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Towards sustained timber production from tropical rain forests in Suriname*

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Summary

From the results of research carried out within the framework of the joint project of the Agricultural University Wageningen, Netherlands, and the Anton de Kom University of Suriname (project LH/UvS, MAB project 949), a system for sustained timber production in the tropical rain forests of Suriname has been developed. This system comprises two independent aspects. Firstly, there is the Celos Harvesting System, which is an improved harvesting technique aimed to reduce logging damage and logging cost. Secondly, there is the Celos Silvicultural System, which aims to increase production of commercial species within the stand so that a second harvest can be achieved within 20 to 25 years. Research results indicate that the silvicultural system is both economically feasible and ecologically acceptable.

Introduction

Suriname is the smallest independent country on the South American mainland being 163 820 km^2 in area. Its population of approximately 370 000 is concentrated in the narrow coastal plain. The remaining 90 % of the land area is covered with largely untouched tropical rain forest. The economy is dominated by the aluminium industry, which accounts for 75 % of the countries' export. There is a need not only

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to diversify the economy but also to develop employment opportunities to counter the high rate of unemployment. Development of the largely untapped forest resources may well contribute to the economic development of Suriname.

Forestry research

Since the 1950s, efforts have been made to develop a silvicultural system for the rain forests of Suriname. Initially artificial regeneration seemed to be preferable to natural regeneration. During the 1960s and 1970s, about 9000 ha of forest plantations mainly of *Pinus caribaea* were established in areas previously under tropical rain forest. However, after an encouraging initial growth, the rate of increment decreased to an unattractive low level, probably because of a considerable loss of nutrients from the ecosystem. In addition, in the 1970s the rising costs of labour, machines, and fuel made clearing and planting very expensive.

Early investigations on natural regeneration demonstrated that the alleviation of competition in the stand results in a substantial increase in the growth of desirable species (Boerboom, 1965; Schulz, 1967). However, an operational system was not developed until the 1970s. This system was tested and developed further within the framework of the joint project of the Agricultural University Wageningen, Netherlands, and the Anton de Kom University of Suriname (project LH/UvS 01, MAB-project 949), entitled 'Human interference in the tropical rainforest ecosystem'. As a result, a polycyclic system for sustained timber production in the tropical rain forests has been formulated. This system is referred to as the Celos Silvicultural System. In addition, a system for improved logging, the Celos Harvesting System, has been developed.

Celos Harvesting System

One presupposition of any polycyclic system is that enough trees survive logging to secure sustained yields in the future, that is, logging damage should remain at an acceptable level.

In Suriname, logging is carried out by private companies, all of whom – with the exception of the largest one – organize their operations in the simplest way possible. No plans or maps are prepared in advance: the operation starts with the felling. Although some basic instructions are given by the concessionary, the feller himself selects the trees to be felled mainly according to his own preferences.

Some time after the feller has finished his work, the skidder is sent in to collect the timber. As the operator does not know where the logs are located, considerable time is spent and damage done driving around in the forest in search of them. When a log is located it is hooked on to the skidder and taken to the landing by the roadside. The skidder is then returned to the forest to resume the search. As a consequence of this rather haphazard procedure, usually some good-quality logs are overlooked and left to rot on the forest floor. This operation causes considerably more damage than necessary, although damage is likely to remain within acceptable limits provided logging intensity remains low (at present in Suriname, the vol-

