

No. 08

**BASIC DESIGN STUDY  
ON  
AGRICULTURAL MECHANIZATION PROJECT  
IN  
THE KINGDOM OF BHUTAN**

**JANUARY 1983**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

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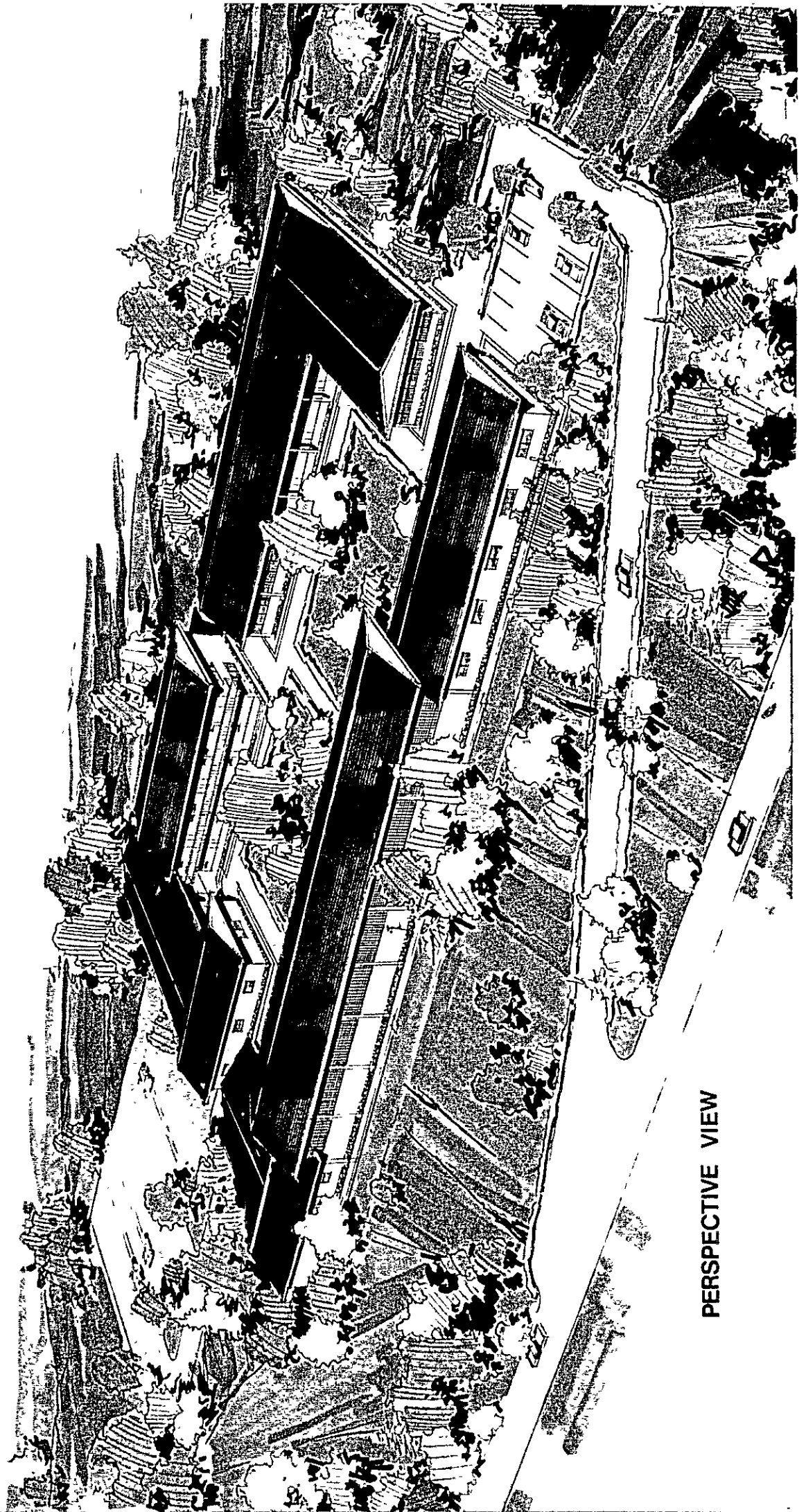


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**JAPAN INTERNATIONAL COOPERATION AGENCY**

国際協力事業団	
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PERSPECTIVE VIEW





## PREFACE

In response to the request of the Government of the Kingdom of Bhutan, the Government of Japan decided to conduct a survey on the Agricultural Mechanization Project and entrusted the survey to the Japan International Cooperation Agency. The J.I.C.A. sent to Bhutan a survey team headed by Mr. Tadashi Shinoura, head, Basic Design Div., Grant Aid Dept., J.I.C.A. from 12th September to 10th October, 1982.

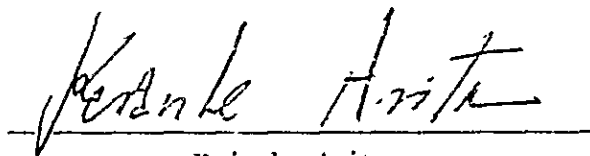
The team had discussions with the officials concerned of the Government of Bhutan and conducted a field survey.

After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Bhutan for their close cooperation extended to the team.

January, 1983

A handwritten signature in black ink, appearing to read 'Keisuke Arita', is written over a horizontal line.

Keisuke Arita

President

Japan International Cooperation Agency



## SUMMARY

With the rapid change from a closed-door-country to a modern country in recent years, the Kingdom of Bhutan has been suffering from various kinds of difficult problems. One of the most serious problems is the labour shortage combined with the low agriculture productivity (low labour efficiency and low land productivity). It is generally believed that the most direct and effective way to solve the problem is to mechanize the farming practices.

The agricultural mechanization straightly aims at releasing the farmers from their painful drudgery, performing timely seasonal operation, reducing the labour input per operation, achieving self-sufficiency in food grain production and expanding cash-crop cultivation and its marketing.

Another objective is to introduce small scale earth moving equipments and machines so that they may release farmers from their great burden of public works such as farm-road construction, irrigation facilities construction, water reservoir construction, school and hospital construction, etc., the labour contribution which is obligatory to farmers and is of special necessity in Bhutan.

As a result of making on-the-spot survey and reconnaissance survey on the general conditions, analysing and examining the collected data and further holding discussions with officers in charge, the following plan was proposed.

Firstly, a plan of a nation-wide mechanization network has been drawn up, and the core of the network is the National Agriculture Mechanization Center. Next, dividing the whole country into 4 regions, a Regional Agriculture Mechanization Center has been planned to be established in each region. Further, each Regional Mechanization Center is to have 3 to 6 District Agriculture Mechanization Centers according to the number of districts within its jurisdiction, one in each district, as can be seen in Fig. S-1.



In the National Center, a Training Center for official staff, a Hire Service Center for large machines and a Repairing and Maintenance Center will be established at the national level.

The Regional Agriculture Mechanization Center will carry out, at the regional level, the training of key farmers, the hire-service and the repairing and maintenance service of machinery. It will be also undertake the improvement of tools and trial manufacture of simple machines.

The District Agriculture Mechanization Center will undertake the training of general farmers, hire-service and repairing and maintenance service at the district level.

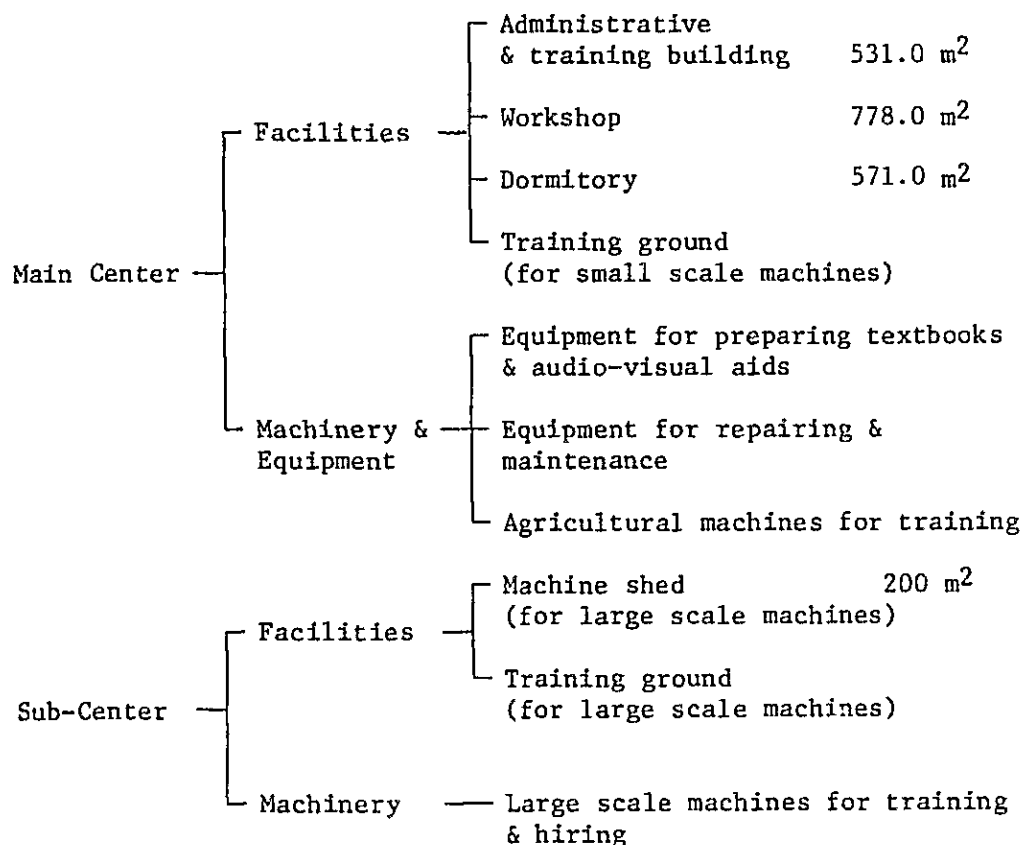
As a result of examining the ways for realizing the above mentioned plan, the establishment of the National Agriculture Mechanization Center, which is the core of the plan, and the strengthening of Paro Regional Agriculture Mechanization Center, which is the model of the Regional Centers, have been brought in relief as the most urgent task to be taken up.

There is no denying of the importance of the National Agriculture Mechanization Center as a pivot in the mechanization plan. It is quite natural and reasonable to establish and to equip the National Center at the highest level in Bhutan. It is also of prime importance to strengthen Paro Regional Agriculture Center, which is at present functioning actively, to make it as a model case for the other Regional Mechanization Centers.

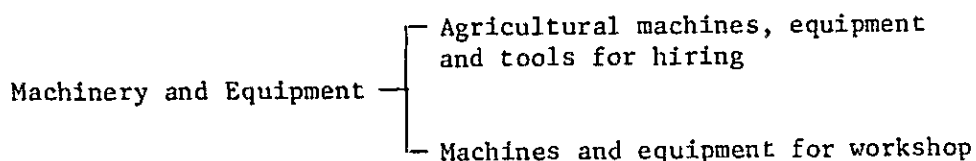
It has finally been concluded that to concentrate the Grant Aid Programme of the Government of Japan on the two centers will be most effective. The establishment and completion of the remaining 3 Regional Centers and 18 District Centers left to the self-efforts of the Royal Government of Bhutan will be most reasonable and appropriate.



The National Agriculture Mechanization Center (hereinafter referred to "the National Center") is outlined as follows.



Paro Regional Agriculture Mechanization Center will be strengthened with the addition of the following items.







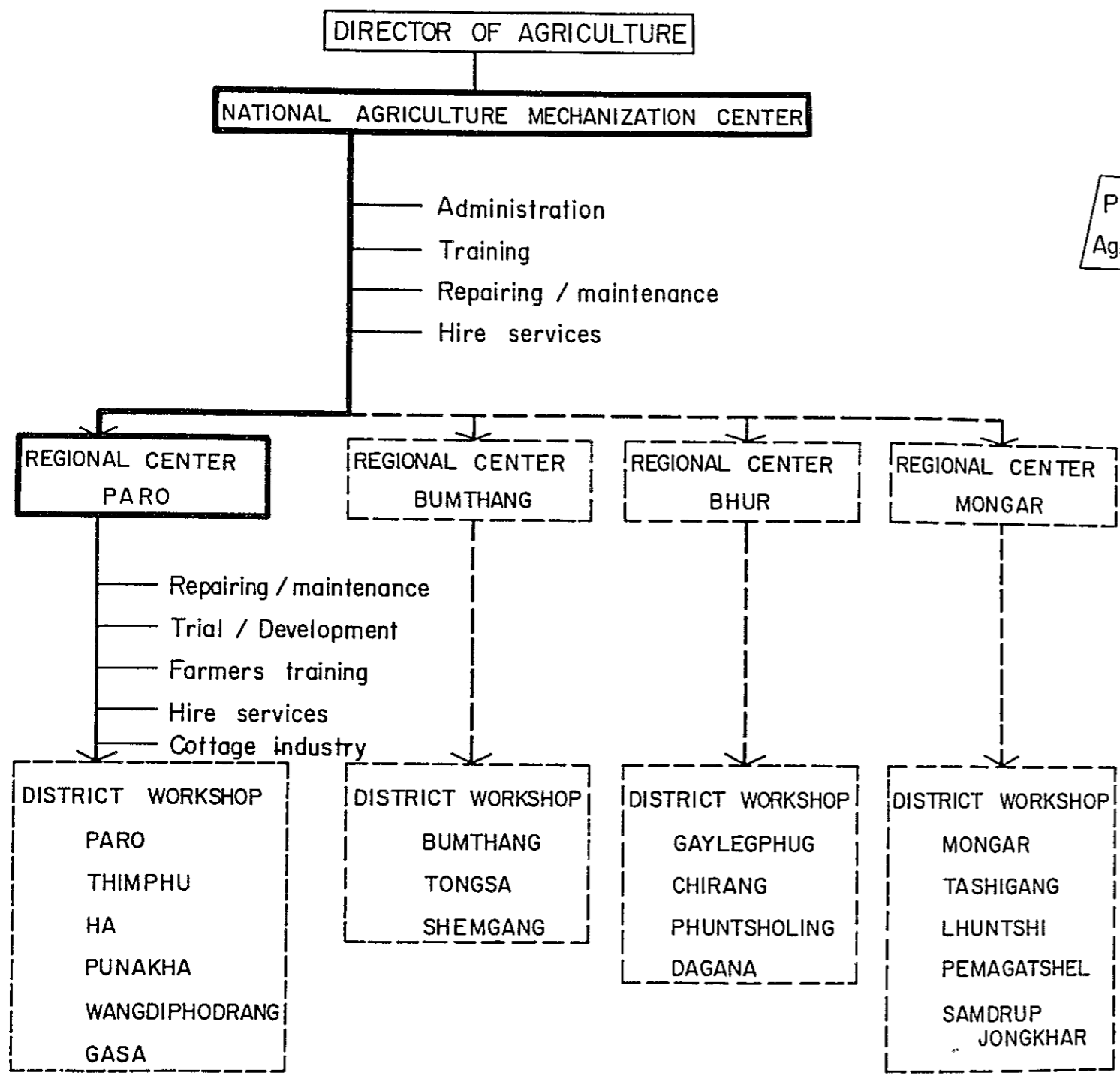
The execution time-schedule for constructing the National Center and introducing the agricultural machinery and equipment mentioned in Sections 12 and 13 will be as follows;

Detailed Design	3 months
Tender/Contract	3 months
Construction and Introduction of Machinery and Equipment	15 months

In case the mechanization plan is realized, (1) timely seasonal operations will be possible, (2) the labour efficiency and the land productivity will raise up, (3) the cropping intensity will greatly increase, (4) farmers will be released from their painful drudgery, (5) the cultivation of cash crops and cottage industry will be developed and (6) the mechanization will also prove to be commercially practicable, as been described in Chapter 5. As a result, the solution of the problems of labour shortage and low agricultural productivity, which is the final goal of the agricultural mechanization project, will spontaneously be worked out.

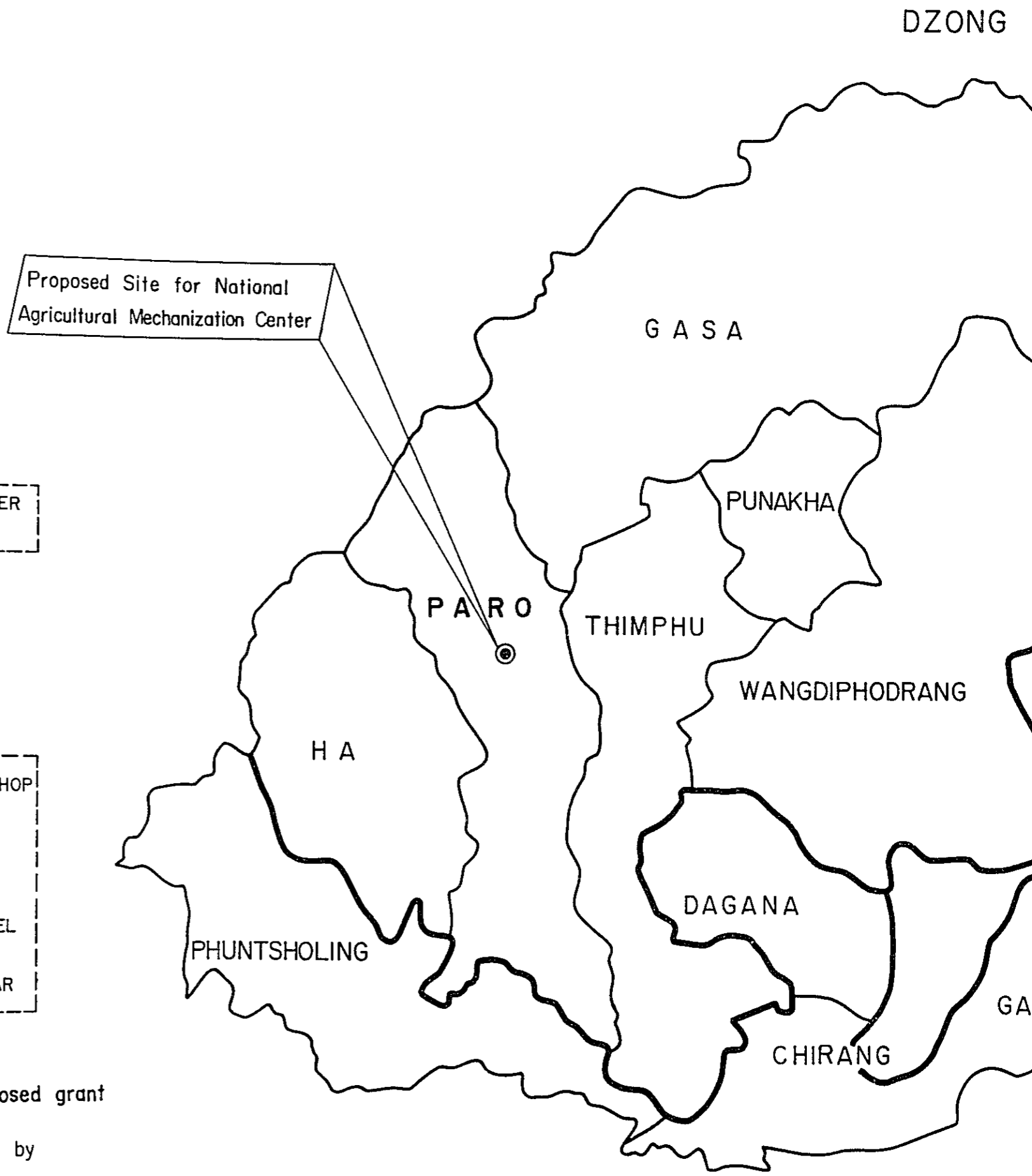
The Royal Government of Bhutan should concentrate its efforts on realizing the mechanization project, and firstly should start with the establishment of the National Center and the strengthening of Paro Regional Center as a model for other Regional Centers. For this purpose, the Royal Government should give priority on taking all necessary budgetary measures, on setting up a steering committee and on the assignment of the necessary staff for the mechanization programme.

Fig. S - I AGRICULTURAL MECHANIZATION NETWORK IN BHUTAN

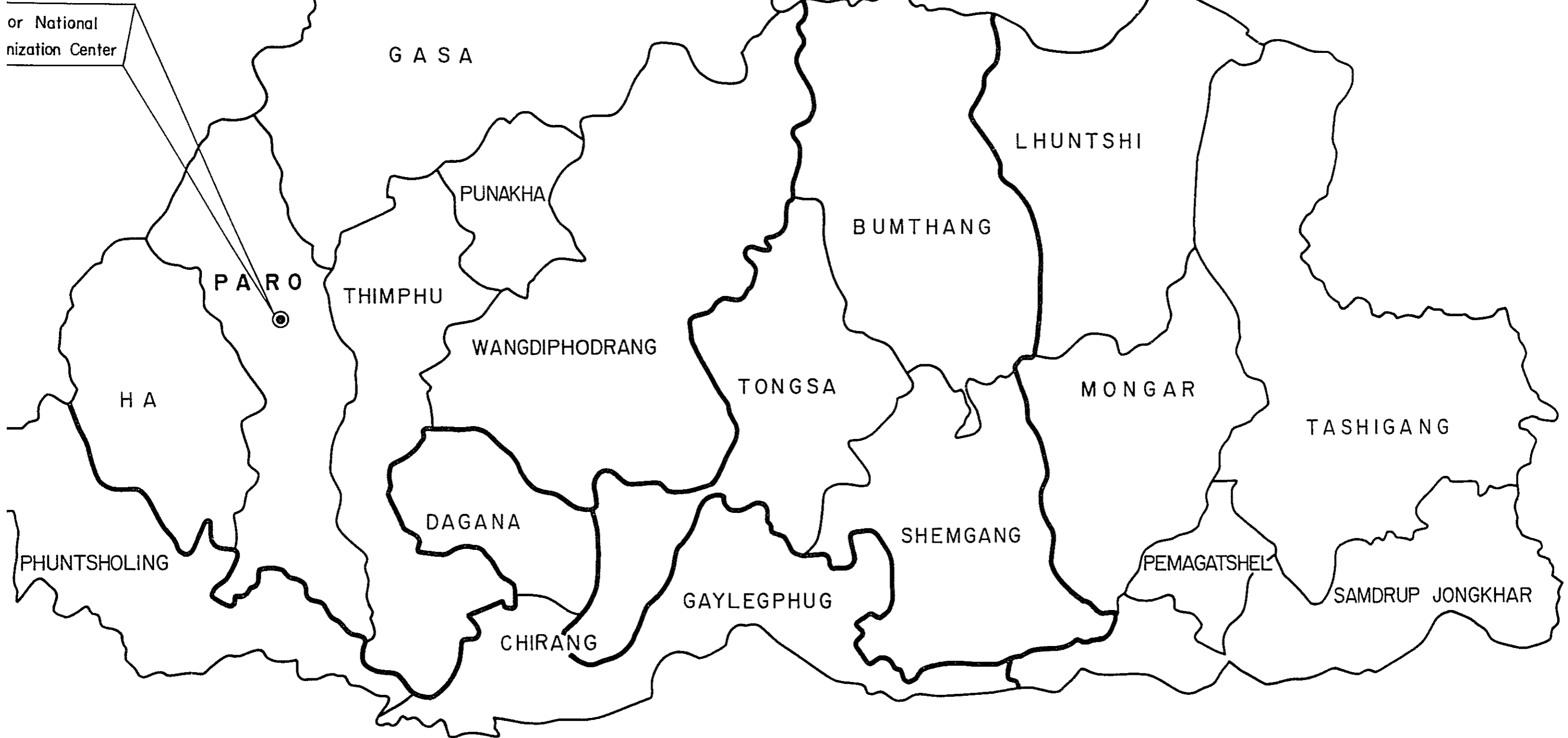


Legends :

- : Items shown in thick line are included in the proposed grant aid programme of the Government of Japan.
- - -→ : Items indicated by dotted lines are to be realized by the Government of Bhutan.



