

## **CHAPTER 4 ASSESSMENT OF AGRICULTURAL SETTING AND DEVELOPMENT POTENTIAL**

### **4.1 Assessment of Agricultural Setting**

#### **4.1.1 Method of Assessment**

##### **(1) Introduction**

The agricultural setting of Lao PDR was assessed based on two sets of census data (Agriculture Census 1998/99 and Population Census 1995) and GIS data. Both census data and GIS data (polygon, polyline or grid data) were compiled at the district level and all the 141 districts in Lao PDR were analyzed. The assessment was carried out with the objective of identifying the present condition of agriculture in Lao PDR by classifying the 141 districts into several groups based on agro- and socio-economic conditions in each district.

As a first step, the collected data were compiled for analysis using computational software. Secondly, a principal component analysis (PCA) was carried out after data compilation. Thirdly, the 141 districts were classified into 10 groups based on the result of PC analysis by applying a technique of cluster analysis. The computational software used in the second and third steps of analysis was Excel Multivariate Analysis Version 4.0. The grouping results were then presented on maps using ArcView GIS Version 3.2.

##### **(2) Data Used in Assessment**

A large number of data produced by several agencies were collected for the assessment as shown in Table 4.1. In the compiling data, all absolute amounts (e.g. number of farm households) were converted into relative figures (e.g. percentage of farm households by group out of the total farm household number).

##### **(3) Principal Component Analysis (PCA)**

The PCA is a statistical technique applied to sets of many potentially related variables to discover any similarity or positioning of the variables using factors that are found following the relations between the different variables. This analysis was carried out using 136 data sets selected as meaningful data from a number of data sets. The selection of data sets was made in the course of computation applying a structure detection method.

**Table 4.1 Data Used in Assessment**

Data Type	Description of Data	Data Source	Data Format
<b>Agricultural Data (950 data set)</b>			
District level digital data from 1998/99 agriculture census	<ul style="list-style-type: none"> <li>• Average area of holding and number of parcels, land use and land tenure conditions</li> <li>• Cropping pattern and major crops cultivated</li> <li>• Purpose of production</li> <li>• Use of production inputs</li> <li>• Average number of livestock raised by livestock type</li> <li>• Number of holdings with aquaculture</li> <li>• Others</li> </ul>	Ministry of Agriculture and Forestry (MAF)	Database file
<b>Social Data (250 data set)</b>			
District level digital data from 1995 population census	<ul style="list-style-type: none"> <li>• Population density</li> <li>• Percent distribution of population by sex</li> <li>• Urban and rural population</li> <li>• Percent distribution by place of birth</li> <li>• Household size by urban and rural</li> <li>• Population by education level and literacy rate</li> <li>• Economically active population by occupational classification and unemployment rate</li> <li>• Children born and deceased persons</li> <li>• Electricity and domestic water supply conditions and availability</li> <li>• Others</li> </ul>	National Statistical Center, State Planning Committee (SPC)	Database file
<b>Natural Data</b>			
Topographical data	<ul style="list-style-type: none"> <li>• Roads in 4 classifications</li> </ul>	Forestry Inventory Center	GIS polyline data
Elevation and slope	<ul style="list-style-type: none"> <li>• Digital Elevation Model (DEM) of 50 and 250 m grid in all Laos</li> <li>• Slope of 50 and 250 m grid in all Laos</li> </ul>	NAFRI	GIS grid data
Administrative boundary of provinces and districts	<ul style="list-style-type: none"> <li>• District boundary containing 141 districts</li> <li>• Province boundary containing 18 provinces</li> </ul>	National Geographical Department	GIS polygon data

In the Principal Component (PC) analysis, five sets of PC that indicate the present setting of agriculture in Lao PDR were discovered through a screen test. Each PC was then interpreted by reading the meaning of variables in order of calculated a score. The result of interpretation is summarized below.

1) PC-1: Transitional Farming

Factors on Positive Side of Axis	Factors on Negative Side of Axis
<ol style="list-style-type: none"> <li>1. Many farmers who don't clear land,</li> <li>2. Many lowland rice farmers,</li> <li>3. Use of improved rice variety,</li> <li>4. Higher rice production per farm,</li> <li>5. Flat land agriculture,</li> <li>6. Use of chemical fertilizers,</li> <li>7. Larger area for dry season rice,</li> <li>8. Higher literacy rate,</li> <li>9. Higher rate of land rent, and</li> <li>10. Many water pump users.</li> </ol>	<ol style="list-style-type: none"> <li>1. Many farmers clear land every year,</li> <li>2. Many upland rice farmers,</li> <li>3. No use of fertilizers,</li> <li>4. Sloping land agriculture,</li> <li>5. Higher elevation,</li> <li>6. Higher upland rice produce per farm,</li> <li>7. Many cereal, root &amp; tuber cultivators,</li> <li>8. Poor supply of domestic water, and</li> <li>9. Many subsistence products.</li> </ol>

(a) Explanation of the Positive Side

The farmers produce lowland rice on flat lowland with considerably higher level of farm inputs. Dry season rice is also cultivated with supply of irrigation water. Farmers' education level is comparatively high, and literacy rate there is better.

