Designing, Developing and Testing Financial Models for Non-industrial Private Forestry

Steve Harrison
School of Economics
The University of Queensland, Qld. 4072
Australia
s.harrison@economics.uq.edu.au

Nick Emtage and John Herbohn
School of Natural and Rural Systems Management
The University of Queensland,
Gatton, Qld. 4343, Australia

Tyron Venn
School of Economics
The University of Queensland, Qld. 4072
Australia

ABSTRACT

This paper describes experiences in the development and testing of three distinct financial models to support farm forestry decisions involving non-traditional tree species in northern Australia and in the Philippines. A variety of options were examined with respect to model design, yield prediction, computing platform, forestry performance criteria and other features. Two of the models focus on the forestry enterprise in isolation, while the third evaluates forestry within the context of the overall farm business. It is found that choice of model design depends on the particular type of application intended and availability of financial data for this application. Some complementarities were gained in replicating features when progressing from one model to the next. Model construction and testing were challenging tasks requiring considerable funds and for two of the models proceeding over a number of years. Validation involved the gradual gaining of confidence in a model as it progressed through various versions. For the more complex models, greater effort in development of the user interface was found to be warranted. The models have proved more suitable for use by extension agents than individual landholders. Even with major resource inputs into model development, a number of desirable additional features can be identified.

Keywords: non-industrial forestry, financial performance criteria, generic model, validation, user interface

INTRODUCTION

Expansion of forest industries offers considerable potential for revenue generation and environmental benefits. Land acquisition cost and environmental concern presents major impediment to expansion of industrial and government-owned forestry. Issues of indigenous land rights and land claims also constrain industrial forestry development, particular in developing countries. These forces have lead to increased recognition of the role of multiple-purpose non-industrial forestry – particularly farm and community forestry – in the expansion of timber production and the provision of environmental benefits.

Considerable effort has been devoted to development of financial models to predict returns from investments in non-industrial forestry. Some examples of these models in Australia and New Zealand are provided by Herbohn *et al*. (in process). Critical design features in these models have been reviewed by Harrison *et al*. (2003). The design of any such model, and the appropriate nature and extent of testing, depend on the purpose of the model. In general, this will be to provide decision-support for forestry investments or to generate information for other business or policy applications. Applications in north-eastern Australia have been found to include:

- Estimation of the financial performance of plantations, for investment planning, making a case for finance, evaluation of forestry by external capital providers, forestry extension, land valuation;
- Financial evaluation of planting mixtures of non-traditional tree species;
- Estimation of the financial risk associated with farm forestry investments;
- Evaluation of the profitability or applying silvicultural treatments to increase productivity in native forests; and
- Supporting the case for multiple-use forestry to achieve both production revenue and conservation benefits.

Some of the design issues which have proved important in developing the models examined in this paper include (Harrison *et al*. 2003):

- Model type in relation to information uses (as indicated above);
- Development of a one-off versus generic model;
- Development of a forestry enterprise versus whole-of-business model;
- Allowance for species mixtures;
- Input of user-estimates of growth and financial parameters versus use of default data;
- Choice of computing platform;
- Choice of financial performance criteria, planning horizon and discount rate;
- Method of modeling investment risk;
- Approach to model testing for validity and user-friendliness;
- Model maintenance, distribution and commercialization;
- Treatment of taxation impacts; and
- Treatment of non-wood forest benefits

This paper examines these issues in model design, development and testing, with reference to three financial models of non-industrial forestry developed by a forestry socio-economic research group in Queensland, Australia. The next section briefly outlines the history, nature and uses of the three models. The methods of testing the models for validity and user-friendliness are reviewed briefly. A comparison is then made of the characteristics of these models. Some concluding comments are made on the basis of experiences in model development.

THREE EXAMPLES OF FORESTRY FINANCIAL MODELS

Over the last 12 years, the forestry socio-economic research group associated with the Rainforest Cooperative Research Centre in Queensland has developed a number of forestry financial models, the three most significant of which are the Australian Cabinet Timbers Financial Model (ACTFM), the Australian Farm Forestry Financial Model (AFFFM), and the Philippines Smallholder Forestry Financial Model (PSFFM).

The Australian Cabinet Timbers Financial Model (ACTFM)

History

Development commenced about 1992, in recognition of the need to make estimates of the profitability for landholders of growing rainforest cabinet timbers and eucalypts in north Queensland to replace the timber resource lost by gazettal of the Wet Tropics of Queensland World Heritage Area in 1988. Development was initially slow, one reason for which was the expectation that biological growth models for rainforest species would be developed by other researchers in the Rainforest Cooperative Research Centre. When it became apparent that this would be a long-term task, a Dephi survey of forestry experts was conducted to obtain estimates of harvest age and mean annual increment for a variety of non-traditional native timber species.