DZONG DISTRICT BOUNDARY



or National  
nization Center

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T H I M P H U

P U N A K H A

W A N G D I P H O D R A N G

H A

P H U N T S H O L I N G

D A G A N A

C H I R A N G

T O N G S A

B U M T H A N G

G A Y L E G P H U G

S H E M G A N G

L H U N T S H I

M O N G A R

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## Chapter 1. INTRODUCTION

The Royal Government of Bhutan planned an agricultural mechanization project (hereinafter referred to as "the Project") for the development of agriculture to be incorporated in her Fifth Five Year Development Plan, 1982 thru 1987 and requested the Government of Japan to extend an assistance in the following two subjects (hereinafter referred to as "the Subject") as the cornerstone for the realization of the Project:

- i) setting up a National Agriculture Mechanization Center and
- ii) strengthening its activities at a model regional center.

In response to the request, the Government of Japan dispatched, through the Japan International Cooperation Agency, a basic design study team headed by Mr. Tadashi Shinoura to Bhutan for 29 days from 12th September to 10th October, 1982.

The team conducted a field survey and held a series of discussions and exchanged views with the officials concerned of the Royal Government of Bhutan on the following items:

- i) The background, objectives and significance of the Project within the frame work of the overall agricultural development scheme in the country
- ii) Master plan for the Project particularly concerning the mechanization network and basic design of the Subject and its implementation schedule
- iii) Reconnaissance on the proposed construction site for the center and field survey on the present agricultural circumstances in the country
- iv) Collection of necessary information and data concerning the implementation of the Project.





This basic study report on the Project and the Subject was worked out based on the discussions and the analysis of the data obtained through the field survey, comprising the background and objectives of the Project and the most recommendable basic design for the Subject.

The basic design study team wishes to take this opportunity to express sincere thanks to Dasho Lam Penjor, Deputy Minister, Planning Commission, Dasho Sangay Penjure, Secretary of the Ministry of Foreign Affairs, Mr. M.P. Sharma, Deputy Director of the Ministry of Finance, Dasho Thinley Dorji, Director of the Department of Development, Dasho Pema Wangchuk, Director of the Department of Agriculture, Dasho Rinchen Tshering, Governor of Paro District, Dasho Kyoji Nishioka, Colombo Plan Expert, Mr. Dorji Norbu, Director of the Department of Public Works and all other officials concerned for their kind cooperation, arrangements and guidance extended to the study team during its stay in Bhutan.

The team's gratitude is also due to Mr. D.B. Rai, Planning Officer, Mr. D.K. Chetri, Director of the Economic Division of the Ministry of Foreign Affairs, Mr. Sonan Tobden Rabgay, Under Secretary of the Ministry of Foreign Affairs, Mr. Pema Wangdi, Deputy Secretary of the Planning Commission, Mr. Ugen Tshering, Under Secretary of the Planning Commission for their valuable advices and suggestions.



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## 2. BACKGROUND

### 2-1 Progress

The Kingdom of Bhutan is an agricultural country and 90% of the country's population depend on the agriculture based on small holding farming. The development programme of the agricultural sector is primarily aimed at small land holding farmers. The policy and strategy for agricultural development are based on the specific conditions and difficulties of the country, such as mountainous conditions, transport and communication difficulties, the pattern of small land holding, labour shortage, etc.

Labour shortage is a prevailing phenomenon in the country, and this phenomenon has greater amplitude when many development activities occur in the same period. The labour shortage which Bhutan is facing to-day is a very exceptional case among the entire developing countries.

The expansion of cultivation or introduction of cash crops or of even any kind of technical innovation to the farming community has been hindered by the labour shortage. Recognizing that much volume of work on the wider range of development activities is needed in Bhutan, the introduction of agricultural mechanization will be an answer to improve agricultural productivity and to achieve self-sufficiency in grain production. Such mechanization will help to expand cash-crop cultivation and further to spare the work-force for other important nation-building development activities.

As the first step to agricultural mechanization, the introduction of small scale agricultural machinery and earth-moving equipment was made on a trial basis. These machineries were found very useful and successful, and the public demand on introducing machineries is increasing. The trial introduction was based mainly on the machinery supplied by the Government of Japan under the Colombo Plan Aid Programme, during the seventies.





Moreover, the Government of Bhutan has emphasized the needs to set up basic infrastructures, such as workshop facilities and the procurement of various equipments, to create sufficient manpower to operate and repair these machineries, to study further expansion of mechanization and to fabricate simple tools and implements.

During the Fifth Plan period (1982 - 1986), the Government is planning to introduce more numbers and varieties of machineries to cope with the public demand and with the plan target, such as increasing productivity, expansion of cash-crop cultivation, improving irrigation facilities, etc.

In relation to the above-mentioned facts, Japan has special experience in the field of agricultural mechanization in small land holding patterns and in the mountainous conditions and terraced fields. In this respect, machinery from Japan will be most useful and will have an immediate effective impact and benefit to the farming community in Bhutan.

The Government of Japan has provided an amount of Yen 300,000,000 worth of agricultural machinery and earth-moving equipment in the 1981/1982 fiscal year. They started to operate in November, 1982, and are expected to help in a wide range of expanded and effective activities in the field of agricultural development.

Under such circumstances, the Royal Government of Bhutan made a request to the Government of Japan, aiming chiefly to receive a wide range of agricultural machinery, earth moving equipment and to expand the workshop service network and also to strengthening the training of technical personnel and up-grading the technical level of existing technicians in Bhutan.



## 2-2 General

The Kingdom of Bhutan comprises an area of approximately 47,000 km<sup>2</sup> situated in the Himalayan region, between 26.5 and 29.0 degrees north latitude and 88.5 and 92.0 degrees east longitude. The country is totally land locked, bordered in the north by China (Tibet), and by India in the South, West and East.

The country can be divided into three district climatic zones. The Southern zone adjoining India consists of the foothills ranging up to an altitude of about 1,000 m. This area has a hot humid tropical climate and the vegetation and forests are very dense. The Central zone mainly consists of valleys at elevation from 1,000 - 3,000 m, and has a temperate climate and vegetation. The capital, Thimphu, is located in this zone. The Northern zone comprising of valleys and snowy ranges about 3,000 m is the region bordering China, and is of an alpine character climatically.

Except for the lowland along the southern border, the country is entirely covered by mountainous terrain. High ridges divide the region, and the country is traversed by numerous streams and rivers which flow in a north-south direction. Of the total land area about 70% is covered by forest, 9% is under cultivation, and the rest is wilderness.

The total population is estimated around 1.003 million, giving an average density of 21 per km<sup>2</sup>. Under the present demographic conditions the assumed growth rate of 2.1% is also relatively high, and a more realistic range would be between 1.6% - 1.8% per annum. Considerable differences in population density exist, with the higher northern region being very sparsely inhabited. Although a few urbanized areas or towns now exist (the largest two, including the capital Thimphu, having a population of approximately 20,000 each) and a road network has been introduced, the country is still essentially rural.

Until the beginning of the present century, Bhutan was a theocracy in which supreme religious and political power was vested in the Shabdung Rimpoche or Dharma Raja. The hereditary monarchy was established in 1907. His Majesty the King, is the Head of State and the

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Head of the Royal Government. The National Assembly is the main legislative and policy-making body; the cabinet is the main executive body. The cabinet is composed of the members of the Royal Advisory Council, heads of the Ministries of Foreign Affairs, Home Affairs, Communications, Development, and Finance, and other important officials.

Administratively, the country is divided into 18 dzongkhangs (districts): three in Eastern Bhutan, five in Central Bhutan, seven in Western Bhutan, and three in Southern Bhutan. The district administration is directly administered by the Ministry of Home Affairs through district administrators. The dzongkhang is primarily responsible for administration and revenue collection within the district. Law and order are the primary responsibilities of the thompon (magistrate).

## 2-2-1 Physical Environment

### (1) Climatic conditions

#### 1) Climatic regions

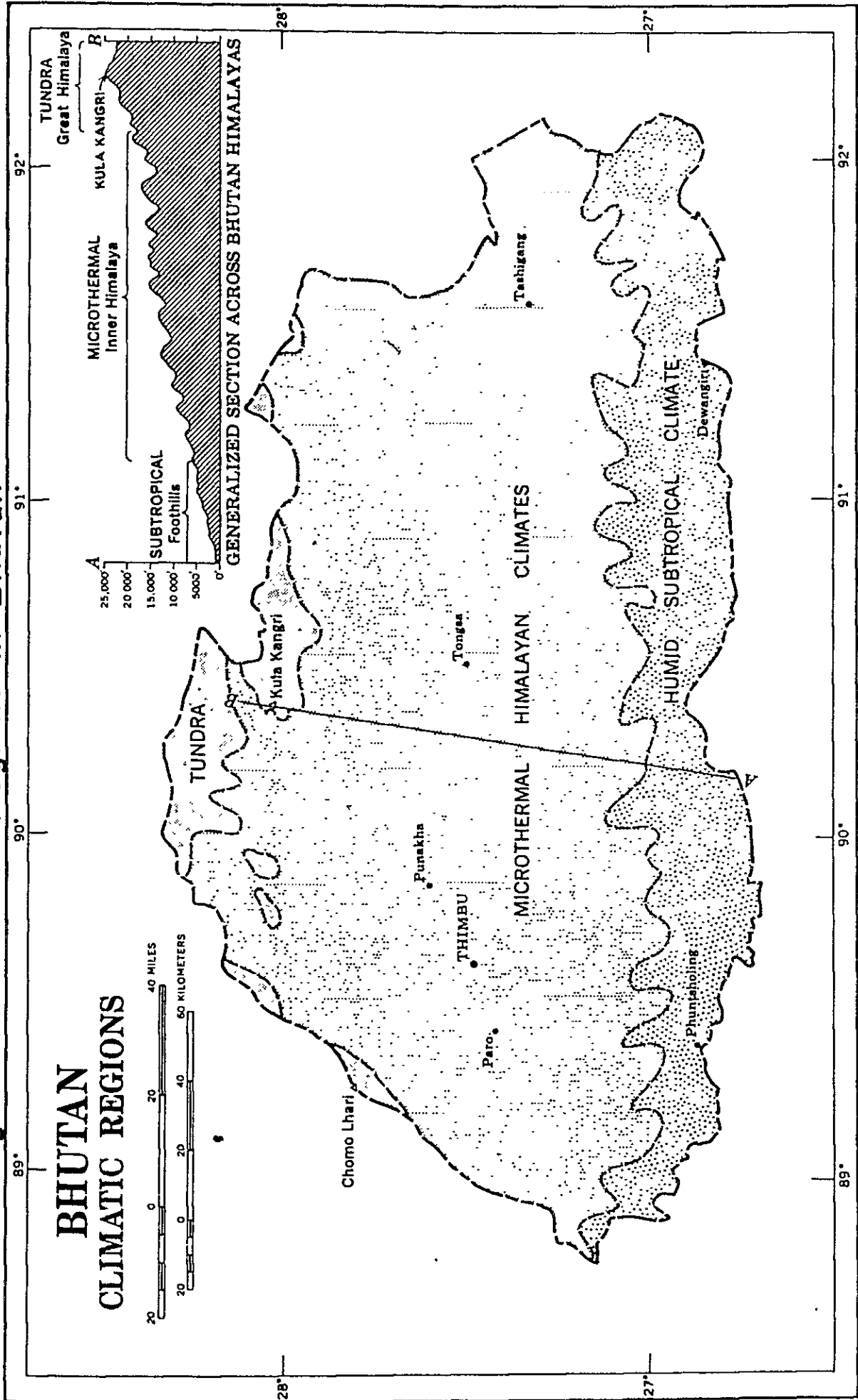
In a mountainous country such as Bhutan, climatic conditions waves a complex pattern. In general, however, this intricacy resolves into broad climatic zones whose limits are determined by altitude. Prof. S.P. Chatterjee has vividly described the rapid climatic changes: "The intense cold of Siberian winter, the terrific heat of the Sahara desert and the mild pleasant weather of Mediterranean Italy may all be experienced in the course of a single day's journey in Bhutan."

At least three major climatic regions can be recognized: the hot and humid subtropical area of the Duar and the foothills, the cooler (microthermal) region of the inner Himalaya, and the tundra region of the Great Himalaya (See Fig. 2-1). Although each of the basic weather elements varies with altitude, temperature is the primary criterion for this division.

A humid subtropical climate prevails at altitudes between 1,200 and 1,500 m. The annual rainfall of 2,000 mm provides the conditions for a tropical forest, or savanna.

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Fig. 1 - 1 Climatic Regions in Bhutan



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North of the humid subtropical belt the climate changes markedly with the elevation. The inner Himalayan ranges have microthermal climates, quite difficult to classify on a map. Winters range from moderately cool to severe, and summers are warm and rainy. Rice, bananas, oranges and other lowland products are all raised in abundance at same point within the zone. In the lower sections and valleys are areas of intensive farming. Approximately 3,000 m above sea level, moderately cold winters and short cool summers tend to limit successful grain farming.

The lower zone of the microthermal Himalayan climates includes narrow valleys which skirt the rugged slopes of the inner Himalayan ranges. The broad-leaved trees of its moist, warm section tend to resemble those of the humid subtropical climate, especially on the southern flanks of the mountains. In higher areas broad-leaved trees give way to coniferous evergreens.

In the upper part of the microthermal climatic zone, above 3,000 m, winters are severe and summers short and cool. This zone may be distinguished from the lower zone in two respects. First, it is a zone of frost, which occurs infrequently below 3,000 m. Second, it is characterized by primitive cultivation primarily devoted to such hardy crops as barley and potato. This zone extends to about 5,300 m -- the upper limit of agriculture and of natural tree growth.

At elevation over 5,300 m, the climate is that of a true alpine tundra.

## 2) Meteorological data

As mentioned above, Bhutan has a wide variation in climatic conditions which range from the tropical climate to the alpine climate. Only few meteorological data, however, are found in Bhutan. The data in Fig. 2-2 are almost all the data the team could obtain in the country.

Fig. 2-2 shows the climatic conditions in various parts in Bhutan.

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The highest temperature occurs in July or August in most places (except for Wangdi-Phielia in which it does in March and Sarbhang in September) and it ranges from 38°C (Wangdiphodrang) to 18°C (Gogona), indicating the average being 29.3°C. The lowest temperature occurs in December or January in most places and it ranges between 13°C (Sarbhang) and -7°C (Paro), showing the average of -0.3°C.

Reading mean-temperatures of maximum and minimum temperatures in August and in January at each place in Fig. 2-2, the relation between mean-temperature and elevation in Bhutan was examined. As a result, following correlation coefficients and regression equations were obtained.

In August (in summer)

$$r = -0.88^{**}$$

$$y = 31.24 - 0.00535x$$

In January (in winter)

$$r = -0.97^{**}$$

$$y = 22.29 - 0.00721x$$

where y expresses mean-temperature (in °C), and x does elevation (in meter).

From the results, it has been clarified that there exists a definite relation between temperature and elevation in Bhutan as in many other countries, and the mean-temperature decreases by 0.53°C in summer and by 0.72°C in winter with every ascent of 100 m in elevation. This fact has first been discovered by the study team in the present survey.

With a view to comparing the climate in Bhutan with that in Japan, reading the monthly mean Maximum-temperature, Mean-temperature and Minimum-temperatures in January (winter) and in August (summer) from Fig. 2-2 in Paro, which is the Centre of Agriculture in Bhutan, and searching for the places which show the corresponding temperatures in Japan respectively, Table 2-1 was obtained.



Table 2-1 Temperatures in Paro and Places in Japan at Which the Corresponding Temperatures Occur

Temperature in Paro		Places in Japan
Summer (Aug.)	Max. 29.0°C	Akita, Sakata, Mito, Utsunomiya
	Mean 20.5°C	Asahikawa, Rumoi, Obihiro
	Min. 12.0°C	Abashiri (15.8°C), Asahikawa (16.3°C)
Winter (Jan.)	Max. 14.0°C	Miyazaki, Kagoshima, Hachijojima
	Mean 3.5°C	Gifu, Nagoya, Kumagaya
	Min. -7.0°C	Hakodate, Uraga, Morioka

According to Table 2-1, in summer the Maximum-temperature corresponds to that in Northern Kanto and Tohoku districts and the Mean-temperature does to that in Hokkaido district, but the Minimum-temperature is too low to find out its corresponding temperature in any place in Japan. In winter, however, the Maximum-temperature is very high and it corresponds to Southern Kyushu district and the Mean-temperature does to Nagoya and Gifu cities, but Minimum-temperature is considerably low and does to Hakodate and Morioka cities. In short, the climate of Bhutan is characterized by the big difference between the Maximum and the Minimum temperatures, and then it is difficult to find out the exactly similar climate in flat area in Japan.

Rainfall data are shown not only in Fig. 2-2 but also in Table 2-2. Scrutinizing these data, so far as the present data are concerned, following points appeared to be clarified. Generally speaking, it might be said that the total amount of annual rainfall increases up to nearly 5,000 mm with a decrease in elevation with some exceptions. Gaylegphug, Tashigang, Wangdiphodrang and Mongar have rather small rainfalls compared with the corresponding elevation, most of them are in basins surrounded by mountains, while rainfall in Gogona is rather large compared with its elevation.



Table 2-2 Annual Rainfall at Various Places in Bhutan

Location	Altitude (in m)	(Unit: mm)												Annual Rainfall
		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
Phuntsholing	234	24	34	46	165	431	880	874	1010	811	166	15	7	4468
Sarbhong	326	22	27	25	128	509	697	970	862	789	206	26	2	4263
Samchi	610	20	150	57	236	499	656	669	554	-	55	16	-	2910
Gaylegphug	196	77	-	5	43	92	170	384	1098	278	8	-	8	2164
Paro	2362	13	4	40	30	44	71	144	135	104	49	9	2	674
Tongsa	2172	11	27	60	57	157	186	256	257	148	60	7	14	1239
Mongar	1520	10	10	23	10	85	152	181	104	71	47	3	1	698
Tashigang	991	16	11	34	50	76	136	124	128	87	51	2	0.3	732
Wangdiphodrang	1374	6	4	10	17	46	117	146	113	97	56	3	8	622
Thimphu	2392	2	11	12	22	48	103	149	152	131	70	-	0.5	691
Bhur (Gaylegphug)	(200)	20	29	84	179	354	1093	1454	820	712	240	53	37	5074

Note: The values in the table are the averages for the following periods:

Thimphu .....	1972 - '75
Bhur .....	1973 - '82
Others .....	1956 - '71





So far as these data are concerned, the largest amount of annual rainfall is found to be nearly 4,500 mm at Phuntsholing while the smallest one to be 450 mm at Missigang, a wide variation in rainfall being found in Bhutan. Further, the seasonal distribution of rainfall in Bhutan is of a monomial type with its maximum in August or July and its minimum in January, December or February in most cases. Roughly speaking, June, July, August and September can be taken as the rainy season, while November, December, January and February as the dry season in Bhutan.

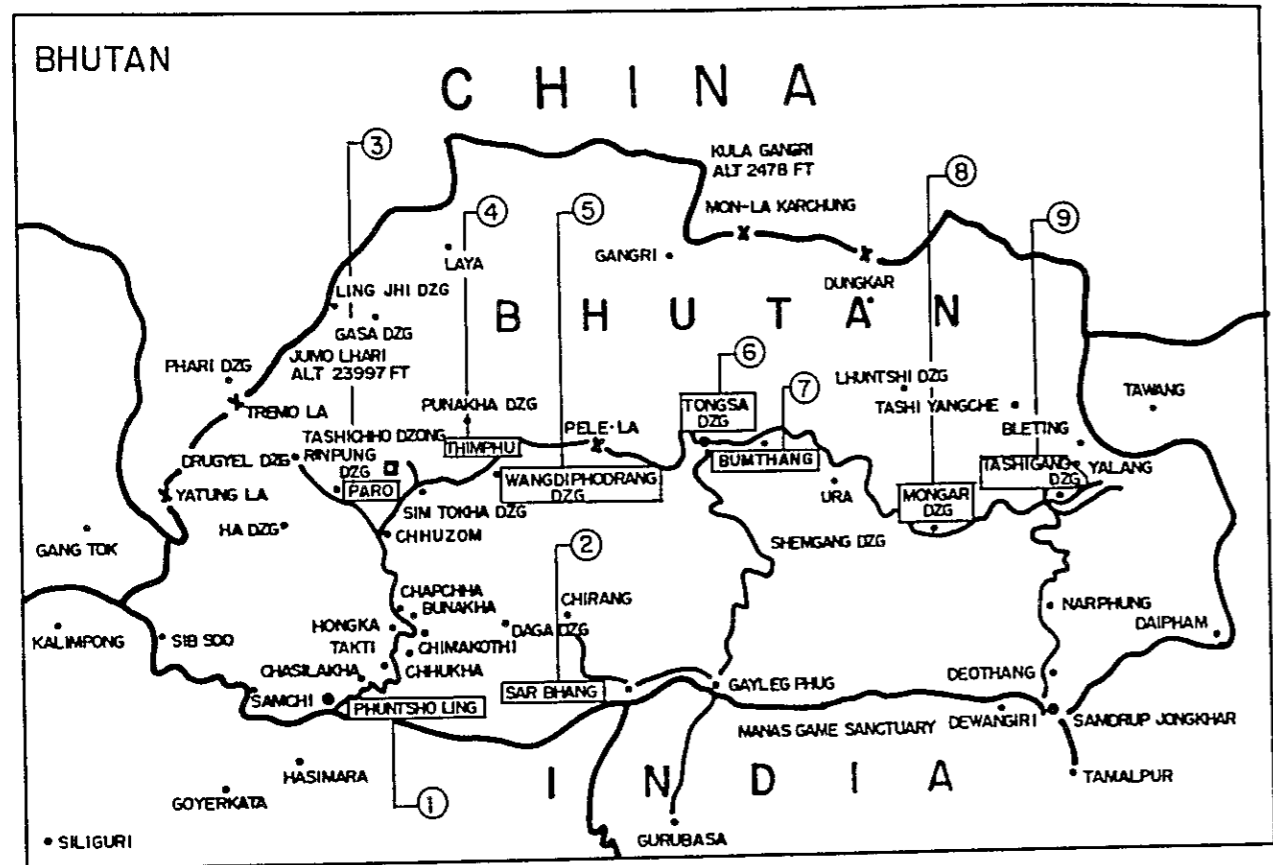
Data of clear days are found at 5 places in Fig. 2-2. The maximum number of clear days per month occurs mostly in January, December or February, and the actual number of clear days is 27 to 30. The minimum number per month occurs in August, July or September, the actual number being 11 (Thimphu) to 3 (Gogona). As can be seen in the pictures at 5 places, there is a clear negative correlation at each place between the number of clear days and the amount of rainfall in each month.

