Chapter 3
Development of the Rice Econometric Model with Endogenous Water in Cambodia (REMEW-CAM)

3-1. Introduction

Cambodia is one of the world's poorest countries, and the percentage of population with income below US$1.35 a day, at purchasing power parity was 36.9% in 2004. It ranks above only Nepal, Laos, Bangladesh and India in Asia. The contribution of production of agriculture, forestry, and fisheries to GDP was 29.7% in 2007; rice was the largest share among agricultural products. Rice consists of 68.5% of food consumption in calorie and the industry associated with the supply of rice is quite important for the economic development of this country.

Impacts of hydrological cycle changes on rice productions in various ecosystems, such as lowland, irrigated fields, recessional fields, and deep water region, are quite different in Cambodia. Lowlands comprise 85% of total rice planted area and there are some simple irrigation facilities, such as embankments, however, they are sometimes inundated and destroyed by flooding. Furthermore, there are some cases when rice cultivation in the dry season is impossible due to delayed wet season cultivation. Therefore, an analysis of how hydrological cycle changes will effect agricultural production and which region will be affected the most is important to aid in the formation of counteracting policy measures in the country.

This chapter describes the supply and demand of rice in Cambodia, which is named Rice Econometric Model Endogenous Water in Cambodia (REMEW-CAM), focusing on the impacts of fluctuations of water supply on rice production.

3-2. NSDP and Policies related to rice production

Cambodia had been an agricultural country based on rice cultivation and this primary industry employed 90% of the nation's worker until the 1980's. The turning point was in the early 1990's, and the Paris Peace Agreement in October 1991 which drew the curtains on an era of civil war. The planned economic system was replaced by capitalistic economic system after the election which was under the monitor of the United Nations Transitional Authority in Cambodia (UNTAC) in May 1993 and establishment of the constitutional law in September 1993.

The economic condition of Cambodia was dramatically changed by the rapid growth of the garment industry with foreign capital, Asian currency crisis and a membership of ASEAN. Following the two five-year Socio Economic Plans, the government started the National Strategic Development Plan (NSDP) focusing on reducing poverty. Increasing the yield of rice, enhancement of micro-finance availability, and improvement of food security are the goals of the plan in relation to agriculture.

Under the market economic system, marketing of paddy and milled rice have been liberalized. National enterprises managed by the Ministry of Commerce controlled the rice distribution in the era of the planned economy; however, the government no longer intervenes in the domestic market.

Many farmers sell a part of their paddy immediately in order to pay debt, and retain the remaining paddy. About 70% of farmers sell their paddy to middlemen and about 20% of farmers sell their paddy directly to rice millers. The rice millers provide finance to farmers and hold paddy in storage. The rice millers also collect specific type of rice using the middlemen.

There is no subsidy for producing rice. Provision of subsidies for fertilizer, research, dissemination of technologies, and finance has just begun under the aids of foreign countries.

Production and dissemination of seed of high yield varieties feature high on the government list of priorities. The Cambodian Research and Development Institute (CARDI) is addressing the challenge under the assistance of the government of Australia; however, the production of seeds is limited.

The government has plans to organize farmers; however, it remains a blueprint in the Ministry of Agriculture Forestry and Fisheries. NGOs and various banks provide finance to farmers, middlemen, and rice millers; the interest rates are very high because the risk is high and there are no policies related to finance. However, there is a system in which the central bank evaluates the fiscal health of the NGOs.

3-3. Model

The supply and demand model for rice in Cambodia consists of sixty-five structural equations and five identities and these are specified as follows. The planted area functions are specified based on the adaptive expectation model where the exogenous

variable is ET. The ET variables in yield and area functions are specified in logarithms, because the coefficients of determination of logarithmic functions are higher than those of linear functions.

Provincial yield function of wet season rice (nineteen functions):

$$YW^i_t = a_{YWi} + b_{YW1i}T + b_{YW2i}\ln ET_{MAR\,t}^{\,i} + \ldots + b_{YW6i}\ln ET_{JLY\,t}^{\,i} \quad (3\text{-}1)$$

Provincial planted area function of wet season rice (nineteen functions):

$$APW^i_t = a_{APWi} + b_{APW1i}T + b_{APW2i}APW^{\,i}_{t-1} + b_{APW3i}FPR_{t-1}/(CPI_{t-1}/100) + b_{APW4i}\ln ET_{MAY\,t}^{\,i} + b_{APW5i}\ln ET_{MAY\,t-1}^{\,i} + b_{APW6i}\ln ET_{JUN\,t}^{\,i} + b_{APW7i}\ln ET_{JUN\,t-1}^{\,i} \quad (3\text{-}2)$$

Provincial yield function of dry season rice (twelve functions):

$$YD^i_t = a_{YDi} + b_{YD1i}T + b_{YD2i}\ln ET_{JAN\,t}^{\,i} + \ldots + b_{YD6i}\ln ET_{MAY\,t}^{\,i} \quad (3\text{-}3)$$

Provincial planted area function of dry season rice (twelve functions):

$$APD^i_t = a_{APDi} + b_{APD1i}T + b_{APD2i}APD^i_{t-1} + b_{APD3i}FPR_{t-1}/(CPI_{t-1}/100) + b_{APD4i}\ln ET_{DEC\,t-1}^{\,i} + b_{APD5i}\ln ET_{DEC\,t-2}^{\,i} + b_{APW6i}\ln ET_{JAN\,t}^{\,i} + b_{APW7i}\ln ET_{JAN\,t-1}^{\,i} \quad (3\text{-}4)$$

Provincial harvested area identity of wet season rice:

$$AHW^i_t = APW^i_t - ABW^i_t = APW^i_t(1\text{-}RABW^i_t) \quad (3\text{-}5)$$

Provincial harvested area identity of dry season rice:

$$AHD^i_t = APD^i_t - ABD^i_t = APD^i_t(1\text{-}RABD^i_t) \quad (3\text{-}6)$$

Country level production identity of wet season rice:

$$QW_t = \Sigma_i YW^i_t AHW^i_t \quad (3\text{-}7)$$

Country level production identity of dry season rice:

$$QDt = \Sigma_i YD^i_t AHD^i_t \quad (3\text{-}8)$$

Production identity of all seasons in milled equivalent:

$$Qt = 0.667(QW_t + QD_t) \quad (3\text{-}9)$$

Import function:

$$IMP_t = a_{IM} + b_{IM1}WPR_t{*}EXR_t/FPR_t \quad (3\text{-}10)$$

Stock change function:

$$STC_t = a_{ST} + b_{ST1}[FPR_t/(CPI_t/100) - FPR_{t-1}/(CPI_{t-1}/100)] + b_{ST2}(Q' - Q_{t-1}) \quad (3\text{-}11)$$

Supply identity:

$$QS_t = Q_t + IMP_t - EXP_t - STC_t \quad (3\text{-}12)$$

Demand function:

$$QS_t/POP_t = a_D + b_{D1}FPR_t/(CPI_t/100) + b_{D2}GDP_t/POP_t \quad (3\text{-}13)$$

where i is the number of province, t denotes that the data are measured at time t, T is a time trend, $ET_{JAN}^{\,i}$ through $ET_{DEC}^{\,i}$ are evapotranspiration values for January through December, YW, APW, AHW, ABW, $RABW$, and QW are yield, planted area, harvested area, abandoned area, abandoned area ratio, and production of wet season rice, YD, APD, AHD, ABD, $RABD$, and QD are yield, planted area, harvested area, abandoned area, abandoned area ratio, and production of dry season rice, Q is total production, IMP is imports, EXP is exports, STC is the annual change of stocks, i.e., ending stock minus beginning stock, QS is total supply, POP is population, GDP is gross domestic products, EXR is exchange rate, WP is the world price of rice (Thailand, 5% broken, FOB), FP is the producer price. Figure 3-1 and Figure 3-2 represent

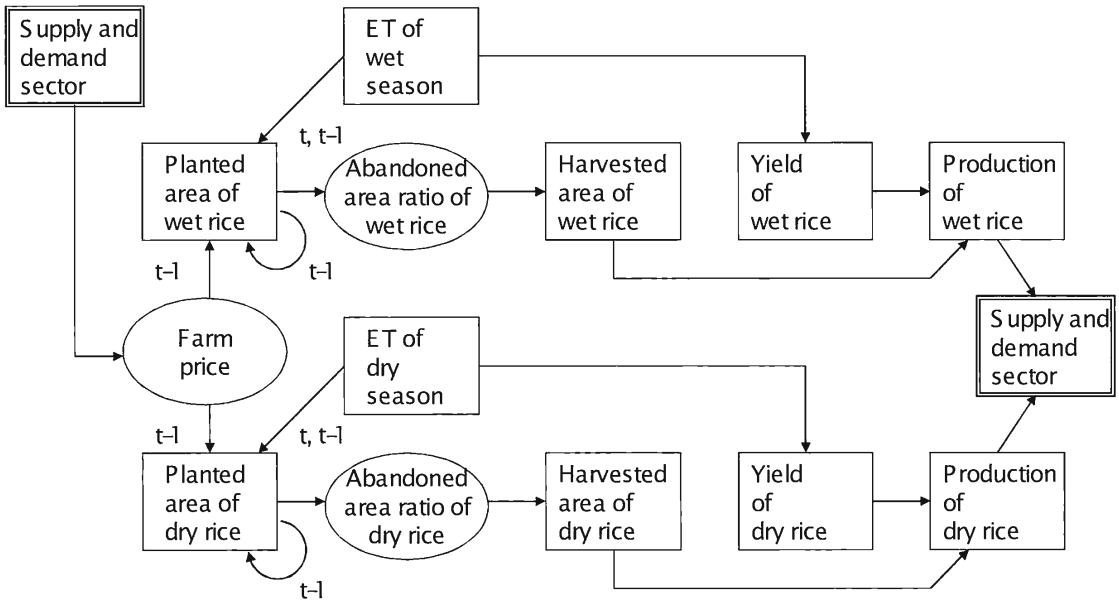

Fig. 3-1. Flowchart of rice production sector

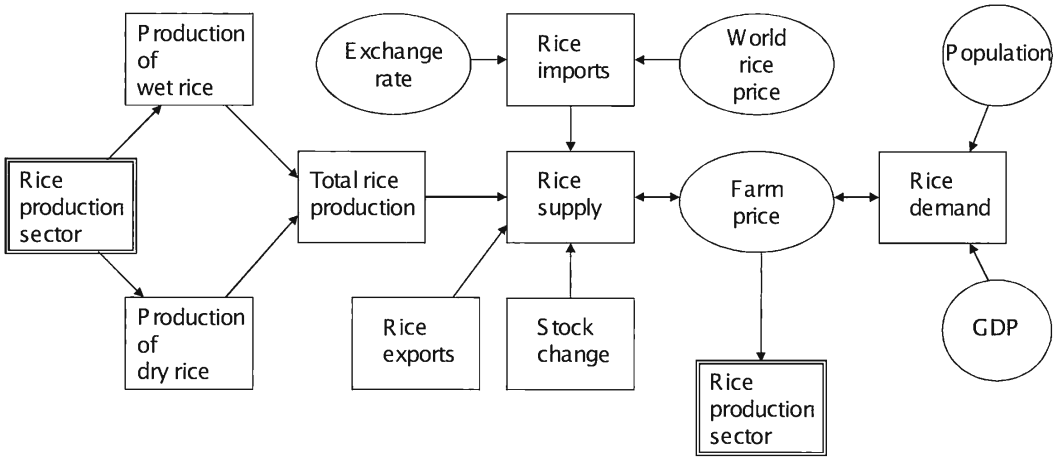

Fig. 3-2. Flowchart of supply and demand sector

models for the production sector and the overall supply and demand sector respectively.

