ARTICLES

Accounting for plantations

National accounts and forestry

Dr Hugh Bigsby*

ABSTRACT
The System of National Accounts provides a mechanism for capturing the economic benefits associated with changes to a forest estate. This is done by treating the forest as a stock or 'material in process' for an eventual log product. The economic benefit is estimated by calculating the change in the value of the forest estate from one year to the next. The change in value can arise from changes in area, age class, market prices or silvicultural practices. New Zealand stands out as being the only nation which has actually implemented this mechanism. The impetus for this was the rapid expansion of the exotic forest estate which was not being captured in economic statistics. Using this measure, additions to the value of the forest estate have contributed to 1.5% of New Zealand's GDP in recent years. The paper describes how the 'materials in process' approach works and how it has been used to account for changes to New Zealand's plantation forest estate.

INTRODUCTION
Forestry and the forest sector are emerging as important components of the New Zealand economy. Roundwood removals have grown from 7.9 to 14.4 million m³ over the last 20 years, and the forest sector now accounts for 5.8% of GDP. All of this growth has been based on plantations of exotic softwoods. Harvests from indigenous forests, which accounted for 59% of roundwood removal in 1951, are now only 1.4% of harvests (Ministry of Forestry 1993). The rise in output from exotic plantations is the legacy of large-scale plantings by the private and public sectors, largely on former agricultural lands.

In a national accounts sense, the changes which have occurred can be seen as an increase in the capital base of exotic plantations, and to some extent, a decrease in the capital base of indigenous forests. Typically though, the national accounts ignore deforestation or afforestation types of changes to a forest asset, and effectively assume that the forest is in a steady state. Instead, the national accounts usually contain entries only for the annual value of human activities in forestry, logging, and wood processing. In a national accounts sense, deforestation is the equivalent of generating income by liquidating assets. Recording only the income derived from deforestation, but not the depreciation of the forests, overstates current national income and hides the potential loss in future income. The rapid deforestation occurring in a number of tropical countries has been the focus of a number of Studies by restating the national accounts to include running down of the forest asset (Meyer 1993, Repetto et al., 1989, Hoern 1993).

In a similar way, there are a few countries which are under-
going rapid afforestation. Afforestation, from a national accounts perspective, is analogous to postponing income while inventories are built up. In New Zealand, the rapid expansion of the exotic plantation estate from the 1960s was such that in 1978 it was decided to expand the coverage of the System of National Accounts (NZSNA) to incorporate the changes to the forest estate. Changes to the plantation estate have since been captured in the national accounts, along with changes to the livestock base in the agriculture sector. Based on these accounts, changes to the value of the plantation stock have contributed, on average, to around 1.5% of total GDP over recent years (Table 1). Changes to the value of the plantation stock have also made up about 25% of the total contribution of the forest sector to GDP.

<table>
<thead>
<tr>
<th>March Year</th>
<th>Change in Value of Stocks</th>
<th>Contribution to GDP</th>
<th>Gross Domestic Product Total</th>
<th>Increase in Forestry Stocks as % GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forestry</td>
<td>Other</td>
<td>Total</td>
<td>Forestry &amp; Logging</td>
</tr>
<tr>
<td>1989</td>
<td>1092</td>
<td>-699</td>
<td>393</td>
<td>1442</td>
</tr>
<tr>
<td>1990</td>
<td>1084</td>
<td>919</td>
<td>2003</td>
<td>1538</td>
</tr>
<tr>
<td>1991</td>
<td>1075</td>
<td>-66</td>
<td>1009</td>
<td>1564</td>
</tr>
<tr>
<td>1992</td>
<td>1083</td>
<td>-543</td>
<td>540</td>
<td>–</td>
</tr>
<tr>
<td>1993</td>
<td>115</td>
<td>480</td>
<td>1645</td>
<td>–</td>
</tr>
</tbody>
</table>

1. Value-added including changes in the value of stocks.
2. Includes Forestry and Logging, Manufacture of Wood Products and Manufacture of Paper Products and Printing.

Source: Statistics NZ, New Zealand Yearbook.

