



Demand Analysis Report- Lao People's Democratic Republic



Programme Management Unit (FTF-ITT)
National Institute of Agricultural Extension Management,
(An autonomous organization of Ministry of Agriculture & Farmers Welfare, Government of India)
Hyderabad – 500 030, India

www.manage.gov.in

CONTENTS

	Page No.
1 An Overview of Country	
1.1 Land Use and Topography	4
1.2 Climate	4
1.3 Demography	5
1.4 Economy and other Social indicators	6
2 Agriculture Sector in Laos-Policies, Programmes, Priorities	
2.1 Agriculture Sector in Laos	9
2.2 Evolution of Agricultural Policy	14
2.3 Priorities	16
3 A Review of Horticulture, Animal Husbandry and Fisheries Sectors	
3.1 Horticulture	17
3.2 Livestock and Fishery	18
4 State of Natural Resources	
4.1 Water	20
4.2 Forests	20
4.3 Land and Land Use	22
5 Status and Challenges in Agricultural and Rural Sectors	
5.1 Rural Poverty	23
5.2 Food Security	24
5.3 Agricultural Production and Productivity	24
5.4 Shifting Cultivation	25
5.5 Water management	25
5.6 Agricultural marketing and Supply chain	26
5.7 Farm Mechanization	26
5.8 Cropping Systems	27
5.9 Topography	28
6 Overview of Agricultural Extension and Research System	29
7 Public and Private Institutions and Their Relevance in Agricultural Development	31
8 Present Capacity Building Programmes and Potential Areas	
8.1 Current Capacity Building Programmes	33
8.2 Challenges and Potential Areas	34
9 Training Priorities in Agriculture and Allied Sectors	
9.1 Agronomy and Cropping Systems	37

9.2	<i>Horticulture</i>	38
9.3	<i>Farm Mechanization</i>	38
9.4	<i>High-tech Agriculture/Horticulture</i>	38
9.5	<i>Income Generation from Agricultural and Allied Activities</i>	39
9.6	<i>Post-Harvest Technology and Management</i>	39
9.7	<i>Natural Resources and Environment Management</i>	39
9.8	<i>Irrigation and Water management</i>	39
9.9	<i>Animal Husbandry and Livestock Management</i>	39
9.10	<i>Food/Dairy Processing Technologies and Management</i>	40
9.11	<i>Integrated Pest Management</i>	40
9.12	<i>Integrated Nutrient Management</i>	40
9.13	<i>Fisheries</i>	41
9.14	<i>Renewable Energy resources</i>	41
9.15	<i>Agri-Entrepreneurship Development</i>	41
9.16	<i>Agricultural Marketing</i>	42
9.17	<i>Information Technology in Agriculture</i>	42
9.18	<i>Agricultural Extension Management</i>	42
10	<i>Conclusions</i>	43
	<i>References</i>	

Chapter I

AN OVERVIEW OF COUNTRY

Laos Peoples Democratic Republic (Laos PDR) is a landlocked country in the center of Indochina sharing its borders with Cambodia to the south, Thailand to the west, Vietnam to the east and China and Myanmar (Burma) in the north and north-west respectively (Fig.1).

1.1 Land use and Topography: The country covers an area of 236,800 square kilometres. – About 20% of the land area is lowland, the other 80% is upland and mountainous. The agricultural land accounts for 900,000 hectares in area. Laos is divided into 17 provinces (*khoueng*) and one prefecture (*kampheng nakhon*) which includes the capital city Vientiane (*Nakhon Louang Viangchan*). Provinces are further divided into districts (*muang*) and then villages (*ban*). Seventy percent of its total land area (236,800 square kilometers) comprises mountain and plateau area (Fig.1). The Annamite chain of mountains stretches along part of the border with Vietnam and averages 1,200 meters in height. The mighty Mekong river, one of the longest rivers in the world, flows along the borders with Thailand. The river flows through nearly 1,900 kilometres of Lao territory and has always been a lifeline for the country in terms of fish supplies, transportation routes and agriculture. Several hydro-electric facilities, situated on the tributaries of the Mekong, generate electricity for export to Thailand.

Laos has one of the most pristine ecology in South East Asia with an estimated half of its woodlands being primary monsoon forest. The forest grows in three layers- a top canopy of tall, majestic trees, a middle layer of hardwood trees such as teak and a lower growth of small trees, bushes and sometimes bamboo. Laos also hosts a diverse selection of exotic and rare animals. Leopard cats, Javan mongoose, goat-antelopes, rare gibbons and Asiatic black bears are just some of the mammals which can be found all over the country. The remote areas of the country are almost certainly home to many unknown species. Laos is also rich in both resident migratory birds.

1.2 Climate: Laos enjoys a warm, tropical climate with two distinct seasons -the rainy season from the beginning of May to the end of September and the dry season from October through to April. Temperatures and rainfall vary considerably throughout the year and also according to latitude and altitude. The tropical monsoon climate of Laos has average temperatures ranging from 28 degrees C to 38 degrees C. The mountainous areas generally stay much cooler with average temperatures of 15 degrees C during winter. Laos' rainy season is from May to September, while the dry season is from October to April.



Fig.1 Administrative map of Laos PDR

1.3 Demography: The estimated population of Lao PDR is 6.77 million in 2013. Laos' population is increasing at an average of 2.5 percent each year, with the 2000 population estimates at over 5.2 million, with women outnumbering men. It is estimated that if Laos continues to grow at the current rate, the it's population will almost double in the next 25 years. 80% of the Lao population lives in rural areas. The official language of Lao PDR is Lao. The local versions of Lao can differ substantially from north and south and many of the ethnic minority groups do not speak Lao at all.

The population of the Lao PDR includes more than 47 official ethnic groups (others put this figure close to 230 groups based on language and other differences) (ADB, 2001). This diversity enriches cultural dimensions, but it also has serious implications for development. In many parts of the country, ethnic minorities are in the majority, and language barriers are serious. Livelihood patterns and sociocultural dimensions require specific considerations for the provision of social services and infrastructure, and for developing and accessing economic opportunities. The northern region has an ethnically diverse population of over 2 million people scattered over 5,000 villages across rugged mountainous terrain, making provision of services (e.g., education, health, and transport) difficult. Gender disparities across ethnic groups are serious. An important factor reflecting poverty among ethnic groups is their high illiteracy rates. Based on the 2005 census, the most recent data available, disparities in literacy rates among ethnic groups were evident. While literacy rates have improved since then, differences among ethnic groups may not disappear in the immediate future (Ministry of Education, 2004).

1.4 Economy and other Social indicators: Laos' economy depends on several things for its survival - agriculture, handicrafts, fishing and on a small scale manufactured clothing. The GDP growth rate is almost 7.7 % and agriculture contributes almost 44.3 % of the GDP. Although Lao PDR's economic growth has been impressive, poverty and disparities remain widespread. The poverty head count ratio in Lao PDR in 2008 was 33.9, an improvement over 1992 when it was 55.7 (World Bank, 2012). The country mainly depends on outside donors such as Japan, France, Sweden and Australia. The overwhelming majority of laborers are in the agricultural field, while laborers in the service industry come in at a distant second. The Lao PDR continues to develop at a commendable pace. On the back of such growth, it graduated to the rank of lower middle-income country in 2006. It is now enjoying the fruits of its investment in infrastructure, economic and social development, as well as regional co-operation and integration. Robust growth has helped alleviate poverty, but more needs to be done to ensure that such growth is sustainable and inclusive. In other words, Lao PDR is now at the crossroads of development: the economy needs to balance economic growth with equity and sustainability to ensure that current and future generations can participate in and benefit from economic growth.

One of Laos' major exports is that of timber, with most of them exported as logs and not processed. The only crop that can be considered a substantial export is coffee. Since the late

1980's tourism has been encouraged, although there isn't a boom of tourism, the numbers were rapidly increasing up through the late 1990's (OECD, 2006).

The Lao PDR is a poor country with a per capita GDP of about \$400 in 2004 at current prices. Since 1986, the economy has grown at between 4% and 7% per annum such that real GDP had almost trebled by 2004. The per capita gross domestic income is about US\$1,646 annually. Table 1 presents the latest trends in the performance of the agriculture subsector with respect to contribution to the gross value of output. As is evident from the Table, the contributions from cereals and livestock sectors were the highest during the recent three-year period, followed by fisheries and the industrial crops. Within the cereals category, lowland rainfed paddy continued to have the most prominent position, while the contribution from upland paddy production declined by about 2 percent between 2008/09 and 2010/11. Although the contribution from lowland rainfed paddy continues to be stronger within the broad cereals sector, the other three sectors – i.e. forestry, fisheries and livestock – have reported significant growth. The industrial crops have also made significant contributions towards national GDP (FAO, 2014).

Table.1 Gross value added in agriculture sector, 2008-2011 (at constant prices 2002)

Sl.No.	Crops/Sectors	Value of GDP (Billion Laotian Kip)		
		2008-11 (Avg)	GDP (%) share	CAG* (2008-11)
1	Total cereals	328.62	27.33	3.14
2	Lowland rainfed paddy	253.37	20.99	2.42
3	Upland paddy	21.62	1.79	-1.80
4	Industrial crops	153.58	12.72	8.87
5	Livestock	321.03	26.60	3.32
6	Fisheries	169.48	14.04	5.79
7	Forestry	31.51	2.61	11.76

- CAG- Compounded Annual Growth rate; *Source: MAF, 2011*

The country's population grew by 57% from 3.7 million in 1986 to 5.8 million in 2004. Life expectancy at birth (54 years in 2002) is low; child malnutrition (15% in 2001–2002) is high; and infant mortality (87 per 1000 in 2002), and maternal mortality (530 per 100,000 in 2000) are high compared with conditions in other countries in the region. Poverty incidence reached 33% in 2002/2003, down from 45% a decade earlier. Poverty incidence data (2002/2003) by region indicate that the central and northern regions are the poorest: Vientiane Municipality (26.2%),

central region (35.8%), northern region (35.5%), and southern region (30.8%) (World Bank, 2010). The major social and agricultural indicators for Laos PDR is given in Table.2.

Table. 2. Major Social and Agricultural Indicators of Laos PDR

	Unit	Source	Quantity/Value
Population 2007	Million	World Bank 2009	5.86
Projected population 2050	Million	Earth Trends 2009	9.29
GDP per capita at PPP	\$	ADB 2009	2387
GDP per capita growth rate 2002-2007		ADB 2009	5
GDP from Agriculture (2008)	%	ADB 2009	32.1
Agricultural Population (20006)	%	FAO 2009	76
Total land area	km ²	World Gazetteer 2009	230800
Population density 2007	Persons/km ²	Calculated	25
Arable land 2007	km ²	FAO 2009	11700
Arable land per capita 2007	Ha/person	Calculated	0.20
Irrigated area (as a percentage of arable land)	%	FAO 2009	26
Population below US\$ 2.00 (PPP) per day	%	ADB 2009	74.4
Per capita water availability 2007	m ³ /person	FAO 2009	57914
Annual Rainfall	mm/year	FAO 2009	1834
Water withdrawal for agriculture	%	FAO 2009	90

Sources: FAO 2009; World Bank 2009; World Gazetteer 2009; Earth Trends 2009

Chapter II

AGRICULTURE SECTOR IN LAOS-POLICIES, PROGRAMMES, PRIORITIES

Agriculture in Southeast Asia is in transition from traditional subsistence systems to modern commercial production of a wide range of commodities for both local consumption and export,

with significant implications for water demand and water quality. Agricultural production in the Greater Mekong Subregion (GMS), which includes Laos, over the last 20 years has seen steady increases across all subsectors and all countries. Production in major commodity groups has more than doubled since 1990, outpacing the region’s rapid population growth (FAO 2009; Johnston et al. 2010). Most of this remarkable increase has come from intensification and increases in yield, rather than from expansion in agricultural area, which grew by less than 5% over the same period (FAO 2009). Increases in crop yield have resulted from the range of new technologies and approaches that underpinned the ‘green’ revolution (IRRI 2008): uptake of improved varieties; increasing use of fertilizers; improved farming practices; and the expansion and more efficient use of irrigation (Johnston et.al, 2010). In the Laos, increasing food security remains a challenge as 75% of food production is dependent on smallholder agricultural systems that are under serious threat due to climate variability and a range of biophysical and socio-economic drivers (Schiller et al., 2001). There is a need for a transformative change in these agricultural systems in order to deliver increased production while preserving or improving soil properties.

