Chapter IV

Watershed and farming systems characterization and diagnosis

A watershed can be considered as an assemblage of different components interconnected by interactions and interdependences which function within a well-defined hydrological boundary to provide specific ecological, social and economic services. Watershed management involves informed decision-making in a complex array of biophysical, social and economic environments made up of processes and interactions between ecosystems, components and between human intervening in such ecosystems. Due to the complexity of issues involved in watershed management, it requires an inter-disciplinary, holistic, and integrated approach to fully understand the system.

Within each watershed, there are household-based farming systems which exhibit diversity further adding complexities to the ecosystem (Grigg 1974, cited in McConnell and Dillon, 1997). Therefore, it is appropriate to classify the diversity of farming systems based on certain typology, for instance ecologically based typology and farm management based. The typification will help in the identification and localization of agro-ecological and socio-economic constraints and potentialities that influence the dynamics of the different systems. Typologies also help in targeting extension messages and in assessing who is benefiting from the interventions.

The following sections present the diagnosis of the Lingmuteychu watershed and farming systems in the watershed. This diagnosis helps to identify and assess the diversity of situation, behaviors and actions which directly or indirectly influence resource management in the watershed with particular emphasis on irrigation water sharing.

4.1. Agroecological zonation and characterization of Lingmuteychu watershed

4.1.1. Bio-physical characteristics

Land features

Lingmuteychu watershed is characterized by mountainous terrains. The watershed is bounded by a ridgeline running down from Antakarchu and Darchula range at 3040m elevation to Punatshangchu river at 1300m elevation. Based on the altitude, watershed can be divided into 3 main zones corresponding to vegetation type and farming activities. About 59% of the total area falls above 2000m which is mostly vegetated with broadleaf forest. The predominant broadleaf species are *Michelia spp.*, *Carpinus spp.*, *Quercus lanata*, *Q. grifithii*, *Rhododendron sp.*, and *Symplocus spp.* Coniferous forest is dominanted by *Pinus rohburghii*. Areas between 1600 and 2000m comprise 29% of the total area and correspond to a transition zone between broadleaf and coniferous forest. The remaining 12% of the area falls below 1600m elevation which is predominantly coniferous forest and rice-based farming (Figure 10).

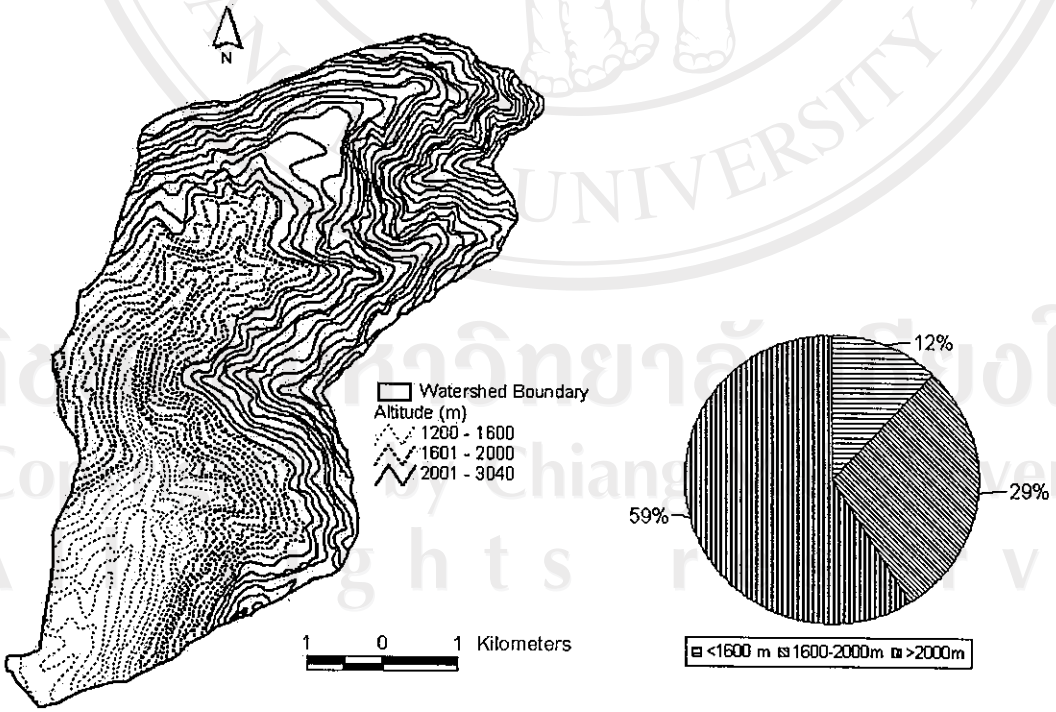


Figure 10. Distribution of watershed area by altitude.

Source: RNRRC, 2002.

There are flat areas in some pockets where people have settled and practice high altitude irrigated rice on terraces. Broadly watershed can be classified into slopy area with 57% of the total area at 25-50% slope angles, (Figure 11). Limtichu river flows in the south-westerly direction dividing the watershed into two halves and finally draining into the Punatshang river.

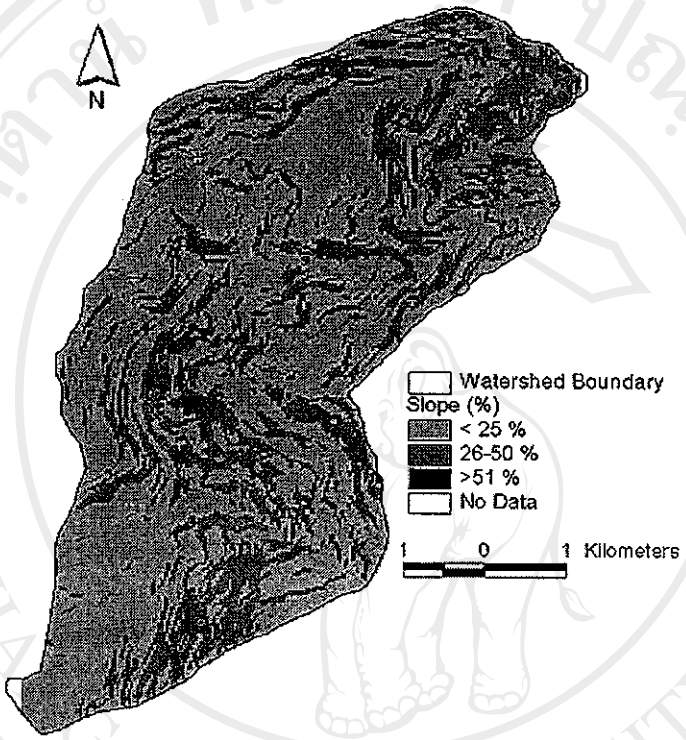


Figure 11. Distribution of watershed area by slope.
Source: RNRRC, 2002.

Major soil types

The major soil types present in watershed are given in Figure 12. This watershed predominantly has shallow and deep brown sandy loam, which covers 65% of the total area. Other soil types like sandy loam, and clayey cover 20%, 11%, and 4% of the watershed area respectively. Considering that the sandy loam type of soil is predominant in the watershed, the water retention capacity is also low, thereby leading to higher water consumption at transplanting (Brand and Jamtsho, 2002). Broadly, there is a distinct zonation between sandy loam and clayey soil according to altitude.

