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This Week's Citation Classic

Monteith J L. Light distribution and photosynthesis in field crops. *Ann. Bot. NS* **29:**17-37, 1965. [Rothamsted Experimental Station, Harpenden, Hertfordshire, England]

The distribution of light in a crop canopy is described by the binomial expansion of an expression containing parameters for the area, geometry, and transmissivity of individual leaves. Crop photosynthesis is calculated assuming a hyperbolic light response and daily photosynthesis rate is explored as a function of leaf parameters. [The *SCI*® indicates that this paper has been cited over 155 times since 1965.]

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"I wrote this paper when I was trying to reconcile laboratory and field measurements of the CO_2 exchange of a barley crop. The laboratory measurements were on individual leaves using equipment mainly built by Pieter Gaastra during a visit to the physics department at Rothamsted Experimental Station in 1960. The field measurements exploited a micrometeorological method, common now, but in those days confined to groups at Rothamsted, Cornell (Ed Lemon), and Tokyo (Eiichi Inoue).

"I developed my own model of light interception because I was not satisfied with some aspects of the model which Monsi and Saeki[1] described in a classic paper. By unfortunate oversight, I did not refer to this work, perhaps because much of my own paper was written when I was confined to bed with bronchitis in the autumn of 1963.

"The essence of my model was to describe the interception of light by a crop canopy in finite layers, each of unit leaf area index, rather than in the infinitesimal layers which lead to the simple exponential model of light extinction. Each layer was supposed to intercept a fraction s of the radiation reaching it from above. Much more rigorous forms of analysis have now been applied to the problem and Nilson[2] showed that the whole class of positive binomial models describes canopies whose leaves are overdispersed, i.e., they overlap less than chance predicts. My model was a special case within this class.

"When sub-models of light interception are used as components of larger models of crop growth, complexity is usually a disadvantage and I have now abandoned my own 's' model in favour of the exponential model interpreted in terms of a Poisson distribution of irradiance.[3] I suppose my paper became a 'classic' because the algebraic simplifications scorned by some of my physicist friends ('You have set the subject back 20 years' —J.R.P.) allowed most crop ecologists to understand what I was trying to do. I've been told that the model is still helpful for introducing undergraduates to the principles of light interception in canopies.

"Our practical conclusion from the model was that the angle at which leaves are held in a canopy is not likely to be an important discriminant of the mean seasonal growth rate and hence of yield. De Wit reached the same conclusion, but we have often been misrepresented by experimentalists trying to demonstrate that leaf angle does influence yield in such a way that breeders should try to select varieties with erect leaves. For reasons discussed by Trenbath and Angus,[4] rice, growing in the tropics, is one of the few crops likely to benefit from erectness and the selection of lines with erect leaves has been conspicuously successful.

"The application of the model to laboratory and field measurements at Rothamsted was never completed: 1963 was the last occasion when I had an excuse to stay in bed and get on with some original work without interruptions!"

1. **Monsi M & Saeki T.** Uber den Lichtfaktor in den Pflanzengesellschaften und seine Bedeutung für die Stoffproduktion. *Jpn. J. Bot.* **14**:22-52, 1953.
2. **Nilson T.** A theoretical analysis of the frequency of gaps in plant stands. *Agr. Meteorol.* **8**:25-38, 1971.
3. **Monteith J L** . Does light limit crop production? (Johnson C B, ed.) *Physiological processes limiting plant productivity.* London: Butterworths, 1981.
4. **Trenbath B R & Angns J F**. Leaf inclination and crop production. *Field Crop Abstr.* **28**:231-44. 1975.