Chapter 2
Development of the Rice Econometric Model with Endogenous Water in Lao PDR (REMEW-LAO)

2-1. Introduction

Laos is a rice producing country in Southeast Asia where 64% of total food supply came from the staple crop in 2003. However, seasonal production is highly variable due to the low share of irrigated fields, i.e., about 10% in 2004. Laos covers 236,800 square kilometers and had a population of only 5.87 million in 2007, so the country is relatively land abundant. However, upland areas in Laos are experiencing population growth pressure and the productivity of shifting cultivation is declining. Stable water supply for wet season and upland rice cultivation is necessary for food security and farm management stabilization. The evaluation of water supply changes on rice yields and the resulting market responses from fluctuations in production are an essential theme of agricultural development in Laos. This chapter describes the supply and demand of rice in Laos, which is named Rice Econometric Model Edogenous Water in Lao (REMEW-LAO), focusing on the impacts of fluctuations of water supply on rice production.

2-2. SEDP and policies related to rice production

Following three-year socio-economic development plan from 1978 to 1980, 1st five-year socio-economic development plan (SEDP) was put into action in 1981. Under the economic plan, farmers' incomes were reduced by the following three policies; (1) High inflation rate. The inflation rate was over 50%. The inflation led to an increase in the real exchange rate and it was hard to export agricultural products. (2) High trade protectionism. Terms of trade of agricultural products got weaker against industrial products due to the high tariff rates and import quota placed on agricultural products. (3) Low government procurement price. The government price of rice and coffee were significantly lower than the prices in the black market.

The Lao government introduced the New Economic Mechanism (NEM; *Rabop Mai*) on the issue in the first SEDP. The NEM was one part of the liberalization policy of culture, politics, and economy (New Thinking; *Chintanakan mai*) modeled after Perestroika. The main policies are as follows; (1) introduction of a self-support accounting system for national and public cooporations, (2) abolishment of the government procurement price of rice, (3) abolishment of the multiple exchange rate system, (4) liberalization of entry of private companies in production and marketing sectors, (5) streamlining of finance sector, (6) centralization of power for management of national assets and budget implementation, (7) trade liberalization except mineral products and timber.

In the agricultural sector, the government attempted to shrink the difference between the government price and the market price in 1984 and the government marketing board and distribution system of the government were abolished in 1987. Furthermore, the land tax rate was changed from a uniform rate to a variable rate depending on yields of agricultural products.

A committee consisted of Ministers and representatives of the party decided to make the transition from a strictly socialist economic system to one which includes faces of a market economy and to reform the land owner system in 1988. The reform guarantees farmers longterm use, alienation, and inheritance of land. Thus, farmers have defacto land ownership under state regulations. The independence of each farmer put an end to the favorable terms for cooperatives and state-owned farms. Participation in cooperatives became voluntary and the state-own farms were partly privatized.

The NEM reformed macro economic conditions and trade policies as follows; (1) sharp devaluation of the currency (kip) in September 1987 and abolishment of the multiple exchange rate system in July 1988, (2) moving the central bank interest closer to that of real rate, (3) abatement of printing money. These economic reforms and changes in agricultural policies increased the terms of trade by 40% from 1985 to 1989.

The 6th five-year SEDP is now in operation. The world economy is recovering and official development assistance (ODA) and foreign direct investment (FDI) are increasing. However, the high oil price had led to further hardship among the low income population. Following the situation, the SEDP set the following directions: (1) producing high value added goods, (2) increasing competitiveness and exploiting comparative advantages under the frameworks of ASEAN and WTO, (3) strengthen the linkage between economic development and social development such as poverty reduction, (4) advancing a market economy under the socialism system.

The government also has outlined a strategic vision from 2000 to 2020. The main target is to increase per capita GDP and it will reach up to US$885 and stepping out the category of least developing country. The main targets of agricultural sector are as follows; (1) increasing the self-sufficiency rate of food and confirmation for food security, (2) export promotion of commercial agricultural products, (3) stabilizing slash-and-burn agriculture.

In the strategic vision, agricultural land is divided into the Mekong river basin advanced market economy and the sloping region with a more closed economy. In the Mekong river basin, diversification and intensification of agriculture will be advanced and high value-added products will be promoted. In the sloping region, slush-and-burn methods are to be traded for fixed agriculture systems to increase the stability of producer livelihoods, increase of productivity, improve the socio-economic conditions, and protection of natural resources will be accomplished.

Organizations related to irrigation are important for this study. There are two types organizations. The Water Use Association (WUA) is a formal famers' association, and it manages irrigation plans and maintains irrigation facilities. Furthermore, the association purchases materials, provides finance, and works in marketing. Public assets such as pump, head works, canals, and constructions were devolved from the government.

The Water Use Group (WUG) is organized in locations where irrigation project supported by the Department of Irrigation (DOI) and Provincial Agriculture and Forestry Service (PAFS) exists. Irrigation facilities are maintained and managed by farmers' group while facility ownership is maintained by the government.

Distribution of rice and meats was restricted before 2002 and prices were controlled by the government. Previously, certificates issued by the local government were necessary for movements of these products. Now, there are no restrictions of the distributions.

Crop selection had been restricted and farmers had to follow instructions of the provincial government such as requiring farmers to cultivate rice in irrigated fields. The restriction on crop selection was also abolished in 2002.

2-3. Model

A supply and demand model for rice which includes a water supply variable affecting regional yields is developed. Planted area, yield, and production for each province, areas of province close to a small river basin, can be analyzed with the model.

The supply and demand model for rice in Laos consists of yield functions, planted area functions, production identities, supply identities, a consumption function, an import function, and a price linkage function. The yield and area functions for wet season are estimated for all provinces and monthly evapotranspiration (ET) is used as an explanatory variable which is a proxy for available water supplies. The generalized forms of these functions are as follows:

Yield function of wet season rice:

$$YL^i = f_{YL}\,(T, ET_{MAY}{}^i, \ldots, ET_{NOV}{}^i), \qquad (2\text{-}1)$$

Area function of wet season rice:

$$AL^i{}_t = f_{AL}\,(AL^i{}_{t-1}, FP_{t-1}, ET_{MAY}{}^i{}_{t-1}, \ldots, ET_{NOV}{}^i{}_{t-1}), \qquad (2\text{-}2)$$

Production of wet season rice:

$$QL^i = YL^iAL^i\,,\ QL = \Sigma_i YL^iAL^i \qquad (2\text{-}3)$$

Yield function of dry season rice:

$$YI^i = f_{YI}\,(T, ET_{NOV}{}^i{}_{t-1}, \ldots, ET_{MAY}{}^i{}_t), \qquad (2\text{-}4)$$

Area function of dry season rice:

$$AI^i{}_t = f_{AI}\,(AI^i{}_{t-1}, FP_{t-1}, ET_{NOV}{}^i{}_{t-2}, \ldots, ET_{MAY}{}^i{}_{t-1}), \qquad (2\text{-}5)$$

Production of dry season rice:

$$QI^i = YIiAIi\,,\ QI = \Sigma_i YI^iAI^i \qquad (2\text{-}6)$$

Yield function of upland rice:

$$YU^i = f_{YU}\,(T, ET_{MAY}{}^i, \ldots, ET_{NOV}{}^i), \qquad (2\text{-}7)$$

Area function of upland rice:

$$AU^i{}_t = f_{AU}\,(AU^i{}_{t-1}, FP_{t-1}, ET_{MAY}{}^i{}_{t-1}, \ , ET_{NOV}{}^i{}_{t-1}), \qquad (2\text{-}8)$$

Production of upland rice:

$$QU^i = YU^iAU^i\,,\ QU = \Sigma_i YU^iAU^i \qquad (2\text{-}9)$$

Total production:

$$Q = QL + QI + QU, \qquad (2\text{-}10)$$

Total supply:

$$QS = Q + IMP - STC, \qquad (2\text{-}11)$$

Demand function:

$$QS/POP = f_{QS}\,(RP, GDP/POP), \qquad (2\text{-}12)$$

Imports function:

$$IMP = f_{IMP}\,(WP \cdot EXR, Q), \qquad (2\text{-}13)$$

Price linkage function:

$$FP = f_{FP}\,(RP), \qquad (2\text{-}14)$$

where *T* is time trend, *ET_May* through *ET_Nov* are evapotranspiration values for May through November, *YL*, *AL*, and *QL* are yield, planted area, and production of wet season rice, i is the number of provinces, *YI*, *AI*, and *QI* are yield, planted area, and production of dry season rice, *YU*, *AU*, and *QU* are yield, planted area, and production of upland rice, *Q* is total production, *IMP* is imports, *STC* is the annual change in stocks, *POP* is population, *GDP* is gross domestic products, *WP* is the world price of rice (Thailand, 5% broken, FOB), *EXR* is the exchange rate, *FP* is the producer price of rice, and *RP* is the retail price of rice. All are specified as linear functions.

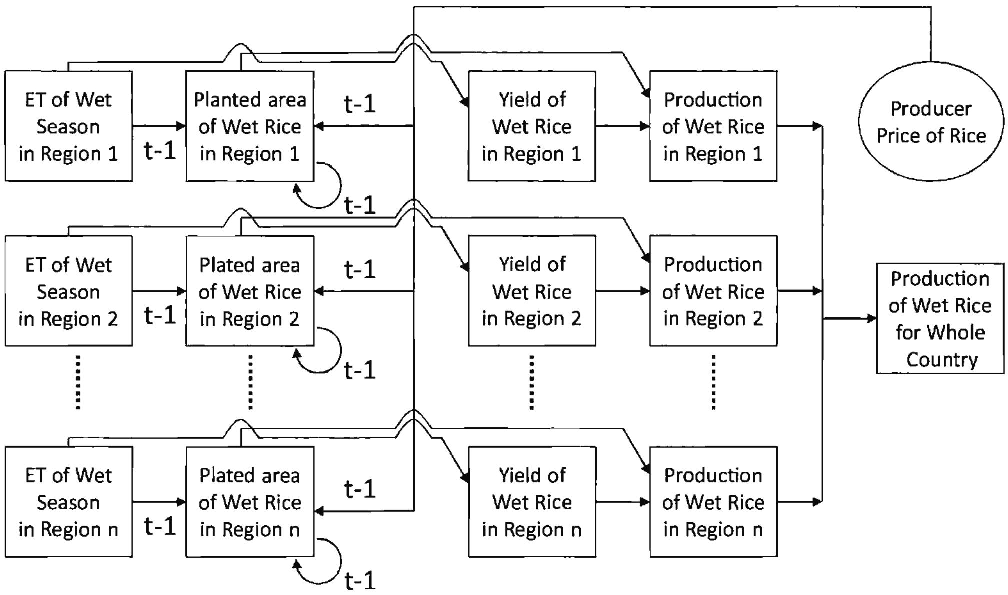

Fig. 2-1. Flowchart of wet season rice production sector

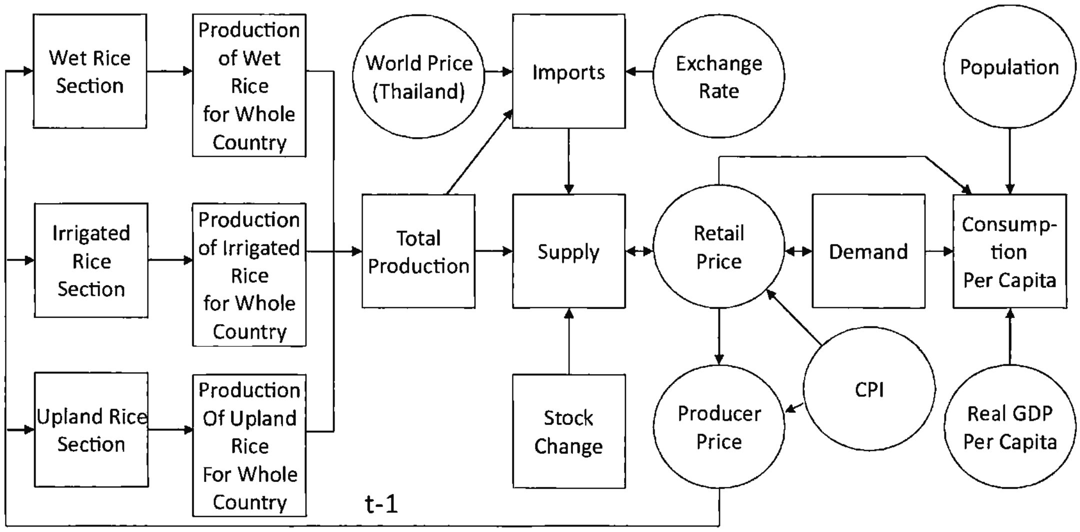

Fig. 2-2. Flowchart of supply and demand sector

Figure 2-1 and Figure 2-2 represent models for the wet season rice production sector and the overall supply and demand sector respectively. The model structures for irrigated and upland rice production sectors are same as those of the wet season rice production sector.

2-4. Data

The time series data for production and planted area for each province was provided by the Department of Planning in the Ministry of Agriculture and Forestry of Laos. The farm price for rice was obtained from FAO-STAT and the retail price of rice was obtained from the National Statistics Center of the Committee for Planning and Cooperation of Laos. The prices used represent a national average price for Laos. CPI, GDP, and population are from the Asian Development Bank and the exchange rate and the world price of rice are data from the IMF. The estimation period for functions (1) through (14) is from 1980 to 2000 which starts in the earliest available year for CPI and ends in the last year of available ET values. The estimation period includes the turning point of the Laotian economy because the trend of rice production in the statistics showed that the shock of the economic liberalization on the rice production was small.

The historical ET values are calculated by Ishigooka et al., 2005 and the calculation method is based on the Penman-Monteith equation (Allen et al., 1998). The climatic data for the calculation are 0.5 degree grid data and these are averaged for each province.

2-5. Estimation results of all functions

There are 17 provinces in Lao, and yield and planted area functions of wet season rice are estimated for all provinces.

Irrigated area is a small share of the total rice area in Laos, therefore, yield and area functions are estimated for only two provinces, Vientiane municipality and Savannakhet province. Yield and area of the other provinces are averaged and aggregated to the north region, central region excluding the two provinces, and south region.

These functions of upland rice are estimated for 15 provinces. There are no data of upland rice for Vientiane municiparity and Champasak province.

