Dr. Joe T. Ritchie Symposium

Evaluation of Rice Model in Taiwan

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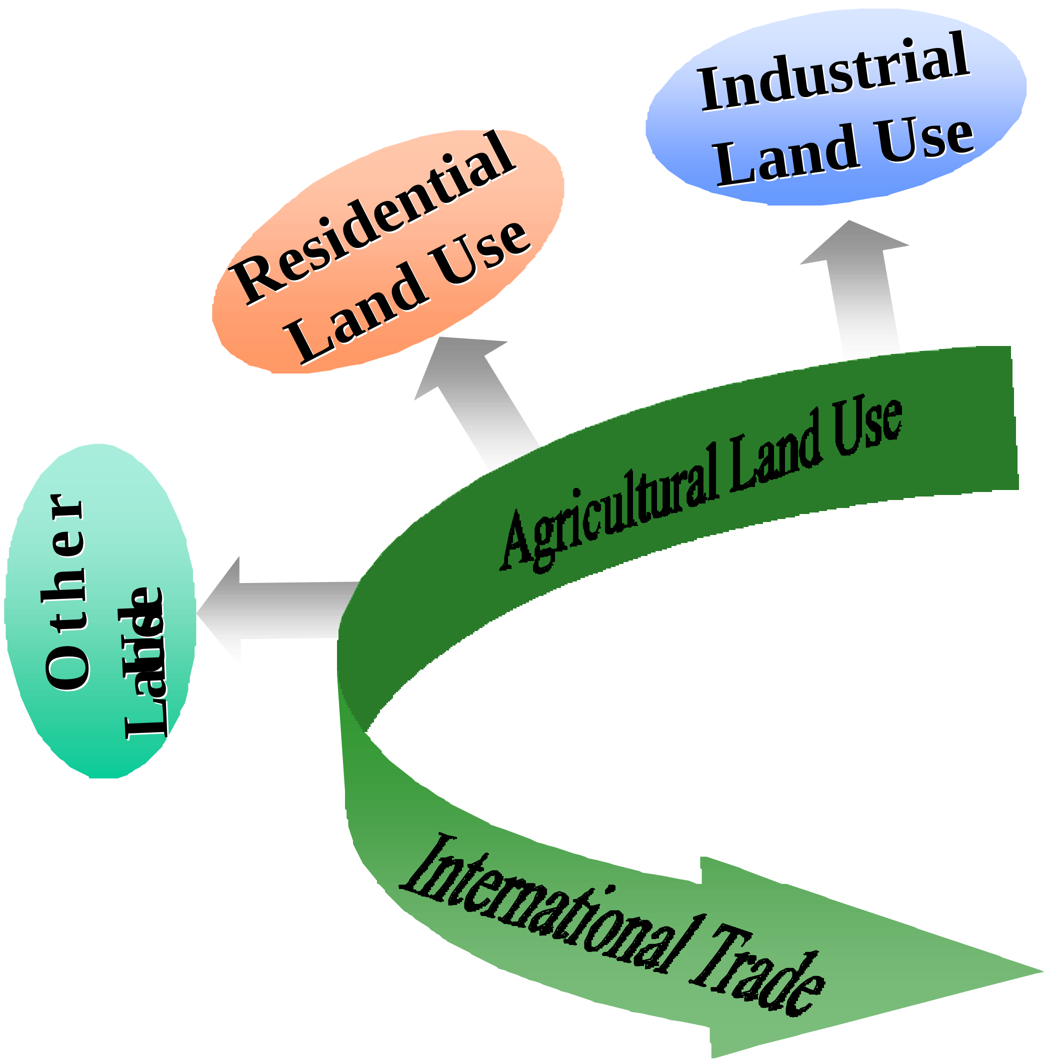
Summary

Five planting strategy treatments of lowland rice species (TN- 67; Taiwan No. 67) field experiments collected from National Chung- Hsing University, Taichung, Taiwan in 1988 and 1989, were used to derive the genetic coefficients for CERES- rice model. The best fitted coefficients were P_1= 580, P_2R= 50, P_2O= 13, P_5= 430, G_1= 46.8, and G_2= 0.025.

