# CHAPTER 4

# MATERIALS AND METHODS

## MODEL CALIBRATION

### Field experiment

The experiment was conducted at the Multiple Cropping Centre Experiment Station, Chiang Mai University, Chiang Mai (18°47'N, 99°57' E), from April to December 1991. The soil was characterized as San Sai sandy loam soil (Coarse loamy, mixed, isohyperthermic, Typic Tropaqualfs) with the pH of 5.9, 0.05% total N, 0.094% OM, 23.25 ppm of available P, and 42.5 ppm of exchangeable K.

The experimental design was split plot design with three replications. Five planting dates were the main plots and three varieties were the sub plots. The treatment combinations are shown in Table 4. Experimental layout is displayed in Appendix A.

Three rice varieties were used i.e., RD7, Niaw San Pa Tong (NSPT) and Kaow Dawk Mali 105 (KDML105). RD7 is a photoperiod insensitive variety, NSPT and KDML105 are both photoperiod sensitive varieties. Twenty-five days old seedlings were transplanted at the 25x25 cm. spacing (16 hills $m^{-2}$). Nitrogen fertilizer was applied at 75 kgN $ha^{-1}$ with split application of 70% and 30% at seven days after transplanting (DAT) and at panicle initiation stage, respectively. Adequate irrigation management and plant protection measures were undertaken to minimize the effects of diseases, weeds, and insects.

**Table 4.** Treatment combination used in the experiment.

| Transplanting date | Treatment combination | | |
|---|---|---|---|
| | RD7 (V1) | NSPT (V2) | KDML105 (V3) |
| May 1 (PD1) | V1PD1 | V2PD1 | V3PD1 |
| June 4 (PD2) | V1PD2 | V2PD2 | V3PD2 |
| July 2 (PD3) | V1PD3 | V2PD3 | V3PD3 |
| August 1 (PD4) | V1PD4 | V2PD4 | V3PD4 |
| September 3 (PD5) | V1PD5 | V2PD5 | V3PD5 |

**Data collection**

Data collected includes the followings:

Climatic data

The model requires daily rainfall, maximum and minimum air temperature, and solar radiation as inputs. These data were recorded by the LI- 1200S Minimum Data Set Recorder (Anonymous, 1986) at the Meteorological Station of Multiple Cropping Centre, Faculty of Agriculture, Chiang Mai University.



Soil data

Soil samples were taken before planting and after harvesting for analysis of pH, organic matter, total nitrogen, phosphorus, and potassium. Soil pH was determined by using the 1:1 soil:water. The

organic matter and total nitrogen content of soil samples were determined by the Walkley Black and the Kjeldahl methods, respectively. The available phosphorus in soil was extracted with Bray II and the concentration was determined colorically. The exchangeable potassium was analyzed by extracting soil samples with $NH_4OAC$ 1N and determined the concentration of the extract by flamephotometer. The values for the lower, drained upper and saturated limits of available soil water (LL, DUL, SAT, respectively) were based on those measured by Maneevan (1990) (Table 5.). Nitrate and ammonium were based on results that measured by Bhromsiri (1991).

Crop data

Crop phenology i.e., panicle initiation date (PI), heading date, and maturity date were recorded. Dates for phenological events were established when 50% of the plants in each treatment had reached that stage of development.

The above ground plant biomass was destructively collected every other week after transplanting until the panicle initiation stage (from 0.125 $m^2$) in each replication. Thereafter the samples were taken every week until maturity stage. After plant numbers from the samples of three replications were recorded, leaf area index (LAI) was measured using the automatic leaf area meter (Model AMM -7, HAYASHI DENKOH Co., Ltd.). All plants samples from each replication were separated into leaf blade, leaf sheath, stem, and panicle (including grain) to determine the distribution of dry matter in different treatments.

Plant parts were dried to constant weight in oven at 70° C for three days and weighed.

Table 5. Soil data for San Sai Series, as employed in the model testing.

| SALB | U | SWCON | CN2 |
|---|---|---|---|
| 0.13 | 22.22 | 0.05 | 88.0 |

| DLAYR | LL | DUL | SAT | WR |
|---|---|---|---|---|
| 0 - 5 | 0.094 | 0.215 | 0.265 | 0.100 |
| 5 - 10 | 0.094 | 0.215 | 0.265 | 0.100 |
| 16 - 30 | 0.116 | 0.236 | 0.208 | 0.300 |
| 31 - 45 | 0.125 | 0.246 | 0.208 | 0.300 |
| 46 - 60 | 0.139 | 0.259 | 0.220 | 0.100 |

Source: Maneevan (1990).

SALB = Soil albedo
U = Stage - soil evaporation coefficient
SWCON = Whole - profile drainage rate coefficient
DLAYR = Layer thickness
LL = Lower limit of plant - extractable water for each layer
DUL = Drained upper limit for each layer
SAT = Saturated water - content for each layer
WR = Root - distribution weighing factor for each layer

Yield components, panicle numbers $m^{-2}$, spikelet numbers $m^{-2}$, percentage of filled spikelets and 1000-grain weight were obtained from 1 $m^2$ (16 hills) from each replication. Grain yields were measured from plant samples taken from 5 $m^2$ of each replication.