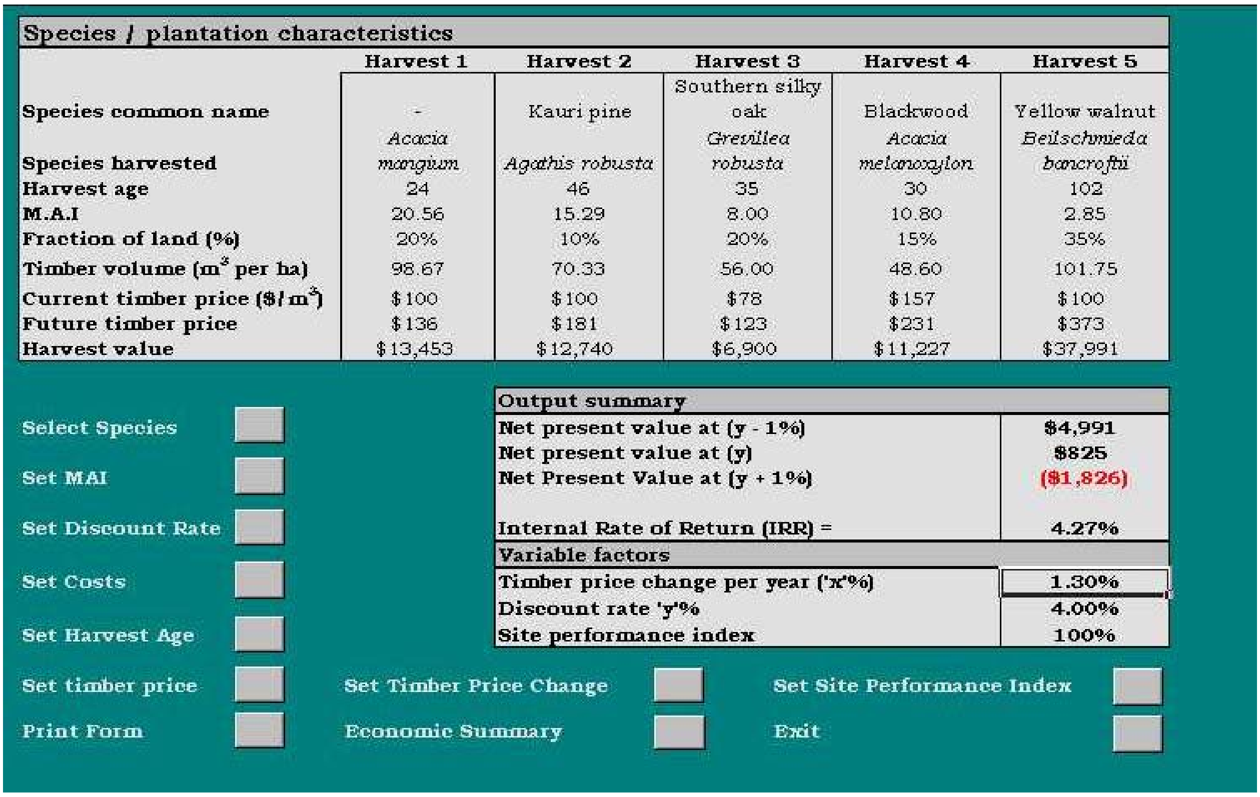
Brief description

The ACTFM has been developed as a flexible and user-friendly financial model for assessing the financial viability of timber plantations using Australian native cabinetwood and eucalypt species in north Queensland. The model consists of a number of linked sheets in an Excel workbook format, supplemented by Visual Basic macros, and makes extensive use of pop-up windows. ‘Button bars’ are used to navigate between various data input and financial performance output screens. Plantation scenarios may be specified which include up to five of 31 species for which harvest age, MAI and cost default data are provided. Timber yield may be modified by the user providing a specific site performance index.

An opening sheet indicates the model name, names of the developers and version of the model, and acknowledges the agencies which providing financial support for model development. Access is gained to the ‘Plantation Output’ summary sheet (Figure 1) by clicking on a ‘Start’ button. This is linked to the various other sheets in the workbook which provide default data and instructions and other information to the user, to allow calculation of net present value and the internal rate of return, for the highest harvest age in the species mixture.