Introduction

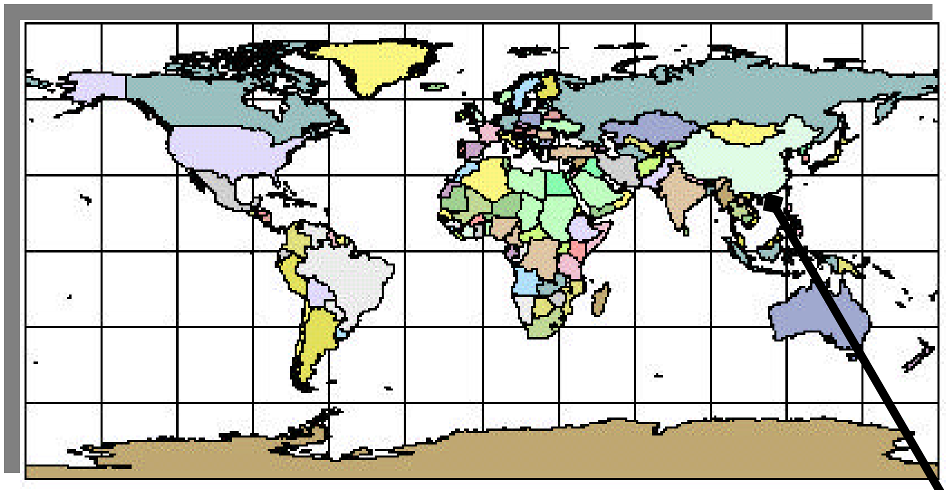


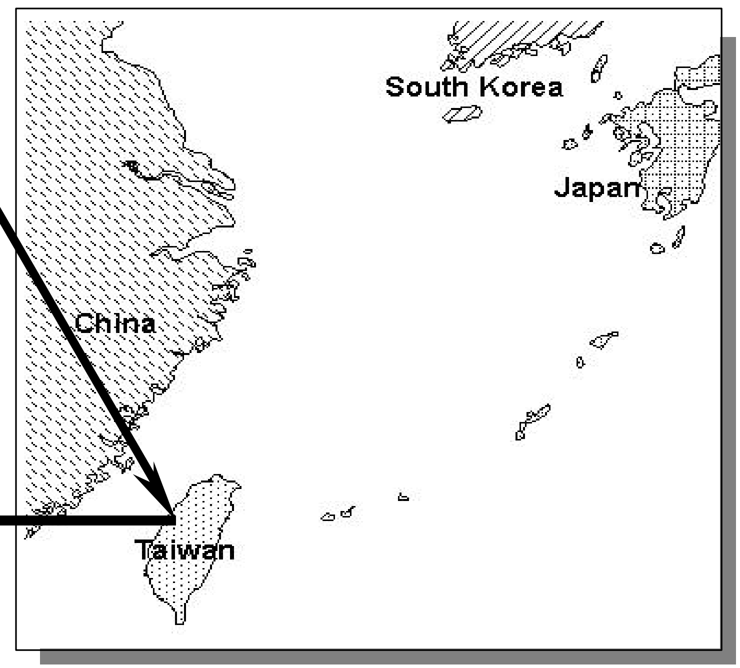
In Taiwan, the past forty years has been a time of rapidly evolving industrialization, commercialization and urbanization. This has created the need for mass agricultural land, especially rice fields, to be transferred to industrial or residential land zoning, which complicated agricultural land management decision. In addition, international trade has also decreased the demand for rice products.