No data of sunshine hours could be obtained at any places, but only one data was found at the Regional Agricultural Research Station, Bhur, as shown in Table 2-3. According to the table, the maximum sunshine hours occurs in November or December, its actual values being 8.6 to 9.2 hrs., and the minimum in June or July, its values being 1.1 to 2.7 hrs. The hours in the table can never be taken as high values when compared with other countries. However, taking that the annual rainfall at Bhur is the highest in Table 2-2 into consideration, the values in Table 2-3 may be taken as the lowest values in Bhutan.

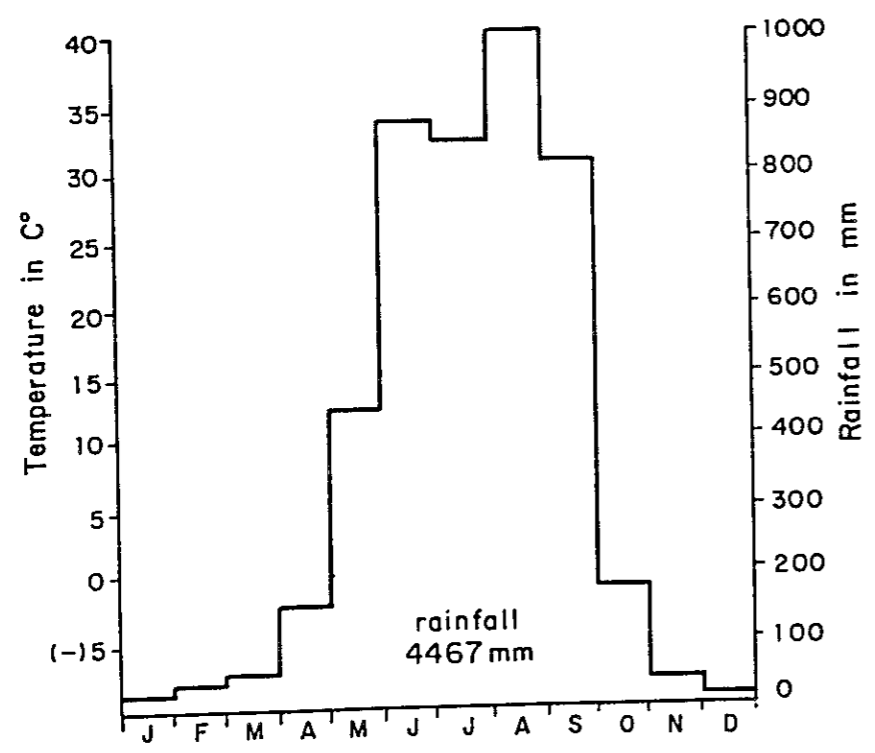
Table 2-3 Sunshine Hours at Bhur (hr.)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1980	6.8	5.9	6.1	-	-	-	2.6	3.4	4.3	7.4	7.0	8.6	(5.8)
1981	4.4	5.3	5.5	5.4	5.2	6.1	2.7	2.9	3.9	7.9	9.2	7.9	5.5
1982	6.1	4.9	5.6	3.6	5.8	1.1	2.6	3.8	3.5	-	-	-	(4.1)
Mean	5.8	5.4	5.7	(4.5)	(5.5)	(3.6)	2.6	3.4	3.9	(7.7)	(8.1)	(8.3)	5.4

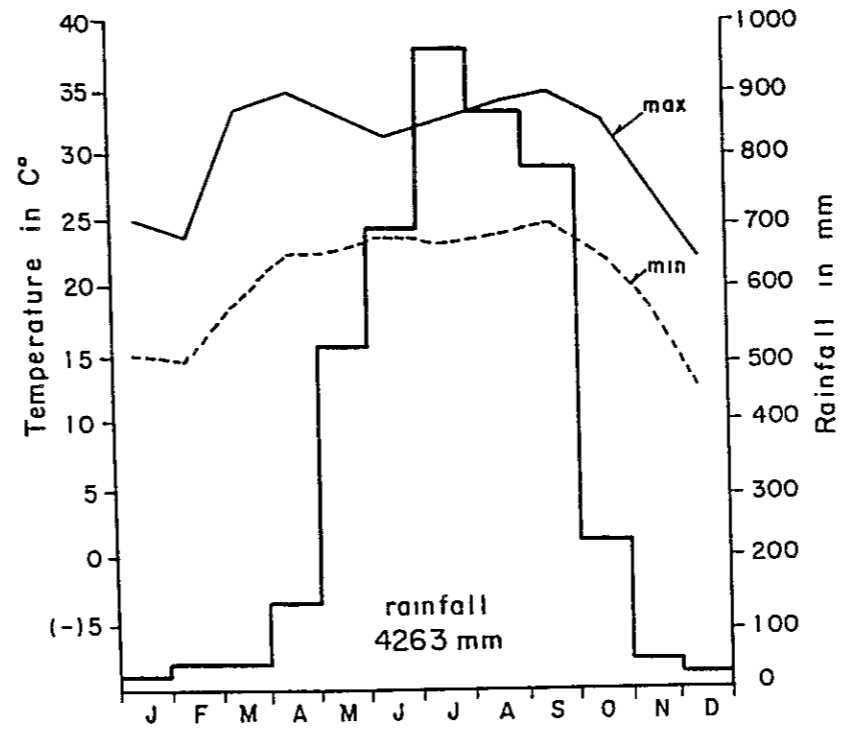
Fig. 2-2 CLIMATIC CONDITIONS



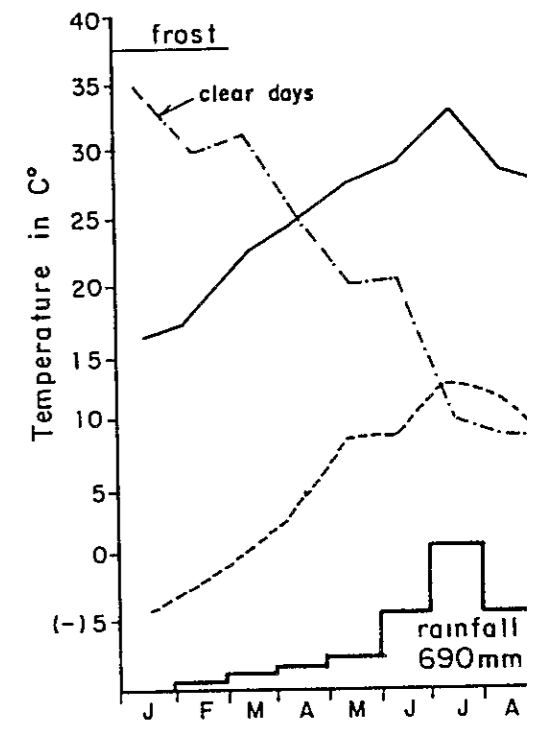
① PHUNTSHOLING (ELEVATION 235 meter)



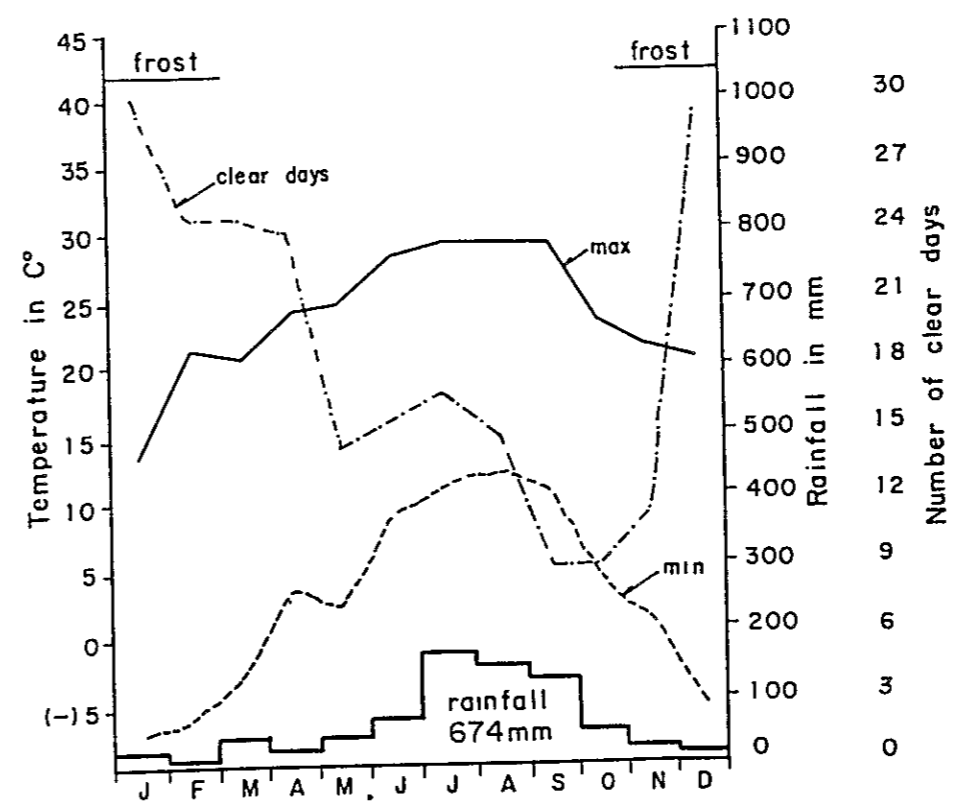
② SARBHANG (ELEVATION 365 meter)



④ THIMPHU (ELEVATION 2320 meter)



③ PARO (ELEVATION 2362 meter)



⑤ WANGDIPHODRANG

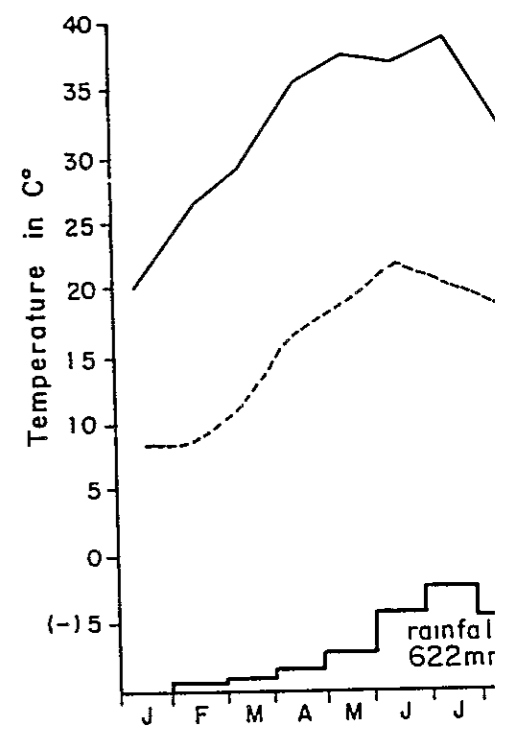
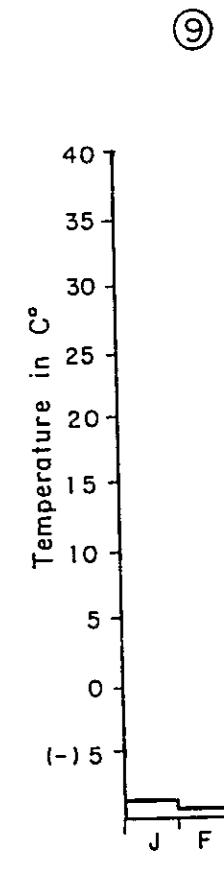
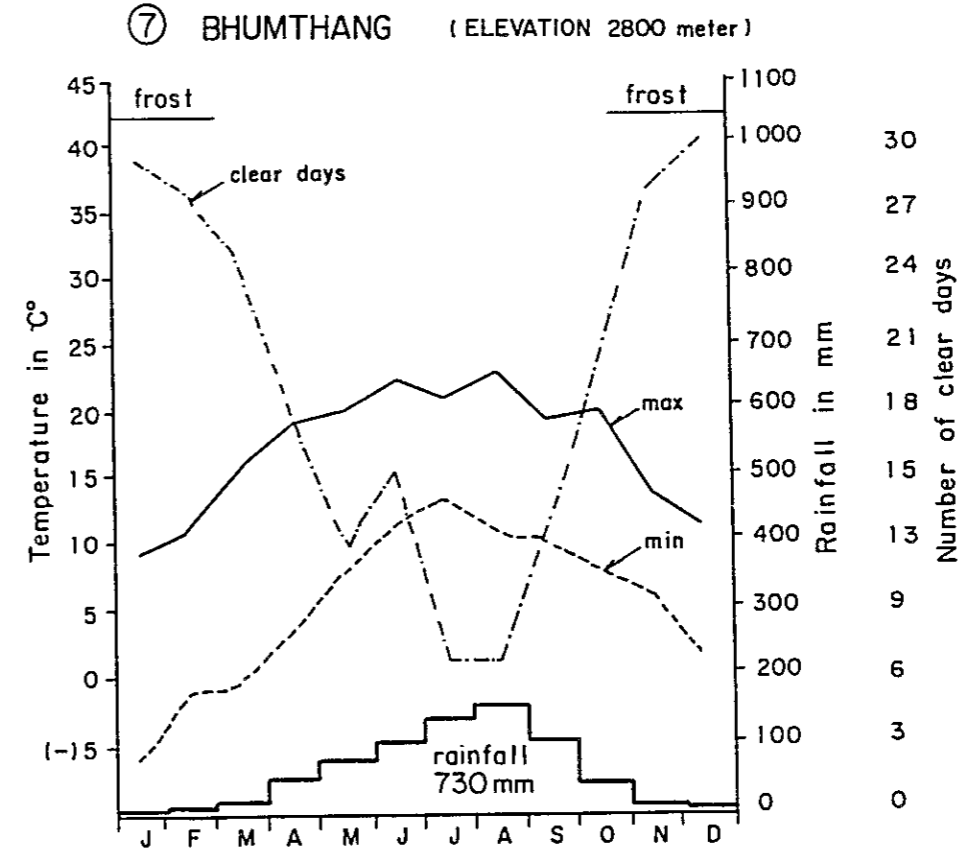
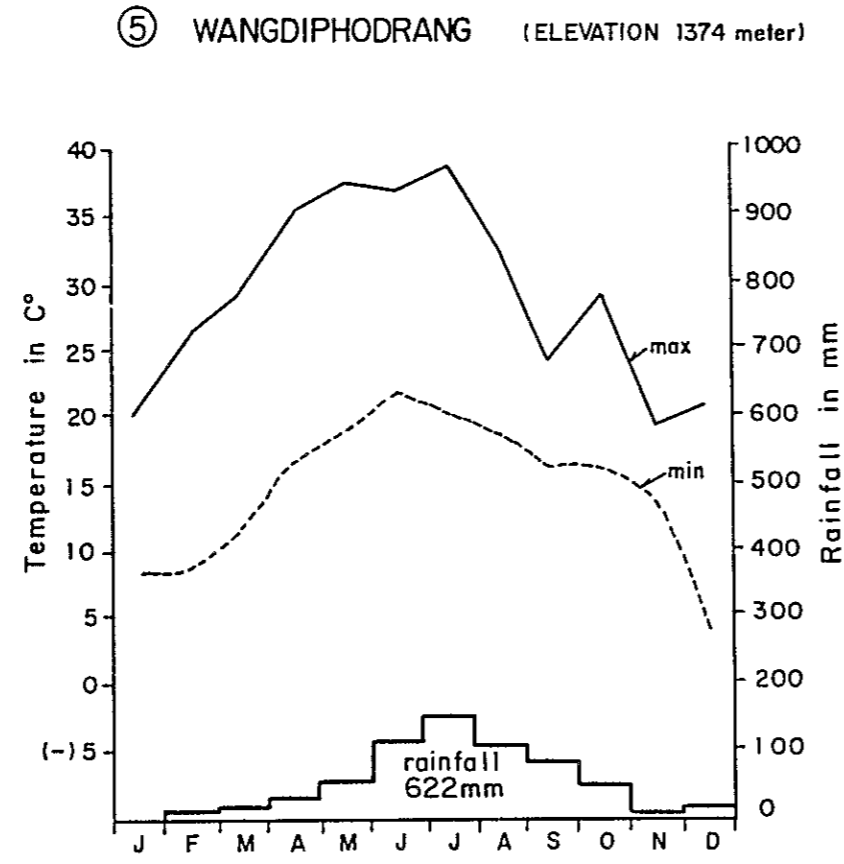
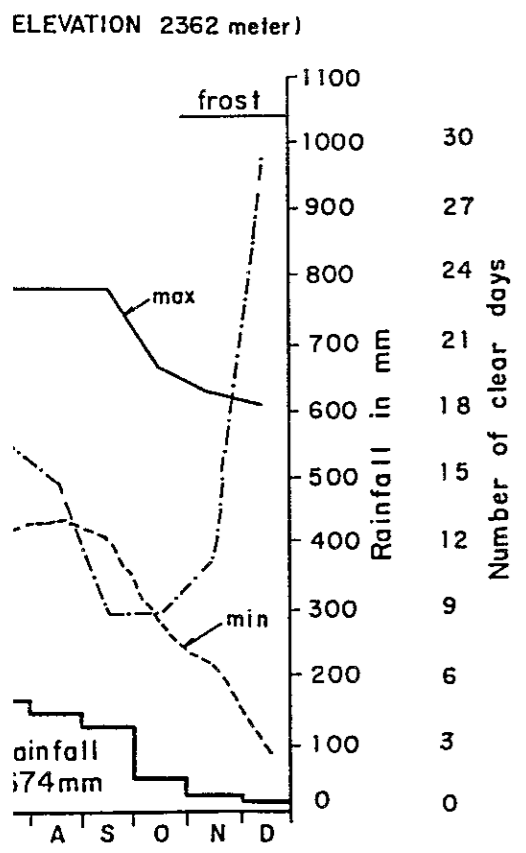
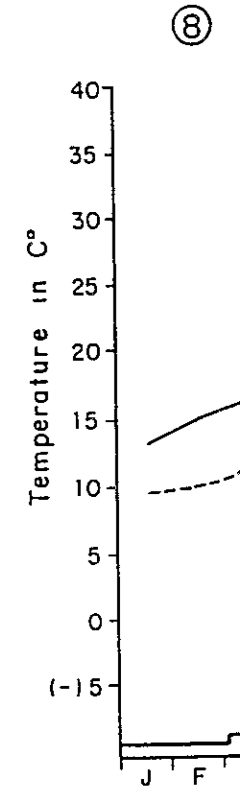
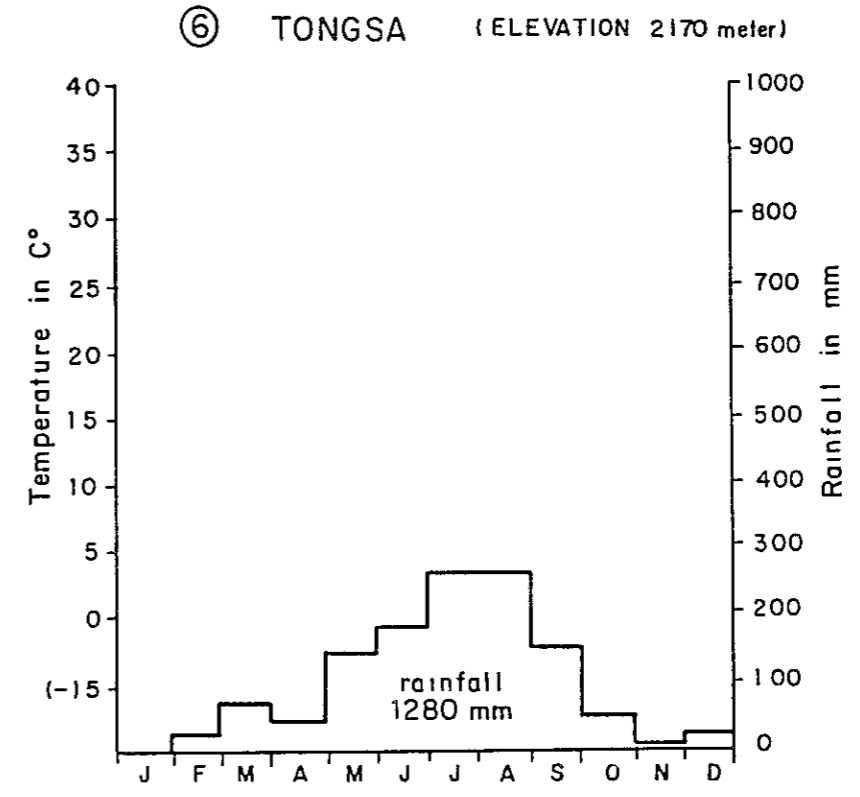
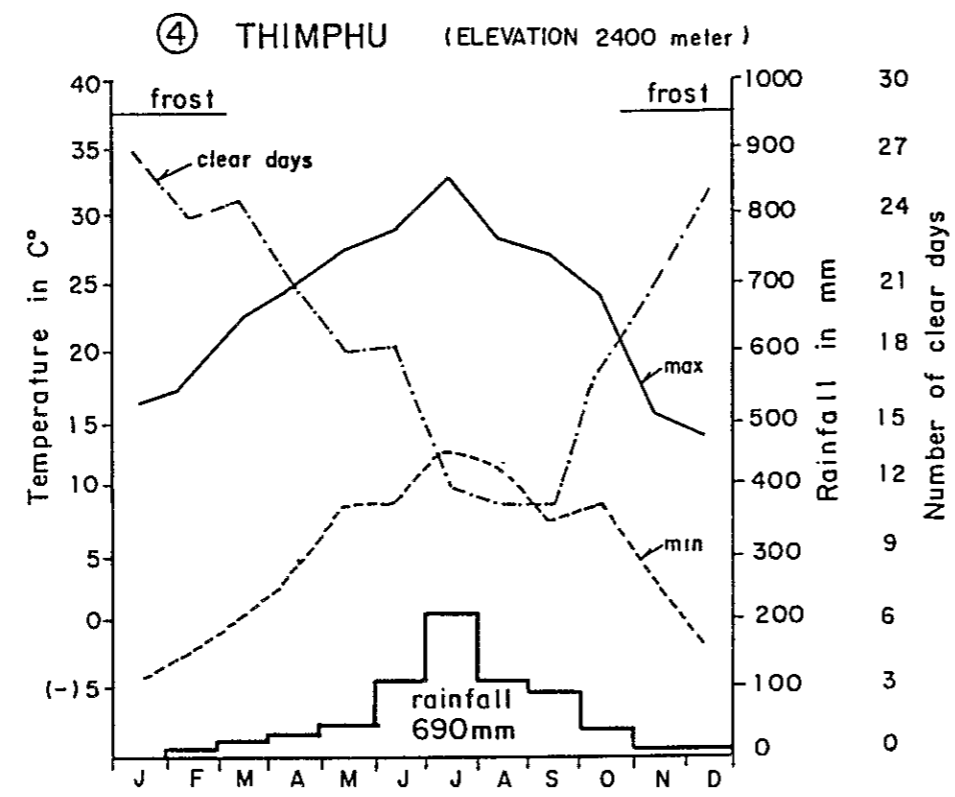
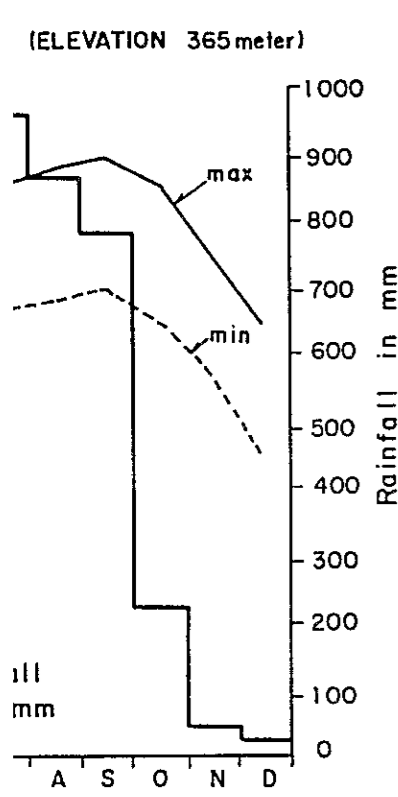
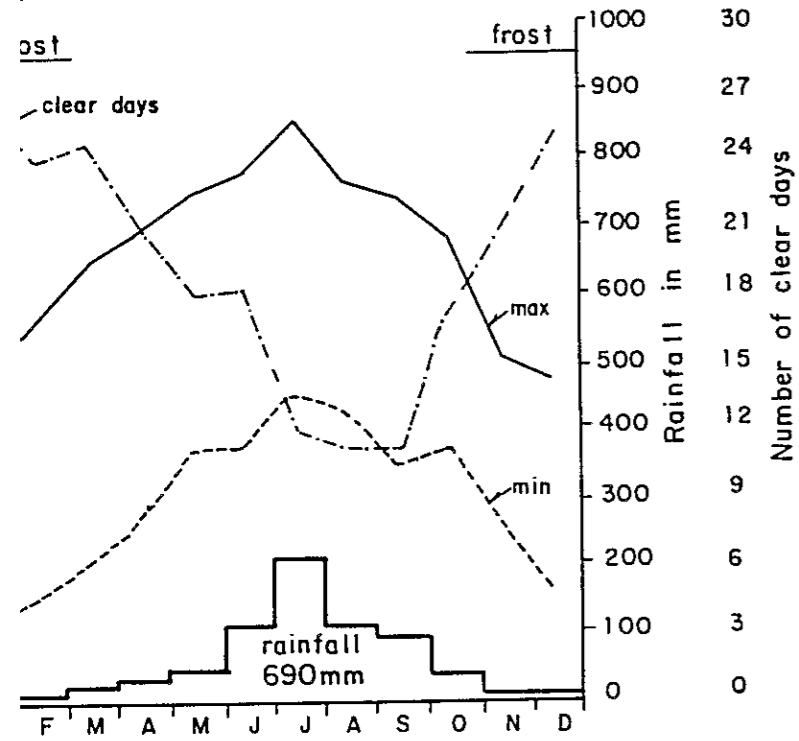


