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A ROUNDWOOD PRODUCTION COST MODEL FOR SURINAME: MODEL DESCRIPTION AND USER GUIDE

by
Adrian Whiteman, FAO, Rome,

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1 INTRODUCTION

In order to calculate an appropriate level of forest fees or levies for the forestry sector in Suriname, it is first necessary to calculate the economic rent from forest operations. Once the economic rent is determined, the government can then decide how much of this rent should be collected by the state. The economic rent from forest operations is equal to the standing value of roundwood[1] taken from Surinam's forests and can be calculated as the surplus of revenues from the sale of the roundwood at the mill or harbour (in the case of exported roundwood) less harvesting, extraction and transportation costs. This cost calculation should also take into account other forest management costs and include an allowance for normal profit.[2] This report describes a model that has been produced to help staff of the Suriname State Forest Service (*Lands Bosbeheer* or *LBB*) and Foundation for Forest Management and Production Control (*Stichting voor Bosbeheer en Bostoezicht* or *SBB*) calculate roundwood production costs (and, hence, economic rent) from the raw data that has been collected about forestry costs in Suriname (see: Whiteman, 1999).

The remainder of this report is in three sections. Section two discusses the methodology used to calculate the total roundwood production cost from the raw information about costs collected as part of this study. Section three works through one detailed example of how to use the roundwood production cost model, using, as an example, a "typical" or “representative” forest operation in Suriname. It then discusses the sensitivity of some of the results to changes in the assumptions and underlying variables used in the model. The final section of the report summarises the general findings of the study and makes recommendations about how this work should continue to be updated by *LBB* or *SBB*.

[1] Also often referred to as stumpage value.

[2] Normal profit can be defined as the level of profit or return on investment which is just sufficient to keep each company in the sector in business. In a situation such as harvesting the natural forest, the level of normal profit is a key variable because it determines how much of the economic rent the government should allow each company to retain and how much they should take in the form of levies and taxes.

2 PRODUCTION COST CALCULATION METHODOLOGY

In order to calculate roundwood production costs, it is necessary to identify all the activities required to produce roundwood, collect information about the productivity and cost of each activity and then convert these into a production cost per unit of output (i.e. cubic metre of roundwood). The following section describes the main activities in the roundwood production process, then presents a simplified accounting system that can be used to categorise or classify each type of production cost. It then describes a simple model for adding together all of these costs and calculating the production cost per unit of output. It finishes by discussing the main variables that are likely to affect total production costs.

2.1 Production cost accounting framework

In order to calculate roundwood production costs, it is first useful to have an accounting framework into which the data can be classified for analysis. This study has used a simple two-dimensional framework based on forestry activity and type of cost.

2.1.1 Forest harvesting and management activities

The forestry activities included in the roundwood production cost accounting framework are defined as follows:

Forest harvesting activities:

Felling - including: cutting; cross-cutting; tagging or marking; and de-limbing felled trees, plus rest periods and time spent refuelling the chainsaw and performing on-site maintenance. In the case of minor forest products (e.g. hewn squares, utility poles, stakes and split poles), the cost of further processing (which will usually take place at the roadside) should be included in this category.

Skidding with bulldozer[3] - including: skid-trail construction; travelling to and from the log landing (roadside) to the felled tree; attaching the cable to the tree and detaching the cable at the log landing; and winching to the skid trail, plus rest periods and time spent refuelling the bulldozer and performing on-site maintenance.

Skidding with wheeled skidder[3] - including: skid-trail construction; travelling to and from the log landing (roadside) to the felled tree; attaching the cable to the tree and detaching the cable at the log landing; and winching to the skid trail, plus rest periods and time spent refuelling the skidder and performing on-site maintenance.

In forest loading - including: collecting the roundwood from the log landing; travelling to and from the lorry; and loading on to the lorry, plus rest periods and time spent refuelling the loader and performing on-site maintenance.

Road transport - including: travelling to and from the log landing to the quayside (in the case of further transportation by barge) or final destination, plus loading time, rest periods and time spent refuelling the lorry and performing on-site maintenance. For roadside sales, this activity would normally be the responsibility of roundwood buyer and, thus, not a cost incurred by the forest manager.

[3] Skidding has been divided into two separate activities - skidding with a bulldozer and skidding with a wheeled skidder - because the productivity rates and costs of operating each type of machine differ considerably. Many forestry operations in Suriname have only one machine for skidding, so any analysis of production costs should consider which type of machine will be used or whether a combination of bulldozer and wheeled skidder will be used for timber extraction.

Unloading and reloading - including: unloading the lorry; and travelling to and from the lorry to the logyard, plus rest periods and time spent refuelling the loader and performing on-site maintenance. If roundwood is delivered by lorry to a final destination (i.e. sawmill or quayside for export), this activity would normally be the responsibility of roundwood buyer and, thus, not a cost incurred by the forest manger. In the case of roundwood transported by barge to the final destination, this activity may occur twice (i.e. unloading at one time then subsequent re-loading on to a barge) unless the barge is present during unloading. Unloading and reloading may also occur one or more times if logs are temporarily stored or sorted between the forest and final destination or have to be transferred between a barge and a lorry more than once. The number of times roundwood is loaded and reloaded will depend on the transport infrastructure available to the forest manager.

Water transport - including: travelling to and from the quayside to the final destination, plus loading time, rest periods and time spent refuelling the barge and performing on-site maintenance. This activity is only relevant for a proportion of forestry operations in Suriname.

Road building - including: uprooting and removing trees and other vegetation; all necessary earthworks; and simple grading/blading, plus rest periods and time spent refuelling the loader and performing on-site maintenance. Currently, road building is not a very common activity in Suriname. Most forestry operators prefer to use existing roads (often built by *LBB* or *Bruynzeel*[4], up to 25 years ago) and skid for long distances rather than incur the costs of road building.

Forest management activities:

Exploration inventory - including: inventory planning and design (including purchase of base maps and aerial photographs, if necessary); travel to inventory plots; cutting trails; plot demarcation; tree identification, measurement and recording; measurement of other plot variables (if necessary); data entry and analysis; mapping; consultation with local communities; and report production, plus rest periods and construction of temporary camps (if necessary).

Outline management plan production - including: preliminary road and felling coupe design; outline production and infrastructure planning; mapping and report production.

Annual stock survey - including: travel to annual felling coupes; cutting trails; tree identification, measurement, marking and recording; stock mapping, measurement and recording of other variables (if necessary); data entry and analysis; final map production; and report production, plus rest periods and construction of temporary camps (if necessary).

Annual cutting plan production - including: final road, skid trail and felling coupe design; estimation of gross and net commercial production volume; mapping and report production.

Production control - including: monitoring and recording of roundwood production and transport; reporting to the Foundation for Forest Management and Production Control (*Stichting voor Bosbeheer en Bostoezicht* or *SBB*).

In addition to the above direct costs, there are other miscellaneous costs, which apply to all activities. These include: transport of workers to and from the forest (where local workers are not used); medical and other social costs; insurance payments (for both workers and machinery); and management and administrative

4 *Bruynzeel* is the largest of the three parastatal companies operating in the forestry sector.

overheads[5]. In a few cases (the largest forest concessions) there are also the costs of permanent forest camp construction and/or maintenance.

Depending on the available transport infrastructure and the point at which roundwood is sold, many forest managers may only undertake some of the activities described above. For example, most local communities sell the roundwood from their community forests (*Houtkapvergunning* or *HKVs*) standing (thus, incurring no costs) or felled at stump (incurring only the felling cost). Other local communities and small logging companies fell and extract the roundwood (often using contractors for the extraction and loading) and sell it at roadside. Larger logging companies buy the roundwood felled and extract and transport it themselves (road and water transport is often contracted to separate companies). Only sawmillers and the largest logging companies tend to engage in all the harvesting activities from felling to delivery to the mill or harbour (for export). Thus, in order to examine where the economic rent is currently being captured, it is important to examine production costs for a range of situations for and compare them with prices (and contracting costs) collected elsewhere as part of this study.

Currently, most forest managers only perform harvesting activities and, of these, some activities are uncommon (e.g. road building). Only a few companies (e.g. *Bruynzeel*) carry-out any forest management activities. Thus, there is likely to be a discrepancy between current production costs and the costs that are likely to be paid in the future when the sector is more closely monitored and has to undertake forest management activities.

2.1.2 Types of production cost

For each stage of the production process, the cost of production has been split into the following three broad categories:

Labour costs - including: wages or salaries, calculated on the basis of time (e.g. monthly wage rate) or production (e.g. payment per cubic metre produced); social costs (including medical, insurance and other social costs), calculated as a percentage of the wage; and overhead (e.g. transport to and from the forest and accommodation expenses), calculated as a percentage of the wage. Payment of social costs and overhead vary considerably depending on the scale and location of forest operations.

Consumable (i.e. raw material) costs - including: fuel and lubricant costs, calculated from unit prices (e.g. cost per litre) and rates of consumption; the cost of minor parts (such as filters, tracks and types), calculated as a cost per working hour (derived from unit costs and the average life of each part); and the cost of other consumable items (e.g. clothing and tools), calculated as an annual replacement cost.

Capital costs - including the cost of depreciation of machinery used in each activity plus the cost of repaying any money borrowed to finance the purchase of the machinery. Depreciation has implicitly been calculated as a fixed percentage loss of value for every year each machine is used, spread over the estimated remaining lifetime of the machinery (i.e. the depreciation period). Loan repayments have been calculated using standard repayment formulae, assuming monthly repayment of principle and interest. The cost of major repairs (i.e. repairs beyond simple on-site maintenance) and insuring machinery has also been included under this heading. Repair cost has been calculated as an average annual cost based on the age of each machine and the annual

[5] Some forest managers also grade their roundwood. At the moment, *LBB* charge a grading fee for all roundwood production recorded in Suriname. However, this fee is generally inadequate to cover the cost of the service. Thus, some producers probably just pay the fee without receiving the service, while others help with transporting and accomodating *LBB's* timber graders in order to get the service. This is somewhat undesirable in as much as it places part of the remuneration of the timber graders in the hands of the forest managers and may lessen their objectivity.

insurance cost has been calculated as a percentage of the current value of the machine (which is, itself, based on the machine's current age and the depreciation rate - i.e. its depreciated replacement value).

In addition to the three types of cost presented above, the forest manager will also expect to earn a level of profit (which should be restricted to normal profit) in return for invested money in the activity. The expected level of profit has been included in the calculation of total production cost in two ways: as an expected rate of return or level of profit on the total amount of capital invested in each activity; or as a profit margin or mark-up on all other (i.e. non-capital) expenditure. The first approach is the standard approach that would normally be used in investment appraisal. However, after discussions with *LBB, SBB* and forest managers, it was discovered that, in view of the age of much of the capital currently used in the forestry sector in Suriname,[6] many forest managers use the simpler second approach in their financial calculations.

For the purposes of updating the economic rent analysis, the results presented later also show the contribution to total production costs of the each of the main types of cost. This should make it easier to update these figures quickly, without having to go back and collect revised information for every individual cost item.

2.2 Calculation of roundwood production cost

There are two main ways in which roundwood production costs can be calculated. The first is the discounted cash-flow approach and the second is the delivered wood price approach.

2.2.1 The discounted cash-flow approach

The discounted cash-flow (DCF) approach involves constructing a cash-flow for the forestry operation and calculating economic performance measures such as the Net Present Value (NPV) or Internal Rate of Return (IRR) of the operation, using standard investment appraisal techniques.

A cash-flow is a table showing, for each year of the investment period, the expected costs and revenues from the operation. In an NPV calculation, all of the costs of the operation are discounted (see Box 1) and added together to give a total discounted cost. Total discounted revenue is calculated in a similar way and total discounted revenue subtracted from total discounted cost gives NPV.

The NPV of an investment can be thought of as the surplus of revenues over costs (expressed as though all financial flows occur at the start of the investment period) after the required rate of return on all expenditure during the lifetime of the project has been covered. If NPV were negative, this would indicate that the expected revenues during the investment period would not be sufficient to cover the required rate of return or normal profits.

Total discounted costs and revenues and NPV can be turned into an amount that is equivalent to an annual payment during the whole of the investment period (the annual equivalent or annuity). Alternatively, they can be converted into lump-sum payments that are equivalent to the total discounted costs, revenues or NPVs of a series of repeated investments carrying-on for ever (the capitalised or expectation value of these items). These alternative ways of expressing total discounted costs, revenues and NPV are sometimes also used in economic analysis under certain circumstances (see below).

IRR is an alternative economic performance measure to NPV and is calculated by varying the discount rate (or expected rate of return) used in the NPV calculation until NPV equals zero. The discount rate at which NPV equals zero is the rate of return on all expenditure during the lifetime of the investment. The IRR can thus, be compared directly to the normal or expected level of profits to see how well an investment performs.

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[6] i.e. most of the capital used in the sector has been fully depreciated or completely written-off and the cost of using this capital does not generally figure in their financial calculations.

Box 1 Discounting future costs and revenues

In order to take into account the timing of future costs and revenues, it is usual to reduce the value of future monetary payments by an amount which depends upon how far into the future they occur. This is based on the principle that an amount of money collected as revenue today is preferred to the same amount at some future time (time preference). The process of doing this is usually referred to as discounting. Cash-flows that have been modified in this way are referred to as discounted cash-flows (comprising discounted costs and discounted revenues) and the amount by which values are reduced for each year into the future in which they occur is called the discount rate. A discounted value is calculated using the following formula:

$$\text{Discounted value} = \frac{\text{Future value}}{(1+r)^y}$$

where r is the discount rate (expressed as a decimal fraction) and y is the number of years into the future in which the payment occurs. When all cost items are discounted and added together, the resulting total discounted cost is the total cost of the investment expressed as though all costs had to be paid at the start of the investment (ie. after they have been adjusted for their timing). Total discounted revenue and NPV can be thought of in the same way.

The major challenge in the process of calculating discounted cash-flows is usually choosing the appropriate discount rate for this calculation (the discount rate can be thought of as the level of profit or return on expenditure which companies operating in the sector would aim to achieve - ie. the level of normal profit). Most of the international development banks use a rate of 10% in their project appraisals. Discussions in Suriname revealed that a rate of return or discount rate of 20% would be considered appropriate for operators in the forestry sector.

The DCF approach can be used to identify the roundwood production cost (per m^3) of a forest operation by dividing the total discounted cost of the operation by total discounted roundwood production.[7] Furthermore, the NPV/m^3 of the operation (calculated in the same way) is a direct measure of the economic rent (per m^3) from roundwood production.

IRR analysis can be used in a similar way to estimate the roundwood production cost and economic rent, by adding a hypothetical rent payment to the roundwood production cost in the IRR calculation. By varying this amount in the calculation, the level of economic rent at which IRR equals the normal level of profit can be discovered.

2.2.2 The delivered wood price approach

Many of the costs of roundwood production are labour and consumable items, which are purchased in proportion to roundwood production each year (i.e. they are variable costs). The only cost items which are purchased occasionally, are used for several years and do not vary exactly in proportion to production, are machinery, equipment and infrastructure such as forest camps (i.e. fixed or capital costs).[8] Thus, the DCF approach can be a complicated way of handling what are mostly simple cost and revenue flows. The delivered wood price approach is a simpler variation of the DCF approach described above, which treats most costs as annual expenditures and only discounts the costs of capital items in the calculation of roundwood production cost.

[7] Discounted production is calculated by discounting annual production volumes over the entire investment period and adding them to gether as described above.

[8] Even the cost of forest roadbuilding can be considered as a variable cost if the length of road built each year varies in proportion to roundwood production.

The easiest way to calculate delivered wood price is to calculate the average annual depreciation of all equipment used in the production process[9], add annual expenditure on labour and consumable items to this and divide the total by annual production. However, this would give a delivered wood price that does not take into account the profit that the forest operator would expect to earn. To include a level of profit in the calculation, a profit margin or mark-up must be added to the production cost.

As noted above, there are two ways in which normal profit might be considered: firstly, as a mark-up on current expenditure (the common approach in Suriname); or as a return on the capital invested in the operation (the standard financial approach). The first approach is relatively easy: a percentage mark-up can be simply added to all labour and consumable expenditures. However, the calculation of delivered wood cost including an allowance for return on capital is slightly more complicated.

Firstly, as noted above, any discounted cost can be converted into an annual equivalent or annuity. Therefore, the total discounted cost of a piece of equipment used in the production process can also be converted into an annuity.[10] This annuity can then be divided by annual production for that piece of equipment to give a discounted cost per unit of production. The difference between this and the capital depreciation cost per unit of output, is the allowance for return on capital. This can be added to the costs of depreciation, labour and consumable items, to give a total delivered wood cost that includes an allowance for normal profit (expressed as an expected return on capital).

2.2.3 Choice of technique

The main strengths and weaknesses of each of the above approaches are described in Table 1. To summarise, the complete DCF approach is better for calculating total roundwood production cost in situations where forest harvesting and management is likely to be complicated and involve a lot of capital equipment, while the simpler delivered wood price approach is more useful where forestry activities are considerably simpler. Thus, the DCF approach might be appropriate for large operations working for a planned period of time (say, a 100,000 ha concession over 20 years) in a variable forest area. It is probably less appropriate for the scale of most forest operations currently working in Suriname.

Given the generally small scale of forest operations in Suriname therefore, the delivered wood price approach has been used to examine roundwood production costs in this analysis. It may be appropriate to consider using the DCF approach to calculate the roundwood production cost of the largest forest operators (e.g. *Bruynzeel* and *MUSA*)[11] and explore the roundwood production cost under the more complex planning and monitoring requirements which will be required when the 1992 Forest Management Act is completely implemented. However, this would probably require a greater amount of information about cost and price structures in such operations than is currently available.

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9 Annual depreciation for each piece of machinery or equipment can be simply calculated as the difference between its current value and its likely value at the end the investment period (or its useful life) divided by the length of the investment period.

10 The total dscounted cost of a piece of equipment is usually calculated as its current value minus its resale or scrap value at the end of the appraisal period, disocunted back to the present.

11 *Bruynzeel* is the large parastatal company working in the forestry sector in Suriname and *MUSA* is the name of one of the large foreign-owned harvesting and sawmilling companies.

Table 1 **Relative strengths and weaknesses of the discounted cash flow and delivered wood price approaches to calculating total roundwood production cost**

	Discounted cash flow approach	Delivered wood price approach
Strengths	This approach can handle large initial investments on items such as forest camps, inventories and training. It can handle expected variations in annual costs and revenues due to factors such as moving into areas with different terrain conditions, roading requirements and stocking levels each year. It can also be used to incorporate more complicated forest management activities such as silvicultural treatments in various years after harvesting.	The approach is relatively simple and does not require a great amount of calculation. It is also generally easier to interpret, explain and understand the results of the delivered wood price approach. The amount of information required to calculate delivered wood price is also generally not very great.
Weaknesses	To achieve the above benefits, the approach generally requires more information and is more complicated to calculate. It can also be more difficult to explain the calculation and results to others.	The approach implicitly assumes that most costs are roughly the same each year and that they generally fall into a few simple categories. Thus, it would not be very useful for very variable or complicated forest areas. It might also end-up being more complicated to use this approach if there are a many large capital investments at irregular times throughout the investment period.

