

Strategies for investment in the Australian macadamia industry: Development and evaluation of an objective investment appraisal software model

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Abstract. This paper describes the development and application of a dynamic financial appraisal software model, known as the *Financial Planner for Macadamia*. This whole farm financial model for macadamia farming integrates both the investment and financing decisions of project appraisal into a single software package. This enables the viability of potential investments to be evaluated in terms of net present value and internal rate of return, as well as the most appropriate financing options to ensure sufficient cash flows over the life of a project. Investment scenarios can also be directly compared and sensitivity analyses undertaken to provide further insights into the robustness of potential business scenarios over time. The *Financial Planner for Macadamia* was developed in response to the limited tools available to assist farmers, investors and financiers to make objective investment decisions in the Australian Macadamia Industry.

Keywords: Investment analysis, cash budget, profile comparison, sensitivity analysis.

Introduction

While macadamia nuts account for less than 3% of the world nut tree trade, Australia's share of the market is around 45% making it the world's largest producer (Australian Nut Industry Council 2012). The Australian macadamia industry has approximately 700 growers with more than 6 million trees in production. Australian production is between 35,000 to 40,000 tonnes of nut-in-shell per year and is worth nearly $A100 million at the farm gate (Australian Macadamia Society 2012). In 2007/2008 approximately 70% of Australian production valued at $A90 million was exported (Australian Macadamia Society 2012; Australian Nut Industry Council 2012). Significant investment in the Australian industry has seen a fivefold increase in plantings since 1990 with demand for production still continuing to exceed supply (Australian Nut Industry Council 2012). However, in spite of strong demand there has been significant price variability for nut-in-shell at the farm gate (mean: $2.65/kg nut-in-shell; standard deviation: 67c) and objective financial data about industry returns has not been readily available (Australian Macadamia Society 2007, 2012).

The Australian Macadamia Society (AMS) the peak industry body in Australia identified the need for objective financial information about the costs and returns of macadamia farming from new macadamia growers and investors entering the macadamia industry. Many growers with existing farms also wanted to benchmark their costs and returns in order to determine which management practices and options would most improve their financial performance. In response to the need for objective financial data, the "On-farm Economic Analysis" (OFEA) project was initiated by the industry in 2003 to begin financial benchmarking of macadamia production in Australia (O'Hare et al. 2008)

Prior to the OFEA project, publicly available financial information for the Australian macadamia industry was limited to three main sources of information. Reilly and Bevan (1995) developed a computer model to assist growers to calculate the percentage return on their operation. Quinlan (2003) published gross margins for 3-, 7- and 15-year-old trees for a 20 hectare orchard in northern New South Wales. O'Hare et al. (2004) also included a gross margin for a 20-hectare 15-year-old farm in south-east Queensland or northern New South Wales. It is clear that these publications only provide information on a limited range of situations and do not allow current and prospective growers to input or benchmark their own financial information. While consultants within the Australian macadamia industry have also developed budgets for growing macadamias, these are not readily available to the wider industry.

Given that most of the financial information was out of date or not available to the industry, an update of financial information with clearly defined benchmarks that would be available to all stakeholders to support their investment decisions was regarded as a high priority. The objective of the resulting on-farm economic analysis project was to develop detailed and current benchmarks of costs, returns and general financial

performance across the Australian industry to provide an objective basis for future investment in the industry.

Materials and methods for model development

The on-farm economic analysis project comprised two distinct stages. Firstly financial and agronomic data were collected over four years and industry benchmarks established to provide an objective assessment of typical costs and returns for Australian macadamia growers. A key part of the benchmarking was the development of a standard chart of accounts in consultation with industry. The standard chart of accounts provided the basis for the consistent categorisation and measurement of farm financial information. This allowed farmers to directly compare their individual farm performance to industry benchmarks using standard metrics.

During the second stage of the project software was developed to utilise the financial and agronomic data collected in stage one in an integrated and objective way. The resulting *Financial Planner for Macadamia* software is a tool to objectively assess the viability of a wide range of macadamia farm business scenarios and forecast both investment viability and cash flows for periods of up to 30 years.

Data collection Past work by members of the project team with the macadamia industry indicated that the quality and comprehensiveness of records between individual farms varied quite significantly. As such obtaining reliable financial data across the sample would be difficult. Depending on business structure and size, some farms were using cash-based accounting while others used accrual accounting.

Before embarking on the data collection stage, key performance indicators were established and standard classifications developed for financial data to ensure relevance to industry (Brown 1996; Ronan and Cleary 2000; Wilson et al. 2005). The project team held discussions with growers and accountants associated with industry to develop a standard chart of accounts, which was then integrated into existing macadamia farm management software (MacMan) previously developed by the project team. Members of the project team were also involved in ongoing extension work with industry best practice groups who widely used MacMan. The best practice groups were used to disseminate information about the OFEA project, data collection needs and to promote adoption of the standard chart of accounts.

The sampling and data collection methods were then selected based on their appropriateness and ability to provide an accurate representation of the underlying industry sample, given the nature of the study (Patton 1990; Heiman 2001). The project team had extensive experience in dealing with the macadamia industry and had information demonstrating that the best practice groups formed a representative sample of the industry in terms of farm size, orchard age, geographic location and management structure. As such the sampling frame was compiled from the industry best practice groups. Selection of respondents in the best practice groups was then undertaken through a judgemental sampling process. This was done to ensure respondents had accurate and up-to-date financial and agronomic data which could be readily collected by the project team. This approach is consistent with Malhotra (2010) and Aaker et al. (2010).

