# A method for comparing investment returns from major rural land uses including forestry

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## Introduction

Changes in rural land use are a common occurrence in New Zealand. These changes enhance returns to land owners, create new downstream industries, and stimulate the entry of new capital and skills. Readily-available information to understand and compare investment returns from alternative land uses encourages this type of beneficial innovation. This paper considers three obstacles to comparing financial returns from forestry with other land uses.

First, the measures used to analyse returns from different land uses vary. Gross farm income and economic farm surplus are used to measure pastoral farming; horticulture uses net income, and forestry uses present net worth and internal rate of return. The lack of a standard evaluation methodology hinders comparison of investment returns from alternative land uses. The proposed approach below uses existing published data for agricultural land uses, to compare investment returns with a forestry alternative.

Secondly, while Ministry of Agriculture and Forestry (MAF) publishes comprehensive economic data on a range of agricultural land uses annually, there are no comparable forestry data. This deficiency also hinders comparison of forestry investment returns with other alternatives.

Thirdly, the returns from farm output are not always differentiated from the returns due to appreciating land values. The proposed method is designed to consider only returns from production. Data are also presented which highlight the recent significance of changes in land values for rural land owners.

## Data

The Farm Monitoring reports produced by the Ministry of Agriculture and Forestry (MAF) provide detailed information on a range of agricultural and horticultural land uses including dairy, sheep and beef, arable, viticulture and kiwifruit. The data (as described in MAF 2008a) used in this analysis are:

- Total farm assets, and value of land and buildings
- Net cash income
- Farm working expenses
- Management costs (wages of management)

Data for 2007/08 were used to demonstrate the method, and the annual cash surplus was calculated as net cash income minus farm working expenses minus management costs. Forestry costs were provided from industry sources, for a typical pruned log regime. Timber revenues only were included, with price information derived from MAF (2008c). Regime assumptions are shown at the end of this paper. For forestry, management costs are included in the annual cost, and in specific operational costs such as silviculture and logging.

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## Method

A discounted cash flow model was developed for each land use option, and the IRR (rate of return where the NPV of the investment is zero, or internal rates of return) was found for each option. The IRR provides a simple method to compare these options, which is valid for the type of cash flows being modelled. The IRR criterion was also selected because it allows returns from asset value changes and productive investment to be readily compared. All IRRs are real, pre-tax. The model assumes:

- an investment period of 30 years
- constant real costs and returns over the entire investment period
- The asset is bought at the start of the investment period and sold at the end (at the same real price).

## Results

The forestry and sheep and beef models are shown in detail (Tables 1 and 2), to highlight the method and assumptions. Cash-flows are discounted at the calculated IRR, which is defined as the discount rate at which the net present value of all cash flows summed is zero. The calculated IRRs for forestry, and sheep and beef, are 2.71% and 1.64% respectively.

Tables 1 and 2 also highlight the key difference between forestry and agricultural investments, i.e. agricultural investments yield annual costs and returns (assumed constant in this case), whereas a new forestry investment incurs establishment and tending costs early in the cycle, as well as annual management costs. Typically for forests managed for timber only, all revenue, as well as additional costs for harvesting, occur at the end of the investment period (normally 25 to 30 years).

The sheep and beef farm IRR calculated as shown in Table 2 is exactly equivalent to the return on assets (calculated as annual cash surplus, divided by value of total farm assets). Under the assumption of constant costs and returns (as shown above in Table 2), the IRR value is not dependent on the time period over which it is calculated (i.e. an IRR calculated using 5 years of costs and revenues would be identical to the 30 year IRR calculated above).

