IJMS 18 (2), 83–100 (2011)

FOOD SECURITY: SELF–SUFFICIENCY OF RICE IN MALAYSIA[1]

FATIMAH MOHAMED ARSHAD
EMMY FARHA ALIAS
KUSAIRI MOHD NOH
Institut of Agricultural and Food Policy Studies
Universiti Putra Malaysia

MUHAMMAD TASRIF
School of Architecture, Planning and Public Policy
Institute Technology Bandung, Indonesia

Abstract

Malaysia's stance on food security is largely translated in terms of achieving self-sufficiency in rice production at about 65-70% of the local consumption. Since Malaysia does not have the comparative advantage in rice production, it implements a wide range of market interventions to achieve the intended level of rice production. The policy instruments include among others: guaranteed minimum price for paddy, price control, price and input subsidies and import monopoly. These interventionist instruments may not be sustainable in the long-term as they incur a high budgetary burden to the government, misallocation of resources and liberalization demand from WTO. The industry faces challenges in terms of land competition for urbanization and industrial uses and declining soil fertility due to heavy use of chemical fertilizer. This paper examines the influence of the fertilizer and the cash subsidies, as well as land conversion and fertility on the level of self-sufficiency in rice. A system dynamics model is applied to analyse the causal and feedback relationships of these variables in the paddy production system framework. The study shows that Malaysia may not be able to sustain the targeted self-sufficiency level without adequate R&D to address the production constraints particularly below-optimum productivity and the threats of climate change. The consumption of rice on the other hand continues to rise due to the increase in population.

Keywords: *Paddy and rice, Malaysia, system dynamics, policy analysis.*

Introduction

Malaysia does not have a comparative advantage in the production of rice, which is the staple food of the majority of her population. On average Malaysia imported about 28% of its local requirement between 1990–2009. The agricultural resources like land, labour and capital receive higher returns from other enterprises such as palm oil and industrial services. Like in other parts of the world, Malaysia's paddy production is highly susceptible to weather changes and natural calamities. The extremely thin world-rice market is highly vulnerable to market vagaries in particular to supply disruptions caused by weather changes. These phenomena forced Malaysia to embark on and maintain a protectionist regime on its paddy and rice industry to achieve food security for her population despite the call for liberalisation under WTO. Since 1973, the paddy and rice policy focused on achieving three main objectives, that is, to attain a reasonable level of production and hence self-sufficiency in rice, to increase paddy farmers' income, and to ensure stable price and high quality rice to the consumers. These are achieved by a comprehensive set of market interventions in the form of price controls, input and output subsidies, import monopoly and production programmes and other marketing restrictions. In general, Malaysia has achieved these objectives at a high cost both in terms of financial as well societal costs (Fatimah et al., 1983 & Amin Mahir et al, 2010). The self-sufficiency level (SSL) in particular is a crucial target that determines the government's allocation and expenditures on the sector.

The industry faces challenges on all fronts. In the international arena, the demand for a more liberal policy may mean that some time in the future Malaysia will have to shift its policy paradigm after years of heavy subsidies and extensive protection. Domestically, paddy land conversion to urbanisation or industrial activities limit area expansion. Limited allocation of R&D, reduction of soil fertility due to heavy use of chemicals and high incidence of paddy losses are hindering productivity improvement. Hence this paper examines the impact of the liberalization move (withdrawal of input subsidy), paddy area conversion, paddy loss and land fertility on paddy area, production, income and SSL.

Background of the Industry

The planted area and productivity of paddy in Malaysia from 1980–2008 are depicted in Figure 1. In general the paddy area shows a decreasing trend. It decreased from 716,873 ha in 1980 to 656,602 ha in

2008 (a negative average annual rate of growth of -0.29%). However, average paddy productivity increased from 2.9 to 3.6 tonnes per ha due to varietal improvements and infrastructural supports. This enabled the production of paddy to increase from 2.04 mn tones in 1980 to an estimated 2.35 mn tones in 2008 (DoS, 2010).

The total consumption of rice has increased from 2.7 mn tonnes in 1985 to 4 mn tonnes in 2009 because of the increasing population. However, the consumption per capita of rice has reduced from 87 kg in 1990 to 79 kg in 2008 due to the increase in the income per capita as well as the change in dietary preferences. The targeted SSL was determined at 70% under the new Agro-Food Policy (2011–2020). The realized SSLs were above this target with an average of 72% for the period 1990–2009. On the other hand the input subsidies have increased from RM45 mn to RM258 mn during the said period (Figure 2).