As awareness of the project increased along with increased adoption of the standard chart of accounts, data collection was expanded to the broader industry, again using a judgmental sampling process to ensure data availability and accuracy.

Given that the basis of the *Financial Planner for Macadamia* model would be analysis of cash flows, data gathered from accrual based accounting records were converted to a cash based system. This ensured that the cost categories and individual costs being obtained from the standard industry chart of accounts were based on cash flows and thus interpreted as the same items from business to business, allowing data to be benchmarked and direct comparisons to be made.

Data were gathered using a standard questionnaire either emailed or mailed to respondents on a six-monthly basis over the three years of the project. Returned data were checked for accuracy and entered into a purpose built database. Data were also validated by the project team to resolve any issues regarding accuracy in a systematic and timely manner.

By the end of the project, comprehensive financial and agronomic data were collected from 31 growers and 41 farms from 2003 to 2006 representing approximately 5% of the Australian macadamia industry in terms of production.

Design methodology

The *Financial Planner for Macadamia* was developed utilising the principles of the "Dynamic Systems Development Method" (DSDM), which is part of the larger family of "agile" development methodologies (Abrahamsson et al. 2002). In accordance with the agile paradigm, the project team acknowledged the value of industry representatives as primary drivers of the project's success (Nerur et al. 2005). The core team comprised a software engineer, an accountant / agricultural economist and a macadamia agronomist. This team worked in collaboration with a steering group comprising four key industry stakeholders. The role of the steering group was to represent the needs of the client industry by reviewing progress, evaluating software functionality and establishing direction and priority for each successive stage of software development. In addition to the steering group, two industry reference groups were formed comprising macadamia industry members from the two major Australian macadamia producing states. These groups of stakeholders were closely and regularly involved with the development process to review functionality of prototypes and to ensure the suitability of the final software product.

By maintaining a strong user-centric focus and a flexible approach to software design, the project team aspired to rapidly deliver functionality that closely met user requirements (Highsmith and Cockburn 2001; Osterwalde 2004).

Instead of pre-determining the scope of functionality of the final product, the DSDM promotes the notion of a set project time and set resources with functionality adjusted within those boundaries (Stapleton 1997). Development phases are iterative and incremental and working results are delivered for client consideration and testing during each of the defined iterations.

Initially the concept and broad design specifications of the *Financial Planner for Macadamia* software were negotiated with the industry steering group at the commencement of the project. Entity relationship diagrams and spreadsheet based "proof of concept" prototypes were created to assist the steering group to understand the nature and scope of system to be developed.

Following agreement of the concept, software development during the remainder of the three-year project was conducted in iterative phases. Each phase included development, testing and documentation of agreed features and functionality followed by the release of prototypes to industry stakeholders, accompanied by appropriate training. Stakeholders would then use the prototypes for several weeks or more to assess functionality and report any issues as they arose. Specifications and features were then reviewed via facilitated sessions with stakeholders to identify issues and determine further development requirements. Requests for features were prioritised in conjunction with stakeholders and the project steering group prior to implementation. The final model structure and underlying functionality is described below.

Model structure

Users describe specific individual macadamia farm business scenarios by creating orchard "profiles". Each profile contains a range of farm business information that represents one unique farm business scenario. After creating one or more profiles, users can assess their viability from either an investment or cash budget perspective. They can also compare investment options and undertake sensitivity analyses. Figure 1 shows the structure of the model.

Profiles Each profile includes detailed information about a specific farm business scenario including inflation, depreciation, taxation, initial costs, required rate of return, planting details, nut price estimates, annual costs, periodic capital and finance. Profile templates are available via the Internet and are used as the basis for creating all new profiles within the *Financial Planner for Macadamia* software. These templates reflect realistic industry scenarios based on data collected during the first stage of the project. Users choose a suitable template to create a new orchard profile, then customise the profile to reflect their specific situation. Profiles can be duplicated and customised to accommodate analysis of a wide range of scenarios. Profiles can also be imported or exported to facilitate sharing.

A relational database management system underpins the model to provide permanent storage for orchard profile data. The database structure is shown in Figure 2.

Price and yield models Production and price are two strong drivers of economic performance. These are also among the most variable and challenging criteria to forecast. The *Financial Planner for Macadamia* software includes a series of pre-defined yield and price models based on industry benchmarks, which can be used to

forecast future price and production trends. Users can also create their own models to reflect specific circumstances as required.

Price models forecast the price to be paid for nut-in-shell delivered to processors at industry standard moisture content (10%) and sound kernel recovery (33%). Models included in the software reflect a range of potential price scenarios including various rates of annual growth as well as significant positive and negative price adjustment phases due to market forces. Historical nut-in-shell prices are also included to provide actual industry trend data on which to base future price estimates (see Figure 3).

The *Financial Planner for Macadamia* software also includes models to estimate the yield potential of trees of various ages and planting densities. Pre-defined yield models built into the system are based on historical data collected as part of a national crop forecasting project (Mayer et al. 2006). Users can either select a specific price model themselves or alternatively the software can assign the most appropriate model based on planting density information within the orchard profile. Users can create and customise their own yield models to reflect specific tree performance criteria if required. Custom yield models can support a wide range of atypical or site specific yield scenarios including biennial bearing, yield decline in aging orchards or temporal effects associated with significant changes to management practices through processes such as canopy management, top working and tree removal (see Figure 4).

