LAO PDR:
AN EVALUATION SYNTHESIS ON RICE

A Case Study from the 2005 Sector Assistance Program Evaluation for the Agriculture and Natural Resources Sector in the Lao People's Democratic Republic

September 2006

Njoman George Bestari
Samjhana Shrestha
Caren Joy Mongcopa

Operations Evaluation Department

Asian Development Bank

Abbreviations

ADB	Asian Development Bank
DAFEO	district agriculture and forestry extension office
ha	hectare
IRRI	International Rice Research Institute
Lao PDR	Lao People's Democratic Republic
LMV	Lao-IRRI modern rice variety
MAF	Ministry of Agriculture and Forestry
MV	modern variety
NAFES	National Agriculture and Forestry Extension Services
NEM	New Economic Mechanism
t	ton

NOTE

In this report, "$" refers to US dollars.

Contents

I. Introduction

1. This case study reviews the development in the rice sector in the Lao People's Democratic Republic (Lao PDR) since the introduction of the New Economic Mechanism (NEM) in 1986, including (i) the importance of rice in the current cultural, social, and economic context; (ii) rice production systems, highlighting characteristics of the rice-growing areas; (iii) constraints facing rice farmers; (iv) research conducted and technologies developed to address these constraints; (v) pattern of growth in rice production; and (vi) future priorities for further rice development.

2. Since the NEM, the country has experienced a steady increase in the national output and improvements in the general standard of living. Policy changes in the agriculture sector have contributed to the economic growth and improvements in welfare.[1] The current strategic objectives for agricultural development are to improve rural livelihoods, reduce vulnerability of poor households, create opportunities for diversifying livelihoods, and maintain environmental quality in rural areas.[2] Increased rice production and improved access of the poor to rice contribute directly to achieving these objectives. Increasing rice production to achieve self-sufficiency at the national level and to generate exportable surplus is one of the eight priority programs in the country.[3] Rice production in the Lao PDR increased by 75% from 1.4 million tons (t) in 1986 to 2.5 million t in 2004.[4] 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.

Rice farmer in Houay Lao, Vang Vieng

II. Current Rice Situation in the Lao PDR

3. **Significance of Rice in Lao Culture.** 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. For example, *Khamu* farmers in Luangprabang consider popularly planted rice varieties as the "father" and the "mother" varieties. *Khao Kam* is a "father" variety, late maturing glutinous (sticky) black rice. It is a special-purpose variety planted in small quantities near the hut in memory of dead parents, and also at the edge of the rice field to indicate

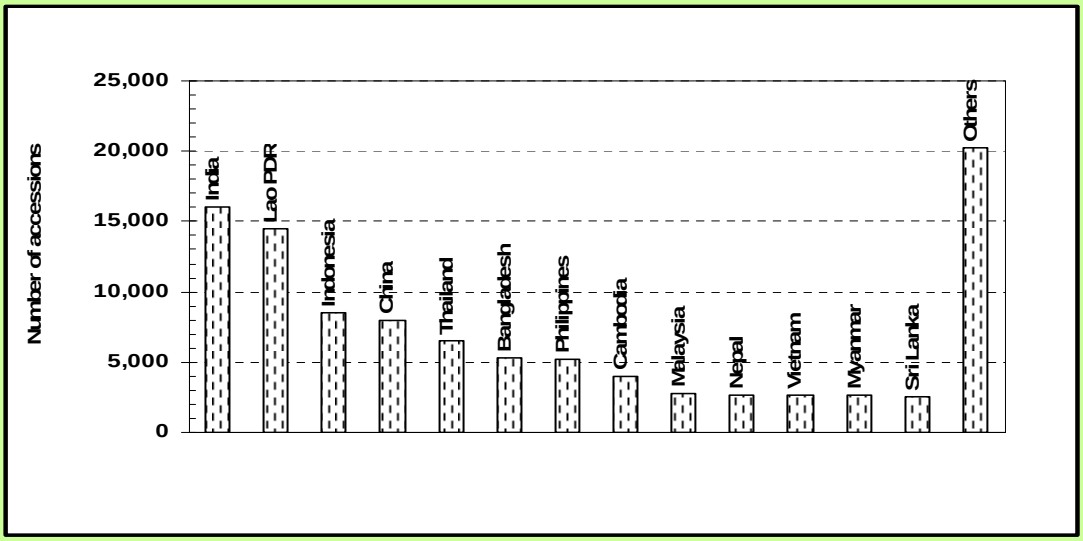
[1] Government of the Lao PDR. 2004. *Northern Region Development Strategy Volume II*: NRDS. Vientiane.
[2] Ministry of Agriculture and Forestry (MAF) and Japan International Cooperation Agency. 2001. *Master Plan Study on Integrated Agricultural Development in the Lao PDR*. Vientiane.
[3] United Nations Development Program. 2002. *National Human Development Report Lao PDR 2001*. Vientiane.
[4] Rice data released by MAF has been used for analyzing the rice sector.

that parents are still alive. *Khao Chao Leuang* is a "mother" variety. It is nonglutinous rice valued for consumption when the rice supply is lean, and for making noodles.[5]

4. **Biodiversity of Rice.** Centuries of farmers' selection and seed exchanges among different ethnic groups have resulted in the development of an amazing diversity of traditional rice varieties in the Lao PDR. Some rice varieties are glutinous and some nonglutinous, with colors such as black, purple, red, and white. Farmers commonly plant three or four varieties—typically a combination of one early, one medium, and one or two late-maturing varieties—to provide the continuity in their food supply.

5. 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. These samples represent more than 3,000 rice varieties. These resources are conserved in the country, and in the International Rice Genebank at the International Rice Research Institute (IRRI), which holds the world's most comprehensive collection of rice genetic resources. The Lao PDR's contribution to the International Rice Genebank ranks the second highest (Figure 1). Indigenous knowledge of the traditional rice varieties have also been collected and catalogued.

