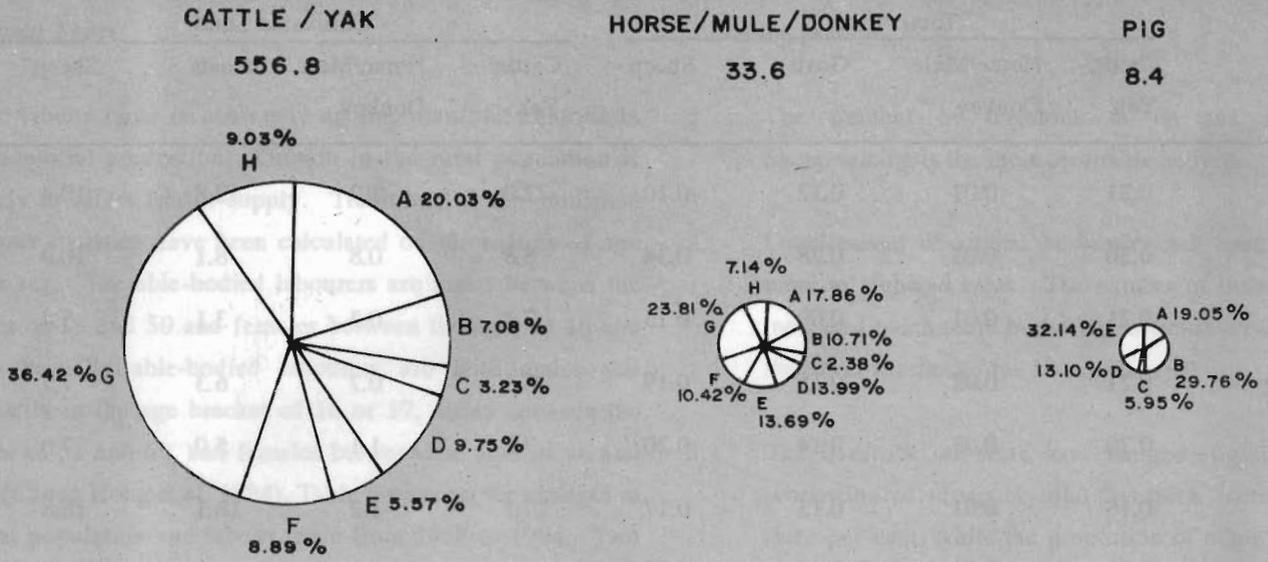
Country	Number of Cattle/yak		Number of Horses/Mules/Donkeys		Number of Pigs		Number of Goats		Number of Sheep		Total	
		(%)		(%)		(%)		(%)		(%)		(%)
Maizho	111.5	47.13	6.0	2.54	1.6	0.68	64.5	27.26	53.0	22.39	236.6	16.19 (100.0)
Dagze	39.4	31.0	3.6	2.83	2.5	1.97	36.7	28.87	44.9	35.33	127.1	8.70 (100.0)
Lhasa	18.0	45.0	0.8	2.0	0.5	1.25	7.5	18.75	13.2	33.0	40.0	2.74 (100.0)
Doilung	54.3	36.13	4.7	3.13	1.1	0.73	40.6	27.01	49.6	33.02	150.3	10.28 (100.0)
Quxu	31.0	34.37	4.6	5.10	2.7	2.99	21.7	24.06	30.2	33.48	90.2	6.17 (100.0)
Nyemo	49.5	32.10	3.5	2.27	-	0	46.8	30.35	54.4	35.28	154.2	10.55 (100.0)
Damxung	202.8	36.47	8.0	1.44	-	0	100.5	18.08	244.7	44.01	556.0	38.04 (100.0)
Lhunzhub	50.3	46.97	2.4	2.24	-	0	39.2	36.60	15.2	14.19	107.1	7.33 (100.0)
Total	556.8	38.10	33.6	2.30	8.4	0.57	357.5	24.46	505.2	34.57	1461.5	100
Birth rate	64.2		2.2		2.9		9.1		40.5			
Breeding animals	186.1		11.2		2.6		154.5		213.2			

In terms of livestock pattern changes from 1958 to 1984, the relative proportions have been maintained, i.e., cattle and yak account for the largest proportion followed by sheep, goats, horses, mules, donkeys, and pigs. But the relative proportional value of each kind of animal differed. The proportion of sheep increased by 2.98 per cent (the number of sheep exceeded cattle and yak during 1977 and 1978), while the proportion of other major animals decreased slightly. In terms of the regional distribution pattern of livestock, Damxung has the largest share (about 40%). Animal husbandry is the most prevalent activity in the county, not only because of the large area it covers but also because of the county concentration on animal husbandry. In this respect, Damxung is followed by Maizho, Nyemo, Doilung, Dagze, Lhunzhub, Quxu, and then Lhasa. From 1958 to 1984 the distributional proportions of livestock in

Damxung, Maizho, and Quxu decreased. The distribution of different livestock in 1984 is shown in Figure 8.

The density of livestock (Table 8) is another indicator of livestock development. Based on the data available, Table 8 used the livestock/total area ratio (head/ha) and livestock/cultivated land ratio (head/ha). The former represents the average density and expresses the fodder-providing capacity. It has been noticed that the density of livestock is higher both in the lower reaches of the Lhasa Valley area (Dagze, Lhasa, Doilung, Quxu), where they partly practise auxiliary pastoralism, and in the highland area (Damxung) where pastoralism is prevalent. The area where mixed pastoralism is principally carried out (Maizho, Nyemo, and Lhunzhub) has a lower livestock density. Regarding grasslands in Lhasa District as a whole, the

Figure 8: Livestock Distribution Pattern (1984)



- A = MAIZHO
- B = DAGZE
- C = LHASA
- D = DOILUNG
- E = QUXU
- F = NYEMO
- G = DAMXUNG
- H = LHUNZHUB

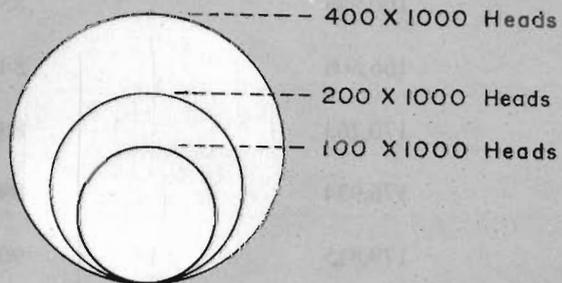


Table 8: Livestock Density (1984)

(head/ha)

County	Total Area				Cultivated Land			
	Cattle/ Yak	Horse/Mule/ Donkey	Goats	Sheep	Cattle/ Yak	Horse/Mule/ Donkey	Goats	Sheep
Maizho	0.21	0.01	0.12	0.10	22.0	1.2	12.8	10.4
Dagze	0.30	0.03	0.28	0.34	8.8	0.8	8.1	10.0
Lhasa*	0.21	0.01	0.09	0.15	7.4	0.3	3.1	5.4
Doilung	0.21	0.02	0.15	0.19	8.5	0.7	6.3	7.7
Quxu	0.20	0.03	0.14	0.20	7.2	1.1	5.0	7.0
Nyemo	0.16	0.01	0.15	0.17	17.1	1.2	16.1	18.8
Damxung	0.20	0.01	0.10	0.25	-	-	-	-
Lhunzhub*	0.12	0.01	0.09	0.04	29.8	1.4	23.3	9.0
District	0.1918	0.0116	0.1232	0.1741	20.4	1.2	13.1	18.5

* The total area of Lhasa County, calculated here, includes the area of Lhasa City.

The total area of Lhunzhub County includes the area of State farms.

Table 9: The Rural Population and Labour Force (1958 - 1984)

Year	Rural Population (person)	Labour force (person)	Percentage of Labour (Rural Population)
1958	119,363	68321	57.24
1960	125,993	74922	59.47
1965	134,750	79260	58.82
1970	148,853	86450	58.08
1975	160,948	85756	53.28
1978	166,608	84200	50.54
1980	170,263	88318	51.87
1982	176,934	89052	50.33
1984	179,815	90845	50.52
Growth rate per annum (%)	1.6	1.1	-

density of livestock (1984) was 0.21 cattle/yak, 0.013 horses/mules or donkeys, 0.19 sheep, and 0.13 goats per ha.

Labour Force

The labour force is obviously an important determinant in agricultural production. Growth in the rural population is likely to effect labour supply. Traditionally, the published labour statistics have been calculated on the indices of age and sex. The able-bodied labourers are males between the ages of 18 and 50 and females between the ages of 18 and 45. Partially able-bodied labourers are both males and females in the age bracket of 16 or 17, males between the ages of 51 and 60, and females between the ages of 46 and 55 (Cheng Hong et al. 1984). Table 9 presents the changes in rural population and labour force from 1958 to 1984. Two notable patterns are revealed from the table. Firstly, the labour force increase was slower than the rural population growth, and this caused a decline in the labour force, affected the rural population ratio, and created a heavier

dependency burden on the labour force. In addition, the numbers of the labour force fluctuated over time. The reasons that partly explain these facts are enumerated in the following passage.

