

SOILS2004 CONFERENCE PROCEEDINGS

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Editors:

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Paper 57

SENSITIVITY ANALYSIS OF THREE MAJOR PARAMETERS IN THE SURHIS MODEL FOR INTERCROPPING OF RUBBER WITH BANANA AND PINEAPPLE

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Introduction

Simulation models are increasingly being used in the agricultural sciences for various purposes including irrigation management studies, yield forecasting, multiple crop sequencing and land use planning. With research fund providers nowadays searching for speedy and reliable results, models have become invaluable tools in aiding agricultural researchers in all disciplines to meet these demands. Models are simply a representation of reality, so there is always the desire for their improvement towards full precision. This improvement can be achieved by several means including, but not limited to, refining of model equations as better understanding is gained in system processes, model testing, validation of outputs and sensitivity analysis of model variables.

Sensitivity analysis involves exploring the behaviour of the model for different values of parameters (Jones et al., 1987). This paper reports the results of sensitivity analysis of three major crop variables (Table 1) of the model SURHIS (Sharing and Utilisation of Radiation Intercepted in a Hedgerow Intercropping System) for rubber, banana and pineapple. The present version of SURHIS accounts for the effects on agro-meteorology and crop variables on model output but can be extended in future to include soil, weeds, insects and disease variables.

Table 1. Initial values of the parameters tested

Parameter	Unit and value	Source
Initial radiation use efficiency (EFF) for individual leaves:	kg CO ₂ ha ⁻¹ h ⁻¹ (J m ⁻² s ⁻¹) ⁻¹	Derived from measurements
Rubber	0.30	
Banana	0.48	
Pineapple	0.11	
Radiation canopy extinction coefficient (k)	ha soil ha ⁻¹ leaf	Derived from measurements
Rubber	0.72	
Banana	0.60	
Pineapple	0.47	
CO ₂ assimilation rate of a leaf at light saturation (P _{MAX})	kg CO ₂ ha ⁻¹ h ⁻¹	Measured
Rubber	48.8	
Banana	28.6	
Pineapple	1.4	

Methodology

The model's sensitivity was tested for three major parameters listed in Table 1 on all three crops. It involved testing the behaviour of the light module's solar radiation interception in response to changes to the canopy light extinction coefficient (k) and the crop growth modules' dry matter yield (DMY) in response to changes to the initial radiation use efficiency (EFF) for individual leaves and CO_2 assimilation rate of a leaf at light saturation (P_{MAX}). A dimensionless measure (Thornley and Johnson, 1990) of the sensitivity (S) of the outputs, O , (light interception or DMY) to the respective tested parameters P_j , is shown in equation 1. Increments and reductions of 10 and 20 % of the initial values of the tested parameters (Table 1) were used for the analysis.

$$S(O, P_j) = \frac{\partial O}{\partial P_j} \frac{P_j}{O} \approx \frac{\delta O}{O} \frac{P_j}{\delta P_j} ; \partial \text{ and } \delta \text{ denote small finite changes.} \quad [1]$$

Results and Discussion

Fractional interception was used to measure the sensitivity of the model to k . Results in Figure 1 show that all the crops are sensitive to change in k . Banana (B) and pineapple (P) showed almost equal sensitivity whereas that of rubber (R) was double the sensitivity of banana and pineapple. On average, for 10 and 20 % increments in k , R was 51 and 52 % more sensitive than B and P, respectively. For 10 and 20 % decrements in k , R was 36 and 41 % more sensitive than B and P, respectively.

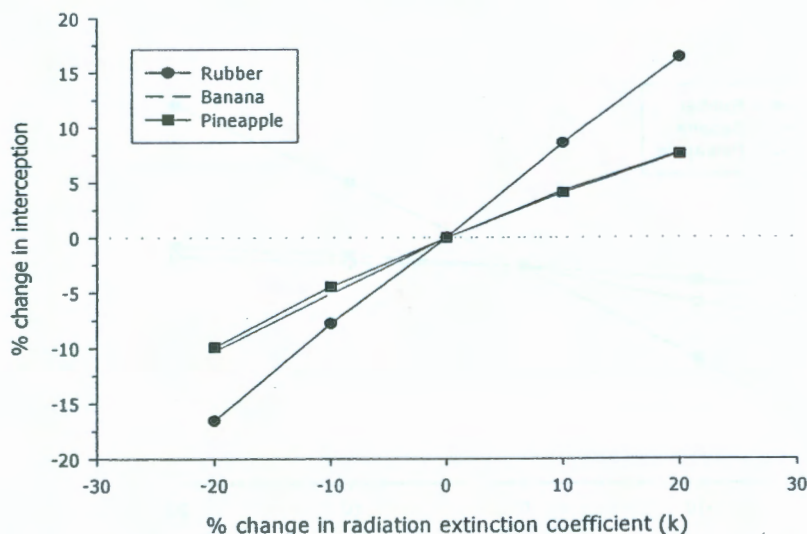


Figure 1: Sensitivity of simulated radiation interception by rubber, banana and pineapple to changes in canopy radiation extinction coefficients (k)