2.2.4 The model used to calculate roundwood production cost

A simple spreadsheet model, which calculates the harvesting component of roundwood production cost using the delivered wood price approach, has been constructed for this study. The model includes all of the various activities currently undertaken to harvest roundwood in Suriname (a general overview of the model can be found in Appendix 1 and a detailed explanation of all the calculations in the model can be found in: *Section 3.2 Data used in the harvesting cost model for a typical forest operation*; and as comments within the spreadsheet itself). The model does not include the cost of management operations, because many roundwood producers do not currently undertake such activities. They will, however, be required to do so when the 1992 Forest Management Act is fully implemented. Therefore, these additional costs will have to be calculated by hand and added into any analysis of managed forest production.[12]

2.3 Sensitivity analysis

With the model described above, it should be possible to examine the effects of changes in variables (such as productivity, machinery costs and transport distances) on the roundwood production cost. Such an analysis is called a sensitivity analysis. It is important in any analysis of economic rent, to carry-out a sensitivity analysis of the results, to examine which factors will have the most effect on production costs and, hence, economic rent.

2.3.1 Variability of the forest resource

Some variables are largely outside the control of forest managers. For example, they may face different production costs due to factors such as the location and stocking level of their forest concessions. These variables, over which the forest manager has no control, often arise as a result of the variability of the forest resource. The most important factors in this category are likely to include:

12 Managed forest production means production from forests managed according to the 1992 Forest Management Act, which requires that various initial investments such as exploration inventroies and stock surveys are carried-out before production begins. The cost of these operations is currently unknowm, but any analysis of economic rent from managed forest in the future will have to take these costs into consideration.

Transport distances. The distance between a concession and the sawmill or harbour can have a significant effect on transport costs and, thus, the cost of roundwood production. The further that roundwood has to be transported and the greater the number of times it has to be loaded and re-loaded onto different types of transport, the more expensive it will be to produce roundwood.

Forest management requirements. With the implementation of the 1992 Forest Management Act, forest managers will have to undertake a range of activities such as forest inventory, consultation and planning which most of them currently do not perform. Once a felling code of practice is implemented, they will also be required to provide proper safety equipment and may have to train workers in better harvesting practices. These are other factors that will be largely outside their control, but will affect the cost of roundwood production.

Concession area and stocking level. Roundwood production costs will vary with the size of forest concessions and the level of stocking of commercial species. Fixed costs, such as planning and forest inventory, will be spread over larger production volumes in larger forest concessions and concessions with higher levels of stocking of commercial species. In such cases, production costs are, therefore, likely to be lower. Larger forest concessions will also generally allow managers to achieve better rates of machinery utilisation, which will reduce production costs.

In cases where production costs are higher or lower than average because of factors over which the forest manager has no control (such as those described above), the economic rent from production is likely to vary and the chosen level of forest levies should take this into consideration. In some cases economic rent may be so low that it is questionable whether any roundwood should be produced at all. Greater benefits may be derived from conserving these areas or using them for some other activity (e.g. ecotourism of the production of non-wood forest products).

2.3.2 Production efficiency

In addition to the above factors, there are other variables that can affect production costs, over which forest managers do have some control. Generally, these variables are associated with how efficiently the forest operation is managed and include:

Roading density. For any level of forest stocking, there is an optimal level of roading density at which roundwood production costs are minimised. Road building is currently uncommon in Suriname, leading to very long skid trails and high extraction costs. It is likely that a certain amount of road building in forest concessions would have the overall effect of reducing the total costs of extraction.

Skid trail length and layout. The length of skid trails required to extract roundwood is determined, in part, by the roading density. If more roads are built, the length of skid trail needed is reduced. However, a second factor which must be considered in determining the average length of skid trails and, hence the costs of skidding, is the design of skid-trails. A certain amount of deviation from the shortest possible route to felled trees is often necessary to accommodate site factors such as streams, steep terrain and trees that have not been felled. However, there is a big difference between the average skidding distance over well designed skid trails and the distance if skid trails aren't planned properly. Thus, careful planning and layout of skid trails can reduce skidding costs dramatically.

Replacement of capital equipment. As machinery gets older it becomes more expensive to maintain and can significantly reduce production capacity. There will be a point at which increases in repair costs and loss of productivity justify the replacement of equipment. This should also be examined in any analysis of production costs.

Types of equipment used in forest operations. A common feature of forest operations in Suriname is the use of old and outdated equipment. In particular, the use of skidders to construct skid trails and the use of light trucks to haul timber may have a significant effect on the roundwood production cost. Therefore, any analysis of production costs should also examine the benefits of using proper equipment such a logging trucks and bulldozers for skid trail construction.

In the case of these factors, the economic rent analysis should examine the scope for reducing production costs (and, hence, increasing economic rent and forest levies), by improving efficiency. In most cases, it is unlikely that forest managers are deliberately inefficient in the production of roundwood. Therefore, the analysis should examine why they may not be producing wood in the most efficient manner. There are often financial, institutional and technical reasons why forest managers might be discouraged from increasing efficiency and these should be identified along with possible solutions to these problems.

2.3.3 Comparison with contract cost information collected during the study

The above section has described how the different components of roundwood production cost can be calculated using standard investment appraisal techniques. However, many producers of roundwood in Suriname use contractors to perform some of their forest harvesting activities. This is particularly true in the case of small loggers and local communities producing roundwood. In these cases, the contract cost of these operations can be used in stead of the production costs (calculated from the raw data) in the economic rent analysis.

It may be more efficient for a forest manager to use contractors rather than invest in their own machinery, particularly in the case of small producers who might not be able to use large pieces of machinery for long periods of time. However, if the government is not capturing all of the economic rent from timber production with their forest levies, it is possible that these contractors are taking some of this rent.[13] Therefore, in order to get some idea of the distribution of rent capture within the sector, the calculated cost of operations (such as extraction and haulage) should be compared with the contract costs of such activities collected during the study. This will start to give some insight into the impact of levy changes on the different stakeholders operating in the sector.

2.3.4 Production of minor forest products

All of the above discussion has centred on the production of roundwood for export or processing in the sawmill or plymill. However, a small amount of roundwood produced in Suriname is converted in the forest into simple value-added products such as utility poles and hewn squares. These products are sold for generally much higher prices in domestic and international markets, but cost only a little more to produce. Therefore, the economic rent from these activities will be different to the economic rent from roundwood production.

Where information exists about the additional cost of producing these minor forest products, this should be examined by varying the production cost and price data in the economic rent analysis. Where economic rent from these activities is significantly higher than that from roundwood production, this should be reflected in the levies set by *LBB* or *SBB*.

[13] There is certainly some *prima facie* evidence of this. For example one forest concessionaire interviewed stated that he has to pay a much higher rate for loading and unloading to his contractor if the wood is destined for export rather than his sawmill (see: Whiteman, 1999).

3 CALCULATION OF ROUNDWOOD PRODUCTION COST

This section of the report presents the calculation of roundwood cost for a "typical" or “representative” forest harvesting operation in Suriname. The section starts by describing the likely scale and level of productivity of the "typical" forest operation, based on information collected during the study. It then goes on to describe how roundwood production cost can be calculated using the harvesting cost model developed for this study. It finishes by summarising the results and showing the relative importance of the various components of the total production cost.

3.1 The scale and location of a typical forest operation in Suriname

The majority of forest operations in Suriname are small-scale logging operations managed either by small to medium-sized sawmills or some of the larger independent logging companies. Mitchell (1998) shows that the average size of the old or former forest concessions in Suriname (many of which are still being logged) is about 12,000 ha. Assuming a cutting cycle of 20 years, this would suggest that about 600 ha[14] is logged each year. Other information collected during this study (Whiteman, 1999) indicated that harvesting intensity in most of Surinam's natural forest varies between 12 m^3/ha to 20 m^3/ha, with a central value of probably around 16 m^3/ha. Thus, taking the central estimate and multiplying it by 600 ha would suggest that production in a "typical" forest concession might be in the order of 9,600 m^3/year.[15]

Most of the former forest concessions in Suriname are located in the "forest belt". This strip starts between 5 km and 20 km from the coast and reaches up to 80 km to 100 km inland. A few sawmills are located within the forest or part of the way up some of the larger rivers reaching into the interior of Suriname. But, the majority of them are located in the coastal towns of Paramaribo, Nickerie, and Moengo. Based on the location of most sawmills and former forest concessions therefore, it has been assumed that the average haulage distance from forest to sawmill is 85 km and that all roundwood is transported entirely by road.

The above assumptions are very general. Many forest concessions are currently working at far less than potential productive capacity (as are many of the sawmills). Some forest concessions also re-load roundwood onto barges or pontoons and transport it by river to sawmills. However, the above assumptions have been used as a reasonable base-case scenario to show what the costs of a "typical" forest operation might look like and demonstrate how the harvesting cost model works.

3.2 Data used in the harvesting cost model for a typical forest operation

The harvesting cost model comprises six spreadsheets within an Excel workbook. The first sheet presents the overall results of the analysis and the other five sheets are used to enter information about the forest operation in order to calculate production or harvesting cost. The data entered into each of these sheets is explained below.

3.2.1 Sheet 2: Miscellaneous data

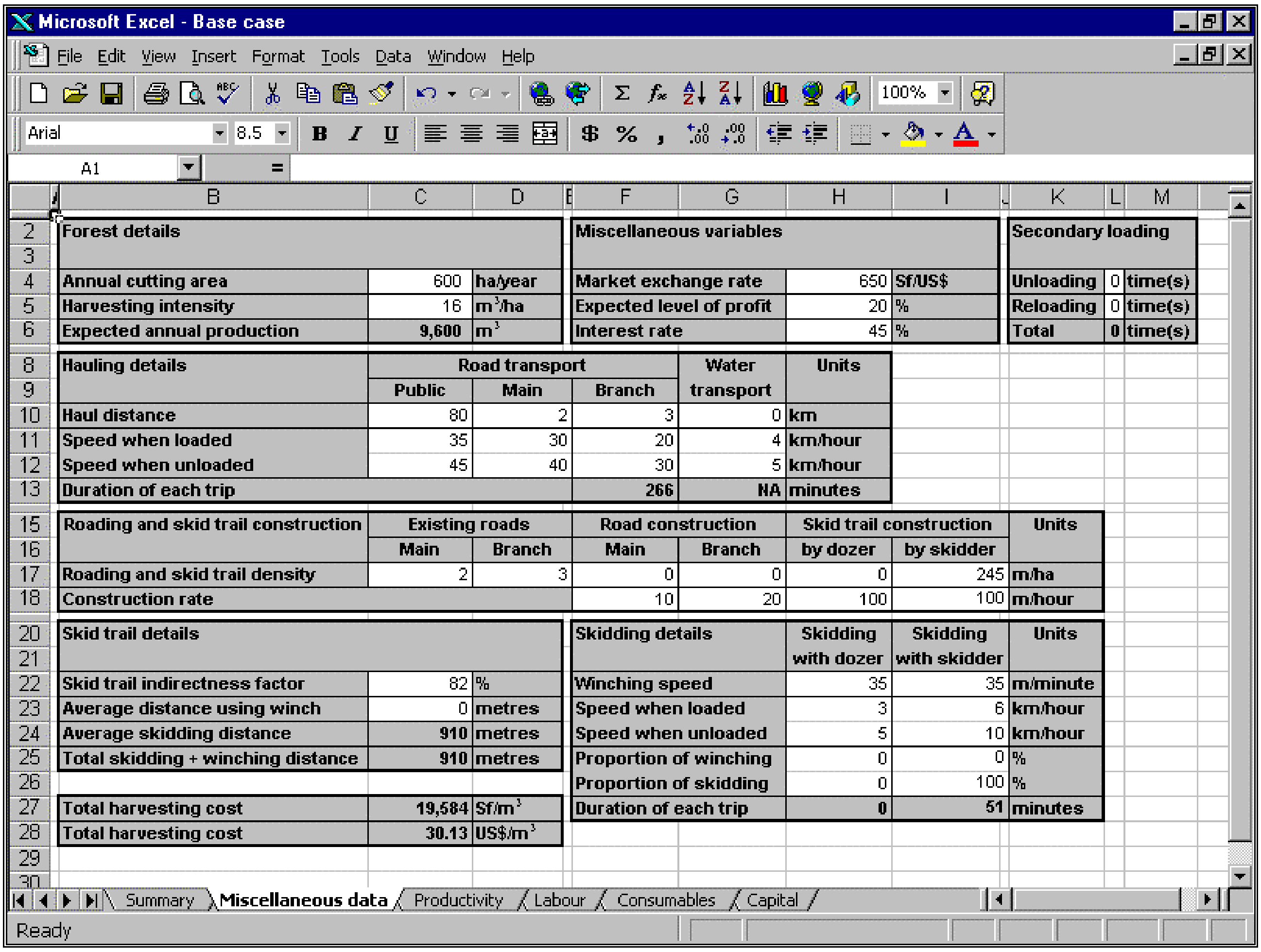
The second sheet in the harvesting cost model is used to enter general information about the forest concession such as: information about forest area and stocking; haulage distances; skidding distances; the number of times roundwood is unloaded and re-loaded; and miscellaneous variables such as the exchange

14 ie. 12,000 ha divided by 20.

15 This is quite high considering the current levels of capacity utilisation in many of Suriname's sawmills. There are 68 sawmills in Suriname with a roundwood input capacity of at least 600,000 m^3/year (Whiteman, 1999). This would give an average annual roundwood input of 8,800 m^3/year per mill. But, current capacity utilisation is estimated to be around 50% to 60%, suggesting that most sawmills are probably only consuming in the order of 4,850 m^3/year of roundwood. However, considering that some roundwood is exported, that the market is currently very depressed and that some roundwood is sold from forest concessions to other processors, the above assumptions are reasonable for a “typical” scenario.

rate, interest rates and the required rate of return. A copy of the second sheet for the base-case scenario is shown in Figure 1.

Figure 1 A copy of the second sheet of the harvesting cost model showing miscellaneous data entered into the model



Forest details		
Annual cutting area	600	ha/year
Harvesting intensity	16	m^3/ha
Expected annual production	9,600	m^3

Miscellaneous variables		
Market exchange rate	650	Sf/US$
Expected level of profit	20	%
Interest rate	45	%

Secondary loading		
Unloading	0	time(s)
Reloading	0	time(s)
Total	0	time(s)

Hauling details	Road transport			Water	Units
	Public	Main	Branch	transport	
Haul distance	80	2	3	0	km
Speed when loaded	35	30	20	4	km/hour
Speed when unloaded	45	40	30	5	km/hour
Duration of each trip			266	NA	minutes

Roading and skid trail construction	Existing roads		Road construction		Skid trail construction		Units
	Main	Branch	Main	Branch	by dozer	by skidder	
Roading and skid trail density	2	3	0	0	0	245	m/ha
Construction rate			10	20	100	100	m/hour

Skid trail details		
Skid trail indirectness factor	82	%
Average distance using winch	0	metres
Average skidding distance	910	metres
Total skidding + winching distance	910	metres
Total harvesting cost	19,584	Sf/m^3
Total harvesting cost	30.13	US$/$m^3$

Skidding details	Skidding with dozer	Skidding with skidder	Units
Winching speed	35	35	m/minute
Speed when loaded	3	6	km/hour
Speed when unloaded	5	10	km/hour
Proportion of winching	0	0	%
Proportion of skidding	0	100	%
Duration of each trip	0	51	minutes

The level of expected annual production (discussed above) is calculated in cell C6 from the annual cutting area and harvesting intensity (entered into cells C4 and C5). The market exchange rate used for the whole of this analysis is Sf 650 to US$ 1.00 and this is entered into cell H4. The market interest rate in Suriname is currently around 45% and this is entered into cell H6.[16] The expected level of profit is the required rate of return on capital or mark-up on other expenditure which has been used in the analysis. In other words, this is the level of normal profit which forest concessionaires should be allowed to retain. Based on discussions with *LBB*, *SBB*, forest managers and sawmillers, this has been set at 20% and is entered into cell H5.[17]

Information about transportation is entered into rows 10 to 12. Distances travelled on each of the different types of road: public road; main forest road; and branch forest road, are entered into cells C10, D10 and F10 respectively. In the base case, these distances are assumed to be 80 km, 2 km and 3km respectively (giving the overall total distance of 85 km as discussed above). Travelling speeds are entered for each type of road below the distance. The speed when loaded is entered into row 11 and the return speed when empty is

16 Information about interest rates were collected as part of this study and are discussed in Whiteman (1999). Currently interest rates are so high that it is suspected that no forest companies are taking on loans. Therefore, this analysis has also assumed that there is no use of external financing in the forestry sector (although the model can accomodate such a development should it occur).

17 The impact on roundwood production cost of changing the level of normal profit can be easily examined by changing the figure in this cell.

entered into row 12. It has been assumed that timber trucks can travel at 35 km/h, 30 km/h and 20 km/h on public, main and branch roads respectively, when loaded and 10 km/h faster when unloaded. These assumptions about travelling speeds were made on the basis of field observations and discussions with forest managers. The total duration of one trip (from forest to sawmill and back) is calculated in cell F13. Similar information can be entered for barges or pontoons in column G if water transport is also necessary (assumed not to be the case in the base case scenario).

Information about road and skid trail construction is entered into rows 17 and 18 of the model. The existing length of forest roads in the forest concession is entered into cells C17 and D17. The figures are entered in terms of the roading density or the length or roads per hectare of forest (in m/ha).[18] The length of forest roads in Suriname is currently unknown, but believed to be relatively small in comparison with the area of forest concessions. Therefore, a relatively low density of 5 m/ha in total (2 m/ha main roads and 3 m/ha branch roads) has been assumed in the analysis (cells C17 and D17). Also, very few forest managers are currently building forest roads, so it has been assumed that new road building is zero (cells F17 and G17). Cells F18 and G18 show the construction rate for new road building in terms of length of road construction per hour (in m/hour). These figures would determine the cost of road building later on in the model. However, because cells F17 and G17 are set to zero, the part of the model that calculates the cost of road building is not activated.

The lengths of skid trails constructed by bulldozer and/or skidder are shown in cells H17 and I17. The model will work with skid trails constructed by bulldozer (e.g. Caterpillar D6) or skidder or a combination of both machines. The base case scenario assumes that a typical forest concession only uses skidders for skid trail construction and skidding.

The length of skid trails constructed will depend upon several factors including: roading density; distance between skid trails; forest stocking; the degree of skid trail planning; and site factors such as terrain. A model was constructed to estimate skid trail construction and skidding lengths for a range of combinations of these variables. Based on current forest harvesting practices, this model determined that the typical amount of skid trail construction Suriname is currently about 245 m/ha. Discussions with forest managers and site visits suggested that skid trails could be constructed at a rate of 100 m/hour and this is entered into cell I18.