Figure 1: Origin of the Germplasm in the International Rice Genebank



Source: IRRI. 2005. *Genetic Resources*. Los Baños: IRRI.
Available: http://irriwww1/irrihome/GRC/GRCHome/Home.htm

6. **Significance as Food and Self-Sufficiency.** Access to rice is the single most important factor determining the welfare status of the Lao people in rural areas. Lao people consume 171 kilograms per capita of milled rice per annum, which constitutes almost 70% of their calorie and protein intake.[6] Self-sufficiency in rice is equated with self-sufficiency in food in The Lao PDR. Achieving self-sufficiency in rice at the national level has been a top priority goal for the country since the introduction of the NEM. Rice self-sufficiency was reported to have been achieved in 1999 at more than 2 million t. However, opinions among observers vary on the extent to which the country has achieved rice self-sufficiency.

[5] International Rice Research Institute (IRRI). 2005. *Lao PDR Rice Biodiversity Project (Phase 2).* Progress Report submitted to the Swiss Agency for Development and Cooperation. Los Baños.
[6] Maclean, J.L., D.C. Dawe, B. Hardy, and G.P. Hettel. 2002. *Rice Almanac*. Los Baños: IRRI.

7. Irrespective of the achievement of rice self-sufficiency at the national level, various studies indicate that not all households are able to meet their rice consumption requirements. According to the United Nations World Food Program, about 30% of the population has insufficient food for more than 6 months of the year. Chronic malnutrition is reported to be high, affecting up to 47% of the population. Much of the severe deficiency occurs in the Northern and Eastern mountainous regions, while surplus areas are mostly along the Mekong River valleys.[7] The Asian Development Bank (ADB) estimated that poor households were able to meet their rice requirements for about 7 months per year on average.[8] Furthermore, annual rice production remains unstable, as much of the rice is produced under rain-fed conditions. Climatic factors account for at least 10% of the annual variability in rice production.[9]


Preparing land for rice cultivation


Rice traders in Phonsavan, Xiengkhouang

8. **Future Rice Demand and Supply.** The demand for rice is expected to grow substantially, as the population is currently growing at 2.5% per annum—the highest in the region. At this rate of growth, the population is expected to increase from 5.3 million in 2000 to 8.8 million in 2020, an increase of 66% (footnote 2). Furthermore, in low-income countries, improvements in income generally lead to an increase in per capita consumption of rice. At the current rate of population growth, and assuming the current rate of rice consumption per capita, the total demand for rice will increase to 3.6 million t by 2020. This will require an additional one million t of rice production annually. Assuming that the total rice area does not increase, the productivity of rice will have to increase to 4.7 tons per hectare (t/ha) at the national level by 2020 to maintain self-sufficiency.

9. **Subsistence and Market Orientation of Rice Production.** Rice production in the country is subsistence-oriented. It is produced mainly by small farm households that have an average farm size of less than 2 ha. Although rice production is the single most important economic activity, accounting for 39% of agricultural gross domestic product, very little rice is currently marketed. The Lao Expenditure and Consumption Survey (LECS)[10] conducted in the late 1990s estimated that, on average, only 8% of

[7] UNWFP. 2005. *World Hunger Laos.* Available: http://www.wfp.org/country_brief/indexcountry.asp?country=418

[8] ADB. 2001. *Participatory Poverty Assessment in the Lao PDR*. Manila.

[9] Pandey, S., and M. Sanamongkhoun. 1998. *Rainfed Lowland Rice in Laos: A Socioeconomic Benchmark Study*. Los Baños: IRRI.

[10] The LECS is a comprehensive national level survey sponsored by the World Bank. Three LECS have been conducted, the first, LECS1, covered 1992–1993; the second, LECS2, 1997–1998; and the third, LECS3, has recently been completed for 2003–2004 (report in preparation).

the rice produced is sold. Compared with the national average, farm communities closer to urban areas sell more rice (by about 10%). It is believed that domestic and international trade in rice has also increased with the increase in production in recent years. Although, there is no recent comprehensive study documenting border trade of rice, there is anecdotal evidence that the rice trade has flourished along the border with the People's Republic of China (PRC) and Thailand.

III. Characteristics of Rice Production Systems

10. **Regional Distribution.** Rice cultivation covers more than 80% of the total cropped area. Rice is grown in all regions of the country. The Central Region accounts for more than half of the total rice area (51%) and production (55%). Savannakhet Province, located in this region, has the largest rice area of all provinces, and it accounts for over 20% of national production. Vientiane (including the municipality) and Khammuane also have large rice areas in the region (Table 1).

Table 1: Rice Area, Production, and Yield
(by Region and Province, 2003—2004)

Region/Province	Area (% of total)	Production (% of total)	Yield (t/ha)
A. Northern	**24.57**	**21.60**	**2.89**
1. Phongsaly	1.89	1.61	2.80
2. Luangnamtha	2.81	2.51	2.93
3. Oudomxay	3.90	3.02	2.54
4. Bokeo	2.25	2.35	3.43
5. Luangprabang	4.30	3.32	2.53
6. Huaphanh	3.60	3.28	2.99
7. Xayabury	5.82	5.52	3.11
B. Central	**51.36**	**55.22**	**3.53**
1. Ventiane Municipality	9.45	11.67	4.06
2. Xiengkhouang	3.24	2.77	2.80
3. Ventiane	6.79	8.09	3.91
4. Borikhamxay	4.51	5.02	3.66
5. Khammuane	6.73	6.11	2.98
6. Savannakhet	20.13	21.09	3.44
7. Xaysomboun	0.51	0.47	3.00
C. Southern	**24.07**	**23.18**	**3.16**
1. Saravane	9.08	9.04	3.27
2. Sekong	0.60	0.53	2.93
3. Champasack	12.32	12.04	3.21
4. Attapeu	2.07	1.56	2.48
Lao PDR	**100.00**	**100.00**	**3.28**

Lao PDR = Lao People's Democratic Republic; t/ha = ton per hectare.
Note: In 2003–2004, the total rice area was estimated at 770,300 ha and total rice production at 2.5 million.
Source: Ministry of Agriculture and Forestry. 2004. *Agricultural Statistics*. Vientiane.