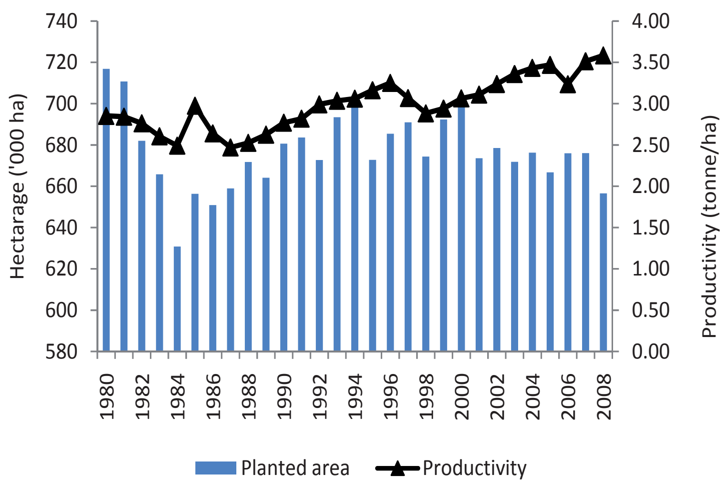

Figure 1. Malaysia: Planted paddy area ('000 ha) and productivity (t/ha).

Source. DoS (2010).

Methodology

The study utilizes the system dynamics approach to analyse the relationship of fertilizer subsidy, physical loss, paddy area conversion, land fertility and SSL in paddy production. System dynamics is defined as an approach to understanding the behaviour of a complex system over time which is characterized by interdependence, mutual interaction, information feedback and circular causality (Sterman, 2004). It deals with internal feedback loops and time delays that affect the behaviour of the entire system. The system dynamics process starts with the statement of the problem that makes it clear what the purpose of the model will be. This is followed by the mapping of the reference mode or the behaviour over time using a causal loop diagram. Consequently the modelling and simulation are carried out.

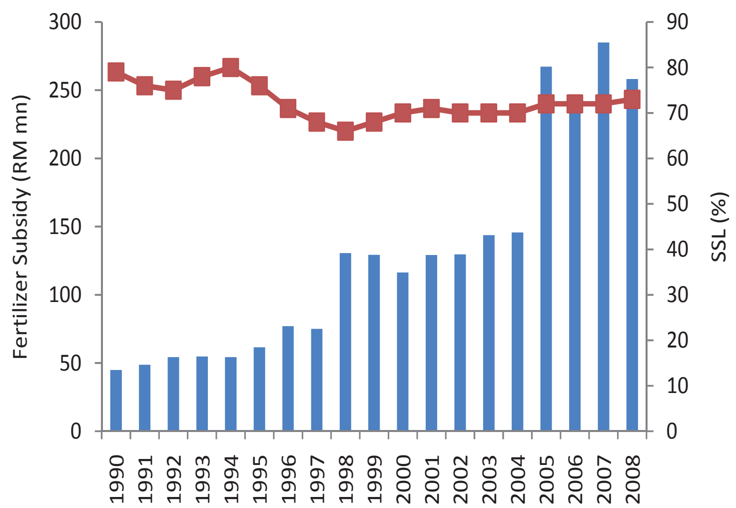

Figure 2. SSL (%) and fertilizer subsidy (RM mn), 1990-2008.

Source. MoA (2010).

The policy variable, which is the desired SSL, is a major driver of the Malaysian paddy system. Given the desired SSL, the desired domestic rice production and paddy production needed to satisfy the target SSL will be determined. The quantity of paddy needed will further determine the area to be set aside for paddy planting. Besides area, the main determinants of paddy production include the amount of fertilizers applied and the physical loss during the harvest period. In the long run investments in R&D will enhance production by the development of improved and new varieties of paddy. The causal loops of these relationships are presented in Figure 3.