The average skidding distance is calculated in cell C24. This is calculated from the average skidding distance (which is itself calculated from the roading density - see Box 2), adjusted by the indirectness factor entered into cell C22. A figure of 82% was entered into the model based on the skidding model results. The resulting average skidding distance of 910m is very long, but was confirmed to be probably about right in discussions with forest managers and staff of *LBB* and *SBB*. To reduce skid trail construction costs and site damage, it is possible to winch felled roundwood to the skid trail and the average winching distance can be entered into cell C23. This is not, however, currently common practice in Suriname, so a value of zero was entered into this cell in the base case scenario.

The speed of winching and skidding should be entered into cells H22 to I24. Skidders are used for skidding in the base case scenario and the winch isn't used, so the only figures which are used in later calculations are the skidder's speed when loaded (cell I23) and speed when unloaded (I24). Figures of 6 km/h and 10 km/h were entered into these two cells respectively, based on the machine performance figures quoted in the Caterpillar Handbook (Caterpillar, 1996). The proportions of skidding and winching performed by skidder and bulldozer are entered into cells H25 to I26. Zero is entered into cells H25 and I25 because winching is not used and zero is entered into cell H26 and 100 into cell I26, because only skidders are used for all skidding operations.

[18] These figures do not necessarily bear any relationship to the haulage distance over forest roads shown in cells D10 and F10. The numbers used in the base case scenario are the same purely by coincidence.

The total average duration of each skidding trip (including the average time to construct necessary extensions to the length of skid trails) is shown in cells H27 and I27. This is calculated from: the total skidding and winching distance; skidding and winching speeds; and the length and speed of skid trail construction discussed above. This result is only calculated for a skidder because only skidders are used in the base case scenario.

The last piece of information required on this sheet is the number of times roundwood has to be unloaded and re-loaded in cells L4 and L5. This is used to calculate secondary loading costs later on in the model. For example, if roundwood has to be unloaded at a riverside and loaded again onto barges, a figure of one has to be entered into each of these cells. It is assumed in the base case scenario, that timber is transported directly by road to the sawmill, so a figure of zero is entered into both of these cells.

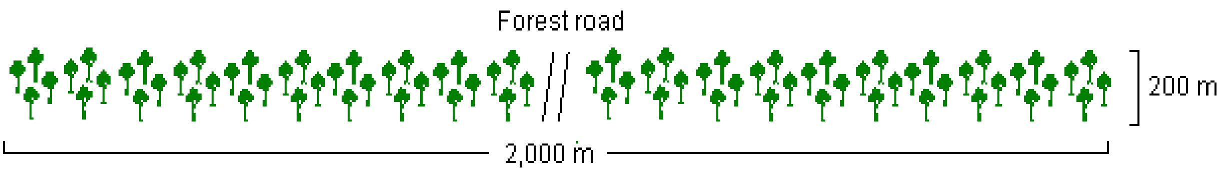
For information, the total roundwood production cost in Sf and US$ (including an allowance for normal profit) is also shown in cells C27 and C28 on this sheet.

Box 2 The calculation of average skidding distance from roading density and the indirectness factor

The calculation of average skidding distance from roading density and the skidding indirectness factor is explained below using the example of the base case scenario.

The average theoretical skidding distance

The easiest way to visualise the calculation of the average theoretical skidding distance from roading density is to think of strips of forest served by skid trails leading on to forest roads. Thus, for example, assuming that main skid trails are 200m apart and that roading density is 5 m/ha, two main skid trails, one off each side of a 200m segment of forest road, must serve 40 ha (200 m divided by 5 m/ha). The length of road is the length of one side of the strip of forest served by the road so, from the total area (ie. 40 ha), the length of the strip can be determined. One hectare equals 10,000 m^2, so 40 ha equals 400,000 m^2 and, if the road side is 200 m long, the length of the strip of forest served by the road must be 400,000 m^2 divided by 200 m, which equals 2,000 m. This is shown in the figure below:



The total length of the strip on each side of the road is 1,000 m, so the centre of the strip on each side of the road and, hence, the average theoretical skidding distance is 1,000 m divided by two, which equals 500 m. More generally, the theoretical skidding distance can be calculated using the formula below:

$$\text{Theoretical skidding distance (in metres)} = \frac{2{,}500}{\text{roading density (in m/ha)}}$$

The skidding indirectness factor

In reality of course, it is very difficult to achieve the average theoretical skidding distance because site factors such as steep areas and streams make it necessary to deviate from the most efficient route to each tree. Poor skid trail layout can also lead to a large amount of deviation from the most efficient route. Therefore, the above calculation is usually multiplied by an indirecness factor to take into account these considerations.

A model was constructed for this study to examine the impacts of stocking, skid trail layout and roading density on skidding length, which suggested that, in the base case scenario, a high level of indirectness (82%) would probably be typical in forest concessions in Suriname. The final average skidding distance shown in sheet 2 of the harvesting cost model is therefore, equal to the theoretical average skidding distance plus this factor which, with a roading density of 5 m/ha, equals 500 m x (100% + 82%), which equals 910 m.

3.2.2 Sheet 3: Productivity

The third sheet in the harvesting cost model contains information about rates of machine productivity for each of the various forest harvesting activities. The purpose of this sheet is to estimate the amount of capital equipment needed to produce the annual volume of roundwood production specified in sheet 2. A copy of the sheet, showing the information about productivity entered into the model for the base-case scenario, is shown in Figure 2.

Figure 2 A copy of the third sheet of the harvesting cost model showing information about productivity entered into the model

Microsoft Excel - Base case

E16 = =IF('Miscellaneous data'!I27=0,"NA",+E15/E13)

Productivity information	Machine productivity and utilisation: Felling	Skidding with dozer	Skidding with skidder	Loading	Road transport	Unloading & reloading	Water transport	Road building	Units
Number of working days	200	200	200	200	200	200	200	200	days/year
Number of working hours	8	8	8	8	8	8	8	8	hours/day
Average machine availability	90	90	90	90	90	90	90	90	%
Available working hours	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	hours/year/unit
Unproductive time		10	10		30		300		minutes/trip
Unproductive time	30	NA	10	10	6	10	NA	10	minutes/hour
Effective working hours	720	NA	1,205	1,200	1,294	NA	NA	NA	hours/year/unit
Output rate		4	4		20		200	NA	m^3/trip
Output rate	8	NA	5	40	5	40	NA	NA	m^3/hour
Number of machines/crews	2.00	1.00	2.00	1.00	2.00	1.00	1.00	1.00	units
Annual production per unit	4,800	NA	4,800	9,600	4,800	NA	NA	NA	m^3/unit
Actual working hours	600	NA	1,026	240	1,063	NA	NA	NA	hours/year/unit
Average machine utilisation	83	NA	85	20	82	NA	NA	NA	%

Summary / Miscellaneous data / Productivity / Labour / Consumables / Capital

Ready

The model is designed with the assumption that most forest managers will use their own equipment for production. Therefore, a certain amount of flexibility has been built into the model to reflect different circumstances. For example, the amount of skidding by bulldozer can be set to zero on sheet 2 (the previous sheet), in cases where all skidding is done by skidder (as in the base case scenario). If this is done, all further cost calculations under the activity: "Skidding by bulldozer" are set to "NA" (i.e. not applicable) irrespectively of the cost data entered into cells under this activity. Alternatively, skidding by bulldozer could be set to 100% on sheet 2 and skidding by skidder could be set to 0%, in which case all calculations under the activity: "Skidding by skidder" would show "NA". Similarly, transport distances by road or by water can be set to zero on sheet 2, depending on how roundwood is transported from the forest to the sawmill or harbour. In the base case scenario it is assumed that all haulage is by road, so costs results under the activity: "Water transport" are set to "NA". The same is true of "Unloading and re-loading" and "Road building" under the base case scenario.

The only activities that absolutely must be specified in this part of the model are "Felling" and "Loading" (or else the model will not calculate results). In cases where these activities are carried-out by contractors, the costs of these services can simply be substituted for the costs of these activities calculated by the model, when the final results are calculated. Similarly, the cost of other contracted services can also be used to calculate the total cost in the final analysis, where these activities are contracted-out.

Machine productivity is a combination of several factors, including: the number of hours worked each year; the amount of time machinery is unavailable for work due to repairs; the amount of time it takes to perform essential functions such as refuelling; and the rate of production when the machine is actually working. This spreadsheet calculates productivity and machine utilisation based on information entered into the model about each of these factors.

Information required to calculate the number of hours a machine is available to do work each year is entered into rows 5 to 7 of the productivity sheet. The number of working days is entered into row 5 of the model for each activity and the number of working hours per day is entered into row 6. Discussions with forest managers and staff from *LBB* and *SBB* suggested that 200 working days per year and an 8 hour working day were normal practice in Suriname and these figures have been used in all the analysis presented in this study.[19] Average machine availability is the amount of time that machines are not broken-down or away from the forest for servicing and repairs. Although most of the harvesting machinery in Suriname is quite old, the scarcity of machinery ensures that forest managers try to reduce work stoppages due to breakdowns, servicing and repairs. Therefore, a relatively high value of 90% has been used in this analysis. The number of available working hours each year is calculated in row 8 of the sheet, using the following formula:

$$\textbf{available working hours each year} = \textbf{number of working days per year} \times \textbf{number of working hours per year} \times \textbf{average machine availability}$$

The number of available working hours represents the amount of time each year that each machine is fully functioning and ready to perform harvesting activities.

In addition to major break-downs, servicing and repairs, there are other time losses in the operation of machinery due to factors such as: breaks and rest periods for staff; refuelling and minor on-site maintenance operations; and time spent waiting for other parts of the harvesting operation to complete their activities. For example, timber trucks have to wait to be loaded every time they make a trip. The time that a piece of machinery is capable of working after such losses have been taken into consideration is called its effective working hours.

Information required to calculate effective working hours is entered into rows 9 and 10 of the sheet. For some machinery, it is easier to think of unproductive time in terms of unproductive time per trip (e.g. the time taken to load a timber lorry or the time taken to attach logs to the back of a skidder) and this is entered into row 9. For other pieces of machinery, it is simpler to think in terms of unproductive time per hour (e.g. the average amount of time per hour which tree fellers take to walk between trees, take breaks and refuel and maintain their chainsaws). Where this is the case, this information is entered into row 10 of the model. For activities where unproductive time is entered in terms of time per trip, this is converted to an average time per hour in row 10, based on the average duration of trips shown on sheet 2.

The figures entered into these rows for each of the harvesting activities in the base case scenario, were based on discussions with forest managers, the staff of *LBB* and *SBB* and the author's previous experience in this area.[20] They have also been kept the same throughout the analysis.

The number of effective working hours each year for every harvesting activity is calculated in row 11 of the sheet, using the following formula:

[19] These figures do, however, seem low compared with forest concessions in many other countries.

[20] However, as noted in Whiteman (1999), productivity rates in forest operations in Suriname are currently not known with any degree of accuracy. It may be beneficial for the development of the sector generally, to examine current productivity rates and see how they can be improved.

$$\text{effective working hours each year} = \text{available working hours each year} \times \frac{60 - \text{unproductive time (in minutes per hour)}}{60}$$

The number of effective working hours represents the amount of time each year that each machine is fully functioning and capable of performing harvesting activities.

The last pieces of productivity information are entered into rows 12 to 14 of the sheet. Rows 12 and 13 are used to enter information about the volume of timber that can be handled by each piece of machinery either by the trip (row 12) or by the hour (row 13). Again, information entered on a trip basis is also converted into an hourly figure, based on average trip duration. It is important to note that this information should be entered in terms of productivity assuming no stoppages for breaks, maintenance and refuelling etc. Thus, for example, the productivity of felling has been entered as 8 m^3/hour on the basis that an average tree is 2 m^3 in volume and that it takes 15 minutes to fell, delimb and cross-cut a tree. The time taken to walk between trees, refuel and maintain the chainsaw and breaks, is accounted for in the calculation of effective working hours.

The figures used in the base case scenario are based on discussions with forest managers, staff of *LBB* and *SBB* and field observations at the *Bruynzeel* forest concession. Felling productivity was explained above. The productivity of skidders and bulldozers is based on an average tree volume of 2 m^3 and two trees per skidding journey. The productivity of loaders is based on observations of the loader employed at *Bruynzeel*. Productivity of road transport and water transport is based on the average capacity of timber trucks, barges and pontoons currently used in Suriname. The average capacity of most timber trucks used in Suriname is quite low and this will increase the roundwood production cost compared to what could be achieved with more efficient forest operations. The productivity of road building machinery is not expressed in terms of m^3 production, so this information is not presented here. Rather, in the case of road building machinery, capacity utilisation is a function of the time taken to build roads and the planned roading density (shown on sheet 2) and this is used to calculate machine utilisation on this sheet.

The number of machines used in the forest concession is entered into row 14. This variable is changed until average machine utilisation is reasonable. Annual production per unit is shown in row 15 and is calculated by dividing the annual production shown on sheet 1 by the number of machines used (above).

Actual working hours, shown in row 16, is calculated by dividing the annual production per unit (in row 15) by the hourly output rate (in row 13). This represents the amount of time that each machine must operate in order to produce the output shown in row 15. This figure is used later on to calculate consumption of consumable items such as fuel and lubricants.

Average machine utilisation is shown in row 17 and is calculated as:

$$\text{Average machine utilisation} = \frac{\text{Actual working hours}}{\text{Effective working hours}}$$

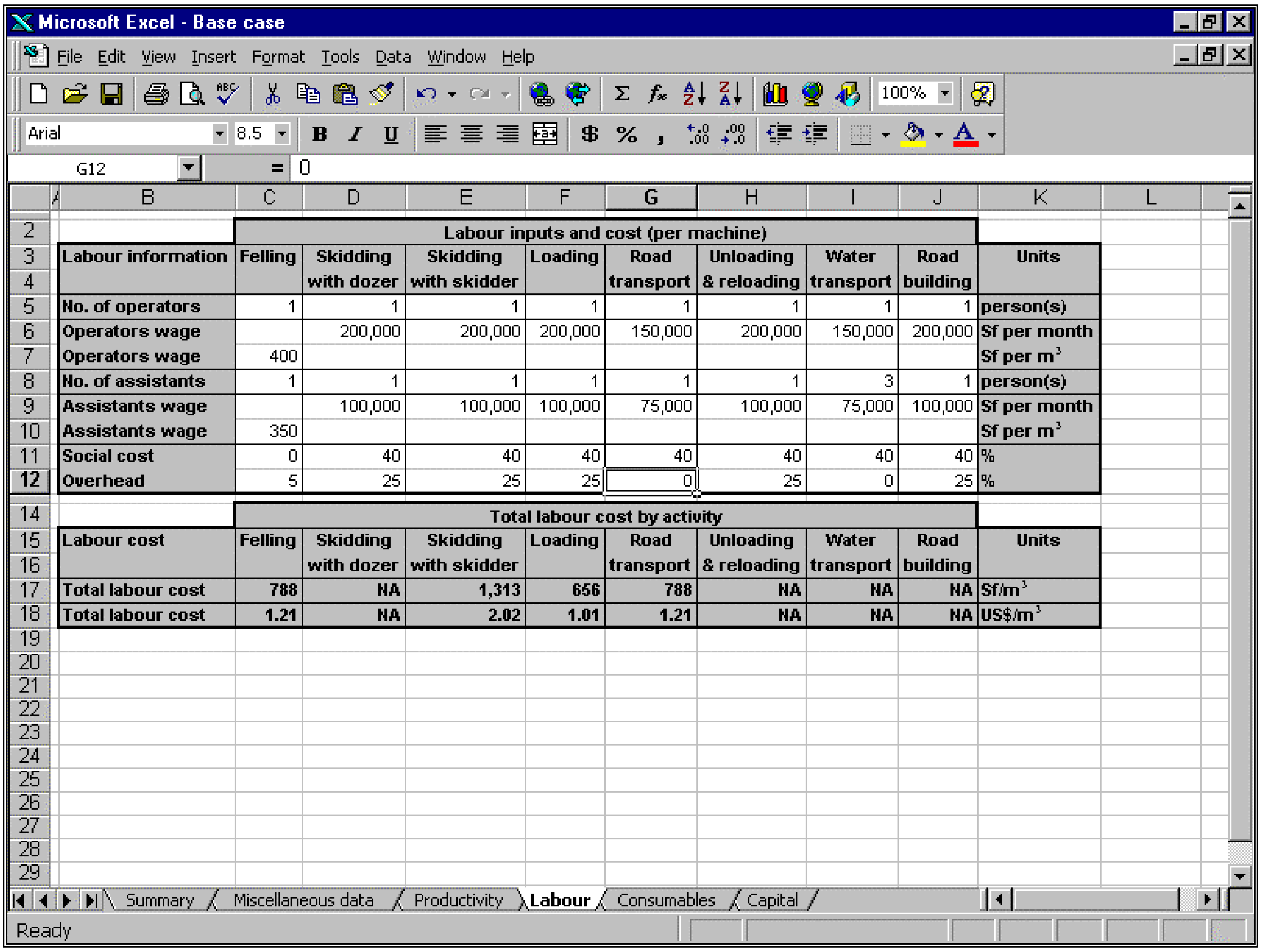
This represents the proportion of effective machine time that is actually used in the forest operation. A utilisation rate of over 100% would indicate that the amount of work required is greater than the time available. Therefore, the number of machines specified in row 14 must be adjusted until the utilisation rate is reasonable (i.e. in most cases - less than 100%, although it may be possible to have machine utilisation of somewhat more than 100% if operators work overtime). For example, one skidder in the base-case scenario would have to work for 2,052 hours to extract 9,600 m^3 of timber in a year, but the number of effective working hours is only 1,205 hours (which would give a utilisation rate of 170%). Therefore, two skidders must be used in the forest operation.[21]

[21] It is also quite possible that some forest concessions will have many more pieces of equipment than are needed for their current levels of production. In such cases, their levels of equipment can be entered into the model to see what effect such overcapitalisation has on average machine utilisation and harvesting cost.

3.2.3 Sheet 4: Labour

The fourth sheet in the harvesting cost model contains information about the cost of labour inputs used in each of the various forest harvesting activities. A copy of the sheet, showing the information about labour costs entered for the base-case scenario, is shown in Figure 3.

Figure 3 A copy of the fourth sheet of the harvesting cost model showing information about labour costs entered into the model



Labour inputs and cost (per machine)

Labour information	Felling	Skidding with dozer	Skidding with skidder	Loading	Road transport	Unloading & reloading	Water transport	Road building	Units
No. of operators	1	1	1	1	1	1	1	1	person(s)
Operators wage		200,000	200,000	200,000	150,000	200,000	150,000	200,000	Sf per month
Operators wage	400								Sf per m^3
No. of assistants	1	1	1	1	1	1	3	1	person(s)
Assistants wage		100,000	100,000	100,000	75,000	100,000	75,000	100,000	Sf per month
Assistants wage	350								Sf per m^3
Social cost	0	40	40	40	40	40	40	40	%
Overhead	5	25	25	25	0	25	0	25	%

Total labour cost by activity

Labour cost	Felling	Skidding with dozer	Skidding with skidder	Loading	Road transport	Unloading & reloading	Water transport	Road building	Units
Total labour cost	788	NA	1,313	656	788	NA	NA	NA	Sf/m^3
Total labour cost	1.21	NA	2.02	1.01	1.21	NA	NA	NA	US$/$m^3$

Most forest harvesting machinery is operated by a machine operator with one or more assistants. The number of operators and assistants used per machine is entered in rows 5 and 8 of this sheet, under each harvesting activity. Generally, most machinery in Suriname is operated by a crew of one machine operator and one assistant. The exception to this is barges, which may use more than one assistant to help operate the vessel.