11. The remaining half of the rice area is located in the Northern (25%) and Southern (24%) regions, which account for approximately 45% of total production. Champasack and Saravane are the two major rice-producing provinces in the Southern Region. The Northern Region is characterized by mountainous terrain and contributes approximately 22% of total production. Of the three regions, the Northern Region has the lowest yield (2.89 t/ha). Xayabury, Luangprabang, Huaphanh, and Oudomxay are the provinces with most of the rice area of the Northern Region. Most of the rice production in these provinces (except for Xayabury) is based on shifting cultivation.

12. **Rice Ecosystems.** Almost 90% of the rice area in the Lao PDR is rain-fed. Rain-fed rice may be grown in lowland or in uplands. Rain-fed rice in the lowlands dominates rice cultivation in the country. In 2004, about 75% of the area cultivated (576,000 ha) and 78% of the production (about 2 million t) originated from this ecosystem (Table 2). Upland rice accounts for over 15% of the total rice area. Almost 50% of the rice grown in the Northern Region originates from the rain-fed upland rice ecosystem (of which over 23% is cultivated under shifting cultivation). Luangprabang (17,000 ha) and Oudomxay (11,000 ha) are the main provinces in the Northern Region where rice is grown under shifting cultivation systems.

Table 2: Rice Area and Production by Region and Ecosystem, 2004

	Rain-fed Lowland (%)		Rain-fed Upland				Irrigated Lowland (%)	
			Upland (%)		Shifting Cultivation (%)			
Region	Area	Production	Area	Production	Area	Production	Area	Production
Northern	46.84	63.97	25.67	17.44	23.23	12.70	4.28	5.90
Central	82.03	79.82	1.94	1.08	1.76	0.79	14.26	18.30
Southern	87.55	87.32	5.10	3.13	0.70	0.36	6.65	9.19
Lao PDR	74.71	78.13	8.53	5.09	6.78	3.26	9.98	13.51

Lao PDR = Lao People's Democratic Republic.
Data source: Ministry of Agriculture and Forestry. 2004.

13. The second rice crop, dry season rice, is cultivated under irrigated conditions.[11] About 10% (76,800 ha) of the total rice area, and almost 14% (34 million t) of total production, originated from this ecosystem in 2004. Most of the dry season rice is cultivated in the Central Region. Vientiane Municipality (103,000 t) and Savannakhet province (80,000 t) have the largest areas under dry season rice. The irrigated rice ecosystem had the highest yield at 4.4 t/ha in 2004. Yields in rain-fed lowlands and uplands were 3.4 t/ha and 1.8 t/ha, respectively.

14. **Shifting Cultivation.** Rice production based on shifting cultivation is practiced mainly in the Northern and Eastern mountainous regions. Estimates in 2000 indicated that about one third of the total Lao population still depended on shifting cultivation, which covered about 13% of the total land area of the country (footnote 1). Traditionally, farmers cleared the forest with fire for growing upland rice. After growing rice for a year or two, land used to be left fallow for 10–20 years before farmers returned to the same field to plant upland rice. Increasing population pressure and land-use restrictions have led to a reduction in fallow periods in recent years to as short as 3 years. Production based on

[11] Estimates of irrigated area vary widely depending on the source. According to the data from the Department of Irrigation, the total irrigated area of rice in the Lao PDR was 295,000 ha in 2000. The area of irrigated rice estimated by MAF was, however, less than 100,000 ha in 2004. The Department of Irrigation data probably include the area of rice based on the total capacity created for providing supplemental irrigation in the wet season, while the data from MAF provide an estimate of the dry season area of irrigated rice.

such short fallow period is unsustainable.[12] Hence, the Government has actively discouraged upland rice production based on shifting cultivation. A two-pronged strategy has been used by the Government to limit the rice area under shifting cultivation. The first is to raise the productivity of rice so that farmers' food needs are met from a smaller area. This may take the form of increasing the productivity of upland rice on sloping lands. The same result can also be obtained by raising the productivity of pockets of lowlands in valley bottoms and irrigated terraces, where rice yields are much higher. With the overall increase in food supply coming from irrigated terraces and valley bottoms, the pressure to intensify rice production in uplands will decrease. The second strategy is to improve the market access of rural communities through investments in roads, transport, and marketing infrastructure. A market-oriented production system may evolve when farmers can use price signals in making their decisions on which crops to grow. Farmers are unlikely to continue growing upland rice using shifting cultivation when more remunerative options become available. The Northern Region Development Strategy is based on this two-pronged approach.

IV. Rice Research, Technology Development, and Dissemination

15. **Institutional Setup for Research and Extension.** 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.[13] 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.


Milling rice in Pacha Village, Xam Neua

16. Before NAFES was established in 2001, much of the extension services 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