Uses

Various versions of the model have been used by the researchers, government agencies and consultants, over a number of years, to evaluate specific forestry investment proposals and in training programs. Copies have been distributed to targeted potential users, as well as ad hoc on request. The ACTFM has been used by regional farm-forestry associations including the Sub-Tropical Farm Forestry Association to give members access to financial projections of the potential impacts of forestry development. It has also been used on a number of occasions to provide an example of financial modeling of farm forestry for students undertaking studies of agroforestry and forestry development (Emtage 2002). During these occasions students have been given a task to develop their own basic financial model using the Excel software. In this setting, the ACTFM has been used as an example of ways that their own model can be extended, and ways that expert appraisals can be used to provide data about the likely growth rates and harvest ages of tree species grown in a specified biophysical environment. An extension of the model has been in the evaluation of investment risk in farm forestry. Here the model was interfaced with the @RISK simulation package, and the cumulative relative frequency distributions estimated for promising individual species and two-species mixtures (Harrison *et al*. 2001)



Species / plantation characteristics	Harvest 1	Harvest 2	Harvest 3	Harvest 4	Harvest 5
Species common name	-	Kauri pine	Southern silky oak	Blackwood	Yellow walnut
Species harvested	*Acacia mangium*	*Agathis robusta*	*Grevillea robusta*	*Acacia melanoxylon*	*Beilschmieda bancroftii*
Harvest age	24	46	35	30	102
M.A.I	20.56	15.29	8.00	10.80	2.85
Fraction of land (%)	20%	10%	20%	15%	35%
Timber volume (m^3 per ha)	98.67	70.33	56.00	48.60	101.75
Current timber price ($\$/m^3$)	$100	$100	$78	$157	$100
Future timber price	$136	$181	$123	$231	$373
Harvest value	$13,453	$12,740	$6,900	$11,227	$37,991

Output summary	
Net present value at (y - 1%)	$4,991
Net present value at (y)	$825
Net Present Value at (y + 1%)	($1,826)
Internal Rate of Return (IRR) =	4.27%
Variable factors	
Timber price change per year ('x'%)	1.30%
Discount rate 'y'%	4.00%
Site performance index	100%

Figure 1. Example of Plantation Output Summary

The Philippines Smallholder Forestry Financial Model (PSFFM)

History

A research project was undertaken in the Philippines in 1998-99, with financial support from the Australian Centre for International Agricultural Research (ACIAR), to determine the likely financial performance of Australian eucalypts and acacias being trialed in various provinces in Philippines. Due to limited time and financial resources of the developer, a simplified version of the ACTFM was devised to predict the financial returns to smallholder plantations[1]. Cost data and silvicultural regimes relevant to industrial Philippines forestry were obtained from Budiknon Forests Inc. in Mindanao. On the basis of consultations with Filipino foresters and anecdotal information, modifications were made to the industrial costs and silvicultural regime to reflect likely smallholder practices.

---

[1] An industrial forestry financial model for the Philippines was also developed.

A major challenge in developing the PSFFM was the scarcity of stand yield data for Australian timber species in the Philippines with which to fit yield models. Site-species trials had been established for a number of species, but contained stands of up to five years old only[2]. A yield transfer technique was adopted whereby published yield data for the same Australian timber species as being trialled in the Philippines were collected from countries with broadly similar climate, soils and management regimes. These data and data from the Philippines were employed to fit stand yield models of the Chapman-Richards form for a 'generic Australian eucalypt' and *Acacia mangium* (Venn *et al*. 2001a). Existing yield models for four traditionally-grown species in the Philippines (*Eucalyptus deglupta and Paraserianthes falcataria, Gmelina arborea and Swietenia macrophylla*) were also incorporated into the PSFFM.

Another concern that arose during model development was that few smallholder yield data have been published, with most published yield data having been collected from scientific trials or industrial plantings. The literature on smallholder yield data from other Asian countries and anecdotal evidence from the Philippines suggested that smallholder yields in the Philippines are likely to be lower than industrial yields. Thus yield models fitted with trial and industrial plantation data are likely to generate optimistic yield predictions for smallholder forestry. For species where insufficient smallholder yield data were available, the average of published yield differences between industrial and smallholder plantations in Asia was adopted as a 'yield reduction factor' to estimate smallholder forestry yields from industrial yield models developed for the Philippines.

Brief description

The model has been developed in Excel and consists of six worksheets, which contain default financial data and yield models for a 'generic Australian eucalypt', *A. mangium* and the four traditional species, respectively. The user has the option of changing default model values. The model predicts the harvestable volumes of sawlogs, poles and fuelwood, and land expectation value (LEV), NPV and IRR for single-species stands (Venn *et al*. 2000b). The model is designed to be used by a researcher; user-friendliness to aid potential non-academic applications of the PSFFM was not a priority during model development.