(b) Explanation of the Negative Side

Shifting cultivation is widely practiced on high elevation sloping land. The major product is upland rice. Farm inputs for production is relatively low. Production is mainly for home consumption. Living conditions are poor.

(c) Titling of PC-1

PC-1 clarifies two distinct agriculture settings, i.e. flat lowland agriculture on the positive side and sloping upland agriculture on the negative side. In comparison, agriculture on the positive side is relatively modernized, while that on the negative side is traditional in terms of farm input level and marketing of products. Taking these distinct settings into account, PC-1 is titled "Transitional Farming" which indicates the degree of farming system from traditional agriculture to modernized agriculture. The farming system is comparatively modern in districts with higher PC-1 score, while those still at the traditional level have a lower scores.

2) PC-2: Market Orientation

Factors on Positive Side of Axis	Factors on Negative Side of Axis
1. Higher population density, 2. Many livestock (except cattle) raising farmers, 3. Many non-rice production farmers, 4. Many dry season rice cultivators, 5. Larger area for vegetable production, 6. Better domestic water supply, 7. Many products for sale, 8. Many rice millers, 9. Higher application of chemical fertilizers, 10. Larger number of chicken per farm.	1. Many farmers use animal power, 2. Dominance of wet season cropping, 3. Higher per capita rice production, 4. Many rice farmers, 5. Production for household consumption, 6. Dominance of non-irrigated farming, 7. Higher agricultural population, 8. Dominance of fish catches from river, 9. Many cattle raising farmers, 10. Many organic fertilizer users.

(a) Explanation of the Positive Side

Population density is comparatively high. A large proportion of products are traded. Farm inputs use (e.g. chemical fertilizers) is relatively high. Private investment in processing (milling) and marketing (farm-input supply) is in progress. Living standard is relatively high.

(b) Explanation of the Negative Side

Wet season rice production is dominant, and irrigation farming is not commonly practiced. Many farmers use animal draught power for crop cultivation, mainly for paddy. Products are mostly for household consumption.

(c) Titling of PC-2

PC-2 distinguishes two different agriculture settings. On the positive side, agriculture products are market oriented. On the negative side, the production system is more subsistence-oriented. PC-2 is thus titled “Market Orientation” which indicates the degree of farm produce targeted for sale.

3) PC- 3: Water Resource Utilization

Factors on Positive Side of Axis	Factors on Negative Side of Axis
1. Larger farm land with irrigation,	1. Many non-irrigated farms,
2. Production for household consumption,	2. Many perennial crop cultivators ,
3. Many rice producers,	3. More production for sale,
4. Higher cultivation intensity,	4. Many non-paddy crop producers,
5. Many livestock raising farmers,	5. Larger land holding size,
6. Dominance of wet season cropping,	6. Higher upland rice produce per farm,
7. Aquaculture practiced on farms,	7. Many farms with wet season vegetables,
8. Larger population of livestock per farm,	8. Many forest land holders,
9. Many machinery users for cultivation.	9. Much production for barter.

(a) Explanation of the Positive Side

The irrigation system are comparatively well developed. With a better supply of irrigation water, rice is produced even in the dry season, but most of the production is for household consumption. Besides rice, a considerable number of farmers practice aquaculture. A large number of farmers raise livestock, mainly cattle. A larger numbers of farmers use machinery for crop cultivation.

(b) Explanation of the Negative Side

Non-irrigated agriculture is practiced. Beside upland rice, many farmers cultivate perennial crops and other non-paddy products. Crops are well diversified, and many products here are produced for sale and/or barter. Farm size is comparatively large.

(c) Titling of PC-3

Distinct differences between the positive and negative side are the degree of irrigation development, marketing of products, size of land holdings, and utilization of farm machinery. For PC-3, the titling is thus very difficult. However, it is titled as “Water Resource Utilization” taking the highest score both in the positive and negative side into account.