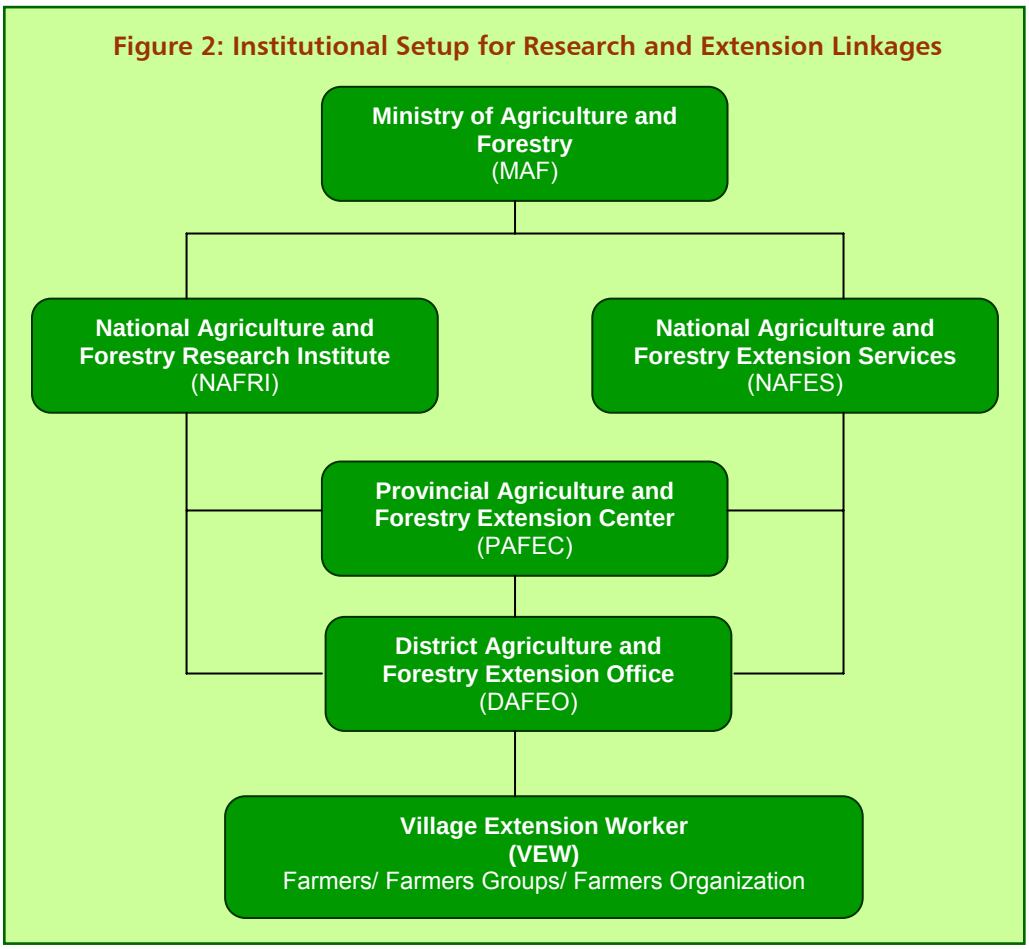
[12] Walter, R. 2001. *Slash-and-Burn Rice Systems in the Hills of Northern Lao PDR: Description, Challenges, and Opportunities*. Los Baños: IRRI.

[13] 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.

Central Committee, and Cooperation Internationale pour le Development et la Solidarité. Furthermore, Lao farmers have a strong tradition of seed exchange among neighbors, across regions, and across the border. Much of the dissemination of new rice varieties has been credited to this practice, rather than through formal channels of seed distribution. Since its establishment, NAFES has coordinated the extension services of the country. Extension service centers have been set up in parallel to the research organizations. Up to June 2005, before NAFES was reorganized, there were provincial agriculture and forestry extension services and district agriculture and forestry extension services.

17. 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.[14] 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).[15] The link between research and extension is illustrated in Figure 2. 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.

Figure 2: Institutional Setup for Research and Extension Linkages



[14] NAFES. 2005. *Consolidating Extension in the Lao PDR.* Vientiane.

[15] Provincial staff subject matter specialists and district staff will be 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 DAFEO have the primary responsibility as generalists to regularly interact with local communities, farmers, and village extension workers, and to understand their needs.

18. 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 recently. Reducing the current gap between research and extension has been identified as an area that is likely to have a high return (footnote 1). 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 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.

19. **Production Constraints.** The main constraints to rice production are abiotic, biotic, and socioeconomic. Abiotic factors include drought, flood, cold temperature, and poor soil fertility. Biotic factors are insects, diseases, and weeds. Socioeconomic factors include labor shortages, and lack of access to credit and markets. The top three production constraints identified by farmers for wet and dry season are listed in Table 3. Annual drought and flooding are the most serious constraints to rice cultivation throughout the Central and Southern regions, and the third most serious in the Northern Region. Regular flooding of the Mekong River affects 10%–30% of the rice area in the Southern and Central regions. Savannakhet Province suffers most from early or late season drought almost every year. Late season drought alone can reduce grain yields by 30%.[16] In the upland environment, drought at seeding is an important production constraint. In addition, short fallow is one of the major factors for low yields. Soils in the Northern Region are generally poor and lacking in basic nutrients. Frequently occurring floods result in further loss of productive capacity through soil erosion.

Table 3: Farmers' Ranking of the Three Most Important Constraints to Rice Production

	Ranking of Production Problems					
	Wet Season			Dry Season		
Province	1	2	3	1	2	3
Vientiane Municipality	Drought	Weeds	Insects	Weeds	Insects	Labor Shortage
Vientiane	Insects	Drought	Weeds	Water Shortage	Insects	Weeds
Khammuane	Drought	Insects	Weeds	Weeds	Insects	Labor Shortage
Savannakhet	Drought	Crabs and Snails	Weeds	Insects	Weeds	Soil Fertility
Saravane	Drought	Insects	Weeds	Weeds	Labor Shortage	Soil Fertility
Champasack	Drought	Insects	Weeds	Credit	Labor Shortage	Weeds
Xayabury	Drought	Insects	Weeds	n.a.	n.a.	n.a.