DMY was used to measure the sensitivity of the model to P_{MAX} and EFF. From the results shown in Figure 2, all the crops were sensitive to changes in the value of P_{MAX} with rubber being half as sensitive compared to banana and pineapple, which showed almost equal sensitivity. On average, for 10 and 20 % increments in P_{MAX}, B was 2 and 57 % more sensitive than P and R, respectively. For 10 and 20 % decrements in P_{MAX}, B was 3 and 49 % more sensitive than P and R, respectively.

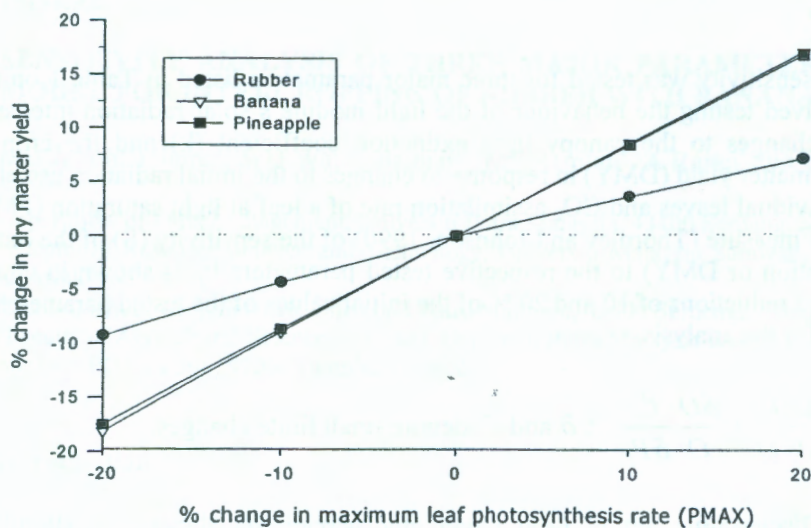


Figure 2: Sensitivity of simulated dry matter yield of rubber, banana and pineapple to changes to their maximum leaf photosynthesis rate

In the case of EFF, the rubber crop was the most sensitive. Banana and pineapple showed very little change (Figure 3). On average, for 10 and 20% increments in EFF, R was 87 and 94 % more sensitive than P and B, respectively. For 10 and 20 % decrements in EFF, R was 65 and 85 % more sensitive than B and P, respectively.

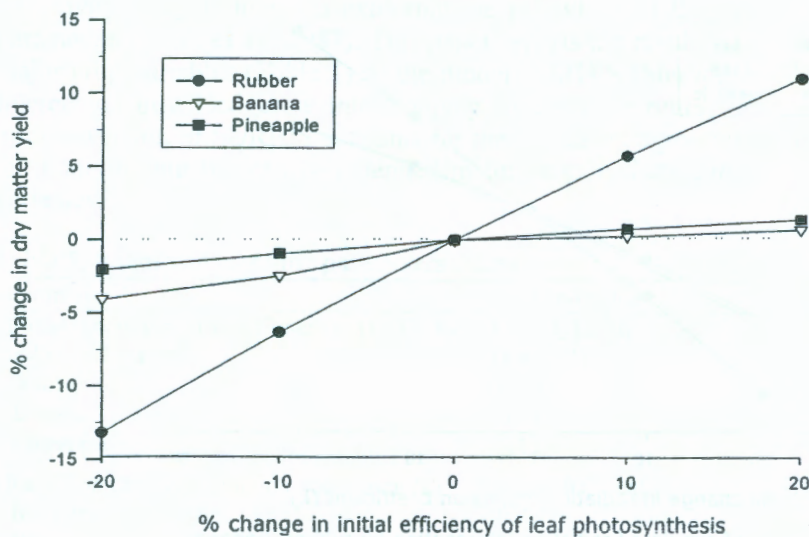


Figure 3: Sensitivity of simulated dry matter yield of rubber, banana and pineapple to changes to their initial efficiency of leaf photosynthesis (EFF)

Conclusion

It is important that accurate measurements of k , Pmax and EFF are used in the model to minimize errors in the estimation of radiation interception and dry matter yield, which are principal outputs of the SURHIS model.

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