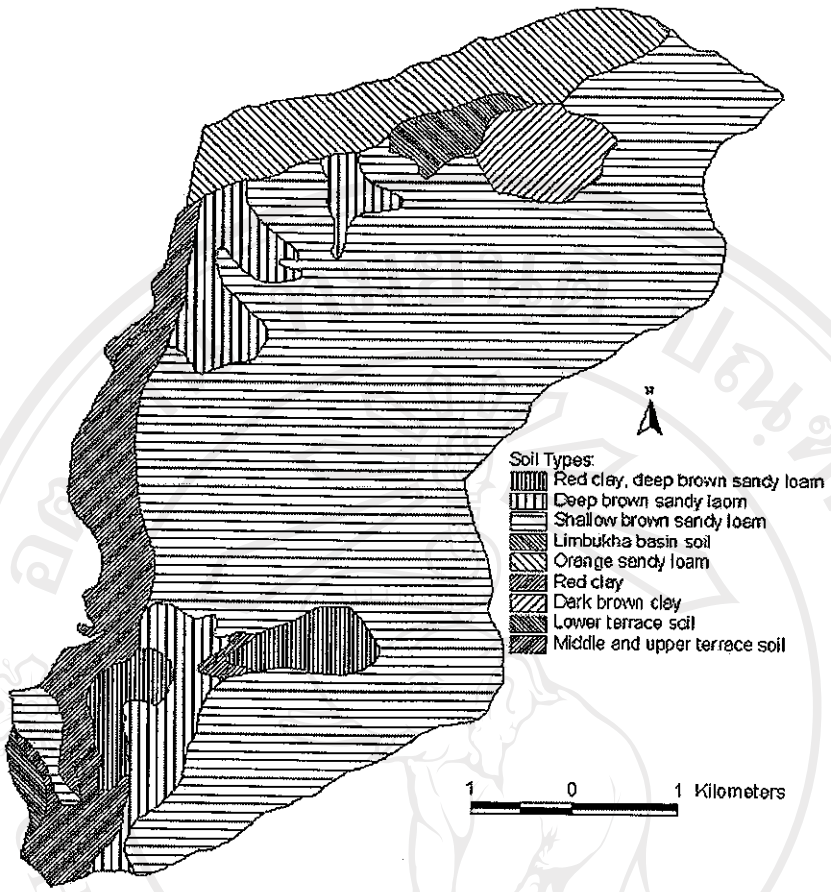


Figure 12. Soil map of Lingmuteychu watershed.

Source: RNRRC, Bajo, 2002

Climate

This watershed experience warm summer with temperature ranging from 15 to 25°C. Winter is cool with temperatures ranging from 3 to 17°C. Annually it receives an average total rainfall of 670mm with July and August being the wettest months (Figure 17). Based on the national agroecological zonation the watershed can be divided into two zones: a wet temperate zone (1800-2600m) and a dry sub-tropical zone (1200-1800m) (RNRRC, 2001). These zonations play a major role in crop and varietal choices. As bulk of the modern introduced rice varieties are suitable for dry sub-tropical zones, traditional white and red pericarp rice varieties dominate in the higher wet temperate zone.

Land use

From an agricultural production point of view, Lingmuteychu is predominantly a rice-growing watershed, with 180 ha of irrigated terraced paddy fields representing 64% of the total farmland in the watershed (Table 8). There are 36.5 ha of rainfed area mainly devoted to growing maize and vegetables. Forest occupies 69% of the total area. The watershed has two types of forest vegetations: broadleaf forest above 1600m and coniferous forest below 1600m. The watershed also features a stretch of barren and degraded area, due to over grazing and poor forest regeneration (Figure 13). A detailed longitudinal zonation of watershed along a transect line, locating the two vegetation types, soils, and altitudinal differences influencing crop choices and other land-use decisions is represented in Figure 14.

Upstream villages have higher forest cover associated with an easier access to forest resources. Conservation of forest in the upstream also implies protection of the whole watershed. However, the greater access to natural pastures by Limbukha, Matalumchu and Omteykha only can be a threat to forest. In contrast other four villages do not have access to grazing land and this is a pertinent example of inequitable access to resources. Except Nabchee and Bajothangu, all villages have more than 60% of land as irrigated rice terraces (Table 8). Although hydrological measurements were not made in this study, minimum flow at the tail-end of the stream demonstrates the pressure on water resources. The pressure is so high that during the peak of the rice transplanting season, there is hardly any water flowing out of the watershed (Jamtsho 2002).

Table 8. Land use by village in the Lingmuteychu watershed, 2001.

District	Village	Grazing land (ha)	Forest (ha)	Irrigated rice land (ha)	Rainfed crops (ha)	Total farmland (ha)	% Irrigated farmland
Punakha	Limbukha	64	801	34	12	46	74
	Dompola	1	316	4	2	6	67
	Nabchee	0	439	1.5	6	7.5	20
	Omteykha	19	129	42	8	50	84
Thimphu	Matalumchu	95	659	58	2	60	97
	Wangjokha	0	0	40	0.5	40.5	99
Wangdue	Bajothang	0	0	0.5	6	6.5	8
Total		179	2344	180	36.5	216.5	
Average							64

Source: RNRRC, 2002.

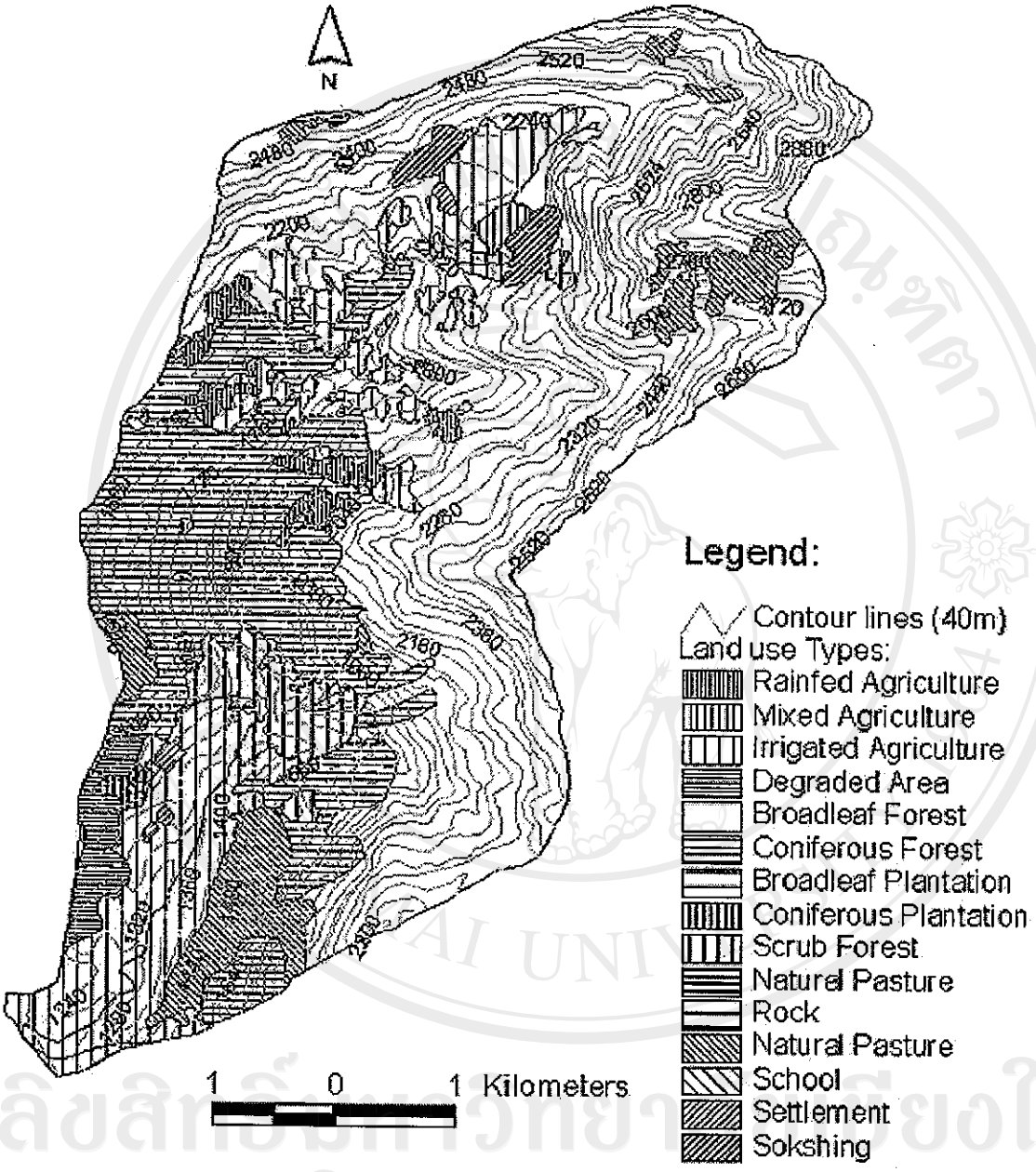
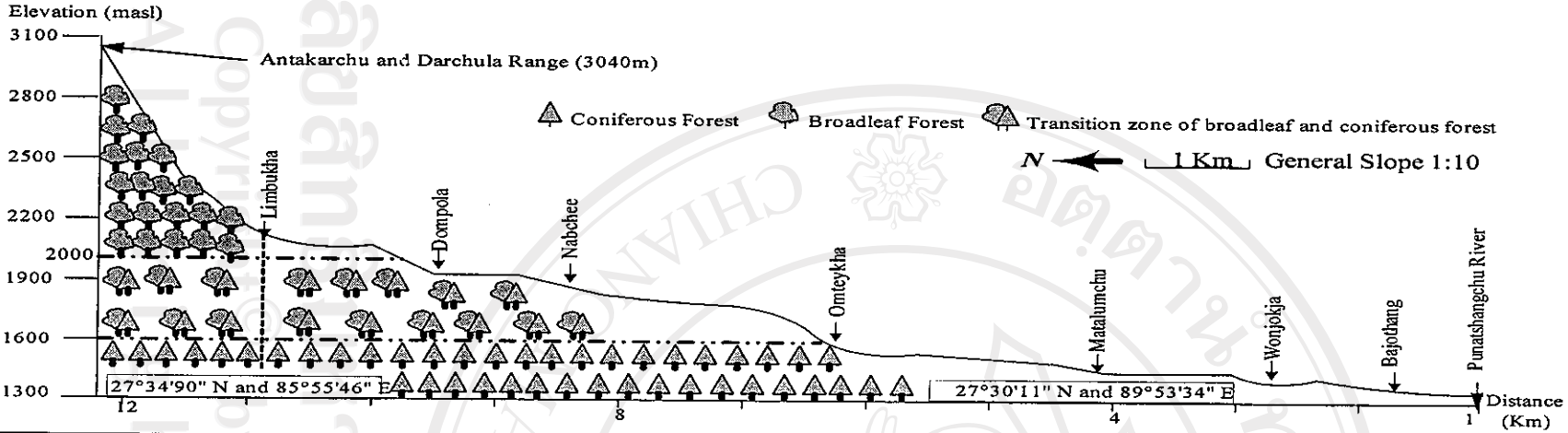