3-4. Data

Evapotranspiration is used as a water supply variable for crops. The ET in a basin is obtained from the following identity:

ET = Irrigation + Rainfall + Capillary rise
+ Subsurface flow in – Runoff – Deep percolation
– Subsurface flow out.

The equation suggests that ET is equivalent to the available water for crops, therefore, it is used as a water supply variable in the model of this study. However, if the target region is large such as a whole country, the cost of a survey to determine the water supply components will be very high. Therefore, many methods in which the ET value is approximated from climatologic data have been presented for these fifty years. The actual ET (*ETa*) is equal to the reference ET (*ETo*) times the crop coefficient (*Kc*) and the stress coefficient (*Ks*). The estimation method of ETo of IMPACT-WATER, as applied in the IFPRI world food model which was the first world food model to consider water accounting, is the Penman method (Doorenbos and Kassam (1979)). The Penman-Monteith method (Allen et al. (1998)), an extension which considers aerodynamics of leaves, is used for calculating ET in our study. Ishigooka et al. (2005) provides the ET data for every province and month. The climatic data for the calculation are 0.5 degree grid data and are averaged for each province.

Available statistics for rice production in Cambodia are few, because the nation had been the planned economy until 1993. Data on rice production, which is divided into wet and dry seasons, are available from 1995. The short data period, along with data quality, is one of constraints in constructing the supply and demand model of rice. The time series data for production, planted area, and harvested area for the two seasons for all provinces are provided by the Department of Planning, Statistics and International Cooperation in the Ministry of Agriculture, Forestry and Fisheries of Cambodia. The farm price for rice is obtained from FAO-STAT and is a national average price for Cambodia. The consumer price index (CPI), GDP, and population are from the Asian Development Bank and the exchange rate and the world price of rice (Bangkok broken 5%, FOB) are data from IMF. The production data are available from 1995, and functions of yield and planted area are estimated using pooled data from 1995 to 2000 for each province. Import, stock, and demand functions are estimated using time series data which are available from 1983 to 2001. The yield and planted area functions of both seasons are not estimated for each province due to the lack of time series data. Parameters are obtained by estimating one function which includes provincial dummies using pooled data for nineteen provinces over six years. The estimation periods of these yield and planted area functions are from 1995 to 2000 which starts in the earliest available year for statistics of production of the two seasons and ends in the last year of available ET values. Parameters of yield and area functions for ET of each province are parameters of the reference province, i.e., Battambang province for the wet season and Prey Veng province for the dry

season, plus those of variables of ET times statistically significant provincial dummies, e.g. $\ln ET_{MAR} * D_{02}$. The water variable in this study is the actual evapotranspiration. The estimated yield and planted area functions are shown in the following general form:

a) Yield function of wet season rice cultivation

$$YW_t = f_{YW}\ (T, T*D_{02},\ldots, T*D_{19}, \ln ET_{MARt}, \ln ET_{MARt}*D_{02},\ldots, \ln ET_{MARt}*D_{19},\ldots, \ln ET_{JLYt}, \ln ET_{JLYt}*D_{02},\ldots, \ln ET_{JLYt}*D_{19}) \quad (3\text{-}14)$$

b) Planted area function of wet season rice cultivation

$$APW_t = f_{APW}\ (D_{02},\ldots, D_{19}, APW_{t-1}, FPR_{t-1}, \ln ET_{MAYt}, \ln ET_{MAYt}*D_{02}, \ldots, \ln ET_{MAYt}*D_{19}, \ln ET_{MAYt-1}, \ln ET_{MAYt-1}*D_{02}, \ldots, \ln ET_{MAYt-1}*D_{19}, \ln ET_{JUNt}, \ln ET_{JUNt}*D_{02}, \ldots, \ln ET_{JUNt}*D_{19}, \ln ET_{JUNt-1}, \ln ET_{JUNt-1}*D_{02}, \ldots, \ln ET_{JUNt-1}*D_{19}) \quad (3\text{-}15)$$

c) Yield function of dry season rice cultivation

$$YD_t = f_{YD}\ (T, T*D_{02},\ldots, T*D_{12}, \ln ET_{JANt}, \ln ET_{JANt}*D_{02},\ldots, \ln ET_{JANt}*D_{12},\ldots, \ln ET_{MAYt}, \ln ET_{MAYt}*D_{02},\ldots, \ln ET_{MAYt}*D_{12}) \quad (3\text{-}16)$$

d) Planted area function of dry season rice cultivation

$$APD_t = f_{APD}\ (D_{02},\ldots, D_{12}, APD_{t-1}, FPR_{t-1}, \ln ET_{DECt-1}, \ln ET_{DECt-1}*D_{02},\ldots,\ln ET_{DECt-1}*D_{12}, \ln ET_{DECt-2}, \ln ET_{DECt-2}*D_{02},\ldots,\ln ET_{DECt-2}*D_{12}, \ln ET_{JANt}, \ln ET_{JANt}*D_{02},\ldots, \ln ET_{JANt}*D_{12}, \ln ET_{JANt-1}, \ln ET_{JANt-1}*D_{02},\ldots, \ln ET_{JANt-1}*D_{12}) \quad (3\text{-}17)$$

where T is a time trend, D_{02} through D_{19} are dummy variables of individual provinces, FPR is the farm price of rice, ET_{JAN} through ET_{DEC} are ET values for January through December.

These yield and planted area functions have many variables, and these variables are selected by empirically obtained statistical criteria. Monthly ETs of these yield functions are selected using stepwise selection method as a guide only with the hypothesized specification estimated by OLS because the water supply affects growth through the cropping season. The p-value of the F statistics as a criterion for the variable selection is 0.2. Alternatively, the numbers of variables in the planted area functions is twice as large as the yield functions due to inclusion of lagged variables, and therefore, obtaining stable estimates of these functions is difficult. Considering the difficulties of the estimation, first, ETs of the transplanting season, i.e., May and June in the wet season and those of December and January in the dry season, are selected as water variables, and then, these variables are selected by backward elimination method. The p-value of the F statistics as a criterion for the variable selection is 0.3, and these functions are estimated by OLS.

3-5. Estimation results of all functions

3-5-1. Yield functions

3-5-1-1. Yield function of wet season rice

YW=
+ 3.40365
(2.12)
+ 0.09519*TREND*D03
(4.69)
+ 0.10142*TREND*D06
(4.23)
+ 0.11065*TREND*D11
(2.50)
+ 0.04941*TREND*D15
(2.40)
- 0.10616*TREND*D16
(-4.99)
- 0.08375*TREND*D17
(-1.82)
- 0.07376*TREND*D18
(-3.52)
- 0.03100*TREND*D19
(-1.51)
- 0.06381*TREND*D20
(-3.10)
- 0.05010*TREND*D21
(-2.47)
- 0.46261*ln(ETMAR)*D07
(-1.96)
- 0.11613*ln(ETMAR)*D08
(-4.51)
+ 0.11765*ln(ETAPR)
(1.95)
- 0.31542*ln(ETAPR)*D01
(-1.91)
+ 0.11452*ln(ETAPR)*D02
(5.41)
+ 0.08901*ln(ETAPR)*D17
(1.90)
+ 0.39643*ln(ETMAY)
(2.34)
+ 0.30164*ln(ETMAY)*D01
(2.18)
- 1.87254*ln(ETMAY)*D04
(-2.66)
+ 0.28439*ln(ETMAY)*D07
(1.74)
- 0.84877*ln(ETJUN)
(-2.96)
+ 1.74622*ln(ETJUN)*D04
(2.55)
+ 0.88050*ln(ETJUN)*D11
(1.32)
- 0.98534*ln(ETJLY)*D11
(-1.43)

AdjR^2=0.6786

YW Yield of Wet Rice for all provinces (MT/HA)

TREND	Time Trend from 1995 to 2000
D01	Dummy Variable, 1 in Phnom Penh, 0 otherwise
D02	Dummy Variable, 1 in Kandal, 0 otherwise
D03	Dummy Variable, 1 in Kampong Cham, 0 otherwise
D04	Dummy Variable, 1 in Svay Rieng, 0 otherwise
D05	Dummy Variable, 1 in Prey Veng, 0 otherwise
D06	Dummy Variable, 1 in Ta Keo, 0 otherwise
D07	Dummy Variable, 1 in Kompong Thom, 0 otherwise
D08	Dummy Variable, 1 in Siem Reap, 0 otherwise
D09	Dummy Variable, 1 in Battambang, 0 otherwise (unused, Base)
D11	Dummy Variable, 1 in Pursat, 0 otherwise
D12	Dummy Variable, 1 in Kampong Chhnang, 0 otherwise
D15	Dummy Variable, 1 in Kam Pot, 0 otherwise
D16	Dummy Variable, 1 in Koh Kong, 0 otherwise
D17	Dummy Variable, 1 in Kompong Speu, 0 otherwise
D18	Dummy Variable, 1 in Preah Vihea, 0 otherwise
D19	Dummy Variable, 1 in Stung Treng, 0 otherwise
D20	Dummy Variable, 1 in Rottanakiri, 0 otherwise
D21	Dummy Variable, 1 in Mondulkiri, 0 otherwise
D22	Dummy Variable, 1 in Kratie, 0 otherwise
ETMAR	Evapotranspiration of March
ETAPR	Evapotranspiration of April
ETMAY	Evapotranspiration of May
ETJUN	Evapotranspiration of June
ETJLY	Evapotranspiration of July

3-5-1-1-1. Yield function of wet rice in Phnom Penh

YW01= +3.40365
+0.00000*TREND
+0.00000*ln (ET01MAR)
-0.19777 *ln (ET01APR)
+0.69807*ln (ET01MAY)
-0.84877*ln (ET01JUN)
+0.00000*ln (ET01JLY)

YW01	Yield of wet rice in Phnom Penh
ET01MAR	Evapotranspiration of March in Phnom Penh
ET01APR	Evapotranspiration of April in Phnom Penh
ET01MAY	Evapotranspiration of May in Phnom Penh
ET01JUN	Evapotranspiration of June in Phnom Penh
ET01JLY	Evapotranspiration of July in Phnom Penh

3-5-1-1-2. Yield function of wet rice in Kandal

YW02= +3.40365
+0.00000*TREND
+0.00000*ln (ET02MAR)
+0.23217*ln (ET02APR)
+0.39643*ln (ET02MAY)
-0.84877 *ln (ET02JUN)
+0.00000* ln (ET02JLY)

YW02	Yield of wet rice in Kandal
ET02MAR	Evapotranspiration of March in Kandal
ET02APR	Evapotranspiration of April in Kandal
ET02MAY	Evapotranspiration of May in Kandal
ET02JUN	Evapotranspiration of June in Kandal
ET02JLY	Evapotranspiration of July in Kandal

3-5-1-1-3. Yield function of wet rice in Kampong Cham

YW03= +3.40365
+0.09519*TREND
+0.00000*ln (ET03MAR)
+0.11765*ln (ET03APR)
+0.39643*ln (ET03MAY)
-0.84877*ln (ET03JUN)
+0.00000*ln (ET03JLY)

YW03	Yield of wet rice in Kampong Cham
ET03MAR	Evapotranspiration of March in Kampong Cham
ET03APR	Evapotranspiration of April in Kampong Cham
ET03MAY	Evapotranspiration of May in Kampong Cham
ET03JUN	Evapotranspiration of June in Kampong Cham
ET03JLY	Evapotranspiration of July in Kampong Cham

3-5-1-1-4. Yield function of wet rice in Svay Rieng

YW04= +3.40365
+0.00000*TREND
+0.00000*ln (ET04MAR)
+0.11765* ln (ET04APR)
-1.47611*ln (ET04MAY)
+0.89745*ln (ET04JUN)
+0.00000* ln (ET04JLY)