2.1 Agricultural Sector in Laos: Laos’ seventh National Socio-Economic Development Plan (2011–2015) (Government of Laos 2010a) states that agricultural intensification, particularly as related to rice, is the key to food security and poverty reduction. Agriculture (including forestry) accounted for 57.3% of GDP in 1987, and 47.2% in 2004. As stated in the National Socio-Economic Development Plan (2011–2015): “[The government] targets to increase rice production to four million tons (or 3.9 ton/ hectare on average) by 2015 and reduces the total number of poor villages in the country.” Or, as stated in the National growth and Poverty Eradication Strategy (Government of Laos, 2004): “from a poverty eradication perspective, the most important policy-related objective regarding agriculture development is improvement of household food security [through rice intensification].”

At least 5 million hectares of Laos's total land area of 23,680,000 hectares are suitable for cultivation (about 21 percent). 17 percent of this land area (between 850,000 and 900,000 hectares) is actually cultivated, less than 4 percent of the total area. The area of arable land per capita and as a percent of total land area of Laos PDR is shown in Table.2.

Table. 2. Area of arable land per capita and as a percent of total land area of Laos PDR

1990 Arable land	2007 Arable land	2050 Arable land	
		Area of arable land constant	Area per capita constant

Area ('000 ha)	ha per capita	% of total land area	Area ('000 ha)	ha per capita	% of total land area	Area ('000 ha)	ha per capita
799	0.20	3	1.17	0.20	5	1855	0.13

Sources: FAO 2009; World Bank 2009; World Gazetteer 2009

Agricultural systems in Lao PDR are broadly divided into lowland and upland systems. Lowland agriculture is dominated by rain-fed and irrigated rice crops, while upland agriculture is dominated by shifting cultivation. Irrigated rice farming largely remains a monoculture system despite government efforts to encourage crop diversification. However, commercial crops are expanding in lowland areas under irrigated conditions. In upland areas, food crops are grown primarily for home consumption (MAF, 2010). Most farm households follow a mixed farming system, depending on the topography of the land. In the uplands of the Northern provinces, farmers grow rice along with other crops, such as maize, cassava and vegetables, in the rainy season. In the rainfed paddy fields of the Central and Southern provinces, farmers also grow vegetables and groundnuts or other rainfed crops, including tropical fruits. Recently, cultivation of commercial crops, such as rubber, sugar cane, cassava and maize, has expanded in several parts of the country (FAO, 2014).

The potential for expansion of arable land area in Lao PDR is severely affected by multiple constraints, such as type of terrain, bodies of water and presence of UXOs (Unexploded Ordnance). Nonetheless, agriculture in Lao PDR is diversified and produces a wide variety of annual (mainly seasonal) crops. The area and production of major crops in Laos are given in the Table.1.

Crop	Cultivated area (ha)	Production (tons)
Rice	812,617	2.71 mil.
Maize	154,255	620,550
Coffee	58,385	33,200
Peanut	15,965	35,070
Chinese pearl barley	14,845	36,715
Cassava	11,015	233,420
Soybean	8,040	10,455
Cardamom	6,745	1,605

Source; FAO, 2014

Table.1 Area and Production of Major Crops in Laos

Rice accounted for about 80 percent of cultivated land, including 422,000 hectares of lowland wet rice and 223,000 hectares of upland rice. This demonstrates that although there is inter-planting of upland crops and fish are found in fields, irrigated rice agriculture remains basically a monoculture system despite government efforts to encourage crop diversification. The rice area cultivated in the uplands decreased by 52%, and its contribution to the total rice area declined from a high of 41% in 1991 to around 15% in 2004. Much of the decline is reported to have been due to the decrease in rice area under shifting cultivation.

As the staple food, rice has cultural and religious significance. There are many traditions and rituals associated with rice production in different environments, and among many ethnic groups in Laos. The Lao PDR has one of the highest degrees of biodiversity of rice in the world, and it appears to be the center of biodiversity for glutinous rice. Since the early 1990s, more than 13,500 rice samples have been collected, of which 85% are glutinous types. Rice production in the Lao PDR increased by 75% from 1.4 million tons (t) in 1986 to 2.5 million t in 2004 and to 3. Million t in 2011(World Bank, 2012).

The country witnessed a notable increase in the number of rice growers (1.4% growth per annum) and rice area (2.5% growth per annum) along with a 13 percent increase in the average rice growing area per grower, from 1.2 ha (1998/99) to 1.4 ha (2010/11). Strengthening of agricultural research and extension systems, implementation of supportive agricultural policies, and increased public sector investments in irrigation are the major factors that have contributed to the rapid increase in production. To maintain self-sufficiency in rice, the Lao PDR will need to produce an additional one million t annually by 2020 to meet the increasing demand resulting from population growth. This will require the yield growth to be no less than the population growth rate of 2.5% per year. However, the yield growth rate in recent years (2010–2014) has been at about 2% per year (Bourdet, 2000).

Cultivated land area had increased by about 6 percent from 1975-77 but in 1987 only provided citizens with less than one-fourth of a hectare each, given a population of approximately 3.72 million in 1986. In addition to land under cultivation, about 800,000 hectares are used for pastureland or contain ponds for raising fish. Pastureland is rotated, and its use is not fixed over a long period of time (UNDP, 2008). Laos plans to produce about five million tons of rice by 2020 from the current four million tons to ensure food security in the country and begin generating exportable surpluses (FAO et al., 2012). To achieve this target, the irrigated area in the dry season

is to be increased by 2015 to 500,000 ha, including 300,000 ha for dry season irrigated rice. In addition, wet season irrigated areas are to be expanded to 950,000 ha. Recently, the Government of Laos (GoL) has established an even more ambitious target to increase overall rice production, aiming for 900,000 ha of irrigated area in 2025, which includes 400,000 ha for dry season irrigated rice (MAF 2014). Related to these goals, irrigation development has been incorporated as one of the eight core programs in the Agricultural Master Plan (AMP). The government positions irrigation infrastructure development as one of its 13 policy measures to achieve the defined development targets (e.g., the area of irrigated rice) (GoL 2010b). To date, the government has implemented 674 projects involving irrigation infrastructure to expand the area of irrigated rice (MAF 2013).

In Laos, maize is the second largest crop produced after rice in terms of harvested area, and recently maize production has been expanding due to demand from neighboring countries, including Thailand, China, and Vietnam. In 2007, the export of maize represented 19.8% of the total exports of agricultural products from Laos ([Southavilay et al., 2011](#)). Maize crop has an average annual growth rate of 15 percent, although the number of growers increased quite slowly (at about 2% per annum). Annual maize production increased tenfold between 2000 and 2009 – from 117 000 to 1 130 000 tonnes – becoming the second largest contributor to the country’s agricultural GDP and agricultural exports (Castella and Lestrelin, 2011). Most farmers reported growing maize along with rice, with maize primarily as a cash crop and rice to meet food requirements (Douangsavanh and Bouahom, 2006). While most maize is exported to animal feed and food processing industries in Thailand, some of it is used domestically for human consumption and animal feed. Most maize is produced by smallholder farmers. Thus, increasing maize productivity at the level of small-scale farmers would be in the strategic interest of the country to increase export revenues, in addition to improving domestic food security. Although a large number of growers also grow other important crops, such as cassava, sugar cane, soybean and groundnut, these crops do not occupy a notable share in the land area across provinces.

There was a 28 percent increase in the total number of Lao PDR households – from 0.79 million to 1.02 million – between 1999 and 2011, with a corresponding increase of 20 percent in the number of farm holdings, including livestock holdings at the national level (Figure 2).

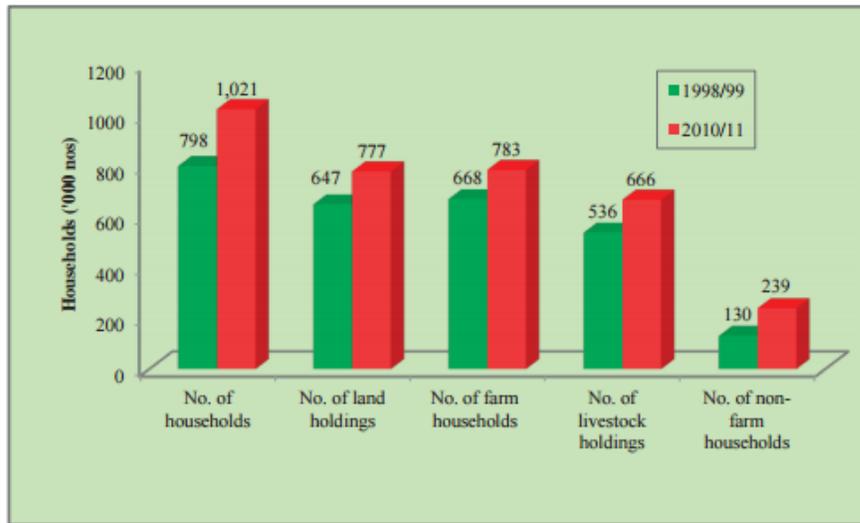


Fig.2. Changes in the status of households in Lao PDR, 1999 & 2011

Key features of agricultural sector in the Lao PDR are given below:

- In 2004, agriculture and forestry accounted for 47% of GDP and provide more than 80% of total employment. Agricultural output rose steadily over the past decade, with an average annual growth of 4.3%. About 620,000 households depend on agriculture for their livelihoods, and more than 80% of farmers practice subsistence farming.
- Arable land (3.7%) and permanent cropland (0.4%) are limited in terms of the country's total land area of 236,800 square kilometers. In comparison, arable land in Cambodia amounts to 21% of the total land area; Viet Nam has 20%, and Thailand 29.4%.
- Geographically, the country is predominantly mountainous, with hills and steep terrain covering two thirds of its land area. Much of the country is characterized by remote settlements and low population density. In terms of arable and cultivable land, the population density is high. In the northern region, only 6% of the land area is with slopes of less than 20%. The northern region is characterized by inadequate market access, poor distribution networks, and lack of all-weather roads. Prime agricultural land is unevenly distributed, and mostly confined to the floodplains of the Mekong River and its tributaries in the central and southern

regions. Existing farming systems are categorized into lowland rain-fed, lowland irrigated, upland rain-fed, highland farming, and plateau farming systems.

