

Table 1

A chronological sample of published tree crop models

Author(s)	Tree type	Biological model	Optimisation/analysis techniques	Decision variables	Objectives
Willis and Hanlon (1976)	apple	survey-generated yield information	dynamic linear programming	variety, capital borrowing	optimal tree mix, maximise PV net returns
Winter (1976, 1986)	apple, pear	mechanistic, (FRUPRO)	simulation	planting density, variety, rootstock, orchard size	orchard system profitability comparisons
Graham et al. (1977)	apple, cherry, pear	survey-generated yield information	Single/multiple period linear programming	orchard system, variety and type, timing of replacement	Profitability, optimise labour, cash borrowing requirements, renewal strategy
Childs et al. (1983)	apple	empirical yield estimation	simulation/dynamic programming	replacement policy	maximise profit
Haley et al. (1990)	apple	mechanistic	inference procedures, simulation	pest numbers	assess benefits of pest control, decision support
Johnson & Rasmussen (1990)	peach	empirical	simulation	fruit load	maximise profit
Thiele & Zhang (1992)	apple	empirical	dynamic simulation model	fruit load	explore revenue per hectare, decision support
Groot (1996)	apple, pear	empirical	simulation	crop protection system	explore cost of pesticide reduction, decision support
Cahn et al. (1997)	apple	empirical	simulation	planting density, year of first harvest	explore NPV, IRR, decision support
Whitaker & Middleton (1999)	apple	yield estimation	cost-benefit analysis, simulation	orchard system, erection of hail net	Profitability of hail netting

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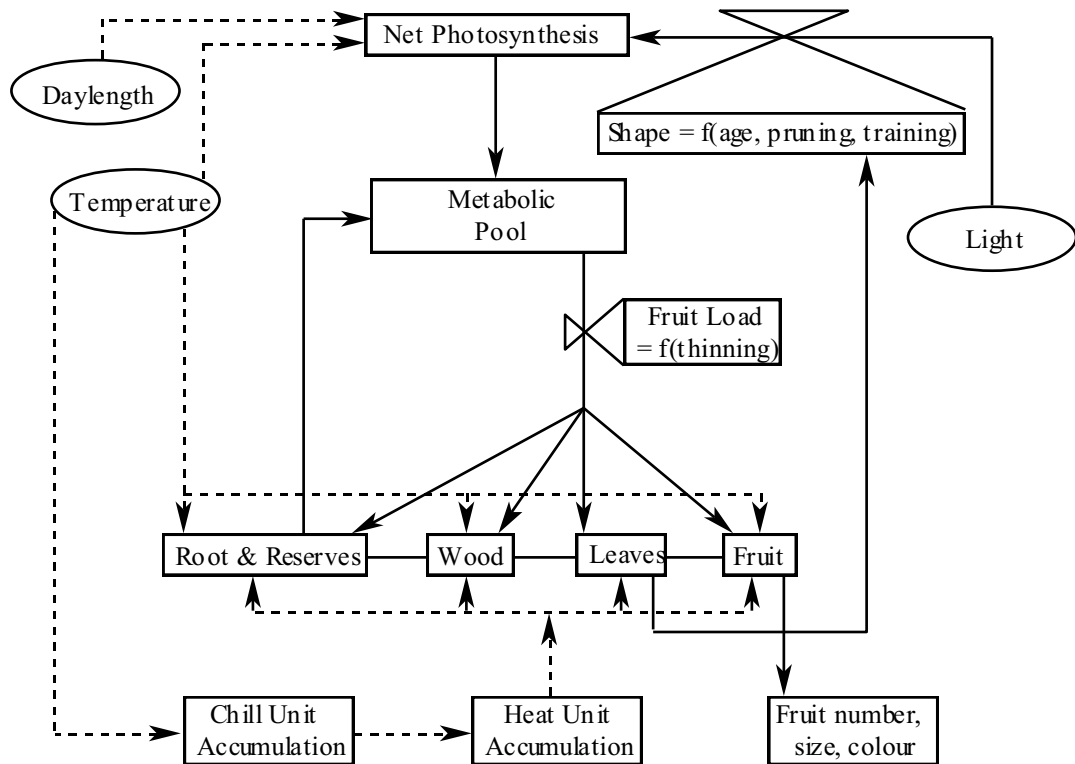