Rice Production Evaluation

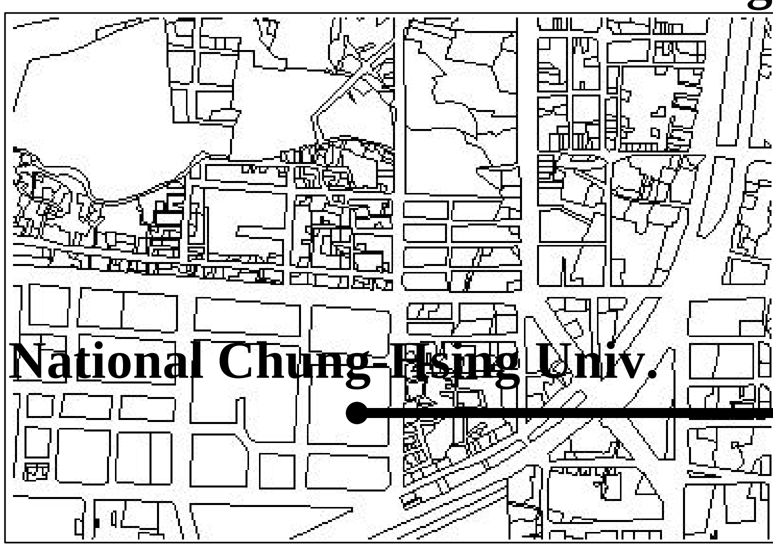
Experiment Site

Taiwan is located in 121° by 24° (LO/LA). The field experiments were collected from National Chung- Hsing Univ. experimental farm in Taichung city, which is in the Midwest region of Taiwan.