Figure 13. Land use map of Lingmuteychu watershed, 2002.

Source: RNRRC, 2002

(Note: Sokshing is a woodlot on which either individual or the community has right-to-collect for leaf litter and dry firewood).



District	Punakha				Thimphu		Wangdue
Villages	Limbukha	Dompola	Nabchee	Omteykha	Matalumchu	Wangjokha	Bajothang
Altitude (masl)	2170	2100	1870	1600	1500	1300	1300
Vegetation	Broadleaf forest				Coniferous forest		
Access to forest (distance)	Very good	Good	Very good	Moderate	Poor	None	
Soil Type	Dark brown clay	Dark brown and sandy loam	Shallow and deep brown sandy loam				Middle and upper terrace soil
Irrigated rice land (ha)	34	4	1.5	42	58	40	0.5
Dryland (ha)	12	1.5	6	8	2	0.5	5.5
Major Crops	Rice, potato	Rice, wheat, vegetables	Maize, vegetables	Rice, wheat, vegetables		Rice, wheat, mustard	
Households	36	35	20	28	20	16	15
Main income source	Potato, rice	Vegetables	Maize, off-farm within watershed	Rice	Vegetables	Off farm (Contract work outside watershed)	
Problems	Wild animals and weeds	Water shortage and wild animals	Wild animals and water access	Water shortage	water shortage and wild animals	Water shortage	Water shortage
Potentials	Potato and rice production	Enhancing water use efficiency	Dryland crops	Rice, wheat production, and access to market (Road)			

Figure 14. North-south longitudinal transect line of Lingmuteychu watershed. December, 2003.

Irrigation infrastructures

There are 5 major irrigation networks in Lingmuteychu watershed. They are Limbukha, Dompola, Omteykha, Matalumchu and Wangjokha/Bajothangu. The first four schemes derive water from the Limtichu stream, and Wangjokha/Bajothangu is irrigated by Bajo canal that brings water from another watershed (Figure 15). As four major channels depend on one source of water, this increases the conflict over access to the water. In principle based on traditional rules, the upstream communities have greater control over water and tend to hold water for longer time. In such situation, downstream communities have to satisfy their needs by their agreed share. However there are cases of water stealing too. As the majority of the canals are earthen without concrete lining, the conveyance efficiency of these canals are reported to be only 40%, which is extremely low (RNRRC, 1998).

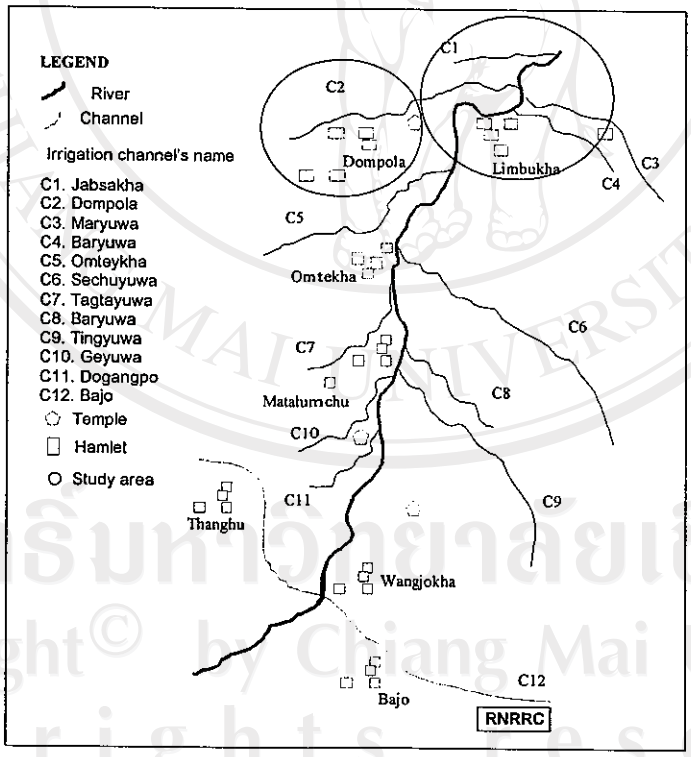


Figure 15. Sketch of network of irrigation canals in Lingmuteychu watershed.
(Not to scale)

Source: RNRRC, 1998.

4.2. Cropping systems

4.2.1 Crop diversity and combinations on farms

Farmers in Lingmuteychu watershed grow diverse crops ranging from rice, wheat, potato, maize, to different species of vegetables. Almost all farmers practice rice-based cropping systems, with the exception of the Nabchee community where maize-based cropping is a more common practice. From the total cropped area of 216 ha, high altitude rice accounts for 52% of the area followed by wheat, mustard, maize and potato (Figure 16). Traditional rice with red pericarp is particularly grown at high altitude and is preferred for its special taste and social status. White rice varieties are preferred for making pop-rice and beaten rice. While rice is grown in all 7 villages, potato is grown only in Limbukha and mustard only in villages located below 1600m.