The estimated method is ordinary least square method (OLS) and time trends and some dummy variables are used for extreme climate or economic events.

2-5-1. Yield functions

2-5-1-1. Yield function of wet season rice (lowland rice)

2-5-1-1-1. Yield Function of Lowland Rice in Vientiane Mun.

YLH01=	+ 1.41350	
	(0.64)	
	+ 0.15216*TREND	
	(12.71)	
	- 0.09906*T90	
	(-5.28)	
	+ 0.76697*ET01MAY	
	(3.54)	[0.599]
	- 1.67357*ET01OCT	
	(-3.86)	[-1.223]
	+ 0.94395*ET01NOV	
	(3.16)	[0.648]
$AdjR^2$=0.9504		D.W.=1.728

YLH01	Yield of Lowland Rice in Vientiane Mun.
TREND	Time Trend from 1980 to 2000
T90	Time Trend from 1990 to 2000, 0 otherwise
ET01MAY	Evapotranspiration of May in Vientiane Mun.
ET01OCT	Evapotranspiration of October in Vientiane Mun.
ET01NOV	Evapotranspiration of November in Vientiane Mun.

2-5-1-1-2. Yield Function of Lowland Rice in Phongsaly

YLH02=	+ 2.38594	
	(1.19)	
	+ 0.14034*TREND	
	(26.60)	
	- 0.11489*T93	
	(-10.06)	
	+ 0.28520*ET02MAY	
	(3.05)	[0.221]
	+ 0.66032*ET02JUN	
	(3.12)	[0.510]
	- 0.55528*ET02JLY	
	(-2.14)	[-0.424]
	- 0.66466*ET02OCT	
	(-3.32)	[-0.502]
	+ 0.43447*D845	
	(8.60)	
	- 0.92268*D93	
	(-10.66)	
	- 0.70954*D956	
	(-13.33)	
$AdjR^2$=0.9876		D.W.=2.505

YLH02	Yield of Lowland Rice in Phongsaly
TREND	Time Trend from 1980 to 2000
T93	Time Trend from 1993 to 2000, 0 otherwise
ET02MAY	Evapotranspiration of May in Phongsaly
ET02JUN	Evapotranspiration of June in Phongsaly
ET02JLY	Evapotranspiration of July in Phongsaly
ET02OCT	Evapotranspiration of October in Phongsaly
D845	Dummy Variable, 1 in 1984 to 1985, 0 otherwise
D93	Dummy Variable, 1 in 1993, 0 otherwise
D956	Dummy Variable, 1 in 1995 to 1996, 0 otherwise

2-5-1-1-3. Yield Function of Lowland Rice in Luangnamtha

YLH03=	+ 5.66198	
	(3.56)	
	+ 0.21550*TREND	
	(12.31)	
	- 0.22559*T90	
	(-7.92)	
	- 0.70205*ET03MAR	
	(-3.95)	[-0.392]
	+ 0.33729*ET03APR	
	(2.30)	[0.204]
	- 0.72535*ET03MAY	
	(-2.29)	[-0.503]
	- 1.22712*D91	
	(-6.22)	
$AdjR^2$=0.9276		D.W.=2.366

YLH03	Yield of Lowland Rice in Luangnamtha
TREND	Time Trend from 1980 to 2000
T90	Time Trend from 1990 to 2000, 0 otherwise
ET03MAR	Evapotranspiration of March in Luangnamtha
ET03APR	Evapotranspiration of April in Luangnamtha
ET03MAY	Evapotranspiration of May in Luangnamtha
D91	Dummy Variable, 1 in 1991, 0 otherwise

2-5-1-1-4. Yield Function of Lowland Rice in Oudomxay

YLH04= - 7.63351
(-3.04)
+ 0.22887*TREND
(25.53)
- 0.24624*T90
(-17.80)
- 0.38784*ET04AUG
(-2.12) [-0.254]
+ 1.33188*ET04SEP
(2.87) [0.886]
+ 1.04487*ET04OCT
(3.41) [0.690]
- 0.46867*D924
(-7.80)
AdjR^2=0.9828 D.W.=1.822

YLH04	Yield of Lowland Rice in Oudomxay
TREND	Time Trend from 1980 to 2000
T90	Time Trend from 1990 to 2000, 0 otherwise
ET04AUG	Evapotranspiration of August in Oudomxay
ET04SEP	Evapotranspiration of September in Oudomxay
ET04OCT	Evapotranspiration of October in Oudomxay
D924	Dummy Variable, 1 in 1992 to 1994, 0 otherwise

2-5-1-1-5. Yield Function of Lowland Rice in Bokea

YLH05= + 0.11707
(14.52)
+ 0.73508*ET05MAY
(2.18) [0.499]
- 1.52907*ET05JUN
(-3.33) [-1.023]
+ 2.80079*ET05JLY
(3.47) [1.837]
+ 1.41703*ET05AUG
(3.53) [0.934]
- 0.87729*D92
(-3.47)
- 1.26539*SHIFT00
(-5.61)
AdjR^2=1.822 D.W.=2.155

YLH05	Yield of Lowland Rice in Bokea
ET05MAY	Evapotranspiration of May in Bokea
ET05JUN	Evapotranspiration of June in Bokea
ET05JLY	Evapotranspiration of July in Bokea
ET05AUG	Evapotranspiration of August in Bokea
D92	Dummy Variable, 1 in 1992, 0 otherwise
SHIFT00	Dummy Variable, 1 after 2000, 0 otherwise

2-5-1-1-6. Yield Function of Lowland Rice in Luangprabang

YLH06= - 6.55499
(-2.15)
+ 0.24501*TREND
(9.63)
- 0.20084*T86
(-6.67)
+ 0.33312*ET06ARP
(3.89) [0.221]
+ 1.40548*ET06SEP
(2.07) [1.024]
AdjR^2=0.9375 D.W.=2.394

YLH06	Yield of Lowland Rice in Luangprabang
TREND	Time Trend from 1980 to 2000
T86	Time Trend from 1986 to 2000, 0 otherwise
ET06ARP	Evapotranspiration of April in Luangprabang
ET06SEP	Evapotranspiration of September in Luangprabang

2-5-1-1-7. Yield Function of Lowland Rice in Huaphanh

YLH07= + 9.51059
(2.39)
+ 0.61266*TREND
(8.26)
- 0.55814*T84
(-6.95)
+ 0.79665*ET08MAY
(2.63) [0.564]
- 2.82517*ET08JLY
(-3.35) [1.992]
+ 0.62473*D89
(2.76)
AdjR^2=0.9226 D.W.=2.075

YLH07	Yield of Lowland Rice in Huaphanh
TREND	Time Trend from 1980 to 2000
T84	Time Trend from 1984 to 2000
ET07MAY	Evapotranspiration of May in Huaphanh
ET07JLY	Evapotranspiration of July in Huaphanh
D89	Dummy Variable, 1 in 1989, 0 otherwise

2-5-1-1-8. Yield Function of Lowland Rice in Xayabury

YLH08= - 31.07729
(-4.61)
+ 0.07559*TREND
(9.03)
- 0.41746*ET08MAR
(-2.56) [-0.230]
+ 1.23084*ET08JUN
(2.43) [0.880]
+ 2.00308*ET08SEP
(2.10) [1.411]
+ 4.74911*ET08NOV
(5.09) [3.221]
AdjR^2=0.8762 D.W.=2.622

YLH08	Yield of Lowland Rice in Xayabury
TREND	Time Trend from 1980 to 2000
ET08MAR	Evapotranspiration of March in Xayabury
ET08JUN	Evapotranspiration of June in Xayabury
ET08SEP	Evapotranspiration of September in Xayabury
ET08NOV	Evapotranspiration of November in Xayabury

2-5-1-1-9. Yield Function of Lowland Rice in Xiengkhuang

YLH09= + 4.37166
(1.16)
+ 0.38932*TREND
(7.41)
- 0.33745*T84
(-6.09)
+ 1.22831*ET09MAR
(4.86) [0.741]
- 1.94472*ET09JUN
(-3.80) [-1.438]
+ 1.32462*ET09SEP
(2.13) [0.982]
- 1.42360*ET09OCT
(-2.83) [-1.064]
AdjR^2=0.9121 D.W.=2.473

YLH09 Yield of Lowland Rice in Xiengkhuang
TREND Time Trend from 1980 to 2000
T84 Time Trend from 1984 to 2000, 0 otherwise
ET09MAR Evapotranspiration of March in Xiengkhuang
ET09JUN Evapotranspiration of June in Xiengkhuang
ET09SEP Evapotranspiration of September in Xiengkhuang
ET09OTC Evapotranspiration of October in Xiengkhuang

2-5-1-1-10. Yield Function of Lowland Rice in Vientiane

YLH10= + 0.12911
(0.03)
+ 0.43839*TREND
(8.24)
- 0.38372*T84
(-6.85)
+ 1.48876*ET10MAY
(5.80) [0.984]
- 2.21065*ET10JUN
(-4.56) [-1.435]
+ 2.08830*ET10SEP
(3.41) [1.355]
- 1.19108*ET10OCT
(-2.28) [-0.781]
- 0.53829*SHIFT00
(-2.99)
AdjR^2=0.9205 D.W.=1.824

YLH10 Yield of Lowland Rice in Vientiane
TREND Time Trend from 1980 to 2000
T84 Time Trend from 1984 to 2000, 0 otherwise
ET10MAY Evapotranspiration of May in Vientiane
ET10JUN Evapotranspiration of Junc in Vientiane
ET10SEP Evapotranspiration of September in Vientiane
ET10OCT Evapotranspiration of October in Vientiane
SHIFT00 Dummy Variable, 1 after 2000, 0 otherwise

2-5-1-1-11. Yield Function of Lowland Rice in Borikhamxay

YLH11= - 4.10774
(-1.64)
+ 0.49191*TREND
(2.46)
- 0.40897*T82
(-2.02)
- 0.29632*ET11MAR
(-2.68) [-0.228]
+ 0.39164*ET11APR
(4.58) [0.328]
- 1.43455*ET11JUN
(-2.68) [-1.343]
+ 1.24675*ET11JLY
(2.01) [1.167]
+ 1.10256*ET11AUG
(3.08) [1.017]
- 0.50009*D93
(-3.29)
AdjR^2=0.9394 D.W.=1.862

YLH11 Yield of Lowland Rice in Borikhamxay
TREND Time Trend from 1980 to 2000
T82 Time Trend from 1982 to 2000, 0 otherwise
ET11MAR Evapotranspiration of March in Borikhamxay
ET11APR Evapotranspiration of April in Borikhamxay
ET11JUN Evapotranspiration of June in Borikhamxay
ET11JLY Evapotranspiration of July in Borikhamxay
ET11AUG Evapotranspiration of August in Borikhamxay
D93 Dummy Variable, 1 in 1993, 0 otherwise

2-5-1-1-12. Yield Function of Lowland Rice in Khammuane

YLH12= + 14.51833
(3.66)
+ 0.50015*TREND
(6.09)
- 0.45942*T84
(-5.32)
- 0.40583*ET12MAR
(-2.81) [-0.271]
+ 1.02754*ET12MAY
(5.45) [0.851]
- 2.37920*ET12JUN
(-4.47) [-1.974]
- 1.41696*ET12OCT
(-2.19) [-1.207]
- 1.51262*D88
(-5.99)
- 0.79501*D93
(-3.76)
AdjR^2=0.8804 D.W.=2.593

YLH12 Yield of Lowland Rice in Khammuane
TREND Time Trend from 1980 to 2000
T84 Time Trend from 1984 to 2000, 0 otherwise
ET12MAR Evapotranspiration of March in Khammuane
ET12MAY Evapotranspiration of May in Khammuane
ET12JUN Evapotranspiration of June in Khammuane
ET12OCT Evapotranspiration of October in Khammuane
D88 Dummy Variable, 1 in 1988, 0 otherwise
D93 Dummy Variable, 1 in 1993, 0 otherwise

2-5-1-1-13. Yield Function of Lowland Rice in Savannakhet

YLH13= + 4.27109
(1.88)
+ 0.35008*TREND
(5.94)
- 0.30109*T84
(-4.66)
+ 0.76054*ET13MAY
(3.56) [0.573]
- 1.45541*ET13JLY
(-2.77) [-1.118]
- 1.71606*D88
(-9.70)
- 0.46290*D93
(-2.79)
$AdjR^2$= 0.9437 D.W.=2.052

YLH13	Yield of Lowland Rice in Savannakhet
TREND	Time Trend from 1980 to 2000
T84	Time Trend from 1984 to 2000, 0 otherwise
ET13MAY	Evapotranspiration of May in Savannakhet
ET13JLY	Evapotranspiration of July in Savannakhet
D88	Dummy Variable, 1 in 1988, 0 otherwise
D93	Dummy Variable, 1 in 1993, 0 otherwise

2-5-1-1-14. Yield Function of Lowland Rice in Saravane

YLH14= + 18.84528
(4.34)]
+ 0.51017*TREND
(5.96)
- 0.47213*T84
(-5.09)
- 2.90249*ET14JLY
(-3.70) [-2.202]
- 1.13524*ET14SEP
(-2.15) [-0.850]
- 1.10894*D98
(-4.60)
$AdjR^2$=0.8636 D.W.=1.495

YLH14	Yield of Lowland Rice in Saravane
TREND	Time Trend from 1980 to 2000
T84	Time Trend from 1984 to 2000, 0 otherwise
ET14JLY	Evapotranspiration of July in Saravane
ET14SEP	Evapotranspiration of September in Saravane
D98	Dummy Variable, 1 in 1982, 0 otherwise

2-5-1-1-15. Yield Function of Lowland Rice in Sekong

YLH15= - 6.57882
(-2.06)
+ 0.03889*TREND
(4.17)
+ 0.39730*T9294
(8.73)
+ 0.40307*ET15MAR
(2.76) [0.284]
+ 1.41744*ET15JUN
(2.84) [1.165]
- 1.28748*ET15JLY
(-2.63) [-1.061]
+ 1.21379*ET15AUG
(2.56) [1.004]
+ 1.57427*ET15OCT
(4.53) [1.289]
- 1.43919*ET15NOV
(-3.46) [-1.178]
+ 0.87315*D846
(8.72)
+ 0.75926*SHIFT00
(4.37)
$AdjR^2$=0.958 D.W.=2.585