The purpose of this paper is to examine the way in which changes to a forest estate can be incorporated into the national accounts and how this has been applied in New Zealand. The paper looks at the theory and methodology of accounting for forests, the context and application of forest resource accounting in New Zealand.

ACCOUNTING FOR PRODUCTION FORESTS
There are two basic ways to view the timber output from a forest. One is to adopt the perspective of an individual tree, and the other is to adopt the perspective of the forest. The difference between the two is only in the point of aggregation at which valuation for the national accounts takes place. The individual tree perspective approaches growth and silvicultural activities on the basis of value adding an input in a production process with the eventual product of a log in mind. In essence, silvicultural and research activities are placed in the context of enhancing the revenue function of the tree. The forest perspective treats the forest as a capital asset or stock resource. The interest yield from this forest capital, or mean annual increment over the forest, is harvested each year, although this is embodied in a small subset of mature trees in the forest. Silvicultural and research activities in

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this context serve to enhance the revenue function or annual allowable cut of the entire forest as a single entity.

### Table 2: Production Forest Accounts for a Net Increase in Forest Volume*

<table>
<thead>
<tr>
<th>Income Accounts</th>
<th>Balance Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change In</td>
<td></td>
</tr>
<tr>
<td>“Value-Added” Approach</td>
<td></td>
</tr>
<tr>
<td>Operating Surplus</td>
<td>Opening Balance A</td>
</tr>
<tr>
<td>Compensation of Employees</td>
<td>Less Depletion 0</td>
</tr>
<tr>
<td>Consumption of Fixed Capital</td>
<td>Plus Growth B</td>
</tr>
<tr>
<td>Other (1)</td>
<td>Revaluation 0</td>
</tr>
<tr>
<td>Gross Domestic Product</td>
<td>Closing Balance A + B</td>
</tr>
<tr>
<td>“Expenditure” Approach</td>
<td></td>
</tr>
<tr>
<td>Final Consumption Expenditure</td>
<td></td>
</tr>
<tr>
<td>Value of Physical Change in Stocks</td>
<td></td>
</tr>
<tr>
<td>Gross Fixed Capital Formation</td>
<td></td>
</tr>
<tr>
<td>Other (2)</td>
<td></td>
</tr>
<tr>
<td>Gross Domestic Product</td>
<td>+</td>
</tr>
<tr>
<td>Less Consumption of Fixed Capital</td>
<td>0</td>
</tr>
<tr>
<td>Net Domestic Product</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note: The table looks only at changes to value arising from a net increase in volume and does not include other forestry or logging activities.

1. Includes indirect taxes less subsidies.
2. Includes net exports of goods and services, and statistical discrepancy.

In the national accounts, the individual tree perspective is captured by treating the forest as a collection of growing trees or as ‘material in process’. The way the approach works is through the SNA framework for reconciliation accounts, or corrections to balance sheets, which cover changes in the value of natural resource stocks due to price and material shifts (Repetto 1989). To illustrate the method, Table 2 shows the entries for any particular year as a new forest estate is being established, assuming an ‘n’ year rotation with an equal area of new plantings each year for ‘n’ years. The table includes only the changes to the accounts arising from changes in the value of the forest stock due to growth.

In a national economic system, income must equal expenditure on goods and services in any year. In Table 2, income is denoted by the ‘Value-Added Approach’ and expenditure on goods and services is denoted by the ‘Expenditure Approach’. GDP as measured by either approach should be equal in any year. In both approaches, the National Accounts are shown on a net basis, so that intermediate transactions are not double counted. Income is measured by value added, the contribution of a producer to the national economy, or Gross Domestic Product (GDP) as measured by the value it adds through production. Value added can be measured two ways. One is to sum the individual components of value added, operating surplus (profit), compensation of employees, consumption of fixed capital and indirect taxes less subsidies, as is shown in Table 2. Value added can also be calculated by taking gross output of goods and services, less the value of goods and services used up in production and expenditure on goods and services. Similarly, expenditure appears as final consumption expenditure on goods and services only, netting out all intermediate expenditures, plus changes to stocks and gross fixed capital formation, as is shown in Table 2.