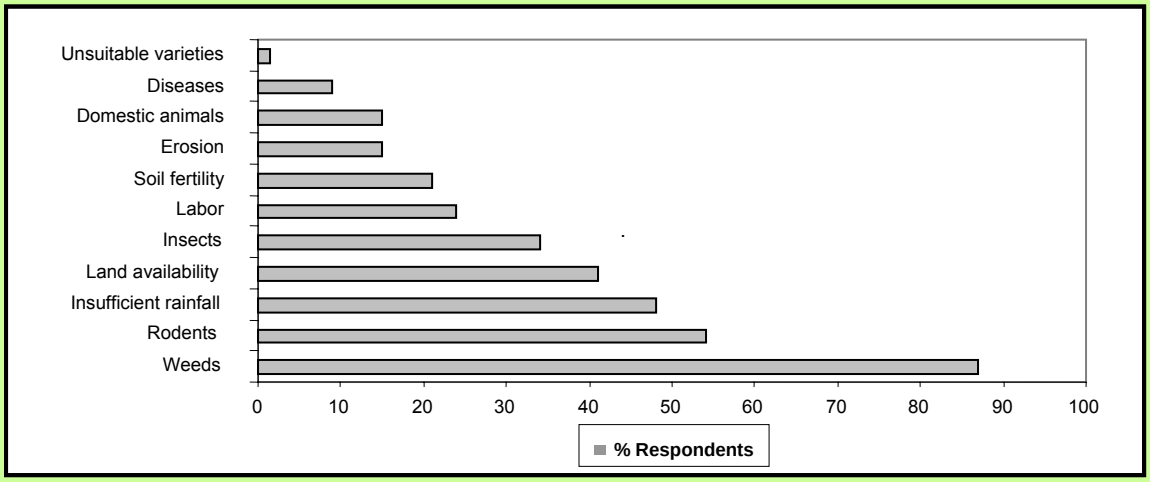
n.a. = not available.
Source: Schiller, J.M., B. Linquist, K. Douangsila. 2001. *Constraints to Rice Production Systems in the Lao PDR.* Vientiane: Lao-IRRI Project.

20. Biotic constraints (insects, diseases, and weeds) are ranked to be the most serious constraints affecting rice production in the uplands and the third most serious among lowland farmers. Brown planthopper, stemborer, rice bug, golden apple snail, gall midge, and white grub (particularly in the

[16] Fukai, S., P. Sittisuang, and M. Chanphengsay .1998. Increasing Production of Rainfed Lowland Rice in Drought Prone Environments: A Case Study in Thailand and Laos. *Plant Prod. Sci*. 1(1):75–82.

drought period) are some of the insect pests reported to result in significant crop losses during both the wet and dry seasons. Blast, bacterial leaf blight, brown spot, bakanae in the lowlands, and nematodes in the uplands also reduce yields substantially. With increasing rice cropping intensity in the lowlands, and shortened fallow periods in the uplands, these factors have become more constraining, and crop losses are expected to increase. In the upland ecosystem, weeds and rodents are the two major constraints that result in significant economic losses (Figure 3). It is estimated that at least 15% of the annual harvest is lost to rodents. The need to control weeds is the single most labor-demanding operation.

Figure 3: Farmers' Perceptions of Major Constraints to Upland Rice Production



Source: Walter, R. 2001. *Slash-and-Burn Rice Systems in the Hills of Northern Lao PDR: Description, Challenges, and Opportunities*. Los Baños: IRRI.

21. **Research Programs.** Systematic rice research in the country was established in 1990 with the initiation of the LIRRTP. The project aimed to improve and stabilize rice productivity. In collaboration with Lao scientists, the project developed technologies consisting of improved varieties and complementary crop management practices (Table 4). These technologies are aimed at improving the productivity of the overall farming system.

Table 4: Rice Research Program and Production Constraints in the Lao PDR

	Research and Technology Development				
Production Constraints	Varietal Improvement	Nutrient Management	Plant Protection	Agronomic Practices	Ecosystem Targeted
Drought	Yes	—	—	Yes	RL, RU
Flood	—	Yes	—	Yes	RL
Low Soil Fertility	—	Yes	—	Yes	RU, IL
Soil Erosion	—	Yes	—	Yes	RU
Insect Pests	Yes	—	Yes	—	RL, RU, IL
Diseases	Yes	—	Yes	—	RU, IL
Weeds	—	Yes	Yes	Yes	RU
Rodents	—	—	Yes	Yes	RU
Labor Shortage	—	Yes	Yes	Yes	RL, RU, IL

IL = irrigated lowland, Lao PDR = Lao People's Democratic Republic, RL = rain-fed lowland, and RU = rain-fed upland.

Source: Shrestha, S. 2002. *Lao-IRRI Project: Impact Assessment of Research and Technology Development*. Los Baños: IRRI.

22. Initially, the activities for germplasm improvement focused on improving the yield potential of glutinous varieties. Collecting and characterizing the abundant biodiversity of traditional varieties were major activities initially. Along with these traditional varieties, introduced lines were also used for the selection of traits suitable to Lao conditions. There has also been some research to develop nonglutinous varieties mainly for the urban and export markets. More recently, breeding efforts have been targeted at specific abiotic constraints limiting rice production. For example, new varieties that escape drought or are more tolerant to drought are being developed.


On-farm rice milling in Soilnafa Village, Xiengkhouang

23. Considerable agronomic research was conducted for improving rice crop management. The effects of plant spacing on efficiency of nutrient use; the effects of sowing time on yield loss to drought, flood, and cold temperature; and the effects of hill spacing on weed management were studied. The feasibility of direct seeding to reduce the labor requirement was also assessed. One of the important research activities in the Lao PDR relates to the development of improved nutrient management technology. Studies were conducted to estimate yield responses to the application of organic and inorganic fertilizers. Studies were also conducted to quantify the minimum input level required to sustain yield improvements. Suitable recommendations for raising fertilizer use efficiency were developed.[17]


Irrigated rice and corn cultivation, Savannakhet

24. To address biotic constraints, earlier studies concentrated on screening and identifying varieties with resistance to common pests and diseases. Some of the newly released varieties have such traits. Studies were also undertaken to help farmers understand the benefits of using natural predators for pest control through the application of integrated pest management.[18]

25. **Research Outputs.** Two major groups of modern rice varieties were released in the Lao PDR after 1990. The first group consists of the Lao-IRRI modern rice varieties (LMVs) developed from the joint Lao-IRRI research programs. Nine varieties developed specifically for Lao conditions have been officially released (Table 5). These are glutinous varieties selected for good quality, high yield potential, and suitability to saline and low fertility soils. Some are also resistant to common insects and diseases such as brown planthopper, gall midge, stemborer, leaf blast, bacterial leaf blight, and brown spot.