Model analyses

The *Financial Planner for Macadamia* software comprises four different analyses: investment, cash budgeting, profile comparison and sensitivity. These analyses can be used by investors or their agents to objectively assess the viability of specific farm business scenarios. They are also useful for existing growers who wish to measure the financial impact of proposed changes to their business over time, such as expansion, capitalisation, cost or revenue fluctuation, or physical changes to macadamia plantings through management strategies such as tree removal or canopy management.

The analyses incorporate relevant external factors such as inflation, depreciation, taxation and interest payable. Terms can span anywhere from 3 to 30 years and results are available in tabular and graphical formats.

Investment analysis The investment analysis measures the profitability of specific investment scenarios over time using standard financial indicators such as net present value (NPV) and internal rate of return (IRR). As such, it allows investors to compare the viability of macadamia production with other forms of investment. It also provides a summary of cash flows, periodic capital expenditure and the present values of net cash flows on a yearly basis.

Cash budget analysis The cash budget analysis is underpinned by the cash flow data in the investment analysis as well as specifically tailored budget data. The focus of this analysis is on the estimation of cash on hand at the beginning and end of each year, with detailed estimation and display of annual cash inflows and outflows from all sources. Farm business performance is analysed annually via a series of standard indicators such as profit/loss and income related ratios such as profit to income, expenses to income, debt to income and interest coverage ratio. Various indicators are calculated over the full analysis term including final cash on hand, cumulative principal and interest paid, minimum cash balance and final principal balance.

Profile comparison analysis The profile comparison analysis compares and ranks the profitability of multiple profiles. To use this feature, users must first create two or more profiles, each of which can reflect a different business scenario. By creating individual profiles, users can model complex scenarios involving many dependent criteria. Once created, profiles can easily be cloned and modified to accommodate very specific management changes as required.

Up to ten profiles can be simultaneously compared and ranked according to their net present value or internal rate of return. Charts are also available comparing annual summaries for each of the profiles for a range of criteria including cumulative cash flow, net nut revenue, nut-in-shell price, operating expenses, present value (PV), profit, production and tax payable.

Sensitivity analysis The sensitivity analysis allows users to adjust values for key criteria to measure their impact on profitability over the life of an investment. These criteria include yield, kernel recovery, annual costs, and nut-in-shell price. By adjusting threshold levels for any two of these criteria at a time, users can model the best and worst case outcomes for any given scenario. These

results can then be directly compared with the original or expected scenario.

The investment viability of each scenario is presented using indicators such as NPV and IRR. A range of annual output measures is available for each scenario including cumulative cash flow, net nut revenue, nut-in-shell price, operating expenses, present value, profit, production and tax payable.

In the two following case studies, the *Financial Planner for Macadamia* is used to demonstrate the additional returns from investing in supplementary irrigation. In the first case study, the software was used to replicate an actual investment scenario on a small macadamia farm to ground truth the concept. In the second case study the software was used to extrapolate the actual small farm data from case study one to a proposed larger-scale investment in supplementary irrigation.

Case study one: supplementary irrigation versus no irrigation

Throughout the development of the *Financial Planner for Macadamia* software, extensive testing has been undertaken to ensure the accuracy and reliability of results. The following case study demonstrates application of the software in evaluating an investment in supplementary irrigation on a small, 6-ha., 1,800-tree farm. The results are then scaled up to model the potential benefits of supplementary irrigation on a larger, 10-ha., 13,000-tree farm.

The aim of the initial analysis was to determine if investment in supplementary irrigation was worthwhile. Data were collected over seven years (2004 to 2010) from a small, 1,800-tree farm. Limited water supply meant only between 0.8 and 1.8 ML/ha. per year could be applied, so irrigation would only be supplemental over the production season. The analysis focuses on two 312-tree blocks, on one of which irrigation was installed (irrigation block) and on the other no irrigation was installed (dry block). Separate agronomic and financial records were kept for each block to allow direct comparison.

The analysis of the dry block versus the irrigated block was performed using the profile comparison analysis. The analysis shows the difference in the net cash flow between the irrigated and dry blocks over a seven-year period. The extra cost involved in both investment in the irrigation ($3,906) and additional running and maintenance are included in the analysis.

The financial and agronomic data were entered into the software to create a separate profile for each block. The price and production models used were based on actual market and production results for the seven-year analysis period. While these results appeared viable, a detailed investment analysis and forecast of net cash flows had not been undertaken prior to investing in the supplementary irrigation, so the *Financial Planner for Macadamia* provided these analyses.

The dry block control profile did not have any initial investment costs and as such the investment analysis yielded only a PV, whereas a NPV could be calculated for the irrigated block due to the initial investment costs associated with the irrigation infrastructure.

The comparison of yield between the dry block and the irrigated block (two sample one-tailed t-test, assuming equal variances) reveals that the yield of the irrigated block is significantly higher than the dry block at the 1% level (P=0.00). Figure 5 shows that the average yield difference over the seven years between the irrigated and the dry block was equivalent to 1.6 tonnes of nut in shell (NIS) per hectare. Even in the better performing higher rainfall years of the study period (e.g., 2006) the irrigated block had greater improvements in yield compared to the dry block.