- The area planted to rice represents more than 80% of the nation's cropped land. The Lao PDR is self-sufficient in rice overall, but localized rice deficits and household food insecurity continue to occur in many parts of the country, particularly in the northern region.
- Crop cultivation is characterized by limited use of pesticides and fertilizers.
- Crop yields are below average for the region. Harvest and postharvest technologies are relatively weak, and crop losses reach as high as 30%.
- Apart from rice, rural households meet their basic food requirements from livestock, inland fisheries, and non-timber forest products.

2.2 Evolution of Agricultural Policy: History of The Lao PDR was proclaimed in 1975, ending the rule of the Royal Lao Government of the Kingdom of Lao (1946–1975). At that time, much of the country was in ruins after 20 years of political struggle and the effects of the Indochina war (1964–1973). The communist government sought development through agriculture. Attempts to collectivize agriculture, designed to gain state control over agricultural production, encountered strong opposition. Agricultural production stagnated. In 1979, the Lao People's Revolutionary Party (LPRP) took its first steps towards market-oriented reform by easing restrictions on private trade and encouraging joint ventures between the State and the private sector. An interim 3-year economic development plan began in 1979. The Government reduced agricultural taxes and increased state procurement prices for most crops, but retained central planning. In 1981, implementation of the first 5-year development plan began (ADB, 2005).

The primary objective of the cooperative farming system, based on the Vietnamese model, had been to help the nation achieve self-sufficiency in food. Reflecting the government's pursuit of this goal, the number of government-assisted cooperative farms nearly tripled between 1978, when the drive to reorganize agriculture began, and the introduction of the New Economic Mechanism (NEM) in 1986. At that time, cooperative farms numbered about 4,000 and employed about 75 percent of the agricultural labor force although most were cooperatives only on paper, and there was no practical cooperative management. The NEM recognized the dominant role of Agriculture and Natural Resources (ANR), which at that time contributed about 60% of the country's gross domestic product (GDP) and more than 80% of total employment. The

Government sought to address shortcomings in the ANR sector through reform measures that would use market forces to improve economic growth and productivity and to create income and wealth. It abandoned the collectivization of agriculture, eased restrictions on private sector activities, and allowed state enterprises to have more decision-making authority. In 1987, the Government eased trade restrictions between provinces, and privatization began in 1988. The Lao PDR and the International Monetary Fund (IMF) entered into an agreement in 1989 for a structural adjustment facility (SAF) to accelerate the pace of economic reforms, including the privatization of state-owned enterprises (SOEs), price and exchange rate liberalization, financial sector development, and improvement of the country's tariff system.

By 1988, however, employment in the cooperatives had decreased and included only 53 percent of all rural families and about half of all rice fields. In June 1988, in line with the policies described by the New Economic Mechanism, the government passed a resolution to reform the agricultural sector. The distribution and sale of collectively managed land to families began in 1989. Most families in the old settled areas had their original land returned, which they still recognized. By mid-1990, most state farms and agricultural cooperatives had been disbanded. This move, in conjunction with the removal of many restrictions on food prices and the distribution of agricultural goods, helped to precipitate a modest growth in agricultural output of about 7 percent in 1990 (Kim, 2007). In the post NEM era private and state enterprises have operated side by side, and foreign investment has been encouraged. A number of nongovernmental organizations, including some from the United States, have been assisting the government, mainly in the fields of rural development and public health (ADB, 2005).

2.3 Priorities: Villagers' definitions of poverty are based on livelihood. Poverty in the Lao PDR is not synonymous with hunger. Primary aspects of livelihood that signify well-being in all villages include rice sufficiency and ownership of livestock. To the rural population, access to rice is the most important factor determining their welfare status. Lao people consume 171 kilograms (kg) per capita of milled rice per annum, constituting almost 70% of their calorie and protein requirements (Maclean et.al, 2002). Achieving national self-sufficiency in rice has been a top priority goal for the country since the introduction of the NEM.

The seventh National Socio-Economic Development Plan (NSED) 2011-2015 is geared to achieving the MDGs and the government is pursuing its commitment to addressing social welfare issues. It has made considerable progress towards poverty reduction – the first of the MDGs

(Anonymous. 2014). In 2010, it completed a framework and financing plan for accelerating achievement of the MDGs by setting six specific targets: access to enabling infrastructure; sustainable practices for improved food security and environmental sustainability; universal access to basic education and gender equity; women's equal participation and empowerment; improved maternal and child health; safe water supplies and improved sanitation for all rural areas and remote communities.

Chapter III

A REVIEW OF HORTICULTURE, ANIMAL HUSBANDRY AND FISHERIES SECTORS

3.1 Horticulture: Coffee and tea are beverage horticultural crops grown in Lao PDR that have great potential in both the domestic and export markets. While coffee, including organic coffee, is

already a major export earner for the country, the case of tea deserves attention as well. Promoting tea as a beverage crop in the domestic sector could assist farm livelihoods through employment and income generation. Cultivation of tea has also been proposed as an alternative to shifting cultivation practices in the mountainous regions (Yoshida and Hemmavanh, 2010). These trends indicate an increase in area and production of both crops, with a consistent rise in coffee productivity. Tea productivity showed more fluctuation during the reporting period, which may be attributable to the varying agro-ecological conditions under which tea is grown and to the harvesting practices, as well as the health of the tea plants. More importantly, improving the performance of these two crops will depend upon better farm management strategies, as well as more conducive environmental conditions, as these crops are known to be highly sensitive to variability in climatic and weather conditions (FAO, 2014).

Rubber is a relatively new plantation crop for Lao PDR and the national government has shown an increasing interest in promoting rubber plantations through investments from outside the country. Though rubber was introduced into Lao PDR as early as the 1930s, the development of rubber plantations on a commercial scale has received serious attention only since the 1990s. The high prices and income potential for rubber have sparked great interest in developing plantations in the country.

However, the prospects for horticulture development in Lao PDR depend on addressing several structural issues and production-related problems, such as: (a) concerns over loss of common property resources (including forests), loss of forests, loss of livestock and loss of farmlands; (b) insufficient availability of skilled labour for rubber-tapping and horticultural processing; (c) need for development of horticultural product processing and manufacturing facilities; (d) lack of standardization of rubber and horticultural produce's processing; and (e) land titling and property rights issues.

3.2 Livestock and Fishery: In the Lao PDR, livestock production is an important sector of the economy, and improving livestock productivity has been recognized as one of the most important national goals to foster sustainable growth of the economy and reduce rural poverty and food insecurity (Khounsy and Conlan, 2008; Nampanya et al., 2010). It was reported that the livestock sector, together with fisheries, contributes up to 16 percent of the nation's gross domestic product (GDP) (Wilson, 2007), providing up to 50 percent of annual household cash income (ADB, 2005).

The importance of livestock in Lao farming systems has been recognized for many years, but livestock did not receive prominence until 1999, when the Government articulated its Strategic Vision for the Agriculture Sector (MAF, 2001). Livestock accounts for 35% of agricultural production in the Northern Region. Shifting cultivation is most prevalent in the Northern Region, one of the poorest areas of the country, where livestock and animal husbandry can play a significant role in improving livelihood systems.

Livestock play a major role in all farming systems in the country, especially smallholder farms in the Lao PDR, with sales of livestock accounting for more than 50% of cash income in many upland and highland areas. Over 95% of all livestock is produced by smallholders, and there are only a few commercial enterprises farming pigs and poultry near major urban markets. Between 1999 and 2011 the number of commercial chickens and ducks increased by 124 percent (6.9% per annum) and 32.5 percent (2.4% per annum), respectively.

Buffalo and cattle are primary sources of organic fertilizer and major instruments of household savings. Animal sales still constitute the major source of cash income for emergencies and on-farm investments. Small animals (pigs and poultry) are raised by farm households, and with fish constitute the main sources of protein for human nutrition in rural areas.

Livestock production has grown rapidly since the pronouncement of the New Economic Mechanism in 1986, averaging more than 4% annually, well above the rate for crops. Livestock and fisheries contribute substantially to unofficial exports, and represent the main source of cash income and rural assets for most farm households. However, these activities receive only 3–5% of the local resource component of the Ministry of Agriculture and Forestry.

Fish is a major source of protein and accounts for 40 % the total protein intake. Fish farming in Laos is characterized by low density without feeding to semi-expensive farming with small amount of feeding (MAF, 2014). Despite support systems like hatcheries and fish stations, fish mortality rates are high. The major constraints are lack of technical support and consistent support systems for fish breeding.

Major constraints to increasing livestock and fish productivity include (i) low quality natural forage and fodder; (ii) inadequate coverage of animal health protection; (iii) low productivity of native species; (iv) remoteness of many upland villages, which limits marketing options; (v) marketing issues including poor market intelligence and continuing official and unofficial tax burdens; and (vi) movement restrictions imposed by some provinces. Formal trade

is also hindered by excessive paperwork for licenses, letters of approval, and certificates—all of which usually require payments to be made at all levels, district and provincial.

The National Growth and Poverty Eradication Strategy (2004) recognized the importance of livestock to poverty reduction, particularly in upland and sloping land areas. The problems of livestock diseases are also recognized, but with little reference to livestock nutrition or forage development.

Despite its importance, this economic sector is still underdeveloped. As mentioned earlier, the majority of livestock products are produced by smallholder farmers (Wilson, 2007). Many rural households with livestock are currently best considered to be “livestock keepers” rather than “livestock producers”, using their livestock as cash reserves and for ceremonial needs (Millar and Phoutakhoun, 2008; Wilson, 2007). The transformation of livestock keepers into more specialized producers requires improved farmer knowledge and practices in livestock husbandry and disease prevention, as well as the formation of farmer groups for marketing of animal products, which can lead to improvements in productivity, increased smallholder household incomes and reduced rural poverty (Windsor, 2011). However, providing effective interventions requires a better understanding of current livestock production, in order to manage the many health and husbandry constraints that compromise smallholder livestock productivity (Nampanya et al., 2010; Windsor et al., 2008)

Chapter IV

STATE OF NATURAL RESOURCES

The four areas of national resource management that are of concern with respect to Laos PDR are forests, land and water management, mining management and hydropower production.

4.1 Water: Water resources in the Lao PDR have regional significance, particularly since more than 35% of the total Mekong River flow is generated in the country's watersheds. There are 12 major river basins in the Lao PDR, including the Nam Ngum River Basin. About 80% of the country's area lies within Mekong River Basin. Total irrigated areas are 315000 ha in rainy season and 215000 ha in the dry season with an increase of 5000 ha per year. The average annual rainfall of Laos is around 1850 mm and the rainfall distribution pattern is shown in Figure.