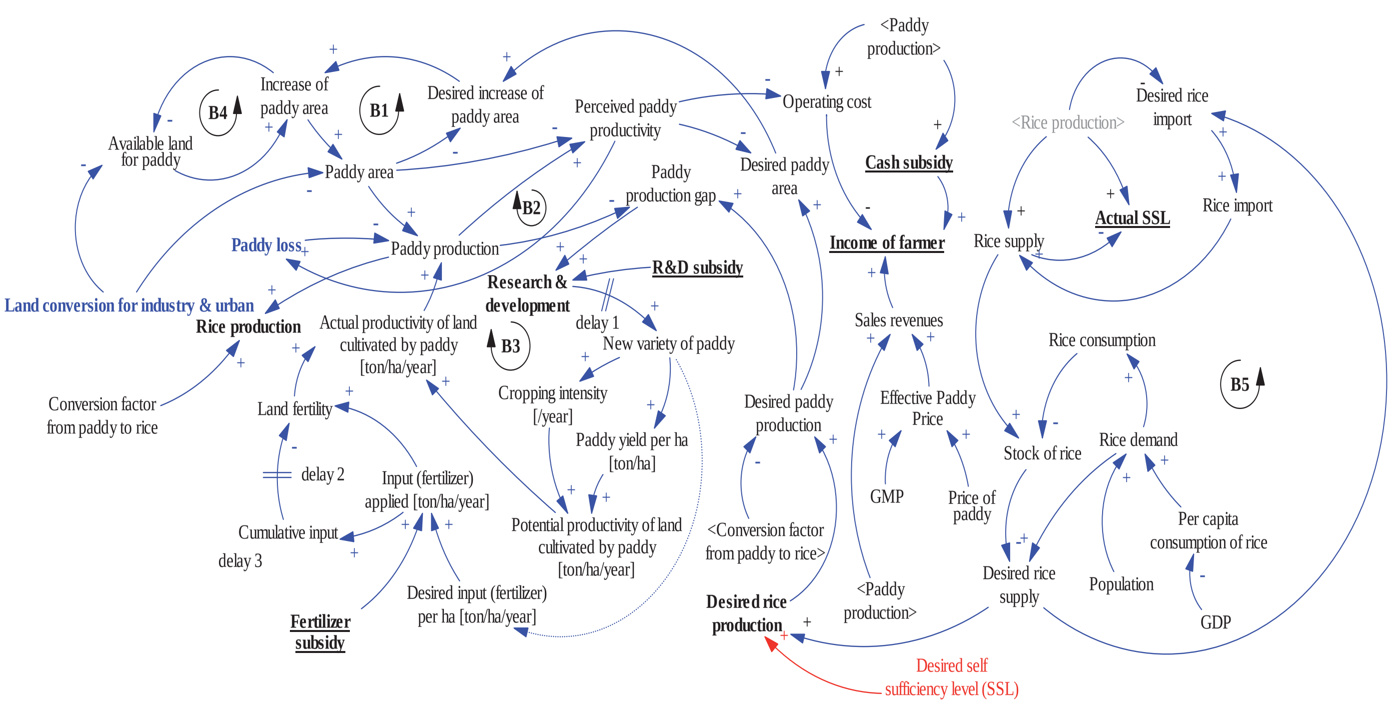

Figure 3. Causal loop diagram for the paddy production system in Malaysia.

Four variables are used in the simulation exercise, namely fertilizer or input subsidy, physical loss, paddy area conversion and land fertility. Based on historical data, farmers only apply about 33% of the fertilizer requirement of the paddy plants. The government fertilizer subsidies help increase the fertilizer application to 41%. As for physical loss, it is mitigated by the use of technology for reducing physical loss. The initial physical loss is estimated at 7.2% (Jafni et al., 2010) while the fraction of paddy area conversion is estimated at 0.2%. As for land fertility, the cumulative input used will affect fertility.

Including the base run, a total of six scenarios are simulated (Table 1). The first scenario, the base line case, involves no change in land fertility, an input subsidy level of 41%, the loss of 7.2% and paddy area conversion of 0.2%. The remaining simulations involve various combinations of the four main policy variables. The input subsidy is withdrawn in stages for scenarios 2 – 6 to reflect a move towards liberalization. Scenario 2 looks at the implications of the reduction of input subsidy while loss, paddy area conversion and land fertility remain unchanged. Scenario 3 examines the implications of the reduction of input subsidy together with the implementation of the loss-reduction technology. Scenario 4 is the combination of scenario 3 and the implementation of the land management policy. The impacts of the activation of all the policy variables will be seen in scenario 5. In scenarios 1 to 5, the desired productivity is based on paddy production gap (the gap between desired paddy production and paddy production). However, under scenario 6, a structural change is introduced into the model where the desired productivity is based on the desired paddy production and the paddy area. The simulation covers the period of 2012–2050. The study examines the impacts of the input subsidy, physical loss, paddy area conversion and land fertility on paddy area, production, income and SSL.