YLH15	Yield of Lowland Rice in Sekong
TREND	Time Trend from 1980 to 2000
T9294	Time Trend from 1992 to 1994, 0 otherwise
ET15MAR	Evapotranspiration of March in Sekong
ET15JUN	Evapotranspiration of June in Sekong
ET15JLY	Evapotranspiration of July in Sekong
ET15AUG	Evapotranspiration of August in Sekong
ET15OCT	Evapotranspiration of October in Sekong
ET15NOV	Evapotranspiration of November in Sekong
D846	Dummy Variable, 1 in 1984 to 1986, 0 otherwise
SHIFT00	Dummy Variable, 1 after 2000, 0 otherwise

2-5-1-1-16. Yield Function of Lowland Rice in Champasack

YLH16= - 7.46465
(-2.49)
+ 0.02978*TREND
(3.63)
- 0.71741*ET16MAR
(-5.16) [-0.389]
- 1.96447*ET16JUN
(-5.06) [-1.532]
+ 1.46027*ET16SEP
(3.54) [1.129]
+ 3.06727*ET16OCT
(7.06) [2.441]
- 0.66619*D812
(-4.66)
+ 0.58777*D846
(5.65)
+ 0.71947*SHIFT00
(4.14)
$AdjR^2$=0.9199 D.W.=2.768

YLH16	Yield of Lowland Rice in Champasack
TREND	Time Trend from 1980 to 2000
ET16MAR	Evapotranspiration of March in Champasack
ET16JUN	Evapotranspiration of June in Champasack
ET16SEP	Evapotranspiration of September in Champasack
ET16OCT	Evapotranspiration of October in Champasack
D812	Dummy Variable, 1 in 1981 to 1982, 0 otherwise
D846	Dummy Variable, 1 in 1984 to 1986, 0 otherwise
SHIFT00	Dummy Variable, 1 after 2000, 0 otherwise

2-5-1-1-17. Yield Function of Lowland Rice in Attapeu

YLH17= - 3.21988

(-0.90)
+ 0.01754*TREND
(2.29)
- 0.91118*ET17JUN
(-3.10) [-0.725]
+ 1.30282*ET17AUG
(2.68) [1.041]
+ 0.92477*ET17SEP
(3.06) [0.726]
- 0.98006*ET17OCT
(-2.50) [-0.782]
+ 0.93113*ET17NOV
(2.42) [0.745]
- 0.70824*D803
(-6.46)
- 1.17524*D88
(-6.73)
- 0.89641*D98
(-6.39)

$AdjR^2$=0.922 D.W.=2.521

YLH17	Yield of Lowland Rice in Attapeu
TREND	Time Trend from 1980 to 2000
ET17JUN	Evapotranspiration of June in Attapeu
ET17AUG	Evapotranspiration of August in Attapeu
ET17SEP	Evapotranspiration of September in Attapeu
ET17OCT	Evapotranspiration of October in Attapeu
ET17NOV	Evapotranspiration of November in Attapeu
D803	Dummy Variable, 1 in 1980 to 1983, 0 otherwise
D88	Dummy Variable, 1 in 1988, 0 otherwise
D98	Dummy Variable, 1 in 1998, 0 otherwise

2-5-1-2. Yield function of irrigated rice (dry season rice)

2-5-1-2-1. Yield Function of Irrigated Rice in Vientiane Municiparity.

YIH01= + 5.11881
(3.65)
+ 0.12231*T82
(22.78)
- 1.55728*ET01NOV(t-1)
(-3.22) [-0.898]
+ 0.95342*ET01DEC(t-1)
(4.29) [0.488]
+ 0.31563*ET01FEB
(2.75) [0.131]
- 0.23937*ET01MAR
(-2.57) [-0.112]
+ 1.94770*D801
(13.23)
+ 0.27719*D867
(3.02)
+ 0.73267*D90
(4.72)

$AdjR^2$=0.9914 D.W.=2.414

YIH01	Yield of Irrigated Rice in Vientiane Mun.
T82	Time Trend from 1982 to 2000, 0 otherwise
ET01NOV	Evapotranspiration of November in Vientiane Mun.
ET01DEC	Evapotranspiration of December in Vientiane Mun.
ET01FEB	Evapotranspiration of February in Vientiane Mun.
ET01MAR	Evapotranspiration of March in Vientiane Mun.
D801	Dummy Variable, 1 in 1980 to 1981, 0 otherwise
D867	Dummy Variable, 1 in 1986 to 1987, 0 otherwise
D90	Dummy Variable, 1 in 1990, 0 otherwise

2-5-1-2-2. Yield Function of Irrigated Rice in Savannakhet

YIH13= - 0.95591
(-1.31)
+ 0.14845*T82
(14.04)
- 0.67468*ET13DEC(t-1)
(3.40) [-0.412]
- 0.85887*D81
(3.02)
- 0.62802*D857
(3.63)

$AdjR^2$=0.9190 D.W.=1.894

YIH13	Yield of Irrigated Rice in Savannakhet
T82	Time Trend from 1982 to 2000, 0 otherwise
ET13DEC	Evapotranspiration of December in Savannakhet
D81	Dummy Variable, 1 in 1981, 0 otherwise
D857	Dummy Variable, 1 in 1985 to 1987, 0 otherwise

2-5-1-2-3. Yield Function of Irrigated Rice in North Region

YIHN= + 7.66036
(2.43)
+ 0.10050*TREND
(14.01)
- 2.34302*ETNNOV(t-1)
(-2.67) [-1.648]
+ 0.93688*ETNDEC(t-1)
(3.64) [0.619]
+ 0.55173*D98
(2.62)

$AdjR^2$=0.9276 D.W.=2.541

YIHN	Yield of Irrigated Rice in North Region
TREND	Time Trend from 1980 to 2000
ETNNOV	Evapotranspiration of November in North Region
ETNDEC	Evapotranspiration of December in North Region
D98	Dummy Variable, 1 in 1998, 0 otherwise

2-5-1-2-4a. Yield Function of Irrigated Rice in Central Region

(including 01 and 13)

YIHC= - 10.94278
(-4.31)
+ 0.13108*TREND
(24.38)
+ 2.78103*ETCNOV(t-1)
(4.26) [1.618]
- 0.72572*ETCDEC(t-1)
(-2.45) [-0.385]
- 0.32143*ETCAPR

(-3.01) [-0.171]
+ 1.07729*ETCMAY
(3.80) [0.647]
- 0.59786*D98
(-3.14)
AdjR^2=0.9728 D.W.=1.990

YIHC Yield of Irrigated Rice in Central Region
TREND Time Trend from 1980 to 2000
ETCNOV Evapotranspiration of November in Central Region
ETCDEC Evapotranspiration of December in Central Region
ETCAPR Evapotranspiration of April in Central Region
ETCMAY Evapotranspiration of May in Central Region
D98 Dummy Variable, 1 in 1998, 0 otherwise

2-5-1-2-4b. Yield Function of Irrigated Rice in Other Central Region (Excluding 01 and 13)

YIHOC= - 37.82907
(-2.77)
+ 0.56928*TREND
(14.82)
+ 9.56978*ETOCNOV(t-1)
(3.19) [1.979]
- 7.87553*ETOCDEC(t-1)
(-4.32) [-1.482]
+ 3.92656*ETOCJAN
(2.91) [0.649]
- 1.92335*ETOCFEB
(-2.48) [-0.301]
+ 5.02468*ETOCMAY
(3.25) [1.081]
+ 2.17725*D857
(3.03)
- 3.69845*D89
(-3.35)
AdjR^2=0.9401 D.W.=2.149

YIHOC Yield of Irrigated Rice in Other Central Region
TREND Time Trend from 1980 to 2000
ETOCNOV Evapotranspiration of November in Other Central Region
ETOCDEC Evapotranspiration of December in Other Central Region
ETOCJAN Evapotranspiration of January in Other Central Region
ETOCFEB Evapotranspiration of February in Other Central Region
ETOCMAY Evapotranspiration of May in Other Central Region
D857 Dummy Variable, 1 in 1985 to 1987, 0 otherwise
D89 Dummy Variable, 1 in 1989, 0 otherwise

2-5-1-2-5. Yield Function of Irrigated Rice in South Region

YIHS= + 4.36084
(1.32)
+ 0.11238*TREND
(13.23)
+ 0.89710*ETSJAN
(3.29) [0.552]
- 0.96686*ETSAPR
(-4.04) [-0.549]
+ 0.92542*ETSMAY
(2.20) [0.526]
- 1.49482*ETSJUN
(-2.57) [-1.000]
- 0.62043*D801
(-3.94)
- 1.32285*D94
(-6.24)
+ 0.97119*D97
(4.42)
AdjR^2=0.9647 D.W.=2.510

YIHS Yield of Irrigated Rice in South Region
TREND Time Trend from 1980 to 2000
ETSJAN Evapotranspiration of January in South Region
ETSAPR Evapotranspiration of April in South Region
ETSMAY Evapotranspiration of May in South Region
ETSJUN Evapotranspiration of June in South Region
D801 Dummy Variable, 1 in 1980 to 1981, 0 otherwise
D94 Dummy Variable, 1 in 1994, 0 otherwise
D97 Dummy Variable, I in 1997, 0 otherwise

2-5-1-3. Yield function of upland rice

2-5-1-3-1. Yield Function of Upland Rice in Phongsaly

YUH02= + 2.97859
(1.52)
+ 0.03296*TREND
(10.54)
+ 0.21401*ET02APR
(3.90) [0.300]
+ 0.72465*ET02JUN
(3.14) [1.129]
- 0.93818*ET02SEP
(-2.94) [-1.456]
- 0.45164*ET02OCT
(-1.97) [-0.688]
- 0.50637*D93
(5.18)
AdjR^2=0.8681 D.W.=2.382

YUH02 Yield of Upland Rice in Phongsaly
TREND Time Trend from 1980 to 2000
ET02APR Evapotranspiration of April in Phongsaly
ET02JUN Evapotranspiration of June in Phongsaly
ET02SEP Evapotranspiration of September in Phongsaly
ET02OCT Evapotranspiration of October in Phongsaly
D93 Dummy Variable, 1 in 1993, 0 otherwise

2-5-1-3-2. Yield Function of Upland Rice in Luangnamtha

YUH03= + 5.78085
(4.01)
+ 0.03275*TREND
(12.04)
- 0.46538*ET03JUN
(-2.76) [-0.633]
- 0.60473*ET03OCT

(-2.66) [-0.813]
+ 0.32814*D80
(4.26)
- 0.35044*D912
(-6.14)
+ 0.18857*D935
(4.47)
AdjR^2=0.9299 D.W.=1.902

YUH03 Yield of Upland Rice in Luangnamtha
TREND Time Trend from 1980 to 2000
ET03JUN Evapotranspiration of June in Luangnamtha
ET03OCT Evapotranspiration of October in Luangnamtha
D80 Dummy Variable, 1 in 1980, 0 otherwise
D912 Dummy Variable, 1 in 1991 to 1992, 0 otherwise
D935 Dummy Variable, 1 in 1993 to 1995, 0 otherwise

2-5-1-3-3. Yield Function of Upland Rice in Oudomxay

YUH04= - 5.62900
(-2.01)
+ 0.23653*T8087
(26.62)
- 0.21243*ET04APR
(-3.05) [-0.256]
- 1.33144*ET04JUN
(-4.57) [-1.778]
+ 1.94699*ET04SEP
(3.70) [2.595]
+ 1.23437*ET04OCT
(3.62) [1.632]
- 0.68520*D92
(-5.56)
- 0.45059*D94
(-4.41)
AdjR^2=0.9807 D.W.=1.675

YUH04 Yield of Upland Rice in Oudomxay
T8087 Time Trend from 1980 to 1987, 0 otherwise
ET04APR Evapotranspiration of April in Oudomxay
ET04JUN Evapotranspiration of June in Oudomxay
ET04SEP Evapotranspiration of September in Oudomxay
ET04OCT Evapotranspiration of October in Oudomxay
D92 Dummy Variable, 1 in 1992, 0 otherwise
D94 Dummy Variable, 1 in 1994, 0 otherwise

2-5-1-3-4. Yield Function of Upland Rice in Bokea

YUH05= - 17.01209
(-5.51)
+ 0.03385*T8087
(7.33)
+ 0.10269*ET05APR
(2.51) [0.103]
+ 0.46675*ET05JUN
(3.05) [0.540]
+ 1.26308*ET05JLY
(4.40) [1.433]
- 0.67638*ET05AUG
(-5.45) [-0.771]
+ 1.25383*ET05SEP
(4.37) [1.446]
+ 1.86612*ET05NOV
(6.28) [2.037]
+ 0.35449*D901
(7.36)
- 0.32928*D96
(-5.18)
AdjR^2=0.9064 D.W.=2.270

YUH05 Yield of Upland Rice in Bokea
T8087 Time Trend from 1980 to 1987, 0 otherwise
ET05APR Evapotranspiration of April in Bokea
ET05JUN Evapotranspiration of June in Bokea
ET05JLY Evapotranspiration of July in Bokea
ET05AUG Evapotranspiration of August in Bokea
ET05SEP Evapotranspiration of September in Bokea
ET05NOV Evapotranspiration of November in Bokea
D901 Dummy Variable, 1 in 1990 to 1991, 0 otherwise
D96 Dummy Variable, 1 in 1996, 0 otherwise

2-5-1-3-5. Yield Function of Upland Rice in Luangprabang

YUH06= + 18.20088
(3.12)
+ 0.02692*TREND
(7.82)
+ 0.17182*ET06MAR
(2.49) [0.193]
- 0.90024*ET06JLY
(-2.60) [-1.233]
- 1.37345*ET06SEP
(-2.17) [-1.905]
- 0.96070*ET06OCT
(-2.49) [-1.326]
- 0.76463*ET06NOV
(-2.10) [-1.005]
+ 0.36720*D95
(4.10)
+ 0.29710*D98
(2.55)
AdjR^2=0.8474 D.W.=2.422

YUH06 Yield of Upland Rice in Luangprabang
TREND Time Trend from 1980 to 2000
ET06MAR Evapotranspiration of March in Luangprabang
ET06JLY Evapotranspiration of July in Luangprabang
ET06SEP Evapotranspiration of September in Luangprabang
ET06OCT Evapotranspiration of October in Luangprabang
ET06NOV Evapotranspiration of November in Luangprabang
D95 Dummy Variable, 1 in 1995, 0 otherwise
D98 Dummy Variable, 1 in 1998, 0 otherwise