4) PC-4: Farm Intensity

Factors on Positive Side of Axis	Factors on Negative Side of Axis
<ol style="list-style-type: none"> <li>1. Dominance of small size farmers,</li> <li>2. Much organic fertilizer users,</li> <li>3. Larger number of buffalo per farm,</li> <li>4. Many large paddy land holders,</li> <li>5. Higher disease infection rate,</li> <li>6. Many lowland paddy farmers,</li> <li>7. Dominance of flat land,</li> <li>8. Higher cropping intensity,</li> <li>9. Larger area for tree crops,</li> <li>10. Many farmers don't clear land.</li> </ol>	<ol style="list-style-type: none"> <li>1. Larger holding size of arable land,</li> <li>2. Many annual crop cultivators,</li> <li>3. Larger area for rice production,</li> <li>4. Larger production of upland rice,</li> <li>5. Larger size of parcels,</li> <li>6. Larger non-irrigated land,</li> <li>7. Larger production of other cereals,</li> <li>8. Larger size of fallow land per farm,</li> <li>9. Higher upland rice dependency.</li> </ol>

(a) Explanation of the Positive Side

Farming size is comparatively small. Many farmers thus use organic fertilizers aiming at increased crop yield. This condition is dominant in the flat lowland area.

(b) Explanation of the Negative Side

Farming size is comparatively large and extensive farming is practiced. Production is not diversified, and mono-culture type paddy production is predominant.

(c) Titling of PC-4

PC-4 is titled as "Farm Intensity" that indicates the degree to which farm resources are utilized for output of agricultural products.

5) PC-5: Degree of Diversification

Factors on Positive Side of Axis	Factors on Negative Side of Axis
<ol style="list-style-type: none"> <li>1. Larger number of parcels,</li> <li>2. Many perennial crop cultivators,</li> <li>3. Larger proportion of products for sale,</li> <li>4. Larger area for vegetable production,</li> <li>5. Larger number of tree crops per farm,</li> <li>6. Larger area for commercial crops,</li> <li>7. Many legume crop cultivators,</li> <li>8. Many livestock raising farmers,</li> <li>9. Larger population of cattle per farm,</li> <li>10. Many paddy production farmers.</li> </ol>	<ol style="list-style-type: none"> <li>1. Many production for home consumption,</li> <li>2. Larger area for paddy production,</li> <li>3. Many dry season paddy producers,</li> <li>4. Lower education level,</li> <li>5. Larger production of upland rice,</li> <li>6. Many goat raising farmers,</li> <li>7. Higher population density,</li> <li>8. Many small size farmers,</li> <li>9. Many non-irrigated paddy lands.</li> </ol>

(a) Explanation of the Positive Side

Farm products are diversified both in crops and livestock, and a considerable amount of output is marketed.

(b) Explanation of the Negative Side

Paddy production is dominant both in the wet and dry season. Products are mostly for household consumption.

(c) Titling of PC-5

By interpretation of the above characteristics, PC-5 is titled as “Degree of Diversification” which indicates the extent of diversification in cropping and livestock farming.

4.1.2 Grouping of Districts

All the 141 districts were classified into 10 groups in accordance with the 5 PC scores of each district through cluster analysis. The grouping results are presented in Figure 4.1. Radar charts in Figure 4.2 show the combination of 5 PC scores that clearly clarifies the present agro- and socio-economic conditions of the respective groups. The detailed interpretation of the 10 groups is presented in Table 4.2.

**Table 4.2 Agricultural Setting in Lao PDR by Group of Districts (1/4)**

Group	Principal Components		Describe Characteristics	Find Constraints	Clarify Targets
	Components	Evaluation			
G-1	Transitional Farming	Low	Shifting cultivation is widely practiced on sloping land for production of upland paddy. In order to supplement a lower productivity, non-paddy products (including livestock and home manufacturing products) are produced and marketed to a certain extent. Expansion of irrigation area mainly for lowland paddy production is at mid to low level. Resource management is poor and depletion is high. Farming intensity is at mid to low level, and diversification is at mid to high level.	(1) Domination of unsustainable shifting cultivation which is a cause of forest cover reduction, soil erosion, etc. (2) Food crops are insufficiently produced. (3) Productivity of non-paddy crops is low, although they are important for cash income. (4) Production and marketing infrastructure is poorly developed. (5) Degree of market orientation is still at medium level.	(1) To prevent expansion of shifting cultivation. (2) To develop adequate production systems for sustainable use of upland. (3) To promote production of cash crops to increase farmers' income both in upland and lowland areas. (4) To provide production and marketing infrastructure. (5) To improve productivity of lowland paddy.
	Market Orientation	Medium to High			
	Water Resource Utilization	Medium to Low			
	Farm Intensity	Medium to Low			
	Degree of Diversification	Medium to High			
G-2	Transitional Farming	Low	Shifting cultivation for upland paddy production is widely practiced similar to G-1. In addition, production of lowland paddy with irrigation is practiced on a relatively large area. Development of crop diversification is lower than G-1. However, access to markets is better than G-1. Farm intensity is higher than G-1, at medium level.	(1) Domination of unsustainable shifting cultivation which is a cause of forest cover reduction, soil erosion, etc. (2) Mono-culture type paddy production is dominant particularly on lowland area. (3) Production is less diversified.	(1) To prevent expansion of shifting cultivation. (2) To develop adequate production system for sustainable use of upland. (3) To promote production of cash crops to increase farmers' income. (4) To provide production and marketing infrastructure. (5) To improve productivity of lowland paddy and promote its diversification.
	Market Orientation	Medium to High			
	Water Resource Utilization	High			
	Farm Intensity	Medium			
	Degree of Diversification	Low			
G-3	Transitional Farming	High	Paddy production is widely practiced on flat lowland. With an expansion of irrigated paddy land to a certain extent, many farmers use improved varieties and chemical fertilizers for paddy production. The cropping system is largely diversified, and well intensified. However, products are not always marketed.	(1) Production of market oriented crops is still at the medium level probably due to small domestic market. (2) Irrigation development is still at medium level.	(1) To assist farmers in marketing. (2) To improve crop productivity using better production infrastructure and technology. (3) To improve existing infrastructure for production and marketing, if feasible.
	Market Orientation	Medium to Low			
	Water Resource Utilization	Medium			
	Farm Intensity	High			
	Degree of Diversification	Medium			