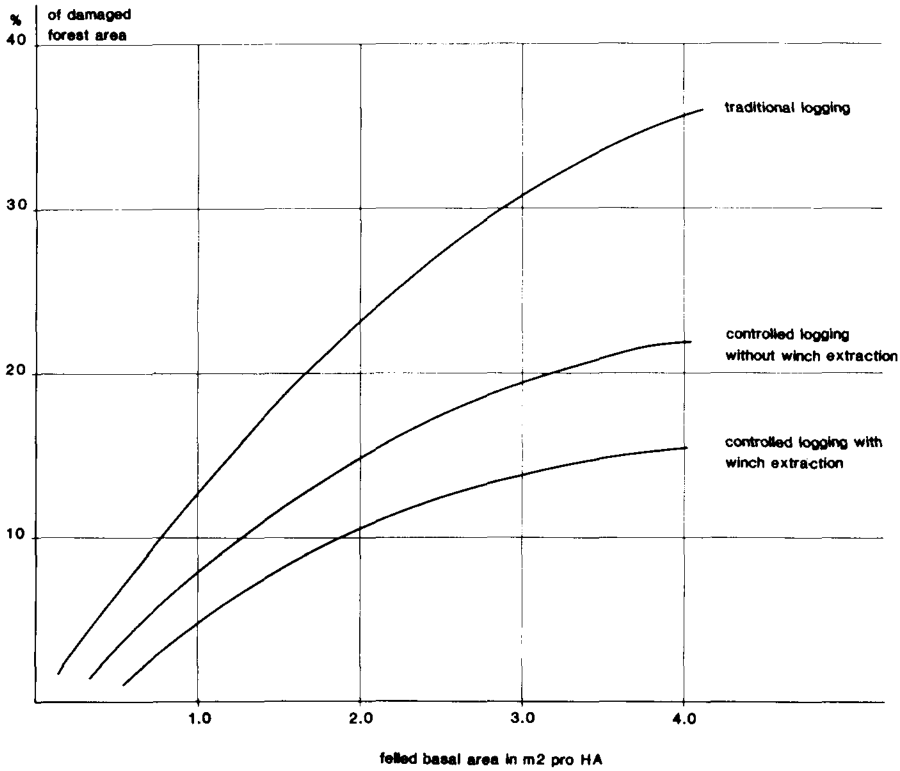


Fig. 1. Impact of logging techniques on harvesting damage in relation to logging intensity.

ume extracted seldom exceeds 20 m^3/ha). Moreover, these logging operations are wasteful and inefficient.

Thus, the Celos Harvesting System aims to reduce both logging damage and logging cost. This system includes mapping of the terrain characteristics and the trees to be felled; planning and opening-up of skid trails prior to felling; directional felling to facilitate skidding; winch extraction; and registration of the log flow from stump to terminal. With this system, skidding cost has been reduced by 10 % to 20 % and skidding damage by about 50 % (Fig. 1). Although no attention has been given to reducing felling damage, this may be achieved by cutting climbers one year in advance of logging. However, regulation and restriction of the volume harvested is likely to be more effective in this respect.

Celos Silvicultural System

The principal aim of the Celos Silvicultural System is to stimulate growth of medium-sized and large marketable trees in selectively logged forests, so that these stands can be logged again within 20 to 25 years. In addition, increment and recruit-