YW04	Yield of wet rice in Svay Rieng
ET04MAR	Evapotranspiration of March in Svay Rieng
ET04APR	Evapotranspiration of April in Svay Rieng
ET04MAY	Evapotranspiration of May in Svay Rieng
ET04JUN	Evapotranspiration of June in Svay Rieng
ET04JLY	Evapotranspiration of July in Svay Rieng

3-5-1-1-5. Yield function of wet rice in Prey Veng

YW05= +3.40365
+0.00000*TREND
+0.00000*ln (ET05MAR)
+0.11765*ln (ET05APR)
+0.39643*ln (ET05MAY)
-0.84877*ln (ET05JUN)
+0.00000*ln (ET05JLY)

YW05	Yield of wet rice in Prey Veng
ET05MAR	Evapotranspiration of March in PreyVeng
ET05APR	Evapotranspiration of April in Prey Veng
ET05MAY	Evapotranspiration of May in Prey Veng
ET05JUN	Evapotranspiration of June in Prey Veng
ET05JLY	Evapotranspiration of July in Prey Veng

3-5-1-1-6. Yield function of wet rice in Ta Keo

YW06= +3.40365
+0.00000*TREND
+0.00000*ln (ET06MAR)
+0.11765*ln (ET06APR)
+0.39643*ln (ET06MAY)
-0.84877*ln (ET06JUN)
+0.00000*ln (ET06JLY)

YW06	Yield of wet rice in Ta Keo
ET06MAR	Evapotranspiration of March in TaKeo
ET06APR	Evapotranspiration of April in Ta Keo
ET06MAY	Evapotranspiration of May in Ta Keo
ET06JUN	Evapotranspiration of June in Ta Keo

ET06JLY Evapotranspiration of July in Ta Keo

3-5-1-1-7. Yield function of wet rice in Kompong Thom

YW07= +3.40365
+0.00000*TREND
-0.46261*ln (ET07MAR)
+0.11765*ln (ET07APR)
+0.68082*ln (ET07MAY)
-0.84877*ln (ET07JUN)
+0.00000*ln (ET07JLY)

YW07 Yield of wet rice in Kompong Thom
ET07MAR Evapotranspiration of March in Kompong Thom
ET07APR Evapotranspiration of April in Kompong Thom
ET07MAY Evapotranspiration of May in Kompong Thom
ET07JUN Evapotranspiration of June in Kompong Thom
ET07JLY Evapotranspiration of July in Kompong Thom

3-5-1-1-8. Yield function of wet rice in Siem Reap

YW08= +3.40365
+0.00000*TREND
-0.11613*ln (ET08MAR)
+0.11765*ln (ET08APR)
+0.39643* ln (ET08MAY)
-0.84877*ln (ET08JUN)
+0.00000*ln (ET08JLY)

YW08 Yield of wet rice in Siem Reap
ET08MAR Evapotranspiration of March in Siem Reap
ET08APR Evapotranspiration of April in Siem Reap
ET08MAY Evapotranspiration of May in Siem Reap
ET08JUN Evapotranspiration of June in Siem Reap
ET08JLY Evapotranspiration of July in Siem Reap

3-5-1-1-9. Yield function of wet rice in Battambang

YW09= +3.40365
+0.00000*TREND
+0.00000*ln (ET09MAR)
+0.11765*ln (ET09APR)
+0.39643*ln (ET09MAY)
-0.84877*ln (ET09JUN)
+0.00000*ln (ET09JLY)

YW09 Yield of wet rice in Battambang
ET09MAR Evapotranspiration of March in Battambang
ET09APR Evapotranspiration of April in Battambang
ET09MAY Evapotranspiration of May in Battambang
ET09JUN Evapotranspiration of June in Battambang
ET09JLY Evapotranspiration of July in Battambang

3-5-1-1-10. Yield function of wet rice in Pursat

YW11= +3.40365
+ 0.11065*TREND
+0.00000*ln (ET11MAR)
+0.11765* ln (ET11APR)
+0.39643*ln (ET11MAY)
+0.03173*ln (ET11JUN)
-0.98534*ln (ET11JLY)

YW11 Yield of wet rice in Pursat
ET11MAR Evapotranspiration of March in Pursat
ET11APR Evapotranspiration of April in Pursat
ET11MAY Evapotranspiration of May in Pursat
ET11JUN Evapotranspiration of June in Pursat
ET11JLY Evapotranspiration of July in Pursat

3-5-1-1-11. Yield function of wet rice in Kampong Chhnang

YW12= +3.40365
+ 0.00000* TREND
+0.00000 * ln (ET12MAR)
+0.11765 * ln (ET12APR)
+0.39643 * ln (ET12MAY)
-0.84877 * ln (ET12JUN)
+0.00000 * ln (ET12JLY)

YW12 Yield of wet rice in Kampong Chhnang
ET12MAR Evapotranspiration of March inKampong hhnang
ET12APR Evapotranspiration of April in Kampong Chhnang
ET12MAY Evapotranspiration of May in Kampong Chhnang
ET12JUN Evapotranspiration of June in Kampong Chhnang
ET12JLY Evapotranspiration of July in Kampong Chhnang

3-5-1-1-12. Yield function of wet rice in Kam Pot

YW15= +3.40365
+ 0.04941*TREND
+0.00000*ln (ET15MAR)
+0.11765*ln (ET15APR)
+0.39643* ln (ET15MAY)
-0.84877*ln (ET15JUN)
+0.00000* ln (ET15JLY)

YW15 Yield of wet rice in Kam Pot
ET15MAR Evapotranspiration of March in Kam Pot
ET15APR Evapotranspiration of April in p Kam Pot
ET15MAY Evapotranspiration of May in Kam Pot
ET15JUN Evapotranspiration of June in p Kam Pot
ET15JLY Evapotranspiration of July in Kam Pot

3-5-1-1-13. Yield function of wet rice in Koh Kong

YW16= +3.40365
-0.10616 *TREND
+0.00000*ln (ET16MAR)
+0.11765*ln (ET16APR)
+0.39643*ln (ET16MAY)
-0.84877*ln (ET16JUN)
+0.00000*ln (ET16JLY)

YW16 Yield of wet rice in Koh Kong
TREND Time Trend from 1996 to 2000,5 after 2001
ET16MAR Evapotranspiration of March in KohKong
ET16APR Evapotranspiration of April in Koh Kong
ET16MAY Evapotranspiration of May in Koh Kong
ET16JUN Evapotranspiration of June in Koh Kong
ET16JLY Evapotranspiration of July in Koh Kong

3-5-1-1-14. Yield function of wet rice in Kompong speu

YW17= +3.40365
-0.08375*REND
+0.00000*ln (ET17MAR)
+0.20666*ln (ET17APR)
+0.39643*ln (ET17MAY)
-0.84877*ln (ET17JUN)
+0.00000*ln (ET17JLY)

YW17 Yield of wet rice in Kampong speu
TREND Time Trend from 1996 to 2000,5 after 2001
ET17MAR Evapotranspiration of March in Kampong speu
ET17APR Evapotranspiration of April in Kampong speu
ET17MAY Evapotranspiration of May in Kampong speu
ET17JUN Evapotranspiration of June in Kampong speu
ET17JLY Evapotranspiration of July in Kampong speu

3-5-1-1-15. Yield function of wet rice in Preah Vihea

YW18= +3.40365
-0.08375*TREND
+0.00000*ln (ET18MAR)
+0.20666*ln (ET18APR)
+0.39643*ln (ET18MAY)
-0.84877*ln (ET18JUN)
+0.00000*ln (ET18JLY)

YW18 Yield of wet rice in Preah Vihea
TREND Time Trend from 1996 to 2000,5 after 2001
ET18MAR Evapotranspiration of March in Preah Vihea
ET18APR Evapotranspiration of April in Preah Vihea
ET18MAY Evapotranspiration of May in Preah Vihea
ET18JUN Evapotranspiration of June in Preah Vihea
ET18JLY Evapotranspiration of July in Preah Vihea

3-5-1-1-16. Yield function of wet rice in Stung Treng

YW19= +3.40365
-0.03100*TREND
+0.00000*ln (ET19MAR)
+0.11765*ln (ET19APR)
+0.39643*ln (ET19MAY)
-0.84877*ln (ET19JUN)
+0.00000*ln (ET19JLY)

YW19 Yield of wet rice in Stung Treng
TREND Time Trend from 1996 to 2000,5 after 2001
ET19MAR Evapotranspiration of March in Stung Treng
ET19APR Evapotranspiration of April in Stung Treng
ET19MAY Evapotranspiration of May in Stung Treng
ET19JUN Evapotranspiration of June in Stung Treng
ET19JLY Evapotranspiration of July in Stung Treng

3-5-1-1-17. Yield function of wet rice in Rottanakiri

YW20= +3.40365
-0.06381*TREND
+0.00000*ln (ET20MAR)
+0.11765*ln (ET20APR)
+0.39643*ln (ET20MAY)
-0.84877*ln (ET20JUN)
+0.00000*ln (ET20JLY)

YW20 Yield of wet rice in Rottanakiri
TREND Time Trend from 1996 to 2000,5 after 2001
ET20MAR Evapotranspiration of March in Rottanakiri
ET20APR Evapotranspiration of April in Rottanakiri
ET20MAY Evapotranspiration of May in Rottanakiri
ET20JUN Evapotranspiration of June in Rottanakiri
ET20JLY Evapotranspiration of July in Rottanakiri

3-5-1-1-18. Yield function of wet rice in Mondulkiri

YW21= +3.40365
-0.05010*TREND
+0.00000*ln (ET21MAR)
+0.11765*ln (ET21APR)
+0.39643*ln (ET21MAY)
-0.84877*ln (ET21JUN)
+0.00000*ln (ET21JLY)

YW21 Yield of wet rice in Mondulkiri
TREND Time Trend from 1996 to 2000,5 after 2001
ET21MAR Evapotranspiration of March in Mondulkiri
ET21APR Evapotranspiration of April in Mondulkiri
ET21MAY Evapotranspiration of May in Mondulkiri
ET21JUN Evapotranspiration of June in Mondulkiri
ET21JLY Evapotranspiration of July in Mondulkiri

3-5-1-1-19. Yield function of wet rice in Kratie

YW22= +3.40365
+0.00000*TREND
+0.00000 * ln (ET22MAR)
+0.11765 * ln (ET22APR)
+0.39643 * ln (ET22MAY)
-0.84877 * ln (ET22JUN)
+0.00000 * ln (ET22JLY)

YW22 Yield of wet rice in Kratie
ET22MAR Evapotranspiration of March in Kratie
ET22APR Evapotranspiration of April in Kratie
ET22MAY Evapotranspiration of May in Kratie
ET22JUN Evapotranspiration of June in Kratie
ET22JLY Evapotranspiration of July in Kratie

3-5-1-2. Yield function of dry season rice

YD= - 2.67199
(-4.86)
+ 2.91089**D11
(1.93)
- 0.09891*TREND*D01
(-1.83)
+ 0.16861*TREND*D02
(1.79)
+ 0.10317*TREND*D03
(2.12)
- 0.13776*TREND*D09
(-2.49)
+ 1.12380*ln(ETJAN)
(10.18)
- 4.77987*ln(ETJAN)*D02
(-3.04)
+ 2.22020*ln(ETJAN)*D09
(4.30)
- 1.22031*ln(ETFEB)*D08
(-2.99)
- 0.87649*ln(ETFEB)*D11
(-2.09)
+ 0.13943*ln(ETMAR)
(1.86)
- 0.53233*ln(ETMAR)*D01
(-2.63)
+ 0.05519*ln(ETMAR)*D12
(2.05)