**Table 4.2 Agricultural Setting in Lao PDR by Group of Districts (2/4)**

Group	Principal Components		Describe Characteristics	Find Constraints	Clarify Targets
	Components	Evaluation			
G-4	Transitional Farming	High	Agricultural setting is similar to G-3. However, it differs from G-3 in the extent of irrigated farming and marketing of products, both of which are less than those in G-3. In addition, farm intensity of this group is lower than that in G-3 at mid level.	(1) Flooding in the wet season prevents agricultural development in these districts. (2) Due to flood and topographic conditions, development of production and marketing infrastructure is still at low level. (3) Mono-culture type paddy production is dominant, and most products are for home consumption.	(1) To assist farmers in marketing. (2) To take measures for flood protection as far as they are economically feasible. (3) To improve lowland paddy production. (4) To promote crop diversification in irrigation areas.
	Market Orientation	Low			
	Water Resource Utilization	Medium to Low			
	Farm Intensity	Medium			
	Degree of Diversification	Medium to High			
G-5	Transitional Farming	High	Districts that belong to this group are located near to Vientiane city, and production of market oriented crops are relatively well developed. Irrigation system is also well developed and supports crop diversification. However, farm intensity is relatively low. Floods occur frequently in the wet season along the Namgum River due to its topographic condition.	(1) Further expansion of market oriented crops are becoming difficult due to small domestic market. (2) Quality of marketing crops is still at a low level for export. (3) Paddy productivity is still at a low level. (4) flood damages are considerable in the eastern part of Vientiane municipality, although the largest market is close by.	(1) To develop and introduce proper cropping patterns and production technologies so as to produce high value crops throughout the year. (2) To improve the quality of products so as to increase their competitiveness. (3) To assist farmers in marketing development. (4) To improve productivity of paddy by use of proper level of inputs taking economic return into account. (5) Some flood mitigation measures in the mid-to long-term are thus needed.
	Market Orientation	High			
	Water Resource Utilization	High			
	Farm Intensity	Low			
	Degree of Diversification	Medium			
G-6	Transitional Farming	Medium to Low	Agricultural production is practiced both on sloping land and lowland. Development of irrigation system and access to market are comparatively poor. Since paddy production is insufficient for home consumption, farmers usually diversify into non-paddy products such as fruit and small animals in order to earn cash income. Some degree of soil erosion.	(1) Expansion of shifting cultivation on sloping land. (2) Lower productivity of agricultural products both on sloping land and lowland. (3) Marketing accessibility is generally poor.	(1) To prevent expansion of shifting cultivation. (2) To develop adequate production systems for sustainable use of sloping land. (3) To promote production of cash crops to increase farmers' income. (4) To provide production and marketing infrastructure. (5) To improve productivity of lowland paddy.
	Market Orientation	Medium to Low			
	Water Resource Utilization	Medium			
	Farm Intensity	High			
	Degree of Diversification	High			



