FINANCIAL MODELLING: A LOGICAL MEANS OF EVALUATING TREE ESPACEMENT FOR AVOCADO ORCHARD DEVELOPMENTS

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Abstract

Good investment decisions require a feel for the relationship between risk and reward. Tree espacement is often approached from a purely horticultural perspective with a view to maximizing tons of production per hectare as early as possible. In this paper a simple model is developed which allows the financial impact of different tree espacements to be examined by setting off establishment, maintenance and production costs against future income streams for different economic scenarios. Results are presented for a set of horticultural and economic assumptions and the efficacy of the model in aiding investment decisions is demonstrated.

1. Introduction

Given fixed land, water and climatic resources, tree espacement and cultivar selection become the most significant decisions in planning new avocado orchards. The cultivar, soils and climate will dictate individual tree growth rates and fruit yields. Tree espacement will ultimately dictate development costs and, together with orchard thinning requirements, the cash inflows and outflows for   the investment.

Land and other costs dictate that better returns are generally achievable with intensive development involving   sophisticated irrigation systems in order to improve yield quantum and reliability (Toerien, 1984). In the drive to increase unit orchard yields, tree planting densities have been increased as high as 800 trees/ha (Köhne et al., 1990, Köhne et al., 1992). At these densities, early overcrowding becomes an issue and chemical   treatments and girdling have been investigated as means of delaying overcrowding and improving early yields (Köhne, 1992). These investigative efforts notwithstanding, precious little has been published on the financial risks and rewards associated with going to higher densities.

This situation can perhaps best be summed up by the findings of the Special Workshop held at the Second World Avocado Congress (Köhne et al., 1992), i.e.

> "Plant as many trees as is economically feasible using precocious cultivars and thin with courage. The closest initial tree spacing that is economically feasible is the spacing that attains high enough yields to make some profit before the first thinning".

While providing some help to planners, these guidelines do not specify what "some" profit is and they do not address the financial risk in trying to achieve this.

The authors believe that each investment's cash flows and risks thereto will be uniquely affected by cultivars, soils, climates, markets and environmental factors such as pests, hail and frost and that the adequacy of the profit margin should be matched to the risk. In this paper, we describe a simple computer modeling method which has been used to great advantage in the authors' organisation for making orchard development decisions, particularly with respect to initial tree espacement.

2. Modeling Methodology

Financial modeling of an investment such as an avocado orchard development requires the calculation of the anticipated cash inflows and outflows over the investment period. Avocado orchards are long term investments and one is typically looking at an investment period of 10 years or longer with cash flows calculated over 1 year intervals. Modern spreadsheet computer software provides the ideal tool for making such calculations and many of the commercial packages have built-in functions for calculating the financial parameters for carrying out the desired financial analysis.

The methodology reported in this paper is based on the unit tree. In this, the basic information required to calculate cash inflows and outflows from income and expenditure is derived from a knowledge and analysis of information on a per tree basis. This is then expanded to a per unit area (per hectare) basis once the number of trees per hectare (tree espacement) is specified.

Cash inflows result from the sale of fruit. These can be modeled by understanding the expected yield per tree over time and converting these to cash inflows per hectare by specifying tree espacement and the revenue per ton of yield which is expected to be realised from the sale of the fruit. Obviously, the price obtained at sale will depend on a number of factors such as size, quality and market dynamics. In the examples presented in the paper tree yields have been taken from the work of Wolstenholme et al. (1991) and revenues per ton from the authors' understanding of the historical pricing which South Africa avocado farmers have been able to achieve for various grades of fruit on the domestic and European markets.

Cash outflows result from the costs incurred in establishing and maintaining the orchard and in harvesting, packaging, marketing and distributing the crop. Depending on individual circumstances, investors may also wish to set off certain indirect costs such as administration charges and financing costs. These different costs will vary from country to country around the world and from organisation to organisation. In the examples presented in the paper, the authors have relied on historical costing data derived from their organization's long standing involvement in the South African avocado industry. Costs are expressed on a per hectare basis and in the context of tree espacement, various costs such as establishment, fertilizer and energy costs will depend on planting density and must be accounted for accordingly.