Rates of pay for these workers can be entered in two ways. Monthly pay rates can be entered in row 6 (for the machine operators) and row 9 (for assistants). Alternatively, if workers are paid on a piece-rate system, the payment per m3 produced can be entered into rows 7 and 10. If figures are entered for both alternatives by mistake, the piece-rate figures are used in the calculation of total labour cost shown at the bottom of the sheet.

The pay rates entered into this sheet for the base-case scenario were based on information collected from forest managers (see Whiteman, 1999). Many forest managers use local villagers to cut timber and pay them Sf 750/m^3 in total, so this figure was used in the base-case scenario. Most other operations are performed by salaried staff and the figures shown in Figure 3 are believed to reasonably reflect current rates of pay in the forestry sector in Suriname.

In addition to the direct labour costs in forest operations, there are also two other costs that must be considered. They can be described as follows:

> **Social cost.** The social cost of employment is the additional cost of: insurance; sickness benefits; medical benefit; and (sometimes) housing benefits and food allowances, given to employees. Some of these benefits (e.g. medical benefits) may extend to the whole family of the employee.
>
> **Overhead.** The overhead on top of direct labour costs includes other costs of employment such as the cost of camping equipment and transport to and from the forest, where the employer provides these facilities. It can also include such items as the cost of employing additional staff not directly working in the forest, such as: the exploitation manager; security staff; clerical staff; drivers and other assistants.

A figure of 40% was commonly quoted as the social cost of employment and this figure was applied to the cost of all harvesting activities in the base-case scenario except felling (where it is doubtful whether such benefits are extended to local villagers)[22]. These figures were entered into row 11 of the model.

Two main overhead costs were considered in the base-case scenario: the cost of providing camp equipment for workers who have to stay overnight in the forest; and the cost of transporting workers to and from the forest. Rough calculations indicated that the former cost might add around 5% onto the direct cost of employment and the latter might add a further 20%. Therefore, an overhead figure of 5% was included in the base-case scenario for felling activities (local villagers camp in the forest, but tend to live fairly close, such that transportation is not likely to be very expensive). A figure of 25%, to cover camping and transportation, was included for all other workers who have to stay in the forest. These figures were entered into row 12 of the sheet.

Other overhead costs such as additional staff (e.g. exploitation manger and clerical staff) were not considered, because only the largest forest operations tend to employ such workers. Where these functions have to be performed in small to medium-sized forest operations, they are usually carried-out by staff of the sawmill.

The total labour cost of production, by activity, is shown in Sf/m^3 and US$/$m^3$, in rows 17 and 18 of the sheet. For activities paid on a piece-rate basis, this is calculated as the operator's and assistant's payments (per m^3), multiplied in each case by the number of operators and assistants used in the activity, then multiplied again by (1 + Social cost % + Overhead %). For salaried staff, this is calculated as the annual staff cost for one machine (i.e. (number of operators x operator's monthly salary) + (number of assistants x assistant's monthly salary), all multiplied by 12), divided by annual production per machine (from sheet 3), then multiplied again by (1 + Social cost % + Overhead %).

3.2.4 Sheet 5: Consumables

The fifth sheet in the harvesting cost model contains information about the cost and rates of consumption of consumables used in each of the various forest harvesting activities. A copy of the sheet, showing the information about consumable costs entered for the base-case scenario, is shown in Figure 4.

The information which has to be entered into this sheet falls into broadly three categories: fuel and lubricant costs and consumption; the consumption and cost of filters, tracks or tyres and other minor parts; and the cost and consumption of other miscellaneous items such as tools, protective clothing and miscellaneous items.

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22 It should be noted that, in the author's opinion, there is considerable uncertainty about this figure. It is suspected that this figure of 40% was once calculated at *Bruynzeel* (who are the only forest operation with anything like adequate record-keeping) and has been used in these sorts of calculations ever since. However, in the absence of any better information, this figure is probably a reasonable estimate to use in this analysis.

Figure 4 A copy of the fifth sheet of the harvesting cost model showing information about consumable costs entered into the model

Microsoft Excel - Base case

	Unit cost		Felling	Skidding with dozer	Skidding with skidder	Loading	Road transport	Unloading & reloading	Water transport	Road building	Units
			Fuel consumption (per machine)								
Fuel and lubricants	**Unit cost**		**Felling**	**Skidding with dozer**	**Skidding with skidder**	**Loading**	**Road transport**	**Unloading & reloading**	**Water transport**	**Road building**	**Units**
Petrol	200	**Sf/litre**	3.00								**litre/hour**
Diesel	180	**Sf/litre**		25.00	20.00	20.00	30.00	20.00	50.00	35.00	**litre/hour**
Oils	1,000	**Sf/litre**	2.50	0.25	0.13	0.11	0.30	0.11	0.50	0.27	**litre/hour**
Grease	1,000	**Sf/litre**	0.25	0.02	0.02	0.01	0.02	0.01	0.05	0.02	**litre/hour**
Other lubricants	1,000	**Sf/litre**	0.25	0.04	0.08	0.05	0.02	0.05	0.02	0.05	**litre/hour**
			Cost of other minor parts and equipment (per machine)								
Other consumable items			**Felling**	**Skidding with dozer**	**Skidding with skidder**	**Loading**	**Road transport**	**Unloading**	**Water transport**	**Road building**	**Units**
Air filter			10	12	12	12	15	12	15	12	**Sf per hour**
Fuel filter			10	20	20	20	15	20	15	20	**Sf per hour**
Oil filter			10	30	30	30	20	30	20	30	**Sf per hour**
Other filters			0	10	10	10	0	10	0	10	**Sf per hour**
Tracks or tyres			0	2,975	2,160	2,320	6,800	2,320	0	4,890	**Sf per hour**
Other minor parts			140	900	900	80	45	80	80	900	**Sf per hour**
Tools			25,000	50,000	50,000	50,000	50,000	50,000	40,000	50,000	**Sf per year**
Clothing			0	0	0	0	0	0	0	0	**Sf per year**
Other consumable items			0	60,000	60,000	60,000	40,000	60,000	100,000	60,000	**Sf per year**
			Total consumable cost by activity								
Consumable cost			**Felling**	**Skidding with dozer**	**Skidding with skidder**	**Loading**	**Road transport**	**Unloading & reloading**	**Water transport**	**Road building**	**Units**
Total consumable cost			**476**	**NA**	**1,511**	**168**	**2,818**	**NA**	**NA**	**NA**	**Sf/m^3**
Total consumable cost			**0.73**	**NA**	**2.33**	**0.26**	**4.33**	**NA**	**NA**	**NA**	**US$ per m^3**

Summary / Miscellaneous data / Productivity / Labour / **Consumables** / Capital

The unit cost of fuels and lubricants is entered into cells C5 to C9 (in Sf per litre). These costs were taken directly from list prices collected in Suriname (see: Whiteman, 1999). The rate of consumption of each of these inputs were taken from the Caterpillar Handbook (Caterpillar, 1996) and *Bruynzeel's* records (e.g. for the use of fuels and lubricants in chainsaws) and were entered into rows 5 to 9 of the sheet, under each of the harvesting activities. These costs and rates of consumption are standard throughout the whole analysis.

The cost of filters, tracks or tyres and other minor parts[23] are entered into the model in terms of the average cost in Sf per actual working hour, in rows 14 to 19. The hourly cost of these items was calculated by dividing the cost of each item (collected in Suriname) by the estimated life of each item (estimated from the Caterpillar Handbook and *Bruynzeel's* records). For example, the cost of an air filter for a skidder or loader is about Sf 8,000. Skidders and loaders have two air filters: one has to be replaced every 2,000 hours and the other has to be replaced every 1,000 hours. In other words, three air filters have to be replaced every 2,000 working hours.

Thus, the total hourly cost of air filters for a skidder or loader was calculated as follows:

$$\textbf{Hourly cost of air filters} = \frac{\textbf{number of air filters changed x cost of an air filter}}{\textbf{number of working hours that the filters are used}}$$

23 Minor parts include items such as winch cables on skidders, batteries on all types of large machinery and replacement chainsaw bars and chains.

$$= \frac{3 \times Sf\ 8{,}000}{2000\ hours} = Sf\ 12/hour$$

Using the above formula, the hourly cost of all such parts was calculated for every piece of equipment used in the forest operation.[24]

The cost of tools, clothing and other consumable items[25] are entered into the model in terms of the average annual cost in Sf per year, in rows 20 to 22. These were estimated from cost information collected locally and a rough approximation of annual use.[26]

The total labour cost of production, by activity, is shown in Sf/m^3 and US$/$m^3$, in rows 27 and 28 of the sheet. Total annual fuel and lubricant cost was calculated by multiplying the unit cost (cells C5 to C9) by hourly consumption (rows 5 to 9) and the number of actual working hours shown on sheet 2 and then adding all these items together. Total annual filters, tyres, tracks and other minor parts cost was calculated by multiplying the cost of each of these items (rows 14 to 19) by actual working hours and adding them together. The total annual cost of other consumable items was calculated by adding together the costs shown in rows 20 to 22. These three annual costs were then added together and divided by annual production per machine (on sheet 2) to give the total consumable cost per m^3 for each activity, shown in rows 27 and 28.

3.2.5 Sheet 6: Capital

The sixth sheet in the harvesting cost model contains information about the cost of capital equipment used in each of the various forest harvesting activities. A copy of the sheet, showing the information about capital costs entered for the base-case scenario, is shown in Figure 5. The calculations in this sheet are far more complicated than in the other sheets in the model and some of the data entered into this sheet was derived from other calculations. These will be explained below.

The first piece of information required about each activity, is the type of machinery usually used (entered into row 5) and its purchase price (entered into row 6). The types of machinery specified throughout this analysis are shown in Figure 5. These machinery types (or very similar alternatives) are believed to be those most commonly used in forest operations in Suriname.

Most forest machinery in Suriname is quite old so, ideally, the second-hand or resale price of such machinery should be used in the analysis as the measure of machinery cost. But, very little machinery is bought or sold each year, so it was impossible to get hold of such data. However, it was possible to get list prices and rough estimates of the price of equivalent new pieces of machinery used in each of the forestry harvesting activities and these were entered into row 6 of the sheet. In order to estimate the current value of harvesting machinery, the average age of such machinery was also entered into row 8.

The depreciation rate for each piece of machinery is the amount by which its value reduces for every year older it gets, expressed as a percentage per year. Estimates of depreciation were calculated from resale price information collected from international sources (see: Whiteman, 1999). An explanation of these

24 The reason why the cost of replacing these items is entered here rather than as a general repair cost in another part of the model, is that they wear out on a fairly regular basis irrespectively of how old a machine is. For example, the number of air filters which have to be replaced every 2,000 working hours is the same for a new machine as it is for a 10 year old machine. However, as will be shown later, the older machine is likely to have much higher repair costs. Tracks and typres are also treated in this way, because they will wear-out depending on site conditions and terrain rather than the age of the machine. For example, tyres on an old machine working in easy terrain might last much longer than the same tyres on a new machine working in difficult terrain.

25 Other consumable items include items used for everyday maintenance, such as: cleaning materials and paint.

26 Basically, the cost of a typical toolkit for each type of machine was estimated and it was assumed that this would have to be replaced every year. Similarly, it was assumed that most machines would be repainted every year and cleaned every week.

calculations is given in: *Section 3.2.6 Calculation of the estimated depreciation rates used in the analysis*. The values calculated in this way were entered into row 7 of the model.

Figure 5 A copy of the sixth sheet of the harvesting cost model showing information about capital costs entered into the model

Consumption of capital, major repairs and insurance (per machine)									
Machine information	Felling	Skidding with dozer	Skidding with skidder	Loading	Road transport	Unloading & reloading	Water transport	Road building	Units
Machine type	Stihl 80	Cat D6	Cat 518	Cat 950	10t truck	Cat 950	Barge	Cat D8	
Purchase price (new)	1,000	280,000	210,000	235,000	200,000	235,000	165,000	500,000	US$
Depreciation rate	25.0	6.9	8.2	3.9	13.7	3.9	3.0	6.9	%/year
Current age	2	15	12	15	10	15	10	20	years
Current value	563	95,808	75,220	129,395	45,829	129,395	121,675	119,664	US$
Investment period	5	10	10	10	10	10	10	10	years
Residual value	133	46,871	31,971	86,927	10,501	86,927	89,726	58,541	US$
Loan financing	0	0	0	0	0	0	0	0	%
Repayment period	5	10	10	10	10	10	10	10	years
Repair cost - parts	0.10		8.71	4.23	5.00		3.00		US$/hour
Repair cost - labour	50		773	306	400		250		Sf/hour
Annual insurance cost	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	%/year

Total capital cost by activity (without allowance for return to capital)									
Capital cost	Felling	Skidding with dozer	Skidding with skidder	Loading	Road transport	Unloading & reloading	Water transport	Road building	Units
Financing payments	0.00	NA	0.00	0.00	0.00	NA	NA	NA	US$/m³
Investor's capital	0.02	NA	1.57	1.35	0.95	NA	NA	NA	US$/m³
Residual value	-0.01	NA	-0.67	-0.91	-0.22	NA	NA	NA	US$/m³
Repairs and insurance	0.03	NA	2.66	0.59	1.58	NA	NA	NA	US$/m³
Total capital cost	29	NA	2,318	671	1,504	NA	NA	NA	Sf/m³
Total capital cost	0.04	NA	3.57	1.03	2.31	NA	NA	NA	US$/m³

Allowance for return to capital									
Capital cost	Felling	Skidding	Skidding	Loading	Road	Unloading	Water	Road	Units

In the absence of second-hand machinery price information, an estimate of the current value of each piece of harvesting machinery is calculated by the model in row 9. The model calculates a depreciated replacement value for each piece of machinery, using the following formula:

$$\textbf{Depreciated replacement value} = \textbf{Purchase price} \times (1-d)^a$$

where d is the depreciation rate and a is the current age of the machinery. For example, in the case of the Caterpillar 950 loader, current value was calculated as follows:

$$\textbf{Current value} = \textbf{Depreciated replacement value} = \textbf{Purchase price} \times (1-d)^a$$

$$= \frac{\text{US\$ 235,000}}{(1.039)^{15}}$$

$$= \frac{\text{US\$ 235,000}}{(1.775)}$$

$$= \text{US\$ 129,395}$$

The investment period is an estimate of the remaining machine life, or the number of years that the machine will be used before it is eventually replaced. Given the high cost of new machinery in Suriname and the general difficulty of financing new machinery purchases, it was assumed that existing machinery would be used for quite some time (despite it already being generally very old) and a figure of 10 years was assumed for all major pieces of machinery and a remaining life of five years was assumed for chainsaws. This information is entered into row 10 of the sheet.

The residual value of machinery is its resale value at the end of the investment period. This is calculated by the model in row 11 of the sheet in the same way as the current value (explained above).

Information about external financing of machinery purchases is entered into rows 12 and 13 of the model. The amount of loan financing for a new piece of machinery, or outstanding loan obligations for an existing piece of machinery is entered into row 12 of the sheet, as a proportion of the current value of the machine. The duration of the loan period, or outstanding loan period, is entered into row 13. Information collected during this study indicated that very little forestry investment in Suriname is financed by loans, so the values in row 12 were all set to zero throughout the analysis.

Repair costs are entered into rows 14 and 15 of the sheet. The cost of repairs is entered into the sheet in terms of average cost per actual working hour. Because most parts are imported, this is split into parts (in US$/hour) and labour (in Sf/hour). The figures shown in Figure 5 were calculated from the Caterpillar Handbook and adjusted to reflect circumstances in Suriname. A full description of the simple model used to estimate repair costs is given in: *Section 3.2.7 Calculation of repair costs used in the analysis*.

The last piece of information entered into this sheet is the annual cost of insurance, which is entered in row 16 as a percentage of the current value of each machine. The little evidence that could be obtained suggested that a figure of 3.5% might be appropriate and this figure was used throughout the analysis.

The total capital cost of production, by activity, is shown in Sf/m^3 and US$/$m^3$, in rows 25 and 26 of the sheet. This is calculated by adding together the four components shown in rows 21 to 24. These individual components are calculated as follows:

> **Financing payments** (row 21) are calculated as the sum of interest payments and principle repayments on the value of the loan for each piece of machinery, divided by total production throughout the investment period. The value of the loan is calculated as the current value of the machine (row 9) multiplied by the amount of loan financing in percent (row 12). It is assumed that loan payments will be made monthly and the average monthly payment is calculated using a standard formula available in excel (based on the value of the loan, the number of monthly payments (i.e. the repayment period x 12), and the interest rate shown on sheet 2). The average monthly payment is multiplied by the number of monthly payments to give the sum of interest payments and principle repayments on the value of the loan.
>
> **Investor's capital** (row 22) is calculated as the current value of the machinery less the value of any loan, all divided by total production throughout the investment period.
>
> **Residual value** (row 23) is calculated as the residual value shown above (in row 11), divided by total production throughout the investment period.
>
> **Repairs and insurance** (row 24) is calculated by adding together the annual repair cost and the annual insurance cost and dividing the result by total annual production. The annual repair cost is calculated as the hourly costs shown in rows 14 and 15, added together and multiplied by actual working hours per year (shown in sheet 3). The annual insurance cost is calculated as the current value of the machine (row 9) multiplied by the percentage shown in row 16.

This capital cost, however, does not include any allowance for the return on capital, which will be critically affected by the amount and timing of payments (e.g. loan payments) and the expected rate of return.

Therefore, the additional allowance for return on capital (based on the expected level of profit entered into sheet 2) is also calculated in rows 31 and 32.

The additional allowance for return on capital is calculated from the NPV (at the expected level of profit) of the first three items shown above (i.e. loan payments plus investor's capital less residual value, but excluding repairs and insurance payments). This NPV is then annualised over the investment period and divided by annual production, to give the capital cost (including return on capital) per m^3, from which the three items in rows 21 to 23 are subtracted to get the additional allowance shown in rows 31 and 32.