## DETERMINATION OF GENETIC COEFFICIENTS

According to Hunt's approach (1989) since the genetic coefficients for given variety are not known these can be estimated using field data. This is accomplished iteratively by running the model with approximate coefficients, comparing model output with actual data, adjusting coefficients and repeating process until acceptable fits are obtained.

The set of genetic coefficients of three varieties, RD7, NSPT and KDML105 from Jintrawet (1991) were used as the initial values to run the model. Some genetic coefficients (P1, P2R, P5 and P2O) were adjusted until the difference between observed and simulated heading and maturity dates were as small as possible in five planting dates. The P1 and P5 coefficients were adjusted until the simulated and observed phenological events were agreed.

## MODEL VALIDATION

The model was validated using data from yield trial experiments which included RD7, NSPT, and KDML105 from San Pa Tong Rice Experiment Station, San Pa Tong, Chiang Mai (18°37'N, 98°54'E). These experiments were conducted from 1989 through 1991 during the wet season under irrigated conditions. Planting, transplanting, heading and maturity dates were recorded as shown in Table 6. Plant density was 25x25 cm. (16 hills $m^{-2}$) with three plants per hill for RD7 and 25x33 $1/_3$ cm. (12 hills $m^{-2}$) with three plants per hill for NSPT and KDML105. Nitrogen fertilizer was applied at 75 kgN $ha^{-1}$ for RD7 and 37.5 kgN $ha^{-1}$ for NSPT

and KDML105 with split application of 50% at one day before transplant and at panicle initiation stage.

Daily solar radiation, rainfall, minimum and maximum air temperature were obtained from the Multiple Cropping Centre located within 19 km. of the experimental site.

The soil at the experimental site is characterized as Hang Dong clayey soil (Fine, kaolinitic, isohyperthermic, Typic Tropaqualfs). The values for the lower, drained upper and saturated limits of available soil water (LL, DUL, SAT, respectively) were based on those measured by Panomtaranichagul (1980); Viensil and Song Sawat (1990). These are presented in Table 7.

## DATA ANALYSIS

Weather data along with soil, nitrogen fertilizer, irrigation data and management practices were entered into the computer as input files for CERES-Rice model version 2.1.

Simulated and observed tiller numbers $m^{-2}$, LAI, and above ground biomass are graphically compared for assessment of model accuracy in mimicking rice growth with time.



Linear regression of 1:1 line of the simulated on observed data was performed. T-test on the regression line was also performed based on the null hypothesis that the slope of the regression line is unity and the intercept is zero. Bias and Root Mean Square Error (RMSE) were

also used as additional measures of model performance (Willmolt, 1992). Goodness of fit was evaluated visually and by computing a standardized bias (R) and a standardized mean square error (V) (Graf et al., 1991).

**Table 6.** Planting, Transplanting, Heading and Harvesting dates from the experiments of RD7, NSPT and KDML105 at San Pa Tong Rice Experiment Station in 1989 -1991.

| Varieties | Year | Planting dates | Transplanting dates | Heading dates | Harvesting dates |
|---|---|---|---|---|---|
| RD7 | 1989 | 6 Jul (187) | 3 Aug (215) | 9 Oct (282) | 9 Nov (312) |
| | 1990 | 5 Jul (186) | 3 Aug (215) | 7 Oct (280) | 3 Nov (307) |
| NSPT | 1989 | 19 Jul (200) | 22 Aug (234) | 31 Oct (304) | 24 Nov (328) |
| | 1990 | 19 Jul (199) | 21 Aug (233) | 29 Oct (302) | 21 Nov (325) |
| | 1991 | 18 Jul (199) | 21 Aug (233) | 17 Oct (290) | 21 Nov (325) |
| KDML105 | 1989 | 19 Jul (200) | 22 Aug (234) | 28 Oct (301) | 22 Nov (326) |
| | 1990 | 19 Jul (200) | 21 Aug (234) | 26 Oct (299) | 20 Nov (324) |
| | 1991 | 18 Jul (199) | 21 Aug (233) | 17 Oct (290) | 19 Nov (323) |

Table 7. Soil data for Hang Dong Series, as employed in the model validation.

| SALB | U | SWCON | CN2 |
|---|---|---|---|
| 0.13 | 24.63 | 0.05 | 87.0 |

| DLAYR | LL | DUL | SAT | WR |
|---|---|---|---|---|
| 0 - 5 | 0.174 | 0.296 | 0.364 | 0.500 |
| 5 - 15 | 0.17 | 0.296 | 0.364 | 0.500 |
| 16 - 30 | 0.169 | 0.289 | 0.355 | 0.200 |
| 31 - 45 | 0.183 | 0.301 | 0.352 | 0.100 |
| 46 - 60 | 0.174 | 0.292 | 0.352 | 0.100 |

SALB = Soil albedo
U = Stage - soil evaporation coefficient
SWCON = Whole - profile drainage rate coefficient
DLAYR = Layer thickness
LL = Lower limit of plant - extractable water for each layer
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