[17] Linquist B., and P. Sengxua. 2001. *Nutrient Management in Rain-fed Lowland Rice in the Lao PDR*. Los Baños: IRRI.

[18] Heong, K. L, M. M. Escalada, V. Sengsoulivong, and J. M. Schiller. 2001. *Insect Management Beliefs and Practices of Rice Farmers in Laos*. Vientiane: Lao-IRRI Project.

Several more LMVs are scheduled for release in 2005 and 2006. The second group of improved rice varieties, referred here as other modern varieties (OMVs), were developed in other countries (mainly Thailand and Viet Nam) and at IRRI. Ten of these OMVs, five glutinous and five nonglutinous, have been released in the Lao PDR. The large pool of genetic biodiversity of rice in the Lao PDR provided important contributions to the development of these improved rice varieties. Of the over 3,000 varieties collected, 2000 samples have been tested and used for crossbreeding. Eight traditional varieties have also been officially released for selected provinces.

Table 5: Improved Rice Varieties Developed and Released for Lao Conditions

Name	Year Released	Major Positive Traits
TDK 1	1993	High N response, good tillering, resistance to most biotypes of BPH and to rice leaf diseases
TDK 2	1993	Moderately resistant to leaf blast, bacterial leaf blight, BPH, gall midge, and stemborer
PNG 1	1994	Good grain quality, moderate yield, broad adaptability, maturity at 125–130 days, and resistance to blast
PNG 2	1995	Moderately resistant to brown spot, flowering in mid-October
TDK 3	1997	Good grain quality, resistance to rice diseases and suited to favorable rain-fed lowland
TDK 4	1998	Good grain quality, high N response, suited to medium fertile and saline soils
TSN 1	1998	Good grain quality and high N response, best suited to fertile soils
NTN 1	1998	Good grain quality, 130 days maturity, resistance to blast
TDK 5	2000	Good grain quality, maturity at 125–130 days, plant height 95–115 cm, resistance to blast, bacterial leaf blight

BPH = brown planthopper, cm = centimeter, N = nitrogen, NTN = Namtane, PNG = Phone Ngam, TDK = Thadokkham, TSN = Thasano.
Source: Lao-IRRI Project. *Annual Technical Reports: 1995 to 2001*. Vientiane.

26. Research outputs were packaged into technological options for wider dissemination to farmers. Recommended technology packages and their major components include (i) establishment of 25-day-old seedlings, (ii) plant spacing of 15 x 15 centimeters with four or five plants per hill, (iii) application of higher and balanced doses of inorganic fertilizers in several splits, (iv) use of organic fertilizers, (v) direct seeding in furrows when transplanting not possible, (vi) weed management strategies for the uplands, and (vii) recommendation of several legume crops to be planted in rice-based farming systems in for the uplands.

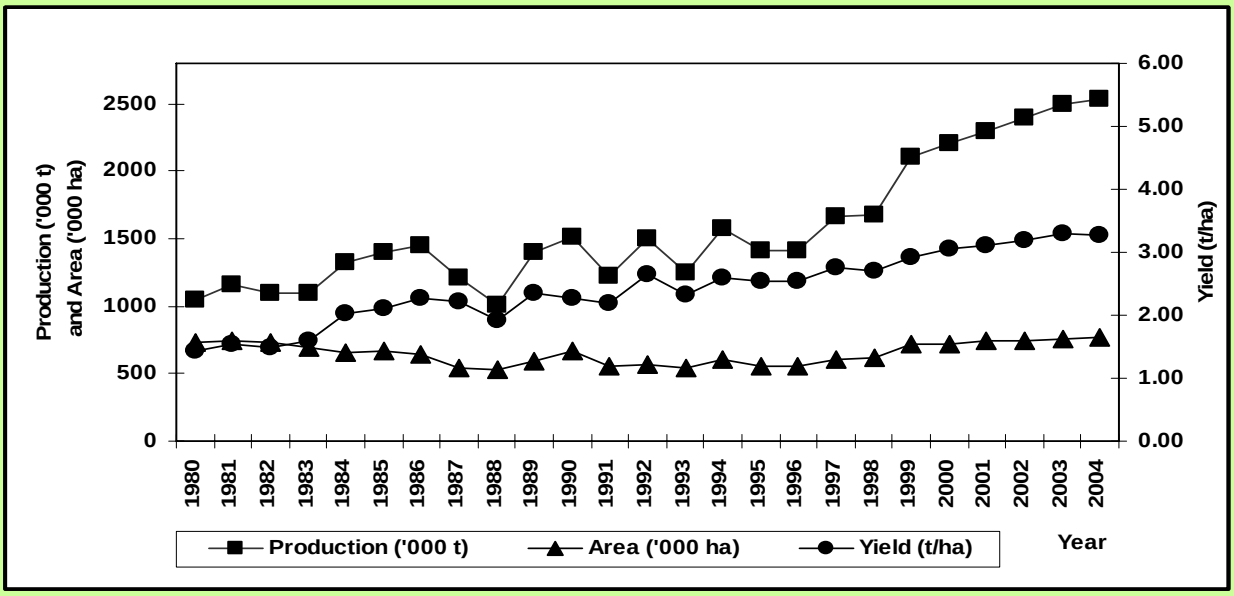

Rice valley, Xiengkhouang


Irrigated rice field adjacent to slash-and-burn agriculture

V. Analysis of Rice Production Trends and Growth Patterns

27. **National Level.** The rice production system of the Lao PDR has undergone tremendous changes since the 1990s. Rice production averaged around 1.3 million t per annum until the early 1990s, with no clear trend in production. A significant breakthrough occurred during the mid-1990s, with production rising steeply to 2.5 million t in 2004 (Figure 4).