+ 0.43562*ln(ETMAR)*D17
(2.33)
+ 0.10595*ln(ETAPR)
(1.30)
+ 0.47643*ln(ETAPR)*D01
(2.25)
+ 0.60381*ln(ETAPR)*D08
(2.33)
- 1.75954*ln(ETAPR)*D09
(-3.85)
+ 4.46306*ln(ETMAY)*D02
(3.15)
- 0.06201*ln(ETMAY)*D03
(-1.46)
- 0.09500*ln(ETMAY)*D04
(-3.91)
- 0.09608*ln(ETMAY)*D06
(-3.65)
+ 0.36658*ln(ETMAY)*D08
(1.72)
- 0.43031*ln(ETMAY)*D17
(-2.85)

$Adj R^2$=0.8003

YD	Yield of Dry Rice for all provinces (MT/HA)
TREND	Time Trend from 1995 to 2000
D01	Dummy Variable, 1 in Phnom Penh, 0 otherwise
D02	Dummy Variable, 1 in Kandal, 0 otherwise
D03	Dummy Variable, 1 in Kampong Cham, 0 otherwise
D04	Dummy Variable, 1 in Svay Rieng, 0 otherwise
D05	Dummy Variable, 1 in Prey Veng, 0 otherwise (unused, Base)
D06	Dummy Variable, 1 in Ta Keo, 0 otherwise
D07	Dummy Variable, 1 in Kompong Thom, 0 otherwise
D08	Dummy Variable, 1 in Siem Reap, 0 otherwise
D09	Dummy Variable, 1 in Battambang, 0 otherwise
D11	Dummy Variable, 1 in Pursat, 0 otherwise
D12	Dummy Variable, 1 in Kampong Chhnang, 0 otherwise
D17	Dummy Variable, 1 in Kompong Speu, 0 otherwise
D22	Dummy Variable, 1 in Kratie, 0 otherwise
ETJAN	Evapotranspiration of January
ETFEB	Evapotranspiration of February
ETMAR	Evapotranspiration of March
ETAPR	Evapotranspiration of April
ETMAY	Evapotranspiration of May

3-5-1-2-1. Yield function of dry rice in Phnom Penh

YD01= -2.67199
-0.09891*TREND
+1.12380*ln (ET01 JAN)
+0.00000*ln (ET01 FEB)
-0.39290*ln (ET01 MAR)
+0.58238*ln (ET01 APR)
+0.00000*ln (ET01 MAY)

YD01	Yield of dry rice in Phnom Penh
TREND	Time Trend from 1996 to 2000,5 after 2001
ET01 JAN	Evapotranspiration of January in Phnom Penh
ET01 FEB	Evapotranspiration of February in Phnom Penh
ET01MAR	Evapotranspiration of March in Phnom Penh
ET01APR	Evapotranspiration of April in Phnom Penh
ET01MAY	Evapotranspiration of May in Phnom Penh

3-5-1-2-2. Yield function of dry rice in Kandal

YD02= -2.67199
+0.1686*TREND
-3.65607*ln (ET02 JAN)
+0.00000*ln (ET02 FEB)
+0.13943*ln (ET02 MAR)
+0.10595*ln (ET02 APR)
+4.46306*ln (ET02 MAY)

YD02	Yield of dry rice in Kandal
ET02 JAN	Evapotranspiration of January in Kandal
ET02 FEB	Evapotranspiration of March in Kandal
ET02MAR	Evapotranspiration of March in Kandal
ET02APR	Evapotranspiration of April Kandal
ET02MAY	Evapotranspiration of May in Kandal

3-5-1-2-3. Yield function of dry rice in Kampong Cham

YD03= -2.67199
+0.10317*TREND
+1.12380* ln (ET03 JAN)
+0.00000* ln (ET03 FEB)
+0.13943* ln (ET03 MAR)
+0.10595* ln (ET03 APR)
-0.06201*ln (ET03 MAY)

YD03	Yield of dry rice in Kampong Cham
ET03 JAN	Evapotranspiration of January in Kampong Cham
ET03 FEB	Evapotranspiration of February in Kampong Cham
ET03MAR	Evapotranspiration of March in Kampong Cham
ET03APR	Evapotranspiration of April in Kampong Cham
ET03MAY	Evapotranspiration of May in Kampong Cham

3-5-1-2-4. Yield function of dry rice in Svay Rieng

YD04= -2.67199
+0.00000*TREND
+1.12380* ln (ET04 JAN)
+0.00000* ln (ET04 FEB)
+0.13943-* ln (ET04 MAR)
+0.10595* ln (ET04 APR)
-0.09500 * ln (ET04 MAY)

YD04	Yield of dry rice in Svay Rieng
ET04 JAN	Evapotranspiration of January in Svay Rieng
ET04 FEB	Evapotranspiration of February in Svay Rieng
ET04MAR	Evapotranspiration of March in Svay Rieng
ET04APR	Evapotranspiration of April in Svay Rieng
ET04MAY	Evapotranspiration of May in Svay Rieng

3-5-1-2-5. Yield function of dry rice in Prey Veng

YD05= -2.67199
+0.00000*TREND
+1.12380*ln (ET05 JAN)
+0.00000*ln (ET05 FEB)
+0.13943*ln (ET05 MAR)
+0.10595*ln (ET05 APR)
+0.00000*ln (ET05 MAY)

YD05 Yield of dry rice in Prey Veng
ET05 JAN Evapotranspiration of January in Prey Veng
ET05 FEB Evapotranspiration of February in Prey Veng
ET05MAR Evapotranspiration of March in Prey Veng
ET05APR Evapotranspiration of April in Prey Veng
ET05MAY Evapotranspiration of May in Prey Veng

3-5-1-2-6. Yield function of dry rice in Ta Keo

YD06= -2.67199
+0.00000*TREND
+1.12380*ln (ET06 JAN)
+0.00000*ln (ET06 FEB)
+0.13943*ln (ET06 MAR)
+0.10595*ln (ET06 APR)
-0.09608 *ln (ET06 MAY)

YD06 Yield of dry rice in Ta Keo
ET06 JAN Evapotranspiration of January in Ta Keo
ET06 FEB Evapotranspiration of February in Ta Keo
ET06MAR Evapotranspiration of March in Ta Keo
ET06APR Evapotranspiration of April in Ta Keo
ET06MAY Evapotranspiration of May in Ta Keonh

3-5-1-2-7. Yield function of dry rice in Kompong Thom

YD07= -2.67199
+0.00000*TREND
+1.12380*ln (ET07 JAN)
+0.00000*ln (ET07 FEB)
+0.13943*ln (ET07 MAR)
+0.10595*ln (ET07 APR)
+0.00000*ln (ET07 MAY)

YD07 Yield of dry rice in Kompong Thom
ET07JAN Evapotranspiration of January in Kompong Thom
ET07FEB Evapotranspiration of February in Kompong hom
ET07MAR Evapotranspiration of March in Kompong Thom
ET07APR Evapotranspiration of April in Kompong Thom
ET07MAY Evapotranspiration of May in Kompong Thom

3-5-1-2-8. Yield function of dry rice in Siem Reap

YD08= -2.67199
+0.00000*TREND
+1.12380* ln (ET08 JAN)
-1.22031* ln (ET08 FEB)
+0.13943* ln (ET08 MAR)
+0.70976* ln (ET08 APR)
+0.36658 * ln (ET08 MAY)

YD08 Yield of dry rice in Siem Reap
ET08 JAN Evapotranspiration of January in Siem Reap
ET08 FEB Evapotranspiration of February in Siem Reap
ET08MAR Evapotranspiration of March in Siem Reap
ET08APR Evapotranspiration of April in Siem Reap
ET08MAY Evapotranspiration of May in Siem Reap

3-5-1-2-9. Yield function of dry rice in Battambang

YD09= -2.67199
-0.13776 *TREND
+3.34400 * ln (ET09 JAN)
+0.00000* ln (ET09 FEB)
+0.13943* ln (ET09 MAR)
-1.65359 * ln (ET09 APR)
+0.00000 * ln (ET09 MAY)

YD09 Yield of dry rice in Battambang
TREND Time Trend from 1996 to 2000,5 after 2001
ET09 JAN Evapotranspiration of January in Battambang
ET09 FEB Evapotranspiration of February in Battambang
ET09MAR Evapotranspiration of March in Battambang
ET09APR Evapotranspiration of April in Battambang
ET09MAY Evapotranspiration of May in Battambang

3-5-1-2-10. Yield function of dry rice in Pursat

YD11= +0.23890
+0.00000*TREND
+1.12380*ln (ET11 JAN)
-0.87649*ln (ET11 FEB)
+0.13943*ln (ET11 MAR)
+0.10595*ln (ET11 APR)
+0.00000*ln (ET11 MAY)

YD11 Yield of dry rice in Pursa
ET11 JAN Evapotranspiration of January in Pursa
ET11 FEB Evapotranspiration of February in Pursa
ET11MAR Evapotranspiration of March in Pursa
ET11APR Evapotranspiration of April in Pursa
ET11MAY Evapotranspiration of May in Pursa

3-5-1-2-11. Yield function of dry rice in Kampong Chhnang

YD12= -2.67199
0.00000*TREND
+1.12380* ln (ET12 JAN)
+0.00000* ln (ET12 FEB)
+0.19462* ln (ET12 MAR)
+0.10595 * ln (ET12 APR)
+0.00000 * ln (ET12 MAY)

YD12 Yield of dry rice in Kampong Chhnang
ET12 JAN Evapotranspiration of January in Kampong Chhnang
ET12 FEB Evapotranspiration of February in Kampong Chhnang
ET12MAR Evapotranspiration of March in Kampong Chhnang
ET12APR Evapotranspiration of April in Kampong Chhnang
ET12MAY Evapotranspiration of May in Kampong Chhnang

3-5-1-2-12. Yield function of dry rice in Kompong speu

YD17= -2.67199
+0.00000*TREND
+1.12380*ln (ET17 JAN)
+0.00000*ln (ET17FEB)
+0.57505*ln (ET17 MAR)
+0.10595*ln (ET17 APR)
-0.43031*ln (ET17 MAY)

YD17 Yield of dry rice in Kompong speu
ET17JAN Evapotranspiration of January in Kompong speu
ET17 FEB Evapotranspiration of February in Kompong speu
ET17MAR Evapotranspiration of March in Kompong speu
ET17APR Evapotranspiration of April in Kompong speu
ET17MAY Evapotranspiration of May in Kompong speu

3-5-1-2-13. Yield function of dry rice in Kratie

YD22= -2.67199
0.00000*TREND
+1.12380*ln (ET22JAN)
+0.00000*ln (ET22 FEB)
+0.13943*ln (ET22 MAR)
+0.10595*ln (ET22 APR)
+0.00000*ln (ET22 MAY)

YD22	Yield of dry rice in Kratie
ET22JAN	Evapotranspiration of January in Kratie
ET22 FEB	Evapotranspiration of February in Kratie
ET22MAR	Evapotranspiration of March in Kratie
ET22APR	Evapotranspiration of April in Kratie
ET22MAY	Evapotranspiration of May in Kratie