2-5-1-3-6. Yield Function of Upland Rice in Huaphanh

YUH07= - 17.34615
(-4.34)
+ 0.03664*TREND
(5.03)
+ 2.82176*ET08JUN

(5.18) [3.808]
+ 1.52572*ET08OCT
(3.05) [2.026]
- 1.06600*D803
(-10.34)
+ 0.59251*D94
(3.74)
$AdjR^2$=0.9648 D.W.=2.075

YUH07	Yield of Upland Rice in Huaphanh
TREND	Time Trend from 1980 to 2000
ET07JUN	Evapotranspiration of June in Huaphanh
ET07OCT	Evapotranspiration of October in Huaphanh
D803	Dummy Variable, 1 in1980 to 1983, 0 otherwise
D94	Dummy Variable, 1 in 1994, 0 otherwise

2-5-1-3-7. Yield Function of Upland Rice in Xayabury

YUH08= + 8.44733
(5.79)
+ 0.04492*TREND
(10.38)
- 0.98298*ET08JUN
(-4.48) [-1.271]
- 0.70610*ET08AUG
(-3.13) [-0.892]
- 0.31016*D87
(-3.01)
+ 0.49883*D89
(4.87)
- 0.36290 *SHIFT99
(-4.06)
$AdjR^2$=0.8858 D.W.=2.464

YUH08	Yield of Upland Rice in Xayabury
TREND	Time Trend from 1980 to 2000
ET08JUN	Evapotranspiration of June in Xayabury
ET08AUG	Evapotranspiration of August in Xayabury
D87	Dummy Variable, 1 in 1987, 0 otherwise
D89	Dummy Variable, 1 in 1989, 0 otherwise
SHIFT99	Dummy Variable, 1 after 1999, 0 otherwise

2-5-1-3-8. Yield Function of Upland Rice in Xiengkhuang

YUH09= - 15.73220
(-5.65)
+ 0.02125*TREND
(8.44)
+ 0.58315*ET09MAY
(4.90) [0.758]
+ 1.22050*ET09JLY
(4.14) [1.549]
- 0.65885*ET09AUG
(-3.64) [-0.826]
+ 1.59956*ET09SEP
(5.71) [2.048]
+ 0.49705*ET09OCT
(2.19) [0.641]
+ 0.57695*ET09NOV
(3.52) [0.706]
- 0.25746*D83
(-3.06)
+ 0.16736*D90
(2.26)
+ 0.37711*D92
(4.91)
$AdjR^2$=0.8959 D.W.=2.409

YUH09	Yield of Upland Rice in Xiengkhuang
TREND	Time Trend from 1980 to 2000
ET09MAY	Evapotranspiration of May in Xiengkhuang
ET09JLY	Evapotranspiration of July in Xiengkhuang
ET09AUG	Evapotranspiration of August in Xiengkhuang
ET09SEP	Evapotranspiration of September in Xiengkhuang
ET09OTC	Evapotranspiration of October in Xiengkhuang
ET09NOV	Evapotranspiration of November in Xiengkhuang
D83	Dummy Variable, 1 in 1983, 0 otherwise
D90	Dummy Variable, 1 in 1990, 0 otherwise
D92	Dummy Variable, 1 in 1992, 0 otherwise

2-5-1-3-9. Yield Function of Upland Rice in Vientiane

YUH10= - 14.14342
(-7.84)
+ 0.02490*TREND
(11.60)
+ 0.20732*ET10MAR
(5.14) [0.228]
+ 0.07054*ET10APR
(2.04) [0.089]
+ 1.68969*ET10JLY
(6.48) [2.339]
+ 1.54062*ET10SEP
(6.85) [2.146]
- 0.42415*D83
(-6.25)
- 0.20204*D93
(-3.23)
- 0.17020*D97
(-2.85)
$AdjR^2$=0.9394 D.W.=2.182

YUH10	Yield of Upland Rice in Vientiane
TREND	Time Trend from 1980 to 2000
ET10MAR	Evapotranspiration of March in Vientiane
ET10APR	Evapotranspiration of April in Vientiane
ET10JLY	Evapotranspiration of July in Vientiane
ET10SEP	Evapotranspiration of September in Vientiane
D83	Dummy Variable, 1 in 1983, 0 otherwise
D93	Dummy Variable, 1 in 1993, 0 otherwise
D97	Dummy Variable, 1 in 1997, 0 otherwise

2-5-1-3-10. Yield Function of Upland Rice in Borikhamxay

YUH11= - 1.35070
(-0.87)
+ 0.09258*TREND
(28.61)
+ 0.27683*ET11MAY
(2.67) [0.365]

+ 0.92119*ET11AUG
(4.36) [1.188]
- 1.38712*ET11OCT
(-5.00) [-1.861]
+ 0.78808*ET11NOV
(5.22) [1.009]
+ 0.42805*D845
(5.97)
- 0.29626*D93
(-3.28)
- 0.31136*D95
(-3.20)

$AdjR^2$=0.9779 D.W.=1.827

YUH11	Yield of Upland Rice in Borikhamxay
TREND	Time Trend from 1980 to 2000
ET11MAY	Evapotranspiration of May in Borikhamxay
ET11AUG	Evapotranspiration of August in Borikhamxay
ET11OCT	Evapotranspiration of October in Borikhamxay
ET11NOV	Evapotranspiration of November in Borikhamxay
D845	Dummy Variable, 1 in 1984 to 1985, 0 otherwise
D93	Dummy Variable, 1 in 1993, 0 otherwise
D95	Dummy Variable, 1 in 1995, 0 otherwise

2-5-1-3-11. Yield Function of Upland Rice in Khammuane

YUH12= + 1.37801
(1.03)
+ 0.01286*TREND
(4.59)
+ 0.20949*ET12MAR
(5.23) [0.247]
+ 0.57628*ET12JLY
(3.64) [0.843]
+ 0.40961*ET12AUG
(3.00) [0.593]
- 1.15021*ET12OCT
(-5.65) [-1.734]
- 0.26565*D812
(-5.14)
- 0.34834*D83
(-4.53)
+ 0.34027*D87
(4.50)

$AdjR^2$=0.9126 D.W.=2.065

YUH12	Yield of Upland Rice in Khammuane
TREND	Time Trend from 1980 to 2000
ET12MAR	Evapotranspiration of March in Khammuane
ET12JLY	Evapotranspiration of July in Khammuane
ET12AUG	Evapotranspiration of August in Khammuane
ET12OCT	Evapotranspiration of October in Khammuane
D812	Dummy Variable, 1 in 1981 to 1982, 0 otherwise
D83	Dummy Variable, 1 in 1983, 0 otherwise
D87	Dummy Variable, 1 in 1987, 0 otherwise

2-5-1-3-12. Yield Function of Upland Rice in Savannakhet

YUH13= - 3.56596
(-2.95)
+ 0.04120*TREND
(16.76)
- 0.16700*ET13APR
(-2.53) [-0.209]
+ 0.44068*ET13MAY
(3.22) [0.628]
- 0.72157*ET13AUG
(-4.24) [-1.041]
+ 0.93468*ET13SEP
(5.97) [1.349]
+ 0.47253*ET13OCT
(2.79) [0.697]
+ 0.17427*D90
(2.81)
- 0.20587*D99
(-3.16)

$AdjR^2$=0.9532 D.W.=1.839

YUH13	Yield of Upland Rice in Savannakhet
TREND	Time Trend from 1980 to 2000
ET13APR	Evapotranspiration of April in Savannakhet
ET13MAY	Evapotranspiration of May in Savannakhet
ET13AUG	Evapotranspiration of August in Savannakhet
ET13SEP	Evapotranspiration of September in Savannakhet
ET13OCT	Evapotranspiration of October in Savannakhet
D90	Dummy Variable, 1 in 1990, 0 otherwise
D99	Dummy Variable, 1 in 1999, 0 otherwise

2-5-1-3-13. Yield Function of Upland Rice in Saravane

YUH14= + 2.59027
(1.11)
+ 0.02284*TREND
(3.41)
- 1.56756*ET14JUN
(-3.57) [-2.110]
+ 1.28597*ET14JLY
(2.27) [1.738]
- 0.32862*D812
(-2.72)
- 0.77331*D88
(-5.08)
- 1.16783*D98
(-7.68)

$AdjR^2$=0.8382 D.W.=1.679

YUH14	Yield of Upland Rice in Saravane
TREND	Time Trend from 1980 to 2000
ET14JUN	Evapotranspiration of June in Saravane
ET14JLY	Evapotranspiration of July in Saravane
D812	Dummy Variable, 1 in 1981 to 1982, 0 otherwise
D88	Dummy Variable, 1 in 1988, 0 otherwise
D98	Dummy Variable, 1 in 1998, 0 otherwise

2-5-1-3-14. Yield Function of Upland Rice in Sekong

YUH15= + 5.54098
(2.75)
+ 0.04253*TREND

(7.08)
- 0.31172*ET15MAR
(-3.22) [-0.416]
- 0.97624*ET15JUN
(-2.90) [-1.520]
+ 0.89644*ET15JLY
(2.56) [1.399]
- 0.70735*ET15AUG
(-2.34) [-1.109]
+ 0.19795*D847
(3.30)
- 0.69819*D88
(-6.83)
+ 0.25297*D934
(3.43)
$AdjR^2$=0.8811 D.W.=2.403

YUH15	Yield of Upland Rice in Sekong
TREND	Time Trend from 1980 to 2000
ET15MAR	Evapotranspiration of March in Sekong
ET15JUN	Evapotranspiration of June in Sekong
ET15JLY	Evapotranspiration of July in Sekong
ET15AUG	Evapotranspiration of August in Sekong
D847	Dummy Variable, 1 in 1984 to 1987, 0 otherwise
D88	Dummy Variable, 1 in 1988, 0 otherwise
D934	Dummy Variable, 1 in 1993 to 1994, 0 otherwise

2-5-1-3-15. Yield Function of Upland Rice in Attapeu

YUH17= - 5.55920
(-2.63)
+ 0.03612*TREND
(8.74)
- 0.32121*ET17MAR
(-2.99) [-0.410]
- 0.93452*ET17JUN
(-3.21) [-1.480]
+ 1.05715*ET17JLY
(2.91) [1.673]
+ 0.90497*ET17SEP
(4.19) [1.415]
+ 0.67149*ET17OCT
(2.92) [1.067]
- 0.26188*D873
(-6.52)
+ 0.50360*D89
(5.51)
- 0.53853*D98
(-5.86)
$AdjR^2$=0.8782 D.W.=2.178

YUH17	Yield of Upland Rice in Attapeu
TREND	Time Trend from 1980 to 2000
ET17MAR	Evapotranspiration of March in Attapeu
ET17JUN	Evapotranspiration of June in Attapeu
ET17JLY	Evapotranspiration of July in Attapeu
ET17SEP	Evapotranspiration of September in Attapeu
ET17OCT	Evapotranspiration of October in Attapeu
D873	Dummy Variable, 1 in 1987 to 1993, 0 otherwise
D89	Dummy Variable, 1 in 1989, 0 otherwise
D98	Dummy Variable, 1 in 1998, 0 otherwise

2-5-2. Planted area functions

2-5-2-1. Area function of wet season rice (lowland rice)

2-5-2-1-1. Area Function of Lowland Rice in Vientiane Municipality

APL01= + 48.09605
(9.43)
+ 0.07999*APL01(t-1)
(0.98)
+ 7.66162*[FPR(t-1)/CPI(t-1)/100]
(2.01) [0.048]
+ 1.01097*T87
(8.67)
- 0.12314*ET01JUN(t-1)
(-2.55) [-0.263]
- 0.09390*ET01AUG(t-1)
(-2.32) [-0.189]
- 18.76004*D95
(-11.55)
$AdjR^2$=0.9303 D.W.=2.179

APL01	Planted Area of Lowland Rice in Vientiane Mun.
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
T87	Time Trend from 1987 to 2000, 0 otherwise
ET01JUN	Evapotranspiration of June in Vientiane Mun.
ET01AUG	Evapotranspiration of August in Vientiane Mun.
D95	Dummy Variable, 1 in 1995, 0 otherwise

2-5-2-1-2. Area Function of Lowland Rice in Phongsaly

APL02= - 0.92726
(-1.25)
+ 0.10490*APL02(t-1)
(1.79)
+ 1.46287*[FPR(t-1)/CPI(t-1)/100]
(2.82) [0.074]
+ 0.07483*T83
(6.69)
- 0.01077*ET02APR(t-1)
(-5.47) [-0.129]
+ 0.01071*ET02MAY(t-1)
(4.82) [0.206]
+ 0.01852*ET02SEP(t-1)
(3.54) [0.334]
+ 0.01779*ET02OCT(t-1)
(4.41) [0.297]
+ 0.01335*ET02NOV(t-1)
(2.39) [0.181]
- 0.35942*D83
(-2.58)
$AdjR^2$=0.9546 D.W.=2.438

APL02	Planted Area of Lowland Rice in Phongsaly
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)

T83 Time Trend from 1983 to 2000, 0 otherwise
ET02APR Evapotranspiration of April in Phongsaly
ET02MAY Evapotranspiration of May in Phongsaly
ET02SEP Evapotranspiration of September in Phongsaly
ET02OCT Evapotranspiration of October in Phongsaly
ET02NOV Evapotranspiration of November in Phongsaly
D83 Dummy Variable, 1 in 1983, 0 otherwise

2-5-2-1-3. Area Function of Lowland Rice in Luangnamtha

APL03= + 12.29642
(5.08)
+ 0.58906*APL03(t-1)
(6.54)
+ 2.03624*[FPR(t-1)/CPI(t-1)/100]
(0.96) [0.084]
- 0.05309*ET03MAR(t-1)
(-3.42) [-0.328]
- 0.04042*ET03MAY(t-1)
(-3.01) [-0.599]
- 0.05092*ET03JUN(t-1)
(-2.39) [-0.726]
- 3.06307*D845
(-4.08)
- 1.91123*D912
(-2.85)
AdjR^2=0.9105 D.W.=2.151