The beauty of spreadsheet software is that it allows revenues and expenses to be set up and calculated in logical tabular form and it permits easy and flexible examination of the impact of changing various parameters, values and assumptions. A typical spreadsheet layout for an investment calculation of this nature is presented in Table 1.

3. Demonstration Examples

Fuerte and Hass at planting densities of 440 trees/ha and 880 trees/ha are modeled to demonstrate the efficacy of the method in assessing the financial viabilities of different tree espacements. The individual tree yields used for these two cultivars are presented in Figure 1. Other key assumptions are set out in Table 2.

The following scenarios are investigated:

3.1 Thinning

It is assumed that no special treatments such as paclobutrazol sprays or special practices such as girdling are deployed to affect tree growth and yield and that thinning occurs before there is any adverse impact on individual tree yields. It is assumed then that Hass, the more vigorous cultivar, requires thinning at years 6 and 8 for 440 trees/ha and at years 4, 6 and 8 for 880 trees/ha. Fuerte is thinned at year 8 for 440 trees/ha and at years 6 and 8 for 880 trees/ha. The impact of having to thin Fuerte one year earlier, i.e. at years 5 and 7, at the higher density (880 trees/ha) is also examined.

3.2 Hail

Hail damage is a real factor in many of the avocado production areas of South Africa. The impact of incurring hail damage in year 4 which reduces yield for that and the subsequent year by 80% and 40% respectively is investigated.

4. Results & Discussion

In this paper cumulative cash flow and internal rate of return (IRR) are used to evaluate the different orchard investment scenarios. The IRR represents the "overall" rate of return produced by the cash flows over the investment period. The pay back time and the risk expressed in terms of the maximum negative position of this investment are revealed by the cumulative cash flow results.

Figure 2 represents the result for the base case investment scenarios for Hass at the two espacements. There is very little difference in the IRR for the two espacements; the pay back time is not significantly better for the 880 trees/ha and the maximum negative exposure at year 2 is nearly R8000/ha (21.7%) greater for the denser planting. Given the extra management effort required, an investor would seriously question whether the high density planting is warranted under these conditions. If, however, we look at the hail damage scenario for these two espacements (Figure 3), the higher density orchard fairs significantly better, suggesting that if hail is a real concern, the 880 trees/ha would be the preferred route.

The Fuerte base case results suggest there is more merit in the higher density planting if thinning is only necessary at years 6 and 8 (Figure 4). The pay back time is significantly shorter and the IRR is 36.97% at 880 trees/ha vs 27.78% at 440 trees/ha. However, should thinning be required at years 5 and 7 instead, the 440 trees/ha would give a higher return with lower risks. Figure 5 represents the results for the hail damage scenario with 440 trees/ha thinned at year 8 and 880 trees/ha thinned at years 5 and 7. Here, the lower density investment is the outright winner with an IRR of 13.40% at 440 trees/ha vs 0.57% at 880 trees/ha.

The above results have been put forward simply to illustrate how the modeling method may be used to assist in decision making. Examination *of these limited number of scenarios demonstrates the fact that there* are no cut and dry answers to the question of appropriate spacing. The modeling method does, however, allow the investor to set down what is believed to be the most likely to occur -under the investor's circumstances and then to examine the sensitivity of the investment outcome to the various assumptions made and to the impact of different physical scenarios. To this end, the impact of cultural practices such as girdling to increase pre-thinning yield and paclobutrazol sprays to delay thinning can easily be modeled as can alternate bearing.

5. Conclusion

Computer spreadsheet technology provides an inexpensive and effective means of evaluating the pros and cons and the risks and rewards associated with avocado orchard investments and the choice of tree espacement. The limited results presented in this paper clearly demonstrate that there are no simple right or wrong answers to the question of appropriate planting density. Rather, one should expect a unique outcome for each physical situation planned and the appropriate decision on tree espacement should be taken after weighing all relevant factors such as climate and management capability and balancing the investor's own appetite for risk and reward.

References

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Köhne, J.S., and Whitney, G.W., 1992. Workshop 4: Tree spacing or tree thinning - which is best? Proc. Sec. World Avocado Cong. 679.