1. The number of livestock is on the increase. Sheep-raising is the most profitable activity.
2. Development of animal husbandry has been shifting more to highland areas. The number of livestock has increased much more in the high altitude areas than in the lower reaches of the Lhasa Valley.
3. The livestock structure has changed slightly. The proportion of sheep to total livestock increased by three per cent, while the proportion of other types of animal decreased.
4. The density of livestock is higher in the lower reaches and in the highland areas.

III. Population Changes

Population

The population of Lhasa District in 1984 totalled 285,591 persons, accounting for 14.5 per cent of the total population of Tibet. Compared with the 165,756 persons enumerated in 1958, the population had increased by 72 per cent, with an average growth rate of 2.1 per cent per annum. Lhasa District is the most "crowded" area in Tibet, with a population density of seven persons per km² in rural areas (5 times more than the average for Tibet) and 197 persons per km² in Lhasa City.

According to the census records of 1982, some characteristics of the population in Lhasa District are as follows: the distribution of the population by gender indicated that 50.28 per cent of the population are males and 49.72 per cent females, with a gender ratio of 101:100; the population aged 0-12 years represented 29 per cent of the total; the education level recorded that, in every thousand people, there were 9.89 persons with college level, 28.72 persons with high school level, 79.32 persons with middle school level, and 235.79 persons with primary school level education; the percentage of illiterates in the population aged above 12 years was 57.4; and nearly 60 per cent of the illiterates were female: the 1981 natural growth rate was 1.917 per cent. The urban-rural population distribution (1984) in Lhasa District was 37 per cent and 63 per cent respectively. The urban population refers to the people residing in the city or town, most of whom are supplied with commercial foodgrain. The term rural population implies people who are engaged in agricultural production and who are living in the rural areas.

Up to 1984, the rural population in Lhasa District numbered 179,815, 1.5 times more than in 1958. The mean annual growth rate, from 1958 to 1984, was 1.6 per cent. A great difference is revealed in examining numerical changes in annual growth rates over several time periods. The rural population increase from 1958 to 1963 was about 15 thousand, averaging 3,050 persons per year and an annual growth rate of 2.24 per cent. From 1963 to 1974, the rural population increased by about 25 thousand, representing an

annual increment of 2,260 persons and a growth rate of 1.6 per cent per annum. From 1974 to 1984, about 20 thousand were added to the rural population, indicating an addition of 2,030 persons per year and an annual growth rate of 1.2 per cent. The declining tendency in rural population growth was partly caused by the changes in population policy, and, in addition, by urban employment in Lhasa City. The rural population is distributed unevenly. The figures in Table 10 give the rural population, rural area, and population density of each county. This distribution pattern reflects differences in natural conditions, land productivity, and economic development among the eight counties. The population density along the lower reaches of the Lhasa Valley, namely Lhasa, Quxu, Dagze, and Doilung, is higher than the rest of the district (in Lhasa it is the highest). In the highland areas, i.e., Damxung, the population is sparsely distributed.

Since the 1960s, great efforts have been made to improve the public health services in Tibet. Medical care has been provided free of charge in the rural areas. Improved medical supplies and treatment have led to a decline in infant mortality and an increase in life expectancy. As a result the age pattern of the population changed, and the number of working population decreased. As Tibet is a relatively remote region and is a minority area (Tibetans accounted for 86.5% of the population in Lhasa District), policies regarding population have been relatively flexible. Because the fertility rate was exceeding the mortality rate (e.g., in 1983, the fertility rate was 2.01% while mortality was 0.63% in Lhasa District) continuously, it resulted in an increasing proportion of young age groups and therefore an increasing dependency syndrome.

Rural - urban migration is also another important factor influencing the relationship between the rural population and the agricultural labour force. Although employment is an important cause for migration, educated young people from rural areas also prefer to work in the city rather than for the agricultural labour force.

In relation to occupation, the labour force is classified into two groups: farm labourers and herdsman. Farm labourers

Table 10: Distribution of the Rural Population (1984)

County	Rural Population (person)	Rural Area (km ²)	Density (Person/km ²)
Maizho	33,203	5,308	6.3
Dagze	20,055	1,318	15.2
Lhasa	11,014	866 (-554)	35.3
Doilung	28,958	2,635	11.0
Quxu	24,126	1,581	15.3
Nyemo	23,693	3,162	7.5
Damxung	27,711	9,901	2.8
Lhunzhub	11,055	4,254	2.6
	(+32,101)		(10.1)

* Population of State farms. The situation of State farms is not discussed in this paper.

are mainly involved in crop production and herdsmen are mainly devoted to animal husbandry. In most cases, the activities of crop production and animal husbandry are mixed, especially along the middle and lower reaches of the Lhasa Valley.

The distribution pattern of the labour force and the changes over time can, more or less, give a general pattern of employment in agriculture (Table 11).

The characteristics of the development of animal husbandry in Lhasa District are described below.

Figures in Table 11 depict that the number of herdsmen is much less than farm labourers in most counties, except in Damxung where labourers are purely involved in animal husbandry; the growth in the numbers of herdsmen has been faster than in the case of farm labourers, especially after the 1970s. The ratio between farm labourers and herdsmen differs significantly by geographical positions; farm labourers in Lhasa and Quxu (the lowest area in Lhasa District) contribute more than 95 per cent to the total labour force. This proportion remained steady during the period

Table 11: Distribution of Farm Labourers and Herdsmen

	1958		1970		1984		% Increase ('58-84)	
	Farm labourers	Herds-men	Farm labourers	Herds-men	Farm labourers	Herds-men	Farm labourers	Herds-men
Maizho	12,198	1542	14,390	1,429	13,150	2,044	7.8	32.56
Dagze	7,302	293	8,260	752	8,60	1,320	17.79	450.51
Lhasa	5,753	148	6,100	200	6,462	257	12.32	73.65
Doilung	9,223	588	13,146	864	13,354	1,330	44.79	226.19
Quxu	8,878	391	1,031	489	11,268	488	26.92	24.81
Nyemo	7,478	965	10,350	1,332	10,255	1,504	37.14	55.85
Damxung	-	10,047	-	13,377	-	13,317	-	32.55
Lhunzhub	2,067	1,448	3,477	1,253	2,807	2,587	35.80	78.66
Total	52,899	15,422	56,754	19,696	58,156	22847	9.94	48.15
%	77.43	22.57	74.24	25.76	71.79	28.21	-	-

from 1958 to 1984; and, in Dagze and Doilung counties, the labour force engaged purely in animal husbandry increased rapidly (by 4.5 times and 2.3 times respectively), while, in other counties (except Damxung), the labour force has experienced a slight decline in the share of farm labourers.

Experience during the last three decades shows that the population in the urban areas grew faster than in the rural areas. However, the growth in the rural population exceeded the growth of labourers involved in agriculture, and the number of herdsmen increased more rapidly than farm labourers. Some basic tendencies in population changes are listed below.

1. The rural population migrated to urban areas. Most of the migrants were skilled (e.g., workers in construction) or educated people. Illiterates formed the majority of the agricultural labour force.
2. Young people account for a large proportion (more than 30%) of the population. More opportunities for employment are needed in the near future.
3. The proportion of herdsmen increased, while the proportion of farm labourers decreased. Employment in animal husbandry has had more potential than crop production, in terms of the ratio of farm labourers and herdsmen, between 1958 and 1984.

Table 17: Distribution of Farm Labourers and Herdsmen

County	1958		1970		1984		% Increase (58-84)
	Farm labourers	Herdsmen	Farm labourers	Herdsmen	Farm labourers	Herdsmen	
Maritime	12,198	1,540	14,700	1,420	13,150	2,044	7.8
Dagze	7,302	203	8,200	780	8,800	1,320	17.99
Lhasa	2,727	148	4,100	200	4,402	227	12.32
Doilung	9,223	288	13,140	804	12,224	1,330	44.79
Gaxa	8,408	301	1,031	480	11,268	488	26.92
Nyemo	7,478	462	10,320	1,322	10,282	1,304	37.14
Damxung	10,047	-	13,277	-	13,217	-	-
Linzhi	2,107	1,418	2,477	1,220	2,207	2,287	22.80
Total	52,899	12,422	66,724	10,686	64,126	22,847	9.84
%	77.82	22.17	74.24	25.76	71.79	28.21	-

IV. Interaction of Agriculture and Population

In the preceding sections we presented a broad overview of agricultural development and population growth in Lhasa District. An important fact is that varying tendencies, i.e., in crop production, numbers of livestock, population, and labour force, did exist in the period from 1958 to 1984. Identifying the relationship of these tendencies is the focus of this section.

Agricultural Production and Supply

The population is both the producer and the consumer. An increased population can provide a bigger labour force for production, but it also needs more products for consumption. Among the needs of the people, food is the most important. In Lhasa District, crop production plays the key role in the district economy. In the 1950s crop production provided the basic necessities for consumption, such as grain and cooking oil, to the local people. As the population continued to grow in the 1980s, crop production still served the same purpose even though the products improved a great deal. Because of the past and current limitations that persist in Lhasa District, e.g., those relating to transportation, it has always been necessary to maintain the food security level. Former experiences in crop production show that, despite the fact that grain crops account for more than 90 per cent of the

croplands and in spite of a gradual improvement in productivity, grain production has not been sufficient to meet the basic food demands of the increasing population. The import of foodgrains has been necessary every year without exception in the past three decades.