*Table 1: Forestry model, 2007/08, IRR = 2.71%*

| Year | Land value | Revenue | Cash costs | Discounted cash |
|---|---|---|---|---|
| 0 | -$2,850,000 | | | -$2,850,000 |
| 1 | | | -$641,500 | -$624,577 |
| 2 | | | -$50,000 | -$47,397 |
| 3 | | | -$50,000 | -$46,146 |
| 4 | | | -$50,000 | -$44,929 |
| 5 | | | -$504,000 | -$440,938 |
| 6 | | | -$453,500 | -$386,290 |
| 7 | | | -$257,000 | -$213,137 |
| 8 | | | -$403,000 | -$325,402 |
| 9 | | | -$50,000 | -$39,307 |
| 10 | | | -$280,000 | -$214,315 |
| 11 | | | -$50,000 | -$37,261 |
| 12 | | | -$50,000 | -$36,278 |
| 13 | | | -$50,000 | -$35,321 |
| 14 | | | -$50,000 | -$34,389 |
| 15 | | | -$50,000 | -$33,482 |
| 16 | | | -$50,000 | -$32,599 |
| 17 | | | -$50,000 | -$31,739 |
| 18 | | | -$50,000 | -$30,901 |
| 19 | | | -$50,000 | -$30,086 |
| 20 | | | -$50,000 | -$29,293 |
| 21 | | | -$50,000 | -$28,520 |
| 22 | | | -$50,000 | -$27,768 |
| 23 | | | -$50,000 | -$27,035 |
| 24 | | | -$50,000 | -$26,322 |
| 25 | | | -$50,000 | -$25,627 |
| 26 | | | -$50,000 | -$24,951 |
| 27 | | | -$50,000 | -$24,293 |
| 28 | | | -$50,000 | -$23,652 |
| 29 | | | -$50,000 | -$23,028 |
| 30 | $2,850,000 | $30,965,250 | -$20,892,050 | $5,794,985 |

*Source: Industry data, MAF (2008c). Assumes a 500 ha forest estate (chosen to be of comparable financial size to other land-use options), and a land value of $5700/ha (equivalent to the sheep and beef farm average land value).*

*Table 2: Sheep and beef (national model), 2007/08, IRR = 1.64%*

| year | Total farm assets | Net cash income | Total cash expenses | Discounted net cash |
|---|---|---|---|---|
| 0 | -$4,468,186 | | | -$4,468,186 |
| 1 | | $287,803 | -$214,326 | $72,288 |
| 2 | | $287,803 | -$214,326 | $71,119 |
| 3 | | $287,803 | -$214,326 | $69,968 |
| 4 | | $287,803 | -$214,326 | $68,836 |
| 5 | | $287,803 | -$214,326 | $67,723 |
| 6 | | $287,803 | -$214,326 | $66,627 |
| 7 | | $287,803 | -$214,326 | $65,549 |
| 8 | | $287,803 | -$214,326 | $64,489 |
| 9 | | $287,803 | -$214,326 | $63,445 |
| 10 | | $287,803 | -$214,326 | $62,419 |
| 11 | | $287,803 | -$214,326 | $61,409 |
| 12 | | $287,803 | -$214,326 | $60,415 |
| 13 | | $287,803 | -$214,326 | $59,438 |
| 14 | | $287,803 | -$214,326 | $58,476 |
| 15 | | $287,803 | -$214,326 | $57,530 |
| 16 | | $287,803 | -$214,326 | $56,600 |
| 17 | | $287,803 | -$214,326 | $55,684 |
| 18 | | $287,803 | -$214,326 | $54,783 |
| 19 | | $287,803 | -$214,326 | $53,897 |
| 20 | | $287,803 | -$214,326 | $53,025 |
| 21 | | $287,803 | -$214,326 | $52,167 |
| 22 | | $287,803 | -$214,326 | $51,323 |
| 23 | | $287,803 | -$214,326 | $50,493 |
| 24 | | $287,803 | -$214,326 | $49,676 |
| 25 | | $287,803 | -$214,326 | $48,872 |
| 26 | | $287,803 | -$214,326 | $48,081 |
| 27 | | $287,803 | -$214,326 | $47,303 |
| 28 | | $287,803 | -$214,326 | $46,538 |
| 29 | | $287,803 | -$214,326 | $45,785 |
| 30 | -$4,468,186 | $287,803 | -$214,326 | $2,784,229 |

*Source: MAF, 2008a*

Table 3 below shows that, under current assumptions, dairy, viticulture and arable provide the best returns, with forestry, deer, and sheep and beef in the next rank, and kiwifruit currently yielding a negative return on investment.