3-5-2. Planted area functions

3-5-2-1. Planted area function of wet season rice

APW= - 6463
(-0.14)
- 2221336*D05
(-5.87)
+ 0.85037*APW(t-1)
(15.02)
+ 0.00944*FP(t-1)/[CPI(t-1)/100]*D05
(1.52)
+ 92680*ln(ETMAY)
(9.52)
- 95019*ln(ETMAY)*D01
(-5.77)
- 85710*ln(ETMAY)*D02
(-5.01)
- 63164*ln(ETMAY)*D03
(-3.76)
-111512*ln(ETMAY)*D04
(-5.85)
- 66418*ln(ETMAY)*D06
(-3.33)
- 81363*ln(ETMAY)*D07
(-4.73)
- 73572*ln(ETMAY)*D11
(-4.48)
-119268*ln(ETMAY)*D12
(-6.01)
-102987*ln(ETMAY)*D15
(-6.58)
- 95084*ln(ETMAY)*D16
(-6.32)
- 87467*ln(ETMAY)*D17
(-5.91)
- 98704*ln(ETMAY)*D18
(-6.58)
- 96906*ln(ETMAY)*D19
(-6.72)
- 92188*ln(ETMAY)*D20
(-6.41)
- 96562*ln(ETMAY)*D21
(-4.50)
-104672*ln(ETMAY)*D22
(-4.77)
- 87472*ln[ETMAY(t-1)]
(-7.47)
+ 83302*ln[ETMAY(t-1)]*D01
(4.92)
+ 75050*ln[ETMAY(t-1)]*D02
(4.28)
+ 74012*ln[ETMAY(t-1)]*D03
(4.31)
+105287*ln[ETMAY(t-1)]*D04
(5.45)
+ 79784*ln[ETMAY(t-1)]*D05
(4.03)
+100213*ln[ETMAY(t-1)]*D06
(4.85)
+ 73241*ln[ETMAY(t-1)]*D07
(4.20)
+ 75349*ln[ETMAY(t-1)]*D08
(4.63)
+ 64419*ln[ETMAY(t-1)]*D11
(3.85)
+110296*ln[ETMAY(t-1)]*D12
(5.41)
+ 96034*ln[ETMAY(t-1)]*D15
(5.99)
+ 83501*ln[ETMAY(t-1)]*D16
(5.36)
+ 78199*ln[ETMAY(t-1)]*D17
(5.14)
+ 87432*ln[ETMAY(t-1)]*D18
(5.63)
+ 85583*ln[ETMAY(t-1)]*D19
(5.72)
+ 80755*ln[ETMAY(t-1)]*D20
(5.43)
+ 84777*ln[ETMAY(t-1)]*D21
(3.87)
+ 93601*ln[ETMAY(t-1)]*D22
(4.18)
+ 7998*ln(ETJUN)
(1.05)
- 16651*ln(ETJUN)*D03
(-1.01)
+137638*ln(ETJUN)*D05
(3.08)
- 38671*ln(ETJUN)*D06
(-1.54)
- 80008*ln(ETJUN)*D08
(-5.01)
+261160*ln[ETJUN(t-1)]*D05
(6.59)

$Adj R^2$=0.9912

APW	Planted area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
CPI	Consumer Price Index (1995=100)
D01	Dummy Variable, 1 in Phnom Penh, 0 otherwise
D02	Dummy Variable, 1 in Kandal, 0 otherwise

D03	Dummy Variable, 1 in Kampong Cham, 0 otherwise
D04	Dummy Variable, 1 in Svay Rieng, 0 otherwise
D05	Dummy Variable, 1 in Prey Veng, 0 otherwise
D06	Dummy Variable, 1 in Ta Keo, 0 otherwise
D07	Dummy Variable, 1 in Kompong Thom, 0 otherwise
D08	Dummy Variable, 1 in Siem Reap, 0 otherwise
D09	Dummy Variable, 1 in Battambang, 0 otherwise (unused, Base)
D11	Dummy Variable, 1 in Pursat, 0 otherwise
D12	Dummy Variable, 1 in Kampong Chhnang, 0 otherwise
D15	Dummy Variable, 1 in Kam Pot, 0 otherwise
D16	Dummy Variable, 1 in Koh Kong, 0 otherwise
D17	Dummy Variable, 1 in Kompong Speu, 0 otherwise
D18	Dummy Variable, 1 in Preah Vihea, 0 otherwise
D19	Dummy Variable, 1 in Stung Treng, 0 otherwise
D20	Dummy Variable, 1 in Rottanakiri, 0 otherwise
D21	Dummy Variable, 1 in Mondulkiri, 0 otherwise
D22	Dummy Variable, 1 in Kratie, 0 otherwise
ETMAY	Evapotranspiration of May
ETJUN	Evapotranspiration of June

3-5-2-1-1. Planted Area function of wet rice in Phnom Penh

APW01= - 6379.25000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00033*FP(-1)/(CPI(-1)/100)
- 2339.00000*ln (ET01MAY)
-4170.00000*ln (ET01 MAY(-1))
+ 7998.00000*ln (ET01JUN)
+ 0.00000*ln (ET01JUN(-1))

APW01	Area Function of wet rice in Phnom Penh
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET01MAY	Evapotranspiration of May in Phnom Penh
ET01JUN	Evapotranspiration of June in Phnom Penh

3-5-2-1-2. Planted Area function of wet rice in Kandal

APW02= -7011.09000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+0.00191*FP(-1)/(CPI(-1)/100)
+6970.00000*ln (ET02MAY)
-12422.00000*ln (ET02 MAY(-1))
+ 7998.00000*ln (ET02JUN)
+ 0.00000*ln (ET02JUN(-1))

APW02	Area Function of wet rice in Kandal
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted Area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET02MAY	Evapotranspiration of May in Kandal
ET02JUN	Evapotranspiration of June in Kandal

3-5-2-1-3. Planted Area function of wet rice in Kampong Cham

APW03= -13050.58000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+0.00697*FP(-1)/(CPI(-1)/100)
+29516.000000*ln (ET03MAY)
-13460.00000*ln (ET03 MAY(-1))
-8653.00000*ln (ET03JUN)
+ 0.00000*ln (ET03JUN(-1))

APW03	Area Function of wet rice in Kampong Cham
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted Area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET03MAY	Evapotranspiration of May in Kampong Cham
ET03JUN	Evapotranspiration of June in Kampong Cham

3-5-2-1-4. Planted Area function of wet rice in Svay Rieng

APW04= -11753.26000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+0.00691*FP(-1)/(CPI(-1)/100)
-18832.00000*ln (ET04MAY)
+17815.00000*ln (ET04 MAY(-1))
+ 7998.00000*ln (ET04JUN)
+ 0.00000*ln (ET04JUN(-1))

APW04	Area Function of wet rice in Svay Rieng
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted Area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET04MAY	Evapotranspiration of May in Svay Rieng
ET04JUN	Evapotranspiration of June in Svay Rieng

3-5-2-1-5. Planted Area function of wet rice in Prey Veng

APW05= -2227799.36000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+0.00944*FP(-1)/(CPI(-1)/100)
+92680.00000*ln (ET05MAY)
-7688.00000*ln (ET05 MAY(-1))
+145636.00000*ln (ET05JUN)
+261160.00000*ln (ET05JUN(-1))

APW05	Area Function of wet rice in Prey Veng
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted Area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET05MAY	Evapotranspiration of May in Prey Veng
ET05JUN	Evapotranspiration of June in Prey Veng

3-5-2-1-6. Planted Area function of wet rice in Ta keo

APW06= -12374.70000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00748*FP(-1)/(CPI(-1)/100)
+ 26262.00000*ln (ET06MAY)
+12741.00000*ln (ET06 MAY(-1))
-30673.00000*ln (ET06JUN)
+ 0.00000*ln (ET06JUN(-1))

APW06	Area Function of wet rice in Ta keo
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted Area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)

ET06MAY Evapotranspiration of May in Ta keo
ET06JUN Evapotranspiration of June in Ta keo

3-5-2-1-7. Planted Area function of wet rice in Kompong Thom

APW07= -8398.44 000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00516*FP(-1)/(CPI(-1)/100)
+11317.00000*ln (ET07MAY)
-14231.00000*ln (ET07 MAY(-1))
+ 7998.00000*ln (ET07JUN)
+ 0.00000*ln (ET07JUN(-1))

APW07 Area Function of wet rice in Kompong Thom
TREND Time Trend from 1996 to 2000, 5 after 2001
APW Planted Area of wet rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET07MAY Evapotranspiration of May in Kompong Thom
ET07JUN Evapotranspiration of June in Kompong Thom

3-5-2-1-8. Planted Area function of wet rice in Siem Reap

APW08= -7271.07000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00792*FP(-1)/(CPI(-1)/100)
+92680.00000*ln (ET08MAY)
-12123.00000*ln (ET08 MAY(-1))
- 72010.00000*ln (ET08JUN)
+ 0.00000*ln (ET08JUN(-1))

APW08 Area Function of wet rice in Siem Reap
TREND Time Trend from 1996 to 2000, 5 after 2001
APW Planted Area of wet rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET08MAY Evapotranspiration of May in Siem Reap
ET08JUN Evapotranspiration of June in Siem Reap

3-5-2-1-9. Planted Area function of wet rice in Battambang

APW09= -3314.56000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.01430*FP(-1)/(CPI(-1)/100)
+92680.00000*ln (ET09MAY)
-87472.00000*ln (ET09 MAY(-1))
+ 7998.00000*ln (ET09JUN)
+ 0.00000*ln (ET09JUN(-1))

APW09 Area Function of wet rice in Battambang
TREND Time Trend from 1996 to 2000, 5 after 2001
APW Planted Area of wet rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET09MAY Evapotranspiration of May in Battambang
ET09JUN Evapotranspiration of June in Battambang

3-5-2-1-10. Planted Area function of wet rice in Pursat

APW11= -9077.98 000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00338*FP(-1)/(CPI(-1)/100)
+19108.00000*ln (ET11MAY)
-23053.00000*ln (ET11 MAY(-1))
+ 7998.00000*ln (ET11JUN)
+ 0.00000*ln (ET11JUN(-1))

APW11 Area Function of wet rice in Pursat
TREND Time Trend from 1996 to 2000, 5 after 2001
APW Planted Area of wet rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET11MAY Evapotranspiration of May in Pursat
ET11JUN Evapotranspiration of June in Pursat

3-5-2-1-11. Planted Area function of wet rice in Kampong Chhnang

APW12= -67174.46000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00352*FP(-1)/(CPI(-1)/100)
-26588.00000*ln (ET12MAY)
+22824.00000*ln (ET12 MAY(-1))
+ 7998.00000*ln (ET12JUN)
+ 0.00000*ln (ET12JUN(-1))

APW12 Area Function of wet rice in kampong Chhnang
TREND Time Trend from 1996 to 2000, 5 after 2001
APW Planted Area of wet rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET12MAY Evapotranspiration of May in kampong Chhnang
ET12JUN Evapotranspiration of June in kampong Chhnang

3-5-2-1-12. Planted Area function of wet rice in Kam Pot

APW15= -11212.50000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00624*FP(-1)/(CPI(-1)/100)
-10307.00000*ln (ET15MAY)
+8562.00000*ln (ET15 MAY(-1))
+ 7998.00000*ln (ET15JUN)
+ 0.00000*ln (ET15JUN(-1))

APW15 Area Function of wet rice in Kam Pot
TREND Time Trend from 1996 to 2000, 5 after 2001
APW Planted Area of wet rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET15MAY Evapotranspiration of May in Kam Pot
ET15JUN Evapotranspiration of June in Kam Pot

3-5-2-1-13. Planted Area function of wet rice in Koh Kong

APW16= -6278.22000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00032*FP(-1)/(CPI(-1)/100)
-2404.00000*ln (ET16MAY)
-3971.00000*ln (ET16 MAY(-1))
+ 7998.00000*ln (ET16JUN)
+ 0.00000*ln (ET16JUN(-1))

APW16 Area Function of wet rice in Koh Kong
TREND Time Trend from 1996 to 2000, 5 after 2001
APW Planted Area of wet rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET16MAY Evapotranspiration of May in Koh Kong
ET16JUN Evapotranspiration of Jun in Koh Kong

3-5-2-1-14. Planted Area function of wet rice in Kompong Speu

APW17= -6638.28 000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00357*FP(-1)/(CPI(-1)/100)
+5213.00000*ln (ET17MAY)
-9273.00000*ln (ET17 MAY(-1))
+ 7998.00000*ln (ET17JUN)
+ 0.00000*ln (ET17JUN(-1))