Table 1

Simulation Scenarios

Scenario	Input Subsidy	Paddy Loss	Paddy Area Conversion	Land Fertility
1 (Base Run)	41%	Unchanged loss=7.2%	Unchanged conversion=0.2%	Unchanged
2	Reduce to 0	Unchanged loss=7.2%	Unchanged conversion=0.2%	Unchanged

(continued)

Scenario	Input Subsidy	Paddy Loss	Paddy Area Conversion	Land Fertility
3	Reduce to 0	Implement loss technology (Start=2012)	Unchanged conversion=0.2%	Unchanged
4	Reduce to 0	Implement loss technology (Start=2012)	Land management (Start=2012)	Unchanged
5	Reduce to 0	Implement loss technology (Start=2012)	Land management (Start=2012)	Use organic fertilizer (Start=2012)
6	Structural change			

Results

The comparison of the historical and the simulated values for the five variables (paddy area, production, value and quantity of fertilizer subsidy and SSL) are presented in Table 2 and Figures A5 - A10 in Appendix 1. The statistical tests (RMSPE, U^m, U^s and U^c) indicate a reasonably well fit between the simulated and the historical data. Hence the system dynamics model developed can be accepted with confidence. The following paragraphs discuss the findings of the study.

Table 2

Comparison of Historical and Simulated Values

Variable	RMS Percent Error (%)	Theil Inequality Statistics		
		U^m	U^s	U^c
Area	1.35	0.04	0.25	0.70
Production	4.18	0.02	0.02	0.96
Fertilizer Subsidy (Value)	12.66	0.00	0.12	0.87
Fertilizer Subsidy (Quantity)	2.92	0.10	0.40	0.50
SSL	3.38	0.10	0.04	0.85

Paddy Area

The simulation results for paddy area are depicted in Figure 4. Scenarios 1-3 show a more or less similar decline in the area planted. A reduction in paddy area is expected due to the conversion of the paddy area to other agricultural (such as palm oil) and non-agricultural activities (such as competing uses associated with increasing urbanization, housing and industrial purposes). Together with the increasing demand from a growing population, the original SSL target cannot be maintained in these three scenarios. The implementation of the land management policy in 2012 (scenarios 4-6), increased the total area.

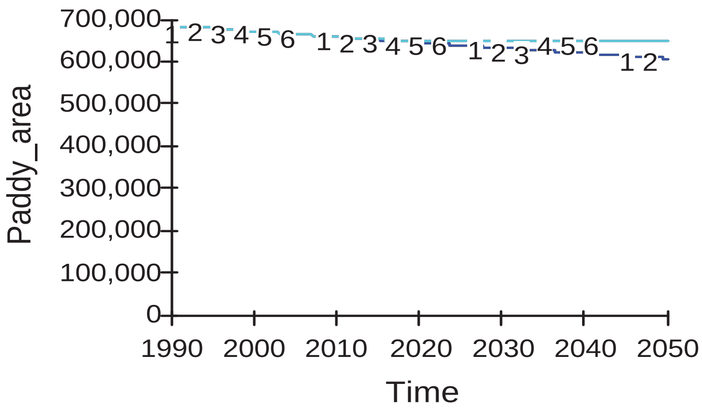

Figure 4. Simulation result: Paddy area (ha).

Paddy Production

The simulated trends for paddy production are presented in Figure 5. The simulations show that in general the production of paddy is expected to have an increasing trend. The trends for scenarios 1-5 are similar but for scenario 5, the trend is higher for the period 2012–2040 due to the smaller gap in the production. However, under a situation where all the policy variables are implemented with a change in structure where the desired productivity is based on the desired production and the paddy area only, the production for scenario 6 yields the highest .

The results of the simulations suggest the following observations. Firstly, the set of scenarios 1-4 yield similar increasing trends of paddy production because of no limitation in the R&D subsidy to improve the potential productivity (Figures 7 and 10). The production is insensitive to land conversion and loss because both variables have relatively small initial values.