Figure 1. Conceptual biophysical model

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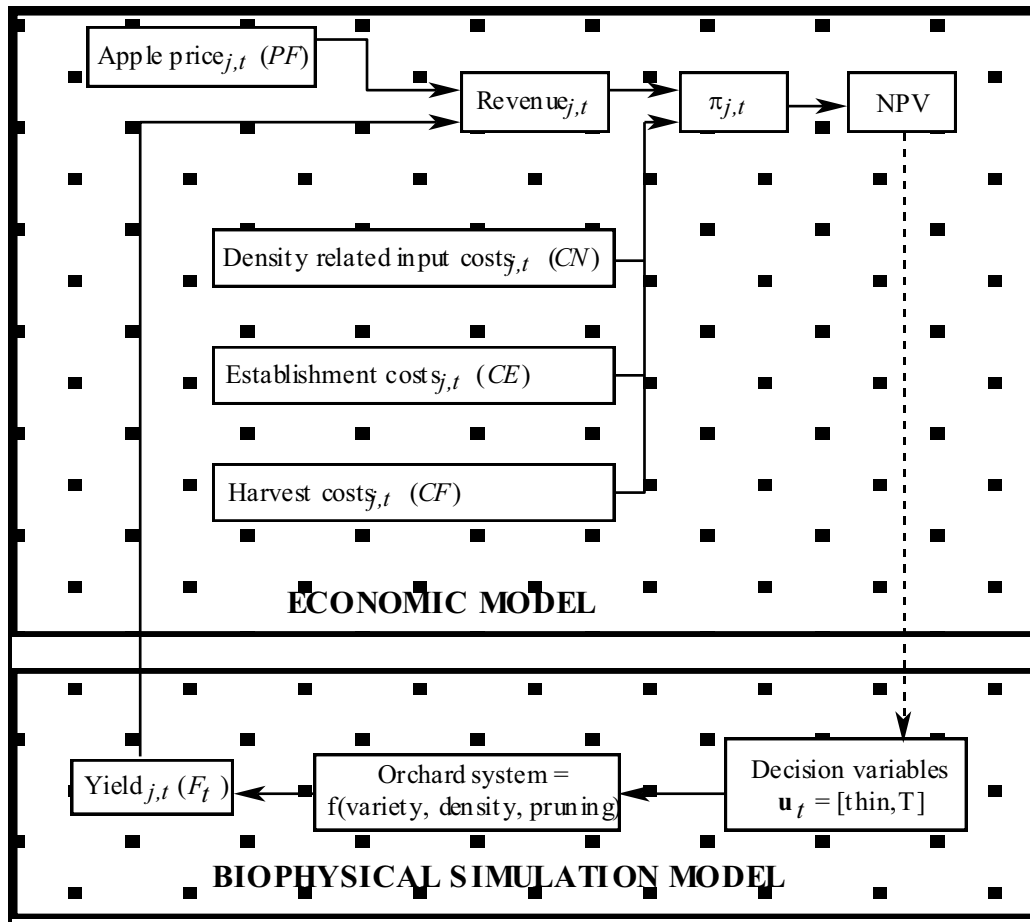


Figure 2: Diagrammatic representation of the bioeconomic model (j =variety, t =year)

Table 2: Price data used to develop price-count relationship

Count	Price per 18 kg carton (\$)
70	36
80	43
90	43
100	43
110	38
120	31
135	25
150	24
165	21
180	16
198	15