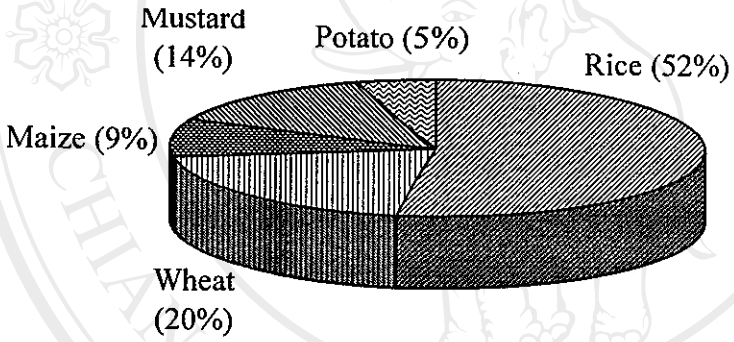


Figure 16. Crop types and share of cropped farmland in Lingmuteychu watershed in 2002.

Farmers generally use traditional varieties of all their crops, as they have special preferences for them. In Lingmuteychu, there are 4 traditional varieties of rice and 1 each of other crops. Correspondingly, there are 7 recommended varieties of rice, 5 for potato, 4 for soybean and 3 each of wheat, maize and mustard. It should be noted that farmer has grown local variety of potato for long time in dryland or kitchen gardens. The potential yields of different crops are given in Table 9.

Table 9. Crop varieties and their potential yields in Lingmuteychu watershed, 2002.

Crops	Yield (t ha^{-1})		Varieties (No.)	
	Recommended/ introduced	Local	Recommended/introduced	Local
Rice	5.1	3.8	7	4
Wheat	1.5	1.3	3	1
Maize	5.0	5.4	3	1
Mustard	0.5	0.4	3	1
Soybean	1.2	1.1	4	1
Potato	16.4	10.6	5	1

Source: RNRRC, 2002.

4.2.2 Cropping patterns

To get a better understanding of the two villages in the upper catchment, their cropping calendar was developed in relation to climatic factors. Figure 17 show 3 cropping patterns each in Limbukha and Dompola. In Limbukha potato-rice and rice-wheat is practiced in irrigated terraced fields, while maize-radish and chili as a sole crop is grown in rain-fed fields. In contrast, Dompola farmers practice rice-wheat pattern in irrigated terraced field and maize-mustard/radish and chili as sole crop in rain-fed fields. The main contrasting features between two villages is the potato crop in Limbukha overlapping rice transplantation, which is assumed to have an impact on water use in both villages. Limbukha farmers start transplanting rice in the second week of May until mid of June. Subsequently rice is transplanted in Dompola and this has to be completed in the last week of July because of the effect of cold temperature at flowering. The maximum limit of transplanting date in both villages is to avoid rice flower coinciding low temperature in September-October. The overlap in transplanting period, receding rainfall and deadline to complete rice transplanting escalates competition for water. The pressure is more severe in Dompola, as Limbukha farmers flood and hold water in their fields for a long period (RNRRC 1998).

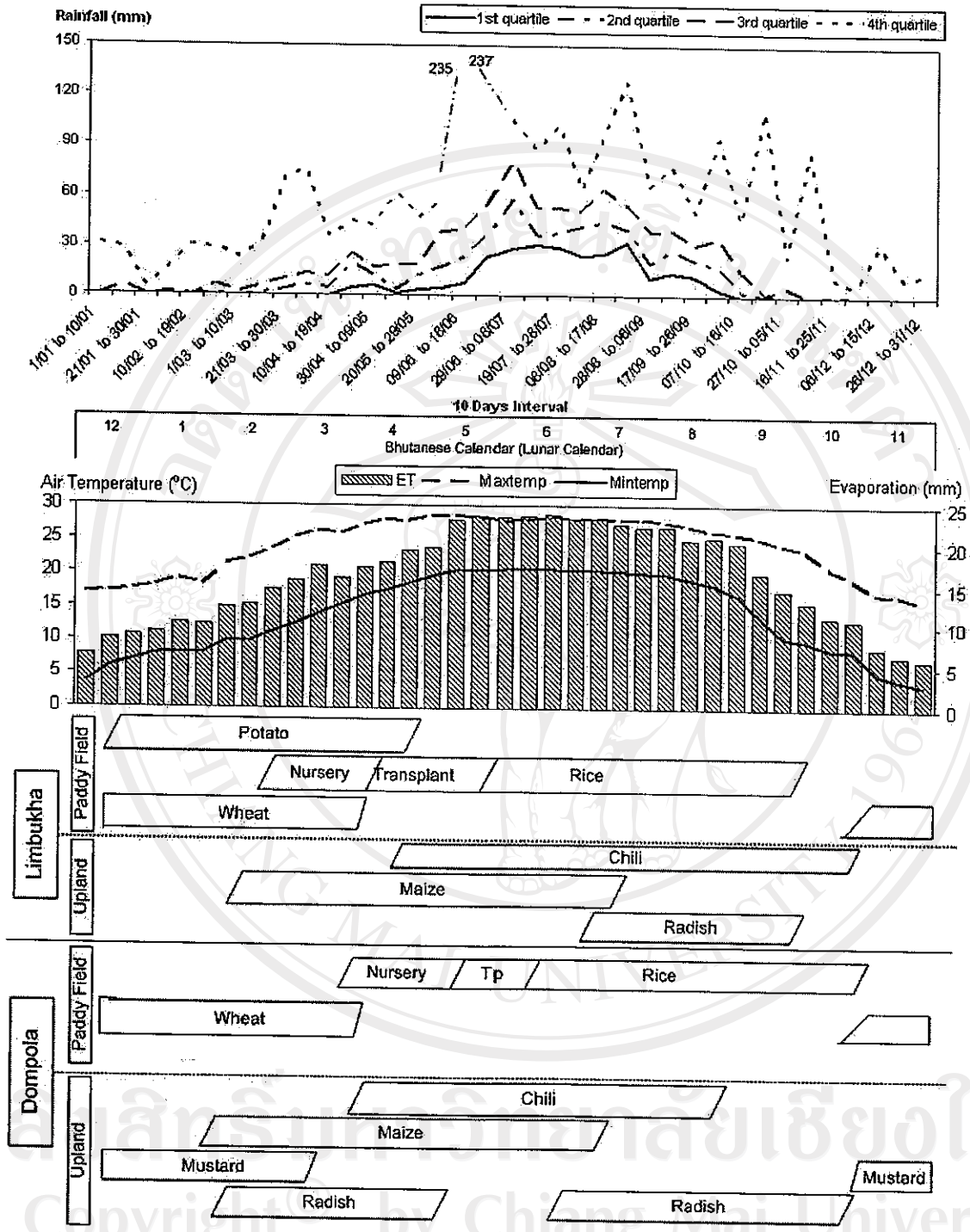


Figure 17. Cropping patterns in relation to climatic factors in two upstream villages of Lingmuteychu watershed.

N.B: Rainfall data is for 17 years (1985-2001); air temperature and evaporation for 6 years (1990-1995); 10 days interval corresponding to rainfall pattern is used for temperature and evaporation graph. Source: CORE

4.3. Socio-economic features

4.3.1 Demography

There are 162 households in Lingmuteychu watershed, with an average household size of 8 there are 1,296 people residing in the watershed. Male to female ratio in the watershed is almost 1:1 (RNRRC, 2002). To get a better insight in their educational background and occupation, 26 household from Limbukha and 21 from Dompola were interviewed. They represented 53% male and 47% female belonging to age groups between of 17 to 81 years. In both villages, high proportions of people have not attended school at all. However things are changing as 27% of Limbukha and 30% from Dompola villagers are presently studying in primary schools. Consequently, high proportions of population engage themselves in farming. According to the interviews, 53% of Limbukha and 49% of Dompola people have farming as their main activity (Table 10).

