

COMPARING PROFITABILITY AND CASH FLOWS OF AGROFORESTRY AND AGRICULTURE ON AUSTRALIAN FARMS

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Author's Biography

Amir Abadi is an economist with the Department of Agriculture in Western Australia and at the CRC for Plant Based Management of Dryland Salinity. In his career as an economist and a business analyst Amir has investigated the economic and commercial viability of new and existing business ventures and government policies. In the main, Amir's work has focussed on enhancing decision-making and resource allocation in the rural and the resources sector. His past and current employers and clients have included the state and federal research and development institutions, the banking sector, management and IT consulting firms, as well as the universities.

Abstract

This paper is a summary of a project that compared the relative profitability of existing, emerging and prospective agroforestry systems with profitability of conventional agricultural land uses in the cropping zones of Western Australia and New South Wales. The project explored the economic boundary conditions under which several promising agroforestry systems may be viable in the lower rainfall zones.

Partial budgeting and discounted cash flow techniques were used to conduct the comparative analysis of alternative land use scenarios. The profitability, cash flows and debt associated with each of the scenario are reported. The analysis underpinning this research provides estimates of the economic value of the temporal and spatial interaction effects of trees on agricultural crops and pastures.

The WA case studies included oil mallees (*Eucalyptus kochii* subsp. *plenissima* and *E. polybractea*), tagasaste (*Chamaecytisus proliferus*), maritime pine (*Pinus pinaster*) and wattle (*Acacia* spp.). The NSW case studies included blue mallee (*E. polybractea*), narrow-leaved peppermint (*E. radiata*), jojoba (*Simmondsia chinensis*), and river red gum (*E. camaldulensis*).

Some tree species such as oil mallees and tagasaste were nearly as profitable as conventional land uses in WA. Others such as jojoba were so highly profitable as to raise doubts in the assumptions about its production and the long-term market outlook for its products. An automated spreadsheet application named “Imagine” was developed in the course of this project. It has proven to be a highly useful, generic partial budgeting, tool for analysis of most land use systems, intentionally designed not to be limited by edaphic and agroclimatic specificity of each site.

Introduction

One of the fundamental determinants of adoption of any new land use system is profitability. However perceptions of the profitability for prospective land use systems need to be supported by sound data and appropriate analytical methods. Limited empirical data and little cultivation history from early adopters and researchers are available for woody perennial crops.

The Australian Federal Government funded this study through the Joint Venture Agroforestry Program (JVAP). This paper is a summary of the final report of this project submitted to JVAP by Abadi *et al.* (2003). This study compares the relative profitability of existing, emerging and prospective agroforestry systems with conventional agricultural land uses in the cropping zones of Western Australia and New South Wales. It maps out the economic boundary conditions under which several promising agroforestry systems may be viable in the lower rainfall zones.

Many new agroforestry systems can be integrated with traditional agricultural enterprises of cropping and grazing. It is important to evaluate the profitability of these agroforestry systems in conjunction with traditional farming system enterprises, rather than in isolation.

This project involved comparative evaluation of eight agroforestry case studies. The WA case studies included oil mallees (*Eucalyptus kochii* subsp. *plenissima* and *E. polybractea*), tagasaste (*Chamaecytisus proliferus*), maritime pine (*Pinus pinaster*) and wattle (*Acacia* spp.). The NSW case studies included blue mallee (*E. polybractea*), narrow-leaved peppermint (*E. radiata*), jojoba (*Simmondsia chinensis*), and river red gum (*E. camaldulensis*).

For each case study data sources and key researchers were consulted to provide estimates of the costs of establishment and maintenance of trees, timing of each harvest and yields and prices of tree products. Given the uncertainty

associated with many of these production parameters, sensitivity analyses were conducted to test the robustness of the findings and the economic importance of the key variables. Among the factors included in the sensitivity analysis were the economic value of the shelter benefits as well as crop and pasture losses associated with competition from trees.