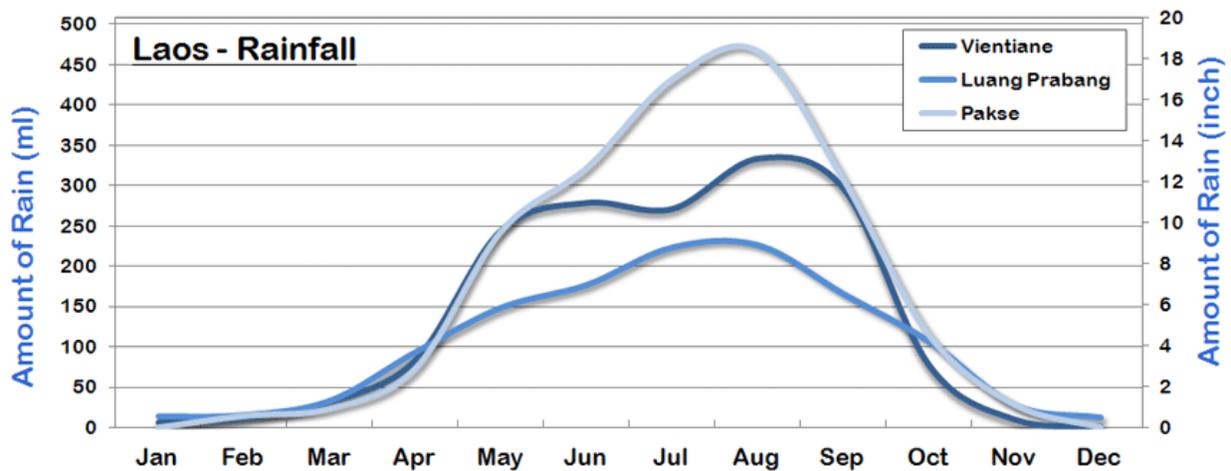


Fig. 3 Rainfall distribution pattern in Laos PDR

4.2 Forests: In 1940, Lao's forest cover was estimated to be around 70% whereas in 2002 the forest cover was estimated to be down to 41% and further to 40% in 2010. The national goal as set in the National Socio-Economic Development Plan (NSED) and the Forestry Strategy is to increase forest cover to 65% of the total country's area by 2015, and to 70% by 2020. Shifting cultivation is a dominant agricultural system for upland communities in Lao PDR but there are a lot of misperceptions related to it. It is estimated that up to 25% of Lao population is engaged in shifting cultivation, and the share could be even higher. Lacombe et.al (2015) suggested that, in Laos, the combination of shifting cultivation system (alternation of rice and fallow) and the gradual increase of teak tree plantations replacing fallow, led to intricate flow patterns: pluri-annual flow cycles induced by the shifting system, on top of a gradual flow increase over years caused by the spread of the plantation.

Lao PDR continues to rely heavily on its forests to support national development. However, an estimated 91 200 hectares of forest have been lost every year since the early 1990s. To make up for their loss, the government is regenerating and reforesting with the aim of ensuring 65%

forest coverage between 2011 and 2015. The aim is to make Lao PDR a greener country and, by 2015, to classify 60% of the country's forests by type, certify 10% of total forest product, strengthen forest management, and support action to mitigate climate change.

The government is also actively encouraging people to get involved in reforestation and tree-planting activities. The private sector has steadily shifted its activities toward wood-processing and is planting commercial trees such as eucalyptus, teak, agar wood and rubber. As a result, deforestation and illegal logging activities have decreased, supported by the laws and regulations that the government has introduced to prevent deforestation. To maximise the effect of its policies, it continuously monitors the progress and evaluates the impact of its law enforcement efforts. It has also drawn up a classified land management plan at macro level (country, province and district) and micro level (village and kumban, or cluster of villages). The purpose is to maximise the benefits of land usage in the country, improve farmers' livelihoods, and sustain natural resources. There are also plans to hand over land management responsibility to organizations and individuals. At the same time, Lao PDR is seeking to increase land revenues collected from tax, rent, transactions and ownership transfer fees so that they account for 15% of national income per year (ADB, 2012). Capacity building initiatives and sensitization programs for the rural folk, people's representatives and government officials on natural resources management with focus on climate change adaptation and green-house-gas reduction strategies are essentially required.

Subsistence agriculture still accounts for nearly half of the gross domestic product and provides 80% of the employment as 69% of the population still live in rural areas. Nevertheless, low lands suitable for agriculture are relatively scarce in Laos (no more than 13% of the watershed, compared with 72% in Cambodia and 65% in Thailand) and without modern techniques and appropriate soil preparation, Laos' arable land is mostly suitable for rice cultivation. As a consequence, cropping still follows the natural supply of rain, being at its peak during the monsoon season and declining to less than 10% in the dry season. Food security is still heavily dependent on water supply. Improvements in health, water supply and sanitation, as well as some irrigation development, are responsible for the substantial reduction in rice shortages in most of the lowland cultivated areas of Laos. Rice pads also provide fish which is the other important protein source in rural Laos (Nessbitt, 2004).

4.3 Land and Land Use Pattern: Laos is the only landlocked country in Southeast Asia, and it lies mostly between latitudes 14° and 23°N (a small area is south of 14°), and longitudes 100° and 108°E. Its thickly forested landscape consists mostly of rugged mountains, the highest of which is Phou Bia at 2,818 metres (9,245 ft), with some plains and plateaus. At least 5 million hectares of Laos's total land area of 23,680,000 hectares are suitable for cultivation (about 21 percent). 17 percent of this land area (between 850,000 and 900,000 hectares) is actually cultivated, less than 4 percent of the total area. The average land holding is 1.62 hectares with 27 percent of households having 2 hectares or more and 36 percent having less than 1 hectare. An impressive 97 percent of farmers own their own land. About 93 percent of the area devoted to rice production is for the production of sticky rice, a subsistence crop used primarily for home consumption. Tree farming is another important part of Lao agricultural life. About 23 percent of such farms have mango trees, 17 percent coconut trees, 17 percent banana trees, 11 percent jackfruit trees, and 11 percent tamarind trees.

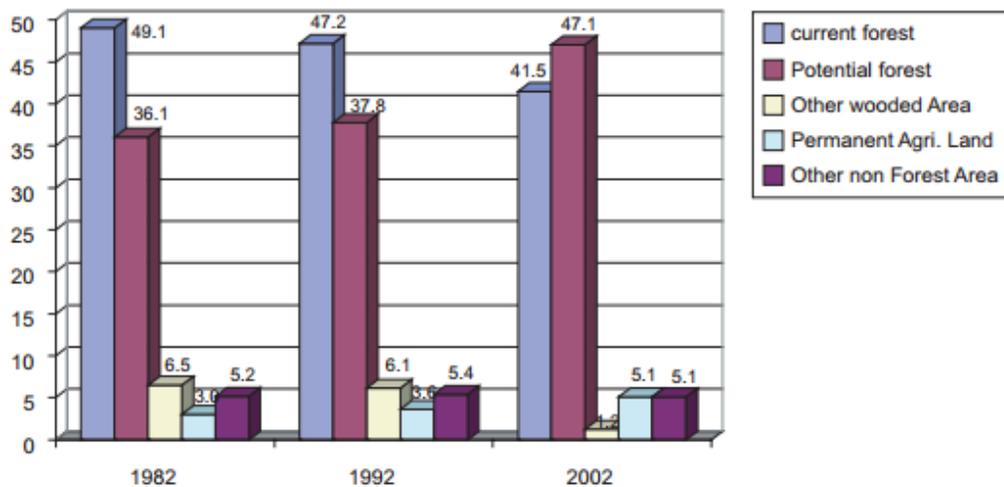


Fig. 4 Changes in Forest and Land use (1982-2002)

Chapter V

STATUS AND CHALLENGES IN AGRICULTURAL AND RURAL SECTORS

Agriculture in Laos has grown at a robust 4.7 percent annually averaged over the past decade. Growth has been fueled in large part by an expansion of land under cultivation (1.9 percent per

year) and agricultural labor, and there are few immediate limits to this continuing (MAF, 2014). Moreover, measures of productivity are improving, based on increases from low levels of such inputs as improved seeds and fertilizers, but are substantially short of levels being achieved elsewhere, providing substantial scope for catch-up growth.

Some critics, however, argue that broad intensification strategies such as those now pursued by the Government of Laos ignore the structural factors and distributional issues that determine food security and rural poverty more than food production and, and that modernization of agriculture and integration of farming into markets can be impoverishing rather than empowering (Wittman et al. 2010). Scholars of agrarian change have also contested the way farm households are portrayed simply as a means and/or unit of agricultural production in the current discourse on sustainable intensification (Holt-Gimenez and Altieri 2013) and thus urged to position food production as an integral part of agrarian change processes embedded in the wider agrarian context.

Current discussion on sustainable intensification positions agricultural production as a starting point to ensure food security and reduce poverty. While such positioning reveals the importance of new technology (OECD, 2006) and to a certain extent the fundamental role of the agro-ecological system in shaping farming objectives and strategies (Sackloham and Baudran 2005), it tends to also homogenize farmers as a group and gives them the appearance of passive recipients. For example, while analysis of technological change has shed light on how farmers' decisions to adopt new technology are often determined by farm plots, agro-ecological environment, access to market, as well as policy and institutional set up (Feder and Umali 1993; Yesuf and Kohlin 2008), current discussion on sustainable intensification seems to overlook the difference in farming households' characteristics and the fact that some farmers are better off economically and/or better equipped (e.g., labor availability, access to land) to expand and/or intensify their farming practices than others. Hence more integrated and holistic approach should be sought for agricultural and rural development programs ensuring equity, partnership and participation. Emphasis should be given to areas such as supply and value chain management, agribusiness management, value addition and storage, equitable distribution, rural markets, food safety and standards, potable water allocation, pollution and environment management etc.

Along with the above mentioned points, some of the issues and constraints with respect to agriculture, environment, rural development and natural resources management are discussed below:

5.1 Rural Poverty: As most recently measured (2003), about 4.25 million people lived in rural areas, with about 38 percent living below the poverty line, still high, but a dramatic improvement from 52 percent a decade earlier. Over this decade, more of the progress in rural poverty reduction occurred in the first half, but then slowing such that only one-third of the total reduction occurred in the last half. This slowing of poverty reduction is correlated with a slowing of agricultural growth and focused effort needed for reinvigorating broad-based agricultural sector growth.

5.2 Food Security: Despite steady economic growth in the past decade, food insecurity remains widespread throughout the country and alarmingly high in rural areas. Nearly every second child under five years of age in Laos is chronically malnourished (stunted). Ethnic groups living in remote areas and rural children are particularly vulnerable. Assisting rural producers manage risks involved with greater market orientation will be important, and food security concerns will remain an important factor in household decision making. Government can facilitate by continuing to prioritize rural road investments, by recognizing that household relocation can reduce traditional risk management options, and by focusing on national integration of rice markets which will improve food security and enable farming households to accelerate shifts to higher valued crops.

5.3 Agricultural Production and Productivity: Agricultural productivity in Laos is relatively low, including a limited competitiveness agriculture on regional and global markets for the major unprocessed crops (MAF, 2014). Farming remains centered on subsistence agriculture with rice as main crops occupying almost 68% of the total cultivated area. The input use in rice cultivation is very low. The productivity of rice is lower than the regional and global averages. Other seasonal and annual crops occupy 9 and 8 % respectively. Only 28% of the households used fertilizers in 2005, and almost one third of households used any form of mechanization (MAF, 2014). The low intensity and low productivity of agriculture in Laos is mainly due to factors such as- (i) Risk aversion livelihood strategies of rural households; (ii) Limited input suppliers; (iii) Lack of information concerning input use due to lack of viable agricultural extension services; (iv) inadequate working capital and access to rural/agricultural credit facilities; (v) Limited access to markets and poorly developed supply chains; and (vi) Limited access to modern farming practices and technologies.