Table 4 below shows the results for different types of sheep and beef farms, including the hill country farms which are most subject to erosion under current land use, where the case for an increased role for forestry has been made on environmental grounds. The analysis shows that, while current returns are not satisfactory for either land use, the case for forestry could also be made on financial grounds, even without possible revenue from carbon credits.

The analysis of major rural land uses above highlights the investment return solely from the productive land use - land values are assumed to remain constant. Since land price appreciation forms a significant part of the total return from some rural land investments (MAF, 2007a), this is quantified below, for the dairy, and sheep and beef sectors.

*Table 3: Summary of results (2007/08)*

| Model | Effective area (ha) | Net Cash Income | Working expenses | Manage-ment costs | Cash surplus | Capital value ($/ha) | IRR % |
|---|---|---|---|---|---|---|---|
| Dairy (National average) | 126 | $1,021,886 | -$468,449 | -$83,610 | $469,828 | $47,161 | 7.91% |
| Sheep and Beef (National average) | 708 | $287,803 | -$180,002 | -$34,324 | $73,477 | $6,311 | 1.64% |
| Viticulture (Marlborough) | 25 | $907,273 | -$288,576 | -$75,000 | $543,697 | $362,940 | 5.99% |
| Kiwifruit (Bay of Plenty) | 5 | $147,975 | -$116,626 | -$48,051 | -$16,702 | $341,022 | -0.98% |
| Arable (Canterbury) | 285 | $903,000 | -$490,670 | -$75,000 | $337,330 | $23,022 | 5.14% |
| Deer (South Island) | 180 | $227,602 | -$109,172 | -$58,771 | $59,659 | $15,428 | 2.15% |
| Forestry | 500 | $682,023 | -$554,825 | -$50,006 | $77,193 | $5,700 | 2.71% |

*Source: MAF (2008a), MAF (2008b), Industry sources for forestry data. Note: Forestry costs and revenues were annualised (using the IRR as the discount rate) for the purposes of comparison*

*Table 4: Regional sheep and beef farm results (2007/08).*

| Model | Effective area (ha) | Net cash income | Farm working expenses | Manage-ment costs | Cash surplus | Total farm assets | IRR % |
|---|---|---|---|---|---|---|---|
| **Northland** | 314 | $215,641 | $118,064 | $64,255 | $33,322 | $3,325,540 | 1.00% |
| **Waikato BOP Intensive** | 300 | $270,839 | $162,659 | $75,000 | $33,180 | $4,419,030 | 0.75% |
| **CNI Hill** | 635 | $309,763 | $196,492 | $75,000 | $38,271 | $4,603,400 | 0.83% |
| **Gisborne Hill** | 821 | $310,305 | $230,471 | $75,000 | $4,834 | $5,642,016 | 0.09% |
| **Hawkes Bay/Wairarapa Hill** | 624 | $277,136 | $210,873 | $75,000 | -$8,737 | $4,664,811 | -0.19% |
| **Eastern Lower North Island Intensive** | 347 | $211,641 | $158,435 | $75,000 | -$21,794 | $5,020,097 | -0.43% |
| **Western Lower North Island Intensive** | 208 | $235,040 | $127,667 | $74,512 | $32,861 | $4,351,217 | 0.76% |
| **South Island High Country** | 10,212 | $622,374 | $400,475 | $75,000 | $146,899 | $10,038,221 | 1.46% |
| **Canterbury Marlborough Hill** | 1,399 | $318,937 | $204,742 | $75,000 | $39,195 | $5,579,890 | 0.70% |
| **Canty Marl breeding and finishing** | 365 | $322,917 | $185,678 | $75,000 | $62,239 | $4,863,868 | 1.28% |
| **Otago Dry Hill** | 2,000 | $383,648 | $252,421 | $70,594 | $60,633 | $3,959,376 | 1.53% |
| **Southland South Otago Hill** | 723 | $399,150 | $221,252 | $75,000 | $102,898 | $4,828,583 | 2.13% |
| **Southland South Otago intensive** | 194 | $205,985 | $113,961 | $58,391 | $33,634 | $2,739,050 | 1.23% |
| **National** | 705 | $287,803 | $180,002 | $34,324 | $73,477 | $4,468,186 | 1.64% |