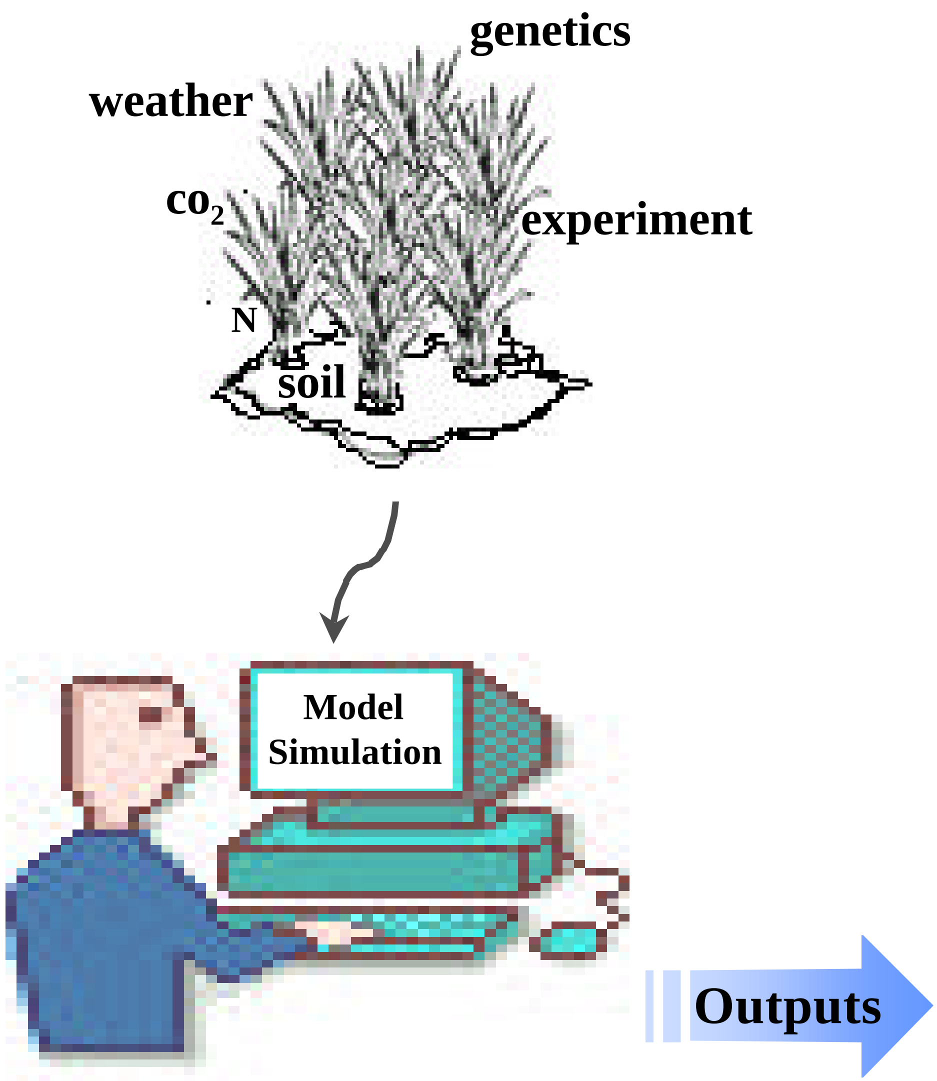




Taichung



CERES-Rice Model



The Results of Simulated

CERES (Crop- Environment Resources Synthesis)- rice model is a process- oriented and management-level model of rice crop growth and development (Singh et al., 1993) that is developed to predict the duration of growth, the average growth rates, and the amount of assimilate partitioned to the economic yield components of the plant (Ritchie et al., 1998).

- Daily growth and development
- Carbon balance
- Soil water balance
- Nitrogen balance

Experiment Data (1)

***1) 1988 and 1989 Daily Weather Data*: solar radiation, precipitation, maximum and minimum temperatures.**

***2) Initial Soil Conditions*:**

SABL	SH_2O	SNH_4	SNO_3
15	0.232	0.5	2.7
30	0.234	0.2	1.6
60	0.247	0.2	0.7
90	0.239	0.2	0.8
120	0.211	0.2	0.9
150	0.251	0.2	1.8
180	0.277	0.5	2.4

SABL: Depth, base of layer, cm

SH_2O: Water, cm^3 cm^{-3}

SNH_4: Ammonium, KCL, g elemental N Mg-1 soil

SNO_3: Nitrate, KCL, g elemental N Mg-1 soil

<u>Experiment Data (2)</u>

3) Field Experiments:

- **Crop Specie:** ***TN-67***
- **Irrigation:** ***no water stress***
- **Fertilizer:** ***no nitrogen stress***
- **Plant Population at Emergence, m-2:** ***48***
- **Row Spacing, cm:** ***25***
- **Crop Season:**

Experiment 1: ***1st crop season, early planting in 1988***

Experiment 2: ***1st crop season, normal planting in1988***

Experiment 3: ***2nd crop season, early planting in 1988***

Experiment 4: ***2nd crop season, early planting in 1989***

Experiment 5: ***2nd crop season, normal planting in 1989***

Trial and Error (1)

1) ***Keep model's nitrogen switch off***

2) **Genetic Coefficients:**

- P_1: thermal time required for the plant to develop after emergence to the end of the juvenile stage.
- P_2R: rate of photo-induction.
- P_2O: optimal photoperiod.
- P_5: thermal time for grain filling phase.
- G_1: conversion efficiency from sunlight to assimilate.
- G_2: single grain weight.

P_1, P_2R, P_2O, P_5, G_1 and G_2

Experiment Data

Model simulation by trial and error

Observed and Simulated Comparison

Observed and Simulated Comparison (1-1)

Table 1. P_1= 580, P_2R= 50, P_2O= 13, P_5= 430, G_1= 46.8, and G_2= .025, the growth stages comparison between simulated results and observed data.

	Panicle Initiation		Flowing Date		Maturity Date		PRESS	SUM
Experiment No.	Observed	Simulated	Observed	Simulated	Observed	Simulated		
Experiment 1	66	65	98	102	132	133	18	125
Experiment 2	59	59	89	93	127	124	25	
Experiment 3	32	30	61	62	95	96	6	
Experiment 4	37	32	64	64	99	98	26	
Experiment 5	36	31	69	65	105	102	50	

Observed and Simulated Comparison (1-2)

Table 2. P_1= 580, P_2R= 50, P_2O= 13, P_5= 430, G_1= 46.8, and G_2= .025, the LAI, yield, and biomass distinction between simulated results and observed data.

