Evaluating Apple Orchard Management using a Bioeconomic Model

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Certification

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis

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Abstract

Managers of deciduous perennial fruit crops must consider both biological and economic relationships in determining orchard design and life-time orchard management strategies. Orchardists require a good understanding of the many environmental, physiological and horticultural factors that influence tree growth, fruit production and fruit quality. Of particular importance in apple-tree management is knowledge of how the growing environment and horticultural manipulation of past years affect current and future growth habits and productivity of the tree.

In addition to understanding biological factors that influence apple-tree productivity, a diverse range of orchard systems are currently available to orchardists. Each system, consisting of a particular combination of cultivar, rootstock, tree spacing and training method, has implications for fruit quality, quantity and ultimately profit.

A dynamic simulation model of apple orchard production is developed in this research, and used to investigate a range of issues of relevance to the commercial apple orchardist. The model is developed in a bioeconomic framework and consists of biophysical and economic components. The biophysical component describes the vegetative and reproductive physiology of an apple tree, factors affecting the quantity and quality of apples produced and interrelationships between these factors. The economic component describes the costs and revenues associated with each orchard system from planting to maturity.

In addition to simulating profitability of selected orchard systems, the bioeconomic model is applied to the issue of thinning fruit each year in order to maximise orchard profitability given the inherent biennial bearing nature of an apple tree. Thinning is one of the few ways an orchardist may influence annual profitability of an orchard, once decisions about orchard design have been made and trees planted. The level of thinning was considered in non-optimising and optimising frameworks. The thinning strategy that maximised profit was the one that reduced the biennial bearing patterns to a negligible level, and hence smoothed fruit production over time.

The bioeconomic model was also used to investigate the effect on orchard profitability of reliance on biological control agents to control two-spotted mite outbreaks. Although the results of this part of the study were limited by data availability, it provides an example of how the model can be applied in dealing with integrated pest management. Other possible uses of the model are also discussed.

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