The Australian Farm Forestry Financial Model (AFFFM)

History

The AFFFM was developed as part of a research project, funded by the Joint Agroforestry Project of the Rural Industries Research and Development Corporation, which produced decision-support models for farm forestry in marginal forestry areas in north-eastern Australia. This model drew on components of the ACTFM and the AGROFARM spreadsheet models of the rural consultancy firm CARE Ltd. The objective was to evaluate proposed forestry investments within the overall business operation of commercial farms. When attempts were made to expand the ACTFM, it was found that the capacity of Excel was exceeded, hence the new model was programmed as a stand-alone Visual Basic package. This had the additional advantage of overcoming problems of transportability between versions of Excel. Early prototypes of the model included considerably detail on the overall

[2] Australian eucalypts are likely to be managed over 15-year rotations in the Philippines.

farm structure, and potential users who examined early versions commented that there was too much detail for their purposes and too much data entry was required. An 'Advanced Livestock' data screen was removed and the livestock herd and flock dynamics were simplified, as were model output options and sensitivity analysis screens.

Brief description

The AFFFM performs a financial analysis of the private cashflows relevant when landholders considering farm forestry activities. Key outputs include NPV, IRR, overall business cash position (or bank balance), annual cash flows (equivalent to enterprise gross margins) as well as cash flows for the various enterprises (agriculture, plantations, native forestry), an equivalent annual return value, and land expectation value (LEV). The model will display financial performance indicators for the 'with' and 'without' forestry situations so that users can ascertain if adding a forestry enterprise improves financial performance over the current farm business structure. Other costs and revenues assessed include finance costs, capital expenditure, overhead expenses and other farm and off-farm income. The capability also exists to include an allowance for 'living expenses', i.e. the landholder's withdrawal of funds from the farm business for family and personal reasons.

The AFFFM has been constructed using a modular approach. Separate modules have been developed for each of the main activities involved with a farm forestry operation (i.e. plantations, native forests, agriculture and farm finances). Modules have also been developed for presentation of outputs of the financial analysis.

The AFFFM includes both plantation forestry and native forestry options, with the ability to model planting of trees in either a woodlot or a shelter-belt configuration to account for potential benefits from livestock shelter. The inclusion of native forestry is important in two geographic regions in which the model has been applied (Darling Downs in Queensland and New England Tableland in New South Wales) because native forestry is a key land-use option for both regions. Forestry experts in these two regions provided lists of the most suitable plantation species and, based on soils and climate data for key locations, tree growth suitability ratings were generated using the PlantGro model (Hackett 1988, 1991a, b). These suitability ratings were then matched to timber yield tables that are stored separately as text files and incorporated into the model as required. Users can therefore select a combination of species, a soil type and a location, and the model will return a suitability rating. Users can then load the appropriate yield table for that suitability rating. It is also possible for users to enter their own tree growth and yield estimates; this is necessary outside the two focus regions because PlantGro data are available only for climate stations within those two regions.

The AFFFM contains default data for costs of plantation establishment which can be loaded by users. The data available are based on information for the New England region and the Community Rainforest Reafforestation Program (CRRP) in north Queensland. The New England data are based on information supplied by a local contractor (Farm Forestry Plantations) while the CRRP data are an average of the per hectare costs of setting up 2,000 ha of plantations of tropical cabinet timbers.

The structure of the AFFFM is illustrated in Figure 2. The model comprises modules for each of the main activities involved with a farm forestry operation (i.e. plantations, native forests, agriculture and farm finances). Modules have also been developed for presentation of outputs