Using a required rate of return of 5%, the NPV of supplementary irrigation was $31,947 compared to a Present Value (PV) of $15,529 for the dry block. The incremental NPV of the supplementary irrigation project was therefore $16,418, indicating a significant improvement in returns over the business as usual dry block, due to increased yields. The comparison of net cash flows between the dry block and the irrigated block (two sample one tailed t-test assuming equal variances) reveals that the yield of the irrigated block is significantly higher than the dry block at the 5% level (P=0.04). It is also apparent that the payback period for the investment in supplementary irrigation is less than one year. At the end of the seven-year period, the irrigated block has a cash balance of $41,516 compared to $17,380 for the dry block, a difference of $24,136. Figure 6 shows that the yearly difference in net cash flow was on average $2,890 higher per year with supplementary irrigation.

In case study one, the *Financial Planner for Macadamia* demonstrated that there were substantial financial benefits associated with

supplementary irrigation. The yield and net cash flows for the irrigated block were significantly higher than the dry block. Using a 5% required rate of return the investment in irrigation yielded a positive incremental NPV of $16,418. The supplementary irrigation system paid for itself in the first year with on-going financial benefits over the remaining six years of the investment analysis, confirming that the investment had been worthwhile.

Based on the results of the small farm in Case Study 1, the data were scaled up to assess the viability of an investment in a dam and supplementary irrigation on a larger, 10-ha., 3,000-tree farm.

Case study two: investment in supplementary irrigation, 3000-tree farm

Assumptions supporting case two study included:

- 20-year forecast based on findings from case study one trial.
- Input data scaled up for a 10-ha., 3000-tree farm.
- Assessment of impact associated with additional infrastructure costs (e.g., using finance to build a 15-Megalitre dam and other irrigation infrastructure).
- Yields from the dry and irrigated blocks in case study one are used as the basis for expected yields in the unirrigated and irrigated scenarios in case study two.
- Dam and irrigation infrastructure are fully financed with a principal and interest loan over 5 years and 6.43% interest per annum, reflecting approximate average market rates.

The business as usual unirrigated scenario has a present value of $141,593 over 20 years, using a 5% required rate of return. The proposed investment in irrigation amounted to $100,000 of which $40,000 was allocated for the construction of a 15-megalitre dam and $60,000 for irrigation infrastructure. These infrastructure costs were based on data from the OFEA project.

The analysis shows that that the extra income from the expected yield increases more than offsets irrigation costs, including the building of the dam and the installation of the irrigation system. The comparison between the business as usual unirrigated scenario and the irrigated scenario (two sample one-tailed t-test assuming equal variances) reveals that the net cash flow of the irrigated block is significantly higher than the business as usual scenario at the 1% level (P=0.00). The NPV of the investment in supplementary irrigation was $506,510 and thus an incremental NPV of $364,917 over the business as usual scenario without irrigation. The average difference in yearly net cash flow per hectare is $31,629 per year over the business as usual scenario. Therefore investment in supplementary irrigation will provide significant financial benefits over the business as usual unirrigated scenario. Figure 7 shows the difference in the net cash flows between each scenario for each year of the 20-year analysis period.

Sensitivity analysis (see Figure 8) reveals that even in a worst case scenario where the yield is 10% lower and costs 10% higher than expected, the investment in irrigation has a net present value of $322,307 using a 5% required rate of return. The incremental NPV over the business as usual unirrigated scenario for the 20-year analysis period is $180,714.

Facilitating adoption by industry

The client base for the *Financial Planner for Macadamia* software includes the peak industry body (AMS), Grower Liaison staff from the major nut processing companies, industry consultants and leading growers.

A preliminary survey of these stakeholders has revealed some significant impacts from its use.

The Australian Macadamia Society

Through consultation and training, Australian Macadamia Society (AMS) staff have adopted the *Financial Planner for Macadamia* software for strategic planning.

At the request of the AMS and Horticulture Australia Limited (HAL), a team was formed comprising staff from each of these organisations as well as members of the *Financial Planner* project team, to evaluate the potential impact of industry's investment in research and development. The *Financial Planner* was used to assess the potential impact of specific projects in the research and development (R&D) program in areas such as disease management, canopy management and extension. The *Financial Planner* was also used to assess the overall impact of the whole macadamia industry research and development program.

Outcomes from these analyses were reported to Industry Reference Groups and the Research and Development Committee and the findings significantly influenced their

planning processes and support for specific projects.

Quantification of potential industry impact for a range of projects also ensured maximum benefit from R&D investment and satisfied strategic planning requirements for industry and funding bodies. The outcome was optimum use of limited levy funding and matched investment from Horticulture Australia Limited exceeding AU $1M annually.

Processors

Four major Australian macadamia processors have adopted use of the *Financial Planner for Macadamia* software to help their suppliers identify key areas where investments can be made to improve production, quality and profitability. Grower Liaison staff in these processing companies are also using the *Financial Planner* to assist potential new investors to assess the viability of a range of investment scenarios in the macadamia industry. Interviews with processors indicated that usage of this nature has directly assisted decision making for more than 50 suppliers or new investors to date.

In some cases processors have published and distributed analysis results via their company journals, newsletters and field days for the benefit of all of their clients. Processors have indicated that information derived from their use of the *Financial Planner* has also informed broader decision making within their companies.

Consultants

Macadamia industry consultants are using the *Financial Planner* to assist existing client growers to evaluate farm business performance and further investment to improve their business operations. The survey indicated that some consultants are also using the *Financial Planner* to attract new investors and assist them by providing objective farm profitability information based on actual farm performance data.