3.2.6 Calculation of the estimated depreciation rates used in the analysis

Information about depreciation rates used in the forestry sector in Suriname could not be obtained locally,[27] so depreciation rates were estimated from information about second-hand machinery prices in North America, collected during the cost and price survey. Resale prices were collected from a number of international sources for several major pieces of forestry machinery (see: Whiteman, 1999) and these prices were analysed using ordinary least-squares (OLS) linear regression techniques. The following model was used in the analysis

Ln(PRICE) = a + b(AGE) + c(MODELTYPE)

where Ln(PRICE) is the natural logarithm of the resale price of each piece of machinery collected in the survey, AGE is the age of the machinery and MODELTYPE is a dummy variable set to 1, for specific model types that were believed to be more valuable than the majority of the machines in the sample (e.g. self-loading timber trucks as opposed to ordinary timber trucks). The dummy variable was only used for some of the types of machinery examined in the analysis.

An adequate amount of information for such an analysis, was collected for four types of forest machinery: timber trucks; skidders; loaders; and bulldozers.[28] The results of the regression analyses for each of these types of machine is presented below:

Ln(TRUCK PRICE)	**= 11.477**	**- 0.137 (AGE)**	**+ 0.791 (SELF LOADER)**	**n = 16**
	(81.68)	**(-13.60)**	**(3.96)**	**R^2 = 93%**
Ln(SKIDDER PRICE)	**= 11.544**	**- 0.082 (AGE)**		**n = 40**
	(82.68)	**(-7.70)**		**R^2 = 60%**
Ln(LOADER PRICE)	**= 11.150**	**- 0.039 (AGE)**	**+ 0.450 (LARGE CAPACITY)**	**n = 25**
	(70.26)	**(-4.07)**	**(2.57)**	**R^2 = 50%**
Ln(BULLDOZER PRICE)	**= 12.221**	**- 0.069 (AGE)**	**+ 0.375 (D8 MODEL)**	**n = 16**
	(70.34)	**(-8.38)**	**(2.71)**	**R^2 = 86%**

The t-statistic for each coefficient estimated by the four models is shown in parentheses under the coefficient and the number of observations (n) and adjusted r-squared value for each regression result (R^2) are shown to the right of each equation.

As these results show, age had a significant effect on resale price (i.e. the t-statistic on the age coefficient was outside the range ±1.96 in all cases), as did the general type of machine for sale (i.e. larger models or models with better equipment generally attracted better prices). The explanatory power of some of the

27 Indeed, most people interviewed seemed to be fairly uninformed about depreciation generally. Most of the machinery in Suriname is very old, so it is likely that the cost of most machinery has been fully recovered. However, from an economic point of view, the use of very old machinery still has an opportunity cost in terms of the resale value of the machinery if it was to be sold in stead of used in the forest operation. This value should therefore, be used as an estimate of the cost of using the machinery.

28 A sufficient amount of information about prices and ages of second-hand fork lifts and mobile bandsaws was also collected and analysed in the study, but the results are not presented here.

equations was quite low, but this is to be expected given the range of machinery types collected in the survey and the number of different locations where machinery was being sold. For example, variants of two basic models of bulldozer (the Caterpillar D6 and D8) were covered in the survey, compared with 16 different types of skidder from eight different manufacturers. The estimated resale prices for each of these types of machinery and the goodness-of-fit of the regression lines are shown in Figure 6 to Figure 9.

Figure 6 Estimated sale and resale values of timber trucks for sale in North America in 1998

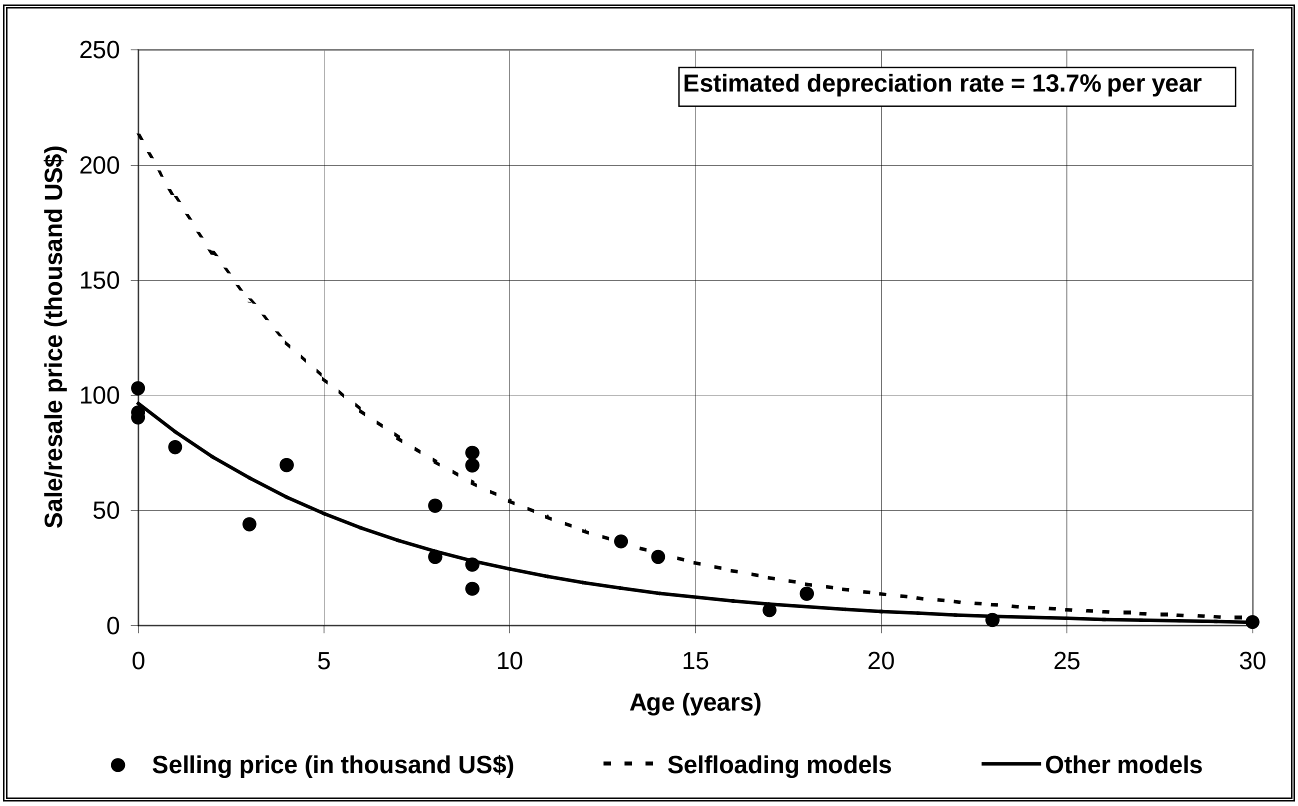


Figure 7 Estimated sale and resale values of wheeled skidders for sale in North America in 1998

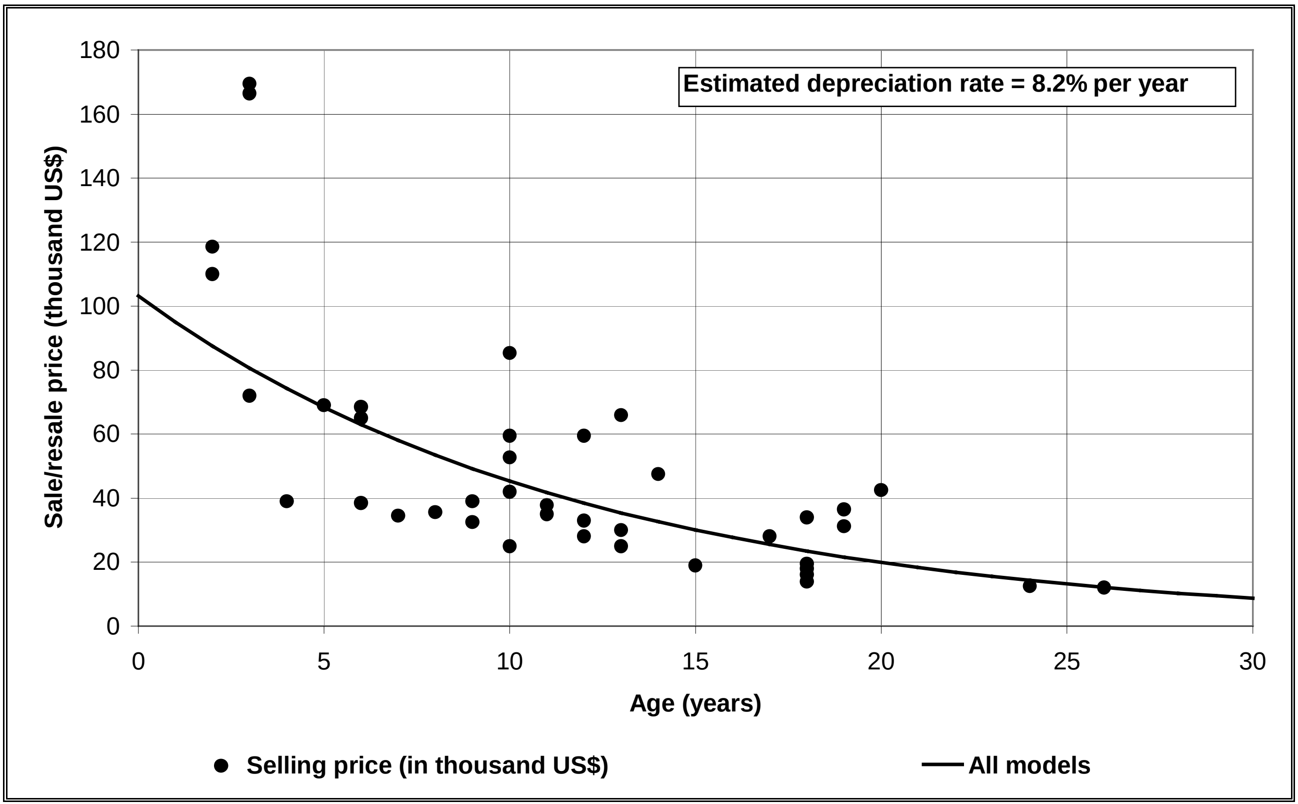


Figure 8 Estimated sale and resale values of wheeled loaders for sale in North America in 1998

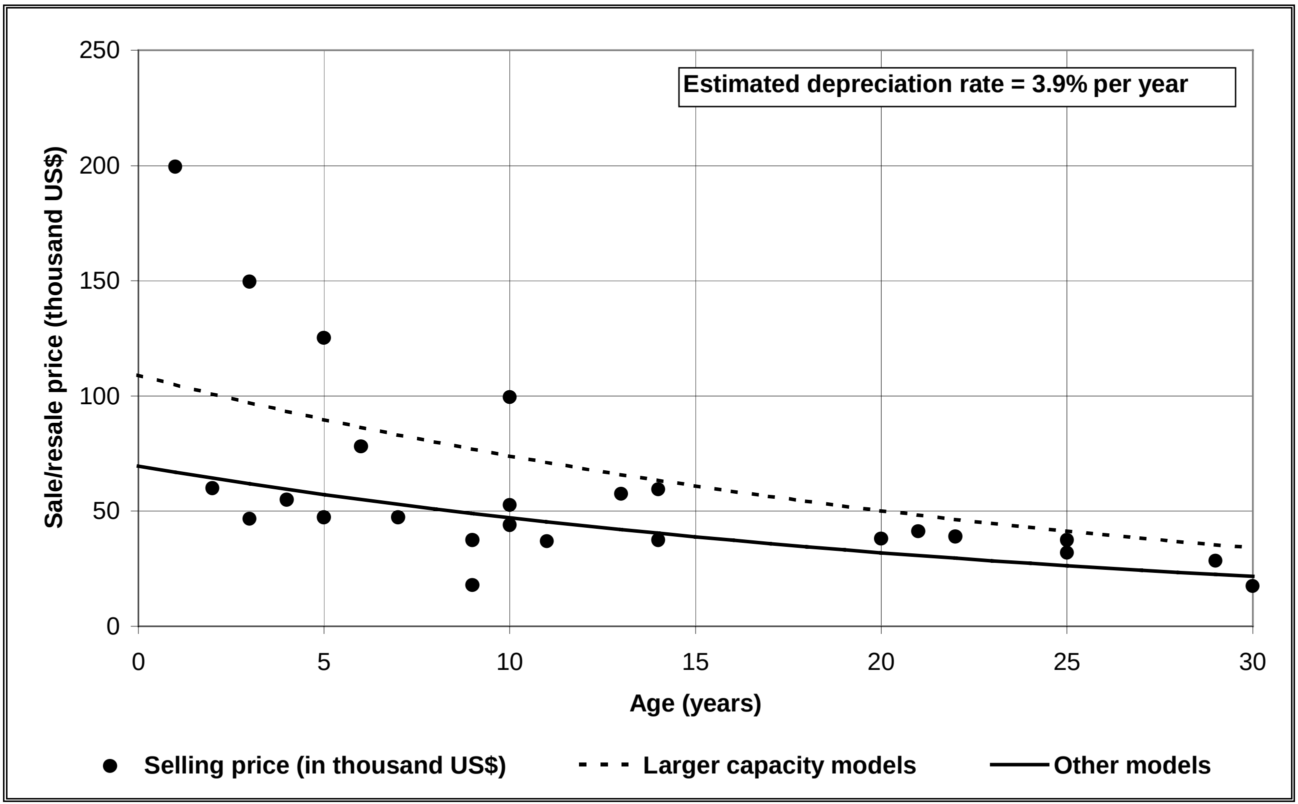
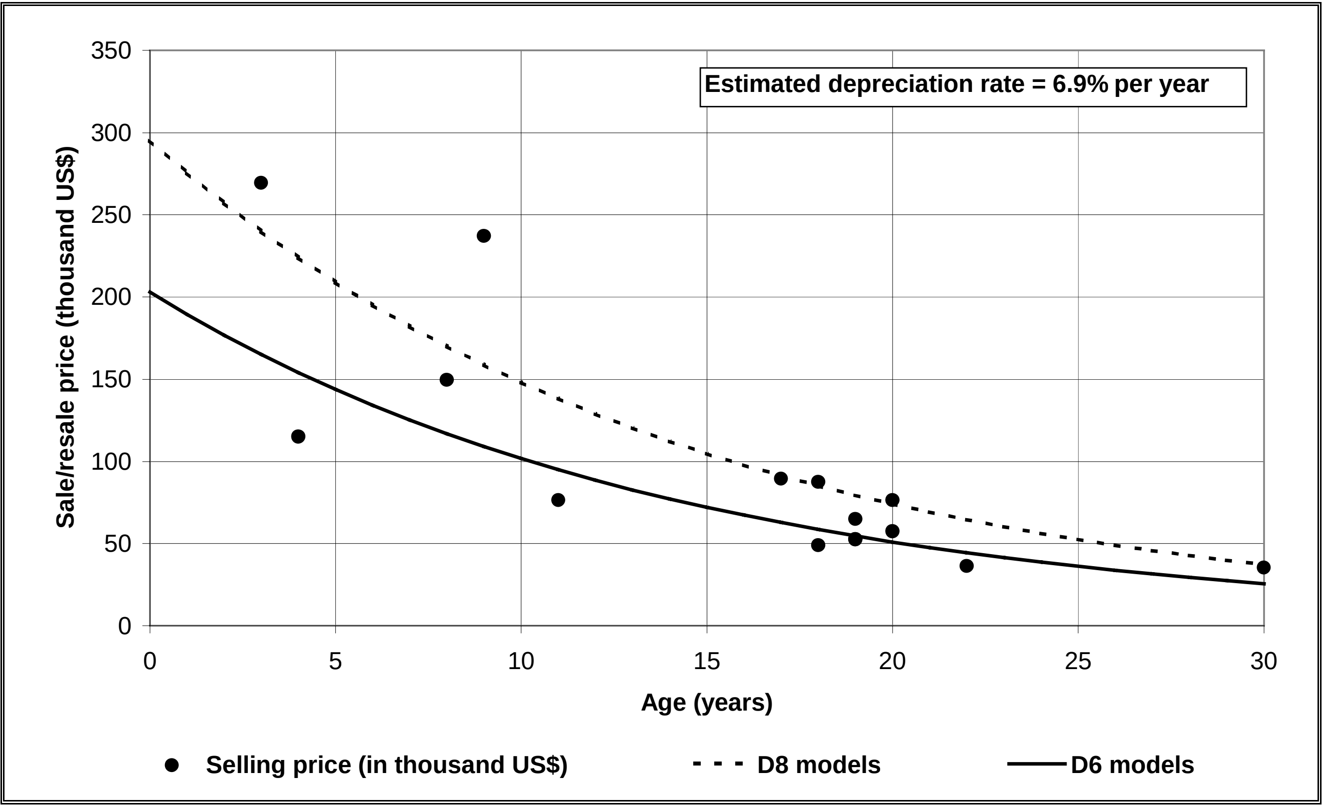


Figure 9 Estimated sale and resale values of bulldozers for sale in North America in 1998



The results of these four models were used to estimate machinery depreciation rates in Suriname on the assumption that they would not be significantly different to the rates of machinery depreciation found in North America. This seemed reasonable, given that the types of machinery used in Suriname are mostly the same as those covered by these models. Indeed, the justification for doing this is even stronger when it is considered that much of the harvesting machinery currently used in Suriname was originally imported second-hand from North America. The only important point to note, however, is that local machinery prices seem to be much higher than the prices obtained from North America (see Table 2). Therefore, the values shown in Figure 6 to Figure 9, can not be used directly as an indication of potential resale values in Suriname. The model implicitly takes this into account by applying the depreciation rate to a local price for new machinery, which acts as a rough adjustment to local market prices.

Table 2 Comparison of new forest machinery prices in North America with the price of similar equipment available in Suriname

Type of machinery	Manufacturer and model	Average price (new) in North America (in US$)	Quoted price (new) in Suriname (in US$)	Price difference in Suriname
Bulldozer	Caterpillar D8	295,000	490,000	+66%
Bulldozer	Caterpillar D6	203,000	280,000	+38%
Wheeled skidder	Caterpillar 528B	170,000	210,000	+23%
Wheeled loader	Caterpillar 950F	150,000	245,000	+63%

Source: Author's own estimates (North American prices) and *Surmac* (Suriname prices)

The estimated annual rate of depreciation can be directly read from the coefficient on age with the model specification used in this analysis (i.e. with the natural logarithm of prices on the left-hand side). For example, the AGE coefficient in the bulldozer model is -0.069, which equals a depreciation rate of 6.9% per year. Therefore, these figures were entered directly into sheet six of the model. No information about depreciation of chainsaws or barges could be obtained from any source, so the information used in the model is the author's best estimate of likely depreciation in comparison with the rates established for the other types of machinery.