5.4 Shifting cultivation: Shifting cultivation has been a traditionally dominant land use system in the uplands of the Lao PDR, particularly in the northern mountainous region. Upland mountainous areas lack facilities and infrastructure required for development. Isolated villages often do not have roads, and when they do, roads are impassable during the wet season. The Government's policy directions and strategies to address shifting cultivation have evolved over time. These have generated effects that need to be considered in the context of ADB's current and future assistance for upland agriculture. Estimates of shifting cultivation areas vary. In the last two decades, increased population pressure and the effects of government policies to curb shifting cultivation have shortened fallow periods from 10–20 years to 3–7 years. Shortened fallow reduces time for vegetative regeneration. This has led to increased soil erosion, reduced secondary forests and biodiversity, and reduced soil fertility. However, in recent years, the Government viewed shifting cultivation as unsustainable, and intended to stabilize it by making agriculture more sedentary through (i) promoting crop diversification on sloping lands, (ii) developing market access to communities through feeder road development and market information delivery, (iii) promoting land use zoning based on land capability and slope, (iv) promoting rural savings and credit provision for alternative livelihoods, and (v) implementing land use planning and land allocation.

5.5 Water Management: In the late 1990s, the Lao PDR enacted a watershed and water resources management law (Water Law) and prepared a national water sector profile, a water sector strategy, and an action plan. The Integrated Water Resources Management (IWRM) concept adopted by the Laos Government seeks to ensure that the water resources of a river basin are managed effectively and efficiently. While the IWRM concept is intended to reinforce links and synergies between water, land use, environment, and development, in practice it is complex and require more emphasis on capacity building of stakeholders and participatory management practices. The IWRM concept involves a number of agencies, often with competing or conflicting interests, and also cuts across administrative boundaries, and therefore emphasis the need for integrated and holistic training, planning and implementation.

5.6 Agricultural marketing and Supply chain: The small rice market and the poor marketing infrastructure have resulted in a lack of integration of the domestic rice market in the country. The situation is similar to most of the other agricultural commodities. Accordingly, prices of agricultural and food products across provinces vary widely. The price differences across provinces in most cases cannot be explained solely on the basis of marketing costs, indicating that

the farm markets in the Lao PDR are segmented spatially. Local demand and supply situations seem to determine price formations, with traders not being able to take advantage of the possibility of arbitrage. Marketing of agricultural products is generally not yet general across rural households, with about half of farming families selling livestock in a given year, and below a third of households selling rice, outside of households in the Vientiane Plain. In upland areas, non-timber forest products are generally a more important source of cash income for rural families than any cultivated crop or livestock. Currently, international trade in rice and most of the other agricultural produces are limited and takes place mainly across the border towns in PRC, Viet Nam, and Thailand, though concerted efforts by the government and extension agencies have made some significant advancements in exports. Support for integration of markets, both domestic and external, can facilitate growth and help all Provinces participate in economic growth. In view of the vast export market for the local commodities and organic agricultural produces, sensitization programmes to the farmers and departmental officers have to be organized, especially on international trade, phytosanitation requirements, food-safety etc.

5.7 Farm Mechanization: Buffalo and cattle are now rarely used for draft animals in lowland areas as they have been replaced with small tractors. More advanced farm implements are now being used, though in small numbers. A significant aspect of agricultural transformation experienced in Lao PDR over the past decade has been the increasing mechanization of farm operations. This has mostly been a case of selective mechanization, characterized by increased adoption of four-wheeled or two-wheeled tractors and use of water pumps and farm processing machinery, as well as other small farm equipment. The proportion of farm households in the country using two wheeled tractors increased three-fold, from 20 percent (1998/99) to 61 percent (2010/11). Ownership of a two-wheeled tractor increased almost five-fold, from 7 percent to 34 percent (FAO, 2014). There is a scope of developing/introducing customized machineries for upland agriculture and for different types of farming systems. Organizing trainings and demonstrations on advanced farm implements suitable for the land topography and high-tech farming techniques occupies a vital role in reshaping the future of modern agriculture in Laos.

5.8 Cropping systems: Traditional cropping systems are generally practiced in Laos. There is a scope for upgrading the farming systems to modern ones like integrated cropping systems, high density cropping systems, System of Rice Intensification (SRI), High-tech farming, Poly-house/Greenhouse technology for high-value crops etc. The System of Rice Intensification, known as

SRI is a climate-smart, agro-ecological methodology for increasing the productivity of rice and more recently other crops by changing the management of plants, soil, water and nutrients. The major components and partners of Mekong SRI project implemented by the Asian Center of Innovation for Sustainable Agriculture Intensification (ACISAI) under the Global Program on Agricultural Research for Development of Asian Institute of Technology (AIT), Bangkok is depicted in Figure.5.

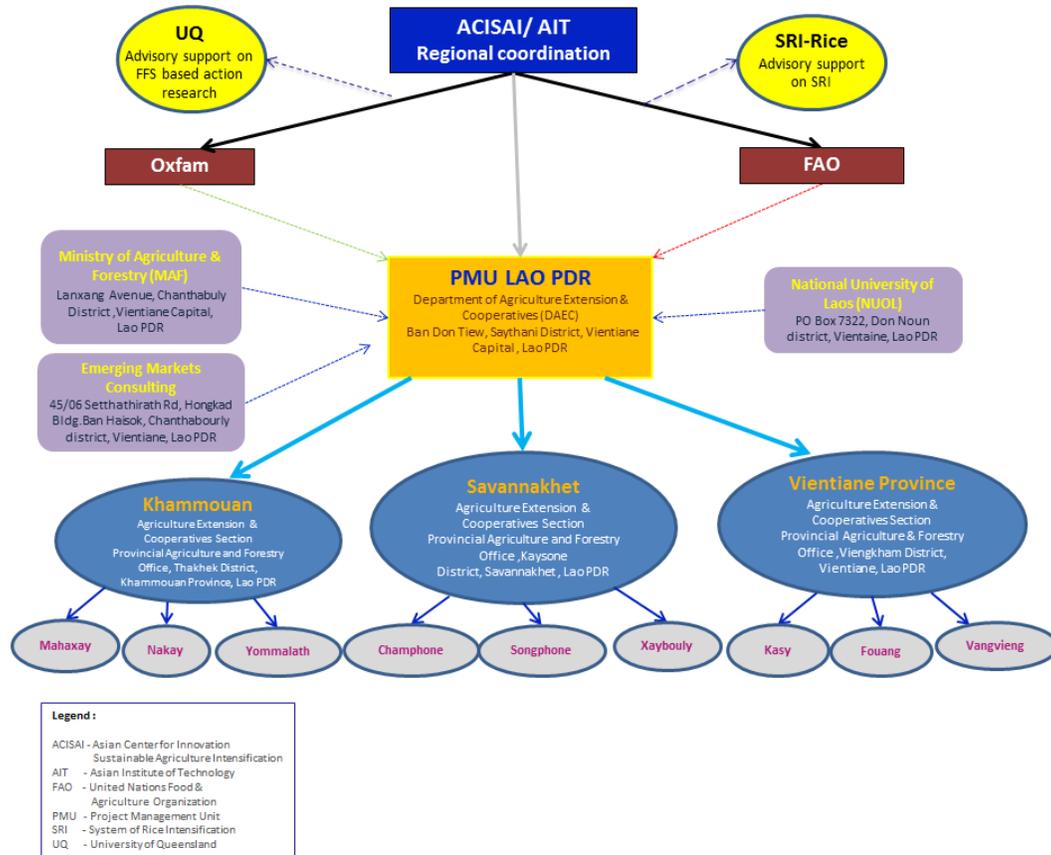


Fig.5 Major components and partners of Mekong SRI project

5.9 Topography: The Lowland and upland agriculture are likely to respond differently. The lowland areas hold the most promise for the intensification, diversification and commercialization of agricultural production. The improvement in rice production and diversification into other crops in lowland areas, require a structural shift towards market-oriented production and a leading role for the private sector, with limits to government policy or investment initiatives leading further gains. While uplands areas are not yet as important as lowland areas, and pose special challenges, for delivering significant gains in agricultural growth, these areas are nevertheless important in the

long term as suitable land becomes scarcer and lowland opportunities more fully exploited. It would be beneficial for Government to invest in further development of the adaptive research and appropriate extension in support of upland agriculture development, and building the capacity to adapt approaches to the biophysical and socio-cultural diversity of upland systems. Further, upland households' management of risks related to ensuring food security, in the face of remoteness and difficult market access, is an impediment to agricultural diversification and productivity innovations, and puts a premium on public rural transport programs.

Laos has the potential for continued the high rates of agricultural growth that are key to continued reduction of rural poverty, and aiming for a 5-6 percent annual rate for the coming decade is reasonable. Achieving this will involve transitioning from past reliance on extensive growth to a future that will depend more on intensive sources of growth. Extensive growth, through the expansion of area and absorption of additional agricultural workers, is likely to continue, albeit at a slower pace. But this alone will not be adequate: it will not achieve the productivity gains upon which improvements in household welfare will be realized, and it will face gradually tightening environmental management constraints as agriculture encroaches on forest resources. Laos has considerable potential for agricultural intensification through catching up technologically, achieving higher farm yields, improving incentives for diversification, and through regional specialization. Intensification prospects are initially better in lowland areas, and managing and moderating disparities that risk emerging if uplands lag will be a particular challenge. The interdependence between the natural environment, agricultural production potential and rural poverty within the specific agro-ecological climates of Laos to be considered while chalking out capacity building initiatives and assessing the needs for training programs at different sectors.

Chapter VI

OVERVIEW OF AGRICULTURAL EXTENSION AND RESEARCH SYSTEM

Much of the extension services in Laos PDR were provided by research organizations, extension departments and local agencies, particularly the provincial agriculture and forestry offices and the district agriculture and forestry offices. Several local and international nongovernment grassroots organizations also played important roles in the dissemination of rice technologies, for example, World Vision, the Menonite Central Committee, and Cooperation Internationale pour le Développement et la Solidarité. Furthermore, Lao farmers have a strong tradition of seed exchange among neighbors, across regions, and across the border. The National Agriculture and Forestry

Extension Services (NAFES) established in 2001 has been now emerged as the pioneer agency in agricultural extension in Laos PDR. Since its establishment, NAFES has coordinated the extension services of the country and extension service centers have been set up in parallel to the research organizations. Following the reorganization of extension services in June 2005, the new arrangement for extension comprises two systems: (i) the government extension system, and (ii) village extension (NAFES, 2005). The Government Extension Service consists of three strata: (i) NAFES, (ii) the provincial agriculture and forestry extension center, and (iii) the district agriculture and forestry extension office (DAFEO). The link between research and extension is illustrated in Figure 6. Once new technologies are successfully introduced, the main responsibility for spreading the technology throughout the villages lies with DAFEO in cooperation with the village extension workers.