Table 10. Educational background and occupation of people in two villages of Lingmuteychu watershed, 2003

Educational Background (%)			Occupation (%)		
Level	Limbukha (n = 162)	Dompola (n = 150)	Type	Limbukha (n = 162)	Dompola (n = 150)
Nil	43	39	Farmer	53	49
High school	14	16	Civil Servant	9	9
Primary school	27	30	School children	22	30
Monk	12	9	Trader	2	1
University	2	2	Monk	7	7
Minor (<6 years old)	3	4	Village headman	1	0
			Asst. to Village headman	1	0
			Minor (<6 years old)	5	4

4.3.2 Population distribution

The population density of the watershed is 39 person km^{-2}, which is higher than the national population density of 14 persons km^{-2} (Central Statistical Organization, 2001). The Population density provides a way of measuring the impact of people on the natural environment. Intensity of resource use, transformation of the ecosystem, and conflict in access to natural resources depend on the level of population density. However, as each village operates independently in terms of resource use systems, analyzing population density at village level both against total land and farm land will provide a better understanding of the local pressure on natural resources. While the density per total village area for most villages is below 50 person km^{-2}, it is comparatively high for Wangjokha and Bajothang mainly because of the lack of forest areas (Table 11).

Table 11. Household and population density of different villages in Lingmuteychu watershed, 2002.

District	Village	No. of Households	Average HH Size[a]	Person km^{-2} of total village area	Person km^{-2} of farmland
Punakha	Limbukha	28	6.4	47	441
	Dompola	35	7.2	26	964
	Nabchhe	20	11.4	46	3115
	Omtekha	28	6.5	18	365
Thimphu	Matalumchu	20	9.7	49	323
	Wangjokha	16	7.3	117	294
Wangdue	Bajothang	15	7.3	255	1795
Average			8.0	39	576

[a] RNRRC 2002.

The population pressure on farm land is very high with an average of 576 person km^{-2} at the watershed level. Nabchee and Bajothang appear denser due to limited farm lands in these villages. Nabchee is a resettled community with limited

access to land, water, and other resources. The high population densities in Nabchee and Bajothang explain that people from these two villages often engage in off-farm activities. The relatively high population density at watershed level also substantiates the pressure on resource including water, as every household tries to maximize the use of scarce resources.

4.3.3 Access and communication

The villages in Lingmuteychu watershed are linked by small meandering tracks used for mules and treks to ensure movement of goods and people (Figure 18). In 1996, a 18 km long feeder road was constructed as a diversion from Wangdue-Shengana road which provided the watershed villages with an access to the nearby towns of Wangduephodrang and Punakha and ultimately to the national east-west highway. This motorable road has facilitated cash income generation from crops like potato, rice and vegetables. It has also helped in marketing animal products like butter and cheese. While the ground distance is approximately 11 km from Limbukha to Bajothangu, it takes 5-6 hours of walk up to Limbukha from Wangjokha. The motorable road has reduced travel distance to 1 hour thus helping farmers to market their agricultural products. In return, people can take materials in bulk at much cheaper cost and in short time. The electrification and installation of satellite telephones in the watershed in 2003-2004 has further facilitated the overall socio-economic development of the community.

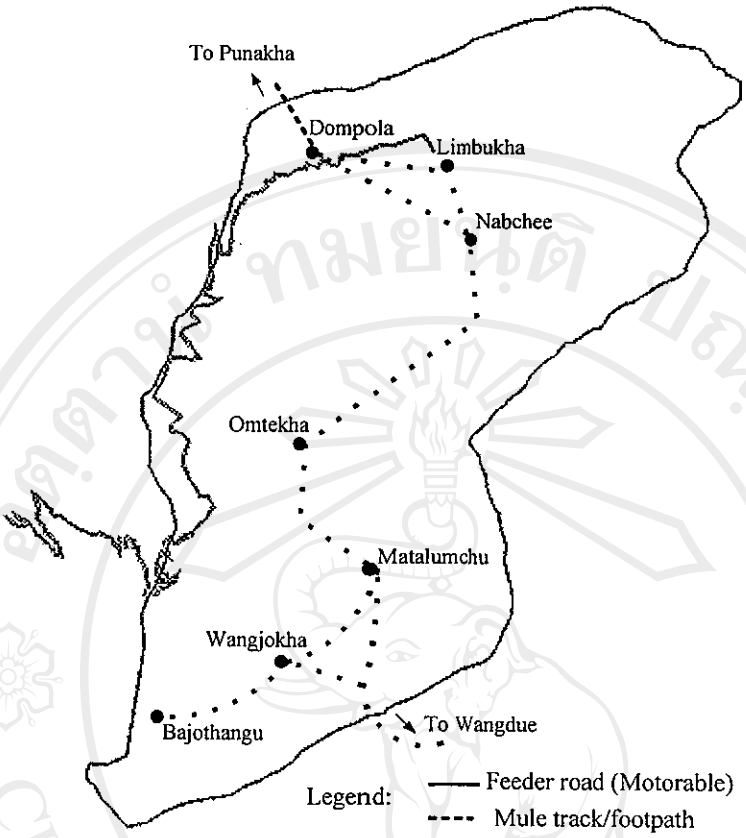


Figure 18. Sketch map of road and tracks in Lingmuteychu watershed

4.3.4 Income sources

Income sources in the watershed range from agriculture crops, dairy products, off-farm activities, and remittances from family members. The annual average income for a Limbukha farmer is US$ 2,144 and US$ 1,624 for Dompola. The 32% higher income in Limbukha is due to potato production. In both villages, remittances form the major source of income contributing 47% of total income in case of Limbukha and 36% in Dompola. Potato, rice and vegetables are major source of income in Limbukha, while Dompola farmers derive higher proportions of income from selling oranges, off-farm employment, and dairy products (Table 12).

Table 12. Sources of annual income for water sharing categories in Limbukha and Dompola, 2003 crop year (in US$).

Village	Sources	Water sharing category			
		Thruelpa	Cheep	Chatro	Lhangchu
Limbukha	Potato	386	333	222	333
	Paddy	244			
	Maize	111	11		
	Vegetables	155	244	355	166
	Butter & cheese	188	222	111	155
	Off-farm	111			
	Remittances	1079	887	1064	
	Total	2274	1697	1752	654
Dompola	Beans	111	78		
	Maize		111		
	Vegetables	67	155	144	
	Orange		222		
	Peach		111		
	Butter & cheese	177	155	222	
	Off-farm	155	185	222	
	Remittances		296	887	
	Total	510	1313	1475	

There is variation in income earned among the water sharing category. For instance, Thruelpa of Limbukha earns US$ 2,274 per annum while a Lhangchu earns only a meager US$ 654 per annum. Thruelpa of Limbukha with a larger land holding and access to water, sells rice both within and outside the watershed. In Dompola, a Chatro earns higher income than other category due to higher remittances capacity and off-farm employment outside the watershed in contractual works. Thruelpa in Dompola earned 22% lower than a Lhangchu of Limbukha. This lower cash income was mainly due to limited income source, particularly absence of remittances. Another possibility may be due to limited access to water and other resource.

4.3.5 Utilization of income

In general income is spent through four major categories of expenses (Table 13). Family use utilizes above 70% of the total income and includes expenses incurred

in purchase of household consumables, clothing, farming, education and other miscellaneous expenses.