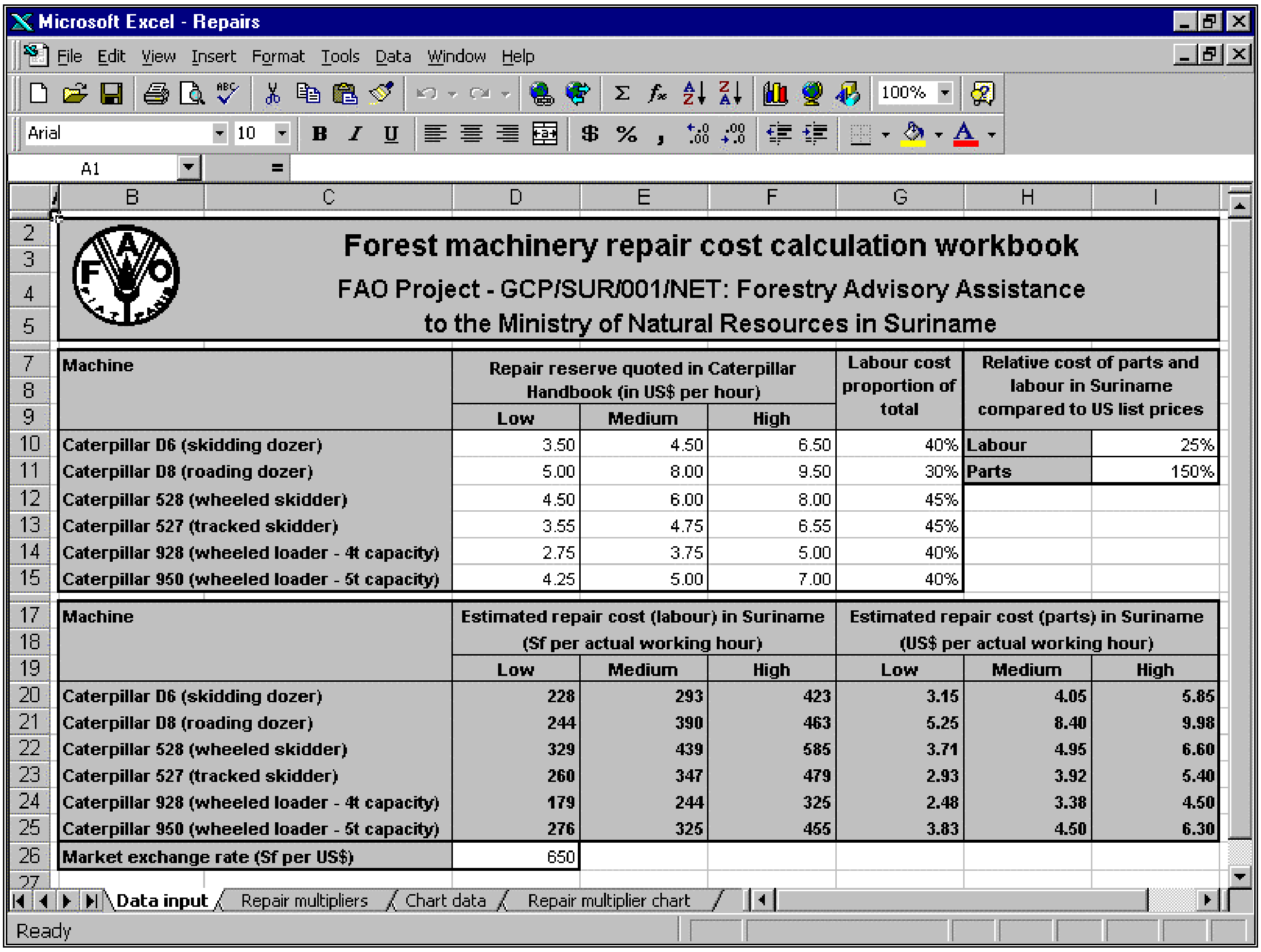
3.2.7 Calculation of repair costs used in the analysis

The other area where a separate analysis was required to estimate figures to put into the forest harvesting cost model, was the cost of repairs to forest machinery. Only one forest manager had adequate information about repair costs in Suriname and he admitted that the budget he had for repairs was not really sufficient to cover all his needs. Therefore, this data could not really be used in the analysis. However, the Caterpillar Handbook contains detailed information about average repair costs for most of the major pieces of forest machinery used in Suriname and this was adjusted to produce a repair cost that reflects local circumstances.

The first task in this analysis, was to adjust the data presented in the Caterpillar Handbook to reflect local circumstances (i.e. costs of labour and spare parts). This was done using a simple spreadsheet model and a copy of the data input sheet of this model is shown in Figure 10. The Caterpillar Handbook gives average repair costs (in US$ per actual working hour) for six types of machinery commonly used in forestry operations and gives low, medium and high estimates of repair cost (which depend upon site circumstances and other operating conditions such as the skill of the machine operator). This information is entered into cells D10 to F15 of the data input sheet of this model. The Caterpillar Handbook also specifies the proportion of the total cost that is estimated to be the cost of parts and the proportion that is labour cost. The labour cost proportion is entered into cells G10 to G15 for each machine.

The costs presented in the Caterpillar Handbook are based on an average labour cost of US$ 50/hour and parts are costed at US list prices. These costs have to be adjusted to the typical levels of prices in Suriname and this is done by entering the relative cost of parts and labour in Suriname in cells I10 and I11. Assuming that the difference in the price of parts in Suriname and the USA is roughly the same as the difference between new machinery prices in North America and Suriname, the price of parts in Suriname was increased to 150% of the US list prices for parts. In terms of the labour cost, it was assumed that the labour cost of repairs in Suriname would be about 25% of the cost in the USA (i.e. 25% x US$ 50/hour = US$ 12.50/hour). This information is then used to calculate the parts and labour cost of repairs in Suriname, shown in cells D20 to I25. The parts cost is expressed in US$ per actual working hour and the labour cost is expressed in Sf per actual working hour (calculated using the exchange rate entered into cell D26).

Figure 10 A copy of the spreadsheet model used to adjust repair costs given in the Caterpillar handbook to an estimate of repair costs in Suriname



Forest machinery repair cost calculation workbook

FAO Project - GCP/SUR/001/NET: Forestry Advisory Assistance to the Ministry of Natural Resources in Suriname

Machine	Repair reserve quoted in Caterpillar Handbook (in US$ per hour)			Labour cost proportion of total	Relative cost of parts and labour in Suriname compared to US list prices	
	Low	Medium	High			
Caterpillar D6 (skidding dozer)	3.50	4.50	6.50	40%	Labour	25%
Caterpillar D8 (roading dozer)	5.00	8.00	9.50	30%	Parts	150%
Caterpillar 528 (wheeled skidder)	4.50	6.00	8.00	45%		
Caterpillar 527 (tracked skidder)	3.55	4.75	6.55	45%		
Caterpillar 928 (wheeled loader - 4t capacity)	2.75	3.75	5.00	40%		
Caterpillar 950 (wheeled loader - 5t capacity)	4.25	5.00	7.00	40%		

Machine	Estimated repair cost (labour) in Suriname (Sf per actual working hour)			Estimated repair cost (parts) in Suriname (US$ per actual working hour)		
	Low	Medium	High	Low	Medium	High
Caterpillar D6 (skidding dozer)	228	293	423	3.15	4.05	5.85
Caterpillar D8 (roading dozer)	244	390	463	5.25	8.40	9.98
Caterpillar 528 (wheeled skidder)	329	439	585	3.71	4.95	6.60
Caterpillar 527 (tracked skidder)	260	347	479	2.93	3.92	5.40
Caterpillar 928 (wheeled loader - 4t capacity)	179	244	325	2.48	3.38	4.50
Caterpillar 950 (wheeled loader - 5t capacity)	276	325	455	3.83	4.50	6.30
Market exchange rate (Sf per US$)	650					

The second adjustment that must be made to these figures, is to alter them to reflect the age of machinery currently being used in Suriname. The repair costs presented in the Caterpillar Handbook are based on a machine life of 10,000 working hours. However, if a machine is used for longer than this, then the average cost of repairs over the life of the machine is likely to be higher than the figures presented above. Therefore, the cost figures shown above should be increased to reflect the greater age of machinery.

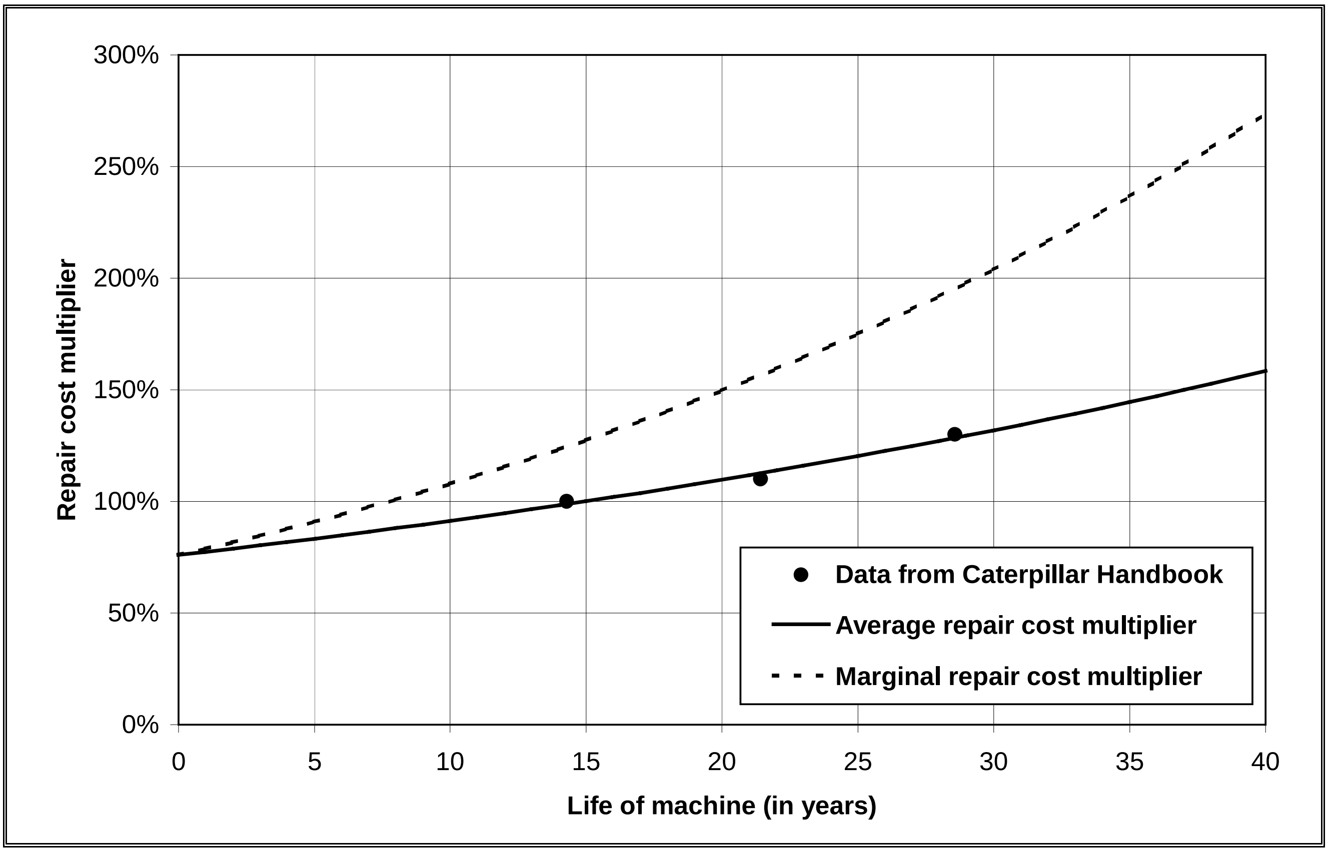
The Caterpillar Handbook presents extended life multipliers that can be used to convert the given repair costs to the repair costs which might be expected if a new machine is used for a longer period of time. These were used to create a series of annual repair cost multipliers for a range of machinery ages and expected remaining lives.

The first part of this process was to estimate an average repair cost multiplier curve for a new machine over any expected life. This was done using OLS regression (see Figure 11). However, most forest machinery in Suriname is not new, but already several years old, so the average repair cost multiplier was converted into an annual repair cost multiplier for every machine age (the marginal repair cost multiplier).[29] This was then used to calculate an average repair cost multiplier for a range of existing machinery ages and expected lives,

29 This calculation can best be explained with a simple example. The average repair cost multiplier for a new machine for one year of expected life is 76%. The average repair cost multiplier for a new machine for two years of expected life is 77.5%. This is the average of the first year's annual repair cost multiplier (76%) plus a second year's annual repair cost multiplier. Therefore, the second year's repair cost multiplier can be calculated as (77.5% x 2) - 76% = 79%. By applying this calculation to the whole of the average repair cost series, the marginal repair cost series can be constructed and so can average repair costs for any age and expected life.

by adding together all the annual repair cost multipliers for every possible machine age and expected machine life and dividing the total by the expected machine life (see Table 3).

Figure 11   Average and marginal repair cost multipliers for forest machinery of varying ages



Note: Machinery life shown above is based on the assumption of 700 working hours per year

The figures shown in Figure 10 and Table 3 were then used to calculate the numbers entered into the Harvesting cost model, using the medium repair cost estimates given in the Caterpillar Handbook. So, for example, the skidder in this scenario is 12 years old and is expected to work for 1,026 hours per year. This would give an approximate current age of 12,312 hours (1,026 x 12), with an expected life of 10,260 hours (1,026 x 10). From Table 3, the row for 12,000 hours current age and the column for an expected future life of 10,000 hours, gives a the repair cost multiplier of 173%. This multiplier should then be applied to the central cost estimate of US$ 4.95/hour for parts (from Figure 10), to give the adjusted repair cost of US$ 8.71/hour shown in Figure 5 (i.e. US$ 4.95/hour x 173% = US$ 8.71/hour).

As with the depreciation rate, no information was available about the repair cost of some of the other pieces of machinery (such as timber trucks, chainsaws and barges), so estimates were made based on comparison with the rates established for these types of machinery.

Table 3 Repair cost multipliers for a range of machinery ages and expected remaining lives

Current age of machine	Expected remaining life (depreciation period) in years									
	1 000 hrs	2 000 hrs	3 000 hrs	4 000 hrs	5 000 hrs	6 000 hrs	7 000 hrs	8 000 hrs	9 000 hrs	10 000 hrs
New	78%	80%	82%	84%	87%	89%	91%	94%	96%	99%
1 000 hrs	82%	84%	87%	89%	91%	94%	96%	99%	101%	104%
2 000 hrs	86%	89%	91%	93%	96%	98%	101%	103%	106%	109%
3 000 hrs	91%	93%	96%	98%	101%	103%	106%	109%	111%	114%
4 000 hrs	96%	98%	100%	103%	106%	108%	111%	114%	117%	120%
5 000 hrs	100%	103%	106%	108%	111%	114%	117%	119%	122%	126%
6 000 hrs	105%	108%	111%	113%	116%	119%	122%	125%	128%	132%
7 000 hrs	111%	113%	116%	119%	122%	125%	128%	131%	134%	138%
8 000 hrs	116%	119%	122%	125%	128%	131%	134%	137%	141%	144%
9 000 hrs	122%	125%	128%	131%	134%	137%	140%	144%	147%	151%
10 000 hrs	128%	131%	134%	137%	140%	144%	147%	151%	154%	158%
11 000 hrs	134%	137%	140%	143%	147%	150%	154%	157%	161%	165%
12 000 hrs	140%	143%	147%	150%	154%	157%	161%	165%	169%	173%
13 000 hrs	146%	150%	153%	157%	161%	164%	168%	172%	176%	180%
14 000 hrs	153%	157%	160%	164%	168%	172%	176%	180%	184%	188%
15 000 hrs	160%	164%	168%	172%	176%	180%	184%	188%	192%	197%
16 000 hrs	168%	171%	175%	179%	183%	188%	192%	196%	201%	206%
17 000 hrs	175%	179%	183%	187%	192%	196%	200%	205%	210%	215%
18 000 hrs	183%	187%	191%	196%	200%	205%	209%	214%	219%	224%
19 000 hrs	191%	195%	200%	204%	209%	214%	218%	223%	228%	234%
20 000 hrs	200%	204%	209%	213%	218%	223%	228%	233%	238%	244%

	Expected remaining life (depreciation period) in years									
	11 000 hrs	12 000 hrs	13 000 hrs	14 000 hrs	15 000 hrs	16 000 hrs	17 000 hrs	18 000 hrs	19 000 hrs	20 000 hrs
New	101%	104%	107%	110%	113%	116%	119%	122%	125%	128%
1 000 hrs	106%	109%	112%	115%	118%	121%	124%	128%	131%	135%
2 000 hrs	112%	115%	118%	121%	124%	127%	130%	134%	137%	141%
3 000 hrs	117%	120%	123%	127%	130%	133%	137%	140%	144%	147%
4 000 hrs	123%	126%	129%	133%	136%	139%	143%	147%	150%	154%
5 000 hrs	129%	132%	135%	139%	142%	146%	150%	153%	157%	161%
6 000 hrs	135%	138%	142%	145%	149%	153%	157%	160%	165%	169%
7 000 hrs	141%	145%	148%	152%	156%	160%	164%	168%	172%	176%
8 000 hrs	148%	151%	155%	159%	163%	167%	171%	175%	180%	184%
9 000 hrs	155%	158%	162%	166%	170%	175%	179%	183%	188%	192%
10 000 hrs	162%	166%	170%	174%	178%	182%	187%	191%	196%	201%
11 000 hrs	169%	173%	177%	182%	186%	191%	195%	200%	205%	210%
12 000 hrs	177%	181%	185%	190%	194%	199%	204%	209%	214%	219%
13 000 hrs	185%	189%	194%	198%	203%	208%	213%	218%	223%	228%
14 000 hrs	193%	197%	202%	207%	212%	217%	222%	227%	233%	238%
15 000 hrs	201%	206%	211%	216%	221%	226%	232%	237%	243%	248%
16 000 hrs	210%	215%	220%	225%	231%	236%	241%	247%	253%	259%
17 000 hrs	219%	225%	230%	235%	240%	246%	252%	258%	264%	270%
18 000 hrs	229%	234%	240%	245%	251%	257%	263%	269%	275%	281%
19 000 hrs	239%	244%	250%	256%	261%	267%	274%	280%	286%	293%
20 000 hrs	249%	255%	260%	266%	272%	279%	285%	292%	298%	305%

Note: The current age and expected remaining life of machinery is expressed in actual hours worked

3.3 Results

Once all the various pieces of information about unit production costs, materials and capital consumption rates and productivity have been entered into the harvesting cost model, the total roundwood production cost can viewed on the first sheet of the model (Summary). The results for the base-case scenario are shown in Figure 12.