APL03 Planted Area of Lowland Rice in Luangnamtha
FPR Farm Price of Laos Rice (thousand kip per kg)
CPI Consumer Price Index (1995=100)
ET03MAY Evapotranspiration of May in Luangnamtha
ET03JUN Evapotranspiration of June in Luangnamtha
D845 Dummy Variable, 1 in 1984 to 1985, 0 otherwise
D912 Dummy Variable, 1 in 1991 to 1992, 0 otherwise

2-5-2-1-4. Area Function of Lowland Rice in Oudomxay

APL04= + 6.86317
(3.64)
+ 0.14939*APL04(t-1)
(1.31)
+ 3.40601*[FPR(t-1)/CPI(t-1)/100]
(2.02) [0.102]
+ 1.22566*T8791
(7.09)
+ 0.32116*T92
(4.31)
- 0.03774*ET04MAR(t-1)
(-2.86) [-0.170]
- 0.03446*ET04JUN(t-1)
(-1.87) [-0.367]
+ 0.02644*ET04AUG(t-1)
(1.93) [0.256]
+ 4.27495*D86
(7.94)
- 3.05029*D92
(-3.44)
AdjR^2=0.9337 D.W.=2.431

APL04 Planted Area of Lowland Rice in Oudomxay
FPR Farm Price of Laos Rice (thousand kip per kg)
CPI Consumer Price Index (1995=100)
T8791 Time Trend from 1987 to 1991, 0 otherwise
T92 Time Trend from 1992 to 2000, 0 otherwise
ET04MAR Evapotranspiration of March in Oudomxay
ET04JUN Evapotranspiration of June in Oudomxay
ET04AUG Evapotranspiration of August in Oudomxay
D86 Dummy Variable, 1 in 1986, 0 otherwise
D92 Dummy Variable, 1 in 1992, 0 otherwise

2-5-2-1-5. Area Function of Lowland Rice in Bokea

APL05= - 1.28032
(-1.19)
+ 0.04186*APL05(t-1)
(0.29)
+ 3.13786*[FPR(t-1)/CPI(t-1)/100]
(3.41) [0.149]
- 0.38599*T8083
(-4.73)
+ 0.33410*T8492
(6.45)
+ 0.66956*T93
(6.68)
+ 0.01554*ET05MAY(t-1)
(4.40) [0.273]
+ 0.03721*ET05NOV(t-1)
(2.86) [0.471]
+ 1.23056*D93
(5.27)
AdjR^2=0.9951 D.W.=2.591

APL05 Planted Area of Lowland Rice in Bokea
FPR Farm Price of Laos Rice (thousand kip per kg)
CPI Consumer Price Index (1995=100)
T8083 Time Trend from 198' to 1983, 0 otherwise
T8492 Time Trend from 1984 to 1992, 0 otherwise
T93 Time Trend from 1993 to 2000, 0 otherwise
ET05MAY Evapotranspiration of May in Bokea
ET05NOV Evapotranspiration of November in Bokea
D93 Dummy Variable, 1 in 1993, 0 otherwise

2-5-2-1-6. Area Function of Lowland Rice in Luangprabang

APL06= + 5.97910
(7.70)
+ 0.02512*APL06(t-1)
(0.26)
+ 0.79977*[FPR(t-1)/CPI(t-1)/100]
(1.37) [0.024]
- 0.01411*ET06MAR(t-1)
(-3.46) [-0.068]
+ 0.00577*ET06APR(t-1)
(2.16) [0.042]
+ 0.01207*ET06JUN(t-1)
(2.03) [0.131]
- 1.85857*D87
(-9.76)
- 0.90359*D92

(-4.96)
- 0.46781*D945
(-3.67)
$AdjR^2$=0.9632 D.W.=1.926

APL06	Planted Area of Lowland Rice in Luangprabang
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET06MAR	Evapotranspiration of March in Luangprabang
ET06APR	Evapotranspiration of April in Luangprabang
ET06JUN	Evapotranspiration of June in Luangprabang
D87	Dummy Variable, 1 in 1987, 0 otherwise
D92	Dummy Variable, 1 in 1992, 0 otherwise
D945	Dummy Variable, 1 in 1994 to 1995, 0 otherwise

2-5-2-1-7. Area Function of Lowland Rice in Huaphanh

APL07= + 4.39814
(1.68)
+ 0.03812*APL07(t-1)
(0.33)
+ 3.55263*[FPR(t-1)/CPI(t-1)/100]
(3.86) [0.106]
- 0.86662*T8083
(-2.79)
+ 0.56311*T93
(7.97)
- 0.03679*ET08JUN(t-1)
(-2.71) [-0.452]
+ 0.04704*ET08JLY(t-1)
(3.25) [0.586]
+ 0.03810*ET08SEP(t-1)
(2.92) [0.461]
- 1.29900*D84
(-2.91)
+ 1.09874*D97
(3.12)
$AdjR^2$=0.9629 D.W.=2.325

APL07	Planted Area of Lowland Rice in Huaphanh
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
T8083	Time Trend from 1980 to 1983, 0 otherwise
T93	Time Trend from 1993 to 2000, 0 otherwise
ET07JUN	Evapotranspiration of June in Huaphanh
ET07JLY	Evapotranspiration of July in Huaphanh
ET07SEP	Evapotranspiration of September in Huaphanh
D84	Dummy Variable, 1 in 1984, 0 otherwise
D97	Dummy Variable, 1 in 1997, 0 otherwise

2-5-2-1-8. Area Function of Lowland Rice in Xayabury

APL08= + 31.23140
(3.87)
+ 0.64936*APL08(t-1)
(6.90)
+ 9.70013*[FPR(t-1)/CPI(t-1)/100]
(2.47) [0.155]
- 0.13111*ET08APR(t-1)
(-4.32) [-0.497]
- 0.8058*ET08MAY(t-1)
(-2.59) [-4.697]
+ 0.11764*ET08JUN(t-1)
(2.79) [0.648]
- 0.28414*ET08JLY(t-1)
(-3.65) [-1.460]
- 0.24766*ET08AUG(t-1)
(-5.90) [-1.226]
+ 0.22685*ET08OCT(t-1)
(3.79) [1.224]
- 8.62696*D83
(-3.72)
- 9.24236*D96
(-4.11)
+ 4.41419*D98
(2.72)
$AdjR^2$=0.8941 D.W.=2.545

APL08	Planted Area of Lowland Rice in Xayabury
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET08APR	Evapotranspiration of April in Xayabury
ET08MAY	Evapotranspiration of May in Xayabury
ET08JUN	Evapotranspiration of June in Xayabury
ET08JLY	Evapotranspiration of July in Xayabury
ET08AUG	Evapotranspiration of August in Xayabury
ET08OCT	Evapotranspiration of October in Xayabury
D83	Dummy Variable, 1 in 1983, 0 otherwise
D96	Dummy Variable, 1 in 1996, 0 otherwise
D98	Dummy Variable, 1 in 1998, 0 otherwise

2-5-2-1-9. Area Function of Lowland Rice in Xiengkhuang

APL09= + 13.86744
(6.43)
+ 0.07501*APL09(t-1)
(0.48)
+ 9.59941*[FPR(t-1)/CPI(t-1)/100]
(3.90) [0.163]
- 0.37718*T8088
(-4.40)
- 0.44761*T9298
(-4.39)
- 0.03997*ET09MAR(t-1)
(-2.70) [-0.109]
+ 3.10659*D86
(3.10)
$AdjR^2$=0.7559 D.W.=2.416

APL09	Planted Area of Lowland Rice in Xiengkhuang
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
T8088	Time Trend from 1980 to 1988, 0 otherwise
T9298	Time Trend from 1992 to 1998, 0 otherwise
ET09MAR	Evapotranspiration of March in Xiengkhuang
D86	Dummy Variable, 1 in 1986, 0 otherwise

2-5-2-1-10. Area Function of Lowland Rice in Vientiane

APL10= - 1.07586

(-0.08)
+ 0.26853*APL10(t-1)
(1.19)
+ 16.19934*[FPR(t-1)/CPI(t-1)/100]
(2.00) [0.129]
- 1.55871*TREND
(-2.42)
+ 2.17728*T87
(2.96)
+ 0.08592*ET10MAR(t-1)
(1.97) [0.096]
- 0.23190*ET10AUG(t-1)
(-2.78) [-0.581]
+ 0.48446*ET10SEP(t-1)
(3.63) [1.317]
- 5.44443*D82
(-1.83)
+ 5.99169*D86
(2.17)
+ 7.11313*D90
(3.01)

AdjR^2=0.6615 D.W.=1.741

APL10	Planted Area of Lowland Rice in Vientiane
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
TREND	Time Trend from 1980 to 2000
T87	Time Trend from 1987 to 2000, 0 otherwise
ET10MAR	Evapotranspiration of March in Vientiane
ET10AUG	Evapotranspiration of August in Vientiane
ET10SEP	Evapotranspiration of September in Vientiane
D82	Dummy Variable, 1 in 1982, 0 otherwise
D86	Dummy Variable, 1 in 1986, 0 otherwise
D90	Dummy Variable, 1 in 1990, 0 otherwise

2-5-2-1-11. Area Function of Lowland Rice in Borikhamxay

APL11= + 9.58894
(3.90)
+ 0.21849*APL11(t-1)
(1.02)
+ 7.77065*[FPR(t-1)/CPI(t-1)/100]
(2.44) [0.150]
+ 2.33176*T95
(4.40)
+ 0.03180*ET11ARP(t-1)
(2.42) [0.145]
- 0.07875*ET11NOV(t-1)
(-3.46) [0.483]
+ 2.28459*D892
(2.95)
+ 4.42793*D96
(2.53)

AdjR^2=0.9527 D.W.=2.357

APL11	Planted Area of Lowland Rice in Borikhamxay
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
T95	Time Trend from 1995 to 2000, 0 otherwise
ET11APR	Evapotranspiration of April in Borikhamxay
ET11NOV	Evapotranspiration of November in Borikhamxay
D892	Dummy Variable, 1 in 1989 to 1992, 0 otherwise
D96	Dummy Variable, 1 in 1996, 0 otherwise

2-5-2-1-12. Area Function of Lowland Rice in Khammuane

APL12= + 92.89300
(3.46)
+ 0.17637*APL12(t-1)
(0.89)
+ 24.31869*[FPR(t-1)/CPI(t-1)/100]
(2.03) [0.173]
+ 0.18230*ET12MAY(t-1)
(2.24) [0.497]
- 0.35250*ET12SEP(t-1)
(-2.01) [-0.969]
- 0.53165*ET12OCT(t-1)
(-3.00) [-1.625]
+ 25.52013*D92
(3.00)
+ 16.40433*D99
(2.76)

AdjR^2=0.4343 D.W.=2.544

APL12	Planted Area of Lowland Rice in Khammuane
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET12MAY	Evapotranspiration of May in Khammuane
ET12SEP	Evapotranspiration of September in Khammuane
ET12OCT	Evapotranspiration of October in Khammuane
D92	Dummy Variable, 1 in 1992, 0 otherwise
D99	Dummy Variable, 1 in 1999, 0 otherwise

2-5-2-1-13. Area Function of Lowland Rice in Savannakhet

APL13= + 132.12505
(5.14)
+ 0.09167*APL13(t-1)
(0.59)
+ 19.26489*[FPR(t-1)/CPI(t-1)/100]
(1.06) [0.057]
- 0.42012*ET13MAR(t-1)
(-3.34) [-0.201]
- 0.48011*ET13SEP(t-1)
(-2.21) [-0.541]
- 17.80456*D83
(-1.94)
- 19.82763*D96
(-2.54)
+ 24.79941*SHIFT99
(3.97)

AdjR^2=0.6002 D.W.=2.005

APL13	Planted Area of Lowland Rice in Savannakhet
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET13MAR	Evapotranspiration of March in Savannakhet
ET13SEP	Evapotranspiration of September in Savannakhet

D83 Dummy Variable, 1 in 1983, 0 otherwise
D96 Dummy Variable, 1 in 1996, 0 otherwise
SHIFT99 Dummy Variable, 1 from 1999, 0 otherwise

2-5-2-1-14. Area Function of Lowland Rice in Saravane

APL14= + 13.56709
(1.96)
+ 0.09541*APL14(t-1)
(0.93)
+ 4.35941*[FPR(t-1)/CPI(t-1)/100]
(0.94) [0.032]
+ 0.013913*ET14AUG(t-1)
(2.65) [0.039]
- 0.07664*ET14SEP(t-1)
(-1.81) [-0.208]
+ 0.10499*ET14OCT(t-1)
(2.78) [0.322]
- 4.49593*D834
(-2.70)
- 4.53109*D868
(-4.29)
- 13.67612*D93
(-8.61)
+ 11.86392*SHIFT00
(6.45)
$AdjR^2$=0.9098 D.W.=2.660

APL14 Planted Area of Lowland Rice in Saravane
FPR Farm Price of Laos Rice (thousand kip per kg)
CPI Consumer Price Index (1995=100)
ET14AUG Evapotranspiration of August in Saravane
ET14SEP Evapotranspiration of September in Saravane
ET14OCT Evapotranspiration of October in Saravane
D834 Dummy Variable, 1 in 1983 to 1984, 0 otherwise
D868 Dummy Variable, 1 in 1986 to 1988, 0 otherwise
D93 Dummy Variable, 1 in 1993, 0 otherwise
SHIFT00 Dummy Variable, 1 from 2000, 0 otherwise

2-5-2-1-15. Area Function of Lowland Rice in Sekong

APL15= + 1.74756
(1.64)
+ 0.44438*APL15(t-1)
(3.06)
+ 1.72531*[FPR(t-1)/CPI(t-1)/100]
(2.70) [0.314]
+ 0.14857*T84
(7.03)
- 0.02016*ET15MAR(t-1)
(-4.80) [-0.734]
+ 0.02153*ET15APR(t-1)
(6.08) [0.828]
- 0.02584*ET15AUG(t-1)
(-3.09) [-1.802]
- 0.01330*ET15SEP(t-1)
(-2.49) [-0.842]
+ 0.01187*ET15OCT(t-1)
(2.60) [0.807]
- 0.88795*D94
(-4.48)
- 1.09821*D96
(-5.22)
$AdjR^2$=0.9619 D.W.=2.592