Figure 4: Rice Area, Production, and Yield in the Lao PDR, 1980 to 2004



ha = hectare, t = ton.
Data source: The Ministry of Agriculture and Forestry. 2004.

28. Rice area increased from approximately 642,000 ha in 1986 to over 770,000 ha, an increase of more 20%. This represents a growth rate of 1.8% per annum (Table 6). The yield increased by over 45% for the period, representing an annual growth of 2.6%.

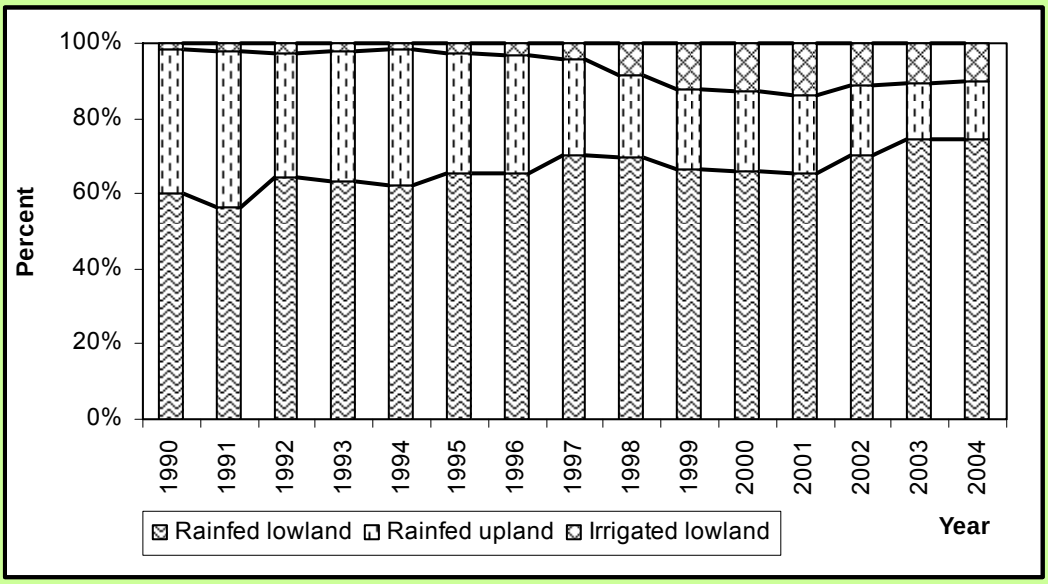
Table 6: Growth in Rice Area, Production, and Yield, 1986–2004

Item	Year		Average (1986–2004)	% Change (1986–2004)	Compound Annual Growth Rate (1986–2004)[a]
	1986	2004			
Area ('000 ha)	641.60	770.30	633.20	20.10	1.75
Yield (t/ha)	2.26	3.28	2.64	45.30	2.60
Production ('000 t)	1,449.30	2,529.00	1,701.10	74.50	4.34

ha = hectare, t = ton.
[a] Growth rates (%) estimated by fitting semilogarithmic trend lines to time-series data.
Data source: Ministry of Agriculture and Forestry. 2004.

29. **Disaggregated Analysis.** Figure 5 illustrates the changes in rice area for different ecosystems from 1990 to 2004. On average, the rain-fed lowland accounted for 66% of the total rice area for the period. This ecosystem experienced a substantial increase in rice area (47%) during this period (Table 7).[19]

Figure 5: Rice Area for Different Ecosystems in the Lao PDR, 1990 to 2004



Lao PDR = Lao People's Democratic Republic.
Data source: Ministry of Agriculture and Forestry. 2004.

Table 7: Change in Rice Area, Yield, and Production by Ecosystem, 1990 to 2004

Item	Rain-fed Lowland			Rain-fed Upland			Irrigated Lowland		
	1990	2004	% Change (1990–2004)	1990	2004	% Change (1990–2004)	1990	2004	% Change (1990–2004)
Area ('000 ha)	392.40	575.50	46.70	245.90	118.00	(52.00)	12.00	76.80	540.30
Yield (t/ha)	2.76	3.43	24.62	1.50	1.79	19.20	3.42	4.45	30.19
Production ('000 t)	1,081.10	1,976.00	82.80	369.40	211.20	(42.80)	41.00	341.80	733.70

ha = hectare, t = ton.
Note: Growth rates estimated by fitting semilogarithmic trend lines to time-series data.
Data source: Ministry of Agriculture and Forestry. 2004.

30. 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 (Figure 5). Much of the decline is reported to have been due to the decrease in rice area under shifting cultivation. The yield of rice in this ecosystem is the lowest and changed marginally from 1.5 t/ha in 1990 to 1.8 t/ha in 2004 (Table 7).

[19] The lowest rice area in rain-fed lowlands was 328,000 ha in 1991, and the highest was 576,000 ha in 2004.

31. Production of irrigated rice took a substantial upward turn and its area increased significantly over the period; in 1990, it made up less than 2% of the total rice area, but this increased to 10% in 2004. The yield in this ecosystem was highest of all three ecosystems at 4.45 t/ha in 2004. Despite its area share being only 10%, the share of production of irrigated rice in 2004 was 14%. However, there has been some decrease in rice area in this ecosystem during recent years.[20] In all rice ecosystems, the increase in yield during 1986–2004 ranges from 20% to 30% (Table 7). The average yield levels for 1986–2004 for irrigated, rainfed, and upland rice ecosystems were estimated at 3.9 t/ha, 3.1 t/ha, and 1.6 t/ha, respectively.

32. **Factors Contributing to Growth in Production.** The increase in rice production during 1986–2004 was due mainly to an overall increase in yield. Rice yield increased at an annual rate of 2.6%, while rice area expanded by 1.8% annually (Table 6). Several factors contributed to this rapid increase in yield. Empirical studies in rice production across Asia have shown that the main factors are the adoption of modern varieties (MVs), use of inorganic fertilizers, availability of irrigation facilities, and government commitment to support rice production. The significant growth in rice production in the Lao PDR during the last two decades is also the result of these factors.