	LAI		Yield		Biomass		Yield	Biomass	Yield%	Biomass%
Exp.[1] No.	Observed	Simulated	Observed	Simulated	Observed	Simulated	%	%	ABS(SUM)	ABS(SUM)
Exp.[1] 1	5.7	13.68	7022	7038	15070	17251	-0.2	-14.47	27.49	67.24
Exp.[1] 2	5.2	13.13	7254	6686	14999	17107	7.83	-14.05		
Exp.[1] 3	4.6	9.53	5442	5926	13134	15163	-8.9	-15.45		
Exp.[1] 4	5.1	9.16	5360	5601	12388	14669	-4.5	-18.41		
Exp.[1] 5	4.5	7.93	6377	5992	14322	15019	6.04	-4.87		

[1] Experiment

Observed and Simulated Comparison (1-3)

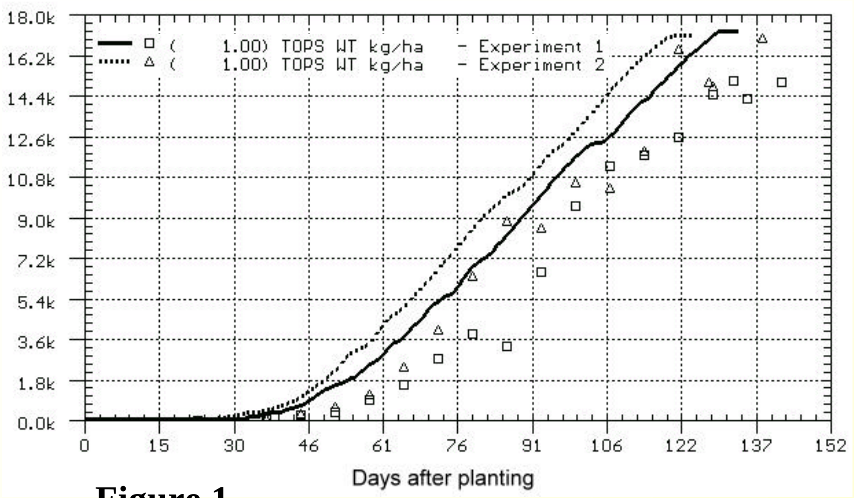


Figure 1.

Figure 1, 2 and 3 present the distinction between simulated and observed tops weight by using the genetic coefficients: P_1= 580; P_2R= 50; P_2O= 13; P_5= 430; G_1= 46.8; G_2= .025.

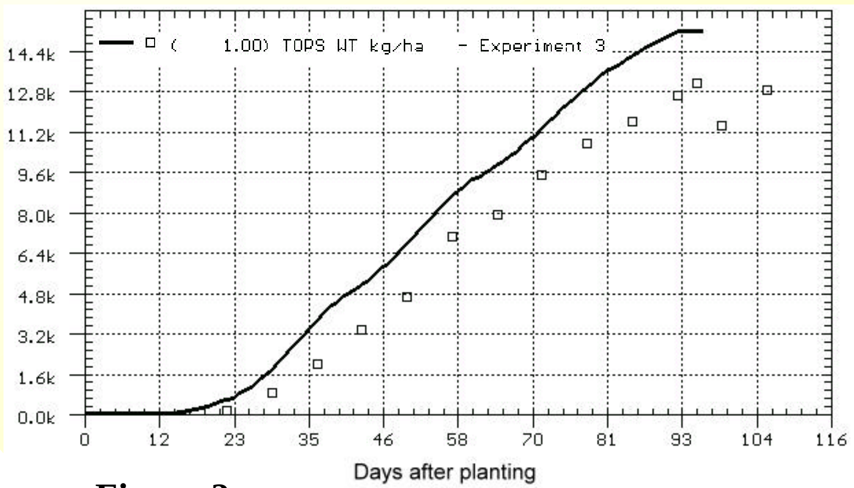


Figure 2.