Fig. 2-2 CLIMATIC CONDITIONS

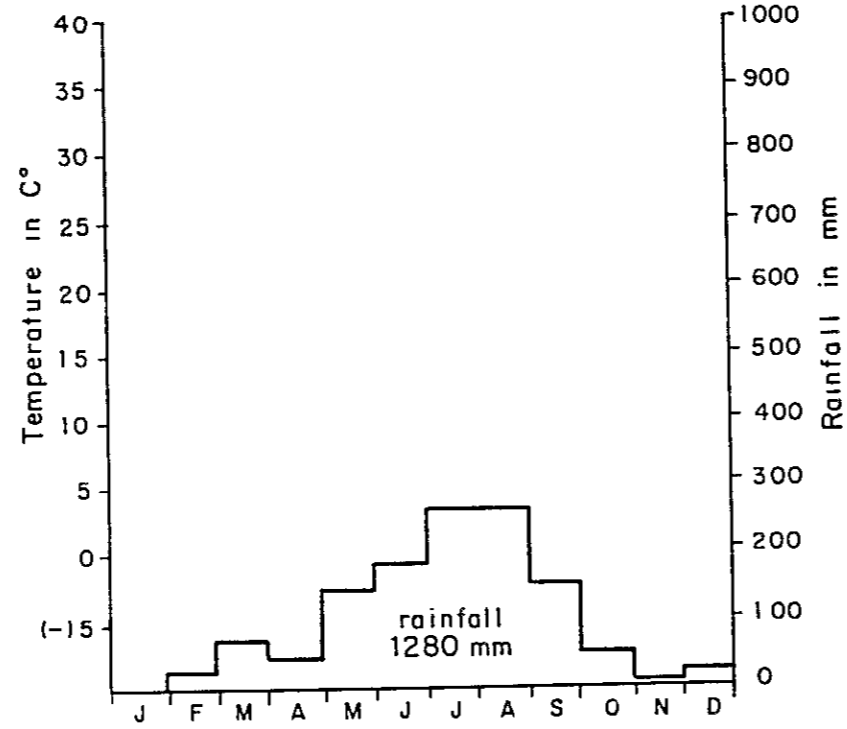


# CONDITIONS

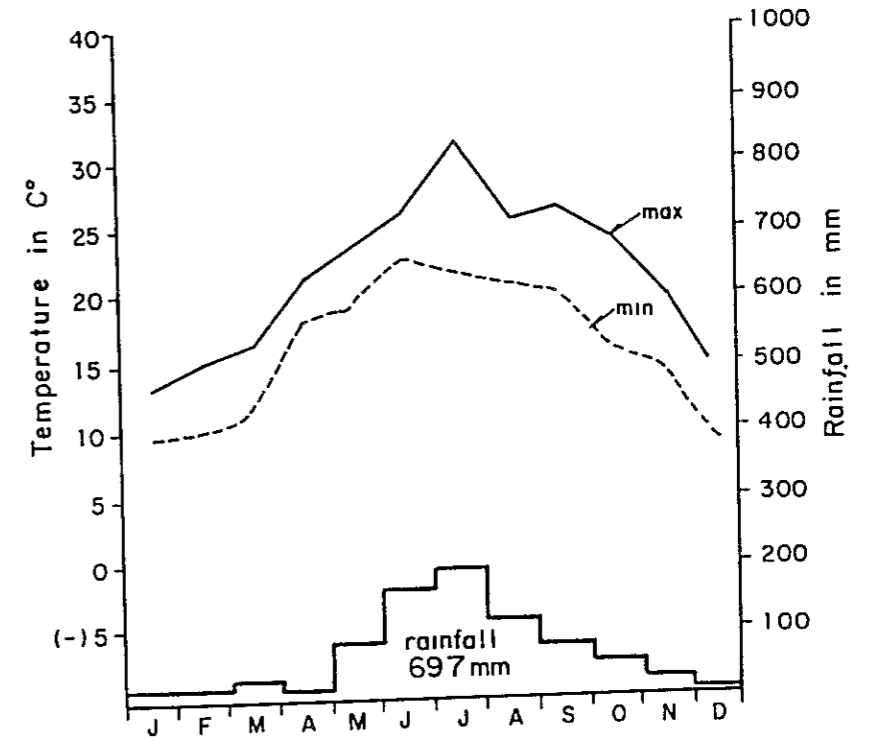
④ THIMPHU (ELEVATION 2400 meter)



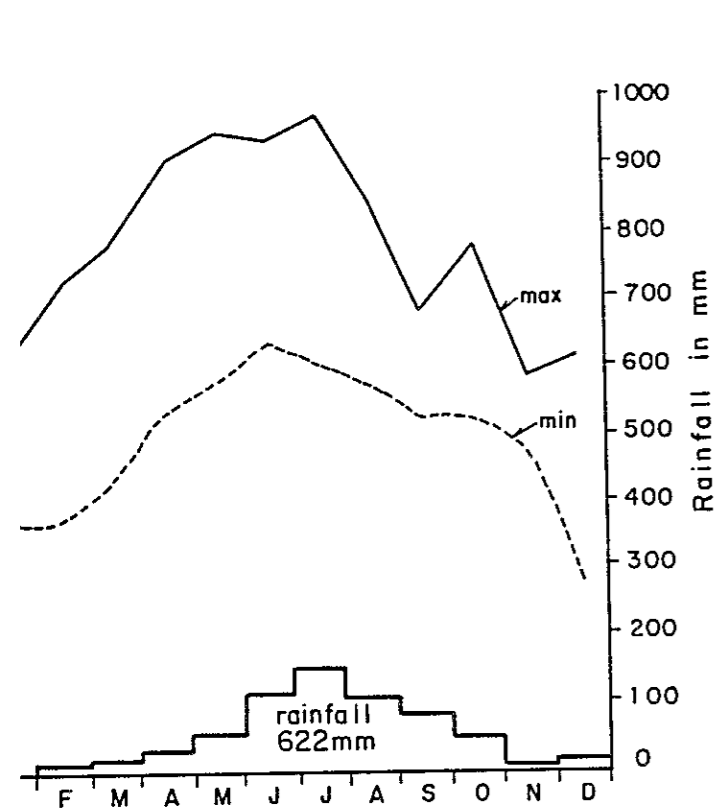
⑥ TONGSA (ELEVATION 2170 meter)



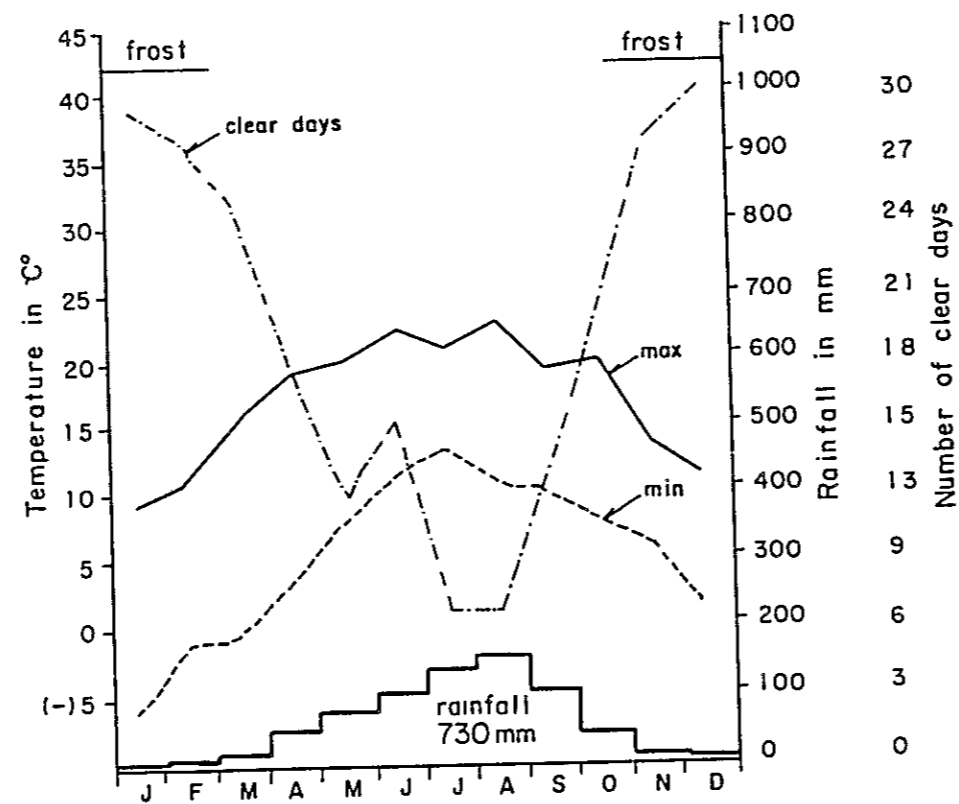
⑧ MONGAR (ELEVATION 1520 meter)



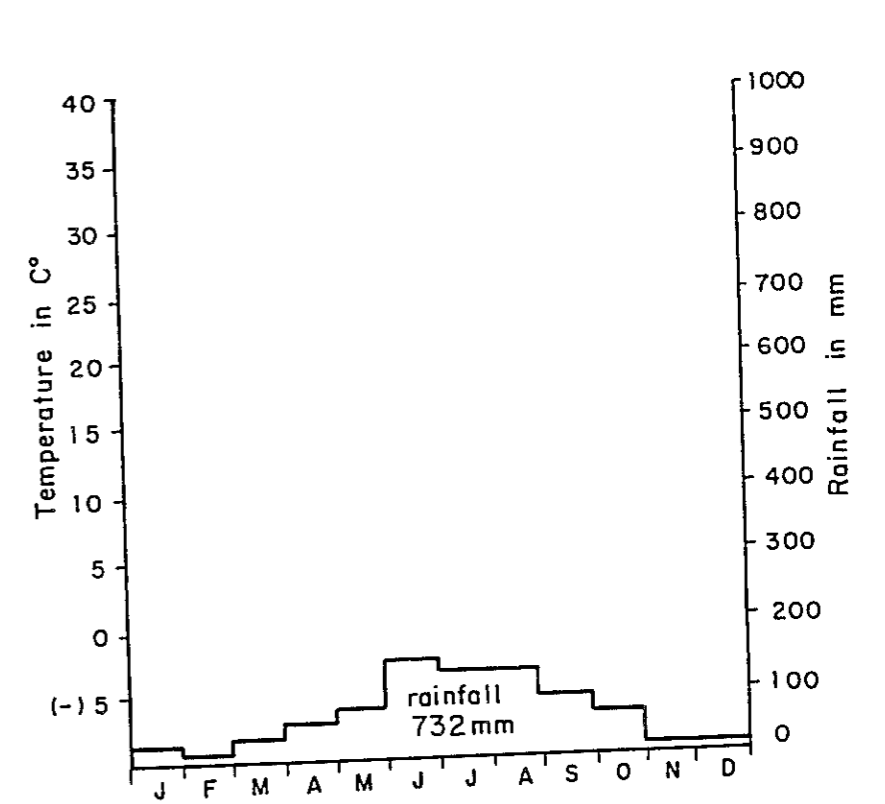
⑤ WANGDIPHODRANG (ELEVATION 1374 meter)



⑦ BHUMTHANG (ELEVATION 2800 meter)



⑨ TASHIGANG (ELEVATION 990 meter)



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In short, the climate in Bhutan consists of a wide variation, ranging from the tropical climate to the arctic one. This means that Bhutan has the high potential for producing any kind of crops. Moreover, the climate in the central area of agriculture is quite moderate, belonging to the temperate zone, though the amount of rainfall appears to be a little in short. Judging from the climatic viewpoints, therefore, it can be said that Bhutan is a quite promising country for the development of agriculture.

(2) Soil conditions

1) Soils in general

The soils of Bhutan reflect the mesothermal, microthermal and tundra climatic zones and the tropical, temperate and alpine vegetation zones. Azonal lithosols (shallow rocky ground) are found on the high, steep Great Himalayan slopes, but on the gentler slopes of the inner Himalayan ranges and foothills shallow zonal soils are more common. Red or yellow soils underlie the tropical deciduous and subtropical moist forest cover on the lower slopes. Brown or gray podzolic (ash-like) forest soils and mountain meadow soils appear at successively higher altitudes in the temperate coniferous and alpine vegetation zones.

Alluvial soils are found along the entire length of the Bhutan Duar. Although there are local variations in their character, they are all derived from materials deposited relatively recently by rivers draining the Himalaya. Immature azonal soils with weak profiles, they are not differentiated into distinctly defined zones. The alluvium is divided into two age groups, the older appearing in the higher land above the flood level. Here the soils are brown, argillaceous loams, permeated with nodular kankar (limestone). The newer alluvium is confined, for the most part, to the existing flood plains. Typical soils of the newer alluvium are pale brown clays and loams containing more sand and less clay than the older alluvium, and usually without kankar.

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Scanty soils prevail in the mountainous region. In the lower ranges and foothills, where the parent material consists of loosely aggregated conglomerates with soft sandy beds, and where the rainfall is heavy, the soil is shallow, immature, sandy, and light, with little humus.

Little is known of the genetic relationships, composition, and physical properties of the soils of Bhutan. Systematic soil surveys will reveal a great diversity, from the highly fertile soils of such valleys as Paro and Thimphu to those of the higher Himalaya on which a very specialized flora struggle to survive. Soils of a characteristic grayish colour caused by excessive leaching are common under the higher coniferous forests. The southern slopes of inner Himalayan ranges often consist of bare rock, while the northern slopes may be clothed with glacial, fluvioglacial talus, and rainwash soils that are used for agriculture at elevations above 2,100 m.

Unlike the densely populated and intensively cultivated Nepal and Sikkim Himalayas, where soil erosion is severe and widespread, the soil erosion in Bhutan is minimal. Between 1,000 m, the average upper limit of the endemic malaria zone, and 3,000 m, the average upper limit of farming, there are area of localized soil erosion accelerated by primitive land use. (After "A physical and cultural geography", 1967.)

## 2) Results of soil survey

In Bhutan the soil survey has just started recently, then very few data are available. Some first-hand information, however, was obtained at the Regional Agriculture Research Station, Bhur. In the following, therefore, some results of soil survey in Thimphu, Punakha, Wangdiphodrang and Gaylephung Districts will be mentioned.

### The values of pH

In Table 2-4 the results for investigation on pH in the soil of cultivated land are shown. The figures in the table express the number of sampled fields. From the table it can clearly be



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recognized that the soils in the cultivated land ranges between 4.5 and 7.5 in pH values, mostly ranging from 5.5 to 6.5, which means that soils in Bhutan are slightly acid. From the viewpoint of rice physiology, however, the values of 5.5 to 6.5 pH are desirable acidity for the growth of rice. Accordingly, so far as the paddy fields are concerned, soils in paddy fields can be taken as most favourable soils in pH values.

Table 2-4 The Values of pH

District \ pH	4.5	5.0	5.5	6.0	6.5	7.0	7.5
Thimphu		1	4	7	8	4	
Punakha		2	3	10	6	1	1
Wangdiphodrang			3	3	11	3	2
Gaylegphug		6	8	13	7	6	

#### Organic carbon percentage

The organic carbon percentage can be taken as an index of soil fertility. Table 2-5 shows the frequency of sampled soils in values of the organic carbon percentage. Thimphu has a so big variation in the percentage that it ranges from 0.2 to as high as 2.8%, while other districts have rather small variations, ranging between 0.2 to 1.4%. Admitting the criterion, which is set up by the Department of Agriculture in Bhutan, that the lower percentages than 0.5% is taken as "Low", those between 0.5 and 0.75% as "Medium", and the higher percentages than 0.75 as "High", the soil fertility in Bhutan appears to be by no means low. The level of this criterion, however, is likely to be much low when compared with the other countries. Accordingly, soil fertility in Bhutan might be said "Low" from the viewpoint of organic carbon percentages.

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Table 2-5 The Values of Organic Carbon Percentage

District	Carbon %														
	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
Thimphu	1	7	4	6	2	1	1		1						1
Punokha	1	3	5	9	3	2									
Wangdiphodrang	1	1	5	8	5	2									
Gaylegphug	2	9	6	10	10	3									

The Value of P<sub>2</sub>O<sub>5</sub>

Phosphate being one of three major elements of fertilizers, Table 2-6 was prepared on the basis of the results of chemical analysis of P<sub>2</sub>O<sub>5</sub> in sampled soils. Total amount of available P<sub>2</sub>O<sub>5</sub> per ha was worked out in each sampled field from the results of chemical analysis. Taking the fields which contain less than 20 kg of P<sub>2</sub>O<sub>5</sub> per ha as "Low" fields in P<sub>2</sub>O<sub>5</sub> content, 20 to 50 kg per ha as "Medium", and more than 50 kg per ha as "High", the frequency of sampled fields is indicated in Table 2-6. By referring to the table, it can easily be recognized that the content of P<sub>2</sub>O<sub>5</sub> in the fields is nearly moderate in Bhutan as far as the present in investigation is concerned.

Table 2-6 The Values of P<sub>2</sub>O<sub>5</sub>

District	P <sub>2</sub> O <sub>5</sub>	Low Less than 20 kg/ha	Medium 20 - 50 kg/ha	High More than 50 kg/ha
Thimphu		2	16	6
Punakha		0	20	3
Wangdiphodrang		2	19	1
Gaylegphug		9	26	5

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### The Value of K<sub>2</sub>O

Potassium being also one of three major elements of fertilizers, sampled soils were also chemically analyzed at the Regional Agricultural Research Station, Bhur. Based on the results of chemical analysis, the total amount of available K<sub>2</sub>O per ha was calculated in each field, as in case of P<sub>2</sub>O<sub>5</sub>. Taking the fields which contain less than 125 kg of available K<sub>2</sub>O per ha as "Low" field in K<sub>2</sub>O content, 125 kg to 300 kg per ha as "Medium", and more than 300 kg per ha as "High", the frequency of sampled fields is shown in Table 2-7. The reference to the table suggests that soils in Bhutan are quite moderate in the content of available K<sub>2</sub>O.

Table 2-7 The Values of K<sub>2</sub>O

District	K <sub>2</sub> O Low Less than 125 kg/ha	Medium 125 - 300 kg/ha	High More than 300 kg/ha
Thimphu	8	16	0
Punakha	1	21	1
Wangdiphodrang	0	22	0
Gaylegphug	1	39	0

In recapitulation, as a result of examining the values of pH, organic carbon percentage, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O in the soils of fields in the main area of agriculture in Bhutan, it has been confirmed that the soils in Bhutan appear to be favourable for agricultural development, though the values of organic carbon percentages are low in general.