Any net increase in forest volume, or the physical stock of material in process, shows up in the national accounts as a change in the value of physical increase in stock on the expenditure side of GDP. A corresponding increase in the gross output or operating surplus of the forestry sector is also recorded on the value-added side of GDP. This is analogous to the way in which any factory records on its books a change in the value, or physical inventory, of semi-finished goods at the end of the year. It must record an increase in the value of physical stocks on the expenditure side of the ledger, as if it had purchased goods into inventory. It must also record an increase in value added on the value-added side of the ledger to reflect the expenditures incurred, and value added to the semi-finished good, during the year. In a subsequent year in which the goods are produced and sold in the forest the firm must record a reduction in the value of physical stocks on the expenditure side. At the same time on the value-added side, it subtracts the value of the semi-finished good as intermediate input for that year and only records the extra value added in that year. In this way there is no double counting of the value of the semi-finished good, or material in process, as it moves in and out of inventory.

Treatment of an expanding and growing forest as a material in process is shown in Table 2 as a (+) beside the values of the physical change in stocks and operating surplus respectively. Similarly, a reduction in forest stock would result in a decrease in the value of physical stocks and a decrease in the operating surplus of the forestry sector. If there is no activity in the forestry sector other than letting trees grow, then gross output and the value of stocks still rise. Both afforestation and deforestation can be accommodated in this approach, since these activities result in changes to the value of the growing stock.

### SOURCES OF CHANGE TO THE VALUE OF FOREST STOCKS

While from a national accounts perspective only the total change in the value of stocks is important, from an industrial user and a public policy perspective, the sources of the increase are also important. It is the details that indicate where value is being added and how, rather than just increases in area. The increase in the value of forestry stocks comes from a combination of revaluation of the stock as log prices rise, volume growth within the existing forest estate and additions to the total area of the plantation estate. The details are important because the latter two factors have typically been the important contributors to the growth in value. The size of the plantation estate has grown by about 66 to 50,000 hectares per year over the past 20 years (Ministry of Forestry 1993), and current estimates for 1994 are that there will be more than 60,000 hectares of new plantings. As a result of the recent plantings, more than half of the growing stock is less than 15 years old (Turland et al., 1993). More recently log prices have moved strongly as well, and this has also influenced the value of the stock.

In a steady state, where the plantation resource was of a similar genetic stock and structured as a normal forest, increments to volume would be offset by harvests and the only change to value of stocks would come from changes to the prices used to value the resource. The situation in New Zealand is much more dynamic than this, given the rate of new plantings and the impact of research which is increasing yields. The treatment of changes in the value of stock becomes important since there are a number of different factors which can generate the change. The increase in value could be created by an increase in the growth rate of trees due to the use of genetically improved planting stock. This would cause an increase in the value of stocks over the period of a rotation until all areas had been replanted with the genetically improved stock. If, as is the usual case, there were continual increases in yield due to genetic improvement, then the increase in the value of stock would continue. An increase in the value of the stock would also occur as more area was planted. There would be an incremental contribution to volume through growth without an offsetting increase in harvest volume until the newest plantings reached maturity. An increase in value could also arise due to genetically improved stock which had better fibre quality or stem form characteristics, or from silvicultural practices such as pruning. These all have the effect of increasing the unit value of the resource by increasing the proportion of high-value products in a tree.

Capturing value changes due to these factors raises the possibility that the national accounts approach could provide an opportunity to identify the contribution that research makes to
the forest sector’s performance. If particular aspects of the increase in forest stocks value can be isolated as being created by faster-growing trees or trees with improved quality, then this could flow back to the research ‘sector’ as their contribution to value added. For example, research over a number of years has increased tree growth by about 25% over the original progeny and permitted the shortening of rotations to 30 years. The extra growth currently shows up as value added to the forest, but could also be attributed to the research effort which brought it about.