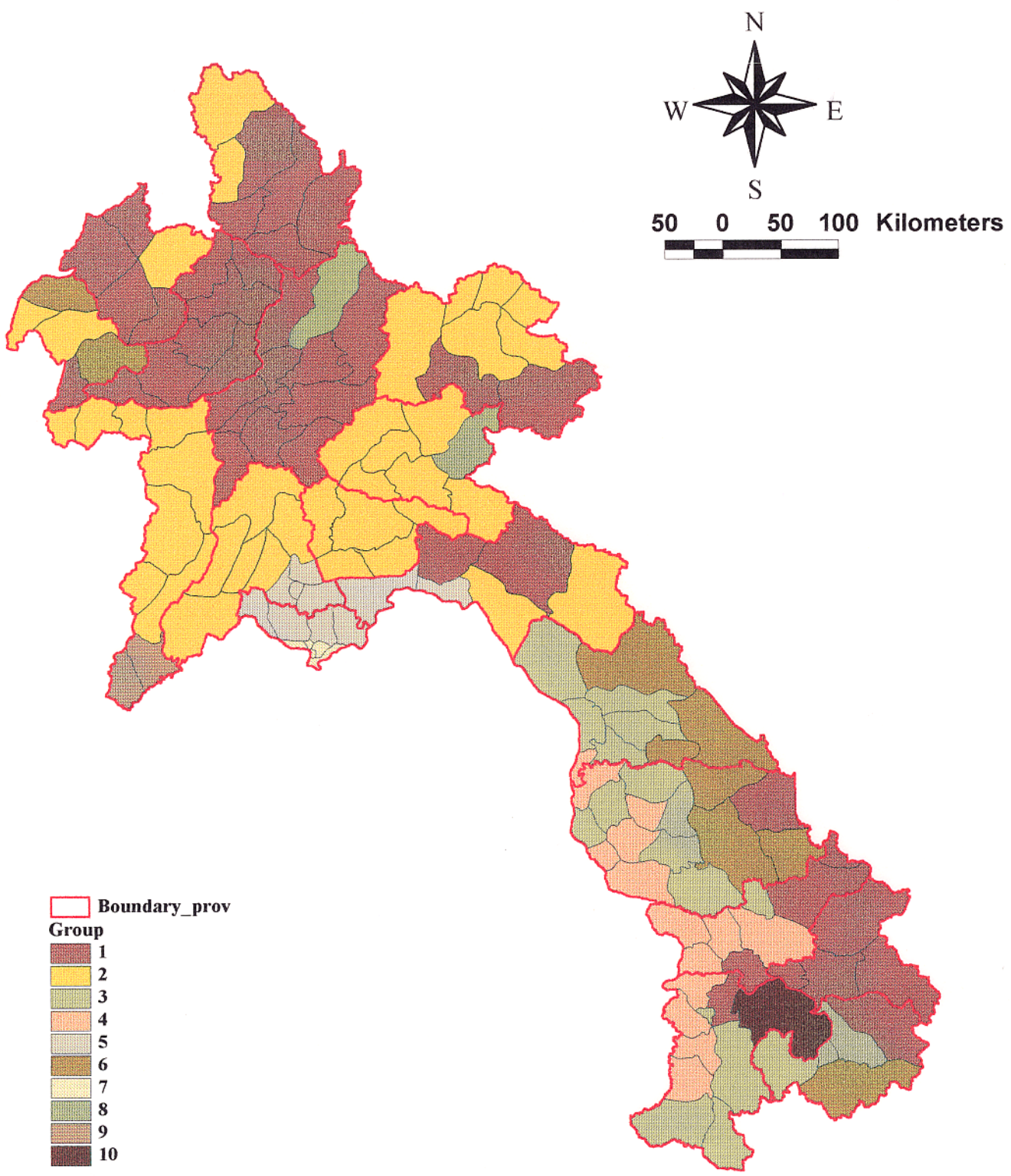
**Table 4.2 Agricultural Setting in Lao PDR by Group of Districts (3/4)**

Group	Principal Components		Describe Characteristics	Find Constraints	Clarify Targets
	Components	Evaluation			
G-7	Transitional Farming	High	Districts belong to this group are located in the suburbs of Vientiane city. Crops produced are well diversified and marketed to the largest market of Vientiane city. Irrigation facility is comparatively well developed. However, farm intensity is at medium level.	(1) Further expansion of market oriented crops are becoming difficult due to small domestic market. (2) Quality of marketed crops is still at low level for export.	(1) To develop and introduce proper cropping patterns and production technologies so as to produce high value crops throughout the year. (2) To improve quality of products so as to increase their competitiveness.
	Market Orientation	High			
	Water Resource Utilization	Medium to High			
	Farm Intensity	Medium			
	Degree of Diversification	High			
G-8	Transitional Farming	Low	Agricultural setting of this group is similar to that in G-1. However, products are more diversified than those in G-1. Most of products are for home consumption and they are rarely marketed. Farm intensity is comparatively low.	(1) Domination of unsustainable shifting cultivation which is a cause of forest cover reduction, soil erosion, etc. (2) Subsistence agriculture is predominant. (3) Food crops are insufficiently produced. (4) Development of production and marketing infrastructure is poor. (5) Marketing accessibility is poor.	(1) To prevent expansion of shifting cultivation. (2) To develop adequate production systems for sustainable use of upland areas. (3) To promote production of cash crops to increase farmers' income. (4) To provide production and marketing infrastructure.
	Market Orientation	Low			
	Water Resource Utilization	Low			
	Farm Intensity	Low			
	Degree of Diversification	High			
G-9	Transitional Farming	Medium	Paddy production is practiced both on sloping land and lowland. However, shifting cultivation area is smaller than that in other groups. On the other hand, the extent of irrigation land is relatively large in this group. Products are not diversified, but some are marketed with certain market competitiveness. Farm intensity is comparatively low.	(1) Domination of unsustainable shifting cultivation on sloping land. (2) Market oriented crops are not fully developed in spite of their development potential. (3) Products are not diversified.	(1) To prevent expansion of shifting cultivation. (2) To develop adequate production systems for sustainable use of upland. (3) To promote further development of market oriented crops and diversification of products.
	Market Orientation	Medium to High			
	Water Resource Utilization	High			
	Farm Intensity	Low			
	Degree of Diversification	Low			