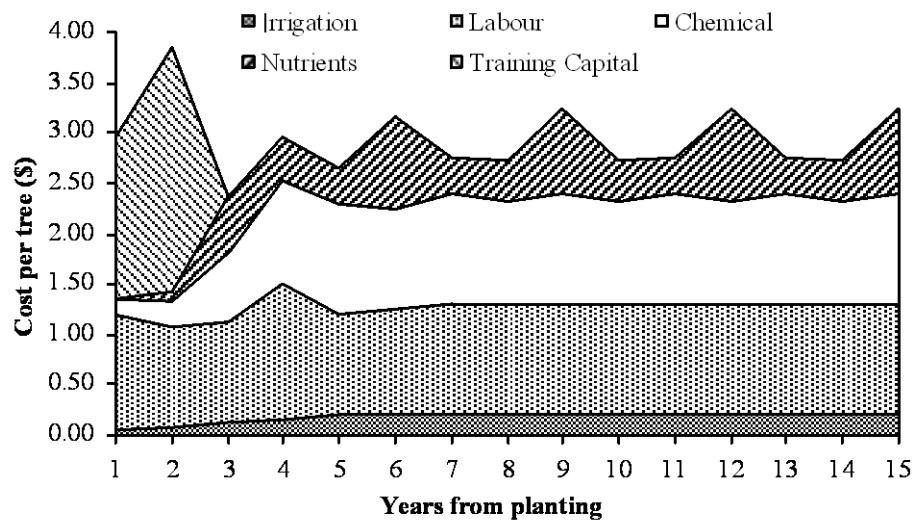


Figure 3: Density related costs (CN) over the simulation period

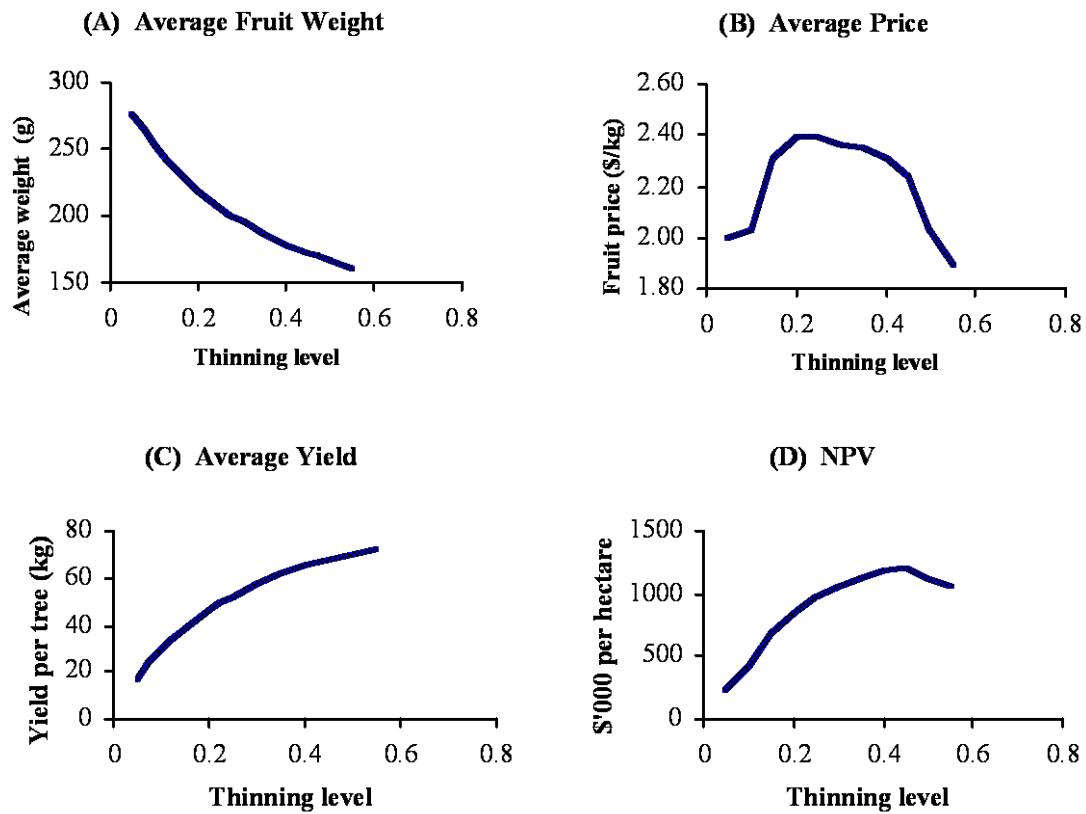


Figure 4: The effect of thinning on average fruit weight (A), price (B), yield (C) and NPV (D)