VALUATION OF FORESTRY ASSETS

The valuation of forest assets for the national accounts requires a method of valuation and a method of aggregating values to the level of the national accounts. Valuation for the national accounts should reflect the market value of the particular stock (United Nations 1993, Meyer 1993). For forest assets in New Zealand, market or commercial valuation can be categorised according to three approaches (Davy 1987, Manley and Bell 1992, Fraser et al., 1985, NZIF 1994):

- market valuation of similar assets;
- net present value of a future stream of income;
- replacement cost.

The techniques for valuing plantations for commercial sale have obvious relevance to valuing stock changes in the national accounts but can also be limited by their focus. The first two approaches have the most obvious applicability to valuation for the national accounts and are widely used for that purpose. They are both variations on the same theme, since in theory the market value of the asset should reflect the capitalised value of future returns. The application of the NPV method is required where there is no market transaction of a similar type from which a comparison might be made. The last approach, of a replacement value, has limitations in applications to resource accounts because incremental growth has a value.

The current practice for calculating the value of forests for the national accounts in New Zealand (NZSNA) diverges from these recommended methods of valuation. The resource is valued by taking a simple standing volume multiplied by an average price (Paine 1994). Volume estimates come from annual updates derived from the National Exotic Forest Description (NEFD) (Turland et al., 1993). The NEFD is a national data base with regionalised information on areas planted by species (four types), age, and silvicultural treatment (four types). Yield tables for six log classes have been estimated for each of the region/species/silvicultural treatment combinations. The data set is used to provide annual updates to standing volume and forecasts of future wood supply. The average price is derived from surveys of annual reports and published data on prices.

The NZSNA current approach takes the perspective of valuing the forest at its liquidation value today, rather than its future earning potential. The approach might also be considered to be a pseudo-discounting, although this is not its intent. Since the valuation is based on an average price at current market values, and current standing volumes in each age class, the effect is that future gains in value from price and volume increases due to natural growth have been ‘discounted’. While theoretically appropriate for valuing goods in process, and particularly for a manufacturing operation, this treatment is not relevant for forests. Since manufactured goods have their value added in discrete and typically short periods, a liquidation value is meaningful. For forests though, time is important in realising the potential value of the forest. As a result, a net present value approach would be more appropriate as a method of valuing the forests.

Given the desirability of capturing the potential of forest growth, and the availability and structure of the NEFD, a more appropriate way to value forests would be through the calculation of NPVs for each of the region, species, and silvicultural treatments. The value of the forest estate would then be the sum of these NPVs,

\[
\text{Value of the Forest Estate (VFE)} = \sum_{g} \sum_{h} \sum_{i} \sum_{j} \text{NPV}_{gij}
\]

where \( g \) is the region, \( h \) is the species, \( i \) is the silvicultural treatment, and \( j \) is the age class. Valuing the change in the forest estate from year to year would then be calculated by,

\[
\text{Value of Stock Change} = \text{VFE}_t - \text{VFE}_{t-1}
\]

This change would make the estimation of the change in value of forest stocks match the recommended approaches for forests and exploit the detailed information available in the NEFD. Values would then reflect the expected log mix, given a particular silvicultural treatment, species and location.

DIFFERENTIATING VALUE CONTRIBUTION

The existence of disaggregated data and an aggregating system, such as the NEFD, provides a powerful tool for breaking the value of the stock change for forests into constituent components. The components of the present value of a forest stand can be separated as prices (P), volume per area (V) and area (A). A change in the net present value could arise from a change to any one or all of these factors.

\[
\Delta \text{NPV} = \sum_{i=1}^{n} \frac{\Delta P_i \times \Delta V_i \times \Delta A_i}{(1+r)^t}
\]

The price, \( P \), is actually a composite price which is a weighted average of the expected products. In addition to general increases in market prices, \( P \) could also rise due to a silvicultural treatment which altered the relative proportions of logs towards higher value logs.

All of these factors can be captured with an aggregating system like the NEFD. This includes data covering area, species, age, and yield based on silvicultural treatment. Given the detail of the NEFD, changes to the present value of a forest could be separated into constituent components, since most of the changes are easily identified and separable. Market prices change with expectations of future prices. Weighted prices change according to yield tables as log mixes are altered with silvicultural treatment. Areas within a particular class of forest change with new planting or movement between classes with silvicultural treatments.