## 2-2-2 Social Environment

### (1) Structure of GNP

Taking a mid-year population as 1.003 million, the estimation of GNP was made for the year 1980 - '81 at market prices, and it is presented in Table 2-8 with sectoral breakdown. The total GNP is estimated to be Nu. 1,020.5 million or US\$113.3 million, this gives a per capita of Nu. 1,017 or US\$113.

Agriculture and related activities make the major contribution at about 63%; services accounts for about 13%, government and administrative activities follow with 10%, and, industry and mining contribute around 5% of the total gross national product. The statistic data reflect the basic economic characteristics which Bhutan has in common with other least developed countries, in particular the very low level of per capita income and the predominance of the agricultural sector in the economy.

Table 2-8 The Structure of GNP (Estimates) (Million Nu.)

<u>Sector</u>	<u>Contribution to GNP</u>	<u>%</u>
1. Agriculture & related activities	<u>645.2</u>	<u>63.2</u>
a. Agriculture	409.4	40.1
b. Animal Husbandry	76.5	7.5
c. Forestry	159.3	15.6
2. Manufacturing & Mining	<u>52.9</u>	<u>5.2</u>
a. Manufacturing	23.7	2.3
b. Small & Cottage Industries	9.6	0.9
c. Mining	8.6	0.8
d. Tourism	11.0	1.2
3. Services	<u>133.8</u>	<u>13.1</u>
a. Power	2.7	0.3
b. Communications	5.8	0.6
c. Transport	27.6	2.7
d. Construction	18.9	1.8
e. Social Services eg. health, education, etc.	34.8	3.4
f. Financial	15.4	1.4
g. Trade	28.6	2.9
4. Government & Administration	106.6	10.4
5. Net Rental Income	<u>82.0</u>	<u>8.1</u>
Total GNP	<u>1,020.5</u>	<u>100%</u>



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## (2) Economic potential

The economy of Bhutan is essentially rural based with 95% of the work force being employed in agriculture and related activities - mainly in subsistence farming and animal husbandry. As a result of the small population, however, the average nutritional level in terms of the daily calorific and protein intake is much higher here than in other countries in the region and is substantially higher than the average for all Asia. Until recently the country had been self-sufficient in her food (at present, however, as much as the amount of 25,000 tons of cereals is imported from India), the principal crops being rice, wheat, barley, maize, some-oil seeds and chillies. This is supplemented by livestock rearing which yields milk, butter, cheese and meat.

Industry is in a stage of infancy with a number of small scale units having been established in recent years. The few larger scale enterprises are a horticultural processing factory, three distilleries, a match plant and a cement factory. There is of course much scope for development of new industries in the future based on agriculture, forestry and mineral resources.

The country has an abundance of undeveloped natural resources. The natural resources mainly consist of the vast forest resources, the energy potential in hydro-electric power, and the commercial exploitation of the various minerals that have been discovered.

In the area of hydro-electricity, there are four major rivers with a number of tributaries which are a potential energy source. At present, a hydrological survey of the country is being undertaken and preliminary estimates suggest that minimum potential for generating 6,000 MW exists. During 1981 only 3.0 MW of hydro-electric power was generated, and at present schemes are under progress by which an additional 336 MW will be generated by 1984.

A number of minerals have been discovered in the country, which include limestone, dolomite, lead-zinc, copper, gypsum, graphite, coal slate, etc. Of the minerals discovered, except for limestone which is being used in the cement plant, commercial exploitation of the other materials has still not been started.



It has been estimated that the growing stock volume of Bhutan's forests is in the range of about 480 million m<sup>3</sup>. The net annual yield of wood is put at around 13.3 million m<sup>3</sup>. When comparing this figure with the actual usage of about 0.2 million m<sup>3</sup> in 1980 - '81, the enormous untapped potential can easily be recognized.

### (3) Budget allocation

The budget allocations in the Fourth Plan (1976 - '81) and the Fifth Plan (1981 - '87) are given in Table 2-9. The agriculture sector has always enjoyed the first priority in the budget allocation in the past, but it has decreased gradually with years. As can be seen in the table, the major increase in expenditure during the Fifth Plan is accounted for by the inclusion of major new industrial and commercial projects in the Plan. The present stage is set for a structural transformation of the economy based primarily on a full exploitation of the natural resource potential. During the Fifth Plan period six major investments costing Nu. 100 million or more are to be undertaken. Two of these projects are in the power sector, three in industries and one for the establishment of a national airline.

From Table 2-9 the increase emphasis and the predominance of the power sector and industries and mines can clearly be seen. The importance of agriculture and the public works programme (mainly roads and bridges) continues to remain. The relative outlays on the social sectors, however, in particular education, show a decline.

In short, the budget allocation for agriculture decreases in percentage of the total year after year, but the absolute value of the allocation is still increasing so markedly with years that its importance can clearly be recognized.



Table 2-9 Budget Allocations\* (Nu. in Million)

	<u>Fourth Plan</u> (1976 - '81)	<u>Fifth Plan</u> (1981 - '87)
Agriculture	259.05 (23.5%)	491.8 (11.2%)
Animal Husbandry	61.49 ( 5.6%)	122.1 ( 2.8%)
Forestry	110.26 (10.0%)	304.2 ( 6.9%)
Power	50.50 ( 4.6%)	715.0 (16.3%)
Industry and Mines	175.00 (15.8%)	760.5 (17.4%)**
Public-works Department	128.32 (11.6%)	536.9 (12.3%)
Civil Aviation	-	100.0 ( 2.3%)
Posts and Telegraphs	16.91 ( 1.5%)	25.0 ( 0.6%)
Communication	37.34 ( 3.3%)	66.6 ( 1.5%)
Tourism	12.50 ( 1.1%)	50.9 ( 1.2%)
Education	134.60 (12.1%)	337.8 ( 7.7%)
Health	54.58 ( 4.9%)	183.1 ( 4.2%)
Information and Publicity	11.04 ( 1.0%)	15.0 ( 0.3%)
Headquarters	34.30 ( 3.1%)	628.6 (14.4%)
Preservation of Ancient Monuments	-	-
Miscellaneous	20.31 ( 1.9%)	40.0 ( 0.9%)
<b>Total</b>	<b>1,106.20 (100%)</b>	<b>4,377.5 (100%)</b>

Note: \*: Excluding the Chukha Project

\*\* : Including Trade and Commerce



#### (4) Trade and commerce

The trade of Bhutan can be said to confine herself to India, because 95% of her trade is with India, and a Trade and Transit Agreement is in force at present. Due to an open frontier and inadequate customs administration there is no accurate account of the flow of goods and services across the border. However, free access to the vast Indian market is very advantageous to Bhutan as the domestic market is limited. In the sphere of agriculture Bhutan has exportable surplus in several items like potato, apple, orange, big brown cardamon, ginger and a few vegetables. Other exportable items are coniferous softwood, a range of tropical hardwoods, tea chest plywood and battens, gum resin, a wide range of handicrafts, hand-made carpets, hand-made paper, hand printed Buddhistic scrolls, basket ware, wood carvings, stone carvings, traditional masks and silverware. The industrial sector in Bhutan is relatively undeveloped. There are therefore few manufactured exports of significance apart from cement and some agro-based products.

As in the case of exports, most imports into Bhutan are from India. Imports have been mainly confined to material and equipment required for the developmental programmes, although recently the inflow of consumption goods has also been increasing. At present about 10% of total imports come from countries other than India, and almost purchases made by the Government from India. While all goods imported on Bhutan Government account are allowed in duty free by the Government of India, all private imports of goods from third countries are subjected to the Indian Customs Tariff. It should be noted from the viewpoint of agriculture that as much as 25,000 MT of cereals, which corresponds to 20% of the total production, was imported from India in 1981 - '82.

Total imports amounted to about Nu. 440 million, while total exports were estimated to be about Nu. 180 million, which means that the value of imports is 2.5 times as much as that of exports. This should be noted not only in foreign trade but also in the political economy of Bhutan.





## (5) Taxation

Under the present fiscal system the Government has three sources of revenue, i.e. direct taxes, indirect taxes and non-tax revenues.

### a) Direct taxes

These taxes occupies an important part of total government revenues. Income taxes are levied on Government employees upto a maximum rate of 5% of the basic salary, and on private business enterprises in the form of a turnover tax at a maximum rate of 7-8% on business with annual sales value exceeding Nu. 1.2 million. There is no income tax levied on the business income of individuals. A flat rate of 5% is payable on all private rental income. At present there is no Income-Tax Act and private enterprises are not required to maintain audited balance sheets. In the agricultural sector, there are certain direct taxes like the land tax, house tax, etc. However, the rates are very low and there are many exemptions. The most important components of direct taxes today are the royalties which are levied on timber and minerals, the licencing and registration fees levied on motor vehicles and business enterprises.

### b) Indirect taxes

These taxes constitute the major source of Government revenues. Most of the duties are specific in nature, but if their advalorem rates were estimated, except for the duties on liquors and spirits, the tax rates are very low. Within excise duties, the major component is the excise duties refund from the Government of India which amounts to Nu. 25 million per annum at present. Sales taxes are the next most important source of revenue, with the rates varying between 4% to 8%. The other indirect taxes like customs duty and stamp duties are negligible in their applicability and revenue contribution.

### c) Non-tax revenues

Non-tax revenues represent the total receipt or gross earnings of Government commercial undertakings and non-commercialised departments, house rents on Government buildings, sale proceeds of Government property, etc.



The total value of tax and non-tax revenues in 1980 - '81 was Nu. 101.6 million, and the value of direct taxes was Nu. 13.6 million, that of indirect taxes Nu. 42.7 million and non-tax revenue Nu. 45.3 million.

#### (6) Education

At the outset of the 1960's there were practically no educational facilities within the country. The illiteracy rate is still estimated to be at the high level of 78%. A system of regular schooling was introduced in the early 1960's and was expanded rapidly. Since then there have been substantial developments and, although university level education is still not available within the country, a basic system of imparting technical training in various fields has been set up.

There are 12 classes from Class I to Class XII in the education system, besides the kindergarden classes (Junior class and Upper class). Classes from I to V are corresponding to the primary school in Japan, Classes from VI to X are the secondary school and correspond to the junior and senior high school, and Classes from XI to XII correspond to the junior college. When finishing the Class V and Class X respectively, students ought to take the national examination.

In Bhutan at present there are over 143 primary and secondary schools with a total of about 36,000 students, and a junior college with an enrollment of about 200 students (1980 - '81).

Further, there are now two teachers' training centres, a technical training school and a diploma level polytechnic, and some schools for fine arts, etc., with a total of around 570 trainees. These institutes train health assistants, foresters, veterinary compounders, agricultural diploma holders, electrical and mechanical technicians, etc.

In addition to this, the Royal Government has also undertaken a programme of in-house training in the various technical departments under which about 400 personnel are receiving training in the areas of agricultural extension, primary health, veterinary assistance, etc.



The total number of educational institutions of various types at the end of 1981 was 176, with a teaching staff of about 1,230. As there are no institutes of higher education in the country, students have to be sent abroad for this purpose. There are at present about 500 students studying at various levels outside the country. The Government has followed a consistent policy of supporting such higher education by providing full scholarships to all students who go abroad for training.

#### (7) Social development

The average life expectancy in Bhutan is 46 years, with a high rate of infant mortality ranging upto 300 per 1,000 live births. The population growth is estimated to be in the region of 1.6 - 1.8% per annum. As the hygienic and sanitary conditions in the country are at a very low level, the provision of adequate health care is therefore of prime necessity.

In spite of all the Government's efforts, the health care system is still very weak and coverage limited, with only about one doctor per 20,000 population and one hospital bed per 2,000 population. There are at present only about 64 qualified doctors in Bhutan.

At present there are 12 general hospitals, 40 dispensaries, 40 basic health units and 3 leprosy hospitals in the country. Moreover, in order to improve the hygienic conditions and provide certain basic facilities to the people, water supply and sanitation schemes have been taken up by the Royal Government. At the end of 1981, 14 out of 17 important towns had been provided with piped water supply.

#### (8) Manpower

Bhutan is one of the few countries in Asia which does not have any population pressures. As around 95% of the population is employed in traditional self-sufficient agricultural activities, the problem has been how to create an adequate work force which could then be employed in the newly developing sectors of the economy. In the past the release of surplus labour from agriculture has been low compared to the requirements of the development process. As a result there has been a shortage



of unskilled and semi-skilled labour, and therefore immigrant labour from Nepal and India have been used to make up the gap. In the modern sector these shortages have been further aggravated by a serious inadequacy of skilled and technical manpower. Of a total force of about 46,300 in March 1982, 76.7% are expatriate workers. The breakdown is as follows:

Category	Nationals	Expatriates	Percent of Expatriates
Public sector	7,787	6,532	45.62
Private sector	1,931	1,732	47.29
Casual labourers (Public + Private)	1,066	27,263	96.24

The manpower policy of the Government is based on the national goal of self-reliance. The policy calls for concerted efforts to bring about a progressive decline in the proportion of the foreign labour force. At the same time, there is a recognition that in the long-run the solution to this problem can only be through increasing agricultural productivity and rendering a large proportion of the work force there superfluous.



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## 2-2-3 Conditions of Infrastructures

### (1) Transportation system

- 1) Not too long ago the only wheeled vehicles in this mountainous country were simple carts used to carry heavy loads, and the only methods of transportation by using ponies, mules, yaks and feet. Today an impressive web of roads curls up the steep valley walls and across breathtaking mountain passes, reducing journeys, which once took several weeks, to a few hours. Work on the first road, from Phuntsholding, near the Indian border to Paro and Thimphu in the central highlands, began in January 1960. Within 15 months with as many as 10,000 people working on the construction at one time, the construction of a 145 km long road was completed. It is mentioned specially that the labour during its construction was mostly derived from the farmers. Today about 2,000 km of highways and arterial roads cross Bhutan as shown in Fig. 3-3. Routes run from north into the western and central regions not only from Phuntsholing but also from Geylegphug, and into the east from Samdrup Jongkhar.
- 2) The Bhutan Government Transport Service (B.G.T.S.) began in 1962 to carry both passengers and goods. Today its network spreads across the country and to the Indian border towns in West Bengal and Assam. Specially the road between the Capital, Thimphu and the Indian border town, Phuntsholing is crowded with buses and trucks which are filled with many people and such cash crops as potatoes, apples and tomatoes.

All imported goods to Bhutan is permitted to enter only through the custom clearance in Phuntsholing.

The goods, which are imported from countries than India and Bangladesh adjoining to Bhutan, are exclusively transported to the Calcutta port by ships and then receive custom clearance based upon the regulation in India. After the clearance, it is transported to Phuntsholing from Calcutta port by

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the trucks of B.G.T.S. It takes one or two days drive on the 900 km long paved road. The process of import on the goods applicable to the Project is shown in Fig. 3-4.

- 3) In the extension programmes of the road network in the Fifth Plan\*, the length of roads is expected to double from 2,000 km to 4,500 km with 450 suspension bridges -- absolutely essentials in this Himalayan Kingdom -- scheduled to be built as listed below.

(a) New roads

Gedu to Dugana  
Samchi to Sibsoo  
Wangdi to Damphu  
Damphu to Dagadzong  
Wangdi to Chirang

(b) Roads to be improved

Mongar to Luntshi  
Pema Gatshal to Tshelingor  
Lupsiboty to Damphu  
Dupidara to Lamidara  
Riju to Renzong  
Chasam to Duksam and Tashiyangtsi

\* The Fifth Plan means the Fifth National Development Plan from 1982 to 1987. The same applies to other numeralized Plans herein in order of their numbers.

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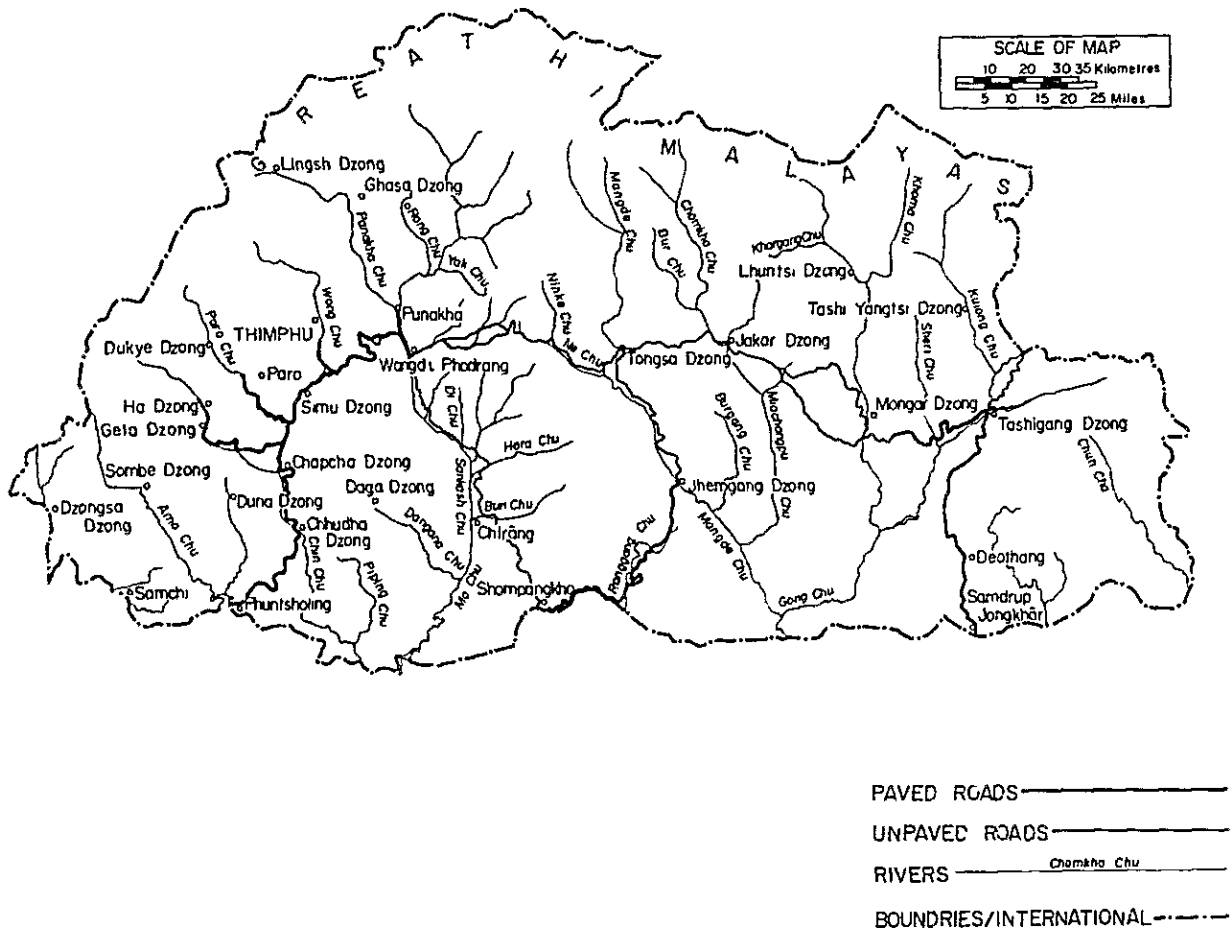
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Fig. 2-3 Road Network in Bhutan



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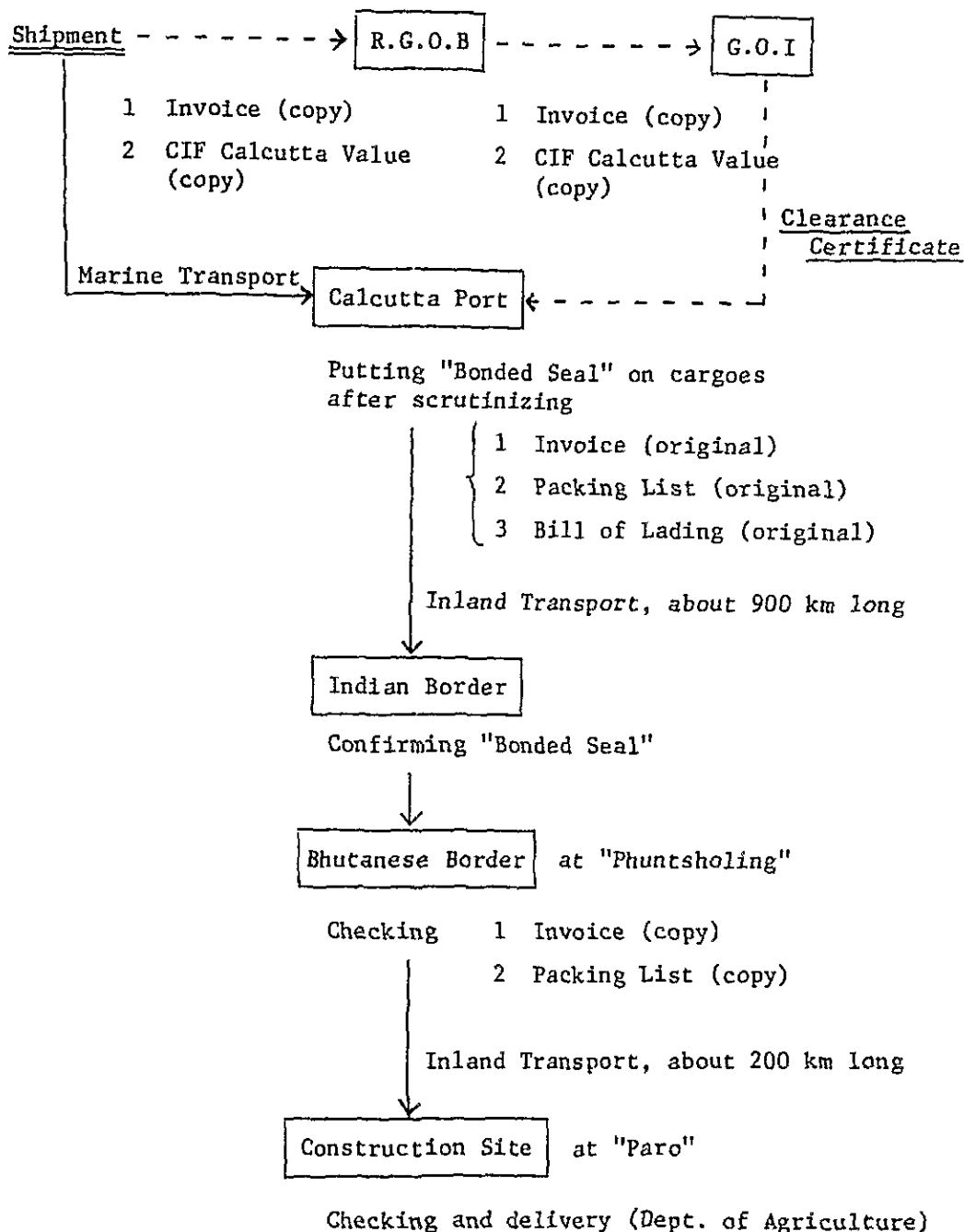
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Fig. 2-4 Process of Import

Process of Import

R.G.O.B : Royal Government of Bhutan

G.O.I : Government of India







(2) Communication

- 1) A regular postal service, begun in 1962, today serves all but the most remote areas. About 500 km of telephone wires, connecting all the main districts, have been laid, and the automatization of telephone exchanges is in progress. A micro-wave station connected to the Indian network in Hashimara is to be installed in Thimphu. Wireless communication, teleprinter and telegraph services available for execution of the Project are shown in Fig. 3-5.