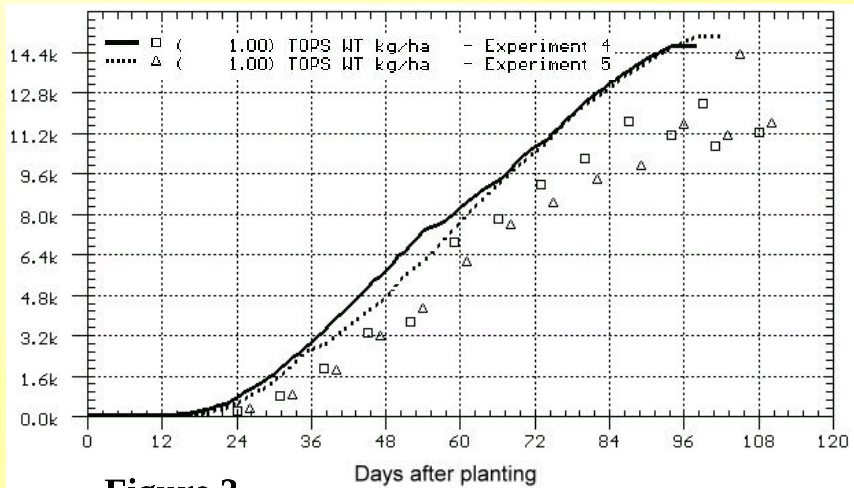


Figure 3.

Trial and Error (2)

1) ***Nitrogen function switch on***

Table 3. By using the same genetic coefficients and experiment data, but turning model's nitrogen switch on to run simulation again. The distinction between simulated and observed growth stages are listed below.

	Panicle Initiation		Flowing Date		Maturity Date		PRESS	SUM
Experiment No.	Observed	Simulated	Observed	Simulated	Observed	Simulated		
Experiment 1	66	65	98	101	132	133	11	118
Experiment 2	59	59	89	93	127	124	25	
Experiment 3	32	30	61	62	95	96	6	
Experiment 4	37	32	64	64	99	98	26	
Experiment 5	36	31	69	65	105	102	50	

Observed and Simulated Comparison (2-1)

Table 4. Under trial and error (2), the yield and biomass distinction between simulated results and observed data are listed below.

	LAI		Yield		Biomass		Yield	Biomass	Yield%	Biomass%
Exp.[1] No.	Observed	Simulated	Observed	Simulated	Observed	Simulated	%	%	ABS(SUM)	ABS(SUM)
Exp.[1] 1	5.7	5.21	7022.4	5190	15070.4	11229	26.1	25.49	114.15	102.65
Exp.[1] 2	5.2	5.33	7254.4	5064	14999.2	11297	30.2	24.68		
Exp.[1] 3	4.6	5.14	5442.2	4569	13134.4	10960	16	16.56		
Exp.[1] 4	5.1	4.92	5360	4518	12388	10658	15.7	13.97		
Exp.[1] 5	4.5	4.92	6377.9	4713	14322.4	11177	26.1	21.96		

[1] Experiment

Observed and Simulated Comparison (2-2)

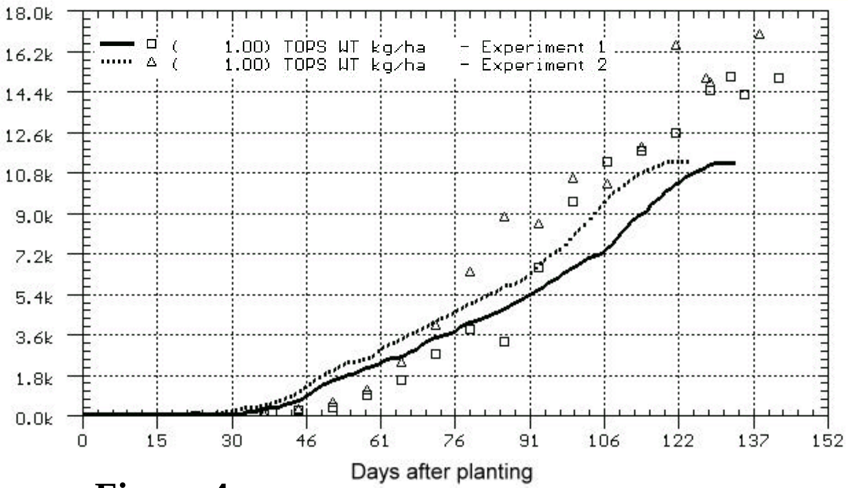


Figure 4.