APL15 Planted Area of Lowland Rice in Sekong
FPR Farm Price of Laos Rice (thousand kip per kg)
CPI Consumer Price Index (1995=100)
T84 Time Trend from 1984 to 2000, 0 otherwise
ET15MAR Evapotranspiration of March in Sekong
ET15APR Evapotranspiration of April in Sekong
ET15AUG Evapotranspiration of August in Sekong
ET15SEP Evapotranspiration of September in Sekong
ET15OCT Evapotranspiration of October in Sekong
D94 Dummy Variable, 1 in 1994, 0 otherwise
D96 Dummy Variable, 1 in 1996, 0 otherwise

2-5-2-1-16. Area Function of Lowland Rice in Champasack

APL16= + 107.91658
(3.90)
+ 0.10362*APL16(t-1)
(0.71)
+ 55.42169*[FPR(t-1)/CPI(t-1)/100]
(3.88) [0.186]
- 0.36446*ET16APR(t-1)
(-2.16) [-0.201]
+ 0.57532*ET16MAY(t-1)
(3.39) [0.728]
+ 0.43942*ET16JUN(t-1)
(2.70) [0.563]
- 0.39015*ET16JLY(t-1)
(-2.23) [-0.501]
- 0.42904*ET16SEP(t-1)
(-3.07) [-0.533]
- 0.54152*ET16NOV(t-1)
(-3.06) [-0.777]
- 43.70553*D88
(-5.99)
- 27.03471*D96
(-4.51)
$AdjR^2$=0.7500 D.W.=2.615

APL16 Planted Area of Lowland Rice in Champasack
FPR Farm Price of Laos Rice (thousand kip per kg)
CPI Consumer Price Index (1995=100)
ET16APR Evapotranspiration of April in Champasack
ET16MAY Evapotranspiration of May in Champasack
ET16JUN Evapotranspiration of June in Champasack
ET16JLY Evapotranspiration of July in Champasack
ET16SEP Evapotranspiration of September in Champasack
ET16NOV Evapotranspiration of November in Champasack
D88 Dummy Variable, 1 in 1988, 0 otherwise
D96 Dummy Variable, 1 in 1996, 0 otherwise

2-5-2-1-17. Area Function of Lowland Rice in Attapeu

APL17= + 2.71396
(0.9)
+ 0.81582*APL17(t-1)

(3.77)
+ 9.65993*[FPR(t-1)/CPI(t-1)/100]
(4.83) [0.253]
- 0.10026*ET17MAR(t-1)
(-4.99) [-0.417]
- 0.11401*ET17SEP(t-1)
(-3.75) [-1.078]
- 0.07938*ET17OCT(t-1)
(-3.96) [-0.818]
+ 0.18449*ET17NOV(t-1)
(4.66) [1.905]
- 4.79054*D83
(-3.92)
+ 2.61644*D88
(3.24)
+ 2.77569*D97
(4.24)
+ 6.53772*SHIFT99
(9.09)
AdjR^2=0.8405 D.W.=1.803

APL17	Planted Area of Lowland Rice in Attapeu
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET17MAR	Evapotranspiration of March in Attapeu
ET17SEP	Evapotranspiration of September in Attapeu
ET17OCT	Evapotranspiration of October in Attapeu
ET17NOV	Evapotranspiration of November in Attapeu
D83	Dummy Variable, 1 in 1983, 0 otherwise
D88	Dummy Variable, 1 in 1988, 0 otherwise
D97	Dummy Variable, 1 in 1997, 0 otherwise
SHIFT99	Dummy Variable, 1 from 1999, 0 otherwise

2-5-2-2. Area function of irrigated rice (dry season rice)

2-5-2-2-1. Area Function of Irrigated Rice in Vientiane Municipality

API01= - 4.15829
(-1.92)
+ 0.66562*T95
(5.94)
+ 0.91504*API01(t-1)
(12.75)
+ 5.87563*[FPR(t-1)/CPI(t-1)/100]
(3.72) [0.206]
- 0.02510*ET01MAY(t-1)
(-2.71) [-0.320]
+ 0.07931*ET01JUN(t-1)
(5.11) [0.946]
- 0.06424*ET01JLY(t-1)
(-3.60) [-0.771]
+ 0.05304*ET01OCT(t-1)
(3.32) [0.682]
- 1.84317*D83
(-3.54)
- 1.73775*D87
(-3.87)
- 2.54397 *D98
(-5.05)
AdjR^2=0.9929 D.W.=2.126

API01	Planted Area of Irrigated Rice in Vientiane Mun.
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
T95	Time Trend from 1995 to 2000, 0 otherwise
ET01MAY	Evapotranspiration of May in Vientiane Mun.
ET01JUN	Evapotranspiration of June in Vientiane Mun.
ET01JLY	Evapotranspiration of July in Vientiane Mun.
ET01OCT	Evapotranspiration of October in Vientiane Mun.
D83	Dummy Variable, 1 in 1983, 0 otherwise
D87	Dummy Variable, 1 in 1987, 0 otherwise
D98	Dummy Variable, 1 in 1998, 0 otherwise

2-5-2-2-2. Area Function of Irrigated Rice in Savannakhet

API13= - 17.02137
(-3.54)
+ 1.33120*T94
(5.46)
+ 0.66973*API13(t-1)
(6.29)
+ 7.06345*[FPR(t-1)/CPI(t-1)/100]
(2.21) [0.432]
+ 0.09520*ET13MAR(t-1)
(3.75) [0.940]
+ 0.08641*ET13JLY(t-1)
(2.47) [2.089]
+ 0.12318*ET13AUG(t-1)
(3.43) [2.838]
- 0.07771*ET13OCT(t-1)
(-1.94) [-2.022]
- 5.61707*D84
(-3.02)
+ 4.34852*D92
(2.97)
AdjR^2=0.9629 D.W.=2.641

AIH13	Planted Area of Irrigated Rice in Savannakhet
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
T94	Time Trend from 1994 to 2000, 0 otherwise
ET13MAR	Evapotranspiration of March in Savannakhet
ET13JLY	Evapotranspiration of July in Savannakhet
ET13AUG	Evapotranspiration of August in Savannakhet
ET13OCT	Evapotranspiration of October in Savannakhet
D84	Dummy Variable, 1 in 1984, 0 otherwise
D92	Dummy Variable, 1 in 1992, 0 otherwise

2-5-2-2-3. Area Function of Irrigated Rice in North Region

AIHN= - 21.03793
(-7.55)
+ 1.57140*T98
(8.25)
+ 0.21623*AIHN(t-1)
(2.32)
+ 1.98217*[FPR(t-1)/CPI(t-1)/100]

(2.99) [0.181]
+ 0.02820*ETNMAY(t-1)
(3.77) [0.981]
- 0.07016*ETNJUN(t-1)
(-6.63) [-2.317]
+ 0.04534*ETNJLY(t-1)
(3.08) [1.410]
+ 0.20926*ETNSEP(t-1)
(9.91) [6.783]
+ 0.04481*ETNOCT(t-1)
(3.93) [1.405]
- 2.03450*D82
(-5.03)
- 0.63629*D93
(-2.00)
+ 0.93235*D96
(2.62)
AdjR^2=0.9818 D.W.=2.156

AIHN	Planted Area of Irrigated Rice in North Region
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
T98	Time Trend from 1998 to 2000, 0 otherwise
ETNMAY	Evapotranspiration of May in North Region
ETNJUN	Evapotranspiration of June in North Region
ETNJLY	Evapotranspiration of July in North Region
ETNSEP	Evapotranspiration of September in North Region
ETNOCT	Evapotranspiration of October in North Region
D82	Dummy Variable, 1 in 1982, 0 otherwise
D93	Dummy Variable, 1 in 1993, 0 otherwise
D96	Dummy Variable, 1 in 1996, 0 otherwise

2-5-2-2-4a. Area Function of Irrigated Rice in Central Region
(including 01 and 13)
AIHC= - 16.41978
(-5.46)
+ 8.28752*T97
(11.74)
+ 0.82161*AIHC(t-1)
(9.16)
+ 3.61403*[FPR(t-1)/CPI(t-1)/100]
(1.86) [0.060]
+ 0.08471*ETCMAR(t-1)
(6.17) [0.219]
- 0.06301*ETCAPR(t-1)
(-5.48) [-0.238]
- 0.13703*ETCAUG(t-1)
(-7.00) [-0.766]
+ 0.14443*ETCSEP(t-1)
(5.68) [0.871]
+ 0.08505*ETCOCT(t-1)
(4.69) [0.554]
+ 0.10360*ETCNOV(t-1)
(6.66) [0.543]
- 1.63112*D82
(-2.82)
- 2.57317*D83
(-3.18)
- 20.42364*SHIFT00
(-12.42)
AdjR^2=0.9992 D.W.=2.156

AIHC	Planted Area of Irrigated Rice in Central Region
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
T97	Time Trend from 1997 to 2000, 0 otherwise
ETCMAR	Evapotranspiration of March in Central Region
ETCAPR	Evapotranspiration of April in Central Region
ETCAUG	Evapotranspiration of August in Central Region
ETCSEP	Evapotranspiration of September in Central Region
ETCOCT	Evapotranspiration of October in Central Region
ETCNOV	Evapotranspiration of November in Central Region
D82	Dummy Variable, 1 in 1982, 0 otherwise
D83	Dummy Variable, 1 in 1983, 0 otherwise
SHIFT00	Dummy Variable, 1 from 2000, 0 otherwise

2-5-2-2-4b. Area Function of Irrigated Rice in Other Central Region
(Excluding 01 and 13)
AIHOC= - 19.65243
(-5.52)
+ 0.66063*AIHOC(t-1)
(8.51)
+ 5.44282*[FPR(t-1)/CPI(t-1)/100]
(2.77) [0.375]
+ 1.67572*T95
(8.67)
+ 0.06448*ETOCMAR(t-1)
(4.52) [0.710]
- 0.03920*ETOCAPR(t-1)
(-3.20) [-0.640]
+ 0.08427*ETOCMAY(t-1)
(4.92) [2.194]
+ 0.11465*ETOCSEP(t-1)
(3.73) [2.861]
- 2.26245*D82
(-2.49)
+3.57380*D92
(3.51)
AdjR^2=0.9832 D.W.=2.348

AIHOC	Planted Area of Irrigated Rice in Other Central Region
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
T95	Time Trend from 1995 to 2000, 0 otherwise
ETOCMAR	Evapotranspiration of March in Other Central Region
ETOCAPR	Evapotranspiration of April in Other Central Region
ETOCMAR	Evapotranspiration of May in Other Central Region
ETOCSEP	Evapotranspiration of September in Other Central Region
D82	Dummy Variable, 1 in 1982, 0 otherwise
D92	Dummy Variable, 1 in 1992, 0 otherwise

2-5-2-2-5. Area Function of Irrigated Rice in South Region

AIHS= + 0.70014
(0.63)
+ 0.82899*AIHS(t-1)
(15.40)
+ 5.13662*[FPR(t-1)/CPI(t-1)/100]
(5.03) [0.366]
+ 4.50486*T97
(23.84)
+ 0.04694*ETSMAY(t-1)
(6.11) [1.215]
- 0.08671*ETSJLY(t-1)
(-5.40) [-2.373]
+ 0.02525*ETSSEP(t-1)
(2.87) [0.650]
- 3.10834*D82
(-5.40)
- 1.38559*D88
(-3.57)
- 12.52035*SHIFT00
(-18.22)
AdjR^2=0.9988 D.W.=1.845

AIHS	Planted Area of Irrigated Rice in South Region
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
T97	Time Trend from 1997 to 2000, 0 otherwise
ETSMAY	Evapotranspiration of May in South Region
ETSJLY	Evapotranspiration of July in South Region
ETSSEP	Evapotranspiration of September in South Region
D82	Dummy Variable, 1 in 1982, 0 otherwise
D88	Dummy Variable, 1 in 1988, 0 otherwise
SHIFT00	Dummy Variable, 1 from 2000, 0 otherwise

2-5-2-3. Area function of upland rice

2-5-2-3-1. Area Function of Upland Rice in Phongsaly

APU02= + 89.13560
(4.56)
+ 0.28997*APM01(t-1)
(2.29)
+ 12.32442*[FPR(t-1)/CPI(t-1)/100]
(3.02) [0.156]
- 0.38040*ET01JLY(t-1)
(-3.01) [-1.671]
+ 0.15637*ET01AUG(t-1)
(3.46) [0.680]
- 0.42462*ET01SEP(t-1)
(-4.32) [-1.910]
- 0.25368*ET01OCT(t-1)
(-3.44) [-1.057]
- 19.98778*D87
(-9.21)
- 5.58592*D92
(-2.54)
AdjR^2=0.8473 D.W.=1.556

APL02	Planted Area of Upland Rice in Phongsaly
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET01JLY	Evapotranspiration of July in Phongsaly
ET01AUG	Evapotranspiration of August in Phongsaly
ET01SEP	Evapotranspiration of September in Phongsaly
ET01OCT	Evapotranspiration of October in Phongsaly
D87	Dummy Variable, 1 in 1987, 0 otherwise
D92	Dummy Variable, 1 in 1992, 0 otherwise

2-5-2-3-2. Area Function of Upland Rice in Luangnamtha

APU03= + 33.03050
(4.70)
+ 0.39093*APM03(t-1)
(3.32)
+ 13.82765*[FPR(t-1)/CPI(t-1)/100]
(3.15) [0.232]
- 0.12240*ET03APR(t-1)
(-5.86) [-0.427]
+ 0.10406*ET03MAY(t-1)
(4.79) [0.631]
- 0.21968*ET03JUN(t-1)
(-6.33) [-1.282]
- 0.14945*ET03JLY(t-1)
(-2.72) [-0.789]
+ 0.08226*ET03AUG(t-1)
(3.07) [0.440]
- 0.07780*ET03OCT(t-1)
(-2.03) [-0.430]
+ 3.72811*D81
(3.14)
- 9.64960*D92
(-8.85)
- 3.05912*D97
(-2.71)
AdjR^2=0.9620 D.W.=2.461

APU03	Planted Area of Upland Rice in Luangnamtha
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET03APR	Evapotranspiration of April in Luangnamtha
ET03MAY	Evapotranspiration of May in Luangnamtha
ET03JUN	Evapotranspiration of June in Luangnamtha
ET03JLY	Evapotranspiration of July in Luangnamtha
ET03AUG	Evapotranspiration of August in Luangnamtha
ET03OCT	Evapotranspiration of October in Luangnamtha
D81	Dummy Variable, 1 in 1981, 0 otherwise
D92	Dummy Variable, 1 in 1992, 0 otherwise
D97	Dummy Variable, 1 in 1997, 0 otherwise