Toerien, J.C., Meyer, N., and Milne, D.L., 1984. The economies of avocado production in the Tzaneen area. The Citrus and Subtropical Fruit Journal.
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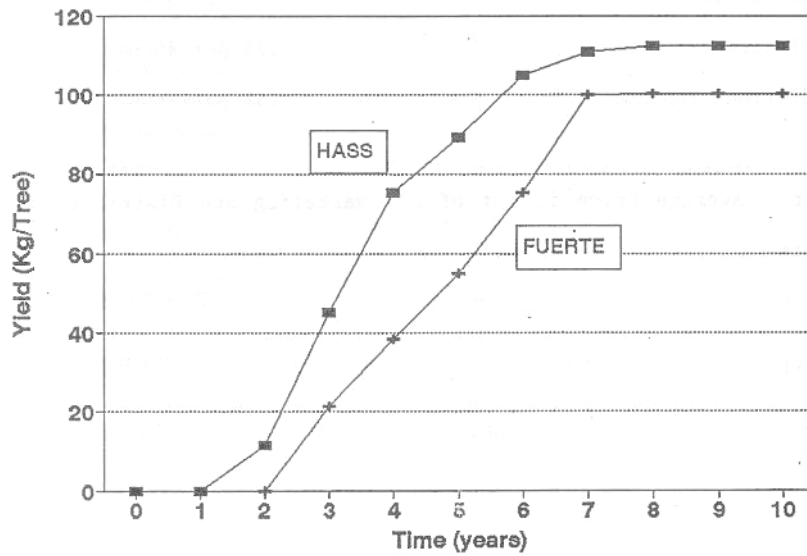# TABLE 1 - TYPICAL SPREADSHEET LAYOUT : FUERTE

	YEAR 0	YEAR 1	YEAR 2	YEAR 3
EXPENSE (R/ha)				
FIELD				
Manpower	0	716	781	841
Transport	0	240	259	278
Repairs & Maintenance	0	50	50	50
Electricity	0	250	250	250
Fertilizer	0	220	220	242
Consumables	0	115	115	115
Pest Control	0	300	350	400
Weed Control	0	430	430	430
Infrastucture	0	1,000	1,100	1,200
Consultation	0	50	50	50
Subtotal	0	3,371	3,606	3,856
HARVESTING	0	0	0	710
PACKAGING	0	0	0	2,467
INDIRECT	0	1,294	1,318	1,660
ESTABLISHMENT	19670	0	0	0
TOTAL	19,670	4,665	4,923	8,694
CASH FLOW BEFORE INT. & INFL. (R/ha)	(19,670)	(4,665)	(4,923)	777
CASH FLOW BEFORE INTEREST (R/ha)	(19,670)	(4,665)	(5,662)	383
INTEREST PAID (R/ha)	0	3,960	5,603	7,092
CASH FLOW (R/ha)	(19,670)	(8,625)	(11,265)	(6,709)
CUMALITIVE CASH FLOW (R/ha)	(19,670)	(28,295)	(39,560)	(46,269)

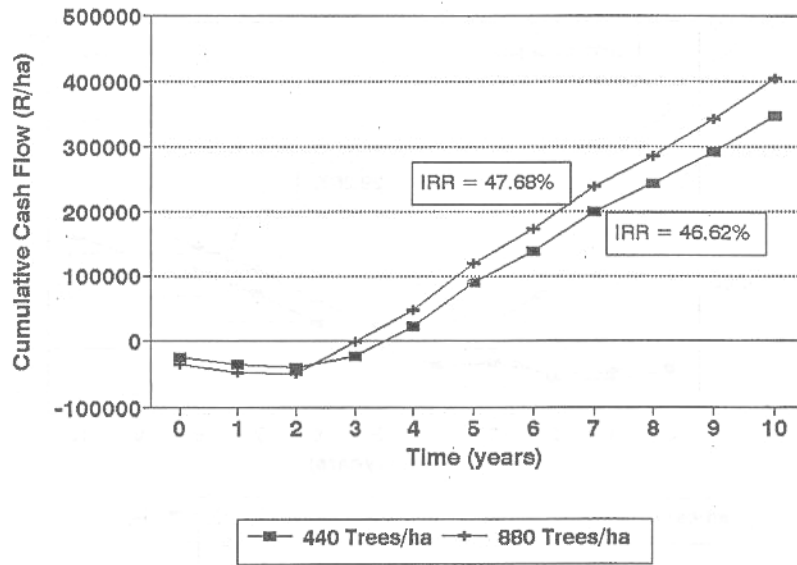Table 2 - Assumptions Used in Demonstration Examples