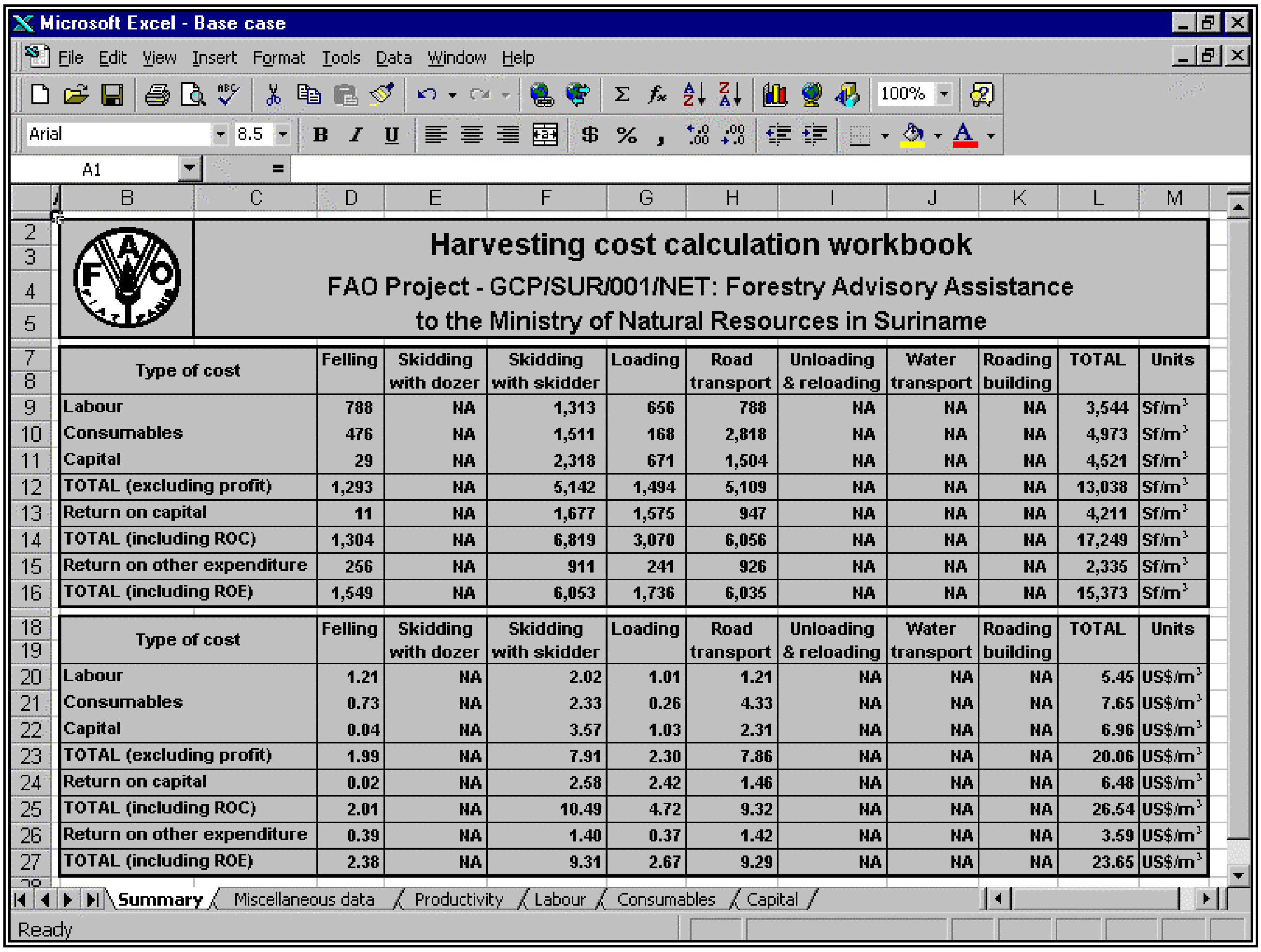
Production cost is given in Sf/m^3 in rows 9 to 16 and US$/$m^3$ in rows 20 to 27 and the cost of each individual harvesting activity within the whole operation is shown in columns D to K. The first three rows (i.e. rows 9 to 11 and 20 to 22) of each of these two blocks of results show the labour, consumables and capital components of production cost (copied from sheets four to six in the model). These are added together in the row below (rows 12 and 23).

These figures do not allow for any return on capital or profit on other expenditure. The fifth row of each block (i.e. rows 13 and 24) shows the additional amount that would be required to give the forest manager the rate of return on capital specified in the second sheet of the model (in cell H5). This is added to the total (in rows

13 and 24) to give the total production cost including an allowance for return on capital (TOTAL including ROC) in rows 14 and 25.

The seventh row of each block calculates the mark-up or allowance for profit (from cell H5 in the second sheet) on other expenditure. This alternative way of including an allowance for normal profit in the calculation, is added to the totals in rows 12 and 23, to give the total roundwood cost including an allowance for a return on other expenditure (TOTAL including ROE) in rows 16 and 27. This mark-up is applied to all labour and consumable costs, plus the repair and insurance components of capital costs (which are not included in the calculation of return on capital).

Figure 12 A copy of the first sheet of the harvesting cost model showing the total roundwood production cost estimated for the base-case scenario



Harvesting cost calculation workbook

FAO Project - GCP/SUR/001/NET: Forestry Advisory Assistance to the Ministry of Natural Resources in Suriname

Type of cost	Felling	Skidding with dozer	Skidding with skidder	Loading	Road transport	Unloading & reloading	Water transport	Roading building	TOTAL	Units
Labour	788	NA	1,313	656	788	NA	NA	NA	3,544	Sf/m^3
Consumables	476	NA	1,511	168	2,818	NA	NA	NA	4,973	Sf/m^3
Capital	29	NA	2,318	671	1,504	NA	NA	NA	4,521	Sf/m^3
TOTAL (excluding profit)	1,293	NA	5,142	1,494	5,109	NA	NA	NA	13,038	Sf/m^3
Return on capital	11	NA	1,677	1,575	947	NA	NA	NA	4,211	Sf/m^3
TOTAL (including ROC)	1,304	NA	6,819	3,070	6,056	NA	NA	NA	17,249	Sf/m^3
Return on other expenditure	256	NA	911	241	926	NA	NA	NA	2,335	Sf/m^3
TOTAL (including ROE)	1,549	NA	6,053	1,736	6,035	NA	NA	NA	15,373	Sf/m^3

Type of cost	Felling	Skidding with dozer	Skidding with skidder	Loading	Road transport	Unloading & reloading	Water transport	Roading building	TOTAL	Units
Labour	1.21	NA	2.02	1.01	1.21	NA	NA	NA	5.45	$US\$/m^3$
Consumables	0.73	NA	2.33	0.26	4.33	NA	NA	NA	7.65	$US\$/m^3$
Capital	0.04	NA	3.57	1.03	2.31	NA	NA	NA	6.96	$US\$/m^3$
TOTAL (excluding profit)	1.99	NA	7.91	2.30	7.86	NA	NA	NA	20.06	$US\$/m^3$
Return on capital	0.02	NA	2.58	2.42	1.46	NA	NA	NA	6.48	$US\$/m^3$
TOTAL (including ROC)	2.01	NA	10.49	4.72	9.32	NA	NA	NA	26.54	$US\$/m^3$
Return on other expenditure	0.39	NA	1.40	0.37	1.42	NA	NA	NA	3.59	$US\$/m^3$
TOTAL (including ROE)	2.38	NA	9.31	2.67	9.29	NA	NA	NA	23.65	$US\$/m^3$

3.3.1 Discussion of results

For the purposes of updating this information, it is important to know which variables are likely to have the most impact on the total roundwood production cost if they were to change. It is also useful to know which forestry activities account for most of the costs, so that the cost-effectiveness or efficiency of these activities can be examined in greater detail.

Figure 13 shows the distribution of costs for the “typical” forest concession between labour, consumables, capital and profit. This shows that the total cost of production is fairly evenly split between these four items. Figure 14 shows how changes in the cost of individual items of expenditure would affect the total production cost. For example, a 25% change in labour costs would alter the total roundwood production cost by just over 5%, but a 25% change in capital costs would change the total cost by nearly 10%. Or, to put it another way, a change in capital costs would have roughly twice the effect of the same percentage change in labour costs.

Figure 13 The distribution of total delivered roundwood production cost, between labour, consumables, capital and normal profit (20% return on capital)

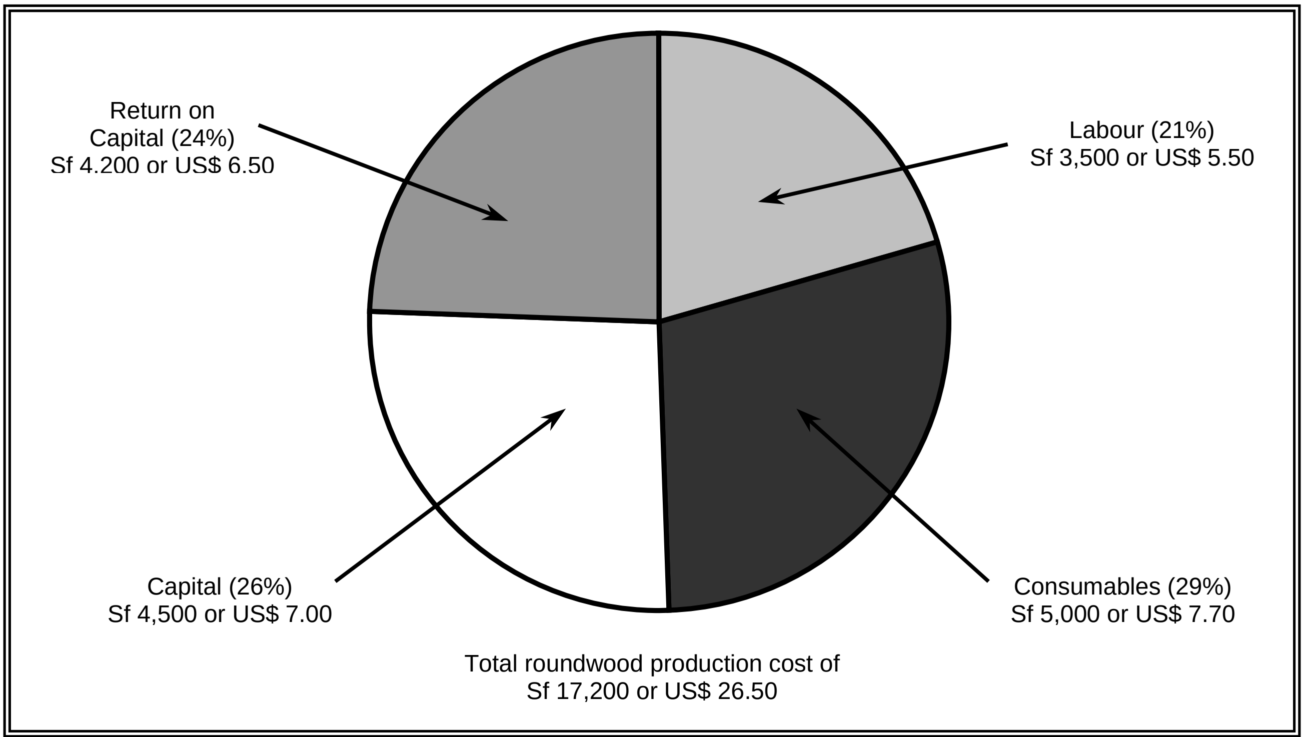


Figure 14 The impact of changes in individual cost items on total roundwood production cost

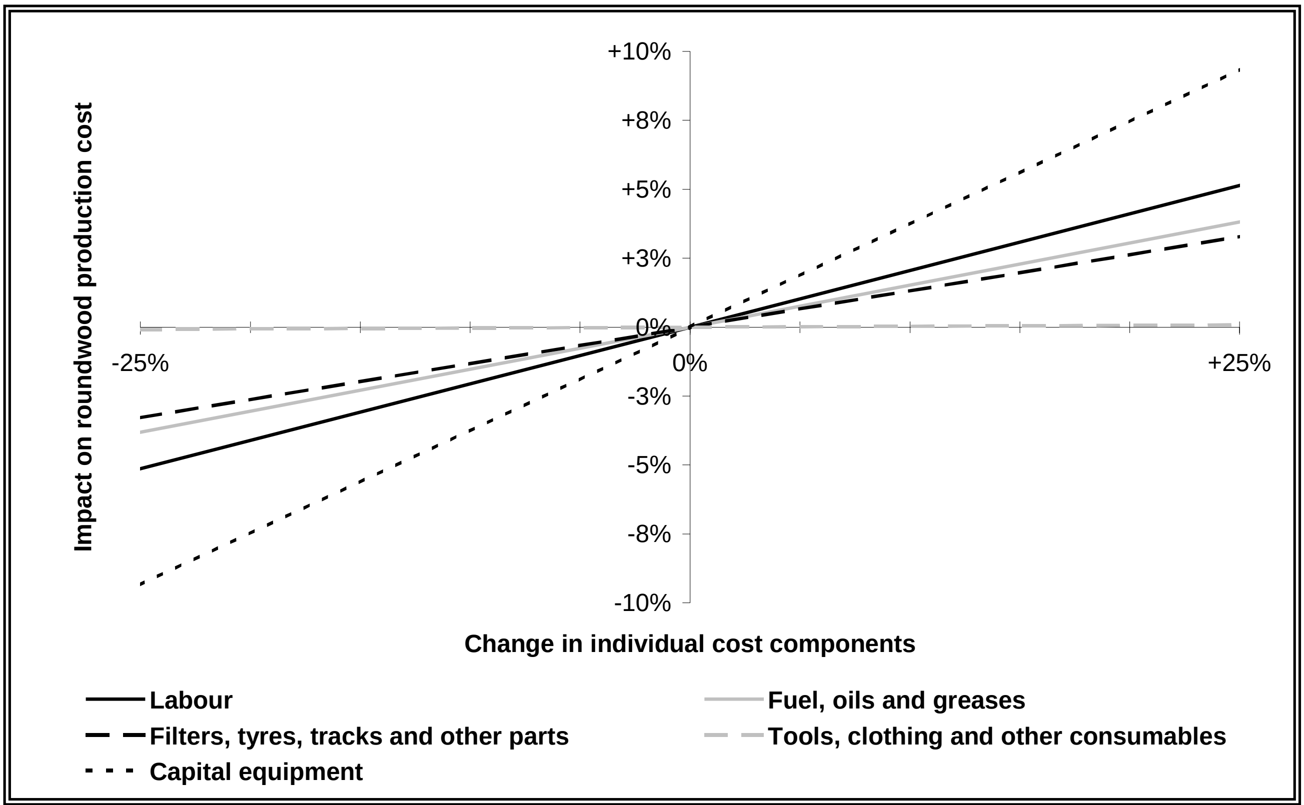
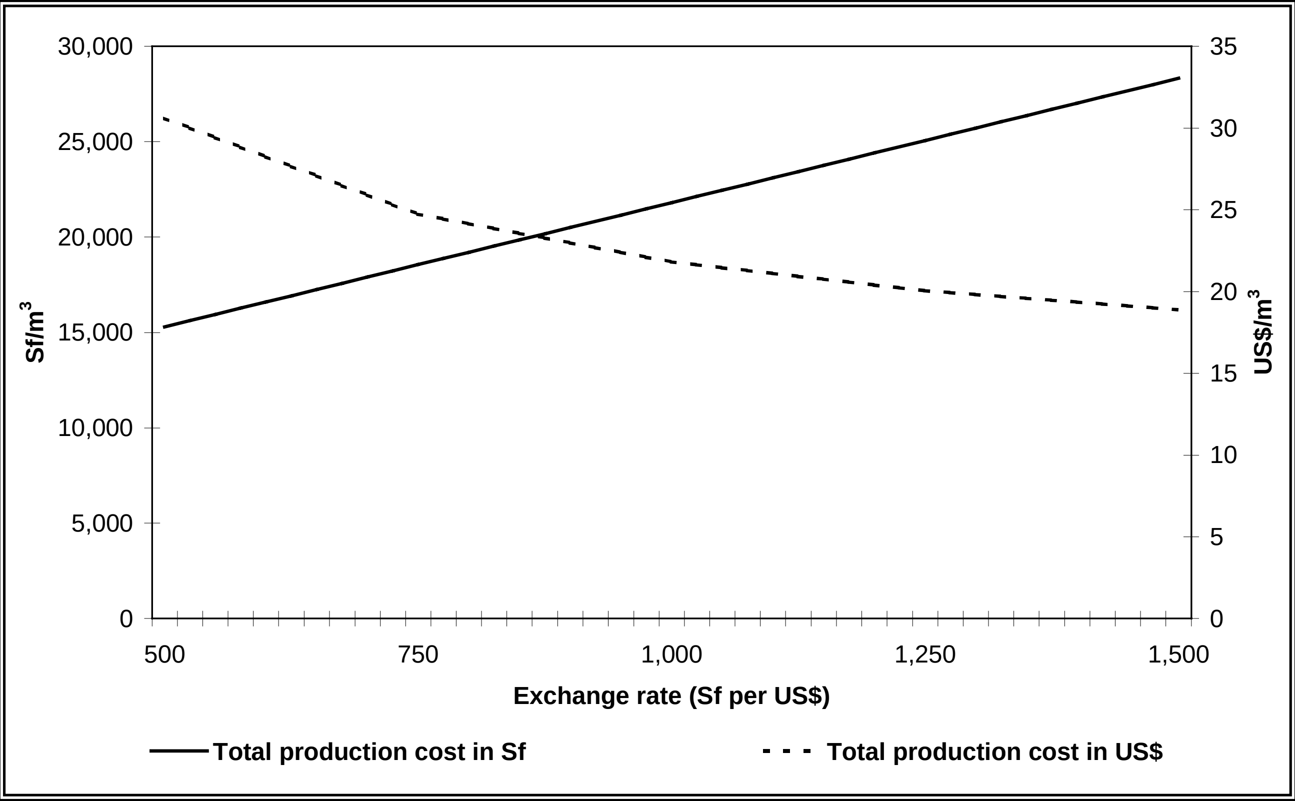


Figure 15 The effect of different exchange rates on total roundwood production costs in Sf and US$



Given that most capital equipment used in the forestry sector in Suriname is imported and, consequently, paid for in US$, the results shown in Figure 14 would suggest that changes in the exchange rate might also have a significant impact on total production costs. Figure 15 therefore, shows the impact of different exchange rates on the total roundwood production cost in local and foreign currency.

As the figure shows, as the exchange rate increases (i.e. the Suriname Guilder devalues), the cost of production in local currency increases (due to the higher cost of imported items used in production), while the production cost in US$ goes down (because local currency expenditure on inputs such as labour, becomes relatively cheaper in US$). However, due to the relative cost of items purchased in local and foreign currency, these changes are not exact opposites. For every 10% increase in the exchange rate, the production cost in local currency increases by 5%. But, as the exchange rate increases, the production cost in US$ falls rapidly at first, then starts to level-out at about US$ 20/m^3 when the exchange rate goes above Sf 1,000 to the US$. This reflects the fact that, at this exchange rate level, the cost of items purchased in local currency starts to become insignificant compared with the cost of items purchased in US$.

Figure 16 shows the distribution of total roundwood production cost across the four main forestry activities. This shows that the costs of skidding and roundwood transport account for the largest share of total production cost. This is largely due to the high cost of machinery and consumables (such as fuel) that are used in these activities. In comparison, the cost of felling is relatively insignificant.