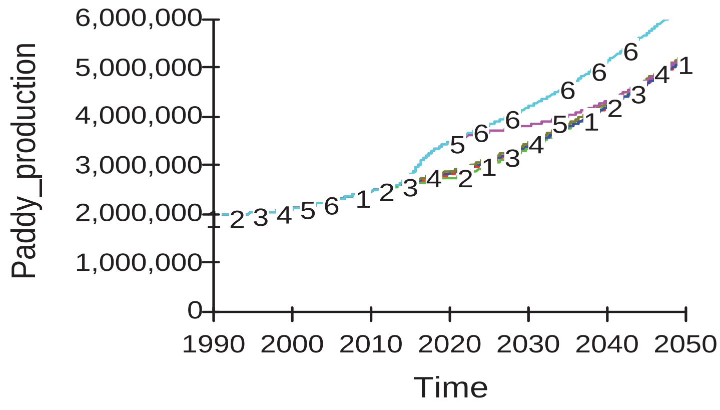

Figure 5. Simulation result: Paddy production (tonne).

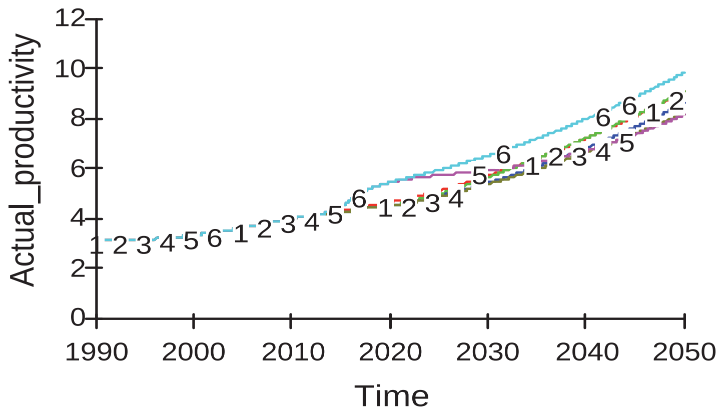

Figure 6. Simulation result: Actual productivity.

Income

Income is a function of production and price. The simulated trends of sectoral income are shown in Figure 8. The patterns tend to emulate the production behaviour of paddy as in Figure 5. As shown in Figure

6, due to productivity increase, paddy farmers receive a steady increase in income. While the other scenarios provide increasing trends, scenarios 5 and 6 yield higher sectoral income .

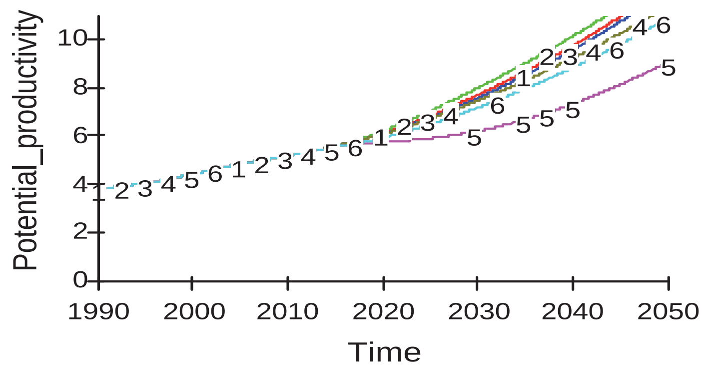

Figure 7. Simulation result: Potential productivity.

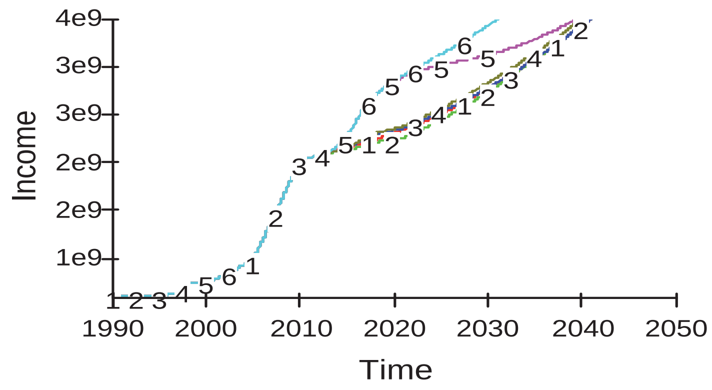

Figure 8. Simulation result: Sectoral income.

SSL

The SSLs of rice under the six scenarios are shown in Figure 9. Overall, the SSLs appear to have declining trends except for scenario

6. As mentioned above, this happens because the growth in the total consumption of rice due to the growth in population is higher than the growth in domestic production. Although the consumption per capita of rice is declining in trend, the effect of population increase on total rice requirement is greater. Again, among the scenarios, scenario 6 gives the highest SSL level. This is followed by scenario 5 while the rest show similar SSLs.

