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ADVANCES IN SOIL SCIENCE FOR SUSTAINABLE FOOD PRODUCTION

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MODELLING OIL PALM GROWTH AND YIELD

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INTRODUCTION

The objective of this study was to develop a model to simulate the oil palm growth and yield.

MATERIALS AND METHODS

The model has four core components. The first component modelled the plant-radiation environment. The oil palm canopy was divided into a network of 3-D cuboids, where for each cuboid, three properties must be calculated: 1) leaf area, 2) leaf orientation, and 3) mean path length of solar beam. To calculate these properties, algorithms from computer graphics, namely polygon clipping and ray-tracing, were adapted. This component also modelled the separate interception of direct and diffuse solar radiation by the oil palm canopy.

The second component modelled the oil palm growth. The growth component in the model by van Kraalingen *et al.* (1989) was adapted. The trunk height growth was based on an empirical relationship established from measured data from previous works. The growth of the oil palm canopy (width and height) was also based on measured data. One major deviation from van Kraalingen's model is this study's model accounts for the factor of water stress on oil palm growth and yield.

Consequently, the third core component was for modelling the water balance in the oil palm environment. Oil palm water use, transpiration and soil evaporation were modelled based on the Shuttleworth-Wallace (Shuttleworth and Wallace, 1985) equation which allows for the interaction of heat fluxes between the tree and soil. The water balance for two soil depths (0-20 mm and 20 mm until rooting depth) were also modelled to determine the critical water amount based on a generic C3 plant. Thus, the oil palm growth and yield would decrease in proportion to the critical water level.

The fourth component modelled the flowering pattern of oil palm. The model by Jones (1997) was adapted, which allows for the setting of threshold values for male, female, mixed and aborted flowers. This component is essential because it allows for the annual cycle of oil palm yield often seen in the fields.

Additionally, this study oil palm model was developed to account for various land slope (elevation) and direction, and planting arrangement, direction and density.

RESULTS AND DISCUSSION

Trial runs of the model showed realistic simulation of measured oil palm growth and yield, in particular the annual cycle of oil palm yield. Simulations were for 30 years from 1974, based on actual soil and weather conditions of Serdang, Selangor (Fig. 1-4).

ACKNOWLEDGMENTS

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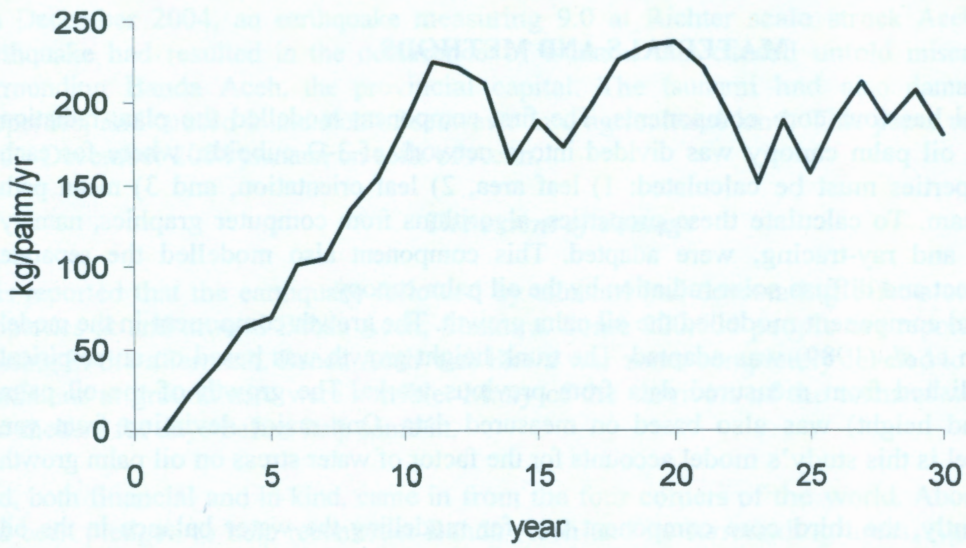

Fig. 1. Simulation of the oil palm yield. Yield begins to fluctuate after 10 years as observed in field conditions. The model accounts for the flower sex ratio and environmental stresses which affect oil palm yield.