Based on local government records and using a linear regression method, a chart on food production patterns from 1958 to 1984 has been constructed (Figure 9). From 1958 to 1984, the grain production in the district increased 2.7 times, with an annual increment of 1,679 tons (on a statistical basis). During the same period, the population of the district grew considerably at a growth rate of 2.1 per cent per annum. In relation to crop production and the population, the grain availability per capita over several time periods is indicated in Table 12. In fact, the shortage of grain has been one of the key issues in the district economy.

The World Bank estimated that, in China, in 1980, the per capita grain consumption in the rural areas was 257 kg per annum (unmilled grain) and in the urban areas it was equivalent to about 400 kg (unmilled grain) per annum in 1980 (World Bank 1983). In 1984 when the harvest was normal, the grain availability per capita was much lower in Lhasa District than the national level.

Table 12: Grain Availability^a (1952-1984)

(kg per capita per annum)

	1952	1965	1970	1977	1979	1980	1984
China ^b	234	215	232	239	274	260	316
Tibet	94	149	151	228	185	218	201
Lhasa	116	168	147	211	161	204	194

^a Seed, feed, incremental reserves, and industrial uses are assumed to be 20% of gross production.

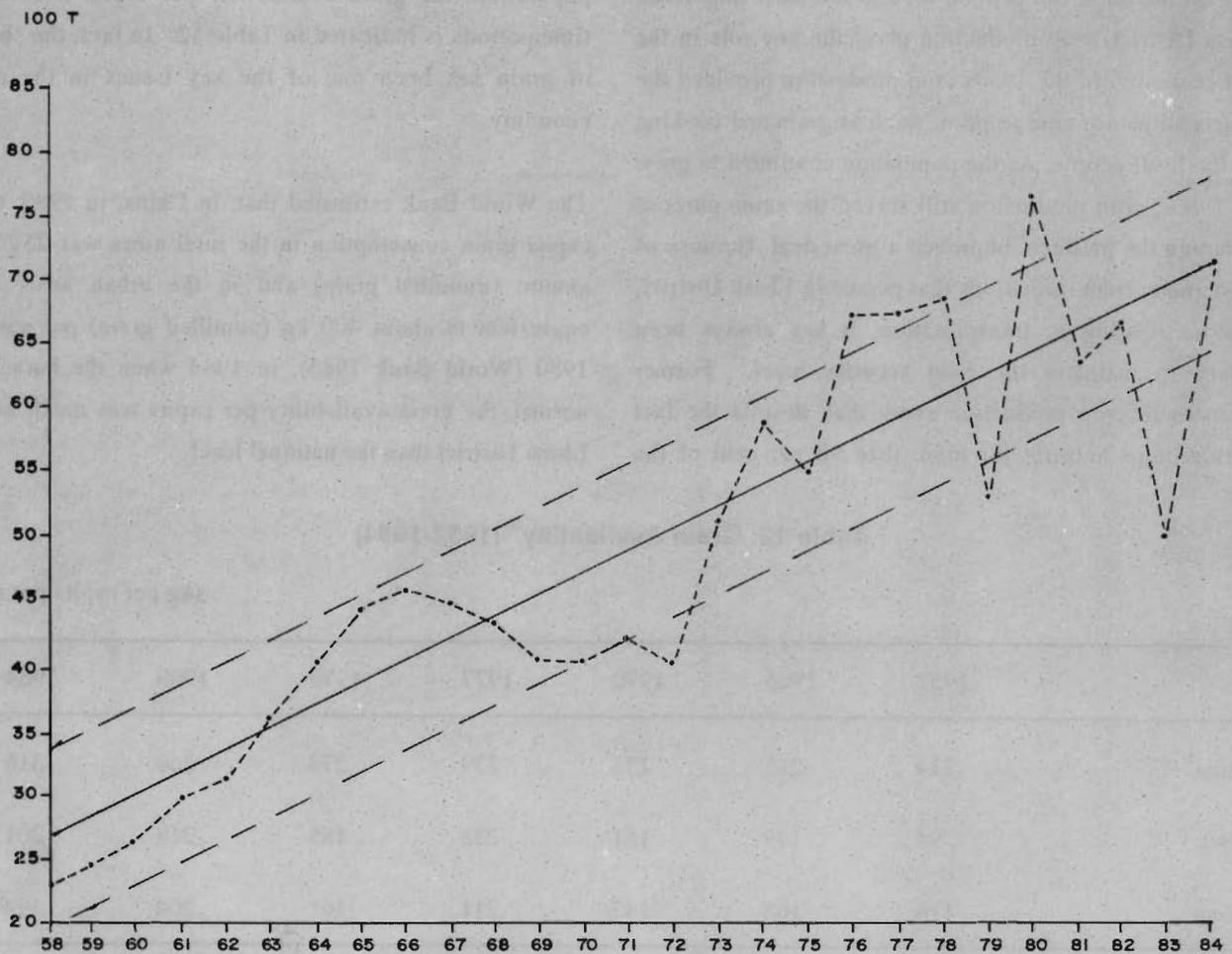
^b The data for China, from 1952 to 1980, are adapted from "The World Bank Country Study: China-Socialist Economic Development" Vol. II, p 62, 1983 and the data for 1984 are adapted from "Chinese Agricultural Yearbook", Agricultural Publishing House, 1985.

Figure 9: Grain Production and Its Incrementation in Lhasa District (1958-1984)

R = 0.904 > 0.487 ($\alpha = 0.01$)
 Y = 1.679 x - 71.614
 S = 6.436

	1000 ton	
1985	=	71.127
1990	=	79.523
1995	=	87.920
2000	=	96.316
2005	=	104.713
2010	=	113.109
2015	=	121.506
2020	=	129.902

± 6.346



It needed grain imports of 33.12 thousand tons, accounting for 45 per cent of the gross crop production, to meet the mean national grain consumption level. In reality, Lhasa District imported about 19.7 thousand tons of foodgrain in 1984. The mean per capita grain availability was increased to 263 kg per annum (total population as a whole), but this was still beneath the national level in 1980.

Looking at the food security situation in Lhasa District, some typical aspects should be emphasised. Firstly, it is not a real rural area, owing to the high proportion of urban population. Almost one-third of the people are living in the city and need

commercial grain supplies. Secondly, with the limitation of climatic conditions in the high mountains, productivity is not likely to increase significantly in the near future. And, lastly, in the case of the need for a better diet, certain cereal croplands will have to be transformed into horticultural lands.

Can crop production meet the population needs in the near future? Based on the regression shown in Figure 9, according to the tendencies of the annual increment in crop production and the tentative population growth (at a rate of 1.5% which is the local government target for the near

Table 13: Estimation of Crop Production and Per Capita Grain Availability (1990-2020)

Population : 1000 persons
 Crop production : 1000 tons
 Per capita grain availability : kg/person/year

Year	Crop Output (+/-6.4)	Population in Total		Rural Population	
		Population	Grain Per Capita	Population	Grain Per Capita
1984	69.4	285.6	194	179.8	309
1990	79.5	312.3	204	196.6	323
1995	87.9	336.4	209	211.8	332
2000	96.3	362.4	213	228.2	338
2005	104.7	390.4	215	245.8	341
2010	113.1	420.6	215	264.8	342
2015	121.5	453.1	215	285.3	341
2020	129.9	488.1	213	307.4	338

Note: Some assumptions implied by the figures in the table are listed below.

1. Crop production in Lhasa District will be more than sufficient for the needs of the rural population in the near future. Rural areas can provide surplus grain to urban areas.
2. Crop production will not be adequate to sustain the total population of Lhasa District in the near future if the present increments in crop yields continue. The import of grain products from other areas will be a necessity. The grain imported will be for the use of the urban population.
3. The grain supply level will improve before 2010 and decrease thereafter. This means that the pressure of cereal shortage in Lhasa District will be partially alleviated.

future), the output from crops and the per capita grain availability per annum in the coming three decades were estimated as indicated in Table 13. The estimation assumes that the arable land in Lhasa District will remain the same in future as it was in 1984 and the increase in crop production will rely mainly on productivity. Therefore, the productivity will have to increase from 2.46 tons per ha in 1984 to 4.58 tons per ha in 2020. This target is realistic because it is not so high as the former records (7.5-10 tons/ha). The estimation also assumes that the growth in population will slow down and that the urban-rural population ratio will be maintained, more or less, at the present level.

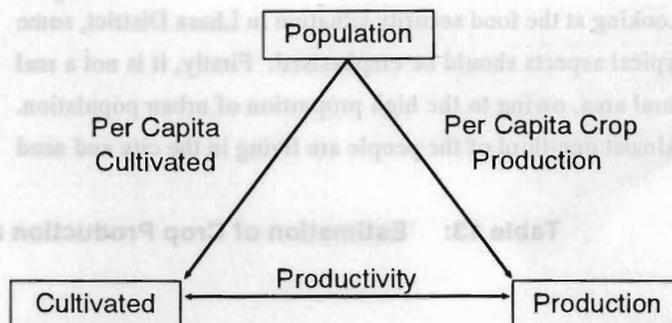
The need to provide basic minimum supplies of foodgrain for a growing population has dominated and will continue to dominate the agricultural strategy. At present, the import of foodgrain in Lhasa District depends upon subsidies from the Central Government. Thousands of trucks, travelling over one thousand kilometres, transport cereal grain from Sichuan or Qinghai Province. A recent survey by the author* revealed that the actual expenditure for transportation exceeds the real price of the foodgrain. A very big challenge will face the district economy, as well as its agricultural development, assuming that no subsidy will be provided in the future. To meet the foodgrain needs of the population, one option is to accelerate the development in crop production and the other is to continue importing. The former option depends upon the extent to which improved technology in crop and livestock production can be profitably mobilised. The latter option depends upon the ability to pay for these imports through exports or continued government subsidies.