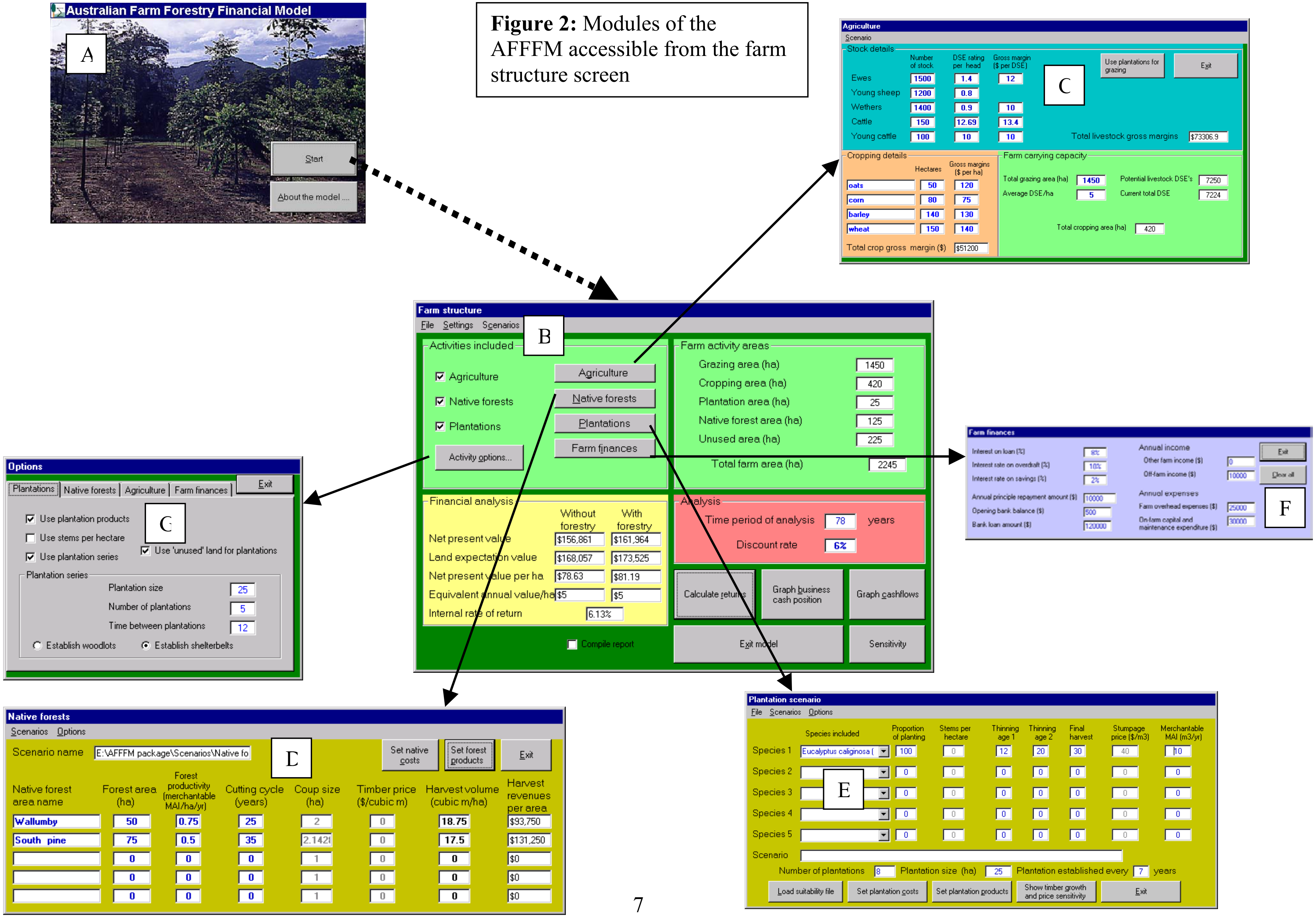


Figure 2: Modules of the AFFFM accessible from the farm structure screen

of the financial analysis. A series of 'forms' (screens) are linked by the use of button bars. Screenshots of the main screens within the AFFFM are provided in Figure 2 and are labelled with an uppercase letter. The model is activated by clicking on the 'Start' button brought up when the program is executed (screen A). Clicking on the 'Start' button brings up the 'Farm Structure' screen (B). From this screen, the main modules of the program are accessed. These modules are 'Agriculture' (C), 'Native forests' (D), 'Plantations' (E), 'Farm finances' (F) and 'Activity options' (G). From these screens, the main parameters of the model are set, by entering the figures directly, accessing other screens through button bars or loading default data or saved scenarios from drop-down menus. Additional screens to those depicted here may be accessed from the 'Agriculture', 'Native Forests', 'Plantations' and 'Activity Options'. The 'Farm structure' screen also has a button bar that provides users with the ability to graph the business cash position and cashflows over time (H). Basic information is also provided on this screen on the results of the financial analysis 'with' and 'without' forestry and a summary of farm activity area. The *AFFFM Users Manual* (Emtage *et al*. 2002) is available for downloading from a website.