Growers

The project team has facilitated adoption of the *Financial Planner for Macadamia* by key growers through Best Practice group meetings and training sessions. The team has also directly assisted key growers to create specific profiles to model a range of farm business scenarios using data that relates to their own business

Several leading growers reported using the *Financial Planner* to assess the viability of potential investment scenarios in their own business operations. These scenarios include changes to capital expenditure or investment, expansion of plantings, estimation of future income for tree valuation and the impact of decline in mature trees. Growers also use the *Financial Planner* to measure the financial impact of a range of management scenarios such as tree removal or replacement, changes to harvesting, sorting and storage practices, employment of staff and replacement of machinery or infrastructure.

The results from many of these analyses have been published by leading growers in industry media and presented at events such as conferences and workshops. As such much of this work has had a significant flow on effect on decision making processes among the wider industry.

Further formal evaluation of the *Financial Planner* is currently underway to more specifically assess the extent and nature of its usage within industry and to facilitate further adoption among each of these industry sectors.

Conclusion

The *Financial Planner for Macadamia* software was developed in response to the limited financial analysis tools available to assist farmers, investors and financiers to make objective investment decisions in the Australian Macadamia Industry. Testing of the software has shown it to be a reliable, accurate and relatively straight forward model that can be used by potential investors and existing industry stakeholders.

The user interface allows industry stakeholders to quickly understand and use the software in a range of contexts without the need for complex spreadsheet or accounting skills. The software also enables decision makers to objectively assess the viability of potential management and investment options. The ability to generate reports from all analyses allows a portfolio of information to be created for borrowing and/or investment purposes. Automatic updates for the software are available online, with new profiles and industry data being updated periodically as a part of ongoing project work with the Australian macadamia industry.

The application of the software in the two case studies explored in this article demonstrates that productivity gains can lead to substantial cash benefits over the life of an orchard. Prior to the development of the *Financial Planner for Macadamia*, evaluating the viability of investment in supplementary irrigation was a time consuming process

requiring well developed financial and data analysis skills. Access to objective industry data has also previously been a limiting factor leading to potentially unreliable forecasts.

The case study examples in this article provide only a brief snapshot of two of the software's potential applications, the profile comparison analysis and the sensitivity analysis. The *Financial Planner for Macadamia* can also be used to examine other scenarios such as purchasing an established orchard versus establishing a new orchard, tree removal and replacement in existing orchards and many other scenarios that may improve financial performance.

Application of the software by the AMS has provided an objective overview of the returns from investment in Research and Development for the industry overall and informed the strategic direction of the AMS's research funding initiatives.

Consultants, processor representatives and key growers are also routinely using the *Financial Planner* to inform decision making within their own businesses and on behalf of a wider client base.

In summary the *Financial Planner for Macadamia* software provides much needed transparency and objectivity in appraising investment opportunities in the macadamia industry as it has been developed in conjunction with the industry, for the industry. Collection of financial and agronomic data to maintain the currency of profiles and refinement of the model is ongoing as is extension and training work to increase industry adoption.

References

Aaker DA, Kumar V, Day DS and Leone RP 2010, *Marketing research*, 10th edition, Wiley and sons New Jersey, USA.

Abrahamsson P, Salo O, Ronkainen J and Warsta J 2002, *Agile software development methods: review and analysis*. VTT Publications 478.

Australian Macadamia Society 2007, *Macadamia Industry report 07/07*, http://cms2live.horticulture.com.au/admin/assets/library/annual_reports/pdfs/PDF_File_55.pdf accessed 19/04/2012

Australian Macadamia Society 2012, *Statistics*, http://macadamias.org/pages/statistics accessed, 15/02/2012.

Australian Nut Industry Council 2012, *Macadamias*, http://nutindustry.org.au/ANIC/Industry-Snapshots/Australian-Macadamias.asp accessed 19/04/2012.

Brown MG 1996, *Keeping score: using the right metrics to drive world-class performance*, Quality Resources, New York, USA.

Heiman GW 2001, *Understanding research methods and statistics: an integrated introduction for psychology*, 2nd Edition, Houghton Mifflin, Boston Massachusetts, USA.

Highsmith J and Cockburn A 2001, 'Agile software development: the business of innovation', *Computer*, 34(9): 120-122.

Malhotra NK 2010, *Marketing research and applied orientation*, 6th edition, Prentice Hall, New Jersey, USA.

Mayer DG, Stephenson RA, Jones KH, Wilson KJ, Bell DJD Wilkie J, Lovatt JL and Delaney KE 2006, 'Annual forecasting of the Australian macadamia crop – integrating tree census data with statistical climate-adjustment models', *Agricultural Systems*, 91(4):159-170.

Nerur S, Mahapatra R and Mangalara G 2005, 'Challenges of migrating to agile methodologies'. *Communications of the ACM,* 48(5): 73-78.

O'Hare P, Stephenson R, Quinlan K and Vock N 2004, *Macadamia grower's handbook – a grower's guide*, Department of Primary Industries and Fisheries, Queensland, publication.

O'Hare P, Slaughter G, Mulo S and Quinlan K 2008, *Final report, On-Farm Economic Analysis in the Australian Macadamia Industry*, MC03023, March, Horticulture Australia, Ltd.

Osterwalde A 2004, *The Business Model Ontology in a design Science Approach*, PhD Dissertation, University of Lausanne, Switzerland.

Patton M 1990, *Qualitative Evaluation and Research Methods*, 2nd Edition, Sage Publications, California.

Quinlan K 2003, *Macadamia gross margins*, New South Wales Department of Primary Industries Agnote.

Reilly T and Bevan P 1995, 'Profitability of macadamia growing', *Australian Macadamia Society News Bulletin*' November 1995.