**Table 4.2 Agricultural Setting in Lao PDR by Group of Districts (4/4)**

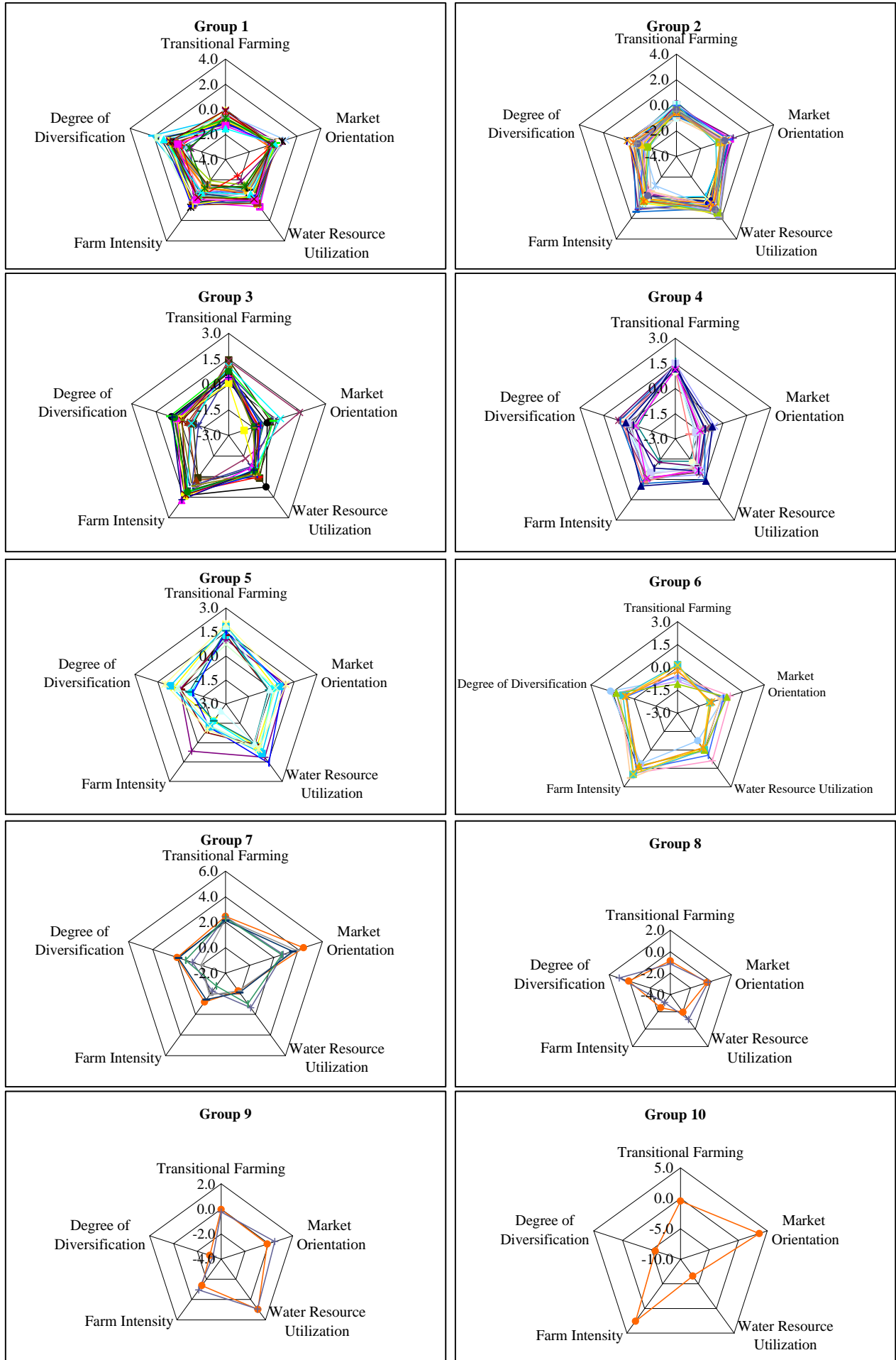
Group	Principal Components		Describe Characteristics	Find Constraints	Clarify Targets
	Components	Evaluation			
G-10	Transitional Farming	Medium	Only one district of Pakxong in Champasak province is classified as G-10. In this district, market oriented coffee and vegetables are intensively cultivated on plateau highland mostly under rainfed conditions. Irrigated agriculture is limited. Farm intensity is comparatively high.	(1) Products are not diversified and farmers' economy mostly depends on international market movements. (2) Production system is unstable under rainfed conditions,	(1) To establish a certain system to strengthen farmers financial and management capacity. (2) To improve a quality of products so that the competitiveness on the international market is increased. (3) To promote farmers investment for improvement of production infrastructure. (4) To improve crop husbandry.
	Market Orientation	High			
	Water Resource Utilization	Low			
	Farm Intensity	High			
	Degree of Diversification	Low			