Figure 4, 5 and 6 present the distinction between simulated and observed tops weight by using the genetic coefficients: P_1= 580; P_2R= 50; P_2O= 13; P_5= 430; G_1= 46.8; G_2= .025 and turning nitrogen switch on.

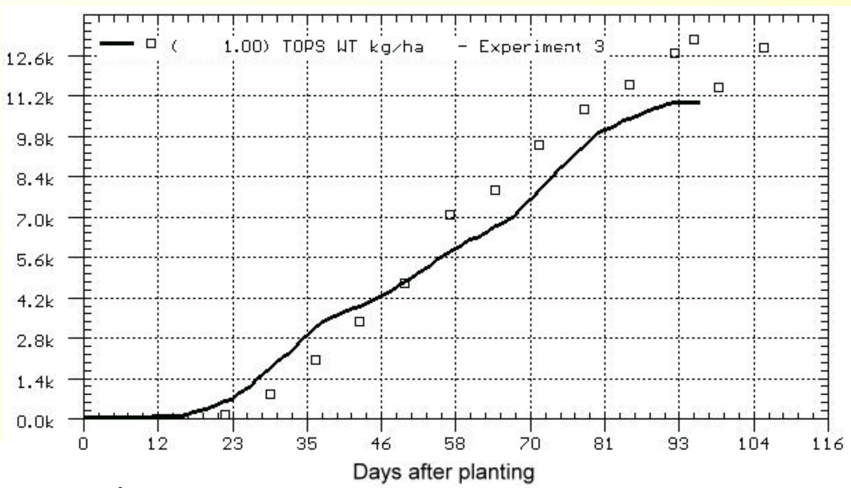


Figure 5.

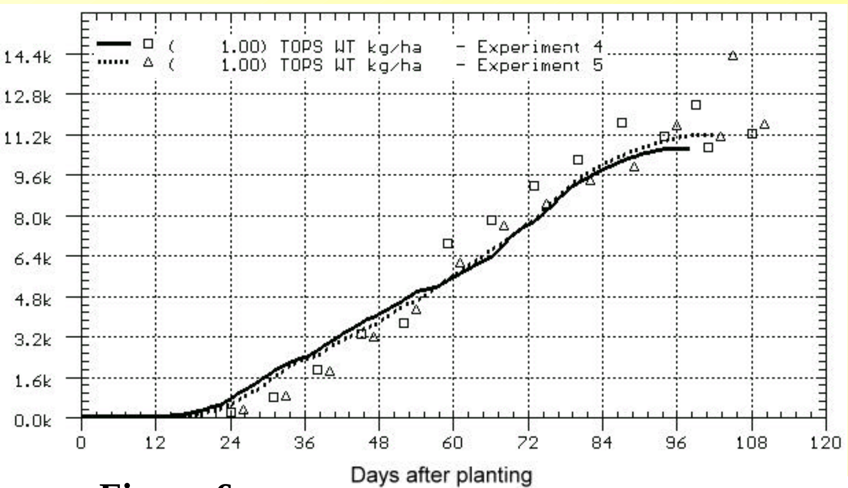


Figure 6.

Discussion

In Taiwan, farmers apply as much fertilizer as necessary in lowland rice production. Rice cropping system is seldom damaged by the lack of nitrogen. For that reason, this approach kept model's nitrogen off in the beginning. When the genetic coefficients were set as P_1= 580, P_2R= 50, P_2O= 13, P_5= 430, G_1= 46.8, and G_2= .025, the fitted growth stages, yields, and biomass could be obtained, with the exception of LAI. Afterwards, the nitrogen switch was on to perform the same computation process. The outcome of this process pointed out that growth stages and LAI were adapted from observed data. The quality of experiment data's precision and the setting of parameters might affect the relation among LAI, yield and biomass.

Major Reference

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