Table 13. Utilization of annual income among water sharing categories of people in Limbukha and Dompola villages. 2002 crop year

Village	Category	Total Income (US$)	% of Income used for			
			Family need	Community contributions	Savings	Investments
Limbukha	Thruelpa	2274	73	10	19	0
	Cheep	1696	57	13	20	13
	Chatro	1752	87	3	10	0
	Lhangchu	654	78	7	15	0
Dompola	Thruelpa	510	65	8	28	0
	Cheep	1312	76	13	11	0
	Chatro	1475	68	13	19	0

Every household contributes on an average 10% of their income for community activities like annual offerings to the local deities, renovations of community infrastructures and community gathering. As mentioned elsewhere, there is a saving group in Dompola that encourages people to save by depositing approximately US$ 1 per month. Thus on an average they save 19% of their income, while Limbukha farmers save 16% of their income on individual basis without any saving group scheme. There was one instance of investment of remittances in Limbukha to repair/construct a house.

4.4. Differentiation among farming systems

4.4.1. Historical profile

Table 14 displays a brief historical profile of the area developed from secondary data and key informant survey to help understand the nature, origins, causes, extent of the main transformations that somehow influenced the evolution of current farming systems in the watershed. Based on the profile, it can be observed that

a shift from the traditional feudal dominated agrarian system into a present tenure system emerged after 1952 with the abolition of serfdom.

Table 14. Historical profile of Lingmuteychu watershed.

Economic and social changes	Date	Agroecological and agronomic transformations
Land ceiling to 10-12 ha per household and abolition of serfdom	1952	Land ownership and household-based small-scale farms
Resettlement of villagers	1952	Clearing forest in Nabchee and establishment of settlement of people from eastern part of Bhutan
Taxation (Kind to monetary)	1969	Surplus production for generating cash income
Access to forest resource transferred from community to government lead to open access situation	1969	Deforestation due to indiscriminate harvesting leading to resource degradation
Standardization of land ownership and tenancy	1979	Increase cropping intensity
Rehabilitation of irrigation channels by the Department of Agriculture (Maryuwa and Baryuwa channel in 1984 and Omtekha channel in 1986)	1984	Efficient water diversion and delivery to farms, increased irrigation command areas
Institutionalized local development committee	1987	Resources were managed according to peoples' plan.
Construction of feeder road as a joint investment project (Machines and materials provided by government; and labor and fuel by beneficiaries)	1997	Potato as major cash crop in Limbukha, rice and vegetables as cash crop in watershed.
Renovation of the Dompola canal with government assistance	1997-98	Improved the conveyance efficiency of canal
Abolition of *Gungda Woola* (labor contribution)	1999	Increase in off-farm within and outside the watershed
Rural electrification program	2003	Forest conservation, (less consumption of firewood)

It was further strengthened in 1979 when the Land Act was ratified. A major shift in the resource management regime particularly forest and forest based resources, took place when the forest was nationalized in 1969. Subsequently forest became an open access resource for any individual to use. The pressure on resources further increased when people from remote areas were resettled in areas with higher crop production potentials and better access to social services, leading to higher concentrations of users. Introduction of taxation, construction of roads, improved access to technologies and inputs, geared farming systems towards more commercialization. With the change of policy to involve people in local development,

it can be seen that people will have to learn the effect of their action and manage the resources in sustainable manner.

4.4.2. Farmers objectives and strategies

Considering that the farmers in the watershed operate in a diverse socio-economic and resource constrained situation although geographically small in extent, it is critical to understand their farming objectives, the farm environment in which they operate, their management choices, and possible improvement. As suggested by Trébuil et al. (1999), to study functioning of farming systems five aspects needs to be analyzed: (i) family situation, farming system size and objectives; (ii) farm environment; (iii) strategy for livelihood; (iv) combination of farm activities and their technical and economic performances; and (v) improvement potentials. Four farm types corresponding to FAO's farm classification (McConnell and Dillon, 1997) were identified in Lingmuteychu watershed as (i) small independent specialized commercial farms; (ii) small independent specialized part-commercial family farm; (iii) small semi-subsistence or part-commercial family farms; and (iv) small subsistence-oriented family farms. These four objectives almost precisely match with the four water sharing categories of villagers in the watershed.

4.4.3. Farming systems typology

Four distinct types of farming systems were identified for the study area based on the analysis of functioning of farming systems (Figure 19 a,b,c,d). The corresponding farm functioning diagrams clearly show that differences are mainly due to resource endowment linked to different social status. Within each type, two subclasses were identified based on the farm location. The differences in the features of these two subclasses clearly show a disparity in access to resources leading to conflict. Depending on their objectives, each type of farm has a unique choice of production and economic activities, and subsequently of management options. The environment in which they function is to a large extent, similar and characterized by a shortage in supply of water, wild animal damages, labor shortage and access to

market. From the analysis of differences in the functioning of farming systems (Figure 19 a,b,c,d), key parameters were identified to distinguish fairly precisely the differences between the four types and subtypes. Major production choices, related management options and access to irrigation water were used to classify farm types. The classification of four farm types was used to further group farms of two villages (Table 15). According to the farm typology, 37% of the farms (35 in Limbukha and 2 in Dompola) can be categorized as Type 1. Similarly, Type 2 includes 26% of the farm; 28% as Type 3, and 8% as Type 4. The analysis also showed that higher percentage of farms control larger share of irrigation water particularly in Limbukha. This could lead to disparity in access to irrigation water. Considering the irrigation as one of the important inputs in irrigated rice, accessing irrigation water at right time and to right volume is of paramount importance. Farm Type 1 with full access to water and during appropriate time put them in advantage. In contrast 30% of the farms in Dompola have to share half of the irrigation flow which increases the conflict for water. The Type 4 farm which represents 8% of the farms, have to depend of other farmers for water. Basically they have to exchange water against labor, which further put the Type 4 under pressure to get water.

a/ Small independent specialized commercial farms (Type 1) in Limbukha and Dompola villages of Lingmuteychu watershed, 2002 crop year.