APW17	Area Function of wet rice in Kompong Speu
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted Area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET17MAY	Evapotranspiration of May in Kompong Speu
ET17JUN	Evapotranspiration of Jun in Kompong Speu t

3-5-2-1-15. Planted Area function of wet rice in Preah Viheat

APW18= -6170.30000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00070*FP(-1)/(CPI(-1)/100)
-6024.00000*ln (ET18MAY)
-40.00000*ln (ET18 MAY(-1))
+ 7998.00000*ln (ET18JUN)
+ 0.00000*ln (ET18JUN(-1))

APW18	Area Function of wet rice in Preah Viheat
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted Area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET18MAY	Evapotranspiration of May in Preah Viheat
ET18JUN	Evapotranspiration of Jun in Preah Viheat

3-5-2-1-16. Planted Area function of wet rice in Stung Treng

APW19= -6357.20000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00066*FP(-1)/(CPI(-1)/100)
-4226.00000*ln (ET19MAY)
-1889.00000*ln (ET19 MAY(-1))
+ 7998.00000*ln (ET19JUN)
+ 0.00000*ln (ET19JUN(-1))

APW19	Area Function of wet rice in Stung Treng
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted Area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET19MAY	Evapotranspiration of May in Stung Treng
ET19JUN	Evapotranspiration of Jun in Stung Treng

3-5-2-1-17. Planted Area function of wet rice in Rottanakiri

APW20= -6022.42000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00079*FP(-1)/(CPI(-1)/100)
+492.00000*ln (ET20MAY)
-6717.00000*ln (ET20 MAY(-1))
+ 7998.00000*ln (ET20JUN)
+ 0.00000*ln (ET20JUN(-1))

APW20	Area Function of wet rice in Rottanakiri
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted Area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET20MAY	Evapotranspiration of May in Rottanakiri
ET20JUN	Evapotranspiration of Jun in Rottanakiri

3-5-2-1-18. Planted Area function of wet rice in Mondukiri

APW21= -5725.57 000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00030*FP(-1)/(CPI(-1)/100)
-3882.00000*ln (ET21MAY)
-2695.00000*ln (ET21 MAY(-1))
+ 7998.00000*ln (ET21JUN)
+ 0.00000*ln (ET21JUN(-1))

APW21	Area Function of wet rice in Mondukiri
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted Area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET21MAY	Evapotranspiration of May in Mondukiri
ET21JUN	Evapotranspiration of Jun in Mondukiri

3-5-2-1-19. Planted Area function of wet rice in Kratie

APW22= -6651.68000
+ 0.00000*TREND
+ 0.85037*AP(-1)
+ 0.00109*FP(-1)/(CPI(-1)/100)
-11992.00000*ln (ET22MAY)
+6129.00000*ln (ET22MAY(-1))
+ 7998.00000*ln (ET22JUN)
+ 0.00000*ln (ET22JUN(-1))

APW22	Area Function of wet rice in Kratie
TREND	Time Trend from 1996 to 2000, 5 after 2001
APW	Planted Area of wet rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET22MAY	Evapotranspiration of May in Kratie
ET22JUN	Evapotranspiration of Jun in Kratie

3-5-2-2. Planted area function of dry season rice

APD= - 21830
(-1.37)
+ 352588*D06
(4.16)
+45604*D08
(1.15)
+ 0.86381*APD(t-1)
(18.64)
+ 0.01293*FP(t-1)/[CPI(t-1)/100]*D02
(6.47)
+ 19144*ln[ETDEC(t-1)]
(3.49)
-18554*ln[ETDEC(t-1)]*D01
(-2.67)
-11223*ln[ETDEC(t-1)]*D02
(-1.46)

-44522*ln[ETDEC(t-1)]*D03
(-3.38)
-19347*ln[ETDEC(t-1)]*D04
(-2.29)
-19587*ln[ETDEC(t-1)]*D07
(-2.81)
-22581*ln[ETDEC(t-1)]*D08
(-2.73)
-16357*ln[ETDEC(t-1)]*D09
(-2.42)
-19475*ln[ETDEC(t-1)]*D12
(-2.47)
-18140*ln[ETDEC(t-1)]*D17
(-2.69)
-19536*ln[ETDEC(t-1)]*D22
(-2.38)
+ 33519*ln[ETDEC(t-2)]
(4.30)
- 33934*ln[ETDEC(t-2)]*D01
(-3.23)
- 39881*ln[ETDEC(t-2)]*D02
(-3.44)
- 40059*ln[ETDEC(t-2)]*D03
(-2.24)
- 27062*ln[ETDEC(t-2)]*D04
(-2.38)
- 33599*ln[ETDEC(t-2)]*D06
(-2.88)
- 32558*ln[ETDEC(t-2)]*D07
(-3.08)
- 38433*ln[ETDEC(t-2)]*D08
(-3.29)
- 39522*ln[ETDEC(t-2)]*D09
(-3.90)
- 28448*ln[ETDEC(t-2)]*D12
(-2.55)
- 32879*ln[ETDEC(t-2)]*D17
(-3.35)
- 29984*ln[ETDEC(t-2)]*D22
(-2.41)
+ 2431*ln(ETJAN)
(1.18)
+ 27478*ln(ETJAN)*D03
(2.89)
- 44644*ln(ETJAN)*D06
(-4.25)
- 48094*ln[ETJAN(t-1)]
(-5.12)
+ 50858*ln[ETJAN(t-1)]*D01
(4.47)
+ 49513*ln[ETJAN(t-1)]*D02
(3.68)
+ 59881*ln[ETJAN(t-1)]*D03
(3.91)
+ 44710*ln[ETJAN(t-1)]*D04
(3.28)
+ 51483*ln[ETJAN(t-1)]*D07
(4.20)
+ 48689*ln[ETJAN(t-1)]*D08
(3.84)
+ 55749*ln[ETJAN(t-1)]*D09
(5.02)
+ 46546*ln[ETJAN(t-1)]*D12
(3.83)
+ 49201*ln[ETJAN(t-1)]*D17
(4.50)
+ 48087*ln[ETJAN(t-1)]*D22
(3.98)

$AdjR^2$=0.9784

APD	Planted area of dry rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
CPI	Consumer Price Index (1995=100)
D01	Dummy Variable, 1 in Phnom Penh, 0 otherwise
D02	Dummy Variable, 1 in Kandal, 0 otherwise
D03	Dummy Variable, 1 in Kampong Cham, 0 otherwise
D04	Dummy Variable, 1 in Svay Rieng, 0 otherwise
D05	Dummy Variable, 1 in Prey Veng, 0 otherwise (unused Base)
D06	Dummy Variable, 1 in Ta Keo, 0 otherwise
D07	Dummy Variable, 1 in Kompong Thom, 0 otherwise
D08	Dummy Variable, 1 in Siem Reap, 0 otherwise
D09	Dummy Variable, 1 in Battambang, 0 otherwise
D12	Dummy Variable, 1 in Kampong Chhnang, 0 otherwise
D17	Dummy Variable, 1 in Kompong Speu, 0 otherwise
D22	Dummy Variable, 1 in Kratie, 0 otherwise
ETDEC	Evapotranspiration of December
ETJAN	Evapotranspiration of January

3-5-2-2-1. Planted Area function of dry rice in Phnom Penh

APD01= -22426.99000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.00033*FP(-1)/(CPI(-1)/100)
+590.00000*ln (ET01DEC(-1))
-415.00000*ln (ET01DEC (-2))
+2430.58000*ln (ET01JAN)
+2764.00000*ln (ET01JAN (-1))

APD 01	Area Function of dry rice in Phnom Penh
TREND	Time Trend from 1996 to 2000, 5 after 2001
APD	Planted Area of dry rice for all provinces (HA)
FP	Farm price for all Cambodia (Riel/MT)
ET01DEC	Evapotranspiration of December in Phnom Penh
ET01JAN	Evapotranspiration of January in Phnom Penh

3-5-2-2-2. Planted Area function of dry rice in Kandak

APD 02= -21380.00000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.01293*FP(-1)/(CPI(-1)/100)
+7921.00000*ln (ET02DEC(-1))
-6362.00000*ln (ET02DEC (-2))
+ 2430.58 000*ln (ET02JAN)
+1419.00000*ln (ET02JAN (-1))

APD 02	Area Function of dry rice in Kandak

TREND Time Trend from 1996 to 2000, 5 after 2001
APD Planted Area of dry rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET02DEC Evapotranspiration of December in Kandak
ET02JAN Evapotranspiration of January in Kandak

3-5-2-2-3. Planted Area function of dry rice in Kampong Cham

APD 03= -26448.98000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.01040*FP(-1)/(CPI(-1)/100)
-25378.00000*ln (ET03DEC(-1))
-6540.00000*ln (ET03DEC (-2))
+ 29908.58 000*ln (ET03JAN)
+11787.00000*ln (ET03JAN (-1))
APD 03 Area Function of dry rice in Kampong Cham
TREND Time Trend from 1996 to 2000, 5 after 2001
APD Planted Area of dry rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)

ET03DEC Evapotranspiration of December in Kampong Cham
ET03JAN Evapotranspiration of January in Kampong Cham

3-5-2-2-4. Planted Area function of dry rice in Svay Rieng

APD 04= -22699.28000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.00323*FP(-1)/(CPI(-1)/100)
-203.00000*ln (ET04DEC(-1))
+6457.00000*ln (ET04DEC (-2))
+2430.58000*ln (ET04JAN)
-3384.00000*ln (ET04JAN (-1))
APD 04 Area Function of dry rice in Svay Rieng
TREND Time Trend from 1996 to 2000, 5 after 2001
APD Planted Area of dry rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET04DEC Evapotranspiration of December in Svay Rieng
ET04JAN Evapotranspiration of January in Svay Rieng

3-5-2-2-5. Planted Area function of dry rice in Prey Veng

APD 05= -29454.37000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.01817*FP(-1)/(CPI(-1)/100)
-19144.00000*ln (ET05DEC(-1))
+33519.00000*ln (ET05DEC (-2))
+2430.58000*ln (ET05JAN)
-48094.0000*ln (ET05JAN (-1))
APD 05 Area Function of dry rice in Prey Veng
TREND Time Trend from 1996 to 2000, 5 after 2001
APD Planted Area of dry rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET05DEC Evapotranspiration of December in Prey Veng
ET05JAN Evapotranspiration of January in Prey Veng

3-5-2-2-6. Planted Area function of dry rice in Ta Keo

APD 06= +324379.82 000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.01762*FP(-1)/(CPI(-1)/100)
+19144.00000*ln (ET06DEC(-1))
-80.00000*ln (ET06DEC (-2))
-42213.42000*ln (ET06JAN)
-48094.00000*ln (ET06JAN (-1))
APD 06 Area Function of dry rice in Ta Keo
TREND Time Trend from 1996 to 2000, 5 after 2001
APD Planted Area of dry rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET06DEC Evapotranspiration of December in Ta Keo
ET06JAN Evapotranspiration of January in Ta Keo

3-5-2-2-7. Planted Area function of dry rice in Phnom Penh

APD 07= -22426.99000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.00033*FP(-1)/(CPI(-1)/100)
-11992.00000*ln (ET07DEC(-1))
+6129.00000*ln (ET07DEC (-2))
+ 7998.00000*ln (ET07JAN)
+ 0.00000*ln (ET07JAN (-1))
APD 07 Area Function of dry rice in Kompong Thom
TREND Time Trend from 1996 to 2000, 5 after 2001
APD Planted Area of dry rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET07DEC Evapotranspiration of December in Phnom Penh
ET07JAN Evapotranspiration of January in Phnom Penh