Definitions: Transitional Farming; Farming system is in transition from traditional to modernized agriculture.  
 Market Orientation; Degree of farm produce targeted for sale.  
 Water Resource Utilization; Degree to which water resources are utilized for agricultural production.  
 Farm Intensity; Degree to which farm resources are utilized for output of agricultural crops.  
 Degree of Diversification; The extent of diversification in cropping and livestock/ aquaculture farming.



Note: The Grouping is made based on the Principal Components Analysis of the Agricultural Census Data 1999

**Figure 4.1 Grouping of Districts**



**Figure 4.2 Radar Charts of Each Group**

## 4.2 Assessment of Agriculture Potential

### 4.2.1 Method of Assessment

#### (1) Introduction

The objective of agriculture potential assessment is to identify the agriculture potential in Lao PDR in terms of lowland rice, upland crops, tree crops and grazing land at the preliminary level. The assessment has been carried out using existing digital data, namely: forest cover and land use, soil, climatic condition, topographic condition, and unexploded ordnance (UXO).

As a first step, the present landuse was classified into potential areas for agriculture and grazing land. Secondly, the agriculture potential area was classified into three potential area for lowland rice, upland crops and tree crops taking into consideration soil data, slope conditions and climatic condition. Finally, the UXO data were overlaid on the above potential areas to analyze the relationship between UXO risk and agriculture potential. For these steps, the geographical information system (GIS) using Arc View Version 3.2 was used. The detailed methodology including classification criteria and findings are explained below.

#### (2) Data Used in the Assessment

The following data have been collected from various concerned agencies and applied to the assessment of agriculture potential.

**Table 4.3 GIS Data Used for the Agriculture Potential Assessment**

Data Type	Description of Data	Data Source	Data Format
<b>Basic meteorological data</b>	Annual and monthly precipitation at 42 meteorological and 38 hydrological stations. Monthly temperature data at 42 meteorological stations.	Meteorological and Hydrological Department	GIS point data
Elevation and slope	Digital Elevation Model (DEM) of 50 and 250 m grid in all Laos Slope of 50 and 250 m grid in all Laos	NAFRI JICA S.T.	GIS grid data
Forest cover and land use	Forest cover and land use in 30 classifications including shifting cultivation of 1993 and 1997 Land use (NOFIP) in 16 classifications of 1992 Land cover change between 1993 and 1997 by district (forest cover, agricultural land, shifting cultivation, grassland)	NAFRI JICA S.T.	GIS grid data GIS polygon data
Administrative boundary of provinces and districts	District boundary containing 141 districts Province boundary containing 18 provinces	National Geographical Department	GIS polygon data
Soil Map	42 classifications according to the FAO criteria Each polygon has pH, nutrients, soil texture, soil depth	SSLCC	GIS polygon data
Unexploded Ordnance	Villages which have high risk of unexploded ordnance	UXO Lao	GIS point data

### (3) Methodology

#### (a) Identification of Agriculture Potential Area

The forest cover and land use map prepared in 1997 was used for GIS analysis of present land use. A total of 30 classifications in the map are reclassified into five categories, namely: forest area, agriculture area, shifting cultivation area, shrub & grassland, and other land use. The agriculture potential for crop production and grazing land is examined in the above five categories based on the following criteria.

- 1) Forest area : Basically no potentials for agriculture
- 2) Agriculture Area : Potential area for crop production.
- 3) Shifting Cultivation : Potential area for crop production. However, slopes more than 75% were excluded.
- 4) Shrub and Grassland : Potential area for grazing land. However, slopes more than 75% were excluded.
- 5) Other land use (Built up area, swamp area, river and water body etc.): Basically no potentials for agriculture

After the above assessment, the following factors were examined for identification of potential area of each crop group, namely: lowland rice, upland crop and tree crops.