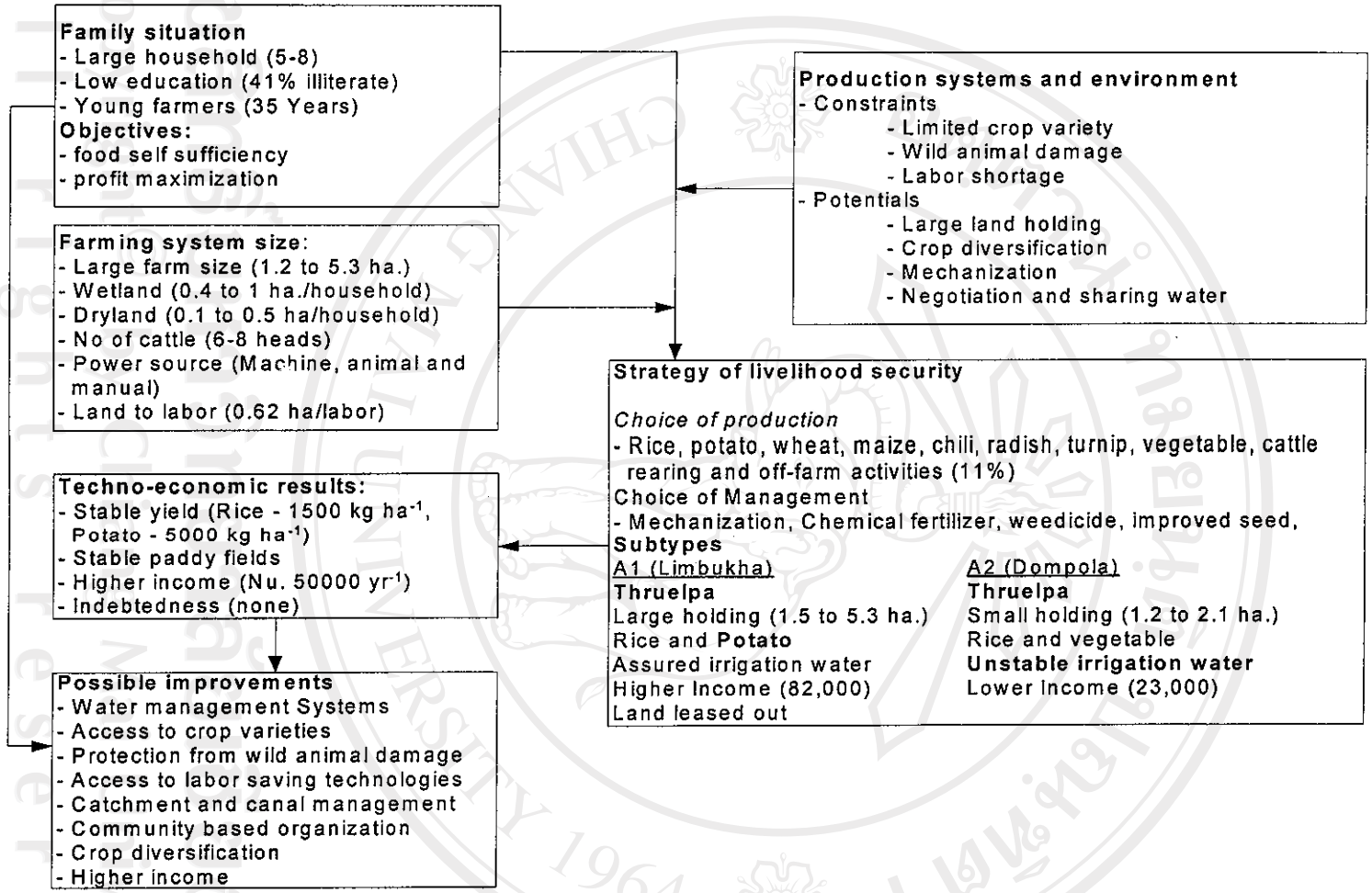


Figure 19a. Schematic representation of the functioning of four types of farming systems in upper catchment of Lingmuteychu watershed

b/ small independent specialized part-commercial family farm (Type 2) in Limbukha and Dompola villages of Lingmuteychu watershed, 2002 crop year.

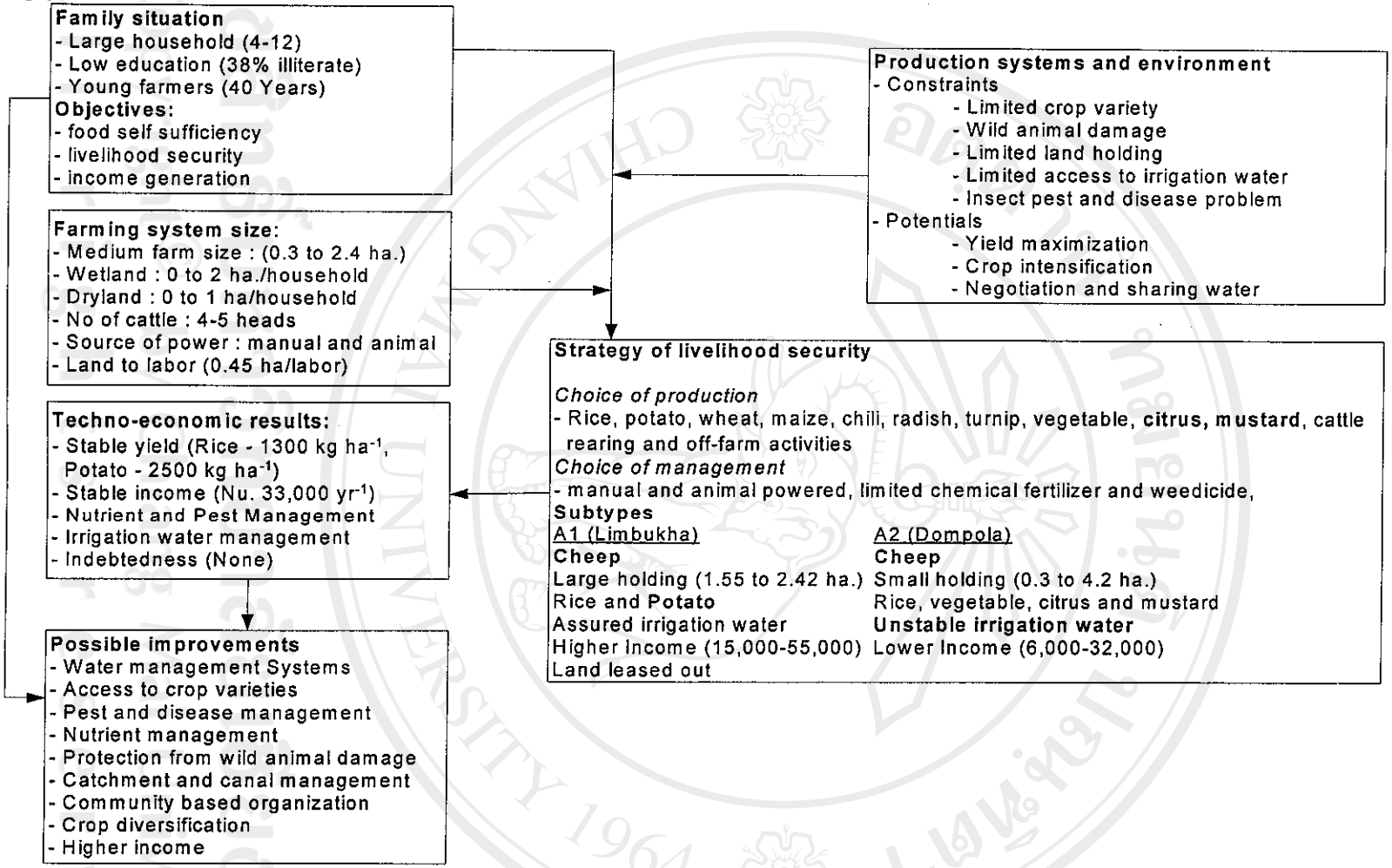


Figure 19b: Continued.

c/ small semi-subsistence or part-commercial family farms (Type 3) in Limbukha and Dompola villages of Lingmuteychu watershed, 2002 crop year.