2-5-2-3-3. Area Function of Upland Rice in Oudomxay

APU04= + 136.23768
(4.72)
+ 0.32724*APM04(t-1)
(2.32)
+ 31.03572*[FPR(t-1)/CPI(t-1)/100]
(3.05) [0.244]
+ 0.26452*ET04APR(t-1)
(4.05) [0.492]
- 0.29712*ET04MAY(t-1)
(-3.34) [-0.877]

+ 0.63946*ET04JUN(t-1)
(3.94) [1.786]
+ 0.40639*ET04AUG(t-1)
(3.96) [1.035]
- 1.09198*ET04SEP(t-1)
(-4.06) [-3.019]
- 1.53653*ET04NOV(t-1)
(-5.01) [-3.342]
+ 12.25215*D81
(3.39)
- 25.32420*D84
(-4.08)
+ 12.79532*D95
(3.01)

$AdjR^2$=0.9382 D.W.=1.981

APU04	Planted Area of Upland Rice in Oudomxay
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET04APR	Evapotranspiration of April in Oudomxay
ET04MAY	Evapotranspiration of May in Oudomxay
ET04JUN	Evapotranspiration of June in Oudomxay
ET04AUG	Evapotranspiration of August in Oudomxay
ET04SEP	Evapotranspiration of September in Oudomxay
ET04NOV	Evapotranspiration of November in Oudomxay
D81	Dummy Variable, 1 in 1981, 0 otherwise
D84	Dummy Variable, 1 in 1984, 0 otherwise
D95	Dummy Variable, 1 in 1995, 0 otherwise

2-5-2-3-4. Area Function of Upland Rice in Bokea

APU05= - 0.27824
(-0.09)
+ 0.87132*APM05(t-1)
(3.98)
+ 5.78557*[FPR(t-1)/CPI(t-1)/100]
(3.01) [0.250]
- 0.10363*ET05JUN(t-1)
(-3.71) [-1.550]
+ 0.09949*ET05AUG(t-1)
(4.14) [1.379]
+ 2.50772*D90
(1.95)
+ 4.58270*D94
(4.15)
+ 1.83388*D96
(1.79)

$AdjR^2$=0.7177 D.W.=1.998

APU05	Planted Area of Upland Rice in Bokea
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET05JUN	Evapotranspiration of June in Bokea
ET05AUG	Evapotranspiration of August in Bokea
D90	Dummy Variable, 1 in 1990, 0 otherwise
D94	Dummy Variable, 1 in 1994, 0 otherwise
D96	Dummy Variable, 1 in 1996, 0 otherwise

2-5-2-3-5. Area Function of Upland Rice in Luangprabang

APU06= + 5.03777
(0.85)
+ 0.48308*APM06(t-1)
(3.96)
+ 27.94326*[FPR(t-1)/CPI(t-1)/100]
(2.78) [0.160]
+ 0.17557*ET06MAR(t-1)
(2.04) [0.163]
+ 13.22756*D81
(2.65)
+ 27.35075*D90
(5.36)
+ 23.18269*D94
(4.52)

$AdjR^2$=0.7769 D.W.=2.046

APU06	Planted Area of Upland Rice in Luangprabang
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET06MAR	Evapotranspiration of March in Luangprabang
D90	Dummy Variable, 1 in 1990, 0 otherwise
D94	Dummy Variable, 1 in 1994, 0 otherwise
D96	Dummy Variable, 1 in 1996, 0 otherwise

2-5-2-3-6. Area Function of Upland Rice in Huaphanh

APU07= - 11.21992
(-1.14)
+ 0.73682*APM07(t-1)
(6.46)
+ 30.61079*[FPR(t-1)/CPI(t-1)/100]
(3.30) [0.318]
- 0.12271*ET08MAR(t-1)
(-1.94) [-0.248]
+ 0.31127*ET08AUG(t-1)
(3.26) [1.246]
- 0.18905*ET08NOV(t-1)
(-2.25) [-0.567]
- 8.78325*D82
(-2.17)
- 9.45343*D93
(-2.29)

$AdjR^2$=0.8711 D.W.=2.257

APU07	Planted Area of Upland Rice in Huaphanh
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET07MAY	Evapotranspiration of May in Huaphanh
ET07AUG	Evapotranspiration of August in Huaphanh
ET07NOV	Evapotranspiration of November in Huaphanh
D82	Dummy Variable, 1 in 1982, 0 otherwise
D93	Dummy Variable, 1 in 1993, 0 otherwise

2-5-2-3-7. Area Function of Upland Rice in Xayabury

APU08= + 49.99883
(4.08)
+ 0.40417*APM08(t-1)
(2.44)
+ 14.58704*[FPR(t-1)/CPI(t-1)/100]

(2.36) [0.222]
- 0.12723*ET08MAR(t-1)
(-3.34) [-0.254]
- 0.19508*ET08SEP(t-1)
(-1.96) [-0.980]
- 0.16067*ET08OCT(t-1)
(-2.57) [-0.822]
- 0.15800*ET08NOV(t-1)
(-1.94) [-0.667]
+ 5.08602*D99
(2.22)

$AdjR^2$=0.8651 D.W.=2.092

APU08	Planted Area of Upland Rice in Xayabury
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET08MAR	Evapotranspiration of March in Xayabury
ET08JUN	Evapotranspiration of June in Xayabury
ET08SEP	Evapotranspiration of September in Xayabury
ET08NOV	Evapotranspiration of November in Xayabury
D99	Dummy Variable, 1 in 1999, 0 otherwise

2-5-2-3-8. Area Function of Upland Rice in Xiengkhuang

APU09= + 24.95975
(6.16)
+ 0.87700*APM09(t-1)
(7.85)
+ 13.25962*[FPR(t-1)/CPI(t-1)/100]
(4.23) [0.237]
- 0.03858*ET09APR(t-1)
(-5.91) [-0.165]
- 0.32318*ET09AUG(t-1)
(-2.20) [-1.844]
+ 5.25945*D901
(3.91)
+ 13.34335*D99
(6.05)

$AdjR^2$=0.8739 D.W.=1.895

APU09	Planted Area of Upland Rice in Xiengkhuang
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET09APR	Evapotranspiration of April in Xiengkhuang
ET09AUG	Evapotranspiration of August in Xiengkhuang
D901	Dummy Variable, 1 in 1990 to 1991, 0 otherwise
D99	Dummy Variable, 1 in 1999, 0 otherwise

2-5-2-3-9. Area Function of Upland Rice in Vientiane

APU10= - 6.08877
(-1.80)
+ 0.87499*APM10(t-1)
(8.82)
+ 8.19291*[FPR(t-1)/CPI(t-1)/100]
(3.74) [0.238]
+ 0.06845*ET10MAY(t-1)
(3.59) [0.751]
+ 0.09089*ET10JUN(t-1)
(2.48) [0.907]
- 0.12403*ET10AUG(t-1)
(-3.68) [-1.140]
+ 2.50864*D89
(2.29)
+ 2.45418*D91
(2.20)
+ 4.06620*D92
(3.47)

$AdjR^2$=0.9247 D.W.=1.898

APU10	Planted Area of Upland Rice in Vientiane
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET10MAY	Evapotranspiration of May in Vientiane
ET10JUN	Evapotranspiration of June in Vientiane
ET10AUG	Evapotranspiration of August in Vientiane
D89	Dummy Variable, 1 in 1989, 0 otherwise
D91	Dummy Variable, 1 in 1991, 0 otherwise
D92	Dummy Variable, 1 in 1992, 0 otherwise

2-5-2-3-10. Area Function of Upland Rice in Borikhamxay

APU11= + 7.62728
(1.41)
+ 0.45513*APM11(t-1)
(3.49)
+ 5.62442*[FPR(t-1)/CPI(t-1)/100]
(2.19) [0.166]
- 0.08872*ET11JUN(t-1)
(-2.17) [-0.928]
+ 0.09023*ET11JLY(t-1)
(2.03) [0.954]
- 0.10883*ET11AUG(t-1)
(-3.80) [-1.066]
+ 0.05134*ET11NOV(t-1)
(2.24) [0.560]
+ 1.78976*D902
(2.29)
- 3.45526*D95
(-2.50)
+ 3.98765*SHIFT00
(3.09)

$AdjR^2$=0.8363 D.W.=1.927

APU11	Planted Area of Upland Rice in Borikhamxay
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET11JUN	Evapotranspiration of June in Borikhamxay
ET11JLY	Evapotranspiration of July in Borikhamxay
ET11AUG	Evapotranspiration of August in Borikhamxay
ET11NOV	Evapotranspiration of November in Borikhamxay
D902	Dummy Variable, 1 in 1990 to 1992, 0 otherwise
D95	Dummy Variable, 1 in 1995, 0 otherwise
SHIFT00	Dummy Variable, 1 from 2000, 0 otherwise

2-5-2-3-11. Area Function of Upland Rice in Khammuane

APU12= + 7.19583
(3.80)
+ 0.72274*APM12(t-1)

(10.64)
+ 1.72720*[FPR(t-1)/CPI(t-1)/100]
(0.64) [0.109]
- 0.03275*ET12MAR(t-1)
(-3.12) [-0.337]
+ 0.01783*ET12APR(t-1)
(2.36) [0.274]
- 0.07627*ET12JLY(t-1)
(-3.31) [-1.835]
+ 8.17571*D80
(9.19)
$AdjR^2$=0.9812 D.W.=2.640

APU12	Planted Area of Upland Rice in Khammuane
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET12MAR	Evapotranspiration of March in Khammuane
ET12APR	Evapotranspiration of April in Khammuane
ET12JLY	Evapotranspiration of July in Khammuane
D80	Dummy Variable, 1 in 1980, 0 otherwise

2-5-2-3-12. Area Function of Upland Rice in Savannakhet

APU13= - 4.84468
(-3.06)
+ 0.67045*APM13(t-1)
(8.37)
+ 8.78030*[FPR(t-1)/CPI(t-1)/100]
(2.39) [0.247]
- 0.04793*ET13APR(t-1)
(-2.58) [-0.286]
+ 0.07984*ET13MAY(t-1)
(3.59) [0.812]
+ 2.63453*D81
(2.59)
+ 2.64344*D912
(3.74)
$AdjR^2$=0.9678 D.W.=2.040

APU13	Planted Area of Upland Rice in Savannakhet
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET13APR	Evapotranspiration of April in Savannakhet
ET13MAY	Evapotranspiration of May in Savannakhet
D81	Dummy Variable, 1 in 1981, 0 otherwise
D912	Dummy Variable, 1 in 1991 to 1992, 0 otherwise

2-5-2-3-13. Area Function of Upland Rice in Saravane

APU14= - 2.69791
(-0.83)
+ 0.25820*APM14(t-1)
(2.22)
+ 0.93255*[FPR(t-1)/CPI(t-1)/100]
(0.47) [0.034]
+ 0.08602*ET14JLY(t-1)
(2.69) [1.222]
+ 2.10905*D847
(1.97938)
- 3.68058*D88
(-3.65)
- 5.94413*D98
(-6.10)
$AdjR^2$=0.7665 D.W.=1.772

APU14	Planted Area of Upland Rice in Saravane
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET14JLY	Evapotranspiration of July in Saravane
D847	Dummy Variable, 1 in 1984 to 1987, 0 otherwise
D88	Dummy Variable, 1 in 1988, 0 otherwise
D98	Dummy Variable, 1 in 1998, 0 otherwise

2-5-2-3-14. Area Function of Upland Rice in Sekong

APU15= + 5.54303
(2.57)
+ 0.45412*APM15(t-1)
(3.75)
+ 4.11123*[FPR(t-1)/CPI(t-1)/100]
(2.47) [0.184]
- 0.04131*ET15AUG(t-1)
(-1.93) [-0.710]
+ 2.54847*D80
(3.22)
+ 1.10703*D867
(2.05)
$AdjR^2$=0.8488 D.W.=1.595

APU15	Planted Area of Upland Rice in Sekong
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET15AUG	Evapotranspiration of August in Sekong
D80	Dummy Variable, 1 in 1980, 0 otherwise
D867	Dummy Variable, 1 in 1986 to 1987, 0 otherwise

2-5-2-3-15. Area Function of Upland Rice in Attapeu

APU17= - 3.42351
(-2.19)
+ 0.23298*APM17(t-1)
(2.04)
+ 2.58664*[FPR(t-1)/CPI(t-1)/100]
(2.23) [0.184]
- 0.02779*ET17APR(t-1)
(-3.32) [-0.368]
+ 0.07055*ET17JLY(t-1)
(4.09) [1.921]
- 2.18113*D84
(-3.41)
+ 1.58899*D86
(2.98)
+ 1.56754*SHIFT00
(2.94)
$AdjR^2$=0.7121 D.W.=2.483

APU17	Planted Area of Upland Rice in Attapeu
FPR	Farm Price of Laos Rice (thousand kip per kg)
CPI	Consumer Price Index (1995=100)
ET17APR	Evapotranspiration of April in Attapeu

ET17JLY Evapotranspiration of July in Attapeu
D84 Dummy Variable, 1 in 1984, 0 otherwise
D86 Dummy Variable, 1 in 1986, 0 otherwise
SHIFT00 Dummy Variable, 1 from 2000, 0 otherwise

2-5-3. Demand function of rice

QC= + 681.30015
(7.63)
+ 6.67679*T8086
(5.01)
+ 13.41221*T8688
(2.38)
+ 15.68680*T9499
(3.87)
- 282.61797*RP/(CPI/100)
(-4.19) [-0.419]
- 1.66306*RGDP/POP
(-3.75) [-0.796]
+ 127.26798*D813
(3.71)
+ 34.70990*D84
(2.37)
- 117.82337*D88
(-5.15)
- 30.99935*D9193
(-3.80)

$AdjR^2$=0.8776 D.W.=3.051

QC Consumption of Rice per capita
T8086 Time Trend from 1980 to 1986, 0 after 1986
T8688 Time Trend from 1986 to 1988, 0 before 1986, 0 after 1988
T9599 Time Trend from 1995 to 1999, 0 before 1996, 5 after 1999
RP Retail Price of Rice (Non-glutinous)
CPI Consumer Price Index
RGDP Realized Gross Domestic Products
POP Population
D813 Dummy Variable, 1 in 1981 to 1983, 0 otherwise
D84 Dummy Variable, 1 in 1984, 0 otherwise
D88 Dummy Variable, 1 in 1988, 0 otherwise
D890 Dummy Variable, 1 in 1989 and 1990, 0 otherwise
D9193 Dummy Variable, 1 in 1991 and 1993, 0 otherwise
D978 Dummy Variable, 1 in 1997 and 1998, 0 otherwise

2-5-4. Import function of rice

IMP= 70.08878
(5.16)
- 42.11725*WP*EXR/(CPI/100)*1000000
(-2.25) [-0.737]
- 0.02268*Q
(-3.49) [-1.787]
- 30.15445*D80
(-3.75)
+ 39.71473*D81
(4.08)
- 28.38935*D858
(-5.32)
- 15.39497*D893
(-3.73)
+ 28.89936*D98
(3.74)

$AdjR^2$=0.7928 D.W.=2.440

WP World Price (Thailand: US$/MT)
EXR Exchange Rate (Kip/US$)
Q Total Production
D80 Dummy Variable, 1 in 1980, 0 otherwise
D81 Dummy Variable, 1 in 1981, 0 otherwise
D858 Dummy Variable, 1 in 1985 to 1988, 0 otherwise
D893 Dummy Variable, 1 in 1989 to 1993, 0 otherwise
D98 Dummy Variable, 1 in 1998, 0 otherwise

2-5-5. Price linkage function of rice

FPR= - 0.00270
(-1.19)
+ 0.49901*RP
(137.06)

$AdjR^2$=0.9989 D.W.=2.217

FPR Farm Price of Rice
RP Retail Price of Rice (Non-glutinous)

Table 2-1 through Table 2-3 show elasticities of yield of wet season rice, irrigated rice, and upland rice with respect to a time trend and evpotranspirations. Table 2-4 through Table 2-6 show elasticities of planted area of the three types of rice with respect to last yearís planted area, last yearís farm price, and last yearís evapotranspirations.