Partial budgeting and discounted cash flow techniques were used to conduct the comparative analysis of alternative land use scenarios. A spreadsheet application, named *Imagine*, provided the analytical framework, the database for storage of assumptions, and the computational environment for conducting the analysis of the case studies. The cash flow pattern, Net Present Value, Annual Equivalent Return, Break-Even Time, Payback Period and Peak Debt of each scenario were reported. Estimates of temporal and spatial interaction effects of trees on agricultural crops and pastures were included to obtain indirect economic value of trees. For several species, this project offered the first opportunity for an assessment of their profitability. In some of the cases, such as the oil mallee and the acacia, no existing industries are in place, and the costs and prices used were based on those expected when large-scale industries develop. A summary of the main results of the case studies is shown in Tables 1 and 2.

Definition of Terms

This paper makes frequent references to several financial terms that are summary indicators of financial viability of land use systems. This section briefly defines the meaning of these financial terms.

- Net Present Value (*NPV*) is the lump sum value of the project expressed as the sum of discounted annual net returns. A 7% percent discount rate was applied across all of the case studies in this report.
- Annual Equivalent Return (*AER*) is an indicator that describes the profitability of a project on a annula basis and thus allows comparison of profitability of long duration agroforestry projects with agricultural rotations with shorter project life.
- Break-even period is the length of time required before the cumulative cash flow of the agroforestry project is equal to that of the agricultural land uses.
- Peak debt is the highest cumulative cash deficit that occurs during the investment project. In Tables 1 and 2 the year in which the peak debt occur is also noted.
- Payback period is the length of time required for cumulative cash deficits of an agroforestry project to become surpluses.

The WA Case Studies

For the WA cropping zone, the commercial prospects of Maritime pine, acacia, Oil mallee, and Tagasaste were investigated. Of these, Oil mallee and acacia have the greater potential for further development given the area of soils suited to their cultivation. Further research is required to determine the potential end uses and market size for acacia biomass.

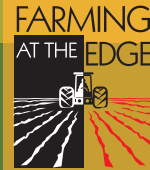
Analysis of the viability of Maritime pine and Tagasaste for the deep infertile sands of the medium rainfall zone of the northern agricultural region of WA indicated that both projects are slightly more profitable than conventional sheep or cattle production on annual pasture in this region. The AERs of tree farming systems ranged from \$33/ha to \$44/ha per annum as compared with the AER of \$31/ha per annum from agriculture.

Maritime pine timber production, undertaken as a share-farming project with the Forest Products Commission (FPC), produced an AER of \$33/ha per annum with no debt and zero payback periods. This scenario is based on the current practice of the FPC, which pays the landowner an incentive payment to gain access to the land and then finances the establishment of the plantation at no cost to the landowner. The revenues from the sale of the timber were assumed to be shared 70:30 between the FPC and the landowner. On the other hand, the Maritime pine plantation that was assumed to be established, maintained and harvested by the landowner had a negative return with an AER of -\$11/ha. This is mainly due to the landowner incurring the significant costs of establishment without any income until year 15.

Tagasaste fodder shrub for cattle production in alley farming or plantation systems proved to be more profitable than cattle production on conventional annual pastures. Tagasaste in alley farming generated an AER of \$37/ha per annum while cattle production in a tagasaste plantation system generated an AER of \$44/ha. Initial cost of the establishing the plantations and the belts meant that the landowner would have to wait 16 and 6 years respectively to break-even with conventional cattle production on annual pastures. The assumption that Tagasaste can provide a valuable feed source from the 2nd year after planting, based on industry experience, is a key factor in its profitability.

A conventional agricultural land use on the sandplain soils of the low rainfall zone of the northern agricultural region of WA is a rotation of two years of wheat followed by one year of lupins. This rotation generated an annual net return of \$73/ha, which includes the value of crop stubbles for the sheep enterprise. By comparison alley farming on the same soil type with oil mallee tree belts and conventional agricultural rotation in the inter-rows of the alleys had an AER of \$76/ha with a peak debt of \$59/ha and a payback period of three years. However, it did not break-even with the conventional agriculture until year 23.