If the effects of all these are removed, only the change in NPV due to growth remains. Within the change due to growth is another possible separation of effects. Over time, research into genetic improvement means that faster-growing trees are planted. If the data and aggregating system make it possible to identify the genetic stock used in a planting, then it would also be possible to isolate the contribution of forestry research to GDP. This would be done by comparing the incremental change in the NPV of the forest stock, with and without the use of the genetically improved stock.

DISCUSSION

The method of treating a forest estate as a ‘material in process’ can provide an adequate mechanism for accounting for the contribution of production forests to the national economy. Using this methodology, the growth of plantation forests has contributed annually to about 1.5% of New Zealand’s GDP in recent years. The contribution to GDP comes from a combination of
valuation of the forest stock as log prices rise, volume growth within the existing forest estate and additions to the total area of the plantation estate.

The key in how successful the system will be in estimating the contribution of forests to GDP though, is in the way that the valuation is done. This includes both the methodology and the level of detail the valuation is based on. The current practice of valuing forests for what is effectively a liquidation value is not adequate and it is suggested that the application of present value analysis would be a more appropriate method of valuing forest resources. Forest valuation in the NZSNA, by taking a simple standing volume multiplied by price, also underutilises the power of the NEFD. The NEFD is able to provide volume forecasts over a wide range of regions, species and silvicultural regimes that could be used to generate present values by detailed forest areas. The NEFD is also an aggregating model for the detailed data contained in the model and aggregates present values to the national level. From a policy analysis and business planning perspective, adopting the detailed present value approach based on the NEFD would have additional benefits. It would permit the sources of changes to the value of plantation forests, such as prices, volume growth and expansion of area, to be identified.

Another aspect of particular interest to New Zealand is the current forecast that roundwood removals will almost double from 13.7 million m$^3$ per year to 23.5 m$^3$ per year over the next 20 years (Turland et al., 1993). The growth in the area of new plantings is reflected in the continued increase in the value of forest stocks every year. This increase, though, does little to provide a picture of the industry that might be supported by this resource in the future, since the national accounts system focuses on year-to-year changes. While the year-to-year movement of GDP and its components have become important measures of economic activity, when extended to forestry, there is a mismatch with the length of the forest production period. This creates the potential for a breakdown in the correlation between current growth, and future output and income. Thus, questions about what the total contribution to New Zealand’s future GDP will be as a result of new planting now and over the past few years will not be answered by the NZSNA focus on what is happening now. In other words, there is no estimate of the sustainable income which could be provided by this forest estate. Development of the NPV approach and the forecasting of future contributions to GDP from forestry are currently the subject of FRST-funded collaborative research involving the New Zealand Forest Research Institute and Lincoln University.

There are also directions for future research. Work has already been done at international levels to develop systems of physical accounts for the forest sector (OECD 1994). Among other objectives, an important component of these accounts is the development of physical input-output tables to track material flows between the forest and the range of users in the economy. New Zealand is now also proposing to apply the OECD system of physical accounts for forestry in New Zealand, including the input-output table (Sheerin and Mohamed 1994b, Sheerin and Mohamed 1994a). The development of physical input-output tables will provide valuable information about the current linkages in the economy. They will also facilitate the measurement of future sustainable income provided by current increases in plantings through linkages to forest estate forecasting models and the national accounts. There has already been one introductory attempt at short-term forecasting of changes to national income in New Zealand arising from forest growth using the NEFD (Savage 1991).

Another potential extension of the treatment of exotic plantations in the NZSNA is the inclusion of indigenous production forests. A characteristic of indigenous forests which complicates the accounting procedure is the presence of many joint products from a single asset, the forest. While accounting for timber growth and production as produced assets, non-cultivated biological assets like wildlife and plants coexisting in the forest could be accounted for separately under a satellite system of accounts called the System of Environmental and Economic Accounting (SEEA) (United Nations 1993).

REFERENCES


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