*Source: MAF (2008a)*

### Increase in land values for dairy, and sheep and beef farms

Data from farm monitoring reports from 1999/2000 to 2007/08 were used to quantify the impact of land price increases on total farmer returns. Table 5 shows the real change (deflated by the Producer Price Index All Markets outputs) in value of dairy land (includes buildings), with value per hectare increasing by 62% over the period or an average of 7.2% per year. Some of this increase (around 10% or 1.3% per year) is related to increased productivity - indicated by the increase in cows milked per hectare, and there may be some increase in value of farm buildings, but this effect is likely to be small. Farm size has also increased, however this impact is removed by analysing changes in per hectare values.

Table 6 shows the equivalent data from the national model for sheep and beef farms. Land values ($/ha) have increased 143% in real terms over the period 2000/01 to 2007/08, or an average of nearly 16% per year. Over the same period productivity decreased, with the number of stock units per hectare declining over the period, although average farm size increased. Recent commentary suggests that increasing sheep and beef land prices may be due to the demand for land for dairy conversion or dairy support, for other features of the land such as coastal access, views and proximity to cities, or overseas demand (MAF, 2007a).

The separate impacts of land value change and returns from farming (calculated as IRR or return on assets, from farm data) are shown below in Figures 1 and 2 for sheep and

*Table 5: Change in price of dairy land and buildings, 1999/00 to 2007/08*

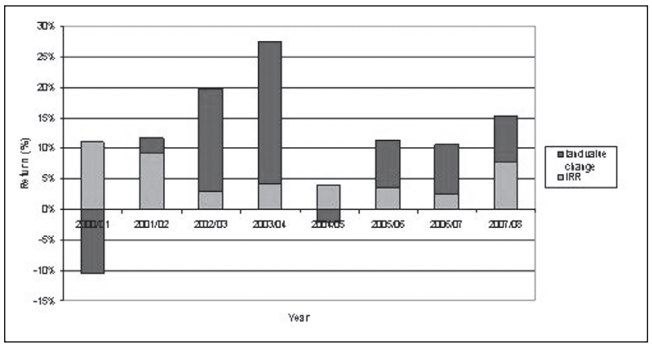
| | PPI All Markets outputs (March years) | Value of land and buildings (2008 $NZ) | Effective area (ha) | Land and bldg value ($2008/ ha) | Real change, value ($/ ha) of land & bldgs (y/y, %) | Cows per ha |
|---|---|---|---|---|---|---|
| **1999/00** | 0.7759 | $1,721,910 | 92 | $18,716 | | 2.57 |
| **2000/01** | 0.8216 | $1,601,809 | 95.6 | $16,755 | -10.5% | 2.43 |
| **2001/02** | 0.8471 | $1,649,111 | 96.1 | $17,160 | 2.4% | 2.57 |
| **2002/03** | 0.8441 | $2,047,605 | 102 | $20,075 | 17.0% | 2.67 |
| **2003/04** | 0.8516 | $2,572,876 | 104 | $24,739 | 23.2% | 3.02 |
| **2004/05** | 0.8786 | $2,831,137 | 117 | $24,198 | -2.2% | 2.67 |
| **2005/06** | 0.9138 | $3,209,358 | 123 | $26,092 | 7.8% | 2.77 |
| **2006/07** | 0.9423 | $3,560,453 | 126 | $28,258 | 8.3% | 2.86 |
| **2007/08** | 1.0000 | $3,980,225 | 131 | $30,383 | 7.5% | 2.82 |