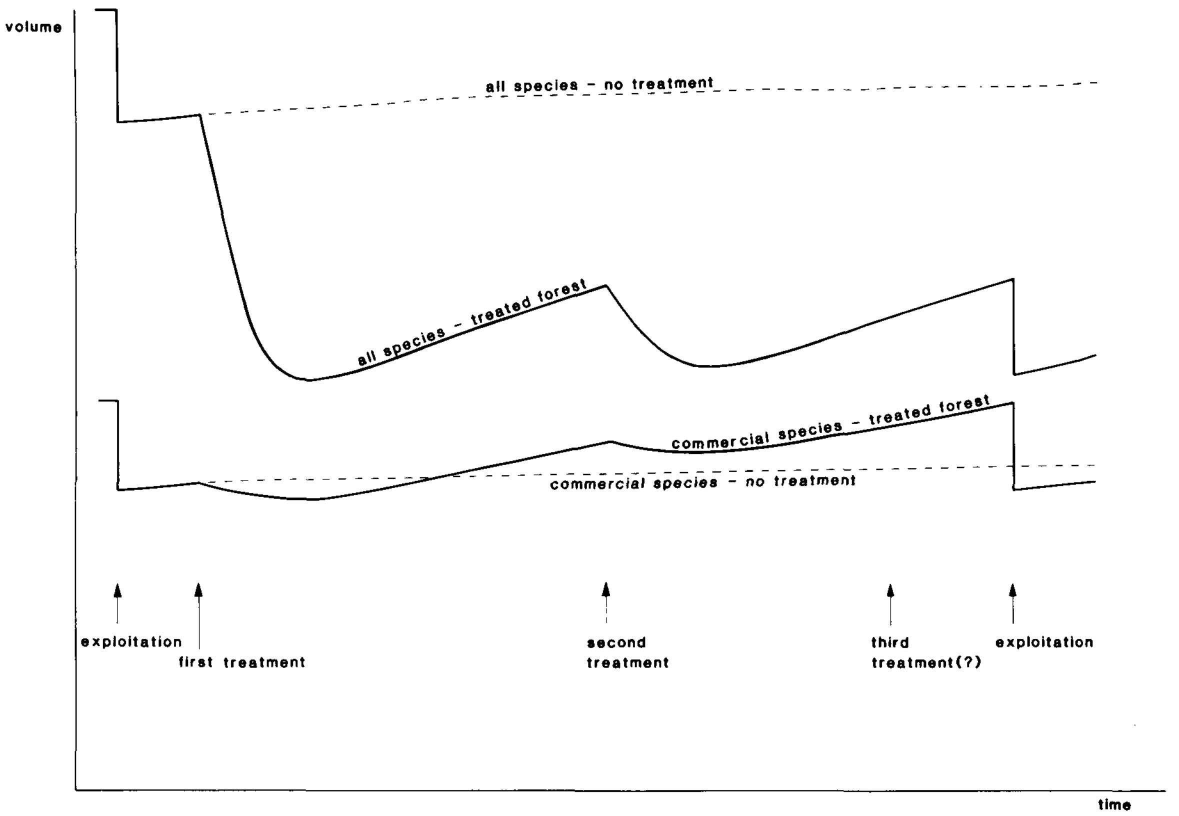


Fig. 2. Indicated changes in standing volume after logging and silvicultural treatment.

ment of smaller individuals of commercial species is enhanced to secure a sustained yield in the years thereafter. These objectives are achieved by eliminating competition from medium-sized and large trees of no commercial potential and lianas. The treatment has also a 'fertilizing effect', that is, the nutrients stored in the trees and climbers killed are made available to the remaining vegetation.

The treatment schedule proposed in 1976 included three silvicultural treatments (de Graaf, 1982). The first, which is called refinement of refining, is scheduled for one to two years after logging. It was proposed to poison-girdle all non-commercial trees above a diameter limit of 20 cm and to cut all lianas. However, recent research suggests that poison-girdling should be restricted to trees in the vicinity of those to be liberated, that is, to areas within a radius of 10 m of trees of commercial species of at least 20 cm dbh (diameter at breast height).

In the study areas, refining has resulted in an increase in annual diameter growth from 4 mm to about 10 mm and a slight increase in annual mortality from about 1.5 % to 2 %. Indications of the changes in the forest as the result of logging and refinement are given in Figs. 2 and 3.