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On the duplex, sand over clay, soils of the low rainfall zone of the northern agricultural region of WA, a conventional agricultural land use is a rotation of two years of wheat followed by two years of annual pasture. This rotation generated an annual net return of \$51/ha. By comparison phase farming on the same soil type with acacia tree plantations had an AER of \$88/ha. In a phase farming system with acacia trees the paddock is planted to acacia for four years. At the end of that four-year period the trees are removed and the entire tree biomass is sold off-farm for fibreboard manufacturing. The paddock is then returned back to the agricultural rotation for a period of 10 years before returning to another four years phase of acacia. Phase farming with acacia has a peak debt of \$437/ha, incurred in year 3 of the project, and a payback period of four years. Under the original assumptions of the analysis the acacia phase is profitable enough in its own right to break-even with the conventional agriculture land use system in year four of the project.

Table 1. The profitability and cash flows of four case studies of agroforestry systems in WA as compared with agriculture.

Agroforestry systems	Enterprise and products	NPV (\$/ha a)	AER (\$/ha)	AER Agricultural Comparator (\$/ha)	Peak debt (\$/ha)	Break-even Periods (Years)	Payback period (Years)
1a Maritime PineM Farmer established Plantation	Timber	-130	-10	31PS	1210 Year 14	Not Reached	Not Reached
1b Maritime PineM FPC established Plantation	Timber	423	33	31PS	Nil	Yrs 1 to 8 & Yrs 32 to 33	Immediate
2a TagasasteM Alley farming	Cattle	478	37	31PC	31 Year 1	6	1
2b TagasasteM Plantation	Cattle	555	44	31PC	360 Year 1	16	9
3 Mallee Alley farming	Oil Biomass for oil, wheat and lupin grains and sheep	970	76	73WWL	59 Year 1	23	3
4 AcaciaL Phase farming	Wood, sheep and wheat grain	112 9	88	51WWPP	437 Year 3	4	4

M: Medium rainfall zone – 450 mm. L: Low Rainfall Zone – 350 mm
PS: Continuous pasture grazed by sheep PC: Continuous pasture grazed by cattle
WWL: A continuous cropping rotation of two year of wheat followed by a year of lupin
WWPP: A rotation of two years of wheat followed by two years of pasture

The NSW Case Studies

Among the NSW case studies, the tree species that show the most promising commercial prospects were *Jajoba* and *E. radiata*. A conventional agricultural land use assumed for the red brown earths in the central west zone of NSW consists of a seven-year rotation of barley and wheat grain crops and a pasture phase. This land use produces an AER of \$111/ha per annum, including the value of crop stubbles for the sheep enterprise. Alley farming with Blue mallee belts and conventional agricultural rotation in the inter-rows is less profitable at an AER of \$82/ha. Under the assumption of this case study, the net revenues from production of oil from the mallee tree belts do not offset the opportunity cost of land taken out of agricultural production.

Jajoba is by far the most profitable of all the case studies of this project. Under the assumptions made for this case study, a *Jajoba* plantation generates an AER of \$2718/ha per annum, which is 24 times more profitable than the conventional agricultural land use. This high estimate of profitability for *Jajoba* is due to the assumption caused that from the fifth harvest onwards (year 9 and later) the plantation is capable of annual oil production of 200 litres/ha with a market value of \$20/litre. However, the landowner would experience a peak debt of \$5810/ha in year 5 of the project and has to wait for nine years for a positive cash flow.

A plantation of *E. radiata* or the Narrow-leaf peppermint is the next most profitable agroforestry option among the NSW case studies. It has an AER of \$460/ha and a peak debt of \$3245/ha in the second year after planting and a positive cash flow is not experienced until year 9. The cash flow of an *E. radiata* plantation breaks even with the cash flow the agricultural rotation in year 9. The high profitability of the *E. radiata* plantation is due, mainly, to the assumption of biannual production of around 300 litres of oil per hectare with a farm gate price of \$7/litre.