Many national government agencies and international research and development agencies, including the Food and Agriculture Organization of the United Nations (FAO), United Nations Development Programme (UNDP), World Food Programme (WFP), World Bank (WB), Asian Development Bank (ADB), National Economic Research Institute (NERI) and the International Rice Research Institute (IRRI) have been undertaken research projects in Laos in the areas of agriculture, natural resources management, environment, live-stock, fisheries and rural development. Systematic rice research in the country was established in 1990 and the developed Considerable agronomic research was also conducted for improving rice crop management. The National Economic Research Institute (NERI) was established in 1997 in Laos as a strategic research institute under the supervision of the Committee for Planning and Investment (CPI). CPI has recently become the Ministry of Planning and Investment (MPI). As a think-tank of the Ministry of Planning and Investment, NERI's main functions are to formulate the long-term provincial, regional, and national socio-economic development strategy, to research, analyze and monitor. Another national institute, National Agriculture and Forestry Research Institute (NAFRI) of Laos was established in 1999 in order to consolidate agriculture and forestry research activities within the country and develop a coordinated National Agriculture and Forestry Research System. Apart from these institutes, CG institutions like IRRI and ILRI have their regional centers operating in Laos.

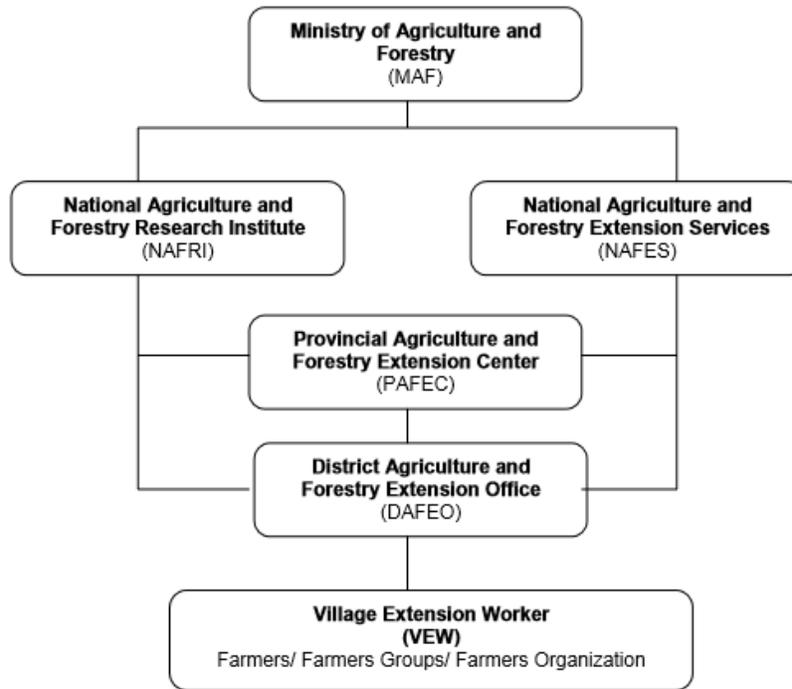


Fig.6. Research and Extension in Laos PDR- Institutional mechanism

Agricultural research and extension systems require further institutional development. There is a need to continue to invest in capacity development for agricultural researchers. Agricultural research and its associated agencies are still not routinely and sufficiently funded to meet the challenges facing them. Although an important milestone has been achieved with the establishment of NAFES, the extension system needs further capacity development, with more effective links among research, district-level organizations, and grassroots agents for extension to be an effective conduit for disseminating agricultural technologies.

Chapter VII

PUBLIC AND PRIVATE INSTITUTIONS AND THEIR RELEVANCE IN AGRICULTURAL DEVELOPMENT

The Ministry of Agriculture and Forestry (MAF) operates its agricultural research program through the National Agriculture and Forestry Research Institute (NAFRI) and its extension program through the National Agriculture and Forestry Extension Services (NAFES). Both NAFRI and NAFES have active and long-term collaboration with a number of international

institutes. NAFRI and IRRI have collaborated on rice research since 1990. The Lao-IRRI Rice Research and Training Project (LIRRTP), funded by the Swiss Agency for Development Cooperation (SDC), established the foundation of rice research in the country. The Australian Centre for International Agricultural Research and other international organizations have also contributed to rice research in the country. In 2004, ADB provided funds to support rice research targeted on less favorable rain-fed areas, and the Lao PDR was chosen as one of the key sites (ADB, 2004) The Helvetas/SDC-funded Lao Extension for Agriculture Project contributes to the institutional development of NAFES. In addition to this, several other international and local organizations work closely with NAFES (NAFES, 2005). Asian Center of Innovation for Sustainable Agriculture Intensification (ACISAI), which is an arm of the Asian Institute of Technology (AIT) has taken up a mega project on research and popularization of SRI method of rice cultivation with many governmental and non-governmental partners in the region (Fig.5)

Both national/international governmental, private, non-governmental agencies have been carrying out research and development programs in the country since a few decades and as a result of their concerted efforts, technologies consisting of improved varieties and complementary crop management practices were developed and transferred to the farmers. However, still there exists a huge scope for further research, development and extension programs in the country to achieve the strategic goals of sustainable agriculture production and poverty alleviation. All stake holders, from policy makers to rural farm folks to be sensitized on modern agricultural technologies, environmental issues, conservation practices, climate change adaptation models and their capacities in specific areas to be developed through training programs.

The country, with external assistance, has invested to improve its research and extension capacity. Although research capacity and human resource skills need to be developed further, the need for skilled extension staff is perhaps even greater, considering that extension organizations have been established only a decade back. Reducing the current gap between research and extension has been identified as an area that is likely to have a high return. Bottom-up and participatory approaches to rural development are increasingly promoted in the Lao PDR. The government sees the district level line agencies such as DAFEO (Fig.6) as the main agencies for implementing agricultural extension programs. Improvements in their capacity are needed for them to be effective change agents for rural development.

Most agricultural value chains also face common constraints of poor physical infrastructure which affects transport access and costs, the weak regulatory frameworks and enforcement of contracts, limited capacity of extension and technical assistance services, poor access to and high costs of formal financial services, limited distribution networks for commercial provision of inputs, low technical levels of farm management, limited ability to contain risks of both flooding and drought, and sometimes disruptive government intervention in market. The most damaging outcome of these cross-cutting issues is a generalized under-investment in production and processing by the private sector. The unfavorable business environment in rural areas leaves Laos with underdeveloped value chains beyond the farm level, leaving Lao farmers with fewer market options, and the Lao economy with limited capacity for domestic transformation and value added of the primary commodities that it produces.

Further integration of domestic markets is vital for agricultural development. Development of the rural road network and its connection to the national transport system will be strengthened by Government interventions along the lines of the rural transport infrastructure policy currently being finalized. Assessment would also be timely of the need for a further reduction in policy interventions in markets, often initiated by sub-national governments through market monopoly arrangements with the State Food Enterprise. Regards external markets, opportunities continue to grow, and with tariffs already low, policy attention is rightly turning to non-tariff constraints such as sanitary and phyto-sanitary (SPS) regulation. The SPS action plan currently under development can assist with priority setting and capacity building in SPS management so as to focus on identifying and addressing constraints for the commodity value chains most sensitive to SPS requirements of external markets, where private players have a lead role.

Chapter VIII

PRESENT CAPACITY BUILDING PROGRAMMES AND POTENTIAL AREAS

8.1 Current Capacity Building Programmes: Presently provincial staff subject matter specialists and district staff are retrained as generalists and called farming systems extension workers. The village extension system is jointly managed by villagers and village authorities. Activities are facilitated by village extension workers who are appointed and compensated by the community, while receiving technical support through the government service. The village extension system involves a cycle of activities that starts with a training needs assessment. The extension workers

from DAFEEO have the primary responsibility as generalists to regularly interact with local communities, farmers, and village extension workers, and to understand their needs (Refer: Fig.4). However, the cascade model, with training of trainers at the provincial level to train officers in the districts, who in turn would work with the farmers, has not proved viable. Training of district extension officers to work directly with the farmers was more successful. Study of National Agriculture Manpower and National Extension Service (MAF, 1989) recommended setting up an internal Ministry of Agriculture and Forestry (MAF) body to continue restructuring work, creating a national extension service based directly on the training and visit (T&V) model, and establishment of a single training division. National Integrated Extension and Research Program of MAF designed an integrated extension and research program within the existing MAF structure with the province as the functional technical unit that is responsible for services like providing agricultural services, training subject matter specialists, among other features. It also incorporated the then- National Agriculture Research Centre (NARC) within the extension system under the Department of Agriculture and Extension (DAE).

A few initiatives, from the MAF as well as from other Governmental and Non-Governmental agencies are listed below:

The Lao-IRRI Rice Research and Training Project (LIR RTP), funded by the Swiss Agency for Development Cooperation (SDC), established the foundation of rice research in the country and conducted extensive training programmes in the area of rice production and management practices. Project on 'Institutional Development and Strengthening of the Ministry of Agriculture and Forestry' (1995) developed numerous training manuals and reports on baseline agro-ecological information, geographic information system (GIS) database development, and overall human resource development for MAF. With capacity development efforts, including training, during the implementation of the Community-Managed Irrigation Sector Project (CMISP), Water Use Associations (WUA) were established (ADB, 1996). Two local development centers were established by the Shifting Cultivation Stabilization Pilot Project (SCSPP), one in each subproject area, to provide assistance to villages in connection with the preparation and implementation of (i) village development plans, (ii) on-farm trials and demonstration, (iii) provision of extension services, (iv) training of farmers, and (v) monitoring and progress reporting on the implementation of the village development plans (ADB, 1999). The ADB-financed Smallholder Development Project (SDP) reported that it has developed successful farmer-to-farmer training models. Detailed

training recommendations were made subsequently for extension (including establishment of a national extension center) and training including an action plan. The SDP provided agribusiness support and training to about 30 agribusiness investors. Training and capacity building were also provided to farmers, staff of district agriculture and forestry extension offices (DAFEOs) and business people.

The ‘Vegetable Research Network in Cambodia, Lao PDR, and Viet Nam’ provided training on vegetable seed multiplication for farmers to produce good quality seeds locally. Training programs for research and extension specialists were also organized. Many training programs were conducted under ‘Farmer Irrigated Agricultural Training Project’ during the period 1994–2000. Under the ADB scheme ‘Livelihoods of Upland Farmers Using Participatory Approaches to Develop More Efficient Livestock Systems’, trainings were organized for provincial and district staff on the extension methods (ADB, 2005).

8.2 Challenges and Potential Areas: The key challenges for Government to improve its capacity to maintain high rates of agricultural growth combined with good distribution of this growth are:

- *Improving farmer productivity* – build knowledge to enable distinguishing upland swidden systems, and to assist calibration of Government policies on swidden agriculture transformation consistent with promotion of sustainable intensification.
- *Linking farmers to markets* – rural road development on the basis of the national strategy being finalized, risk management for upland households through adequate access to forests as a buffer, improved market information for farmers, encouragement of competition in domestic trade in farm products, and facilitation of contract farming.
- *Capturing value added opportunities* – partnering with the private sector to identify and address the main constraints in the rural investment climate facing agro-industry, but also developing and implementing adequate social and environmental safeguards to integrate as criteria in assessing commercial agriculture investments proposals.
- *Strengthening public expenditure performance* – integration of donor resources into the national budget, improvement of central authorities’ information on sub-national governments’ agricultural expenditures, adequate recurrent expenditure budgeting, control of arrears in the investment program, and greater efficiency in irrigation investment to permit resource reallocation to provision of public service provision including adaptive agricultural research and extension.