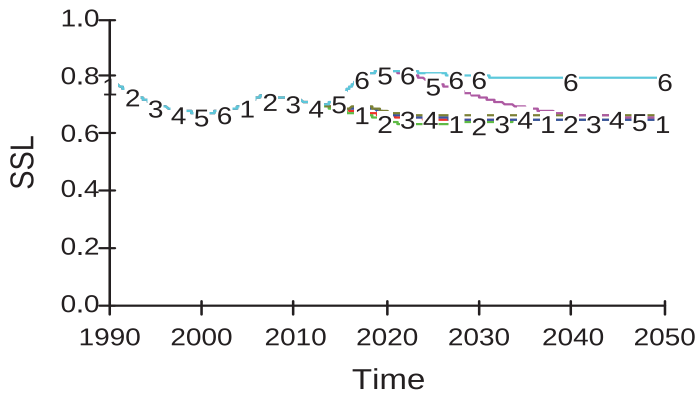

Figure 9. Simulation result: SSL.

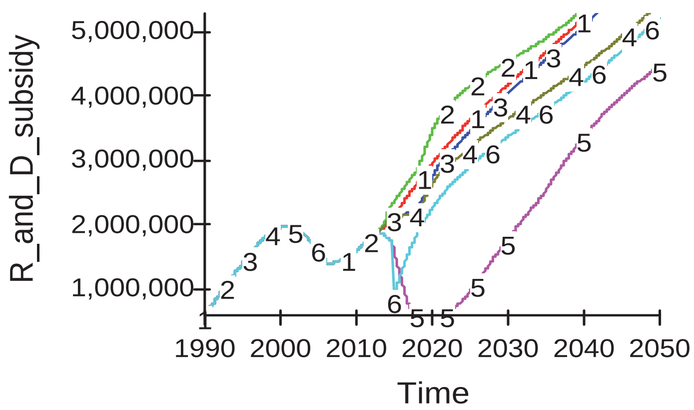

Figure 10. Simulation result: R&D subsidy.

Conclusion

The study attempts to examine the sustainability of the Malaysian policy stance of assuring 70% SSL in rice until 2020 under a changing environment. A system dynamics model is used to examine the impact of liberalization of the market (withdrawal of input subsidy), paddy loss, land conversion and land fertility on the SSL. Six simulation scenarios were carried out to examine the impact of these variables on paddy area, production, income and SSL.

The study indicates that Malaysia may be able to sustain the 70% SSL target in the long-term and comply with the WTO agreement. With continuous support of R&D to produce new high yielding varieties, the SSL could be sustained at the targeted level. The study suggests that there are two important aspects of R&D that need to be considered, that is the productivity target and the R&D fund. In setting the target, two alternatives are available, that is, one that is based on the conventional method (productivity target needed to fulfill the gap between the actual and the desired production) and the other that is based on the explicit target. The study shows that a productivity target based on an explicit target is recommended as it gives higher production. The conventional target may not be relevant as it is based on the past trend which was subjected to factors which may not be relevant in the future. The combination of explicit goals and R&D funds will ensure the attainment and sustainability of SSL in the long term.

End Note

1. Paper presented in the National Conference on the Tenth Malaysia Plan: Transformation towards a High Income Economy, organized by the Malaysian Institute of Economic Research (MIER) and Universiti Utara Malaysia, Kuala Lumpur, 18 July 2011.

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Appendix 1. Comparison of Historical and Simulated Data

Figure A1. Historical vs simulated data: Paddy area.

Year	Historical	Simulated
1990	680,647.0	680,647.0
1991	683,640.0	685,719.1
1992	672,753.0	686,639.3
1993	693,434.0	686,082.8
1994	698,624.0	685,002.3
1995	672,787.0	683,737.0
1996	685,468.0	682,407.6
1997	690,975.0	681,057.2
1998	674,404.0	679,701.0
1999	692,389.0	678,344.6
2000	698,702.0	676,989.7
2001	673,634.0	675,637.2
2002	678,544.0	674,287.3
2003	671,820.0	672,940.0
2004	667,310.0	671,595.4
2005	666,781.0	670,253.5
2006	676,034.0	668,914.2
2007	676,111.0	667,577.7
2008	656,602.0	666,243.8
Mean	679,508.4	677,567.2
Std. Dev.	11,120.2	6,461.0
RMSPE (%)	1.35	
U^m	0.04	
U^s	0.25	
U^c	0.70	

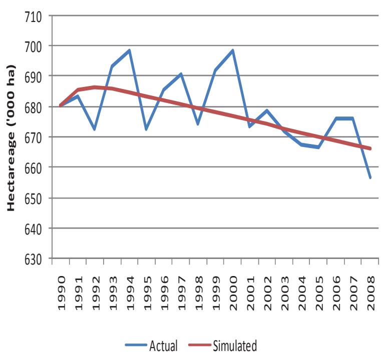

Figure A11. Actual vs simulated in paddy area.