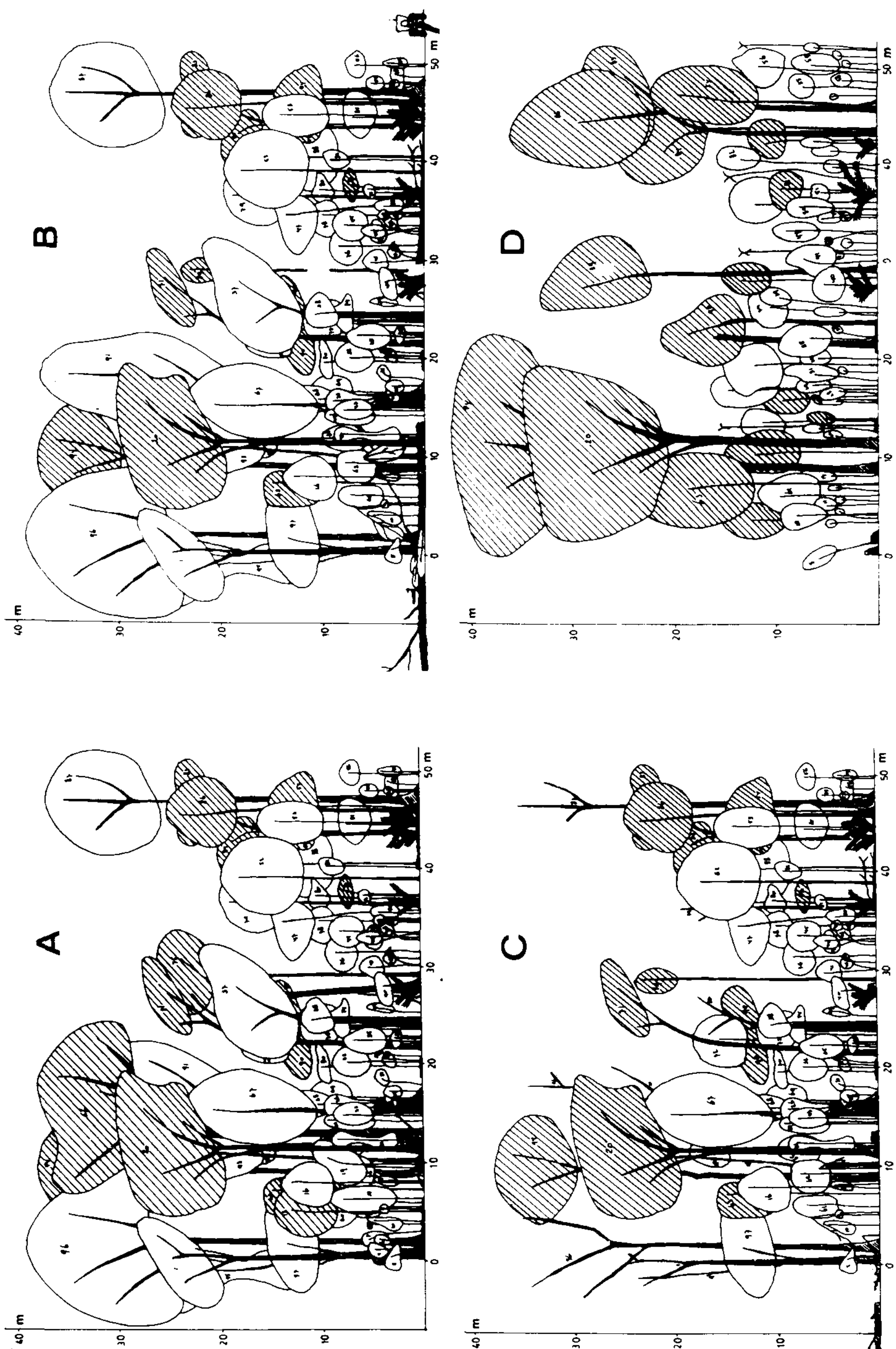
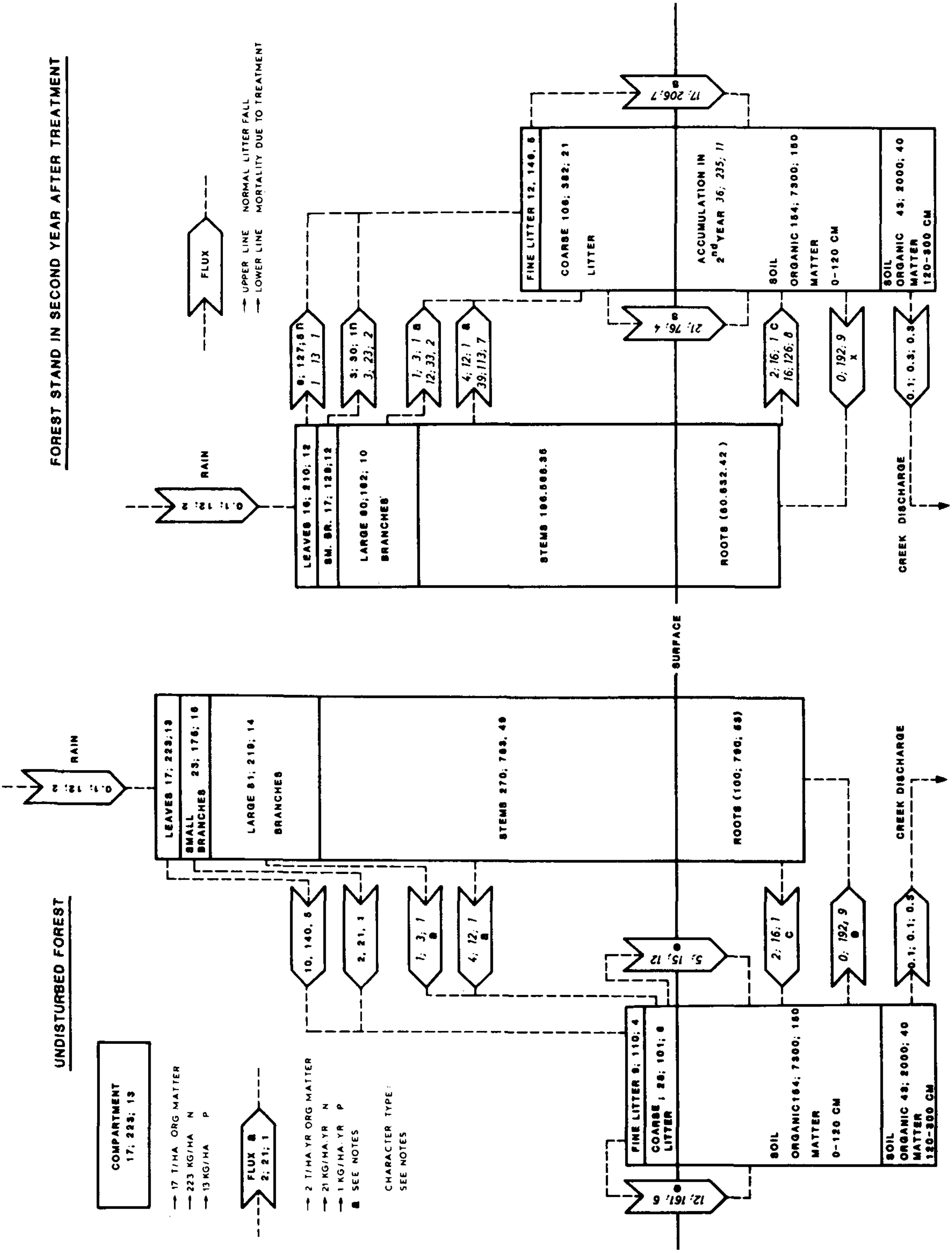