Ronan G and Cleary G 2000, 'Best practice benchmarking in Australian agriculture: issues and challenges', Australian Agribusiness Perspectives – Paper 39, *Australian Agribusiness Journals Online*, Available at: http://www.agrifood.info/perspectives/2000/Ronan.html Accessed 3 December 2012.

Stapleton J 1997, *Dynamic systems development method – the method in practice*. Addison Wesley, Boston.

Wilson RH, Charry AA and Kemp DR 2005, 'Whole farm financial performance indicators and benchmarks in Australian Agriculture: a review', *Extension Farming Systems*, 1(1): 45-57.

Appendix

Figure 1 Model structure

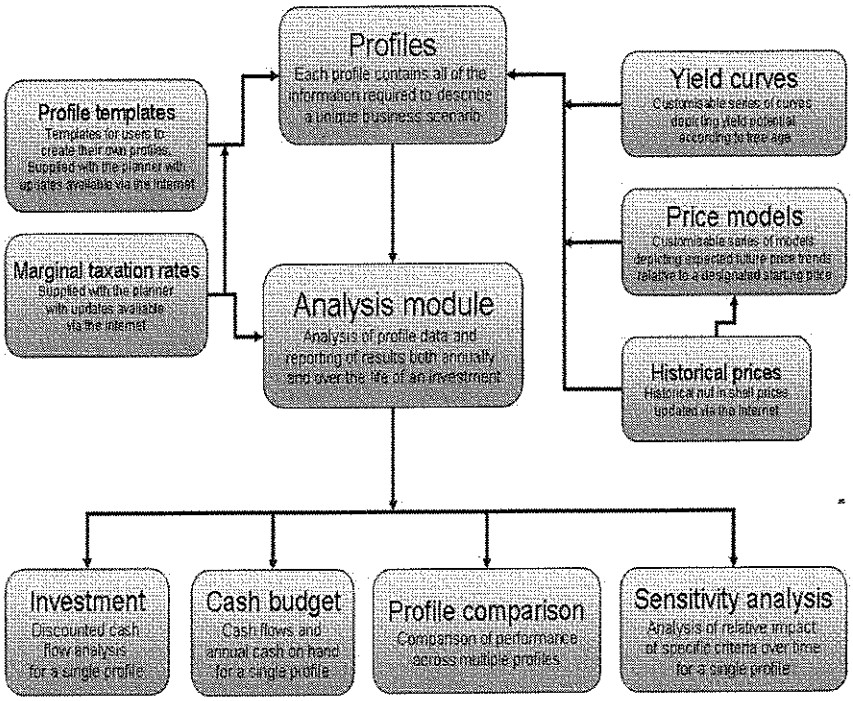

Figure 2 Database structure

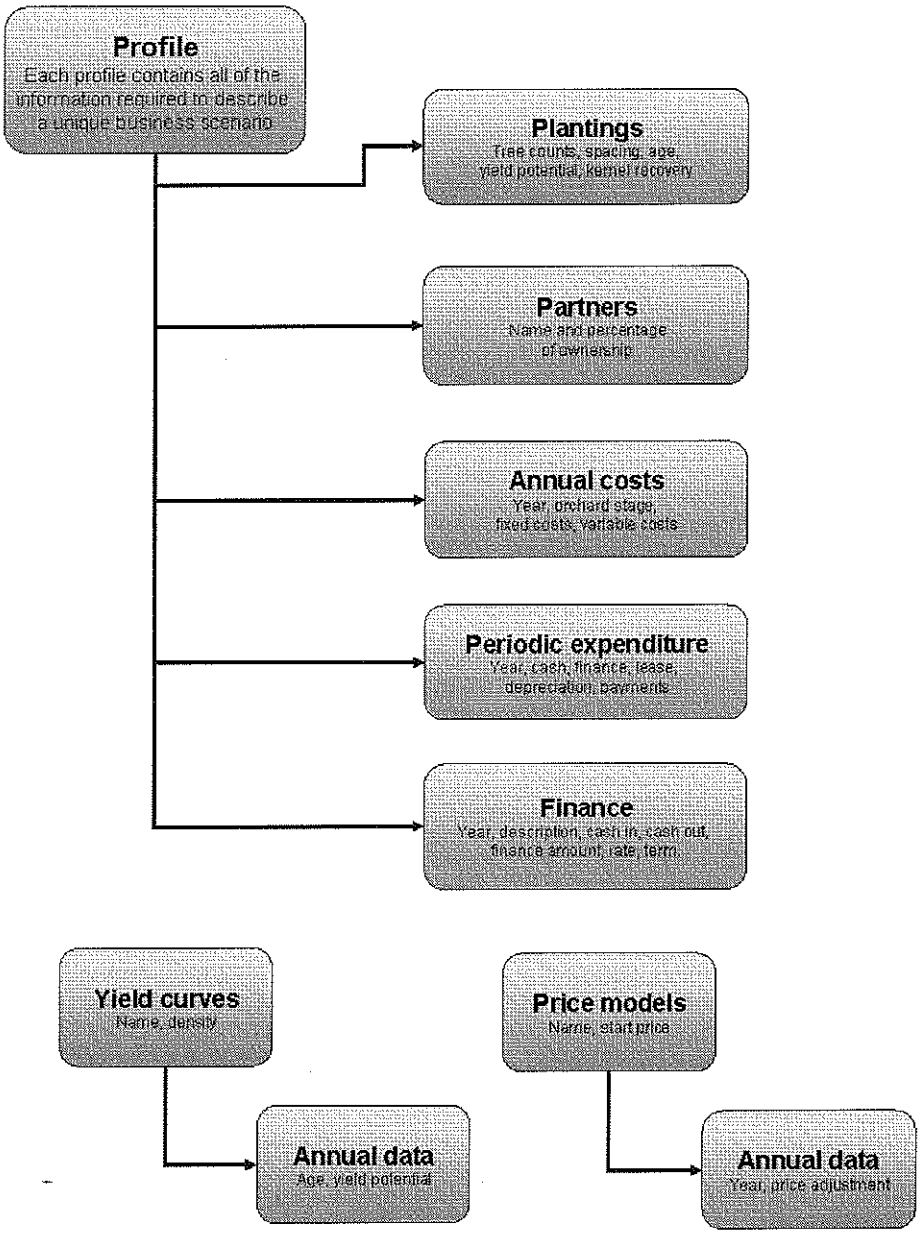

Figure 3 Price model