In terms of the current situation in Lhasa District, food security is a key issue in the district economy. This issue can also be seen as a critical element in the land-food-population relationship.

In considering the land-food-population relationship, three elements are of basic importance: per capita land cultivated, land productivity, and degree of per capita crop production. Per capita land cultivated represents the availability of cultivated land to the rural population; productivity stands for the impact of integrated factors (e.g., climatic conditions, soil quality, improved technology, and management

efficiency); and the per capita crop production indicates the capacity of grain supply. These three elements link with, or cover, the other three elements as shown below.

Relationship of Elements



To identify the differences, the fuzzy matrix method is used to classify types of land-food-population interaction (see Annex). In doing so, the data for per capita land cultivated (land sown with oil seeds and vegetables) is not included, but per capita crop production and grain crop productivity (1984) for each county are used in the calculation. Damxung is treated as a typical category because there is no crop production. The basic data are shown in Table 14.

Lhasa, Quxu, Dagze, and Doilung are located along the lower reaches of Lhasa Valley where the climatic condition is suitable for crop production; the broad valley basin provides a large area of cultivable land. The management here is more intensive. These four counties could be defined as being more than self-sufficient in foodgrains, and they can provide surplus cereals to the market. According to a former survey (Gao Yixin et al. 1983), there are 2,500 ha of wasteland suitable for cultivation within the lower reaches of the Lhasa Valley. In future, the prospect of foodgrain supply will largely depend upon these four counties.

Maizho and Nyemo counties do not have any potential for increasing cultivated land. These two counties could, however, produce foodgrain for themselves and provide some surplus to the market when there is a good harvest. Future strategies should concentrate on improving productivity.

* The expenditure for transportation (in 1986) was 0.7 yuan per kg, while the mean retail price of cereal was 0.45 yuan per kg.

Table 14: Land Cultivated Per Capita, Crop Production Per Capita, and Productivity

County		Land Cult. Per Capita (ha/person)	Crop Per Capita Production (kg/person)	Productivity (ton/ha)
Maizho	1	0.125	271	2.18
Dagze	2	0.216	648	3.07
Lhasa	3	0.195	731	3.75
Doilung	4	0.211	551	2.62
Quxu	5	0.179	547	3.41
Nyemo	6	0.122	338	2.78
Lunzhoub	7	0.118	127	1.08

Lunzhub County is not as yet self-sufficient in foodgrain because of the shortage of cropland and low productivity.

Damung County is not suitable for crop production. The supply of foodgrain in the future will also depend on the commercial cereal supply.

Animal husbandry products in Lhasa District mainly consist of meat, milk (including dairy products), hides, and wool. Except for hides and wool, the products from animal husbandry are consumed locally. Meat and milk are the traditional components of the local people's diet. In rural areas red meat and dried meat are traditionally preferred, and dairy products (e.g., butter for making yak tea) are used daily. The demand for meat and milk products in urban areas is high, but the supply capability is still below the current demand.

Not many data are available regarding the exact quantity of livestock products before 1983, because the local people were accustomed to the traditional manner of trade (material-barter trade) rather than commercial or market trade. In addition, the statistical system, before 1983, paid more attention to numbers of livestock rather than products. The only data available about the livestock products in 1984 were acquired by the author and are given in Table 15. Compared to the average level for Tibet, the per capita productivity level of animal husbandry in Lhasa District is low and it cannot meet the demands of the local people. The

import of livestock products, e.g., meat and milk powder, is also a necessity in the area.

Meat and milk (dairy) are important components of the Tibetan diet. An increase in meat and milk production could mitigate the pressure on foodgrains. The livelihood of the people in future will depend partly on the development of animal husbandry.

The former policy, which was devised to encourage the increase of livestock, was inadequate. The most important immediate requirement is to match livestock numbers with carrying capacity through herd reduction and qualitative improvements. The policy objectives should shift from those of expanding animal numbers to increasing the output of animal products per unit of land area.

Animal husbandry production in Lhasa District is far from commercialised. Taking the figures for 1984, the dressing percentage (about 5.7% for cattle/yak and 12.5% for sheep or goats) was still very low. The reasons for the low rate are:

- a. limitation of transportation and storage capabilities to accommodate a reasonable scale of slaughter,
- b. high ratio of load-carrying livestock (15.7% of big livestock in 1984),
- c. insufficient marketing channels to stimulate the output of animal products, and
- d. the religious beliefs are against killing animals.

Traditionally, herdsmen used to butcher their animals at the beginning of the winter season. The number of animals to be slaughtered depended upon the herdsmen's judgement of their needs (red meat used during the cold season and dried meat used in the warm season) rather than the necessity to eliminate. Even at present, there is no fundamental move towards efficient collection and storage to facilitate slaughtering animals on a larger scale. The conflict between the short slaughtering period and daily demands is still a problem to be solved.

In addition to use as draught animals, livestock are also used for salt-grain exchange or other trade in the pastoral areas.

Table 15: Animal Husbandry Products (1984)

	Beef (ton)	Mutton or goat (ton)	Other meat (ton)	Milk (1000 ton)	Sheep wool (ton)	Goat wool (ton)	Cattle or yak wool (ton)	Sheep hide (x1000)	Goat hide (x1000)	Cattle or yak hide (x1000)
Production (1984)	3380	1236	168	14.25	292	103.4	176.3	70.5	45.5	35
Per capita of pastoral labourers (kg)	138	50	-	580	11.9	4.2	7.2	2.9	1.8	1.4
Per capita of rural population (kg)	18.8	6.8	0.9	79	1.6	0.6	1.0	0.4	0.24	0.19
Per capita of total population (kg)	-	16.8	49	1.0	0.4	0.6	0.24	0.16	0.12	-
Average level for Tibet (kg)	-	36.1	71	3.8	0.63	0.84	1.03	0.36	0.25	-
Average level* for China (kg) (1980)	-	12.3	1.4	-	-	-	-	-	-	-
Average level* for the United States (kg) (1980)	-	72.6 (red meat)	103.2	-	-	-	-	-	-	-

* Adapted from "A World Bank Country Study-China", Annex 2, p 74, 1985

One cattle or yak = 100 kg beef
 One sheep or goat = 10 kg mutton
 One pig = 40 kg p

Yaks, carrying about 50 kg, and sheep, carrying about 10 kg of goods, are driven 20 to 30 km each day. People are dependant on livestock for their livelihood. Whether or not the number of load - carrying animals can be reduced in the near future depends upon the development of the district economy.

The role of marketing was not fully understood in the past. The State purchasing system, with fixed low purchasing prices, did not encourage the sale of livestock products. After 1980, the quota - out quota - negotiation - market price system was introduced. However, as the marketing system was not yet established and marketing channels quite deficient, the herdsmen still wished to keep their animals provided they received satisfactory benefits.

Religious influences were quite strong until recently. Herdsmen were traditionally reluctant to butcher their animals as long as they could keep them. One or more free range animals, with red cloths tied around their heads, are kept in most pastoral households. These free range animals are kept alive (e.g., about 20 years for yaks) until their natural death.

Animal husbandry products are not merely an important source of income for farmers, they also meet a number of their basic needs. As argued earlier, we can conclude that livestock products have the potential for further development. Any substantial development in transforming traditional management into commercialised livestock production to meet the increasing needs of the population

requires efforts in several directions. Improving commercial channels and services could play a stimulating role.

To sum up, owing to the limitation of environmental conditions, the burden of urban population, and inadequate management, the agricultural production in Lhasa District could not meet the basic needs of the population. This situation might continue for a certain period in the future. To ameliorate the situation, improvement of crop production, exploitation of livestock potential, and identification and establishment of prospective export products should be part of the fundamental strategy over the long term.

Changes in Average Landholdings

Land is the fundamental agricultural resource and is used to sustain the growing population. The population size and the land available are closely linked and they determine the level of average landholdings. Under the law, land is the property of the whole nation rather than of any one individual, and collective groups or individuals can acquire the rights to use the land. As shown in Table 16, the average landholding pattern indicates that intensive and increasing pressures on the limited land base are the major elements in agricultural

change. The area of land per capita, in terms of both the rural population and the labour force, is declining. The term "average landholding" is broadly defined as the per capita mean landholding of the rural population or labour in the district or county.

The inconsistent increase in population, labour force, and arable land influenced the average holding of arable land. The rural population, at a growth rate of 1.6 per cent per annum, increased faster than the labour force (0.9% per annum). However, the increase in the labour force is greater than the increase in arable land (0.7% per annum). As a result, the land per capita cultivated by the rural population decreased by 32 per cent, and the land per labourer cultivated decreased by 9.9 per cent from 1958 to 1984. In addition, the ratio of farm labourers to the rural population increased from 1:2.27 to 1:2.71.

In future, decrease in labourers per amount of arable land and increase in the ratio of farm labourers to the rural population will be more or less unavoidable.