Fishpond in a rice field, NamNga Village, Vang Vieng

33. In the early 1990s, the rice varieties grown were mostly traditional varieties, with the MVs accounting for only 2%–5% of the total rice area.[21] A national statistical bulletin published in 2000 indicated that the area under MVs expanded to 30% of the rice area during the 1990s.[22] In more recent years, several farm-level studies conducted in major rice-growing regions of the country indicated substantially high adoption rates. An extensive literature review on this topic suggests that the adoption rate in recent years is at least 50% of the total rice area (Table 8).

34. Based on a farm-level study, the yield of MVs is estimated to be 43% higher than that of traditional varieties. At the national level, this yield increase translates to a production gain of at least 280,000 t. Net income among the adopters was 15% higher despite a significant increase in the cost of production. These gains translate at the national level to the range of $9–$13 million per year.[23]

[20] Irrigated rice area was reported to be highest at over 102,000 ha in 2001.

[21] Lao-IRRI Project. 2000. *Rice Variety Recommendations for the Wet Season Lowland Environment of the Lao PDR.* Vientiane.

[22] Agricultural Census Office. 2002. *Lao Agricultural Census, 1990 to 1999: Highlights*. Steering Committee for the Agricultural Census Office. Vientiane.

[23] Shrestha, S. 2002. *Lao-IRRI Project: Impact Assessment of Research and Technology Development, Consultancy Report for IRRI*. Los Baños: IRRI.

Table 8: Adoption of Modern Rice Varieties in the Lao PDR

Author(s)	Study Based on Province(s)	Study Year	Households Adopting MVs	% of Area Under MVs
Shrestha[a]	Champasack, Savannakhet, and Vientiane Municipality	2001	88	81
Braun[b]	Savannakhet	2000	87	50
Pilot Extension Project[c]	Champasack and Saravan	1998	42	20
Hossain, et. al.[d]	na	1998	na	53
Schiller, et. al.[e]	Champasack	1998	100	61
Schiller, et. al.	Vientiane	1998	94	57
Pandey and Sanamongkhoun[f]	Champasack and Saravan	1996	60	21

Lao PDR = Lao People's Democratic Republic, MV = modern variety, na = not available.
Sources:

[a] Shrestha, S. 2002. *Lao-IRRI Project: Impact Assessment of Research and Technology Development*. Consultancy Report for IRRI. Los Baños: IRRI.

[b] Braun, R. 2002. *Savannakhet Province Survey Data.* Vientiane. Lao-IRRI Project. (draft report).

[c] Pilot Extension Project. 1999. *Project Completion Report: An Internal Assessment*. Vientiane: Department of Agriculture.

[d] Hossain M., D. Gollin, V. Cabanilla, E. Cabrera, N. Johnson, G. S. Khush, G. McLaren. 2002. Research for Genetic Improvement in Rice in Asia and Latin America: Investment, Output and the Role of International Centers. In: *Constraints to Increasing Rice Production in Asia*. Edited by M. Hossain. Los Baños: IRRI.

[e] Schiller, J.M., S. Phanthavong, V. Siphaphone , S. Sidavong, and A. Erguiza. 2000. *Impact Assessment of Improved Rice Production Technologies for the Rain-fed Lowland Environment in the Lao PDR*. Vientiane.

[f] Pandey S. and Sanamongkhoun, M. 1998. *Rain-fed Lowland Rice in Laos: A Socioeconomic Bench Study*. Los Baños: IRRI.

VI. Rice Marketing

35. The small rice market and the poor marketing infrastructure have resulted in a lack of integration of the domestic rice market in the country. Accordingly, prices 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 rice 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. It has been found that, with few exceptions, the price of rice is positively correlated with per capita income in various provinces.[24]


Transporting rice in Phonsavan, Xiengkhouang

36. Currently, international trade in rice is limited and takes place mainly across the border towns in PRC, Viet Nam, and Thailand. One of the major factors limiting the access to international

[24] Bourdet, Y. Undated. *Emerging Rice Market in Laos*. Lund: University of Lund.

markets is that Lao rice is predominantly glutinous while export demand is mainly for nonglutinous rice. Glutinous rice accounts for 80%–90% of the rice consumed in the Lao PDR. Trade in glutinous rice is limited mainly to the areas bordering Thailand, where glutinous rice is also consumed. However, Lao glutinous rice has to compete with Thai glutinous rice in these markets. Depending on seasonal effects and local price factors, glutinous rice may be traded in small quantities in either direction. Some small quantities of rice were exported recently through the mechanism of contract farming. Despite the likely opening of rice markets through regional trade arrangements, poor marketing infrastructure severely limits the export competitiveness of the Lao PDR relative to neighboring countries; Thailand and Viet Nam have established themselves as major rice exporters, and it will be a difficult task for the Lao PDR to compete for the same product in the markets already captured by these countries. One way out of this situation is to be able to differentiate the Lao product by targeting some niche markets such as those for organically grown rice or high-quality black rice. The Government is exploring the production and marketing possibilities for such products.

VII. Major Current and Future Issues

37. The rice economy has made tremendous progress during the past two decades. Rice production has increased, and its growth rate has been above the population growth rate. Thus, per capita rice availability has increased at the national level. Important progress has been made 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.

38. 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 (2000–2004) has been at about 2% per year. 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 rice production. Improved rice varieties 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 rice productivity but also to conserve fragile resources. There is also an urgent need to improve the availability of high-quality seeds of LMVs to maintain their productivity potential.


Walking home after a day's work

39. Although food availability at the national level has improved, household food security has not been achieved fully. Farmers with limited incomes and those in remote areas are still unable to meet their rice requirements fully. Addressing this will not only require increased rice productivity on the farms operated by such households, but also improved marketing systems so that rice from surplus areas in the south can be

economically marketed in the deficit areas in the north. Addressing such regional variations in food availability still remains a major issue.

40. 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. ■