Media is still in a fledgling state. A small radio station in Thimphu broadcasts local news and educational programmes twice a week in Dzongkha, English and Nepali. It is proposed to develop this station into a full-fledged broadcasting operation in the near future.

Kuensel, the official news gazette, is published weekly in all three languages.

- 2) During the Fifth Plan, the following items for communication will be set up, established and expanded:
  - Setting up new branch post offices and mobile post offices
  - Starting new runner routes
  - Upgradation of selected existing branch post offices to full-fledged post offices
  - Purchase of vans for carrying mail and also to be used as mobile post offices
  - Purchase of equipment for post offices such as cancelling machines, weighing machines, post boxes, stamps vending machines, teleprinters, etc.
  - Establishment of new telegraphic links

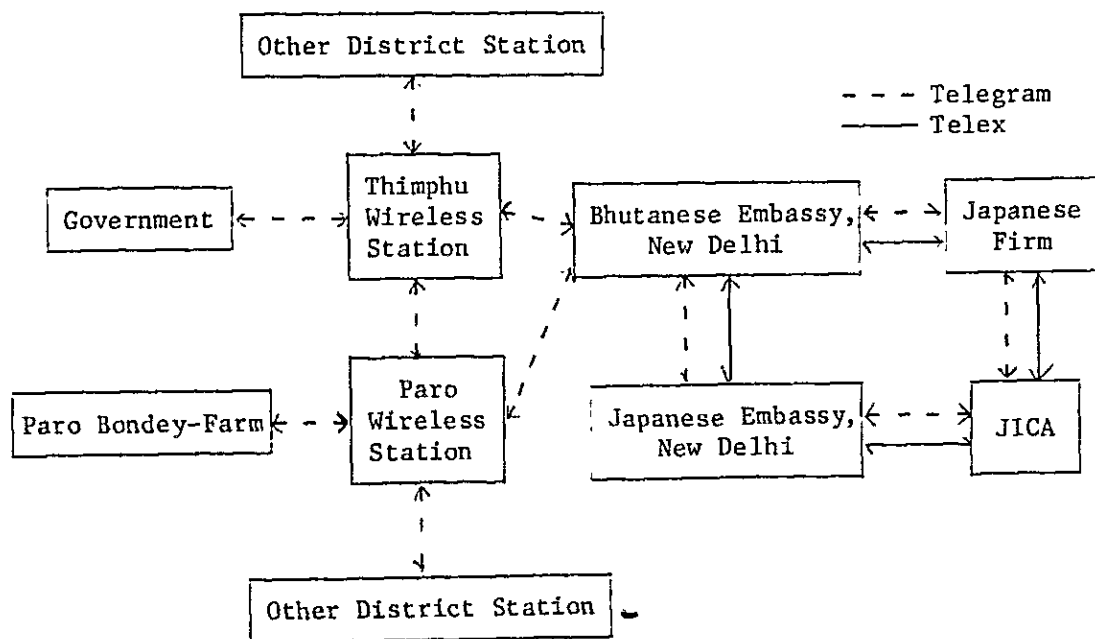


- Expansion of telephone lines as follows:

Samchi	50 to 100 lines
Sarbhang	50 to 100 "
Wangdiphodrang	50 to 100 "
Samdrupjongkhar	50 to 100 "
Tashigang	30 to 50 "
Phuntsholing	400 to 600 "

- Installation of the new automatic telephone exchange at Jagar and Damphu
- Setting up two 20 lines telex exchanges at Thimphu and Phuntsholing
- Improving wireless communications

Fig. 2-5 Communication System





### (3) Power

- 1) Hydro-electric power generation in Bhutan begun in 1967 with the installation of the micro-hydel project of 360 kW capacity in Thimphu.

During the Third Plan and the Fourth Plan, 21 townships and 97 villages were electrified through these small schemes including transmission and distribution networks. In spite of the steady increase in electrification almost the entire requirements of domestic fuel, particularly in the rural areas, was still met from firewood. Furthermore, as the result of the agricultural and industrial development programmes, the rural areas have undergone a change and substantial new demands for power have been building up. These demands were reflected in the change in the consumption pattern of electricity. In other words, as compared to the domestic sector which consumed 80% of the energy at the end of the Third Plan, by 1981/82 industrial and commercial demands were 45%, domestic demands 45% and the agricultural sector took 10%.

- 2) Under these circumstances, the installed capacity was built up to reach about 5.25 MW by the end of the Fourth Plan. About 3.5 MW was hydro-generated from six mini-units spread over the country and the rest generated from diesel sets.
- 3) Though a total of 3.09 MW was generated during 1981-82, this was not adequate to meet the local demand and an additional 5.23 MW had to be imported from India.
- 4) At present, a hydrological survey of the country has been undertaken and preliminary estimates suggest that minimum potential for generating 6,000 MW exists.
- 5) In order to meet these growing requirements and to develop Bhutan's hydro-electric resources, a major project at Chukka, on the way to Thimphu from Phuntsholing, was undertaken and is now under construction. This project is expected to go on stream during 1984, and by the end of the Fifth Plan is likely to generate about 260 MW-270 MW of power.



The project is directly financed by the Government of India.

6) Programmes in the Fifth Plan

The objectives of the power development plan during the Fifth Plan are as follows:

- to progressively augment the generating capacity through hydro-electric plants primarily for domestic and industrial use and also for export.
- to build up a viable national grid of transmission and distribution lines starting from a regional grid in Western Bhutan, and to promote rural electrification.
- to replace the use of non renewable energy resources to the extent possible and to explore alternative energy sources.

The total outlay proposed for the power sector in the Fifth Plan is NU. 715 million as shown in Table 3-1.

Table 3-1 OUTLAY AND SOURCES OF FINANCE: POWER SECTOR (1981-87)

Programme	Fifth Plan Outlay			Sources of Finance		
	Total	Develop- ment	Mainte- nance	Committed		
				Budget Support	International Assistance	Defic.
1	2	3	1	2	3	
Generation	440.07	440.07	-	98.83	-	341.2
Transmission and sub-transmission	229.50	229.50	-	49.66	-	179.8
Rural electrification	5.00	5.00	-	5.00	-	-
Urban electrification	7.50	7.50	-	7.50	-	-
Feasibility studies	2.63	2.63	-	2.63	-	-
Central establishment	30.33	14.29	16.04	14.73	15.6	-
TOTAL	715.03	698.99	16.04	178.35	15.6	521.0





During the Fifth Plan period, it is proposed to carry out detailed investigation and survey on 3 mini-hydel plants at Tangsibi (5 MW), Pemagatshel (0.5 MW) and Tashiyangtshe, those which are planned as small isolated systems to provide power in townships and rural areas. Furthermore, the 1.5 MW plant at Gaytcha will be completed by the end of the Fifth Plan and commissioned in the Sixth Plan.

With the commissioning of the Chukha Hydel Projects in the Fifth Plan, the transmission network of this power will create a regional grid in Western Bhutan.

This grid will consist of a 220 kV line running north from Chukha to Thimphu. This line will be not only tapped through 66 kV lines which will feed the Paro and Ha valleys, but also further extended into the Punakha valley up to Wangdiphodrang to complete the northern part of the western regional grid. From Chukha a 66 kV line is already in existence to take power south to Phuntsholing and will be extended to the cement plant at Penden and then further to the town of Samchi. In view of the fact that Gaylegphug is emerging as a large industrial and commercial center, it is also proposed to draw a 220 kV line from Chukha to Gaylegphug which will be further tapped at Dagana, Chirang and Sarbuang to supply the southern region. The total length of these lines which are to be constructed in the Fifth Plan is about 275 km. In addition to these transmission lines, a further 220 kV line is to be constructed from Chukha southward to carry the power which will be exported to India.



## 2-3 Agriculture in Bhutan

### 2-3-1 Agriculture in General

As mentioned before (Par. 2-1, 2-2-2), about 90% of the population of Bhutan is primarily dependent on agriculture. The contribution of this sector to GNP in 1980 - '81 was estimated at 47% (including animal husbandry). The principal food crops grown are rice, wheat, maize, barley, oil seeds and chillies. Recently, there has been a considerable expansion of commercial and horticultural crops such as potatoes, oranges, apples, cardamons, ginger and other vegetables.

Agricultural development has enjoyed a high priority in all development plans. The principal aim of agricultural development has been to increase productivity and generate marketable surpluses. However, rapid progress in this sector has been constrained by a lack of the required infrastructure and supporting facilities. Limited irrigation coverage, a weak transport system, inadequate storage and marketing facilities, and a limited supply of seeds, fertilizers and rural credit, have been the major problem factors.

However, there is no doubt that the programmes undertaken in this sector have had a profound impact on the traditional system of agriculture, and had laid a sound basis for rapid progress in the future.

Although traditionally Bhutan has been self-sufficient in food production, the rise in agricultural production has not kept up with the growth in consumption levels. As a result in the last few years there have been annual imports of cereals ranging between 15,000 and 25,000 metric tons. The gross cropped area under cereal cultivation is estimated to have increased from about 81,000 ha in 1973 to about 97,000 ha in 1978 and 113,000 ha in 1982. Net cereal production is estimated to be about 125,000 MT. In other words 20% of net cereal production was imported from India in 1981 - '82, which is worth noticing in the agriculture in Bhutan. On the other hand, the major effort to introduce and encourage the growing of cash crops has met with some success. From negligible quantities in the early 70's, the production of vegetable and fruit crops have reached a sizeable level.



## 2-3-2 Agricultural Land Use

### (1) Agricultural land

The total present agricultural land is estimated to be about 148,000 ha (370,000 acres), and its breakdown is presented as follows:

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Wet land	26,700 ha ( 66,795 acres) .....	18%
Dry land	64,450 ha (161,135 acres) .....	43%
Tsheri land <sup>1)</sup>	40,125 ha (100,320 acres) .....	27%
Horticultural crop land <sup>2)</sup>	13,400 ha ( 33,500 acres) .....	9%
Kitchen garden	2,300 ha ( 5,750 acres) .....	2%
Pangshing and other cultivable land	1,025 ha ( 2,600 acres) .....	1%
<hr/>		
Total	148,000 ha (370,000 acres) .....	100%

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Note: 1) Land under shifting cultivation

2) Apple, orange, other fruits, cardamom, arecanut, etc.

Thus only about 3% of the total land of Bhutan (47,000 km<sup>2</sup>) is cultivable agricultural land.

### (2) Wet land cultivation

Wet land is terraced irrigated paddy land. The entire area of 26,700 ha of wet land in the country is cropped in summer (wet season) with paddy, occupying almost 99% of this area and the remaining being accounted for by a small amount of maize in some of the southern districts.

About 34% of the wet land is cropped again in winter (dry season) with wheat and barley which are the main second crops after paddy in most areas. Buckwheat, potato, mustard, and maize are also important second crops on wet land. Double cropping on wet land is more extensive in the Paro, Thimphu, Punakha, and Wangdi valleys where irrigation is better, and the area between 60% to 70% of the wet land is cropped again in winter. Two crops of paddy are taken on wet land in some parts of



the southern districts of Gaylegphung, Chirang and Bamdrupjongkhar where the high rainfall makes this possible. This practice is however limited to a total of about 445 ha (1,100 acres) in three districts.

Almost 97% of the gross cropped area on wet land is at present under cereal crops. Potato is at present the only cash crop grown on wet land mainly in the Paro and Thimphu valleys.

### (3) Dry land cultivation

Of the 64,450 ha (161,135 acres) of the total dry land in the country, only about 89% is estimated to be cropped annually. Double cropping is being practiced on about 30% of the total net cropped area of 58,184 ha (143,715 acres) of the dry land. Maize is the major dry land crop at lower altitude especially in the eastern, central and southern parts of the country.

At higher altitude wheat, barley and buckwheat are the most important dry land crops. Mustard, potato, raddish and turnip are also important dry land crops especially in the western and central parts of the country. Ginger in parts of southern Bhutan and soybean in eastern and central Bhutan (mainly intercropped with maize) are other important dry land crops.

Almost 90% of the gross cropped area on dry land is at present under cereal crops. Potato and ginger are the main cash crops grown on dry land. Pulse crops (soyabean, black gram, etc.) and mustard are the other important non-cereal crops cultivated on dry land. In the Gaylegphug area, sugarcane has recently gained importance as a dry land crop.

### (4) Tsheri land cultivation

'Tsheri' or shifting cultivation has until now been fairly widespread. The total land area on which tsheri cultivation has been in practice is estimated to be 40,125 ha (100,320 acres). In most areas, farmers crop about 20% to 25% of their tsheri land annually. Thus about 8,643 ha (21,350 acres) of the total tsheri land is estimated to





be cropped annually, double cropping being practiced on about 12% of this land. Maize, buckwheat and millet are the main tsheri land crops at present.

(5) Land under fruit and tree crops

About 13,400 ha (33,500 acres) of land is at present estimated to be under perennial crops. Orange, apple and cardamon cover more than 99% of this area and the remaining is accounted for by areca nut, peach, plum, walnut, nut trees and other fruits. In the southern districts of Samchi, Gaylegphug and Chirang are the main orange and cardamon growing area, accounting for about 87% of the total orange growing area and 93% of the cardamon growing area in the country. The main apple growing areas at present are in the valleys of Thimphu, Paro and Bumthang which together account for about 80% of the total area under apple.

(6) Kitchen gardening

Almost every household throughout the country maintains a backyard or kitchen garden plot where chilly, beans, other vegetables and some fruits are generally grown for home consumption. The total land under kitchen garden cultivation is estimated to be about 2,300 ha (5,750 acres).

### 2-3-3 Area, Yield and Production of Major Crops in Bhutan

In Table 2-10 the major crops in Bhutan are listed, and their planted area, yield and amount of production are presented.

Maize is by far the largest in planted area, followed by rice, wheat (barley) and buckwheat (millets). Cereal crops occupy 80% of the total planted area in Bhutan.

The yields of cereal crops per ha in Bhutan are by no means high, which can easily be recognized from the following instances. According to the FAO Production Yearbook 1979, the yields of rice (paddy) per ha in various countries are as follows:



	ton/ha		ton/ha		ton/ha
Korea	6.56	U.S.A.	5.14	Nepal	1.98
Japan	6.24	China	3.72	Bangladesh	1.94
Spain	6.19	Indonesia	2.98	Thailand	1.88
North Korea	6.15	Pakistan	2.51	Vietnam	1.87
Egypt	5.76	Philippines	2.00	India	1.79
Italy	5.61	Burma	2.00	Brazil	1.40

Comparing the yield in Bhutan with that of Japan, Bhutan is less than one third of that of Japan. Since the natural conditions of Bhutan fairly resemble those of Japan, it is firmly believed that there is left much room for rising the average yield of rice in Bhutan.

The total production of cereals amounts to 160,907 tons, while that of rice and wheat (barley) is only 70,897 tons. As mentioned before, the imported cereals most of which are rice and wheat amount to 25,000 tons in 1980 - '81. This means that an increase of the production of rice and wheat (barley) is of the prime importance in Bhutan. On the other hand, the Government's effort to introduce and encourage the growing of cash crops can be recognized from the fact that the production of vegetables and fruit crops have reached a sizable level, as can be seen in Table 2-10, from the negligible quantities in the early 70's.

Table 2-10 Area, Yield and Production of Major Crops in Bhutan

Crops	Planted Area (ha)	Yield (ton/ha)	Production (ton)
Paddy (Rice)	27,982 ( 69,115 ac)	2.05	57,363
Maize	56,798 (140,290 ac)	1.41	80,085
Wheat, Barley	12,304 ( 30,390 ac)	1.10	13,534
Buckwheat, Millets	12,563 ( 38,440 ac)	0.79	9,925
Pulse Crops	4,036 ( 9,970 ac)	0.62	2,502
Mustard	2,905 ( 7,175 ac)	0.64	1,859
Potato	3,682 ( 9,085 ac)	6.81	25,074
Ginger	425 ( 1,050 ac)	4.70	1,998
Chilly & Other Vegetables	2,688 ( 6,640 ac)	3.70	9,946
Orange (53% bearing)	6,247 ( 15,430 ac)	7.67	25,395
Apple (45% bearing)	1,504 ( 3,715 ac)	4.95	3,350
Cardamon (74% bearing)	5,887 ( 14,540 ac)	0.62	2,701



## 2-3-4 Cropping Pattern and Cropping Intensity

### (1) Cropping pattern

One of the biggest characteristics in the cropping pattern in Bhutan is that the pattern varies markedly with the altitude on which crops are grown, as shown in Fig. 2-6.

On the cultivated land at nearly 300 m height above sea level, two croppings a year are prevailing in general such as maize and maize, maize and rice, and rice and wheat, as shown in Fig. 2-6. In a very limited area (445 ha, 1,100 ac) in southern districts, as mentioned in 2-3-2 (1), two croppings of rice a year are practised.

At the altitude of nearly 500 m, a single cropping of rice, three croppings of buckwheat, millet and buckwheat, two croppings of maize and wheat, and two croppings of maize and maize are mainly conducted.

At the altitude of about 1,000 m, a single cropping of rice, two croppings of maize (long-term variety) and buckwheat, two croppings of maize (short-term variety) and buckwheat, two croppings of rice and buckwheat, two croppings of rice and wheat (or barley) are generally practised.

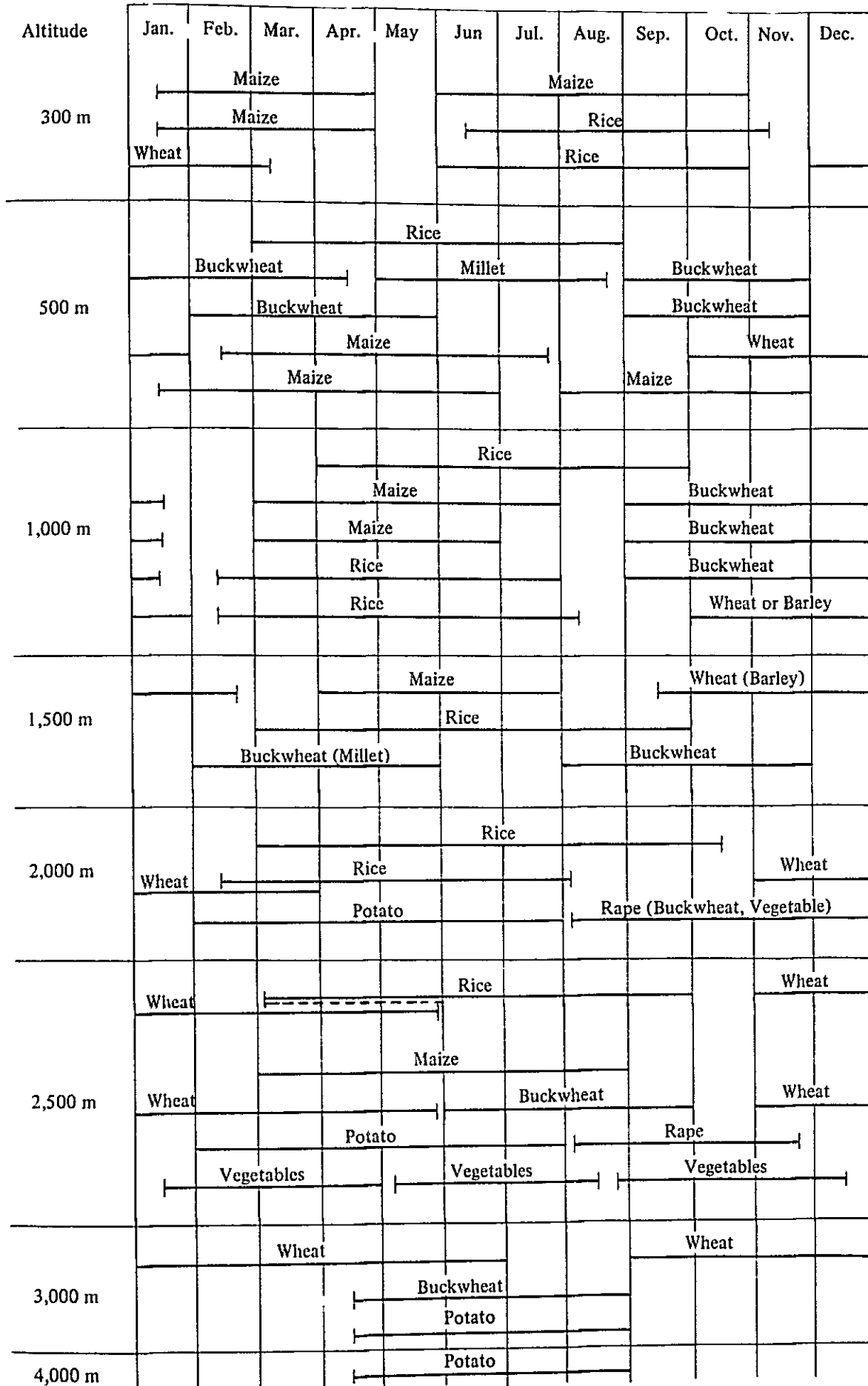
At the altitude of about 1,500 m, two croppings of maize and wheat, a single cropping of rice and two croppings of buckwheat (or millet) and buckwheat are prevailing in general.

At the altitude of 2,000 m, a single cropping of rice, two croppings of rice and wheat and two croppings of potato and rape (or vegetables or buckwheat) are commonly practised. In case of two croppings of rice and wheat (barley), the nursery period of rice is overlapping with the growth duration of wheat (barley) for one month and half, as can be seen in the figure.

At the altitude of 2,500 m, two croppings of rice and wheat (in which rice nursery-period of 2.5 months is overlapping with the growth duration of wheat), a single cropping of maize, two croppings of wheat and buckwheat, two cropping of potato and rape and three croppings of vegetables are generally carried out.



Fig. 2 — 3 Cropping Pattern in Bhutan







At the altitude of 3,000 m, a single cropping of wheat, a single cropping of buckwheat and also a single cropping of potato are commonly practised.

At the altitude of 4,000 m, only potato is cultivated once a year.