Average Price (year 1)	=	R2000/ton
Interest Paid	=	18% per annum
Interest Earned	=	15% per annum
Inflation (Revenue)	=	12% per annum
Inflation (Expenses)	=	15% per annum

Note: Average Price is net of all Marketing and Distribution Costs

FIGURE 1
INDIVIDUAL TREE YIELDS

FIGURE 2
HASS - BASE CASE SCENARIOS

IRR = 47.68%

IRR = 46.62%

440 Trees/ha   880 Trees/ha

FIGURE 3
HASS - HAIL DAMAGE SCENARIOS

IRR = 29.26%

IRR = 21.93%

440 Trees/ha   880 Trees/ha
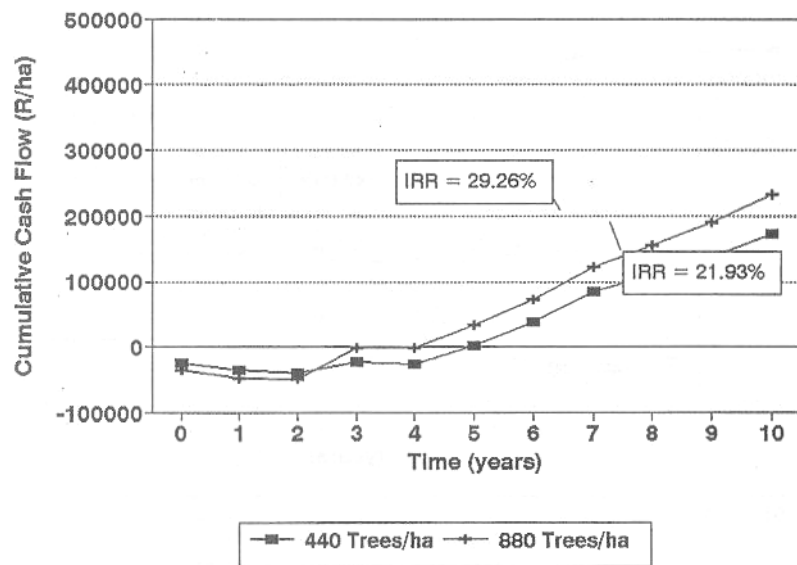
FIGURE 4
FUERTE - BASE CASE SCENARIOS

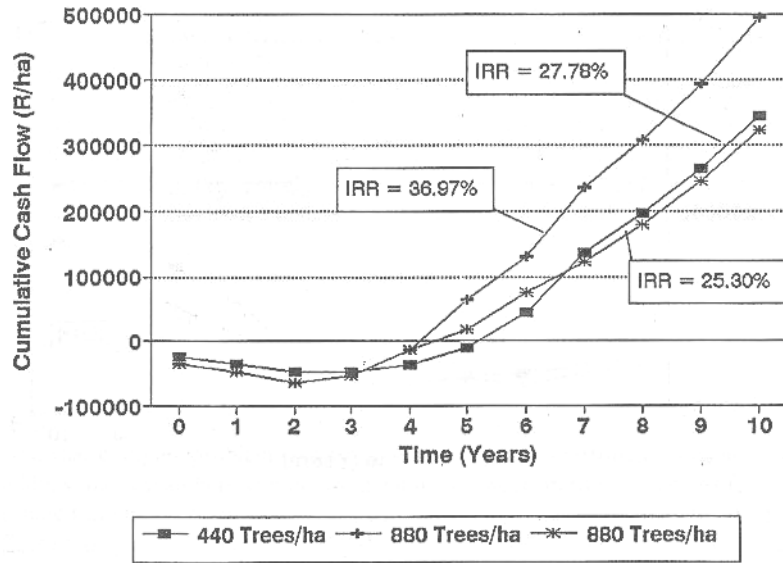IRR = 27.78%

IRR = 36.97%

IRR = 25.30%

440 Trees/ha —+— 880 Trees/ha —*— 880 Trees/ha

FIGURE 5
FUERTE - HAIL DAMAGE SCENARIOS

IRR = 13.4%

IRR = 0.57%

440 Trees/ha —+— 880 Trees/ha
Thinned yrs 5 & 7