At a farm level, economic returns are the single most important attributes that drive farmers to adopt agricultural technologies. By analyzing the status of agriculture and natural resources in Laos PDR, a few strategic priorities are as follows:

(i) strengthening the social and environmental management of infrastructure developments, (ii) supporting community-based initiatives to better protect the environment, (iii) supporting activities to improve upland agricultural systems, and (iv) developing management capacity for sustainable river basin development, (v) develop and modernize social and economic infrastructure in order to facilitate economic development in each region of the country and to accelerate the Lao PDR's regional and international economic integration; (vi) promote industries utilizing domestic natural resources, and actively promote small and medium enterprises (SMEs), (vii) develop and promote all economic sectors, particularly the private sector, including FDI, in order to expand business opportunities, (viii) enhance market linkages and trade facilitation, (ix) strengthen existing legal and regulatory frameworks; and (x) promote economic cooperation with all partners and countries (ADB, 2005). The most important pre-requisite for achieving all these priorities is sensitizing different players in the policymaker –implementation agency- farmer pyramid and build the capacity among them by organizing need-based training programs.

Lao PDR's long-term development agenda is based on its gradual transformation from a closed and centrally planned economy to an open, private sector-led economy. The current development strategy aims to support sustainable economic growth and reduce poverty and inequality. Lao PDR has to contend with some important areas, where capacity building in relevant areas assumes a vital role. The identified areas include:

- Increase of educated and skilled human resources to accelerate farm-sector growth and economic diversification.
- Agri-Business management, Rural markets, Cold-chains, Agricultural value and supply chain management.
- Poor nutrition and food insecurity that lead to low worker productivity, coupled with food safety and safe drinking water.
- Research and development institutions for developing advanced agricultural and veterinary technologies integrated with transfer- of technology units.
- Livelihood improvement programs based on integrated watershed management and participatory resource generation/conservation concept.

- Topics encompass irrigation, uplands development, agribusiness/market deepening and livestock, microfinance and biodiversity conservation

Chapter IX

TRAINING PRIORITIES IN AGRICULTURE AND ALLIED SECTORS

As a country, Laos PDR has made important progress on the technological and institutional fronts. Nevertheless, the country continues to face challenges in developing a dynamic, stable, and market-responsive agriculture that meets the dual goals of achieving household food security and income growth. Thus, there is a need to continue and accelerate productivity growth through the development and dissemination of improved technologies, maintenance and expansion of irrigation, and policy support for agricultural production. Improved crop varieties, animal breeds and management practices that produce stable yields even in the face of adverse conditions need to be continually made available to farmers. In uplands, suitable technologies and cropping options are needed, not only to improve farm productivity but also to conserve fragile resources. There is also an urgent need to improve the availability of high-quality seeds, improved breeds of crops

and animals to increase the productivity potential. Above all these, to achieve these challenging targets, the capacity of the stakeholders at all level has to be built. Organizing capacity building programs assumes great significance as it promotes new learnings, inter-regional and inter-country networking, and provide access to new research techniques. In this context, a training need analysis has been made targeting different categories of stakeholders- Practicing farmers, Rural Youth, Agri-Entrepreneurs and Extension functionaries, covering all sectors of agriculture, livestock, fisheries and other allied sectors, which is depicted as follows:

(Targeted category is given in bracket-**PF- Practicing Farmers; RY- Rural Youth; Extension Functionaries-EF; Agri-Entrepreneurs-AE**)

9.1 Agronomy and Cropping Systems:

- Modern Rice Production Technology (PF)
- SRI-System of Rice Intensification Method of Rice Cultivation (PF)
- Integrated Crop Management Methods in Maize (PF)
- Soybean Production and Processing Technology (PF, RY)
- Multi-Level High Intensity Cropping Systems for Uplands (PF, EF)
- Integrated Farming- Crop-Fodder-Animal-Poultry-Fisheries (PF, EF)
- Homestead Farming System Involving Tuber Crop s(PF, EF)
- Organic Farming (PF, EF)

9.2 Horticulture:

- Horticultural Nursery Management (PF, RY, AE)
- Protected Cultivation Techniques of Vegetables (PF, AE, EF)
- Coffee- Production, Processing, Value Addition and Food Safety (PF, EF)
- Advanced Training on Rubber Cultivation and Rubber Plantation Management (PF, EF)
- Rubber Processing and Quality Improvement (PF, AE)
- Cardamom Production Technology (PF)

9.3 Farm Mechanization:

- Farm Machineries for Small and Marginal Farmers (PF, EF)
- Mechanization in Rice- Paddy Seeder, Transplanter, Cono-weeder, Sprayers, Vertical Conveyor Reapers (VCR), Combine Harvesters, Threshes, etc. (PF)

- Sprayers & Dusters and Precautions while Pesticide Application- Theory and Practice (PF, EF)
- Machineries for Hill Agriculture (PF, EF)
- Operation and Maintenance of Upland Agro-Machineries (PF, RY)
- Modern Dryers for Horticultural Produces (PF, RY)

9.4 High- Tech Agriculture/Horticulture:

- Green-House/ Poly-House Technology (PF, RY, AE)
- Floriculture and Raising of High-Value Crops in Controlled Atmosphere (PF, EF, AE)
- Soil-Less Agriculture and Nutrient Film Technology for High-Value Crops/Flowers/Orchids (PF, EF, AE)
- Precision Farming Techniques (PF, EF, AE)

9.5 Income Generation from Agricultural and Allied Activities:

- Bee Keeping: Production Processing and Marketing (RY, PF)
- Mushroom Production and Management (RY)
- Farm Tourism (PF, EF, AE)

9.6 Post-Harvest Technology and Management:

- Value Addition of Horticultural Produces (AE)
- Post-Harvest Machineries and Equipment for Small-Scale Processing Units (AE, PF)
- Newer Trends in Processing of Rice, Coarse Grains and Pulses (AE, PF)
- Value Added Products from Cassava and Other Tuber Crops (AE, PF)

9.7 Natural Resources and Environment Management:

- Soil and Water Conservation (PF, EF)
- Strategies for Combating Shifting (Swidden) Cultivation (PF, EF)
- Watershed Management and Livelihood Improvement (PF, EF)
- Climate Change Adaptation and Green-House-Gas(GHG) Reduction Strategies (EF)

- Farm Management Using Remote Sensing/GIS/GPS Tools (EF)
- Management of Forests and Forest products (PF, RY, EF)

9.8 Irrigation and Water Management:

- Micro-Irrigation Techniques (PF)
- Drip Irrigation for Horticultural Crops (PF)
- Increasing Water Productivity and Use efficiency (PF, EF)
- Participatory Water Management through Water Use Associations (WUA) (PF, EF)

9.9 Animal Husbandry and Livestock Management:

- Improving Livelihoods of Upland Farmers by Developing Efficient Livestock Systems (PF, EF)
- Transboundary Animal Disease Control (PF, EF)
- Participatory Livestock Development (PF, EF)
- Developing Responsive to Emerging Challenges of Global and Regional Threats of Highly Infectious Diseases like Avian Influenza (PF, EF)
- Commercial Dairy Farming (PF, EF, AE, RY)
- Animal Nutrition and Fodder Cultivation Practices (PF, EF)
- Modern Technologies for Poultry and Hatchery Management (PF, EF, AE)

9.10. Food/Dairy Processing Technologies and Management:

- Phyto-sanitation Requirements, Food-Safety and Quality Control (AE, EF)
- Quality Assurance of Milk and Milk Products (AE, EF)
- Advanced Dairy Products and Low-Cost Machineries for Dairy Plant (AE)
- Milk and Milk Products Processing (AE, EF)
- Whey and Dairy Based Beverages (AE, EF)
- Cheese and Fermented Milk Products (AE, EF)
- Value Added Meat Products (AE, EF)
- Post-Harvest Technologies of Fresh Fruits and Vegetables for Commercial Trade (AE, EF)

9.11 Integrated Pest Management:

- Production Technology of Bio-Pesticides (PF, EF, RY)

- Bio-Control Agents- Opportunities and Production Methods (PF, EF)
- Integrated Pest and Disease Management in Nurseries (PF, RY)

9.12 Integrated Nutrient Management:

- Management of Soil Testing Laboratories (PF, EF)
- Production Technology of Bio-Fertilizers (PF, EF, AE)
- Soil Test based Nutrient Management (PF, EF)
- Production and Use of Vermi-compost (PF, EF, RY)

9.13 Fisheries:

- Fish Products Development and Value Addition Techniques (PF, EF)
- Advancement in Fisheries Technologies (PF, EF)
- Responsible Fishing and Hygienic Handling of Fish (PF, EF)
- Harvest and Post-Harvest Technologies for Inland Fisheries (PF, EF)
- Breeding and Hatchery Management of Freshwater Prawn/Fishes (PF, EF)
- Freshwater Pearl Culture (PF, EF, RY)
- Breeding and Culture of Ornamental Fish (PF, EF, RY)
- Aquatic Environmental Management in Freshwater Aquaculture (EF)
- Engineering Applications in Freshwater Aquaculture (PF, EF)
- Sewage-Fed Fish Culture (PF, EF)
- Peninsular Aquaculture and Cage Culture of Carps (PF, EF)
- Reservoir Fisheries Management (PF, EF)
- High Density Fish Culture-Practices and Possibilities (PF, EF)
- Fresh Water Fish Seed Production in Portable Carp Hatchery (PF, EF)

9.14 Renewable Energy Resources:

- Clean and Green Energy- Opportunities & Technologies (PF, EF)
- Tapping Solar Energy for Agricultural Uses (PF, EF)
- Wind Mill for Power Generation and Water Lifting (PF, EF)
- Biogas Plants from Farm Wastes (PF, EF)

9.15 Agri-Entrepreneurship Development:

- Agri-Business Incubation (AE, RY, EF)
- Entrepreneurship Development in Agri-Business Management (AE, EF)

- Protection of Intellectual Property and Farmer's Verities (PF, EF)
- Agri-Clinics and Agri-Business Centers (RY, AE)
- Entrepreneurship Development in Fisheries Based Eco-Tourism (AE, EF)
- Entrepreneurship Development in Mushroom Farming/Seed Production (RY)
- Rubber Products Development and Manufacture (AE)
- Avenues for Business Development in Food Processing Industry (AE, EF)
- Rural Innovation- Scouting, Validation and Refinement (EF)

9.16 Agricultural Marketing:

- Farm Markets- Operational and Logistic Issues (EF)
- Agricultural Supply Chain Management- Cooperative and Cluster Approach (EF, PF)
- Management of Agriculture Cooperatives (EF, PF)
- Good Practices and Institutional Innovations in Agricultural Marketing (EF, PF)
- International Trade (EF, AE)
- Marketing and Certification of Organic Agricultural Produces (PF, EF, AE)
- Commodity Trade and Export Management (EF, AE)

9.17 Information Technology in Agriculture:

- Agricultural Information Management (EF)
- ICT Application in Agricultural Extension (EF, PF)
- GIS/GPS based land use planning and crop/yield monitoring (EF, PF)
- Mobile (App) based farm advisory services (EF, PF)

9.18 Agricultural Extension Management:

- Capacity building of Women Self-Help-Groups (EF, RY)
- Leadership Development and Cluster Based Income Generation Groups in Rural Areas (EF, RY)
- Public Private Partnership in Agricultural Extension Management (EF,)

Chapter X

CONCLUSIONS

Lao PDR's resource-based economy – driven by forestry, agriculture, hydropower and minerals – is on a robust, impressive growth path. However, development is uneven and poverty consequently remains widespread. The government should adopt a sustainable, inclusive growth model so as to reduce poverty and implement sound, suitable strategies for natural resource management to ensure that the country's economic growth is environmentally sustainable.