District-wise, the ratio of population to arable land (1984) was 10.2 persons per hectare in terms of the total population

Table 16: Average Landholding (1958 - 1984)

Year	Land Cultivated		Grassland	
	Rural population	Labour ^a	Rural population	Labour ^b
1958	0.201	0.454	22.3	50.3
1960	0.206	0.443	21.1	45.4
1965	0.204	0.453	19.7	43.8
1970	0.193	0.430	17.9	39.8
1975	0.176	0.439	16.5	41.2
1980	0.167	0.431	15.6	40.3
1984	0.152	0.413	14.8	40.1
Growth rate per annum	1.2 %	- 0.4 %	- 1.6 %	- 0.9 %

a Labour involved in crop production.

b Labour involved in both crop production and animal husbandry.

to total arable land and 6.4 persons per hectare in terms of the rural population to total arable land. Compared to Tibet and China (Table 17), the situation in the context of arable land available per capita in Lhasa District was worse in terms of total population and better in terms of rural population.

Table 17: Ratio of Population to Arable Land (1984)

	(person/ha)	
	In terms of total population	In terms of rural population
China*	10.0	8.0
Tibet	9.2	8.0
Lhasa	10.2	6.6

* The data for China are adapted from "China, Agricultural Yearbook, 1985" pages 93 and 114, Agricultural Publishing House, 1985

The ratio of rural population to arable land differs from county to county. Table 18 indicates the distributional patterns over several time periods. Among the counties involved in crop production, leaving aside Lhunzhub, the ratio of land to population is poor. The land-population ratio in Nyemo was the worst, not only because of the greater burden on land but also because the population has been increasing rapidly. In the counties along the lower reaches

Table 18: Rural Population - Arable Land Ratio (1958-1984)

County	(person/ha)			
	1958	1970	1984	Increase
Maizho	5.1	4.6	6.5	14
Dagze	3.7	3.7	4.5	0.8
Lhasa	3.5	4.8	4.5	1.0
Doilung	3.0	3.6	4.5	1.5
Quxu	4.0	4.7	5.6	1.6
Nyemo	5.6	6.9	8.2	2.6
Damxung	-	28.5	-	-
Lhunzhub	11.2	7.1	6.6	-4.6

* According to local experience one cattle/yak is equivalent to 5 sheep units, one horse/mule/donkey equals 3.6 sheep units, and one goat equals 0.7 sheep units. The calculation for total sheep units does not include swine.

of the Lhasa Valley, there is more arable land per capita, but the situation in Quxu was also not very encouraging.

A declining trend in the ratio of grasslands is also evident. Since the 1950s, the grassland per capita among the rural population has decreased by 50.7 per cent, at a rate of 1.6 per cent per annum, whereas, the labour/grassland ratio decreased by 25.4 per cent, at a rate of 0.9 per cent per annum. People have less and less grassland on which to rear their livestock. As a matter of fact, the population and the number of livestock were increasing but the area of grassland remained unchanged. As a consequence, heavier pressure was exerted on the grasslands.

In terms of sheep units*, the ownership per capita of sheep among the rural population and the grassland available per sheep unit are shown in Table 19.

In the past, increasing the number of livestock seemed to be the only way to solve the conflict between environment and population. Natural resources were limited to the increase in the number of livestock in the traditional management system, defined as semi-nomadic with low-grain feeding. New techniques to improve the productivity of the grasslands (e.g., through irrigation, planting fodder) could hardly be implemented in the past or even currently. On the other hand, the growing population needed more livestock to maintain their standard of living and for employment as well. The growing numbers of livestock are, from certain aspects, critical in the light of the growing population. As a matter of fact, this results in increased pressure on the environment. The available evidence suggests that most grazing areas are already seriously overgrazed and are in danger of progressive and, perhaps, irreversible degradation (Zhang Rongzu et al. 1982). In addition, the living herds suffered during bad weather (e.g., drought, very cold winters, etc) owing to which the breeding rate became very low and the death rate very high during certain years. Therefore, fluctuation in the numbers of livestock occurred.

As the population continues to grow, the livestock per capita tends to decrease. Figure 10 indicates two distinct periods with regard to increase in the number of livestock and in

Table 19: Comparison of Livestock - Rural Population - Grassland (1958 - 1984)

	Total sheep units (million head)	Sheep units per capita (head/person)	Sheep units per/ha of grassland (ha/sheep unit)
1958	2.20	18.4	1.21
1960	2.41	19.1	1.10
1965	3.08	22.9	0.86
1970	3.18	21.4	0.83
1975	3.33	20.7	0.80
1980	3.41	20.0	0.78
1984	3.66	20.4	0.73
increase %	+ 66.36%	+ 10.87%	- 39.67%

Note:

- 1) As the average grassland per capita of the rural population declined, the space available for living animals decreased. The herds became more and more crowded and the burden on grazing land became heavier, creating difficulties for long-term sustainability.
- 2) The livestock per capita of the rural population has changed or reduced little since the mid-1960s, although livestock numbers increased by 66 per cent.

livestock per capita. In the first period (1958-1967), the livestock numbers (in sheep units) increased by 49.6 per cent, at a growth rate of 4.5 per cent per annum. Simultaneously, the rural population increased by 16 per cent, at a rate of 1.7 per cent per annum. This resulted in an increase in the strength of the labour force and an increasing tendency in terms of the livestock per capita. This period can be defined as a period of rapid improvement in animal husbandry, because of the large range of grasslands that were exploited step by step. In the second period (1968-1984), the increase in livestock numbers slowed down. Numbers increased (in sheep units) only by 14 per cent, at a rate of 0.83 per cent per annum. In the meantime, the population grew continuously; it increased by 28 per cent, at a rate of 1.55 per annum.

The second period can be defined as a fluctuating, or as a negatively balanced, period because the livestock per capita decreased notably. As the grassland was already fully used, the increase in the livestock numbers was restricted by the limited natural resources. Future prospects depend upon intensive management of grassland rather than its mere usage.

Productivity of Labour

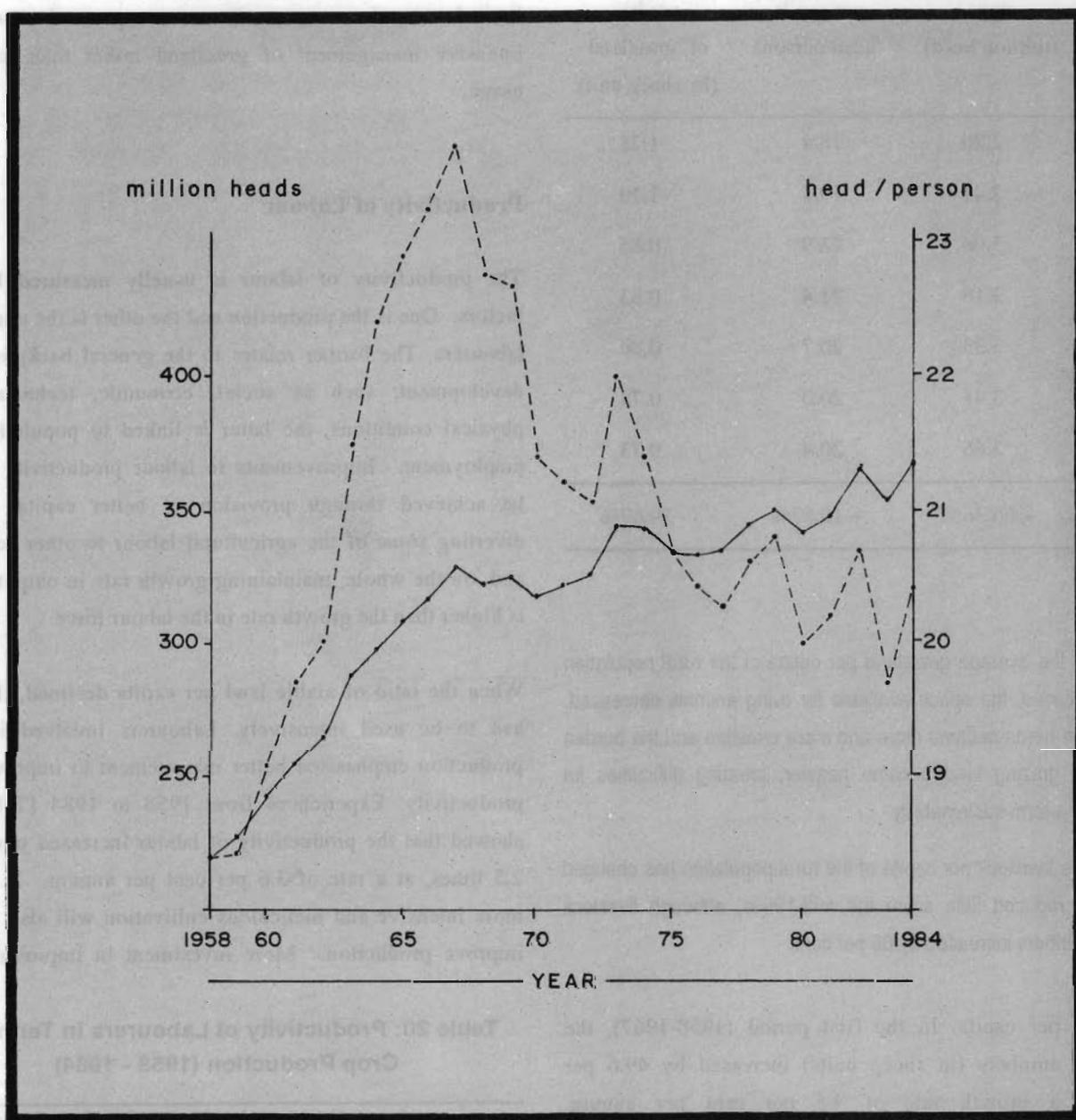
The productivity of labour is usually measured by two factors. One is the production and the other is the number of labourers. The former relates to the general background of development, such as social, economic, technical, and physical conditions, the latter is linked to population and employment. Improvements in labour productivity should be achieved through provision of better capital inputs, diverting some of the agricultural labour to other activities and, on the whole, maintaining growth rate in output which is higher than the growth rate in the labour force.