An *E. camaldulensis*, or River red gum, plantation, intended for timber production, was not viable under the range of assumptions used for this tree crop. It made a loss of \$181/ha. The establishment cost resulted in a peak debt of \$4479/ha in the 34th year after planting and it would not break-even with conventional agriculture. The main reasons for negative net returns for this tree crop are the high establishment costs and the long wait before timber of only modest yield and market value could be harvested. Timber harvest was assumed to take place in the 20th and the 35th year after planting. In projects such as this, where revenues occur towards the end of the life of the project, discounting of cash

flows produces a lower NPV than projects with revenues at the beginning of the life of the project. This is a common problem with slow growing timber crops.

Table 2. The profitability and cash flows of four case studies of agroforestry systems in NSW as compared with agriculture.

Agroforestry systems	Enterprise and products	NPV (\$/ha)	AER (\$/ha)	AER Agricultural Comparator (\$/ha)	Peak debt (\$/ha)	Break-even Period (Years)	Payback period (Years)
5 Blue mallee Alley farming	Oil, wheat and barley grain and sheep	1069	82	111CP	21 Year 1	Not reached	1
6 E. radiata Plantation	Oil and biomass	5991	460	111CP	3245 Year 2	9	9
7 Jojoba Plantation	Oil	35426	2718	111CP	5810 Year 5	9	9
8 E. camaldulensis Plantation	Timber	-2353	-181	111CP	4479 Year 34	Not reached	Not reached

CP: A rotation consisting of a seven-year rotation of barley and wheat grain crops and a pasture phase. After the grain is harvested, sheep graze the crop residues and stubbles in summer and autumn. The pasture phase is for winter and grazing of sheep for production of wool and meat.

Further research is required to determine the potential yield, market size and demand elasticity for the products of these trees. Additional empirical data is required to firm up estimates of commercial yields of trees evaluated in this project, particularly for NSW. Estimates of various parameter values varied widely among agronomists, forest researchers, hydrologists and tree crop advocates. There is a diversity of expert opinion about the production of trees and their likely response to edaphic and climatic conditions as well as to silvicultural management. This points to a serious problem for the industry. It is unlikely that landowners would seriously consider tree cropping investment projects without sound and credible production and cost estimates.

Conclusions

In general farmers are likely to be investigating agroforestry projects as alternatives to their current land use on soil types and land management units with the lowest opportunity cost. For instance, the infertile sands of WA where the opportunity of cost of land is lower than other soils are prime candidates for development of agroforestry systems.

This study shows that the least viable agroforestry systems are those that require the landowner to forego the returns from conventional agriculture by completely replacing it with an agroforestry project that has high up-front costs and little or no income until the end of the project. The most attractive projects are those where initial costs of establishment could be offset through share farming, or alley farming systems where trees are integrated with conventional agriculture and regularly harvested for biomass or grazed by livestock.

Joint venture financing arrangements would be desirable in cases where there are up-front costs in establishing the tree crops. The joint venture arrangements that made some annuity payments to growers would be desirable from the cash flow point of view. These annuity payments could be extended to include environmental services when institutional arrangements and markets have been established for credits associated with carbon sequestration, salinity or biodiversity. Share farming arrangements like those that have been developed by the Forest Products Commission in WA for the Maritime pine should be encouraged. Institutional arrangements and policies that provide incentives for tree plantings by growers can, if firmly established, increase the profitability of agroforestry by providing an extra source of revenue or income.

It has been shown that in some alley farming systems the interactions between tree belts and agricultural enterprises in the inter-rows can make a positive, significant difference to the economic viability of integrating trees on farms. This project has shown that there are good economic grounds for directing research toward identifying the interactions.

For the most promising agroforestry systems reported here at the farm-level, the next requirement is analysis at the industry scale to take into account the perspectives and needs of investors, buyers, processors and manufacturers.

References

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