Uses

The AFFFM is pitched primarily at farm forestry advisers, researchers and computer literate farmers, with the explicit purpose of improving their ability to estimate the returns from farm forestry investments. The AFFFM also has considerable scope as an educational and extension tool in workshops held to encourage farm forestry. In particular, it can be used to illustrate the financial performance and cashflow patterns of alternative forestry options for landholders with an interest in farm forestry. It could be used as an adjunct to the type of technical information typically delivered in farm forestry courses. The developers' experience has been that such courses generally have limited economic content and the ability to experiment with the financial outcomes of alternative plantation and native forestry scenarios would add value to these courses. Greening Australia staff in south-east Queensland have expressed interest in using the model in workshops.

TESTING OF THE FINANCIAL MODELS

A variety of steps were applied in testing the financial models, as now reviewed.

Testing of the ACTFM

Testing of the ACTFM involved the construction of separate Excel based spreadsheet models to assess the accuracy of the results given by the ACTFM. Additional testing involved using the model to replicate the results of other published studies of the financial implications of plantation development (e.g. those of Ward 1995). Study of the results of the ACTFM was also undertaken by an accounting lecturer at James Cook University, a group of exchange students from Sweden, and an honours degree student who used the model to examine the farm financial risk implications of developing farm forestry. Further confidence was gained in the model by obtaining reactions to the model by the research group and other users, and consequent revisions, as the model proceeded through a number of versions over time.

Testing of the PSFFM

Statistical tests of the PSFFM's ability to predict real-system performance were found to be inappropriate because of inadequate data observations independent of those used in model construction. However, hypothesis tests were conducted to compare two different forms of yield model for the Australian species – the Chapman-Richards and Schumacher models. The model selection criteria Akaike Information Criterion (AIC), Schwartz Bayesian Criterion (SBC) and Consistent Akaike Information Criterion (CAIC), revealed the Chapman-Richards model to be the best *approximating* model, i.e. the model with the highest information gain. As with the ACTFM, testing of the PSFFM involved mainly obtaining feedback from experts, in this case foresters in the Philippines and project team members. Comparison with yield and revenue predictions in other published studies of smallholder forestry with the same Australian timber species in the Philippines, Laos and Thailand indicated that the results generated by the PSFFM are in the correct 'ballpark'. Future field measurements of trees in site-species trials in the Philippines could facilitate objective testing and refinement of the PSFFM.

Testing of the AFFFM

The testing of this model is discussed in detail by Emtage (in process). Initial testing involved assessment of the calculations made by the model through comparison of the results with those of other models where possible, the definition of simplistic scenarios to verify data manipulation within the model, and tests of the effects of various functions and combinations of functions of the output values. The model was further tested by the developers replicating the results of published studies of small-scale forestry enterprises, and by carrying out case studies of real-life farms using the model.

Various people not directly involved the project also tested the AFFFM user interface. The model was presented at a series of seminars and workshops for publicity purposes and to demonstrate the results of analyses using this package. Researchers who requested and received early versions of the model included:

- The Queensland Forest Research Institute and Department of Primary Industries personnel in Far North Queensland;
- The Commonwealth Scientific and Industrial Research Organisation personnel involved in plant physiology studies based in Brisbane;
- The Private Forestry Development agency in New South Wales (NSW);
- NSW Agriculture personnel;
- Officers of Private Forests North Queensland (the regional plantation committee for Far North Queensland); and
- Western Australian researchers investigating crop diversification strategies.

The model was demonstrated at a number of conferences, seminars and meetings including those involving:

- researchers from the Rainforest Cooperative Research Centre at the Rainforest CRC Annual Conference, Cairns;
- RIRDC staff and researchers interested in farm forestry financial modeling, Canberra;
- researchers in the Department of Forestry at Leyte State University, Leyte, Philippines;
- landholders, researchers, politicians and timber industry personnel at a workshop "Farm Forestry: what's in it for me?", in Mareeba in North Queensland;
- members of the project research group and invited guests at regular project meetings over the course of the research project; and
- landholders and timber industry workers who visited a stall at the agricultural exhibition manned by members of the project research team, held in Toowoomba, south-east Queensland.

In general, the extent of feedback from researchers was disappointing. Despite requests for feedback about the AFFFM, those who assessed early versions of the model provided little if any useful feedback. In part this may have been due to the informal nature of the requests for feedback, the instability of early versions of the model, and the lack of on-line help. Also, many of the people requested to test the model did not have a reason to use the model as part of the work activities.