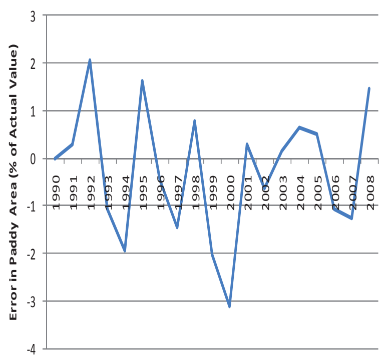

Figure A12. Error in paddy area.

Figure A2. Historical vs simulated data: Paddy production.

Year	Historical	Simulated
1990	1884984.0	2,019,986.1
1991	1926354.0	2,035,105.6
1992	2012732.0	2,038,749.2
1993	2104447.0	2,040,142.0
1994	2138788.0	2,043,099.8
1995	2127271.0	2,049,196.7
1996	2228489.0	2,059,017.7
1997	2119615.0	2,072,687.2
1998	1944240.0	2,090,124.5
1999	2036641.0	2,111,200.1
2000	2140904.0	2,135,743.6
2001	2094995.0	2,163,510.3
2002	2197351.0	2,194,162.6
2003	2257037.0	2,227,248.4
2004	2291353.0	2,262,184.4
2005	2314378.0	2,298,270.6
2006	2187519.0	2,338,859.7
2007	2375604.0	2,384,268.4
2008	2353032.0	2,426,061.0
Mean	2,143,986.0	2,157,348.3
Std. Dev.	137,788.9	126,510.0
RMSPE (%)	4.18	
U^m	0.02	
U^s	0.02	
U^c	0.96	

Figure A21. Actual vs simulated in paddy production.

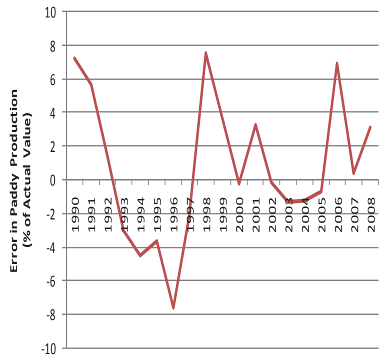

Figure A22. Error in paddy production.

Figure A3. Historical vs simulated data: Fertilizer subsidy (value).

Year	Historical	Simulated
1990	44,945,309.00	46,004,640.77
1991	48,745,656.00	50,271,170.83
1992	54,284,135.00	57,057,233.35
1993	54,923,172.00	58,745,585.88
1994	54,366,447.00	60,437,623.23
1995	61,511,146.00	62,161,437.73
1996	76,946,629.00	66,834,027.01
1997	75,036,585.00	68,731,208.74
1998	130,567,318.00	116,777,914.99
1999	129,325,826.00	127,897,918.07
2000	116,434,146.00	126,197,742.30
2001	129,245,478.00	140,094,775.06
2002	129,717,570.00	155,414,430.68
2003	143,790,661.00	180,910,755.50
2004	145,789,853.00	181,580,018.05
2005	267,246,557.00	216,401,491.90
2006	237,384,232.00	217,590,601.09
2007	285,028,003.00	241,075,092.70
2008	258,109,096.00	260,579,764.58
Mean	128,599,885.2	128,145,443.8
Std. Dev.	77,069,385.1	69,452,437.2
RMSPE (%)	12.66	
U^m	0.00	
U^s	0.12	
U^c	0.87	

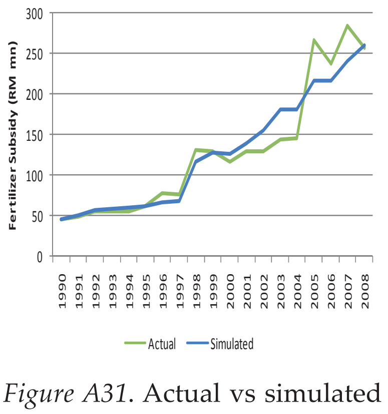

Figure A31. Actual vs simulated in fertilizer subsidy.