*Sources: MAF (2000a), MAF (2001a), MAF (2002a), MAF (2003a), MAF (2004a), MAF (2005a), MAF (2006a), MAF (2007a), MAF (2008a), Statistics New Zealand (PPI was re-based to provide Mar 2008 real values).*

*Table 6: Change in price of sheep and beef and buildings, 2000/01 to 2007/08*

| | PPI All Markets outputs (March years) | Value of land and buildings (2008 $NZ) | Effective area (ha) | Land and bldg value ($2008/ ha) | Real change, value ($/ ha) of land & bldgs (y/y, %) | Stock units per ha |
|---|---|---|---|---|---|---|
| **2000/01** | 0.8216 | $1,449,486 | 614 | $2,361 | | 7.6 |
| **2001/02** | 0.8471 | $1,711,981 | 586 | $2,921 | 23.8% | 7.3 |
| **2002/03** | 0.8441 | $2,254,766 | 627 | $3,596 | 23.1% | 7.8 |
| **2003/04** | 0.8516 | $2,536,636 | 636 | $3,988 | 10.9% | 7.7 |
| **2004/05** | 0.8786 | $3,141,546 | 660 | $4,760 | 19.3% | 7.6 |
| **2005/06** | 0.9138 | $3,599,491 | 708 | $5,084 | 6.8% | 6.3 |
| **2006/07** | 0.9423 | $3,992,182 | 708 | $5,639 | 10.9% | 6.4 |
| 2007/08 | 1.0000 | $4,040,748 | 705 | $5,732 | 1.6% | 6.4 |

*Figure 1: Annual productive returns and land value increases, dairy farms, 2001 to 2008*




beef, and dairy farming. Assuming that asset values in the Farm Monitoring reports are representative, real land and building value increases have been a significant component of total farm returns over the past decade.

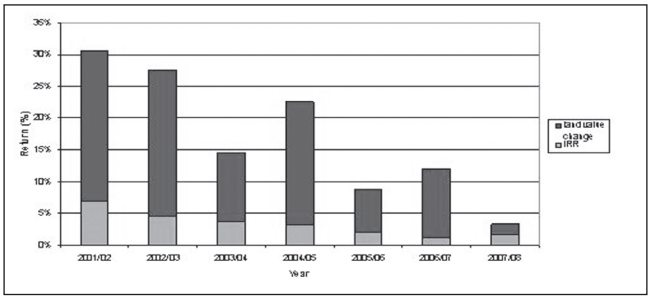
## Discussion

The analysis method proposed here allows ready comparison of forestry with a wide range of land-based investment alternatives. Comparative studies of the profitability of forestry and agriculture have been completed in the past (for example, Ward et al., 1965), however these have been "one-off" studies, completed for specific purposes and relating to specific sites, and it would not be appropriate to extrapolate their findings to draw more general conclusions about the profitability of alternative land uses. The on-going debate about comparative profitability of competing land uses would benefit from a standard methodology for comparison, and publicly-available data. Recent discussion (for example, Brown, 2006) has highlighted this need, and proposed similar methods of analysis.

This analysis primarily uses the latest annual agricultural cost and revenue data derived from farm monitoring reports to quantify productive returns. Data from a single year are unlikely to be representative of long-term average returns; the historical data presented above show dairy returns (excluding land value increases) from 2001 to 2008 have varied from 11.0% to 2.4%, and averaging 5.7%. Sheep and beef returns have shown a steady decline from 2002 to 2008, ranging from 6.9% to 1.1% with an average of 3.3%. Equivalent forestry data are not available in the public domain.