More through testing was through an exercise for students enrolled in a Project Appraisal subject in the Agribusiness Program within the School of Natural and Rural Systems Management, The University of Queensland (Emtage, in process). The students were asked to use the model to set up a hypothetical plantation development scenario. This 'captive audience' identified a number of shortcomings in the model, with respect to technical details and user-friendliness. A particular problem noted by students, who often used model options and entered data in unpredictable way, was that the model could be 'crashed' under particular circumstances, resulting in data loss and the need to reboot the computer. Substantial model revisions were carried out as a result of this highly effective form of model testing.

COMPARATIVE FEATURES OF THE THREE MODELS

Some of the features of the three models are listed in Table 1. Each of the models evaluates forestry from a private (rather than social viewpoint), and estimates pre-tax returns in present day dollars from timber products. Similar discounted cash flow (DCF) financial performance criteria are estimated by each model, with net present value and internal rate of return the standard criteria.

Table 1. Relative features of the three forestry financial models

Characteristic		Model	
	ACTFM	PSFFM	AFFFM
Design purpose	Evaluation of financial performance of non-traditional (especially rainforest) tropical tree species	Comparison of financial performance of Australian and traditional species for smallholders in the Philippines	Evaluation of the financial performance of plantations and managed native forests in marginal forestry areas of north-eastern Australia
Development period	1992-98	1998-99	1999-present
Model developer	Research officer	Honours student	Research officer and professional computer programmer
Type of model	Generic	One-off	Generic
Species targeted	Mixtures of cabinetwood and eucalypt species	Australian eucalypts and acacias	Mixed species, including eucalypts
Method of modeling tree growth and yield	Estimates of harvest ages and MAIs from a Delphi survey of forestry experts	Chapman-Richards stand growth curves	MAI predictions using the PlantGro model
Performance criteria derived	NPV, LEV, IRR	LEV	Various whole-farm financial performance indicators
Computing platform	MicroSoft Excel and Visual Basis	MicroSoft Excel	Visual Basis (stand-alone package)
Methods employed for model testing	Replication of financial results of other studies; subjective assessment by experts; evolution through a number of versions, with feedback from users and training groups	Subjective assessment by experts; comparison of yield predictions with those of other studies.	Evolution through a number of versions, evaluation by potential users in government agencies, trials with undergraduate student classes, testing by a professional programmer
Approximate number of users to date	200	Researcher group members only	100
Approximate expenditure to date	$30,000	$3000	$60,000
Further model development plans	None at present	Revision of yield curves as further trial data become available	Tax, non-wood benefits

The models differ considerably in complexity and in the development and testing effort which has been required. More develop and testing effort and time is required in the generic models. As model complexity increases, limitations of the spreadsheet computing platform become apparent, as does the need for input from professional software developer.

A major difference between the three models arises in the method of stand yield estimation. This is a particular problem for farm and smallholder forestry involving non-traditional native species, for which yield modeling is a necessary part of the model development.

The ACTFM was the first of these models developed, and was designed to evaluate non-traditional species grown together in mixtures in small stands of farms in the Queensland Wet Tropics. A spreadsheet platform proved suitable for this purpose. Since the planted areas were generally small, and on degraded farm land, and many of the farms were not commercially viable units, a model confined to the forest enterprise was appropriate. Since users had little idea of the likely growth performance or future timber prices for these species, extensive use was made of default data obtained through a Delphi survey of forestry experts.

The PSFFM is an example of a relatively inexpensive model, designed for a one-off application, although it is envisaged that this model will be used in current ACIAR-funded forestry research project in the Philippines and Vietnam.

The AFFFM was designed for commercial farmers who are contemplating the addition of a forestry enterprise to their business. This application called for a model which could evaluate the effect of a forestry investment on the overall farm business, including impact on income from crops and livestock, annual cash income and debt servicing ability.

While a considerable number of people other than the developers have found the generic financial models useful, and these have been made downloadable on wed sites, the models have not been commercialized. The three models were developed by forestry researchers, not by professional programmers. Commercialization would require further development effort, particularly with regard to user interfaces, and would impose a commitment to provide advice and continue model development. There may also be liability problems, should investors undertake forestry projects which turn out to be unprofitable. These complexities make commercialization unattractive for model developers working in a research environment.

CONCLUDING COMMENTS

Experience in developing of financial models of non-industrial forestry has revealed that there is a demand for various types of models and levels of model complexity, for specific user groups and use purposes. There is a need for both models of forestry within the overall farm business, and simpler models which consider only the forestry enterprise. Commercial forestry (typically using proven species) as an activity of full-time farmers requires evaluation in a whole-of-business context. However, there is strong interest in multiple-use forestry growing non-traditional tree species on small and sometimes non-commercial farm. At least in an Australian context, often the ‘real farmers’ are not the ‘real farm foresters’. For landholders growing non-traditional species for multiple uses, there is a particular need in financial models for default data, especially with regard to stand yield.