Fig. 3. Visual impression of forest structure before logging (A), after logging (B), after refinement (C) and before second logging (D). Commercial trees are hatched.


UNDISTURBED FOREST
FOREST STAND IN SECOND YEAR AFTER TREATMENT
COMPARTMENT 17; 223; 13
17 T/HA ORG MATTER
223 KG/HA N
13 KG/HA P
FLUX
2; 21; 1
2 T/HA.YR ORG MATTER
21 KG/HA.YR N
1 KG/HA.YR P
SEE NOTES
CHARACTER TYPE: SEE NOTES
UPPER LINE NORMAL LITTER FALL
LOWER LINE MORTALITY DUE TO TREATMENT
RAIN
0.1; 12; 2
LEAVES 17; 223; 13
SMALL BRANCHES 23; 176; 16
LARGE 81; 219; 14 BRANCHES
STEMS 270; 783; 40
ROOTS (100; 790; 65)
LEAVES 16; 210; 12
SM. BR. 17; 128; 12
LARGE 80; 162; 10 BRANCHES
STEMS 186.566.36
ROOTS (60.632.42)
SURFACE
CREEK DISCHARGE
10, 140, 5
2, 21, 1
1; 3; 1
4; 12; 1
2; 16; 1 C
0; 192; 9
0.1; 0.1; 0.5
5; 15; 12
12; 161; 6
FINE LITTER 9; 110; 4
COARSE ; 28; 101; 6 LITTER
SOIL ORGANIC 184; 7300; 180 MATTER 0-120 CM
SOIL ORGANIC 43; 2000; 40 MATTER 120-300 CM
9; 127; 8
1 13 1
3; 30; 1
3; 23; 2
1; 3; 1
12; 33; 2
4; 12; 1
39; 113; 7
2; 16; 1 C
16; 126; 8
0; 192; 9 X
0.1; 0.3; 0.3
17; 206; 7
21; 76; 4
FINE LITTER 12, 140, 5
COARSE 106; 382; 21 LITTER
ACCUMULATION IN 2nd YEAR 36; 235; 11
SOIL ORGANIC 184; 7300; 180 MATTER 0-120 CM
SOIL ORGANIC 43; 2000; 40 MATTER 120-300 CM