It is feasible using the method proposed here to quantify separately the returns from farm output and the change in asset values. Increases in farm asset values have been significant over the period for which data are readily available, and are shown for dairy, and sheep and beef farms (national average). In some cases increases reflect the increasing productive value of the land, in others, the increasing value of the land for alternative uses. Forestry usually competes for land with sheep and beef at the extensive margin, and increasing land values will have reduced the profitability of forestry on this land.

*Figure 2: Annual farm returns and land value increases, sheep and beef farms, 2002 to 2008*




Some analysts have advocated using different discount rates for forestry and agriculture, based on perceived riskiness of different land uses. The IRR was selected as the evaluation criterion because it ensures that all land uses are compared on a "like for like" basis. The IRR allows ready comparison with other investments which are measured using an interest rate or yield. It also facilitates comparison of productive returns and land value changes, as demonstrated in this paper.

The forest is modelled as a single age class. An alternative approach would be to model the forestry option as a "normal" forest - in this case, 20 hectares per year harvested on a 30 year rotation. However the method outlined in this paper is consistent with the objective of evaluating alternative investment options. The single age-class model highlights that a major difference between forestry and farming is the timing of cash flows - with forestry managed for timber only, the frequency of cash returns is dependent on the age class structure of the forest. Thus for investors who require annual cash returns, a single age-class forest managed for timber is unattractive as an investment option; on the other hand, forests that earn annual revenues from carbon credits should become more attractive to such investors.

The forestry option must be evaluated on a 30 year investment horizon (or similar), because of the necessary time for the trees to grow to maturity, while the farming options could be evaluated over a shorter period (such as the average tenure for farm ownership); 30 years was initially chosen to provide strict comparability. However it should be recognised that, under the assumptions used in this paper, the farming IRRs will be identical irrespective of the length of the period chosen to model the cash flows. Alternatively, the IRR can be calculated simply as the return on assets, as described above.

The MAF Farm Monitoring reports constitute an extremely valuable and comprehensive data set, which can be used to compare returns from a wide range of New Zealand agricultural land uses. The addition of a report monitoring commercial forestry would provide consistent data in the public domain, and would be warranted both on the grounds of the area of land in commercial forest, and the importance of the sector to the New Zealand economy. There would also be justification for a number of regional

reports (in the same way that the sheep and beef sector is treated), which would account for variation in growth rates, regional wood quality differences, and cost differences related to topography and soil type. Pruned and unpruned regimes should also be represented, based on current practice. It is recommended that the sector support (through contribution of data), the development of a forestry report by MAF, so that data are available for analysing and comparing all major rural land uses in New Zealand.

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## Appendix

*Forestry regime information*

| Age | Operation | Cost |
|---|---|---|
| **1-30** | Annual cost | $ 100/ha |
| **1** | Land preparation and planting | $ 1183/ha |
| **5** | Pruning (1st lift) | $ 908/ha |
| **6** | Pruning (2nd lift) | $ 807/ha |
| **7** | Thinning | $ 414/ha |
| **8** | Pruning (3rd lift) | $ 706/ha |
| **10** | Thinning | $ 460/ha |
| **30** | Logging/loading | $36/m3 |
| **30** | Transport | $21/m3 |

*Log prices*

| Log type | P1 | Other pruned | S1/S2 | S3/L3 | L1/L2 | PULP |
|---|---|---|---|---|---|---|
| **Price (at mill, $/m3)** | $130 | $110 | $90 | $75 | $65 | $45 |

*Log yields (age 30)*

| Log type | P1 | Other pruned | S1/S2 | S3/L3 | L1/L2 | PULP | Total |
|---|---|---|---|---|---|---|---|
| **Yield (m3/ha** | 27 | 203.7 | 157 | 158 | 93.5 | 92.1 | 731.1 |

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