When the ratio of arable land per capita declined, the land had to be used intensively. Labourers involved in crop production emphasised better management to improve their productivity. Experiences from 1958 to 1984 (Table 20) showed that the productivity of labour increased more than 2.5 times, at a rate of 3.6 per cent per annum. In future, more intensive and meticulous cultivation will also help to improve production. More investment in improving land

Table 20: Productivity of Labourers in Terms of Crop Production (1958 - 1984)

	Productivity kg/labourer/ per annum	Output value yuan/ labourer/per annum at 1980 constant prices
1958	413	183
1960	464	201
1970	595	269
1980	1110	461
1984	1059	458
Growth rate	+ 3.6%	+ 3.6%

Figure 10: Numbers of Livestock and Sheep Units Per Capita for the Rural Population (in Sheep Units)



----- Number of sheep units

_____ Sheep units per capita

productivity will also help to improve the productivity of labour.

The increase in the labour force leads to a decline in the average grassland holding per capita. The fact that the labourers have to work on less land with more livestock was experienced from 1958 to 1984. The changing process of productivity, in terms of sheep units and output value per labourer, is shown in Table 21. Positive changes are

recognised. The average output per labourer, in terms of rearing animals, increased by 25 per cent and the average productivity per labourer increased by 69 per cent. Should the future strategy for animal husbandry shift from raising the number of livestock to increasing the slaughtering rate (reaching 10 to 15% for cattle/yak, 15-20% for sheep/goats, instead of 5.7% and 12.5% respectively as of 1984), then the average output per labourer would change fundamentally.

Table 21: Productivity of Labourer* in Animal Husbandry (1958 - 1984)

	Sheep units/ labourer	Output value <i>yuan</i> / labourer/per annum, at 1980 constant prices
1958	32.2	202
1960	32.2	206
1970	36.8	234
1980	38.6	297
1984	40.3	341
Increasing rate	+ 0.86%	+ 2.1%

* The numbers calculated here are the total number of labourers involved in agriculture because labourers involved in crop production are also involved in livestock production.

'Sideline' activities are not direct land-based activities. But the development of 'sideline' activity-based production has become more and more important. At the beginning of the 1970s, the productive value per labourer from 'sideline' activities was about 30 *yuan* (at 1980 constant prices). It increased to about 60 *yuan* in 1980 and reached 175 *yuan* in 1984 (at 1980 constant prices). It is a sign that the workers are diversifying their occupations.

For maintaining/improving the productivity of labour, diversion of the labour force from limited land-based activities could be of significant importance. In doing so, the core issue is to set up a number of activities that can absorb the surplus labour force. Solving this issue is not an easy task but is an important strategy for environmentally- balanced development of the district economy.

V. Lessons from Past Experiences

Indicators of Change and Causes of Change

This paper has discussed the general features of agricultural development, population growth, and their interactions in Lhasa District from 1958 to 1984. A review of the indicators shows that many changes have taken place in the development process. The major indicators of change and their implications are listed in Table 22.

Looking at the changing process of agricultural production and population, it has been noted that the impact of agricultural development has exceeded population growth. The important features are that the living standards of the

people improved e.g., the per capita income of the rural population increased from 125 *yuan* per annum in 1971 to 384 *yuan* per annum in 1984 at 1980 constant prices, the productivity of the labour force increased, and the availability of grain per capita improved. At the same time, some problems, such as the decline of arable land per capita, became more and more critical.

Lhasa District, the economic centre of Tibet, faces problems of economic and environmental sustainability. In the past, the district was not a self-sufficient area. Since the agricultural sector dominated the district economy, the growing population, and their increasing needs depended

Table 22: Agriculture-Population Interaction: Indicators of Change and Causative Factors (1958-1984)

Indicators	Causative Factors
1. Grain availability per capita (improved)	Arable land increased, production level improved, input increased
2. Grain supply and demand (shortage in supply) <ul style="list-style-type: none"> . present situation . tendency 	Limited resources, limited scope for intensive use of land, population pressure on land, unstable increase in productivity
3. Average landholding (decreased) <ul style="list-style-type: none"> . land cultivated per capita . land cultivated per labourer . grazing land per sheep unit . grazing land per labourer 	Faster increase in population, limited land for cultivation and grazing, domination of land-restricted activities
4. Livestock output per capita (relatively low)	High ratio of load-carrying livestock, limited transport and storage facilities, insufficient marketing channels
5. Output capability of labour (improved) <ul style="list-style-type: none"> . output productivity . output value 	Productive techniques improved, intensive land use
6. Agricultural income per capita (increased)	Increase in production, diversified source of income (after 1980)
7. Burden of population on agriculture (increased) <ul style="list-style-type: none"> . urban/rural ratio . age structure 	Urban population and young population increased the demand on agricultural production

heavily upon agricultural development. In future, the main emphasis will continue to be on the improvement of agriculture which will be the main economic resource for some time to come.

Reviewing the experiences in Lhasa District, we can say that agricultural development has been restricted by the prevailing environmental conditions. Improvement of agricultural production should rely more on the integration of agricultural and environmental management of agriculture and of the environment.

Sustainability Assessment

Although agricultural development in Lhasa District has significantly improved, it has not been able to sustain the needs of its population. The problem of sustainable agriculture is evident from the four aspects discussed below.

First productivity -- both the labour available and the area of land have not kept pace with the population growth and increasing needs. Increases in the productivity of agricultural labour permit agricultural incomes to grow quite rapidly. But it is not easy. One reason why is that the increasing labour force has not had enough opportunity to engage in non-agricultural activities. Farmers are bound to the limited land base from generation to generation. Intensive land use with more labour inputs has not improved labour productivity. Another reason is that the technology level and management level have not changed basically in the past three decades. Extensive cultivation, poor irrigation systems, and the simple implements used have not improved the function of labour in production. Increase in land productivity depends upon land availability. Experiences from Lhasa District show that marginal land reclamation has been a failure. Reasonable land use needs alternative uses to maximise land productivity.

Secondly, there is an increasing instability in agricultural production. The production fluctuated sharply during certain years. Natural hazards, pests, and mono-production are the main factors in instability. In Lhasa District, the major hazards have proved to be gales, droughts, and frosts. Gales occur frequently from February to April (6 days a month on average). They often damage winter crops and grasses and

cause the inter-monsoon drought to affect the productivity of rainfed farming. More than 40 per cent of the croplands are still covered by irrigation schemes. Almost every year, frost causes a decrease in crop yields from high croplands (above 3,900 masl) and the current forecast and prevention measures are far from sufficient. Controlling diseases (both plant and animal) and insect pests is not an easy task because of the shortage of agricultural technicians and the limitations of agricultural support services. In addition, mono-cropping sometimes results in a very sharp decline in productivity. The introduction of "Fei Mai" (a species of wheat), which brought about a sharp decline in productivity due to widespread transmission of disease (1979), is a very good example. It shows that diversified farming is a necessary condition to mountain agriculture.

Thirdly, a balanced sectoral development within agriculture has not been achieved. One reason is that different sectors in the farming system are unevenly developed. Before 1979 the policy stressed "grain crops as the key link", following which large areas of marginal land and high altitude land were cultivated. Although grain production increased to some extent, the other agricultural sectors improved very slowly. Consequently, over-reclamation caused land degradation, and this further constrained the development of other sectors.

Another reason for unbalanced development in agriculture is related to geographical differences. Following the introduction of economic reforms (1980), horticultural development (fruit, vegetables) in the valley area led to a rapid increase in rural incomes. Increases in the prices of livestock products benefitted herdsmen in highland areas. Recently, the discrepancies in rural incomes between different regions has widened. Midland areas, namely the Maizho, Nyemo, and Lhunzhub counties, have been left behind. These areas need production readjustment in order to improve their income levels.

Fourthly, over-exploitation of natural resources has resulted in the deterioration of the ecology and the environment. Soil erosion and grassland degradation are extensive in Lhasa District. Because of the high demand for food, croplands were cultivated year after year and this resulted in coarser soil texture (wind erosion) and a decline in the natural fertility of the soil. More manures

and fertilisers are needed to maintain the productivity level. Because of the increase in livestock and hardly any improvement in livestock management, both the productivity and the quality of grassland worsened. Energy shortage is one of the key problems. In relatively populous areas, especially around Lhasa City, soil erosion increased more seriously. As shrubs were cut for firewood many valley slopes quickly changed into barren land and this process moved higher and higher up the slopes as time passed. Grass roots in the meadows are uprooted for fuel purposes. Ecological conservation is not a simple task, alternatives must be found to solve the basic demands of the population.