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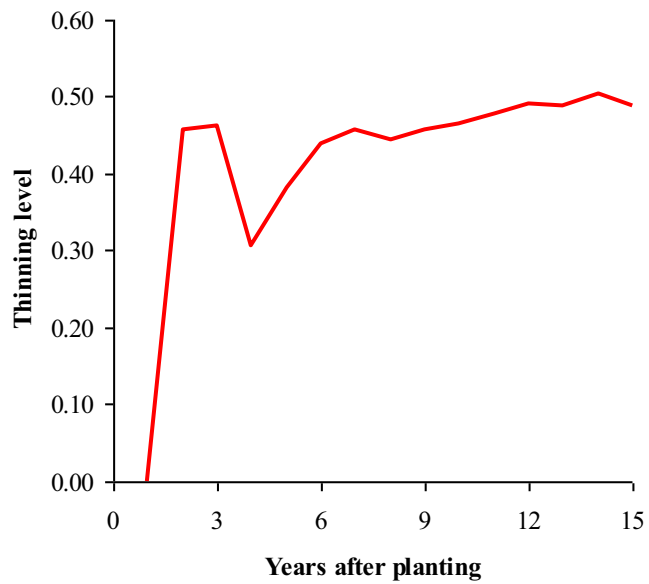


Figure 5 Optimal thinning rates from optimising the model using a Genetic Algorithm

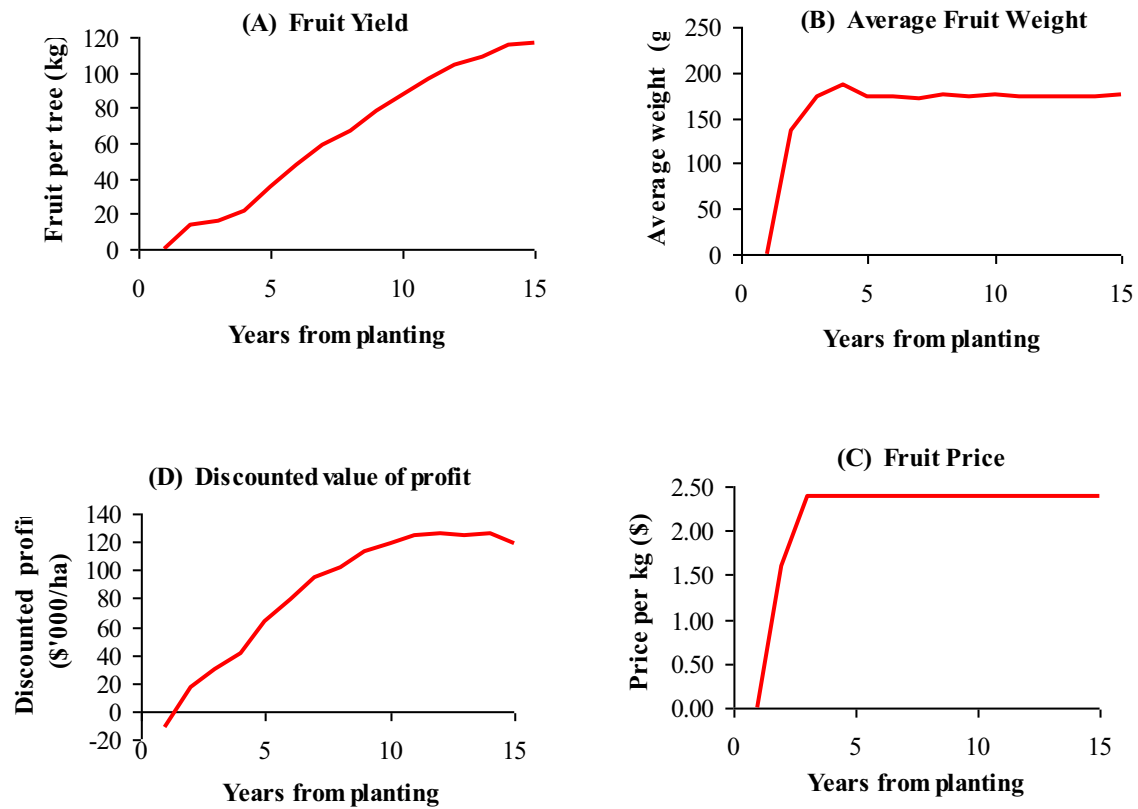


Figure 6 Fruit yield (A), fruit weight (B), Fruit price (C) and Net Present Value (D) under the GA optimising routine