Building capacities all stakeholders in the agricultural supply chain and all players in Government-departments (MAF)- farm gate pyramid is essential to ensure the effective implementation of the above said growth model. To make it happen efficiently, need-based training programmes to be designed and organized targeting different types of stakeholders. The stakeholders include practicing farmers, rural Youth, agri-entrepreneurs and extension functionaries.

In this context a training need analysis was conducted by taking into consideration of the land use and cropping pattern, demography, topography, geography, climate and other issues and constraints in agricultural, livestock and allied sectors. The burning issues like rural poverty, climate change, carbon footprint, land degradation, etc were also considered while designing the training programmes. The designed capacity building programs covers all sectors of agriculture, livestock, fisheries and other allied sectors. Due considerations were also given to areas like entrepreneurship development, agri-incubation, agricultural extension and transfer of technology. Topics encompass irrigation, uplands development, agri-marketing, microfinance, environmental protection, forestry and biodiversity conservation were also given due importance.

The designed training programmes are expected to be imparted to the targeted community considering the temporal and spatial variations in the cropping sequence and based on the agro-ecological peculiarities. While organizing the training programmes, it is also envisaged to give importance to hands-on exercises, method demonstrations and practical exposures based on the principle of ‘learning by doing’.

REFERENCES:

- Anonymous. 2014. STRUCTURAL POLICY COUNTRY NOTES Lao PDR. Economic Outlook for Southeast Asia, China and India 2014: Beyond the Middle-Income Trap, <http://dx.doi.org/10.1787/saeo-2014-en>.*
- Asian Development Bank (ADB). 1996. Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the Lao People’s Democratic Republic for the Community-Managed Irrigation Sector Project. Manila.*
- Asian Development Bank (ADB). 1999. Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the Lao People’s Democratic Republic for the Shifting Cultivation Stabilization Pilot Project. Manila.*
- Asian Development Bank (ADB). 2001. Participatory Poverty Assessment: Lao People’s Democratic Republic. Manila.*

- Asian Development Bank (ADB). 2004. Integrating and Mobilizing Rice Knowledge to Improve and Stabilize Crop Productivity to Achieve Household Food Security in Diverse and Less Favorable Rainfed Areas of Asia. TA No: 6136-REG. Manila.*
- Asian development Bank (ADB). 2005. Sector Assistance Program Evaluation for the Agriculture and Natural Resources Sector in the Lao People's Democratic Republic. Operations Evaluation Department Asian Development Bank, Manila.*
- Asian Development Bank (ADB).2005. Sector Assistance Program Evaluation for the Agriculture and Natural Resources Sector in the Lao People's Democratic Republic. Operations Evaluation Department Asian Development Bank.*
- Asian Development Bank (ADB). 2012. Key Indicators for Asia and Pacific 2012, Asian Development Bank, Manila.*
- B. Southavilay, T. Nanseki, S. Takeuchi. 2011. Analysis of maize supply chain in Northern Laos, Res. J. Int. Stud., 20 (2011), pp. 140–153*
- Bourdet, Y. 2000. Emerging Rice Market in Laos. Lund: University of Lund.*
- Castella J.C. & Lestrelin G. 2011. Accompanying the agro-ecological transition in Lao PDR: Opportunities and challenges for conservation agriculture in maize production areas, 5th World Congress of Conservation Agriculture Incorporating 3rd Farming Systems Design Conference, September 2011 Brisbane, Australia, <http://agroecologie.cirad.fr> (accessed 6 November 2013).*
- Douangsavanh, L. & Bouahom, B. 2006. Pathways out of poverty through maize and Job's Tears in Lao People's Democratic Republic, CAPSA Working Paper No. 92, Centre for Alleviation of Poverty through Secondary Crops' Development in Asia and the Pacific (CAPSA), United Nations Economic and Social Commission for Asia and the Pacific, 121 pp.*
- Eric Holt-Giménez & Miguel A. Altieri. 2013. Agroecology, Food Sovereignty, and the New Green Revolution, Agroecology and Sustainable Food Systems, 37:1, 90-102.*
- FAO, World Bank, and IRRI. 2012. Lao's people democratic republic rice policy study.*

- FAO. 2009. *LAO People's Democratic Republic Forestry Outlook Study. Asia-Pacific Forestry Sector Outlook Study Ii Working Paper Series. Food and Agriculture Organization Of The United Nations Regional Office For Asia And The Pacific Bangkok, 2009*
- FAO. 2014. *Lao Census of Agriculture 2010/11 Analysis of Selected Themes Vientiane, LAO October 2014. Food and Agriculture Organization.*
- Feder, G., and D. L. Umali. 1993. *The adoption of agricultural innovations: a review. Technological Forecasting and Social Change 43(3-4): 215219.*
- Government of Laos. 2004. *National Growth and Poverty Eradication Strategy.*
- Government of Laos. 2010a. *Laos' Seventh National Socio-Economic Development Plan (2011–2015).*
- Government of Laos. 2010b. *Strategy for agricultural development 2011–2020. Sector framework vision and goals: Agriculture and forestry for sustainable development, food, and income security. Ministry of agriculture and forestry: Final draft 15 Sep 2010.*
- J.M. Schiller, B. Linqvist, K. Douangsila, P. Inthapanya, B.D. Boupha, S. Inthavong, P. Sengxua Johnston, R.; Lacombe, G.; Hoanh, C. T.; Noble, A.; Pavelic, P.; Smakhtin, V.; Suhardiman, D.; Kam, S. P.; Choo, P. S. 2010. *Climate change, water and agriculture in the Greater Mekong Subregion. Colombo, Sri Lanka: International Water Management Institute. 60p. (IWMI Research Report 136). doi:10.5337/2010.212*
- Khounsy, S. & Conlan, J. 2008. *Classical swine fever and foot and mouth disease in Lao PDR. ACIAR Monograph no.128. In: Conlan, J.V., Blacksell, S.D., Morrissy, C.J. & Colling, A., eds., Management of classical swine fever and foot and mouth disease in Lao PDR, pp. 39-42. ACIAR Proceedings, Vientiane Capital, Lao PDR.*
- Kim Alexander. 2007. *Agricultural change in Lao PDR: Pragmatism in the face of adversity. Unpublished thesis report presented to Charles Sturt University in fulfillment of the thesis requirement for the degree of Doctor of Philosophy In Environmental Science, New South Wales, Australia.*
- Lacombe, G., Ribolzi, O., de Rouw, A., Pierret, A., Latsachak, K., Silvera, N., Pham Dinh, R., Orange, D., Janeau, J.-L., Soulileuth, B., Robain, H., Taccoen, A., Sengphaathith, P.,

- Mouche, E., Sengtaheuanghoung, O., Tran Duc, T., and Valentin, C. 2015. Afforestation by natural regeneration or by tree planting: examples of opposite hydrological impacts evidenced by long-term field monitoring in the humid tropics, Hydrol. Earth Syst. Sci. Discuss., 12, 12615-12648, doi:10.5194/hessd-12-12615-2015.*
- Maclean, J. L. D.C. Dawe, B. Hardy, and G. P. Hettel. 2002. Rice Almanac. Los Baños: IRRI.*
- MAF (Ministry of Agriculture and Forestry). 1999. The Government's Strategic Vision for the Agricultural Sector. Vientiane.*
- MAF (Ministry of Agriculture and Forestry). 2001. Basic statistics. Department of Planning, Ministry for Agriculture and Forestry, Vientiane, Lao PDR.*
- MAF (Ministry of Agriculture and Forestry). 2010. Strategy for agricultural development 2011 to 2020—draft, Ministry of Agriculture and Forestry, Vientiane.*
- MAF (Ministry of Agriculture and Forestry). 2013. Mid-term report of agriculture and forestry development plan 2011–2015. Vientiane Capital.*
- MAF (Ministry of Agriculture and Forestry). 2014. Agriculture strategy 2025 and vision 2030. Vientiane Capital.*
- Millar, J. & Phoutakhoun, V. 2008. Livestock development and poverty alleviation: revolution or evolution for upland livelihood in Lao PDR. Inter. J. Agr. Sust., 6:89–102.*
- Ministry of Education. 2004. Lao National Literacy Survey 2001. Vientiane.*
- NAFES. 2005. Consolidating Extension in the Lao PDR. Vientiane.*
- Nampanya, S., Rast, L., Khounsy, S. & Windsor, P.A. 2010. Assessment of farmer knowledge of large ruminant health and production in developing village-level biosecurity in northern Lao PDR. Transbound. Emerg. Dis., 57:420–429.*
- Nessbitt, H. Johnston, R. and Solien, M. 2004. Mekong River water: Will river flows meet future agriculture needs in the Lower Mekong Basin? In. Seng, V.; Craswell, E.; Fukay, S. and Fischer, K. Water in Agriculture. ACIAR Proceedings 116e.*
- OECD. 2006. Good Practices in the National Sustainable Development Strategies of OECD Countries, OECD Sustainable Development Studies, OECD Publishing, Paris.*

- Pravongviengkham P. 1998. *The Role of Animal Husbandry and Aquaculture in Improvements of Swidden-Based Livelihood Systems in the Lao PDR*. Unpublished Doctoral Dissertation. Asian Institute of Technology. Bangkok.
- Sackloham, S., and Baudran, E. 2005. *Using agrarian systems analysis to understand agriculture. In Improving Livelihoods in the Uplands of Lao PDR*. Vientiane: NAFRI, NAFES, and NUOL, pp. 218-225.
- UNDP. 2008. *Energy & Environment for Sustainable Development*. United Nations Development Programme.
- Wilson, R. 2007. *Status and prospects for livestock production in the Lao People's Democratic Republic*. *Trop. Animal Health Prod.*, 39:443-452
- Windsor, P.A., Soun, S. & Khounsy, S. 2008. *Identifying research priorities for development of the beef industry in Cambodia and Lao PDR, with special reference to animal health interventions*. ACIAR, Canberra. Available at: <http://www.aciar.gov.au/project/AH/2006/077> (Accessed: August 2010)
- Wittman, H. K., A. A. Desmarais, and N. Wiebe. 2010. *Food sovereignty: Reconnecting food, nature and community*. Oakland, CA: Food First Books.
- World Bank. 2010. *Lao PDR Development Report, Natural Resource Management for Sustainable Development: Hydropower and Mining*, World Bank, Washington, DC.
- World Bank. 2012. *World Development Indicators 2012*, World Bank, Washington, D.C., <http://data.worldbank.org/data-catalog/world-development-indicators/wdi-2012>.
- Yesuf, M. and G. Khlin. 2009. *Market imperfections and farm technology adoption decisions: Case study from the highlands of Ethiopia*. Unpublished manuscript. University of Gothenburg, Department of Economics.
- Yoshida, A. & Hemmavanh, C. 2010. *Mountainous tea industry promotion: An alternative for stable land use in the Lao PDR in Pandi*, Zdurli, M. Pagliai, S. Kapur & A.F. Cano, eds., *Land Degradation and Desertification: Assessment, Mitigation and Remediation*, Springer Science, Netherlands, pp. 323-331.