Issues in Development

At present, Lhasa District is not self-sufficient in basic food supplies. The district economy has benefitted from the 'no-taxes in agriculture' and the high-subsidy policies of the Central Government. Can the district economy be managed to bring about sustainable development in the future? Some issues should be considered in this context.

As Lhasa District is a minority area, the population policy will continue to be flexible in future. Although family planning has been encouraged, the population growth will definitely exceed the proposed target (1.5% per annum) set by the Government. Therefore, the economic development of the district cannot depend upon a decrease in the population growth and must concentrate on rational management of the existing natural resources and their development potential.

The economic capacity of a region can be seen from two aspects. One is the self-sustaining capacity and the other is the export capability. Lhasa District is relatively weak in the first aspect, but it is even worse in the second. This is mainly because of the biased policies imposed on areas with fragile mountain resources; policies that did not consider their many potentials.

At present, the policy of the Tibetan Government calls for "developing animal husbandry first, coordinating animal husbandry, agriculture, and forestry, corresponding to local

conditions, and promoting multi-enterprises and cash crops" (Zhang Rongzu 1989). In the case of Lhasa District, there is no doubt that animal husbandry has potential, but some problems might be worth considering in light of the policy call to "put animal husbandry as the first priority".

- Compared to land-based production, animal husbandry depends upon natural conditions. The improvement of vast rangelands in the mountain terrain, e.g., through mobilising irrigation and increasing fertiliser use, is not easy and has not progressed very far.
- So far, animal husbandry is prevalent in the highland areas, while most of the population are living in the lower areas, especially in the valley basin areas. The relationship between population distribution and labour availability for animal husbandry needs to be studied carefully.
- Crop production is unable to meet the basic needs of the population. The foodgrain consumption of Lhasa District has depended heavily upon subsidies. If animal husbandry is prevalent in the valley basin areas, the big demand for fodder will compete with crops for land use.
- The development of animal husbandry is closely linked to the socioeconomic situation. Changing sociocultural practices and improving marketing systems and transportation are not easy. They require effort, time, and heavy investment.

The many constraints in the recent research and extension system are discussed below.

Shortage of Manpower

Researchers and technicians (1985) account for only 0.4 per cent of the population in Lhasa District; lower than the average for China as a whole (0.64%). Among the researchers and technicians who are in Lhasa District, only 15.4 per cent are involved in agriculture (Ren Gueling 1986), and they including 107 veterinarians, four grassland researchers, and 64 technicians. The technical manpower in fields other than agriculture is even more limited.

Lack of Continued Support

During the period of the people's commune, agricultural extension stations were established in each county. With changes in the production system, these extension institutions did not operate because of lack of financial support. They shifted their functions from extension to their own production. Neglect of agricultural extension will hamper agricultural development in the long run.

Inadequate Communication

Because illiteracy is prevalent in the rural areas, there is a need for widespread demonstration and easily understood instruction programmes to encourage farmers to adopt new techniques of production and management.

Under the Responsibility System, farmers have a strong incentive to make more efficient use of inputs for agricultural production. At present, the marketing system in Lhasa District is inadequate in terms of input. The major constraints in this respect are discussed below.

- The input supply has been administratively managed by the State market through planned allocation. Because of limitations in the input demand assessment and distribution system, farmers are unable to purchase the required amount of inputs.
- At present the open market (free market system) is in operation at the subcounty level. It mainly markets consumer goods, not input supplies. Collective or individual trade in agricultural inputs could contribute to household agriculture, provided that quality control can be ensured.
- Household production also faces difficulties regarding access to markets. In filling the gaps in input supply, the village cooperatives could play an important role. Household management in agriculture needs information and appropriate assistance through intermediate institutions.

To sum up, the past successes and failures provide lessons for future development in Lhasa District. The past achievements are encouraging, but much more effort is

necessary in many fields of activity. In formulating future development strategies, the three aspects listed below are very important.

1. Development policies and programmes should be linked to different sectors. Integrated development is likely to be more sustainable in the district economy.
2. Development objectives should match the potentials, and diversified approaches need to be adopted in view of the extensive degradation of the environment.
3. Public interventions should be strengthened, new institutions in research and extension need to be established, and technological assistance, and marketing systems need to be strongly supported.

Conclusions

The farming systems in Lhasa District are dominated by agro-pastoral farming systems. This paper focusses on the interaction of agriculture and population in Lhasa District during the period from 1958 to 1984. The paper reviews the experiences in agricultural development and population growth, identifies major interactions between agriculture and population, and addresses some of the issues raised by population-agricultural interactions in the context of sustainable agricultural development in mountain areas.

Lhasa District is the centre of Tibet not only in terms of geographical location but also in the context of politics, economics, culture, communications, and commerce. The physical conditions in Lhasa District are characterised by high elevation, a vast mountain terrain, and a semi-arid and temperate climate. The land use pattern of the district is limited by the physical environment. Crop cultivation prevails in areas below 4,200 masl and animal husbandry is prevalent in areas above this. Land involved in agriculture occupies 92.6 per cent of the total area of the district. The economic situation of Lhasa District is relatively better than in other parts of Tibet because its level of economic development is higher. This is, however, not a cause for satisfaction because it is not

yet economically self-reliant. Heavy subsidies from the Central Government are needed every year.

Agriculture plays an extremely important role in the district economy. Since the 1950s, four distinct periods, a slave society - democratic reform - cultural revolution - readjustment, can be distinguished. These social transformations had a strong influence on agricultural development.

The components of agriculture in Lhasa District cover various sectors, including crop production, animal husbandry, forest-based activities, and fisheries. Among these, crop production and animal husbandry are obviously the most important.

The cropland in Lhasa District accounts for 0.9 per cent of the total land and the predominant crops are cereals. From 1958 to 1984 the output of cereal crops increased 3.2 times, mainly because of (i) increases in arable land (from 25 thousand ha to 28 thousand ha), (ii) growth in yield per unit area (about 1 ton per ha to 2.5 tons per ha), (iii) changes in cropping patterns (wheat, replacing pulses, became the second most important crop), and (iv) changes in the distribution pattern of crops (crop production increased more rapidly in the lower reaches of the Lhasa Valley). The increase in crop productivity has made a significant contribution to improvement in overall production.

Animal husbandry, characterised mainly by semi-nomadic herding, is the established tradition of the district. About 26,600 sq.km. of rangeland were used to support 1.46 million head of animals in 1984. In moving from the valley floors to the high mountain lands, the significance of pastoralism increases. From 1958 to 1984, the livestock increased by 68 per cent, at the rate of two per cent per annum. Cattle (yak) represent the highest proportion of animals and the number of sheep is increasing rapidly. At present, the density of livestock is higher in the lower reaches of the Lhasa Valley than in highland areas.

The population of Lhasa District, in 1984, totalled 285,591 persons, with an average density of 9.8 persons per km². The urban-rural population distribution was 37 and 63 per

cent respectively. From 1958 to 1984, the rural population increased by more than 50 per cent, at the rate of 1.6 per cent per annum. The labour force involved in agriculture accounted for about 50 per cent of the rural population in 1984. The growth in labour force was slower than in the rural population, reflecting an increasing burden of dependency. Increases in the number of herdsmen were greater than the number of crop farmers.

Lhasa District is not yet self-sufficient in terms of agricultural production. The increase in food production has not kept pace with the demands of the increasing population. Import of foodgrains has been necessary. If the annual increment in grain production (about 1,700 tons/per annum) is maintained and the growth of population slightly lowered (1.5% per annum), in future the crop production in Lhasa District will not be able to sustain the demands of the total population, but could, however, be sufficient to meet the needs of the rural population.

The current land-food-population relationship reveals four types of area - grain surplus area, grain self-sufficient area, grain shortage area, and grain dependency area. The future agricultural strategies for each of these areas should be different.

The productivity per capita from animal husbandry in Lhasa District was higher than in China as a whole but lower than Tibet as a whole. Meat and dairy products are traditional components of the local people's diet. Livestock production has further potentials for development. The transformation from traditional management to commercialised production will be important for achieving higher productivity.

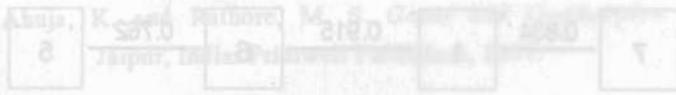
The increasing pressure on the limited land base is the major agricultural problem in Lhasa. Continuous growth in the population brought about a decline in the agricultural land per capita. During 1958 to 1984, the contribution per labourer increased by about 150 per cent in crop production and 75 per cent in animal husbandry. The future prospects for agricultural production will also depend largely upon the improvement in labour productivity.

Reviewing the experiences in agricultural development and population growth in Lhasa District from 1958 to

1984, the impact of agricultural improvement has exceeded that of population increase. However, certain problems have also become increasingly serious.

The sustainability aspect of the development process in Lhasa District is weak mainly because (i) productivity,

both in terms of labour and area of land, did not keep up with the population growth and the increasing needs, (ii) agricultural production is unstable, (iii) balanced sectoral development, within agriculture, has not been given sufficient attention, and (iv) the ecology and environment is becoming more fragile.



APROSC. Integrator of Population with Agriculture.