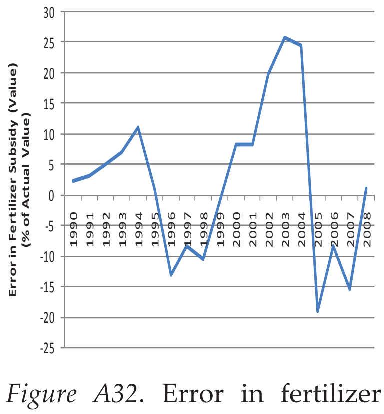

Figure A32. Error in fertilizer subsidy.

Figure A4. Historical vs simulated data: Fertilizer subsidy (quantity).

Year	Historical	Simulated
1990	98,548.18	100,871.89
1991	100,196.90	106,972.18
1992	110,280.60	117,827.30
1993	115,935.40	117,731.81
1994	115,026.70	117,546.40
1995	111,307.60	117,329.27
1996	119,371.50	122,423.93
1997	122,180.20	122,181.66
1998	197,726.70	201,463.39
1999	215,597.50	211,643.51
2000	198,111.50	195,379.24
2001	197,010.90	200,258.88
2002	205,696.50	205,118.20
2003	220,962.20	220,455.15
2004	203,472.40	204,299.33
2005	222,864.20	224,803.02
2006	212,549.30	208,701.24
2007	218,091.70	213,491.34
2008	214,382.40	213,064.75
Mean	168,384.9	169,555.9
Std. Dev.	49,194.4	46,883.7
RMSPE (%)	2.92	
U^m	0.10	
U^s	0.40	
U^c	0.50	

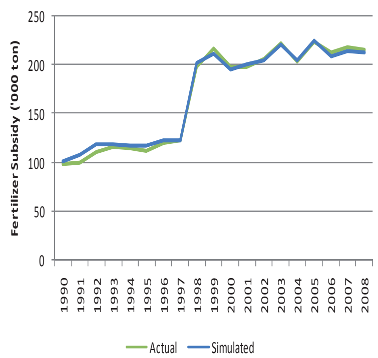

Figure A41. Actual vs simulated in fertilizer subsidy.

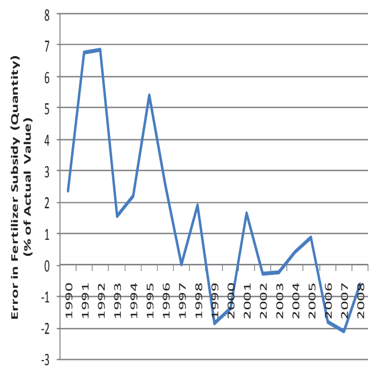

Figure A42. Error in fertilizer subsidy.

Figure A5. Historical vs simulated data: SSL.

Year	Historical	Simulated
1990	79.00	79.04
1991	76.00	77.64
1992	75.00	75.88
1993	78.00	74.07
1994	80.00	72.58
1995	76.00	71.22
1996	71.00	70.11
1997	68.00	69.16
1998	66.00	68.58
1999	68.00	68.16
2000	70.00	68.01
2001	71.00	68.08
2002	70.00	68.46
2003	70.00	69.09
2004	70.00	69.99
2005	72.00	71.27
2006	72.00	73.03
2007	72.00	73.66
2008	73.00	73.41
Mean	72.5	71.7
Std. Dev.	0.0	0.0
RMSPE (%)	3.38	
U^m	0.10	
U^s	0.04	
U^c	0.85	

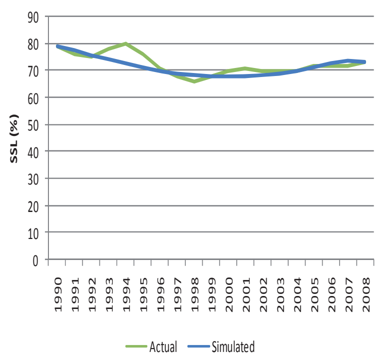

Figure A51. Actual vs simulated in SSL.

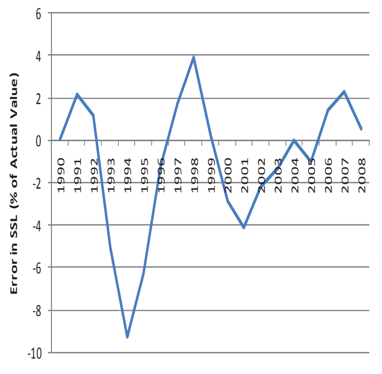

Figure A52. Error in SSL.