The cropping pattern in Bhutan varies remarkably with the elevation as above, but the central part of agriculture in Bhutan is in the altitudes between 2,000 m and 2,700 m, and accordingly the cropping patterns at 2,000 m and at 2,500 m can be taken as the most popular patterns in Bhutan.

## (2) Cropping intensity

In Table 2-11 cultivated land areas with breakdown of "Wet land" (lowland field), "Dry land" (upland field), and "Tsheri land" (burnt field) by districts are presented.

From the table it is noted that (1) "Dry land" area is by far the largest in Bhutan, followed by "Wet land" area, and "Tsheri land" is by far the smallest, (2) Samchi district is outstandingly the largest in "Wet land" area, followed by Gaylegphug, while Pemagatshel is the smallest, followed by Haa and Gasa, (3) Gaylegphug, Samchi and Tashigang are outstandingly large in "Dry land" area and Gasa and Punakha are markedly small, (4) Samdrunjongkhar is by far the largest in "Tsheri land" area, followed by Samchi, Tashigang and Paro, and Gasa, Punakha and Wangdiphodrang are quite small in area, and (5) in total land area Samchi, Tashigang, Gaylegphug and Chirang are quite large, while Gasa, Punakha, Haa and Bumthang are all less than 2,000 ha (5,000 ac) in area.

Further, it is evident from the table that (1) the double cropped area is largest in "Dry land" and smallest in "Tsheri land", (2) double cropped area on "Wet land", is largest in Samchi and smallest in Pemagatshel, (3) double cropped area on "Dry land" is markedly large in Gaylegphung and Tashing, and outstandingly small in Punakha and Gasa, (4) double cropped area on "Tsheri land" is by far the largest in Samdrunjongkhar and less than 160 ha (400 ac) in all other districts, (5) Tashigang and Gaylegphug are strikingly large in the total double cropped area, while Gasa and Haa are markedly small.



On the basis of the above mentioned data, the gross cropped area was worked out, and then the cropping intensity was calculated as shown in the last column in Table 2-11. The cropping intensity is high in Punakha, Thimphu, Wangdiphodrang, Pemagatshel and Mongar, while it is low in Haa, Chirang and Samachi, with an average value of 130% in whole Bhutan, which is considered considerably low. It should be noted, therefore, that there is left much room for increasing the cropping intensity in Bhutan, and an increase of the intensity will play an important role in increasing agricultural production in Bhutan.



Table 2-11 Cultivated Land Area and Cropping Intensity in Each District (1980-'81)

District	Cultivated land area (ha)			Double cropped area (ha)			Total	Gross cropped area (ha)	Cropping intensity(%)
	Wet land	Dry land	Tsheri	Wet land	Dryland	Tsheri			
Bumthang	-	1,780	180	-	830	15	845	2,805	143
Chirang	2,455	7,205	110	445	1,330	20	1,795	11,565	118
Dagana	585	2,025	160	185	450	20	655	3,425	124
Gasa	90	210	-	30	45	-	75	375	125
Gayleghphug	3,580	9,820	170	715	3,610	20	4,345	17,915	132
Haa	70	1,235	285	30	180	-	210	1,800	113
Lhuntshi	980	1,520	285	110	570	25	705	3,490	125
Mongar	470	2,740	525	225	1,325	75	1,625	5,360	144
Paro	1,995	2,205	970	1,155	525	40	1,720	6,890	133
Pemagatshel	30	1,830	285	5	925	15	945	3,090	144
Samchi	5,700	10,200	1,215	1,405	1,650	100	3,155	20,270	118
Samdrupjongkhar	1,445	3,665	2,105	385	1,415	435	2,235	9,450	131
Shemgang	920	1,175	810	295	390	160	845	3,750	129
Tashigang	3,150	9,890	1,010	1,085	3,360	70	4,515	18,565	132
Thimphu	1,680	980	240	1,105	375	15	1,495	4,395	152
Punakha	1,435	160	-	845	30	-	875	2,470	155
Tongsa	665	1,115	235	195	245	10	450	2,465	122
Wangdiphodrang	1,790	605	50	1,030	150	10	1,190	3,635	149
Total	27,040	58,360	8,635	9,245	17,405	1,030	27,680	121,715	130



### 2-3-5 Labour Pressure in Farm Practices through the Year

With a view to preparing the basic data for mechanization in Bhutan, an investigation was made on all kinds of farm practices through the year and on the degree of their overlapping with one another. As a representative example, a series of farm practices in Paro, where is a center of agriculture in Bhutan and which practices are most widely prevailing in Bhutan, was subject to the investigation.

As a result of investigating and arranging the main farm practices in individual cultivations of crops grown commonly in Paro district, Fig. 2-7 was drawn.

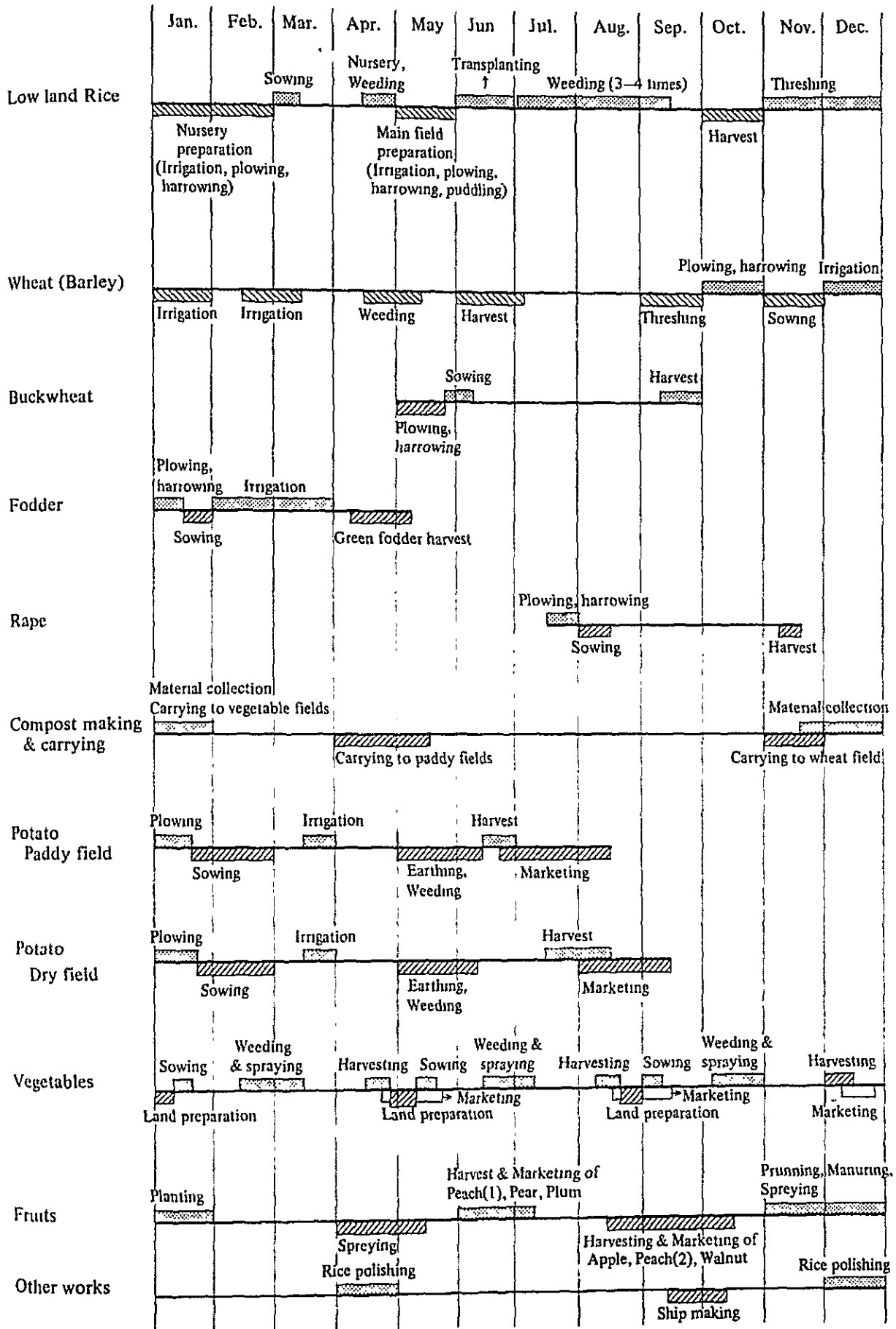
The reference to Fig. 2-7 makes it possible to estimate the degree of labour pressure of farm practices by knowing the degree of overlapping of farm practices of various crop growings and other works. From the figure it is evident that May and June are the busiest season through the year, because the degree of overlapping of practices is most conspicuous, i.e. main field preparation and transplanting in rice, weeding and harvesting in wheat or barley, plowing, harrowing and sowing in buckwheat, harvesting in fodder, carrying out of compost, earthing-up, weeding and harvesting in potato, land preparation, sowing and marketing in vegetables, spraying, harvesting and marketing in peach (short-term), pear and plum being concurrently conducted in May and June. On the other hand, February and March can be taken as the most leisure season in the year, because the degree of overlapping of practices is slightest through the year.

Likewise, one can easily estimate from Fig. 2-7 the degree of labour pressure of farm practices at any time of the year.





Fig. 2 - 7 Farm Practices in Paro (Altitude 2400 m)





## 2-3-6 Labour Requirements for Farmers in Bhutan

Farmers in Bhutan are usually requested to carry out not only ordinary farming practices but also various kinds of public works and obligatory works in village communities.

### (1) Kinds of farming practices

Works directly related to farming are as follows:

<u>Cultivation</u>	<u>Post Harvest</u>	<u>Marketing</u>
Compost carrying	Drying	Material handling
Land preparation	Transport	Weighing
Nursery works	Threshing	Transport
Transplanting	Washing	Storing
Irrigation	Cleaning	Packing
Weeding	Packing	Travelling
Plant protection	Curing	
Harvesting	Storing	
	Hulling	
	Polishing	

### (2) Kinds of obligatory works in village communities

During the farmers' daily life, there are many works which are not directly related to farming but in which the farmers must obligatorily participate to the traditional custom of village communities, besides their own household basic works. Further, all farmers are obliged to participate on almost all public works. The main works are outlined below.

#### a) Household basic works

- Fire-wood collection
- Drinking water collection
- Compost making
- Bedding material collection



b) Irrigation works

Digging  
Material carrying  
Cement works  
Protection work  
Maintenance  
Water control

c) Village obligatory works

House construction  
Timber collection  
Roofing material collection  
Soil works  
Road maintenance

d) Public works

Basic health unit construction  
Dispensary construction  
School construction  
Monastery work  
Bridge work  
Dzong (castle) work  
Cattle migration  
Road construction

As mentioned above, Bhutan's farmers have much more works than those in any other countries. In particular, it is worth noticing that all farmers have the obligation to engage in almost all public works.



### 2-3-7 Labour Requirement per Hectare in Growing Cereal Crops in Bhutan

No data was found on the labour requirement per ha for growing various crops in Bhutan, except for the following data. The data was obtained from the household surveys conducted in Punakha sub-division in 1981.

In Table 2-12 the labour requirement per ha in rice cultivation as well as wheat cultivation is given. In rice cultivation the required man-hours per ha amount to as many as 2,024 hours, which draws much attention. To understand this fact fully, Table 2-13 is prepared.

According to Table 2-13, in Japan required man-hours per ha have been decreasing markedly in rice cultivation over the years. The main reason for it can clearly be ascribed to the fact that farm mechanization has advanced markedly yearly in Japan. The total required man-hours are as few as 869 hours in 1974 and 722 hours in 1978, which are corresponding to 43% and 36% of the required man-hours in Bhutan, respectively. From this viewpoint the importance of farm mechanization in Bhutan can hardly be over-emphasized.





Table 2-12 Labour Requirement per ha in Rice and Wheat Cultivation

Rice Cultivation in Bhutan

<u>Operation</u>	<u>Man-days</u>	<u>Man-hours</u>	<u>Bullock day</u>	<u>Bullock hours</u>
Nursery raising	5.75	46.00	5.75	46.00
Pre-transplanting operations	19.00	152.00	19.00	152.00
Manuring	20.60	168.00	-	-
Transplanting	58.30	466.00	12.00	96.00
Weeding	59.00	473.00	-	-
Harvesting	51.00	407.00	-	-
Threshing	39.00	312.00	-	-
<b>Total</b>	<b>252.65</b>	<b>2,024.00</b>	<b>36.75</b>	<b>294.00</b>

Wheat Cultivation in Bhutan

Manuring	20.60	165.00	-	-
Ploughing	21.00	192.00	25.00	192.00
Harvesting	51.00	408.00	-	-
<b>Total</b>	<b>92.60</b>	<b>765.00</b>	<b>25.00</b>	<b>192.00</b>

Table 2-13 Labour Requirement (Man-Hours) per ha in Rice Cultivation in Japan

<u>Operation</u>	<u>1965</u>	<u>1969</u>	<u>1974</u>	<u>1978</u>
Nursery raising	84	81	71	74
Pre-transplanting operations	144	122	96	85
Manuring	66	75	50	46
Transplanting	244	247	141	97
Weeding	174	146	90	71
Irrigation, disease· insect control	153	149	125	130
Reaping·threshing	480	396	243	173
Hulling (including drying)	65	63	52	46
<b>Total</b>	<b>1,410</b>	<b>1,279</b>	<b>869</b>	<b>722</b>

Source: Crop Statistics, Ministry of Agriculture, Forestry and Fishery in Japan, 1979



### 2-3-8 Data of Labour-Saving by Using Agricultural Machinery

Some labour-saving trials by using agricultural machinery were carried out in the Department of Agriculture, Ministry of Development. The results are summarized in Table 2-14.

A trial was conducted on one-acre basis and then all the values were expressed on the basis per acre. The thresher used was power-operational, and both the rotovator and the plough were fixed with a power tiller. The calculation of labour wages was made on the basis of a fixed value of Nu. 15 per day, but in fact it was customary to pay Nu. 25 per day in not a few cases, and further to offer 3 times meals. Accordingly, the benefit per acre in the table can be taken as a minimum benefit.

In case of plowing by bullocks without machinery, which is most popular in Bhutan, two pairs of bullocks are needed to plow one acre of paddy field, and each pair of bullocks calls for one driver, and further one and half man-day is necessary to dig corners in the field by a hoe.

From Table 2-4 it is evident that any use of machinery can save much labour and can reap an enough benefit. In case of the plough, however, the benefit is rather small. This is mainly due to the fact that the trial field was small and terraced and accordingly the mobility of power tiller was greatly disturbed. All other cases proved the distinct advantage of using machinery for saving labour. From this viewpoint the importance of farm mechanization in Bhutan can fully be understood.



Table 2-14 Experimental Results of Labour-Saving and Benefit by Using Agricultural Machinery (Based on one acre's operation)

	Thresher		Rotovator		Plough		Paddy Weeder	
	Man-day	Nu.	Man-day	Nu.	Man-day	Nu.	Man-day	Nu.
Labour required by machinery	3.0	45	1.0	15	2.0	30	7.0	105
Labour required without machinery (Manual work)	10.0	150	15.0	225	18.0	270	15.0	225
Labour saved with machinery	7.0	105	14.0	210	16.0	240	8.0	120
Hire charge of machinery		55		55		220		20
Net amount saved		50		155		20		100
Benefit per acre	3.3	50	10.3	155	1.3	20	6.7	100

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## 2-3-9 Agricultural Supporting Services

There are several agricultural supporting services in Bhutan as follows.

### (1) Food Corporation of Bhutan

All agricultural commodities produced by farmers are usually sold at markets by the farmers themselves. When the prices of commodities, however, go down lower than certain fixed prices, the Food Corporation purchases all these commodities for preventing farmers from their heavy losses. The support prices of food grains and cash crops in 1982 - '83 are determined as shown in Tables 2-15 and 2-16.

Table 2-15 Support Prices of Food-Grains (1982 - '83)

Commodity	Grade	Support Price (Nu./100 kg)	Moisture (%) less than
Paddy (up-hills)	I	130	15
Paddy (up-hills)	II	120	15
Rice ( " )	I	290	13
Rice ( " )	II	275	13
Rice (lower-hills)	I	210	13
Rice ( " )	II	190	13
Wheat	I	160	15
Wheat	II	140	15
Maize	I	115	15
Maize	II	105	15
Kalai dal (yellow)*	I	300	15
Kalai dal (yellow)	II	275	15
Soyabean	I	200	10
Arhar dal (full size)*		150	10
Mustard seed	I	300	10
Mustard seed	II	275	10

Note: \* ..... Bean



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Table 2-16 Support Prices of Cash Crops (1982 - '83)

Commodity	Grade	Support Price (Nu./100 kg)	Remarks
Potato	I	75	
Potato	II	70	
Apple (Dellicious)		200	
Dry Red Chilly	I	700	
Dry Red Chilly	II	600	
Ginger	I	200	Nov. - Dec.
Ginger	II	150	Nov. - Dec.
Ginger	I	100	Jun. - Jul.
Ginger	II	75	Jun. - Jul.
Orange	I	10	per 80 oranges
Orange	II	8	"
Pineapple		4	with leaves
Pears		25	

(2) Machinery hire service and workshop service

The trial introduction of small scale agricultural machinery and earth-moving equipment was made and these machines were found very useful and successful. Accordingly, the public demand on introducing machines has strongly been increasing. The Royal Government, therefore, has initiated the machinery hire service as well as workshop service for farmers in Bhutan.

The workshop service and hire service started at the following locations; Paro, Phuntsholing, Gaylegphug, Samdrupdzongkhag, Thimphu, and Wangdiphodrang.

The hire charges per day fixed in September, 1982 are as follows. All machines work for 6 hours at least per day, and operators, fuel, lubricant, repair and spare parts are all included in the charges shown below.

Power tiller with diesel engine	.....	Nu. 150
D-50A size bulldozer (110 H.P.)	.....	Nu. 1,500
D-20S size bulldozer ( 36 H.P.)	.....	Nu. 1,200
Power thresher with prime mover	.....	Nu. 150
Four-wheel tractor (36-46 H.P.) with any kind of accessory	.....	Nu. 250



(3) Rural credit

The credit was established by the funds of the Royal Government of Bhutan and those of UNCDF (United Nations' Capital Development Fund).

The credit is utilized by the farmers to buy their farm-inputs, i.e. seed, fertilizers, chemicals and machines, etc. The borrowing term is 6 to 12 months.

(4) Food processing unit

The units were set up at three places, i.e. Paro, Thimphu and Bhumthang. The role of the unit is to purchase and process surplus apples, pears, peaches, mushroom, beans, etc. Canning and bottling are the main processings in this case.

(5) Oil mill service

Oil mills have been established at many places in the country, and the main function of the oil mill services is to purchase rape-seed from farmers or to make oil extraction at due charges for them.

(6) Fruit preservation factory service

Oranges, pineapples and tomatoes are produced abundantly every year in Bhutan. These fruits and vegetables are purchased by the Factory from growers at appropriate prices, and then they are canned or bottled in the Factory.

(7) Funeral insurance

It has long been customary for the farmers in Bhutan to spend much money for performing a fine funeral and memorial services. Poor farmers, therefore, have to sell their products at much cheaper prices than usual for getting their funeral expenses. In such cases, the Funeral Insurance plays an important role. Those who are more than 8 years old can be covered by the insurance with a yearly installment of Nu. 10, and they can receive Nu. 1,500 at their deaths.



## 2-3-10 Existing Cultivation Methods in Cereal Crops

For mechanizing the various kinds of cultivation practices in Bhutan, it is of prime necessity to clarify the aspects of the traditional and existing cultivation methods in Bhutan. In the following the existing cultivation methods in cereal crops will be outlined. (As a representative area, Paro and Thimphu districts have been taken up.)

### (1) Rice cultivation

#### 1) Varieties

Leading varieties at present in Bhutan are Jya-NAK (40%), Jya-KAP (30%), Ku-CHUN (20%) and Dung-JYA (10%). The percentage in each bracket shows the roughly estimated growing area in percentage of each variety. Generally speaking, these existing varieties are tall in culm length and liable to lodge, and further they are rather low in yielding ability. Recently, however, some improved varieties have been introduced from India and Japan, and some of them proved to be highly adaptable to Bhutan and of high yielding ability. For instance, Takanenishiki (No. 11) was recently introduced from Japan and has been spreading rapidly in Paro and Thimphu districts, showing much higher ability in yield and in lodging resistance as well than the existing varieties.

#### 2) Nursery field

In February or March farmers plow their nursery fields by using a pair of bullocks. After plowing, soil clods are harrowed with rakes or hoes. Some farmers use bullocks again for harrowing. The nursery fields are usually set up on the upland, not using irrigation water. Recently, however, some advanced farmers set up flooded nurseries with nursery beds by irrigating water. Farmers usually do not make any nursery beds, just making the soil surface flat. When finishing the harrowing and levelling, they broadcast the seed all over a nursery field. The amount of seed to be sown per ha is 60 - 100 kg. The nursery period from sowing to transplanting ranges from 2 months to 3 months, which is abnormally long. Weeding in nursery fields is carefully practised by hand.



### 3) Main field

In early May farmers clean the boundaries in paddy fields, and then plowing of main fields starts. Usually plowing is conducted by bullocks and it lasts from the late May up to the end of June.

When plowing is over, paddy fields are irrigated and then plastering of boundaries, puddling and levelling are concurrently practised. In some cases, after irrigation farmers plow again under water instead of harrowing.

As soon as pre-transplanting operations are completed, uprooting of seedlings and transplanting start. Transplanting time lasts from the late May to the end of June or to the early July. Planting density is 90 hills per m<sup>2</sup> with a seedling per hill, the density being abnormally high. A random transplanting method is generally used, but recently a stripe (line) planting using a rope is beginning to be popular among advanced farmers. In the stripe planting the planting density is 27 hills per m<sup>2</sup> with 2 or 3 seedlings per hill. Anyway, it should be noted that the operation of transplanting takes much labour, and accordingly the operation should be mechanized as soon as possible.

As to fertilizer application, most farmers apply only compost amounting to 5 - 16 tons per ha as basal dressing, not applying any kind of chemical fertilizers. Some advanced farmers, however, apply a compound chemical fertilizer called "Suphala" which contains N (15%) · P (15%) and K (15%) at the amount of approximately 15 - 20 kg of Nitrogen, Phosphate and Potash per ha, respectively, as a top-dressing at the first weeding time. For Japanese varieties each element of N·P and K of 25 kg to 50 kg per ha is recommended to apply as a top-dressing.