Testing of generic models has been found critical for both model validity and user-friendliness. With generic models, the possibility for commercialization arises, although this carries with it complexities and risks which may be unacceptable to researchers.

Some complementarity has arisen in model development. The PSFFM and the AFFFM were both in part derived from the ACTFM, but with further developments to suit their specific application areas. Various desirable further developments of the financial models have been recognized, including improved modelling of financial risk, inclusion of income tax impacts, and inclusion of private non-wood benefits of forestry. However, making these refinements will depend on availability of research funding. In general, research funding bodies appear more willing to support applications of the models than further model development.

ACKNOWLEDGEMENTS

We wish to thank the Rainforest CRC, ACIAR and RIRDC for financial support which allowed the model development and testing discussed in this paper.

REFERENCES

Emtage, N. (in process), ‘Development, testing and presentation of the AFFFM’, Ch. 11 in Harrison, S.R. and Herbohn, J.L., *A Whole-Farm and Regional Agroforestry Decision-Support System*, Rural Industries Research and Development Corporation, Canberra.

Emtage (2002), Assessing the Financial Viability of Farm Forestry: A Tutorial Exercise, Chapter 5, in S. Harrison et al. (eds.) Socio-Economic Research Methods in Forestry: a Training Manual. Cairns, Rainforest Cooperative Research Centre: 45-52.

Emtage, N., Harrison, S., Herbohn, J. and Thompson, D. (2002), *The Australian Farm Forestry Financial Model – Users Guide*, Rural Industries Research and Development Corporation, Canberra.

Hackett, C. (1988), *Matching Plants and Land: Development of a General Broadscale System from a Crop Project for Papua New Guinea*, CSIRO Division of Water and Land Resources, Natural Resources Series No. 11, CSIRO, Melbourne.

Hackett, C. (1991a), *Plantgro: A Software Package for Coarse Prediction of Plant Growth*, CSIRO, Melbourne.

Hackett, C. (1991b), ‘Mobilising environmental information about lesser-known plants: the value of two neglected levels of description’, *Agroforestry Systems*, 14(2): 131-143.

Harrison, S.R., Herbohn, J.L. and Emtage, N.F. (2001), 'Estimating Investment Risk in Small-Scale Plantations of Rainforest Cabinet Timbers and Eucalypts', in Harrison, S.R. and Herbohn, J.L., *Sustainable Farm Forestry in the Tropics*, Edward Elgar, Cheltenham, pp. 47-60.

Harrison, S.R. and Herbohn, J.L. (in process), *A Whole-Farm and Regional Agroforestry Decision- Support System*, Rural Industries Research and Development Corporation, Canberra.

Harrison, S., Herbohn, J., Emtage, N. and Thompson, D. (2003), 'Designing and developing financial models to support farm forestry decisions', in Vacik H., Lexer M.J., Rauscher M.H., Reynolds K.M., Brooks R.T. (eds.), *Decision support for multiple purpose forestry. A transdisciplinary conference on the development and application of decision support tools for forest management*. April 23-25, 2003, University of Natural Resources and Applied Life Sciences, Vienna (CD-Rom Proceedings).

Herbohn, J., Thompson, D. and Harrison, S. (in process), 'Development of Farm Forestry Financial Models In Australia', Ch. 3 in Harrison, S.R. and Herbohn, J.L. (in process), *A Whole-Farm and Regional Agroforestry Decision- Support System*, Rural Industries Research and Development Corporation, Canberra.

Venn, T.J., Harrison, S.R. and Herbohn, J.L. (2001a), 'Predicting Yields and Returns to Smallholder Plantation Forestry: a Philippines Case Study', in Harrison, S.R. and Herbohn, J.L., *Sustainable Farm Forestry in the Tropics*, Edward Elgar, Cheltenham, pp. 61-76.

Venn, T., Herbohn, J.L. and Harrison, S.R. (2000b), 'Relative Financial Performance of Australian and Traditional Timber Species in the Philippines', in S.R. Harrison and J.L. Herbohn, *Socio-Economic Evaluation of the Potential for Australian Tree Species in the Philippines*, Australian Centre for International Agricultural Research, Canberra, pp. 93-110.

Ward, J. (1995). *An Economic Analysis of Small-scale Hardwood Pplantations*, Hons. Thesis, Faculty of Environmental Sciences, Griffith University, Gold Coast Australia.