Bloom, D. E. et al. "The Effects of Rapid Population Growth on Labour and Employment". In *Population and Development in India*. (1974)

Year	1950	1955	1960	1965	1970	1975
Population (Millions)	360	400	450	500	550	600
Area (Million Hectares)	160	170	180	190	200	210
Yield (kg/ha)	1000	1100	1200	1300	1400	1500

Table 1. Agricultural Development in India

Lin Dawe et al. "Study of Yellow Rust Disease in Wheat in Tibet". In *Selected Papers on Agriculture and Animal Husbandry*. Lhasa: Tibetan Publishing House, 1985.

Lin Dawe et al. "Study of Yellow Rust Disease in Wheat in Tibet". In *Selected Papers on Agriculture and Animal Husbandry*. Lhasa: Tibetan Publishing House, 1985.

Lin Dawe et al. "Study of Yellow Rust Disease in Wheat in Tibet". In *Selected Papers on Agriculture and Animal Husbandry*. Lhasa: Tibetan Publishing House, 1985.

$$Y = \frac{1}{1 - C} \sum_{i=0}^{t-1} C^i X_{t-i} \quad (When i = 1)$$

$$Y = \frac{1}{1 - C} \sum_{i=0}^{t-1} C^i X_{t-i} \quad (When i = 2)$$

Lin Dawe et al. "Study of Yellow Rust Disease in Wheat in Tibet". In *Selected Papers on Agriculture and Animal Husbandry*. Lhasa: Tibetan Publishing House, 1985.

Lin Dawe et al. "Study of Yellow Rust Disease in Wheat in Tibet". In *Selected Papers on Agriculture and Animal Husbandry*. Lhasa: Tibetan Publishing House, 1985.

Annex

The steps involved in the calculation are given below.

- 1) Standardising the original data using formula:

$$X = \frac{X' - \bar{X}}{C}$$

In which X' is the original data, \bar{X} is the mean value of the original data, and C is the covariance of the original data.

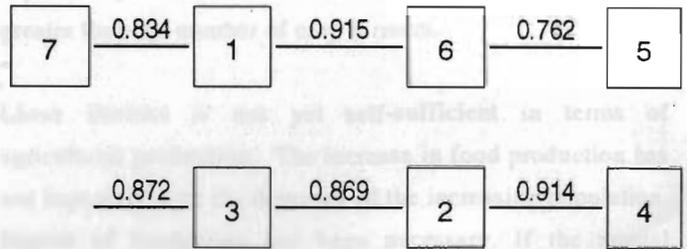
- 2) Demarcating the standardised data, using the formula:

$$r_{ij} = \begin{cases} 1 & \text{(When } i = j) \\ 1 - C \sum_{k=1}^m |X_{ij} - X_{jk}| & \text{(When } i \neq j) \end{cases}$$

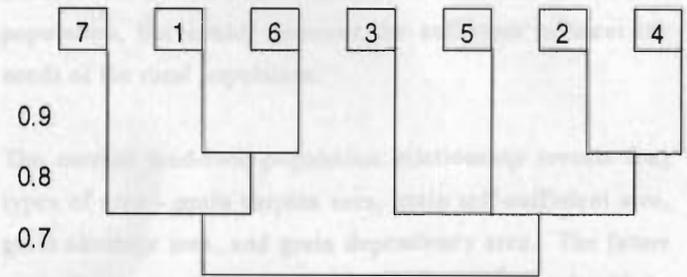
Selecting $C = 0.08$ $m = 3$, $i, j = 1, 2, 3 \dots 7$, the fuzzy matrix R is established as follows:

1	0.614	0.561	0.700	0.686	0.915	0.834
1		0.869	0.914	0.864	0.688	0.449
	1		0.802	0.872	0.634	0.395
		1		0.868	0.744	0.534
			1		0.762	0.523
				1		0.761

- 3) Using Krustal's Method, the "maximum branches" are transferred from the fuzzy matrix.



- 4) The dynamic classification chart is drawn.



- 5) If the value λ is chosen as 0.84, three categories can be classified. Including the special category - Damxung, there are four types of land - food - population relationship in Lhasa District.

References*

- Agricultural Publishing House. *Chinese Agricultural Yearbook*. Beijing: APH, 1985 (in Chinese)
- Ahuja, K. and Rathore, M. S. *Goats and Goatkeepers*. Jaipur, India: Printwell Publishers, 1987.
- APROSC. *Integration of Population with Agriculture, Livestock and Forest*". Nepal : Agricultural Projects' Services Centre, 1985.
- Bloom, D. E. et al. "The Effects of Rapid Population Growth on Labour and Employment". In *Population and Development Review*, Vol.12, No.3, Sept. 1986.
- CAS. "Agro-resources Evaluation and Agro-regionalization of Tibet" (In Chinese). China: Chinese Academy of Sciences, 1980.
- Cheng Hong et al. "*Agricultural Geography of Xizang (Tibet)*". In Chinese. China: Science Press, 1984.
- Edwin L. et al. "China, Long Term Development Issues and Options". A World Bank County Economic Report. Washington D.C.: The World Bank, 1985.
- Gao Yixin et al. "Natural Resources of Agriculture in Tibet". In *Evaluation of Agricultural Resources* p 19, 1986.
- Gao Youxi et al. "*Climate of Xizang (Tibet)*" (In Chinese). China: Science Press, 1984.
- Jodha, N. S. "Population Growth and the Decline of Common Property Resources in India". In *Population and Development Review*, Vol.11, No. 2, New York: The Poulation Council, June 1985.
- Jodha, N. S. Banskota, M. and Pratap Tej (eds) 1992. *Sustainable Mountain Agriculture*. Delhi: Oxford IBH Co, 1992.
- Lin Dawa et al. "Study of Huag Tiao Xioye Disease in Wheat in Tibet". In *Selected Papers on Agriculture and Animal Husbandry*. Lhasa: Tibetan Publishing House, 1985.
- Liu Yanhua et al. "Land Type Study in Lhasa Valley Region". In *Mountain Research*, (In Chinese), Vol 3, 19.
- Luo Hamxian. *Economic Changes in Rural China*. Beijing: New World Press, 1985.
- Ren Gueliang. "Discussion on Researchers and Technicians in Tibet" In the *Science and Technology Policy of Tibet*, p 70, 1986.
- Swarup, R. et al. *Agricultural Development in Himachal Pradesh*. Himachal Pradesh: Agricole Publishing Academy, 1982.
- World Bank. *China-Socialist Economic Development, Vol II*, Washington D.C.: World Bank, 1983.
- Yu Guangyuan et al. *China's Socialist Modernisation*. Beijing: Foreign Languages Press, 1984.
- Zhang Rongzu. *Mountain Environmental Management Nyemo County (Tibet), China*. Occasional Paper No. 13. Kathmandu: ICIMOD, 1988.
- Zhang Rongzu et al. *Physical Geography of Xizang (Tibet)* (In Chinese). Beijing: Science Press, 1982.

* A number of the documents by Chinese authors are not available in translation and publishers and places of publication are not available for two of them.

The Author

Dr. Liu Yanhua, an economic geographer by training, is a senior scientist at the Chinese Academy of Sciences and is working at the Institute of Geography, Beijing.

He is a specialist on the development problems of Tibet, having worked in and on the development problems of the region for more than a decade. He has not only published several research papers and books on Tibet, but has been engaged in advisory work on Tibet for both the Tibetan and Chinese national governments. He prepared this paper while working at ICIMOD.

Agarwal, R. S. (1982). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1983). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1984). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1985). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1986). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1987). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1988). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1989). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1990). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1991). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1992). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1993). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1994). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1995). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1996). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1997). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1998). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (1999). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2000). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2001). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2002). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2003). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2004). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2005). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2006). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2007). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2008). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2009). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2010). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2011). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2012). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2013). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2014). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2015). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2016). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2017). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2018). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2019). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Agarwal, R. S. (2020). *Land Use and Development in the Himalayas*. Oxford: Oxford University Press.

Founding of ICIMOD

ICIMOD is the first International Centre in the field of mountain area development. It was founded out of widespread recognition of the alarming environmental degradation of mountain habitats and the consequent increasing impoverishment of mountain communities. A coordinated and systematic effort on an international scale was deemed essential to design and implement more effective development responses based on an integrated approach to mountain development and mountain environmental management.

The establishment of the Centre is based upon an agreement between His Majesty's Government of Nepal and the United Nations Educational Scientific and Cultural Organisation (UNESCO) signed in 1981. The Centre was inaugurated by the Prime Minister of Nepal in December 1983, and began its professional activities in September 1984, with the support of its founding sponsors:

**HMG Nepal, the Government of Switzerland,
the Federal Republic of Germany, and UNESCO**

The Centre, located in Kathmandu, the capital of the Kingdom of Nepal, enjoys the status of an autonomous international organisation.

Participating Countries of the Hindu Kush-Himalayan Region

- Nepal
- India
- Bhutan
- Bangladesh
- China
- Pakistan
- Myanmar
- Afghanistan

**INTERNATIONAL CENTRE FOR INTEGRATED
MOUNTAIN DEVELOPMENT (ICIMOD)**

4/80 Jawalakhel, G.P.O. Box 3226, Kathmandu, Nepal

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

Telex: 2439 ICIMOD NP
Cable: ICIMOD NEPAL