Table 2-1. Elasticities of yield of wet season rice for evapotranspiration and trend

Province	Trend	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Vientiane Mun.	0.152			0.599					-1.223	0.648
Phongsaly	0.025			0.221	0.510	-0.424			-0.502	
Luangnamtha	0.216	-0.392	0.204	-0.503						
Oudomxay	-0.017						-0.254	0.889	0.690	
Bokea				0.499	-1.023	1.837	0.934			
Luangprabang	0.044		0.221					1.024		
Huaphanh	0.055			0.564		1.992				
Xayabury	0.076	-0.230			0.880			1.411		3.221
Xiengkhuang	0.052	0.741			-1.438			0.982	-1.064	
Vientiane	0.055			0.984	-1.435			1.355	-0.781	
Borikhamxay	0.083	-0.228	0.328		-1.343	1.167	1.017			
Khammuane	0.041	-0.271		0.851	-1.974				-1.207	
Savannakhet	0.049			0.573		-1.118				
Saravan	0.038					-2.202		-0.850		
Sekong	0.039	0.284			1.165	-1.061	1.004		1.289	-1.178
Champasack	0.030	-0.389			-1.532			1.129	2.441	
Attapeu	0.018				-0.725		1.041	0.726	-0.782	0.745

Note) Trend is for after 2000

Table 2-2. Elasticities of yield of irrigated rice for evapotranspiration and trend

Province	Trend	Nov.	Dec.	Jan	Feb.	Mar.	Apr.	May.	Jun.
Vientiane Mun.	0.122	-0.898	0.488		0.131	-0.112			
Savannakhet	0.148		-0.412						
North region	0.101	-1.648	0.619						
Central region	0.131	1.618	-0.385				-0.171	0.647	
Central region[2)]	0.569	1.979	-1.482	0.649	-0.301			1.081	
South region	0.112			0.552			-0.549	0.526	-1.000

Note) Trend is for after 2000, Central region[2)] excludes Vientiane municipality and Savannakhet province

Table 2-3. Elasticities of yield of upland rice for evapotranspirationand trend

Province	Trend	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Phongsaly	0.033		0.300		1.129			-1.456	-0.688	
Luangnamtha	0.033				-0.633				-0.813	
Oudomxay			-0.256		-1.778			2.595	1.632	
Bokea			0.103		0.540	1.433	-0.771	1.446		2.037
Luangprabang	0.027	0.193				-1.233		-1.905	-1.326	-1.005
Huaphanh	0.037				3.808				2.026	
Xayabury	0.045				-1.271		-0.892			
Xiengkhuang	0.021			0.758		1.549	-0.826	2.048	0.641	0.706
Vientiane	0.025	0.228	0.089			2.339		2.146		
Borikhamxay	0.093			0.365			1.188		-1.861	1.009
Khammuane	0.013	0.247				0.843	0.593		-1.734	
Savannakhet	0.041		-0.209	0.628			-1.041	1.349	0.697	
Saravan	0.023				-2.110	1.738				
Sekong	0.043	-0.416			-1.520	1.399	-1.109			
Attapeu	0.036	-0.410			-1.480	1.673		1.415	1.067	

Note) Trend is for after 2000

Table 2-4. Elasticities of planted area of wet season rice

Province	Area	Price	Evapotranspiration (t-1)								
	(t-1)	(t-1)	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Vientiane Mun.	0.080	0.048				-0.263		-0.189			
Phongsaly	0.105	0.074		-0.129	0.206				0.334	0.297	0.181
Luangnamtha	0.589	0.084	-0.328		-0.599	-0.726					
Oudomxay	0.149	0.102	-0.170			-0.367		0.256			
Bokea	0.042	0.149			0.273						0.471
Luangprabang	0.025	0.024	-0.068	0.042		0.131					
Huaphanh	0.038	0.106				-0.452	0.586		0.461		
Xayabury	0.649	0.155		-0.497	-4.697	0.648	-1.460	-1.226		1.224	
Xiengkhuang	0.075	0.163	-0.109								
Vientiane	0.269	0.129	0.096					-0.581	1.317		
Borikhamxay	0.218	0.150		0.145							0.483
Khammuane	0.176	0.173			0.497				-0.969	-1.625	
Savannakhet	0.092	0.057	-0.201						-0.541		
Saravan	0.095	0.032						0.039	-0.208	0.322	
Sekong	0.444	0.314	-0.734	0.828				-1.802	-0.842	0.807	
Champasack	0.104	0.186		-0.201	0.728	0.563	-0.501		-0.533		-0.777
Attapeu	0.816	0.253	-0.417						-1.078	-0.818	1.905

Table 2-5. Elasticities of planted area of irrigated rice

Province	Area	Price	Evapotranspiration (t-1)								
	(t-1)	(t-1)	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Vientiane Mun.	0.915	0.206			-0.320	0.946	-0.771			0.682	
Savannakhet	0.670	0.432	0.940				2.089	2.838		-2.022	
North region	0.216	0.181			0.981	-2.317	1.410		6.783	1.405	
Central region	0.822	0.060	0.219	-0.238				-0.766	0.871	0.554	0.543
Central region[2)]	0.661	0.375	0.710	-0.640	2.194				2.861		
South region	0.829	0.366			1.215		-2.373		0.650		

Note) Central region[2)] excludes Vientiane municipality and Savannakhet province

Table 2-6. Elasticities of planted area of upland rice

Province	Area	Price	Evapotranspiration (t-1)								
	(t-1)	(t-1)	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Phongsaly	0.290	0.156					-1.671	0.680	-1.910	-1.057	
Luangnamtha	0.391	0.232		-0.427	0.631	-1.282	-0.789	0.440		-0.430	
Oudomxay	0.327	0.244		0.492	-0.877	1.786		1.035	-3.019		-3.342
Bokea	0.871	0.250				-1.550		1.379			
Luangprabang	0.483	0.160	0.163								
Huaphanh	0.737	0.318	-0.248					1.246			-0.567
Xayabury	0.404	0.222	-0.254						-0.980	-0.822	-0.667
Xiengkhuang	0.877	0.237		-0.165				-1.844			
Vientiane	0.875	0.238			0.751	0.907		-1.140			
Borikhamxay	0.455	0.166				-0.928	0.954	-1.066			0.560
Khammuane	0.723	0.109	-0.337	0.274			-1.835				
Savannakhet	0.670	0.247		-0.286	0.812						
Saravan	0.258	0.034					1.222				
Sekong	0.454	0.184						-0.710			
Attapeu	0.233	0.184		-0.368			1.921				

2-6. Simulation results

2-6-1. Results of estimation of yield functions

Table 2-1 shows the elasticities of yield of wet season rice with respect to evapotranspiration (ET) evaluated at the average value for yield and ET. The results indicate that if the ET value for May or September increases, the resulting yield will increase, and if the ET value for June increase, the yield will decrease in many provinces. The results suggest that the water supply during the planting and flowering season greatly impacts production.

Table 2-2 shows the elasticities of yield of irrigated rice with respect to ET. If water supply in December increases, yield of irrigated rice in the north region will increase, and if the water supply in January increases, the yield in the south region will increase.

Table 2-3 shows the elasticities of yield of upland rice with respect to ET. The results are similar to those of wet season rice. If the water supply in May increases, yields will increase, and if water supply increases in June, yields will decrease. These results are consistent with the relationship between yield and planting time. If transplanting is delayed by the shift of the rainy season, the growth period will be shortened.

2-6-2. Results of estimation of planted area functions

Table 2-4 shows the elasticities of planted area of wet season rice with respect to farm price and ET. The equation is based on an adaptive expectation model in the case that ET is an expected value. The elasticities of area with respect to farm price are equivalent to the supply elasticities of price. The results indicate that if the water supply increases in September, farmers will decrease planting area. This could be a result of flood damage during the cultivation season which leads to a decrease in farmers' income. In this case, the low income will make preparation for planting difficult.

Table 2-5 and Table 2-6 show the elasticities of planted area for irrigated rice and upland rice with respect to farm price and ET. The results suggest that if the water supply increases in September, farmers will expand planting area in the dry season, because of the abundant water stock. The results also indicate that if the water supply increases in August in the north region, farmers cultivating upland rice will expand their planting area. The water supply probably induces much plant production in forest region and it will prepare suitable plant area for upland rice cultivation.

2-6-3. Simulation results of supply and demand model

The simulation term is from 2001 to 2015. The assumptions of the simulation are as follows; (1) the forecast growth rate of CPI is the average between 1995 and 2002, (2) the growth rate of real GDP is the average between 1980 and 2002, (3) the growth rate of exchange rate is the average between 1993 and 2002, (4) the growth rate of the population is the average between 1980 and 2002, (5) the linear trend of the yield functions are continued, (6) The trend of area functions are flat except for upland rice which is in decline.

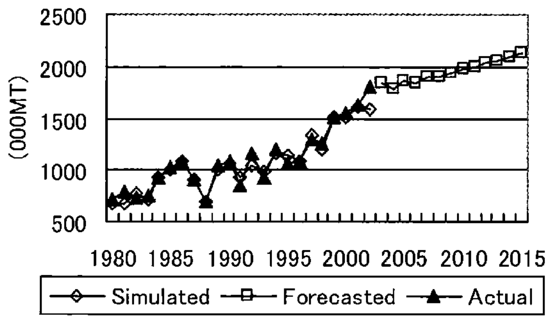

Fig. 2-3. Production of wet season rice

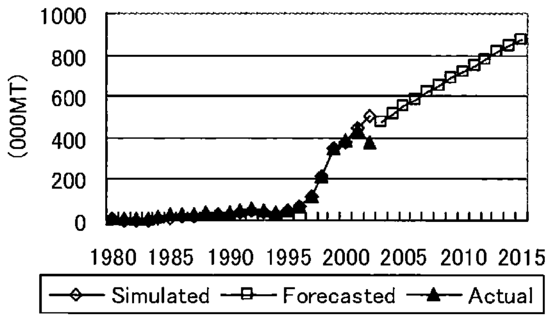

Fig. 2-4. Production of irrigated rice

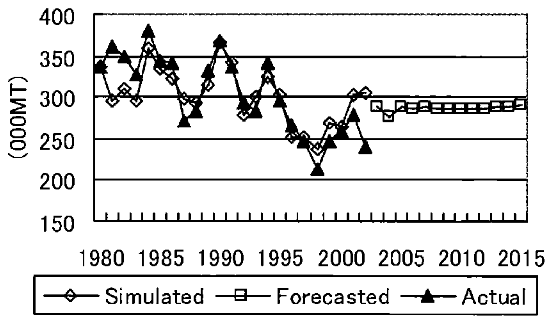

Fig. 2-5. Production of upland rice

Figure 2-3 through Figure 2-5 show the simulation results for the production of wet season rice, irrigated rice, and upland rice. The production of the wet season rice will increase 273,000 MT (metric tons) from 2005 to 2015. The dry season rice will also increase 326,000 MT during the period. However, the production of upland rice will be stable at around 290,000 MT during the period.

Figure 2-6 shows the simulation result of the market clearing realized farm price. The realized farm price will increase from 410 kip per MT to 610 kip per MT

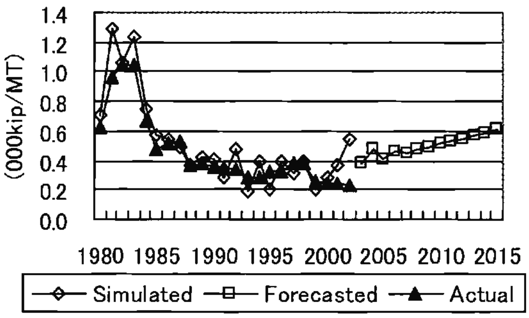

Fig. 2-6. Farm price

during the period. The realized farm prices are deflated by CPI with a base year of 1995.

2-7. Conclusion

A supply and demand model of rice in Laos which can analyze production and water supply impacts for each province is developed. The results of the baseline analyses indicate that production of wet and dry season rice steadily increases and that of upland rice remains stable at the current production level. If the cycle of shifting cultivation changes by population growth, the production of upland rice will decrease due to the reduction in the fertility of the upland crop (Evenson, 1994).

The impacts of water supply changes on rice production and market in Lao are analyzed in Chapter 6 along with the other three countries.