3-5-2-2-8. Planted Area function of dry rice in Siem Reap

APD 08= +22780.33 000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.00311*FP(-1)/(CPI(-1)/100)
-3437.00000*ln (ET08DEC(-1))
-4914.00000*ln (ET08DEC (-2))
+2430.58000*ln (ET08JAN)
+595.00000*ln (ET08JAN (-1))
APD 08 Area Function of dry rice in Siem Reap
TREND Time Trend from 1996 to 2000, 5 after 2001
APD Planted Area of dry rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET08DEC Evapotranspiration of December in Siem Reap
ET08JAN Evapotranspiration of January in Siem Reap

3-5-2-2-9. Planted Area function of dry rice in Battambang

APD 09= -22456.68000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.00061*FP(-1)/(CPI(-1)/100)
+2787.00000*ln (ET09DEC(-1))
-6003.00000*ln (ET09DEC (-2))
+2430.58000*ln (ET09JAN)
+ 7655.00000*ln (ET09JAN (-1))
APW09 Area Function of dry rice in Battambang
TREND Time Trend from 1996 to 2000, 5 after 2001
APD Planted Area of dry rice for all provinces (HA)

FP Farm price for all Cambodia (Riel/MT)
ET09DEC Evapotranspiration of December in Battambang
ET09JAN Evapotranspiration of January in Battambang

3-5-2-2-10. Planted Area function of dry rice in kampong Chhnang

APD 12= -22862.09000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.00327*FP(-1)/(CPI(-1)/100)
-331.00000*ln (ET12DEC(-1))
+5071.00000*ln (ET12DEC (-2))
+2430.58000*ln (ET12JAN)
-1548.00000*ln (ET01JAN (-1))

APD 12 Area Function of dry rice in kampong Chhnang
TREND Time Trend from 1996 to 2000, 5 after 2001
APD Planted Area of dry rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET12DEC Evapotranspiration of December in kampong Chhnang
ET12JAN Evapotranspiration of January in kampong Chhnang

3-5-2-2-11. Planted Area function of dry rice in Kompong Speu

APD 17= -22387.17 000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.00032*FP(-1)/(CPI(-1)/100)
+1004.00000*ln (ET17DEC(-1))
+640.00000*ln (ET17DEC (-2))
+2430.58000*ln (ET17JAN)
+ 1107.00000*ln (ET17JAN (-1))

APD 17 Area Function of dry rice in Kompong Speu
TREND Time Trend from 1996 to 2000, 5 after 2001
APD Planted Area of dry rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET17DEC Evapotranspiration of December in Kompong Speu
ET17JAN Evapotranspiration of January in Kompong Speu

3-5-2-2-12. Planted Area function of dry rice in kratie

APD 22= -22565.44 000
+ 0.00000*TREND
+ 0.86381*AP(-1)
+ 0.00203*FP(-1)/(CPI(-1)/100)
-392.00000*ln (ET22DEC(-1))
+3535.00000*ln (ET22DEC (-2))
+2430.58000*ln (ET22JAN)
-7.00000*ln (ET22JAN (-1))

APD 22 Area Function of dry rice in kratie
TREND Time Trend from 1996 to 2000, 5 after 2001
APD Planted Area of dry rice for all provinces (HA)
FP Farm price for all Cambodia (Riel/MT)
ET22DEC Evapotranspiration of December in kratie
ET22JAN Evapotranspiration of January in kratie

3-5-3. Harvested area

3-5-3-1. Harvested area of wet rice

AHW = APW - ABW = APW(1-RABW)

AHW Harvested area of wet rice (HA)
APW Planted area of wet rice (HA)
ABW Abandoned area of wet rice (HA)
RABW Ratio of abandoned area and planted area [(APW-AHW)/APW]

3-5-3-2. Harvested area of dry rice

AHD = APD - ABD = APD(1-RABD)

AHD Harvested area of dry rice (HA)
APD Planted area of dry rice (HA)
ABD Abandoned area of dry rice (HA)
RABD Ratio of abandoned area and planted area [(APD-AHD)/APD]

3-5-4. Production

3-5-4-1. Production of wet rice

QW = YW*AHW
QW Production of wet rice (MT)
YW Yield of wet rice (MT/HA)
AHW Harvested area of wet rice (HA)

3-5-4-2. Production of dry rice

QD = YD*AHD
QD Production of dry rice (MT)
YD Yield of dry rice (MT/HA)
AHD Harvested area of dry rice (HA)

3-5-4-3. Total production in milled equivalent

QME = 0.667*(QW+QD)
QME Total production in milled equivalent (MT)
QW Production of wet rice (MT: Paddy equivalent)
QD Production of dry rice (MT: Paddy equivalent)

3-5-5a Import Function of Cambodia (Relative price versions, for open economy)

Estimation period: 1983-2001

IMPME= 85497
(10.47)
- 9322.39*(WP*EXR)/FP
(-2.22) [WP:-0.263, FP: 0.263]
- 41589*D891
(-3.65)
+ 35816*D923
(2.26)
- 39977*D967
(-2.95)

$Adj R^2$=0.5900 D.W.=2.145

IMPME Rice imports in milled equivalent (MT)
WP World price of rice (Thailand: US$/MT)
FP Farm price for all Cambodia (Riel)
EXR Exchange Rate (Riel/US$)
D891 Dummy Variable, 1 in 1989 to 1991, 0 otherwise
D923 Dummy Variable, 1 in 1992 and 1993, 0 otherwise
D967 Dummy Variable, 1 in 1996 and 1997, 0 otherwise

3-5-5b. Import Function of Cambodia (World

price and production versions, for planned economy)

Estimation period: 1983-2001

IMPME= 181563
(6.66)
- 0.04442*WP*EXR/(CPI/100)
(-3.47) [-0.796]
- 0.03606*QME
(-4.24) [-1.054]
+ 58834*D88
(3.52)
- 72398*D91
(-4.21)
- 35373*D967
(-2.93)

$Adj R^2$=0.6987 D.W.=2.293

IMPME	Rice imports in milled equivalent (MT)
QME	Rice production in milled equivalent (MT)
WP	World price of rice (Thailand: US$/MT)
EXR	Exchange Rate (Riel/US$)
D88	Dummy Variable, 1 in 1988, 0 otherwise
D91	Dummy Variable, 1 in 1991, 0 otherwise
D967	Dummy Variable, 1 in 1996 and 1997, 0 otherwise

3-5-6. Stock change function of Cambodia

Estimation period: 1982-2001

STCME= - 116111
(-2.99)
- 45175*T8894
(-4.22)
+ 63119*T9500
(5.85)
177.75624*[FPt/(CPIt/100)-FPt-1/(CPIt-1/100)]
(-2.45)
+ 0.32968*(QMEt-QMEt-1)
(4.01)
+ 227030*D823
(3.02)
+ 255918*D889
(3.47)

$Adj R^2$=0.8760 D.W.=2.262

STCME	Rice stock change (ending stock - beginning stock)in milled equivalent (MT)
T8894	Time trend from 1988 to 1994, 0 otherwise
T9500	Time trend from 1995 to 2000, 0 otherwise
FP	Farm price for all Cambodia (Riel/MT)
CPI	Consumer Price Index (1995=100)
QME	Rice production in milled equivalent (000MT)
D823	Dummy Variable, 1 in 1982 and 1983, 0 otherwise
D889	Dummy Variable, 1 in 1988 and 1989, 0 otherwise

3-5-7. Total rice domestic supply of Cambodia

QSME= + QME + IMPME - EXPME - STCME

QSME	Total rice domestic supply in milled equivalent (MT)
QME	Total rice production in milled equivalent (MT)
IMPME	Rice imports in milled equivalent (MT)
EXPME	Rice export in milled equivalent (MT)
STCME	Rice stock change (ending stock - beginning stock)in milled equivalent (MT)

3-5-8. Rice consumption per capita

QSPC = QSME/(POP*1000)

QSPC	Rice domestic supply per capita (kg/person)
QSME	Total rice domestic supply in milled equivalent (MT)
POP	Population (million people)

3-5-9a. Demand Function of Rice for Average of Cambodia

Estimation period: 1991-2000

QSPC = + 291.65636
(8.90)
- 0.00015661*FP/(CPI/100)
(-3.35) [-0.3250]
- 0.19703*GDP/POP
(-2.81) [-0.2610]
- 34.93674*D92
(-3.75)
+ 49.55690*D95
(-2.56)
+ 11.38128*D97
(1.52)
+ 14.23134*D9698
(2.24)

$Adj R^2$=0.8599 D.W.=2.143

3-5-9b. Demand Function of Rice for Average of Cambodia

Estimation period: 1991-2000

QSPC = + 299.31567
(9.88)
- 0.00016728*FP/(CPI/100)
(-3.86) [-0.3471]
- 0.21318*GDP/POP
(-3.28) [-0.2823]
- 37.00111*D92
(-4.28)
+ 52.20910*D95
(-4.80)
+ 14.74369*D968
(2.42)

$Adj R^2$=0.8702 D.W.=2.541

QSPC	Rice domestic supply per capita (kg/person)
FP	Farm price for all Cambodia (Riel/MT)
CPI	Consumer Price Index (1995=100)
GDP	Gross Domestic Products (million US$)
POP	Population (million people)
D92	Dummy Variable, 1 in 1992, 0 otherwise
D95	Dummy Variable, 1 in 1995, 0 otherwise
D97	Dummy Variable, 1 in 1997, 0 otherwise
D9698	Dummy Variable, 1 in 1996 and 1998, 0 otherwise

D968 Dummy Variable, 1 in 1996, 1997, and 1998, 0 otherwise

Table 3-1 and Table 3-2 show elasticities of yield of wet season rice and dry season rice with respect to time trend and evpotranspirations. Table 3-3 and Table 3-4 show elasticities of planted area of the two types of rice with respect to last year's planted area, last year's farm price, and last year's evapotranspirations.

Table 3-1. Elasticities of yield of wet season rice for evapotranspiration and trend

Province 9 base	Trend	Mar.	Apr.	May	Jun.	Jul.
Phnom Penh	0.000	0.000	-0.104	0.366	-0.445	0.000
Kandal	0.000	0.000	0.109	0.186	-0.399	0.000
Kampong Cham	0.166	0.000	0.059	0.198	-0.423	0.000
Svay Rieng	0.000	0.000	0.089	-1.119	0.680	0.000
Prey Veng	0.000	0.000	0.072	0.244	-0.521	0.000
Ta Keo	0.173	0.000	0.057	0.194	-0.414	0.000
Kompong Thom	0.000	-0.298	0.076	0.439	-0.547	0.000
Siem Reap	0.000	-0.084	0.085	0.286	-0.611	0.000
Battambang	0.000	0.000	0.065	0.220	-0.471	0.000
Pursat	0.217	0.000	0.066	0.223	0.018	-0.553
Kampong Chhnang	0.000	0.000	0.068	0.228	-0.488	0.000
Kam Pot	0.094	0.000	0.064	0.215	-0.460	0.000
Koh Kong	-0.271	0.000	0.086	0.289	-0.620	0.000
Kompong speu	-0.165	0.000	0.116	0.223	-0.478	0.000
Preah Vihea	-0.173	0.000	0.079	0.266	-0.569	0.000
Stung Treng	-0.069	0.000	0.074	0.251	-0.537	0.000
Rottanakiri	-0.156	0.000	0.082	0.277	-0.592	0.000
Mondulkiri	-0.119	0.000	0.080	0.268	-0.575	0.000
Kratie	0.000	0.000	0.072	0.243	-0.521	0.000

Note) Battambang is the base province for the calculation

Table 3-2. Elasticities of yield of dry season rice for evapotranspiration and trend