- 1) Climatic Condition : annual mean rainfall and temperature
- 2) Topographic Condition: slope
- 3) Soil : texture of top soil, soil depth and pH

Using the above factors, the identification criteria for potential area of each crop group was established based on previous studies and after discussions with NAFRI staff (Table 4.4).

#### (b) Assessment of UXO Risk

The UXO LAO Operations Section processed UXO risk data. The map represents UXO risk as a combination of Level One (General) survey results and historical records of air bombardment provided by the U.S. Department of Defense, Office of Humanitarian Assistance and De-mining.

**Table 4.4 Criteria of Identification of Potential Area by Crop Groups**

Item	Lowland Rice	Upland Crops	Tree Crops	Grazing Land
Temperature ( )	More than 18 and Less than 35	<35	<35	-
Rainfall (mm)	>800	>500	>500	-
PH	4.5-8.0	4.5-8.5	4.5-8.5	-
Soil Survey Result	Area occupied by rock shall be excluded.			
Soil Depth (cm)	> 30 cm	> 30 cm	> 100 cm	-
Soil Texture of Top Soil	All except LS (Loamy Sand)	All except HC (Heavy Clay)	All except HC (Heavy Clay)	-
Slope Classification (Degree)	Less than 4.5 degree (8%)	Less than 16.5 degree (30%)	Less than 37 degree (75%)	Less than 37 degree (75%)

**Level One Survey:**

The UXO Program Office has conducted Level One Survey of 15 of the 18 provinces. Level One Survey was not conducted in Oudomxai (04), Bokeo (05), and Xaignabouri (08) provinces. In the Level One Survey, comprehensive village interviews were conducted in 93 of 135 districts. Based on the result of the Level One Survey, cells that are within five (5) kilometer distance from a village reporting UXO impact (high, moderate, or low) have been assigned a value of one (1). All other cells have been assigned a value of zero (0).

One (1) = UXO Impact in Village (5 km radius)

Zero (0) = no UXO Impact in Village

**Air Bombardment:**

Data were derived from historical records of air bombardment provided by the U.S. Department of Defense, Office of Humanitarian Assistance and De-mining. A density map of air bombardment was created from the vector (point) data of U.S. historical records. The density map shows the number of bombing records per square kilometer.

One (1) = density greater than 0.25 bombing records per km.sq.

Zero (0) = density less than 0.25 bombing records per km.sq.

These two values were combined to produce a national map of UXO Risk. UXO Risk is depicted on a scale from zero (0) to two (2) as follows:

**Table 4.5 UXO Risk Category**

		Level One Survey Result	
		0	1
Air Bombardment Record	0	Minimal Risk	Probable Risk
	1	Probable Risk	High Risk

#### 4.2.2 Outputs of Assessment for Agriculture Potential

Based on the above process, the agriculture potential maps with UXO risk for lowland rice, upland crops, tree crops and grazing land are illustrated in Figures 4.3, 4.4, 4.5 and 4.6. The area extent of each potential and UXO risk is summarized as follows:

**Table 4.6 Extent of Agriculture Potential Area for Each Crop Group and Grazing Land**

	Area ('000 ha)	Proportion (%)
<u>Potential Area for Crops</u>	<u>3,120</u>	<u>13.2%</u>
- For Lowland Rice & Upland Crops & Tree Crops	1,583	6.7%
- For Lowland Rice & Upland Crops	360	1.5%
- For Lowland Rice & Tree Crops	695	2.9%
- For Lowland Rice Only	92	0.4%
- For Upland Crops Only	195	0.8%
- For Tree Crops Only	195	0.8%
<u>Potential Area for Grazing Land</u>	<u>1,093</u>	<u>4.6%</u>
<u>Less Agriculture Potential Area</u>	<u>19,467</u>	<u>82.2%</u>
Total	23,680	100.0%

**Table 4.7 Extent of UXO Risk Area**

UXO Risk	Area ('000 ha)	Proportion (%)
High	630	2.7%
Probable	3,260	13.8%
Minimal	19,790	83.6%
Total	23,680	100.0%

The above tables show that the total potential area for annual and perennial crops is around 3.1 million ha compared to 1.0 million ha of existing agriculture land as specified in the Lao Agriculture Statistics, 1975-2000. It is therefore judged that the expansion of further 2.1 million ha is possible in terms of annual and perennial crop cultivation. It is also noted that the slope classification is of a very preliminary nature using 250 m grid data and accordingly, the micro relief cannot be identified fully. Therefore, the potential area for lowland rice might be on over-estimation since lowland rice cannot be cultivated in the micro relief.