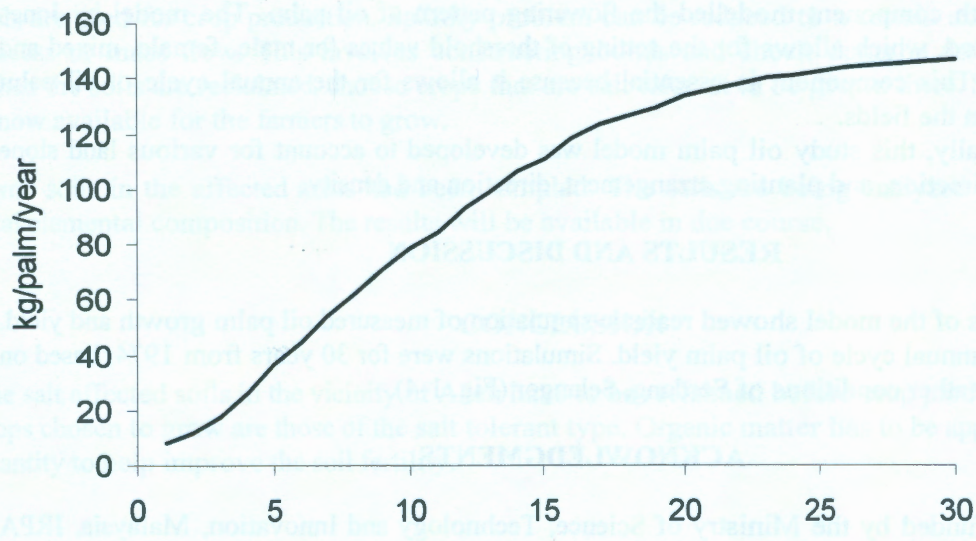

Fig. 2. Simulation of the above ground dry matter of oil palm

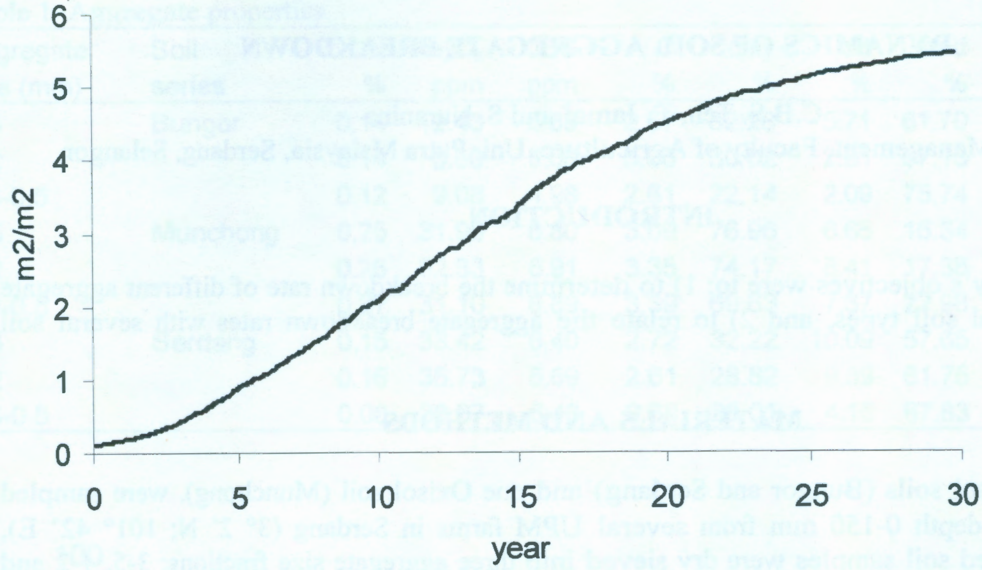

Fig. 3. Simulation of the leaf area index (LAI)

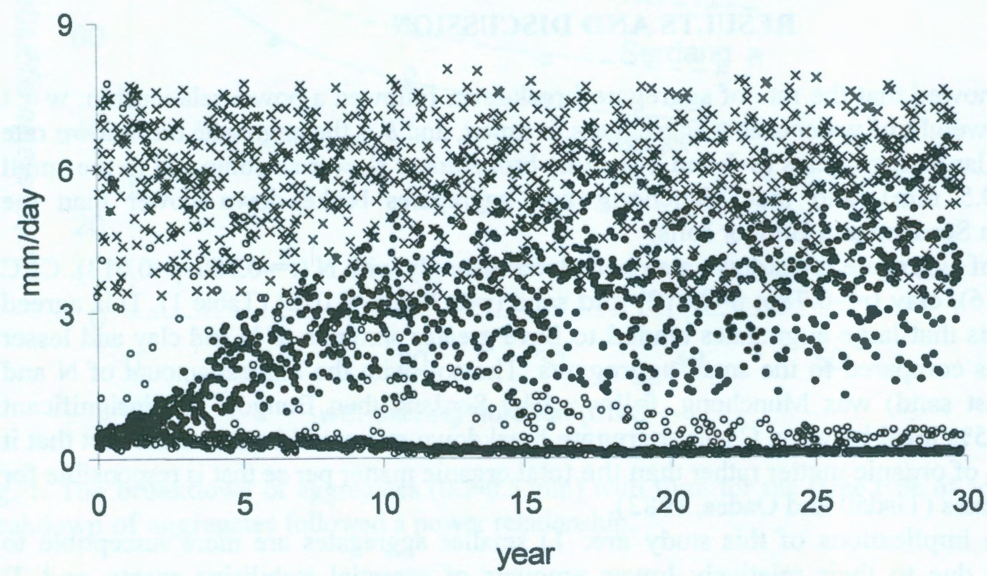

Fig. 4. Simulation of the soil evaporation (open circles), oil palm transpiration (close circles), and the potential evapotranspiration (crosses)