Approximately eight to ten years after refinement, increment rate has been shown to decline, and thus a follow-up treatment is required to maintain a high rate of growth. This treatment is analogous to but less drastic than the refinement. A third treatment is proposed a few years before the second harvest to consist mainly of cutting lianas. However, as yet is it not certain whether this treatment will be necessary.

The inputs required for refinement in a 200-ha trial were 2.8 man-days per hectare and 17 litres per hectare of a 2.5 % solution of 2,4,5-T in diesel oil. The cost of line cutting, overhead cost and some minor expenses have to be added. Follow-up treatments are likely to cost considerably less.

Changes in phytomass and nutrient cycling

Logging and silvicultural treatment have a number of side-effects (see Jonkers & Schmidt, 1984), of which the most crucial seems to be the potential loss of considerable amounts of nutrients from the ecosystem. The rain forests in the study areas are characterized by an abundant vegetation growing on very poor acid soils. Nutrients are stored mainly in the living phytomass of approximately 500 t/ha. The forest is very effective in taking up nutrients directly from dead phytomass (fallen leaves and branches, dead stems), before these reach the mineral soil. An almost closed nutrient cycle is maintained in which the soil plays only a minor role. In managed stands this cycle and a sufficient amount of living phytomass must be maintained to prevent leaching of nutrients.

Logging and refinement reduce the amount of living phytomass considerably. A relatively small amount is removed from the ecosystem as logs (about 15 t/ha) but a much larger proportion is killed as a result of logging damage or poison-girdling (about 190 t/ha). Comparison of nutrient cycling in undisturbed forest and in managed stands in the second year after refining has shown (Fig. 4) that in spite of the accumulation of decaying dead phytomass and the reduction in living phytomass, logging and silvicultural treatment have resulted at most in a slight increase in leaching of nutrients. Thus, it would seem that the Celos Silvicultural System does not lead to serious chemical impoverishment of the ecosystem.

Fig. 4 (see opposite page). Phytomass and two nutrients stored in major compartments and moving through major pathways of the tropical rain forest ecosystem before and in the second year after treatment. Provisional data.

Character types: numbers in roman are measured data.
numbers in italics are calculated data.
numbers in parenthesis are estimated data.

a: based on mortality rate of 1.5 % (undisturbed forest) or 2 % (treated forest).
c: see a, excluding turnover of rootlets.
e: assuming steady state.
i: including standing dead trees.
n: partly normal litter fall, partly due to treatment.
s: assuming same decomposition rate as in undisturbed forest.
x: assuming no changes in nutrient uptake in first two years after treatment.

Conclusions

More than twenty years of research have resulted in two complementary methods for rain forest management in Suriname. In comparison with traditional logging methods, the Celos Harvesting System was shown to be less costly, and also the incidence of logging damage was less. Under the Celos Silvicultural System, growth of desirable species was found to increase greatly. Treatment costs were reasonable and ecological research did not reveal undesirable side-effects. Thus, overall results indicate that the methods proposed are both economically feasible and ecologically acceptable.

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