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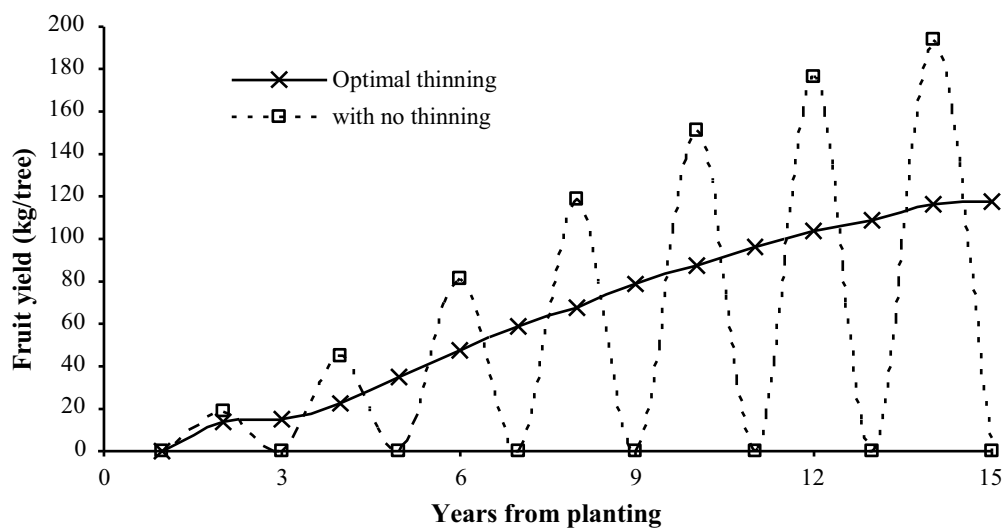


Figure 7 Annual fruit yield with optimal thinning strategy and no thinning

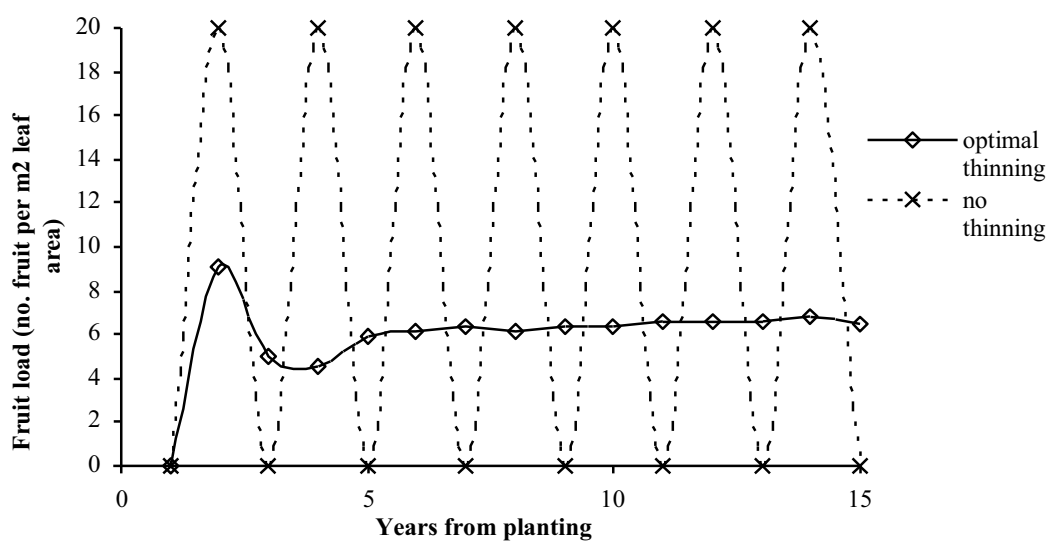


Figure 8 Comparisons of fruit load from no thinning and the optimal thinning strategy