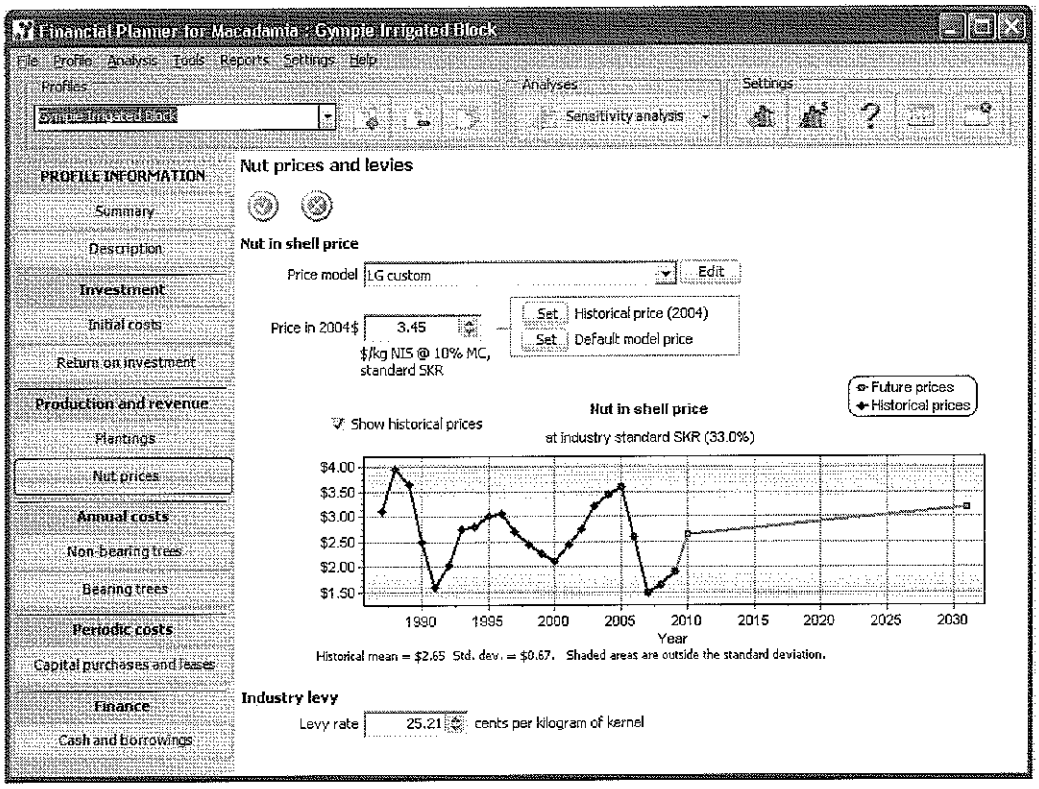

Figure 4 Yield model

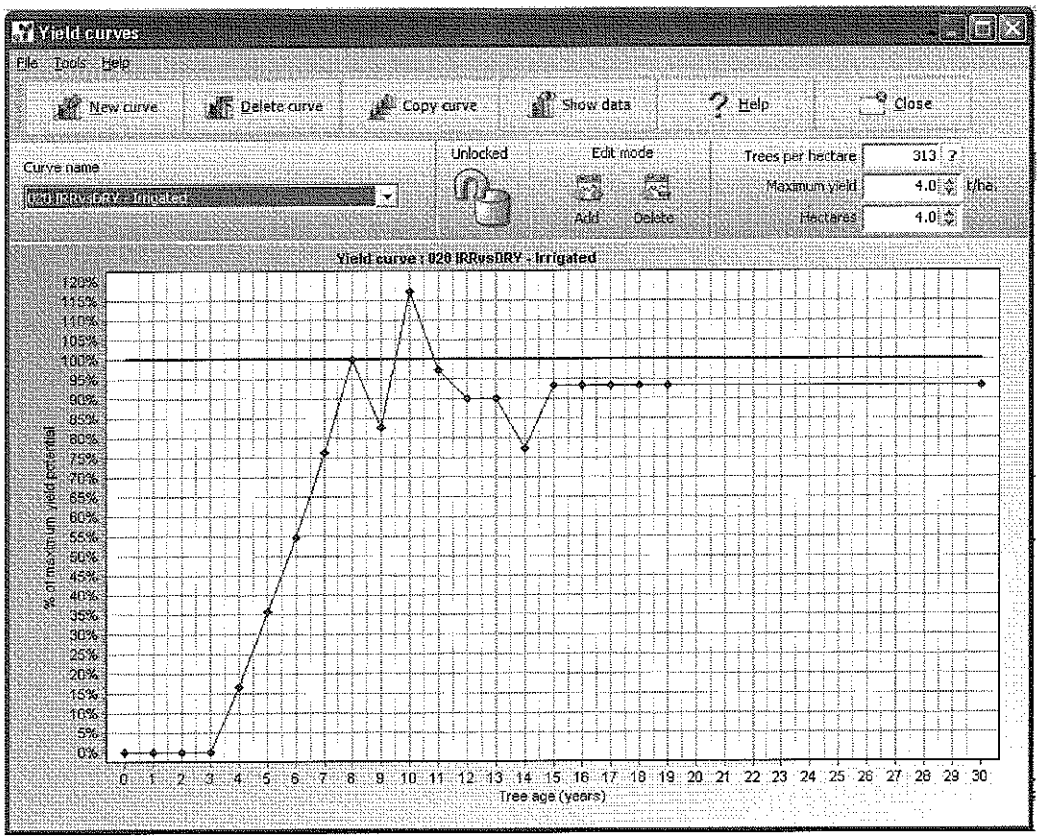

Figure 5 Yield comparison

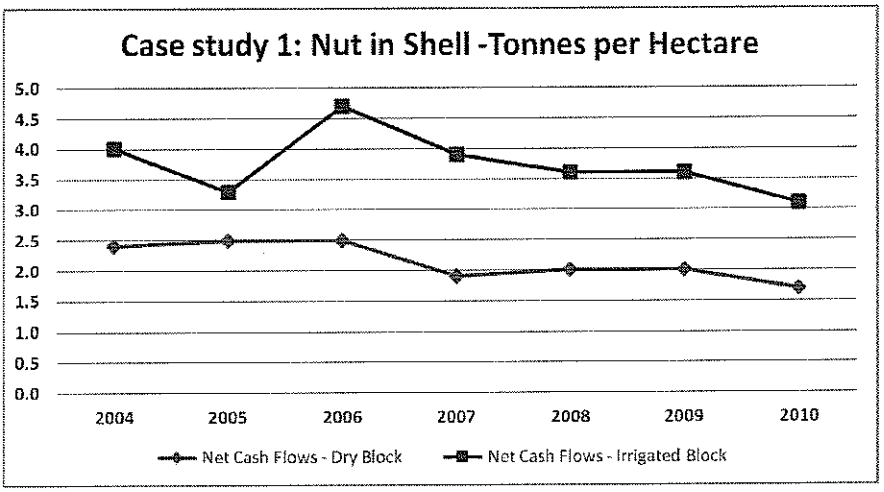

Figure 6 Net cash flow comparison

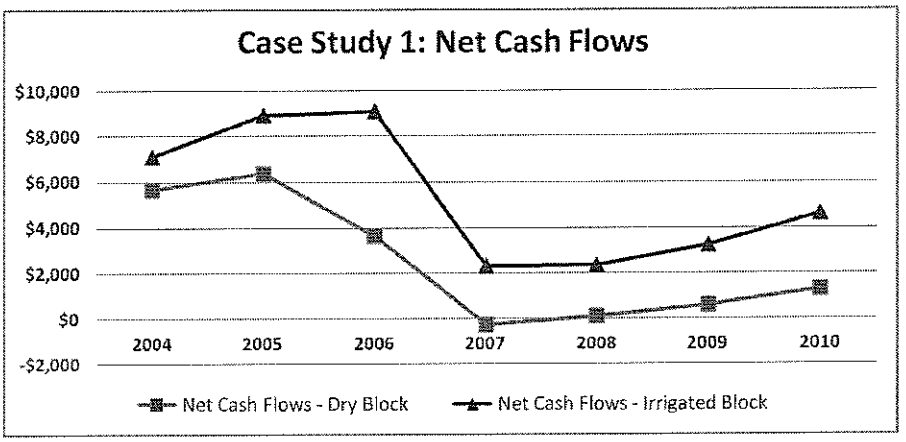

Figure 7 Net cash flows per hectare

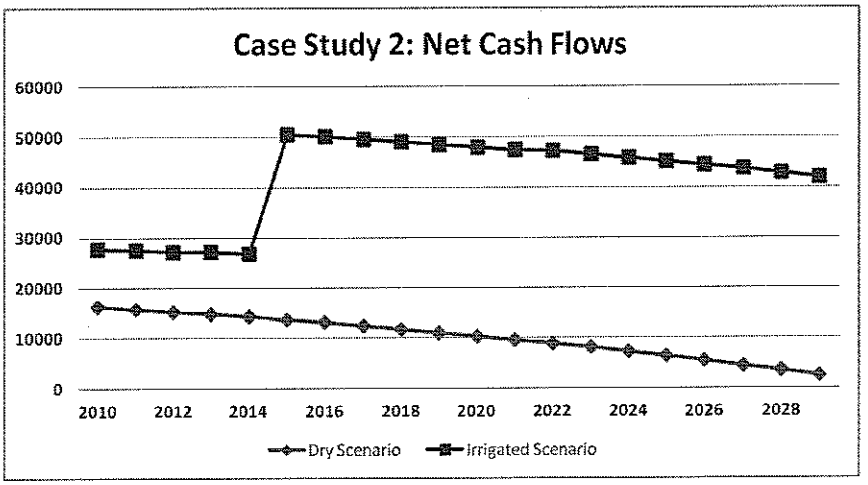

Figure 8 Sensitivity analysis