The cost of loading calculated here only accounts for about 18% of total roundwood production cost. However, under the assumptions made about forest productivity in this calculation, the loader is fairly well utilised, which keeps the unit cost of this activity down to a relatively low level. In smaller forest operations, it may not be possible to fully employ a forest loader and costs may be consequently higher, or it may be more profitable to contract-out this operation. Loading costs are also likely to be much higher in situations where timber has to be unloaded and reloaded onto barges or at the logyard.

Figure 16 The distribution of total delivered roundwood production cost, between forestry activities

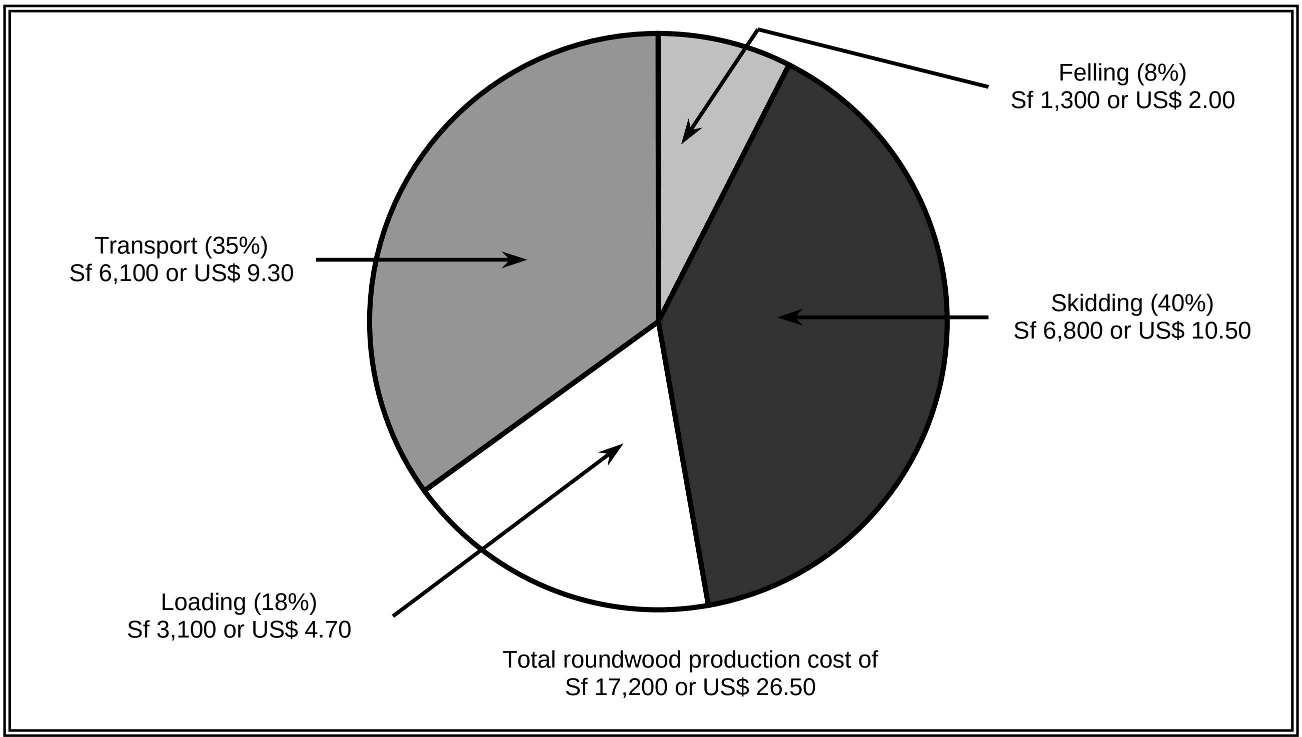


Figure 17 The effect of transport distance on total roundwood production cost

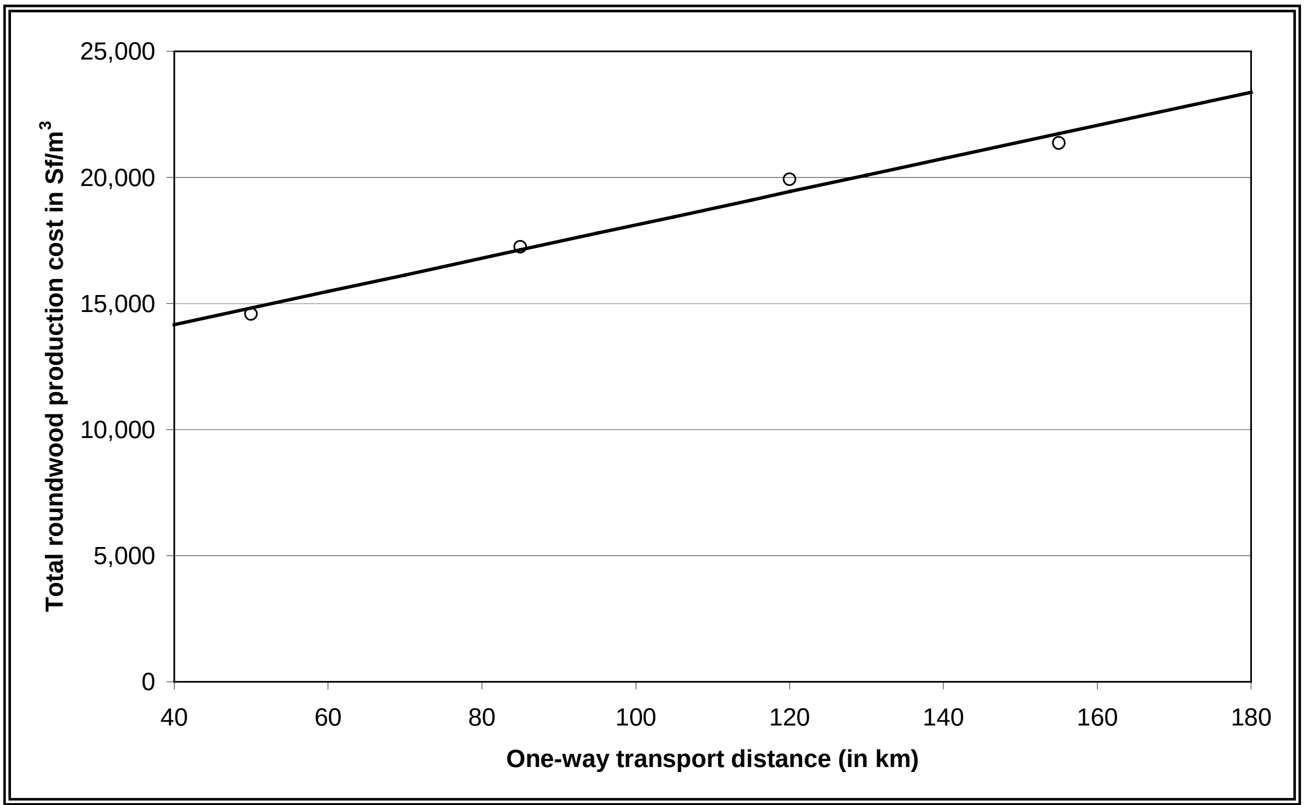
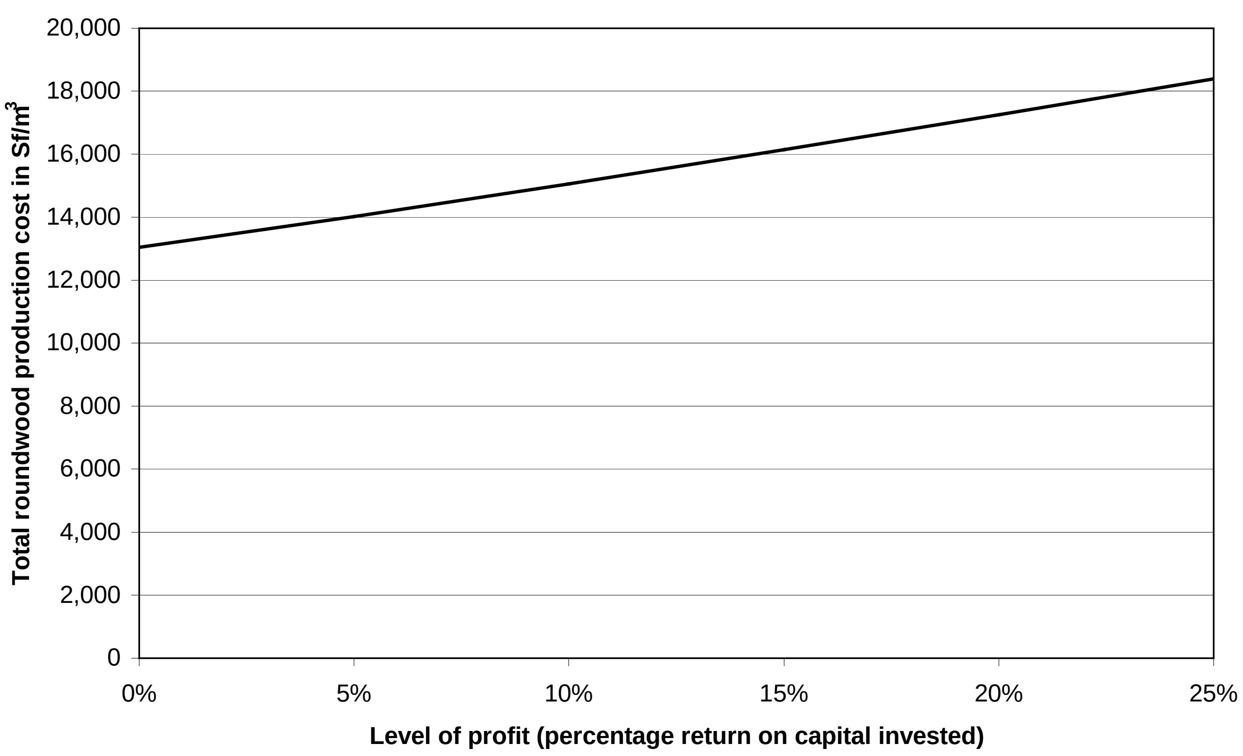


Figure 17 shows the effect of transport distance on total roundwood production cost. The points in the figure are the results of the model calculation for a number of different transport distances and the line is a trend line between these points. The points do not follow a straight line because transport cost is a function of the number of vehicles required as well as the cost of running the vehicles (i.e. the running cost per km travelled). Thus, for example, the first three points require one, two and three timber trucks respectively to transport timber over these distances, but at the distance represented by the fourth point, three trucks will suffice and it is not necessary to use a fourth timber truck. This is why the fourth point appears below the trend line. At greater distances, it may be more economical to use water transport to transport roundwood, although this may also then require additional loading and reloading costs.

3.3.2 The effect of changing the level of normal profit on the roundwood production cost

As noted above, the cost of roundwood production in the model changes if it is assumed that forest managers require a different level of profits to remain in business. Figure 18 shows how the roundwood production cost varies with the level of profit used in the model. The roundwood production cost changes by roughly 7% for every change of 5% in the amount of profit forest managers are allowed to retain.

Figure 18 The effect on roundwood production cost of changing the assumption about the amount of profit forest managers are allowed to keep (the level of normal profit)



The crucial question that is intimately linked with the calculation of economic rent and setting of forest levies, is: how much profit should forest managers be allowed to keep (i.e. what should be the normal level of profit)? A level of 20% has been used here, based on discussions with forest managers and staff of *LBB* and *SBB*. This figure is high compared with the returns to forestry in many temperate countries, but is broadly comparable with the returns expected in other tropical countries. In part, this rate is high because of the greater risks associated with conducting business in tropical countries, but it also reflects the generally high returns that can be obtained from other investments in such fast growing economies.

3.3.3 Comparison of the model results with contract costs collected during the study

Another pointed noted earlier was that one sign that there might be excess profits[30] or rent capture by private individuals operating in the forestry sector is if the contract cost of operations is higher than calculated by the

[30] Excess profits is the term used to describe the situation where a forest operator is earning more than the normal level of profit. In effect, they are capturing some of the economic rent that should be being collected by the government, as owner of the forest resource, in the form of forest levies.

model. In other words, if the government were collecting all of the economic rent from roundwood production, there would be very little scope for contractors to charge high rates for their services that allowed them to operate inefficiently or earn excess profits.

Table 4 Current costs of contracting-out various forest operations compared with the costs estimated by the roundwood production cost model

Operation	Model results (costs per m^3)		Contract costs (per m^3)	
	In local currency	In US$	Roundwood for the domestic market	Roundwood for the export market
Felling (with own chainsaw)	Sf 1,300	US$ 2.00	Sf 2,000	n.a.
Skidding	Sf 6,800	US$ 10.50	Sf 8,000	n.a.
Loading	Sf 3,100	US$ 4.70	Sf 1,500 - Sf 3,250	US$ 5.00
Unloading	Sf 3,100	US$ 4.70	Sf 2,000 - Sf 4,000	US$ 10.00
Road transport	Sf 70/m^3/km	US$ 0.11/m^3/km	Sf 50/m^3/km - Sf 180/m^3/km	n.a.

Source: Model results and Whiteman (1999)

A comparison between the current costs of contracting-out various forest operations and the costs estimated by the roundwood production cost model is shown in Table 4. In most cases the costs calculated by the model are at the lower end of the range of costs quoted during interviews with forest managers and contractors. This could indicate one or more of three things: that the model assumptions are incorrect in some way; that operators are not working efficiently; or that operators are earning excess profits.

The production costs calculated by the model are comparable with those calculated by the author in other countries, suggesting that contractors may be operating inefficiently or earning excess profits. Another indication that they may be earning excess profits is that the costs quoted for handling export quality roundwood are somewhat higher than the costs quoted for handling other roundwood. There is no reason why the costs for basically the same type of operation should vary in this way, which suggests that contractors are charging higher prices for handling export quality roundwood in order to capture some of the economic rent from the production of this roundwood. They are, presumably, able to do this because of the limited amounts of capital available to many forest managers. In other words, they can charge a rent above their production cost because they own a piece of scarce equipment (i.e. forest machinery).

4 CONCLUSIONS AND RECOMMENDATIONS

This report has described an accounting framework that can be used to collect cost information about roundwood production in Suriname and a model that can be used to convert this raw data into unit roundwood production costs. It has also shown how total roundwood production cost might be affected by changes in certain key cost variables and assumptions about productivity. In order to calculate economic rent and, consequently, set forest levies, it is important that this information is updated regularly and that these calculations are carried-out for a range of situations in Suriname.

4.1 Interpreting the results

Based on assumptions about the likely levels of cost and productivity in a "typical" or "representative" forest concession in Suriname, the model has shown that the total roundwood production cost is currently around Sf 17,250/m^3 or US$ 26.50/m^3. This is broadly comparable with production costs in other tropical countries.

Given current roundwood prices in Suriname, this level of production cost would imply that the economic rent from roundwood production might be in the region of US$ 18.50/m^3 to US$ 33.50/m^3, in the case of export quality roundwood, or up to Sf 7,750/m^3, in the case of roundwood sold to domestic forest processors (see Table 5). Very few roundwood producers are currently producing low grade roundwood for the domestic market (indeed, as the table shows, there would be little or no profit from this at all), which suggests that the economic rent from roundwood sold on the domestic market may be near the top of this range.

Table 5 Current costs of contracting-out various forest operations compared with the costs estimated by the roundwood production cost model

Operation	**Roundwood price (per m^3)**		**Economic rent (per m^3)**	
	Low	**High**	**Low**	**High**
Logs for export	US$ 45.00/m^3	US$ 60.00/m^3	US$ 18.50/m^3	US$ 33.50/m^3
Logs for the domestic market				
1st quality	*Sf 22,000/m^3*	*Sf 25,000/m^3*	*Sf 4,750/m^3*	*Sf 7,750/m^3*
2nd quality	*Sf 18,000/m^3*	*Sf 22,000/m^3*	*Sf 750/m^3*	*Sf 4,750/m^3*
3rd quality	*Sf 15,000/m^3*	*Sf 18,000/m^3*	*negative*	*Sf 750/m^3*

Source: Model results and Whiteman (1999)

The analysis has shown that the total production cost is distributed fairly evenly between expenditure on labour, consumables, capital and profit. However, it has also shown that costs are most sensitive to changes in capital and labour costs and the foreign exchange rate. In terms of the individual forestry activities, it has shown that skidding and transport costs account for the majority of production costs. Therefore, most attention must be given to these items of expenditure in further analysis.

4.2 Refining and updating the analysis

As a result of this preliminary analysis, the following recommendations for refining and updating the production cost analysis are suggested:

> **<u>Recommendation 1:</u> In order to update the above figures, it is recommended that new data about individual items of expenditure should be collected periodically. Given the sensitivity of the results to changes in the underlying variables and the likelihood of them changing over time, it is suggested that this should be done once a year, with priority being given to collecting information about the costs of capital machinery, spare parts, fuel, oils and greases and labour costs. The figures should also be immediately revised if there is a sudden change in any of these variables or in the exchange rate. Priority: HIGH.**

<u>Recommendation 2:</u> The above analysis has only examined a "typical" forest concession, which is believed to represent average conditions in Suriname. However, the analysis has also shown that the total production cost is sensitive to variables such as transport distance and forest stocking levels. In order to refine the analysis, it is recommended that this analysis should be repeated for a range of different stocking rates and transport distances. This should also include an analysis of production costs, in situations where water transport is used. It would be useful to present these results in the form of a map showing how production cost varies with distance from the main processing centres in Suriname. Priority: HIGH.

<u>Recommendation 3:</u> In order to examine the efficiency of forest operations, it is also suggested that the methodology and model described above should be used to examine the production cost under a range of different production techniques. Key variables that should be examined, include: the product recovery rate in logging operations; the roading density and skid trail layout; and the use of better harvesting and transport machinery. Priority: MEDIUM.

In order to carry-out the above analyses, it is also recommended that the relevant staff of *LBB* and *SBB* should be trained in data collection techniques and the use of the model, specifically:

<u>Recommendation 4:</u> Staff should receive training in the following areas: project and policy appraisal (specifically with reference to stumpage value or economic rent calculation and the setting of forest levies); economic modelling using the harvesting cost model (and more general training in spreadsheet modelling if possible); and techniques for data collection, interpretation, validation and data management. Priority: HIGH.

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GLOSSARY

DCF	Discounted cash-flow – a table showing costs and revenues for a project, by year, which is used for the calculation of NPV and IRR
HKV	*Houtkapvergunning* (Community forest): an area of forest granted in perpetuity to tribal communities to allow harvesting of wood and non-wood products for the community's own use.
IRR	Internal rate of return – the average annual percentage rate of return earned on all capital invested in a project.
LBB	*Lands Bosbeheer* (Suriname Forest Service): the government department with responsibility for the forestry sector in Suriname.
NPV	Net present value – the surplus (or deficit, if negative) of revenues over costs, over the total lifetime of the project, after taking into account the timing of these cash-flows (using discounting).
SBB	*Stichting voor Bosbeheer en Bostoezicht* (Foundation for forest management and production control): the proposed foundation, which will check and approve future harvesting plans and monitor roundwood production.