Weed control is still conducted by hand 3 to 4 times during one cropping season in general, which is one of the most laborious drudgery. Recently, however, as the stripe (line) planting increases, the farmers who use paddy weeders (manual) have rapidly been increasing in number. On the other hand, herbicides have





been introduced into some districts in Bhutan for weed control, and the chemicals have successfully been used by advanced farmers. For instance, 30% of farmers in Tongsa district have already been using herbicides with satisfactory results. The use of herbicides will rapidly be increased in near future in Bhutan without fail, whether one likes it or not.

As to irrigation, on account of insufficient irrigation water in general in Bhutan, rotational irrigation with intervals of 5 to 10 days has been conducted in most areas. Farmers therefore irrigate their paddy fields fully when they get water, and keep water carefully until they will get water again. Such operations are repeated after transplanting until maturity. At the time corresponding to 10 to 14 days before harvest, farmers drain water completely from their paddy fields.

Harvest is done by using traditional sickles, the reaping efficiency of which is so low that they are considered necessary to be improved at the earliest convenience. After harvest the cut rice plants are dried up for 3 to 5 days on the field, and then they are threshed by manpower. Recently, pedal-type threshers are beginning to be introduced with satisfactory results.

## (2) Wheat cultivation

### 1) Varieties

Leading varieties are mostly Mexican varieties such as Karyansona and Sonalika.

### 2) Cultivation method

Plowing is mostly done by bulls in November, but harrowing is done by manpower with rakes or hoes. These operations are said to be most laborious works.

Sowing is generally conducted during November. If sowing is done before November, wheat plants are easily subjected to the low temperature at the panicle initiation stage, and consequently wheat plants are severely damaged by the cold, resulting in a much



reduction in yield. On the contrary, should sowing be conducted after November, wheat plants can hardly bear grains. Then, the optional sowing time is very limited.

No weed control, no disease and no insect control are generally practised, but irrigation is carried out at least 3 times during one season on account of the lack of rainfall.

For manuring, only compost is applied at the rate of 5 - 10 tons per ha, not applying any kind of chemical fertilizers. Some farmers, however, apply chemical fertilizers with 20 - 35 kg of N·P and K each. The yield of wheat is considerably low, the main causes of which might be due to not only the shortage of fertilizers but also due to the shortage of irrigation water.

There is one noticeable example, however, which produced 6.17 tons per ha (2.5 tons per acre) in Paro district. One of the most important factors in this example is characterized by the practice of irrigation repeated 8 times. This proves undoubtedly that irrigation is a quite important practice and further there is much room left to increase the yield of wheat in Bhutan.

The harvest of wheat is generally conducted by using sickles in the late May or early June corresponding to the beginning of the rainy season in Bhutan.

### (3) Barley cultivation

#### 1) Varieties

The main varieties are all traditional varieties such as Na(Ne), Nap and Kap.

#### 2) Cultivation method

The cultivation method of barley is almost the same as that of wheat, but barley is grown at higher altitudes than those of wheat being grown. At the altitudes of 2,800 - 3,300 m, both barley and wheat are cultivated side by side, but at the higher altitudes than 4,000 m only barley is cultivated.



At the altitudes ranging from 2,800 m to 3,300 m barley is sown in autumn (September) and harvested in the next summer (July), while at the altitudes higher than 4,000 m barley is sown in spring (April) and harvested in autumn (October).

#### 2-3-11 Preparatory Activities for Agriculture Mechanization in Bhutan

The Royal Government of Bhutan has been initiating agricultural mechanization and is making strenuous efforts for its diffusion, though the present status of mechanization is still at an infant stage.

The preparatory activities for mechanization, however, have been extended so far as follows.

The Government has set up 4 vehicle repair workshops, where many agricultural machinery and earth moving equipment can be maintained and repaired. The locations are shown below.

1) Phuntsholing, 2) Gaylegphug, 3) Samdrupdzongkhag, 4) Thimphu. These workshops are managed by the Ministry of Finance and can assist in the repair of agricultural machinery and earth moving equipment in addition to complete repairing of commercial vehicles, transport vehicles, etc.

Also, a small scale workshop has been set-up at Wangdiphodrang under I.F.A.D. (International Fund for Agricultural Development) and at Bumthang under R.D.P. (Rural Development Project, Swiss Helvestas Project) and they can both repair agricultural machinery, vehicles and earth moving equipment.

The trial introduction of agricultural machinery has been made under the assistance provided by the Government of Japan under the Colombo Plan Aid Programme and these machines were found most useful and effective to increase agricultural productivities and to solve labour shortage. The small scale earth moving equipment provided by the same assistance programme was also found most helpful to cut down labour requirement on various construction activities.



The initiation on agricultural mechanization was taken up by the Agri-Horticulture Farm, Bondey, Paro under Department of Agriculture, which has led to fruitful results and is a good example of easier approach on mechanization, and accordingly the public demand on mechanization is increasing at every corner of the country. The Government also supported to equip this farm with reasonable equipment and machinery for repairing and maintenance of machinery and for carrying out small scale fabrication and trial manufactures of useful tools and equipment.

The Government has provided sufficient fund to the counter cost of the agriculture mechanization programme under the Grant Aid Programme of the Government of Japan and Nu. 3,925,000 (US\$436,000) have been provided for supporting the programme as below. Further, more than 8 hectares of land has been chosen to set up the National Agricultural Mechanization Center at Uchu, Paro.

Table 2-17 Local Counter Cost for Agriculture Machinery Center  
(Budget allotment already made)

	<u>1982 - 1986</u> <u>5th Plan Period</u> (in Ngultrums)
1. Establishment	475,000.00
2. Stipend for Trainees (for fresh trainees)	350,000.00
3. Uniform/Working Wear	50,000.00
4. Fuel, Oil, Material Electric Charge	400,000.00
5. Maintenance of Vehicle	600,000.00
6. Service Charge and Machinery Transport etc.	1,000,000.00
7. Building for Garage and Regional and Water Supply Function	600,000.00
8. Study Tour and Cost for In-service Training	100,000.00
9. Fencing & Furniture etc.	200,000.00
10. Books, Textbooks etc.	150,000.00
<b>Total</b>	<b>3,925,000.00</b> <b>(US\$436,000.00)</b>





## 2-3-12 Fifth Five Year Plan for Agriculture Development

The main objectives of agricultural development in the Fifth Five Year Plan are to:

- 1) Achieve self sufficiency of agricultural development in the next five years.
- 2) Steadily increase the income of the farming community.
- 3) Improve the nutritional status of the population as a whole, both as a result of increasing incomes as well as by diversifying farm production patterns.

Ten development schemes for agricultural development have been planned to be implemented at the district (dzongkhag) level for the achievement of the above mentioned objectives, considering the constraints, potentials and present level of development in each district.

### (1) Land development

- 1) Overall fifth plan physical targets (Total for all districts)
  - (a) Land to be terraced : 6,339 ha (15,658 ac)
  - (b) Land to be contour-bunded: 2,245 ha ( 5,547 ac)
  - (c) Land drainage work : 41 ha ( 100 ac)
- 2) Operational policy guidelines
  - (a) A subsidy of Nu. 300 per acre for terracing and drainage of land, and Nu. 100 per acre for contour-bunding will be given to encourage farmers to develop their land.
  - (b) Emphasis will be given firstly to convert as much of the existing Tsheri cultivation area into permanent fields (paddy or dry), and secondly to convert as much of the dry land into wet land as possible.
  - (c) Priority for subsidy payment will be given to land development in the backward areas (gewos) in each district.
  - (d) The work schedule for this important core scheme will be closely linked with land area targetted to be brought under irrigation during the plan period.



(2) Multiplication and supply of improved seeds and plants

1) Overall fifth plan physical targets (Total for all districts)

- (a) Seed multiplication : 5,155 MT
- (b) Supply of improved seed : 5,155 MT
- (c) Supply of fruit seedlings  
and cardamom rhizomes : 4.1 million (Nos.)

2) Operational policy guidelines

- (a) This scheme is aimed towards introducing improved crop varieties and new crops, and thereby increasing productivity and diversifying agricultural production.
- (b) Nucleus seed requirements of cereals, oil seeds, potato and other vegetables seeds will be supplied from the agricultural research farms within the country or, where necessary, procured from outside.
- (c) Multiplication of the nucleus seeds to meet seed requirements in the districts will be carried out through registered seed growers. Progressive farmers in each district will be selected and registered for this purpose.
- (d) Each district will attempt, as far as possible, to produce adequate seed to meet its own requirements so as to cut down on transportation costs and losses.
- (e) Registered growers will be required to carry out roguing and screening according to the instructions of the agriculture extension personnel.
- (f) The price of procurement of seed from the registered growers will be fixed at a rate higher than the prevailing market rate in each district, so as to provide for progressive farmers an incentive to enrol in the scheme.
- (g) The supply price for different varieties of improved seeds, plant seedlings and rhizomes will be fixed at rates higher than the procurement rates so as to cover the operational costs of the scheme.



(3) Plant protection service

1) Overall fifth plan physical targets (Total for all districts)

- (a) Total coverage of field crops  
over the fifth plan period : 68,826 ha (170,000 ac)
- (b) Total coverage of orchards  
over the fifth plan period : 23,381 ha ( 57,750 ac)

2) Operational policy guidelines

- (a) The scheme aims to reduce losses due to crop diseases, pests and weeds for which both preventive and curative plant protection measures will be carried out free of cost during the plan period through the agricultural extension network in each district.
- (b) Requirement of plant protection chemicals and equipment for use by the agricultural extension staff will be met through the budgetary outlay made for the scheme in each district. However, supply of plant protection equipment to farmers will be done through the 'Farm Mechanization' scheme, for which farmers will be charged the actual cost of the equipment.

(4) Farm mechanization

1) Overall fifth plan targets (Total for all districts)

(a) Supply of farm machinery and implements for sale to farmers (Nos.):

Pedal threshers	: 496	Driers	: 56
Hand-operated winnowers	: 319	Power threshers	: 35
Pedal maize shellers:	125	Power tillers	: 35
Paddy weeders	: 432	Cotton ginning units:	9
Paddy de-husking machine	: 64	Maize mills	: 5
Rice huller	: 54	Oil mills	: 10
Improved ploughs	: 110	Chilly-power making machines	: 3
Potato ploughs	: 105	Alkathene pipe	: 32200
Sprayers	: 164	Bullock-drain implements	: 153
Planting rope sets	: 1,175	Weeding implements	: 50
Oil expellers	: 18	Miscellaneous tools & implements	: 111731



(b) Supply of farm machinery for hire to farmers (Nos.):

Power threshers	: 196	Oil mills	: 4
Powered maize shellers:	29	Water turbines	: 4
Sprayers	: 46	Winnowers	: 4
Power tillers	: 77	Sugarcane planters:	2
Tractors	: 35	Sugarcane ridgers :	5
Pedal threshers	: 69	Fertilizer-cum-	
Rice hullers	: 22	seed drills	: 5
Oil expellers	: 11	Bullock-drawn	
Pedal maize shellers	: 10	implements	: 20

(c) Training of farmers as machine operators: 597 Nos.

(d) Establishment of field workshops : 21 Nos.

2) Operational policy guidelines

(a) The sale of tools and machinery will be at actual cost. Only transportation costs will be subsidized up to district headquarters.

(b) Hire service of machinery will be operated on a commercial basis taking into account all costs involved and the scheme should generate enough resources to procure new machinery when required.

(5) Soil fertility development

1) Overall fifth plan physical targets (Total for all districts)

(a) Supply of chemical fertilizer and other nutrients : 3,918 MT

(b) Construction of compost sheds : 11,589 Nos.

2) Operational policy guidelines

(a) Fertilizer will be supplied at actual cost, with transport costs being subsidized upto district headquarters.

(b) Emphasis is to be given to encourage the construction of compost sheds and other local manurial resources to reduce dependance on chemical fertilizer, due to uncertainty of supply and the rising costs of fertilizer.





- (c) To encourage compost shed construction, a subsidy of Nu. 300 and Nu. 500 per compost shed is to be given based on the size and specifications of the compost shed.
- (d) A subsidy of Nu. 50 will be given for construction of compost pit.

(6) Rural credit scheme

1) Operational policy guidelines

- (a) Rural credit to cover the economically backward farm families in each district.
- (b) Short, medium and long term loans amounting to Nu. 1,000, Nu. 3,000, Nu. 5,000 respectively, to be given at the minimum interest rate of 6%, 8% and 12% respectively and the loans being repayable in 12, 36 and 60 months respectively.
- (c) Loans to be utilised for purchase of agricultural inputs like seeds, fertilizer, tools and implements.
- (d) Loans preferably to be given in terms of input rather than cash loan so as to avoid expenditure on other uses not related to agriculture.

(7) Information and training service

1) Overall fifth plan targets (for all districts)

- (a) Exhibitions : 113 Nos.
- (b) Demonstrations : 3773 Nos.
- (c) Farmers' training : 6603 Nos.
- (d) Farmers to be taken on study tours: 1561 Nos.

2) Operational policy guidelines

- (a) Each district to set up at least one exhibition every year with public participation regarding agricultural development so as to disseminate useful information to the farming community on latest development in agriculture.



- (b) Demonstrations to be set up in each Gewo, pertaining to cultivation methods of crops, use of new equipment, fertilizer and compost usage and use of tools and machinery.
- (c) Farmers to be taken on study tours within the country or outside to study first-hand developments that have taken place in agriculture and to create an awareness amongst the farmers in such developments.
- (d) Farmers' training to be undertaken so as to enable them to take to modern practices in farming. Training to cover all elements of agriculture, i.e. land development, irrigation, soil fertility, plant protection, mechanization, etc.

(8) Strengthening extension network

1) Overall Fifth Plan targets (for all districts)

- (a) Strengthening existing extension centres: 83 Nos.
- (b) Construction of new extension centres : 29 Nos.

2) Operational policy guidelines

- (a) New extension centres will be set up in sub-districts (Gewos) where extension facility does not exist at present, taking into account availability of extension personnel coverage of farm house holds and accessibility to the extension centre.
- (b) Existing extension centres to be strengthened to provide for housing of extension personnel accommodation facility and procurement of equipment required (weighing equipment etc.) for efficient functioning of the centre.



(9) Food processing (Trial unit at district level)

1) Overall fifth plan physical targets

- (a) Construction of buildings : 4 Nos.
- (b) Supply of processing equipment : 3 sets
- (c) Maintenance of existing units at Bumthang and at Paro

2) Operational policy guidelines

- (a) Food processing units will be established only in selected districts during the plan period.
- (b) The trial units set up in Bumthang and Paro districts have produced commendable results and will therefore be strengthened so as to help them diversify and improve on their present processing activities. A similar unit will be established in Tashigang district utilizing the operational experience gained in Bumthang and Paro. Small processing units will be set up in Pemagatshel, Mongar and Lhuntshi districts.
- (c) All the processing units will aim to become self-sustaining or profit-making venture within as short a gestation period as possible.

(10) Seed production

1) Overall Fifth Plan physical targets

- (a) Construction of buildings : 1 No.
  - (b) Supply of equipment : 1 set
  - (c) Maintenance of existing activities:
- } all at Paro

2) Operational policy guidelines

- (a) Seed production units will be established only in selected districts.
- (b) The first trial unit established at the Bondey Farm in Paro has produced commendable remarks in producing grading, packing, and supplying vegetable and flower seeds to other districts. The unit will be further strengthened so as to increase the magnitude and diversify of activities at Paro.



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## Chapter 3. PLANNING OF AGRICULTURAL MECHANIZATION IN BHUTAN

### 3-1 The Objectives

The agricultural mechanization aims at introducing the efficient technology which is the combination of (1) Hand tool technology, (2) Animal draught technology, (3) Mechanical power technology in order to solve labour shortage in farming and to improve agricultural productivity (soil productivity and labour efficiency).

The agricultural mechanization straightly aims at releasing the farmers from most labour consuming tasks, performing the timely seasonal works, reducing the labour input per operation, achieving self-sufficiency in food grain production and expanding cash-crop cultivation and its marketing.

Another objective is to introduce small scale earth moving equipments so that they may release farmers from their great burden of public works such as road construction, irrigation facilities construction, water reservoir construction, school and hospital construction, etc., the labour contribution to which is obligatory on farmers and is of special necessity in Bhutan. This seems to have no direct relation with the agricultural mechanization, but it is quite important to the farmers in Bhutan.



### 3-2 The Plan of Agricultural Mechanization

The mission studied the actual conditions in Bhutan and analyzed and examined the data collected and further discussed the plan with the officers concerned in the Royal Government of Bhutan. As a result, the following plan has been formulated.

#### 3-2-1 Mechanization Network and Functions

For mechanizing agriculture in Bhutan, it is of an absolute necessity to set up a mechanization network through the country. After considerable discussions the following plan has been laid out.

The core of the network is the National Agriculture Mechanization Center which will be established in Paro, and then four Regional Agriculture Mechanization Centers, i.e. Paro, Bumthang, Bhur and Mongar, will be founded in the four Regions, each having one center, covering the whole country. Further, each Regional Mechanization Center will have 6 to 3 District Mechanization Centers in its jurisdiction districts, each district having one, as shown in Fig. S-1. In short, one National Mechanization Center at the national level, four Regional Mechanization Centers at the regional level and 18 District Mechanization Centers at the district level will be established. Then, the whole country will be completely covered by the network.

The National Mechanization Center will exercise three functions, i.e. training of the official staff, repairing and maintenance, and hire service (only for large scale machinery), at the national level. The Regional Mechanization Centers will function in training farmers, in making hire service, in repairing and maintenance, in making trial development of tools and simple machines, in guiding cottage industries at the regional level. The District Mechanization Centers will perform the farmers' training, hire service, repairing and maintenance at the district level.

In Fig. S-1, the system of mechanization network and the functions of each level of mechanization center are schematically represented.



3-2-2 Items Which Should Be Included in the Present Grant Aid Programme of the Government of Japan

Since it is quite difficult to cover all the necessary expenses for completing the whole mechanization network mentioned above with the limited Grant Aid Programme of Japan, much discussion was made between the Royal Government of Bhutan and the study team with regard to which items (parts) should be taken up from the whole network to be included in the Grant. As a result it was concluded that the following two items (parts) should be included in the present Grant.

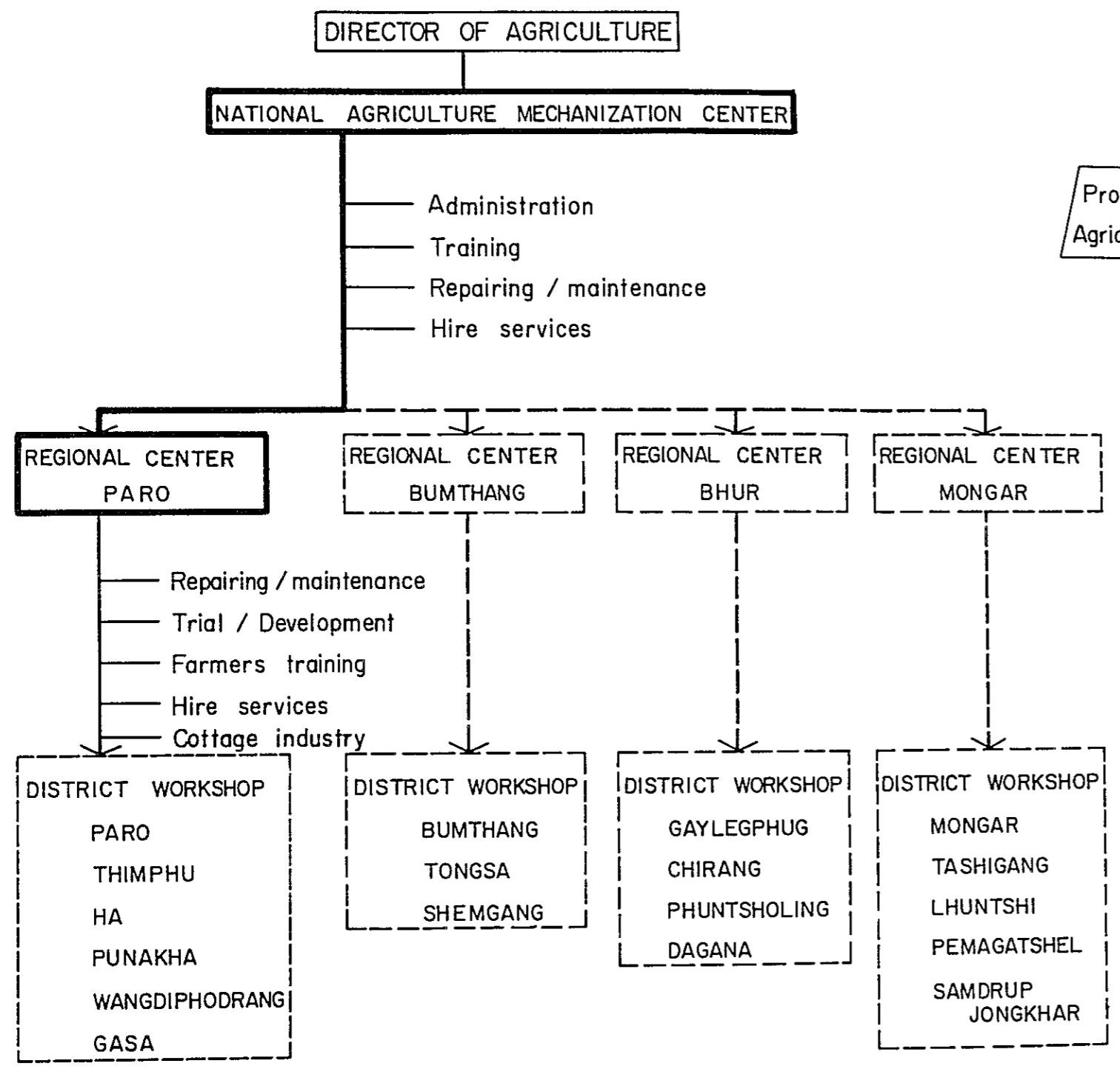
- (1) The establishment of the National Agriculture Mechanization Center
- (2) The strengthening of Paro Regional Agriculture Mechanization Center, which is to be a model case to the other three Regional Centers

Namely, the National Center is the kernel of the mechanization network, and Paro Regional Center, which is already functioning fairly well, should be selected as a model for the other three Regional Centers, then the present Grant Aid should be concentrated on these two items.

A glimpse at Fig. S-1 makes it possible to understand which parts are included in the present Grant Aid Programme of the Government of Japan and further these parts are the core of the network. The study team proposed the plan that making this core as an initiator, other parts of the network should be completed by the very efforts of the Royal Government itself, and the proposal was entirely supported by the Government.

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Fig 3 - 1 AGRICULTURAL MECHANIZATION NETWORK IN BHUTAN



Proposed Site for National Agricultural Mechanization Center



Legends .

- > : Items shown in thick line are included in the proposed grant aid programme of the Government of Japan.
- -> : Items indicated by dotted lines are to be realized by the Government of Bhutan.

# DZONG DISTRICT BOUNDARY





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