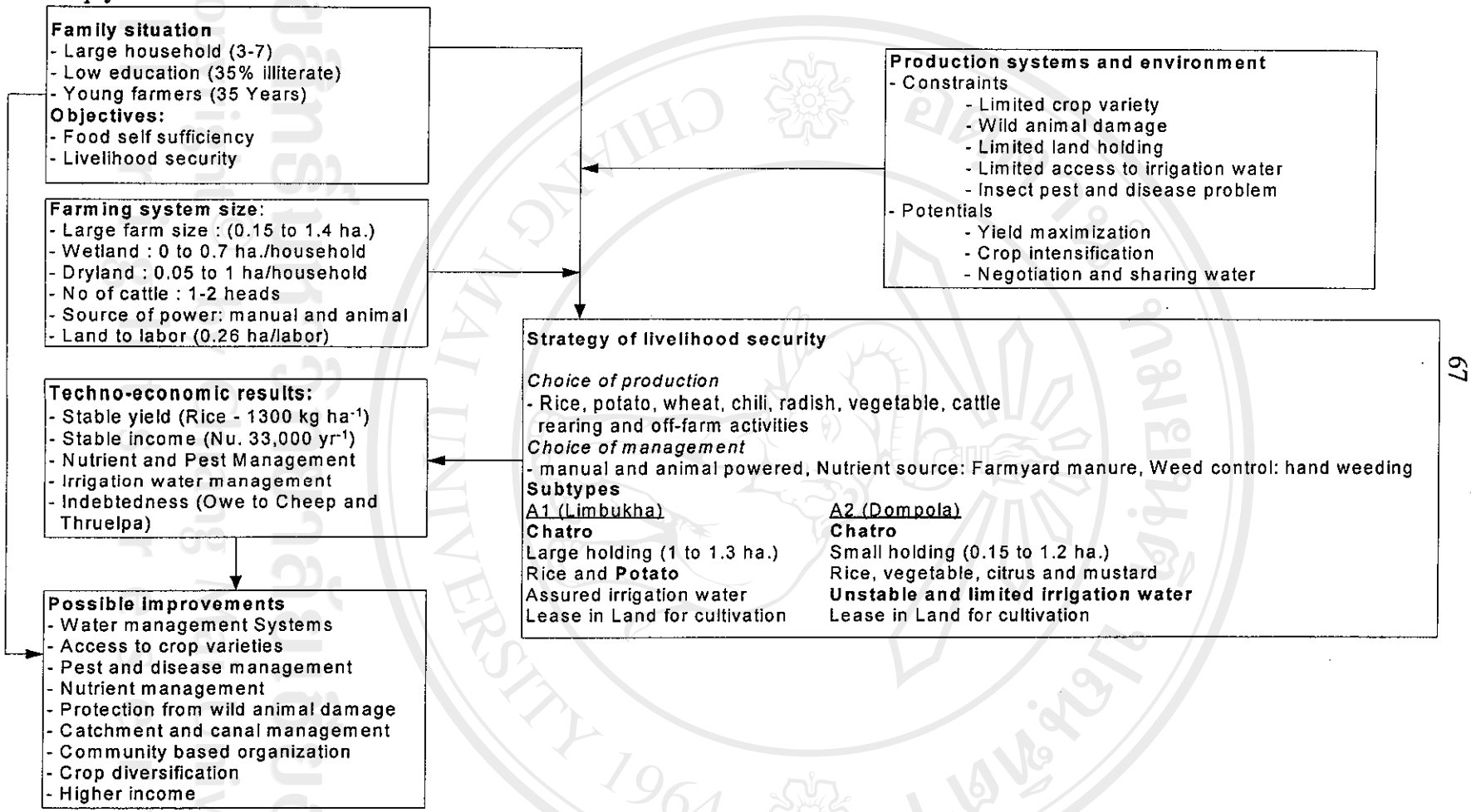


Figure 19c. Continued.

d/ small subsistence oriented farms (Type 4) in Limbukha and Dompola villages of Lingmuteychu watershed, 2002 crop year.

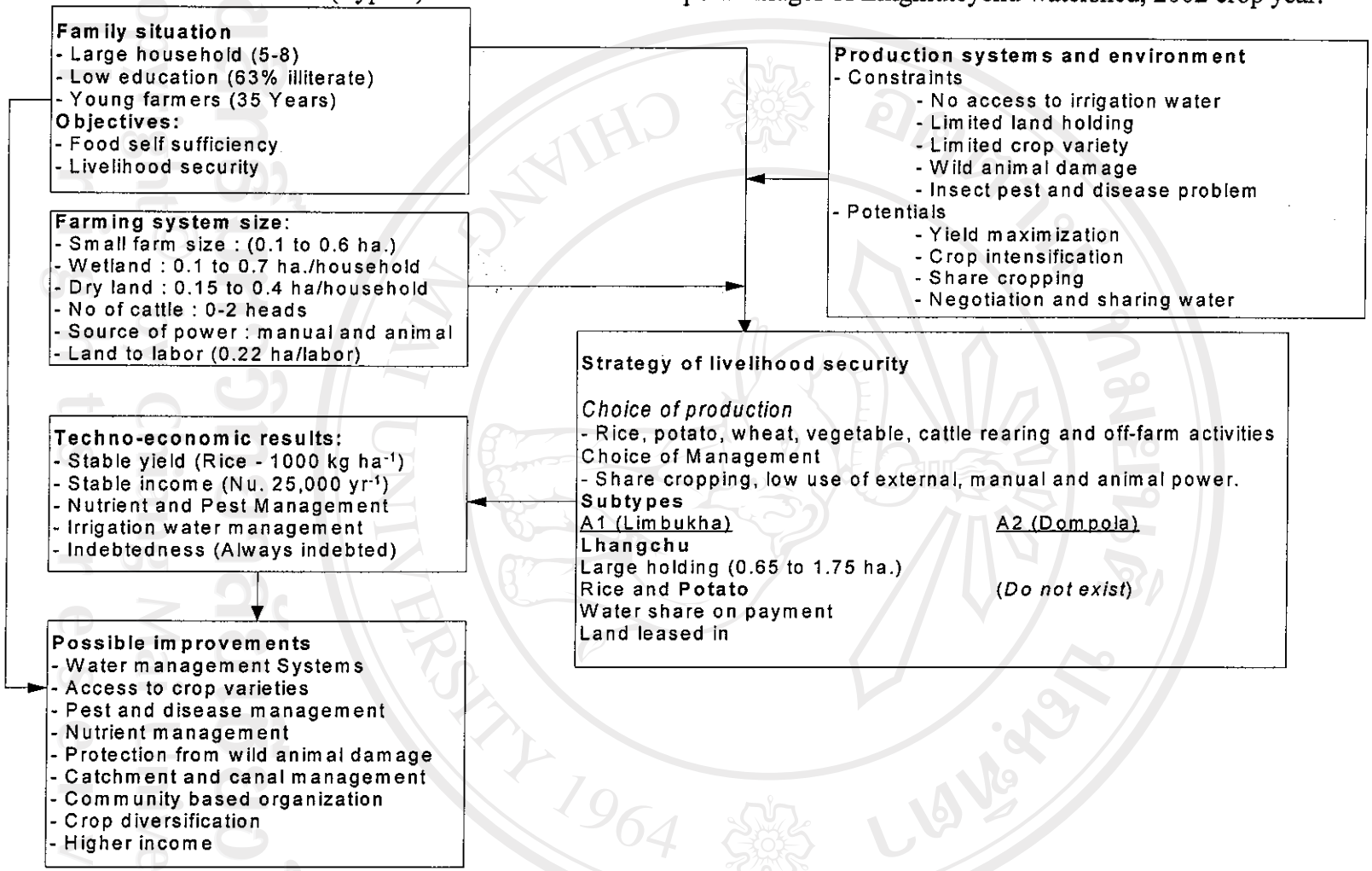


Figure 19d. End.

Table 15. Share of irrigation water used by different farm types in two villages of Lingmuteychu watershed.

Typology	Land holding (ha)	Water share	Income source	Management choice	% Farms (n = 49)		Farmer category
					Limbukha (n = 33)	Dompola (n = 16)	
Type I: Small independent specialized commercial farms	1.2 - 1.5	Full flow of canal	Potato and vegetables	Mechanization, fertilizer and pesticides	35	2	Thruelpa
Type II: Small independent specialized part-commercial family farm	0.3-2.4	Half of Thruelpa's share	Potato and vegetable	Manual and animal power, chemical fertilizer	16	10	Cheep
Type III: Small semi-subsistence or part-commercial family farms	0.15 – 1.4	Half of Cheep's share	Potato, vegetables, off-farm, dairy	Manual and animal power	8	20	Chatro
Type IV: Small subsistence oriented farm[a]	0 - 0.6	No share	Off farm	Share cropping, manual	8	0	Lhangchu

[a] Type IV farmers also grow potato and sell in small quantities.

4.5 Summary

The use of the principles of agrarian systems analysis and detail analysis of functioning of farming systems have helped in establishing a concrete understanding of the study area. The diagnosis particularly helped in classifying the diversity of farming systems and typifying them which facilitated in identifying constraints and potentials influencing functioning of the farming systems. With the understanding of the situation, the typologies will help in focusing the intervention. As the diagnosis sufficiently integrates physical, ecological, social and economical aspects of the farming systems, the knowledge generated can form as an entry point to very specific and focused interventions. As the analysis advance in hierarchical manner, from watershed to farm household, it helps in converging to the level where the problem is most critical. In doing so, it helps in relating both the potentials and constraints to different hierarchies, such that the intervention does not become a stand-alone solution. The findings of the diagnostic analysis will be vital input for designing the role-playing game.