Province 5 base	Trend	Jan.	Feb.	Mar.	Apr.	May.
Phnom Penh	-0.142	0.460	0.000	-0.161	0.238	0.000
Kandal	0.173	-1.070	0.000	0.041	0.031	1.306
Kampong Cham	0.129	0.401	0.000	0.050	0.038	-0.022
Svay Rieng	0.000	0.424	0.000	0.053	0.040	-0.036
Prey Veng	0.000	0.364	0.000	0.045	0.034	0.000
Ta Keo	0.000	0.389	0.000	0.048	0.037	-0.033
Kompong Thom	0.000	0.541	0.000	0.067	0.051	0.000
Siem Reap	0.000	0.463	-0.503	0.057	0.292	0.151
Battambang	-0.199	1.382	0.000	0.058	-0.684	0.000
Pursat	0.000	0.480	-0.374	0.060	0.045	0.000
Kampong Chhnang	0.000	0.394	0.000	0.068	0.037	0.000
Kompong speu	0.000	0.461	0.000	0.236	0.043	-0.177
Kratie	0.000	0.462	0.000	0.057	0.044	0.000

Note) PreyVeng is the base province for the calculation

Table 3-3. Elasticities of planted area of wet season rice for price and evapotranspiration

Province	Planted area (t-1)	Farm price (t-1)	Evapotranspiration			
			May	May (t-1)	Jun.	Jun. (t-1)
Phnom Penh	0.887	0.000	-0.265	-0.472	0.906	0.000
Kandal	0.871	0.000	0.145	-0.259	0.167	0.000
Kampong Cham	0.843	0.000	0.180	-0.082	-0.053	0.000
Svay Rieng	0.839	0.000	-0.117	0.111	0.050	0.000
Prey Veng	0.849	0.025	0.418	-0.035	0.658	1.179
Ta Keo	0.849	0.000	0.147	0.071	-0.172	0.000
Kompong Thom	0.862	0.000	0.089	-0.112	0.063	0.000
Siem Reap	0.827	0.000	0.535	-0.070	-0.416	0.000
Battambang	0.825	0.000	0.304	-0.287	0.026	0.000
Pursat	0.838	0.000	0.253	-0.305	0.106	0.000
Kampong Chhnang	0.824	0.000	-0.354	0.304	0.106	0.000
Kam Pot	0.830	0.000	-0.077	0.064	0.059	0.000
Koh Kong	0.806	0.000	-0.391	-0.646	1.301	0.000
Kompong speu	0.847	0.000	0.065	-0.116	0.100	0.000
Preah Vihea	0.834	0.000	-0.393	-0.003	0.522	0.000
Stung Treng	0.788	0.000	-0.323	-0.145	0.612	0.000
Rottanakiri	0.818	0.000	0.033	-0.450	0.535	0.000
Mondulkiri	0.795	0.000	-0.667	-0.463	1.374	0.000
Kratie	0.833	0.000	-0.492	0.251	0.328	0.000

Note) Battambang is the base province for the calculation

Table 3-4. Elasticities of planted area of dry season rice for price and evapotranspiration

Province	Planted area (t-1)	Farm price (t-1)	Evapotranspiration			
			Dec. (t-1)	Dec. (t-2)	Jan. (t)	Jan. (t-1)
Phnom Penh	0.892	0.000	0.573	-0.403	2.362	2.686
Kandal	0.786	0.184	0.190	-0.152	0.058	0.034
Kampong Cham	0.784	0.000	-0.962	-0.248	1.133	0.447
Svay Rieng	0.728	0.000	-0.035	1.112	0.418	-0.583
Prey Veng	0.803	0.000	0.425	0.744	0.054	-1.067
Ta Keo	0.848	0.000	0.389	-0.002	-0.859	-0.978
Kompong Thom	0.761	0.000	-0.187	0.405	1.024	1.428
Siem Reap	0.820	0.000	-0.406	-0.580	0.287	0.070
Battambang	0.840	0.000	1.652	-3.559	1.441	4.539
Kampong Chhnang	0.793	0.000	-0.039	0.604	0.289	-0.184
Kompong speu	0.877	0.000	0.880	0.561	2.131	0.970
Kratie	0.826	0.000	-0.066	0.597	0.411	-0.001

Note) PreyVeng is the base province for the calculation

3-6. Simulation results

3-6-1. Results of estimation of yield functions

Table 3-1 and Table 3-2 show elasticities of yield with respect to ET in the wet and dry seasons. In the case of Phnom Penh, the elasticity of yield for ET in May is 0.366, indicating that if ET in May increases 1%; the yield will increase 0.366%. Differences in these elasticities correspond to the parameter ky; the yield response coefficient for the relationship between yield and water stress as specified in the introduction.

These results show that higher ET levels in May leads higher yields but those same elevated levels in June leads lower yield in many provinces for wet season cultivation. This is likely occurring because if transplanting is delayed from May to June, the growing period will be shortened, the number of shoots will decrease, and the stock of starch before the shooting period will decrease. These results also show that ET in January leads to higher yields in many provinces for dry season cultivation. Therefore, water supply during the transplanting season is quite critical for rice production.

3-6-2. Results of estimation of planted area functions

Table 3-3 and Table 3-4 show elasticities of planted area with respect to the previous year's planted area and farm price, and current and one year lagged ET for wet and dry seasons. The elasticities of lagged planted area are around 0.8 and it indicates significant stability in planted area. The elasticities of area for farm price are zero for almost all provinces; however, that of Kandal province, where production primarily occurs in the dry season, is very high. If the elasticities of planted area with respect to ET in May is positive, June will be negative for the wet season, and if the elasticities in December are positive, those in January are negative.

3-6-3. 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 value of CPI is the average annual growth between 1998 and 2003, (2) the growth value of real GDP is the average annual growth between 1996 and 2002, (3) the growth value of exchange rate is the average annual growth between 2000 and 2002, (4) the growth value of population is the average annual growth between 1996 and 2002, (5) the linear trend of the yield functions are continued, (6) there is no trend applied to area, (7) the price elasticities of planted areas for all provinces are same as those of the main production provinces.

Figure 3-3 through Figure 3-6 show the simulation results for the production of rice during the wet season and dry season for the main production provinces and for Cambodia as a whole. The production of wet season rice in Battambang province is expected to increase 23,800t (metric tons) from 2005 to 2015. On the other hand, the production of dry season rice in PreyVeng will increase 99,800t during the period; however, the production will at first decline due to unstable water supplies.

The production of wet and dry season rice for all of Cambodia will increase 386,100t and 192,800t respectively through additional area but also through improved yields over the period. While planted area during the dry season in Kanpong Cham, Ta Keo, Siem Reap, and Battambang will decrease, area in other provinces will increase. Production of dry season rice for the country as a whole will increase. However, future rice production during the dry season is potentially quite variable due to the difficulties of management of irrigation facilities under uncertain land ownership.

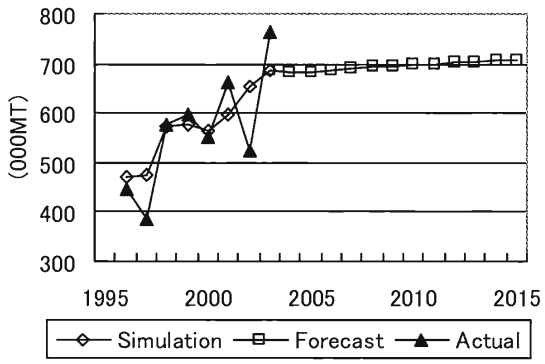

Fig. 3-3. Production of wet season rice in Battambang

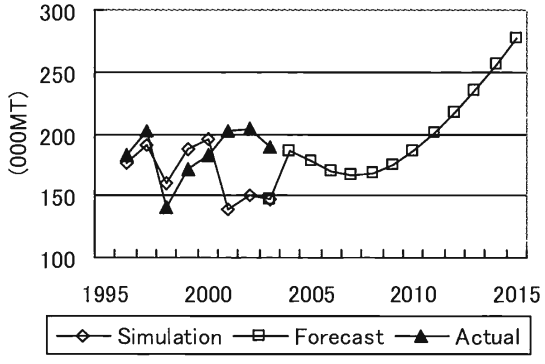

Fig. 3-4. Production of dry season rice in Prey Veng

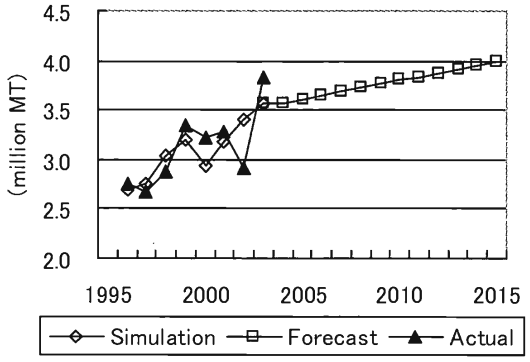

Fig. 3-5. Production of wet season rice for all Cambodia

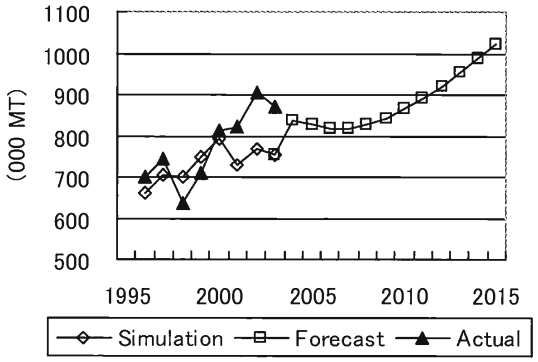

Fig. 3-6. Production of dry season rice for all Cambodia

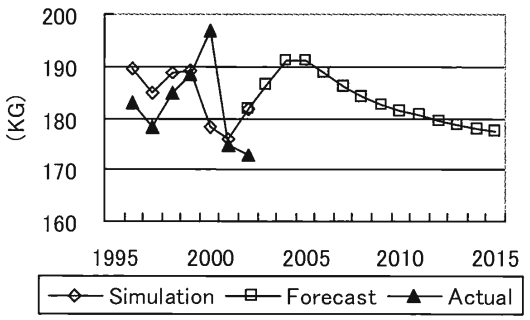

Fig. 3-7. Per capita consumption

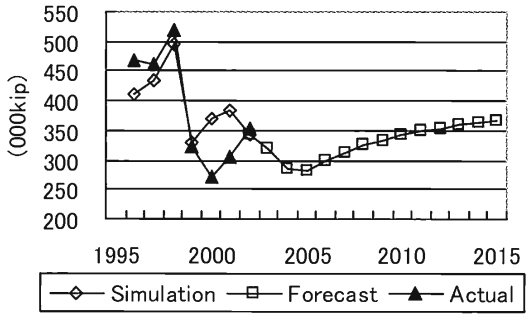

Fig. 3-8. Farm price

Figure 3-7 shows per capita rice consumption which decreases slightly due to a negative income elasticity while total consumption expands with population. Figure 3-8 shows the simulation of the equilibrium farm price. These prices are deflated by CPI. The farm price is estimated to be stable at around 350,000 Riel per metric ton.

3-7. Conclusions

A supply and demand model for rice in Cambodia which can be used to analyze production and water supply impacts for each province was developed for use in examining the impacts of changes in the regional water cycle. The supply and demand model can estimate changes in yield and planted area independently and considering supply responses and demand changes to the market price while equating supply and demand. While much previous research has considered only yields, the inclusion of area and demand response to price changes makes the results are more realistic than those of a yield function analysis alone. The baseline analysis, to be used in a subsequent water cycle scenario, indicates that production of wet and dry season rice steadily increases and prices rise modestly throughout the projection period. This deterministic projection is used as the starting point, and increased variation in the water cycle is then introduced into the system.