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REPLY

R. A. Powell and J. B. Hardaker*

In his comment on our paper Barry raises a semantic point about our use of the term "sub-optimal". He implies, quite validly, that a solution which is preferred by the decision-maker cannot be sub-optimal for him. We used the term to imply a solution which falls short of the profit maximizing solution, but which might nonetheless be preferred by the farmer. We make no value judgments about which solutions farmers should prefer, and it is unfortunate that apparently Barry has been misled into believing that we do.

We take issue with the second and more substantial point contained in Barry's comment. He seems to be arguing that if any farm planning problem is fully specified in terms of the activities, constraints, and objective function of a linear programming model, there will be no need to consider more than the one, unique, optimal solution. We refute this point of view on two main grounds.

First, farmers real planning objectives are generally too complex to be adequately described by a single, linear objective function. Indeed, risk aversion, to which Barry refers, implies a non-linear utility function, requiring at least a quadratic programming formulation.¹ Moreover, the problem of getting a farmer to articulate his objectives in a manner which can be represented by a cardinal objective function, whether linear or not, is severe.

Second, even if we were to concede the possibility that a linear programming model could be refined to the extent that it yields the solution most preferred by the farmer, we would argue that the costs of the planner's time and computing time would rule out such an approach for practical farm planning. Efforts to refine a model are likely to be subject to rapidly diminishing marginal returns, since the solution space in the region of the optimum is generally very "flat".² Experience of using linear programming for farm planning in Europe and Australia clearly indicates that it is better to devote limited analytical resources to the construction of an adequate but relatively less refined planning model.

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¹ R. J. Freund, "The Introduction of Risk into a Programming Model" *Econometrica*, Vol. 24 (1956), pp. 253-263.

² U. Renborg, *Studies in the Planning Environment of the Agricultural Firm* (Uppsala: Almqvist and Wicksells, 1962).

This is not to imply that more refined models, in terms of both constraints and objective function, could not be developed. It is simply that the planning and programming resources are better deployed in using a relatively simple model to explore the planning environment of the farm firm by generating solutions for alternative sets of assumptions. A selection of these solutions can be presented to the farmer who can select the one which is most nearly optimal for him. This method will be even more appropriate in computing longer term development plans where additional complexities arise in specifying the farmer's objectives, for example, the complex relationship between the household and farm cash requirements. We find it more plausible to suppose that one could deduce something about the farmer's objectives from his expressed preferences among alternative farm plans, rather than the other way about, as Barry would have it.