Investigations on the poisoning of tropical rainforests for land-reclamation and wood-exploitation purposes

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1. Purpose of the investigations

The investigations were made with the purpose of examining the possibility of combining mechanical reclamation of tropical rainforests to arable land and exploitation of the suitable kinds of wood.

The investigations were made at an experimental object of 3000 ha situated in Sumatra, Indonesia, reclaimed by the Sukadana Ltd. (Managing board Nederlandsche Heidemaatschappij).

The method applied is called the "selective-poisoning method" because the suitable trees are not poisoned while the others are.

2. Suitable kinds of wood

The suitable kinds of wood are classified into 4 value classes according to the "Daftar nama pohon-pohonon 'Lampung' No. 42" (Report of the Forestry experimental station Bogor, No. 65). These kinds are the following:

1.	Bajur	*Pterospermium javanicum*	Class IV
2.	Djambu	*Eugenia* Sp.	„ III
3.	Kelutum basah	*Laplacea subintegerima*	„ III
4.	Kandis	*Garcinia dioica*	Not given
5.	Leban	*Vitex pubescens*	Class I
6.	Meranti-kinds	*Shorea* Sp.	„ IV
7.	Manggris	*Koompassia malaccensis*	„ III
8.	Merawan telor	*Hopea mengarawan*	„ II
9.	Merawan batu	*Hopea latifolia*	„ II
10.	Kemateru	*Schima wallactii*	„ III
11.	Nangi	*Adina polycephala*	„ II
12.	Sungkai	*Peronema canescens*	„ III
13.	Waru (Kehiang)	*Albizzia procera*	„ II
14.	Minjak	*Dipterocarpus gracilis*	„ III/IV
15.	Mesegar	*Anisoptera marginata*	„ IV
16.	Medang talas	*Alseodaphne macro carpa*	„ III
17.	Kaju besi	*Irvingia malayana*	Not given

The most important species are: Meranti, Menteru minjak, Merawan, Nangi and Leban. Not all trees of the abovementioned species can be used for exploitation, viz.

1. Trees with a diameter smaller than 35 cm at breastheight providing boards with a breadth less than 20 cm;

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2. Croocked trees or trees of insufficient length are unsuitable;
3. Trees affected by insects or diseases cannot be used either.

By the Forestry Department the amount of suitable wood was estimated at 40 m³/ha.

3. The method of selective poisoning

The plots were surveyed in the usual way and taking into account that the Forestry Department desires to have a strip of 25 m on either side of the brooks and rivers excluded from the project. This is an advantage to mechanical reclamation because just near the banks of brooks and rivers the terrain slopes heavily which is a bar to the mechanical cutting of trees.

After the trees in the plots were examined and classified, the undergrowth was cut by hand. All little stems with a diameter less than 10 cm were cut at a height of about 50 cm above the ground, so that the remaining stumps are clearly visible. In order to facilitate the work of the poisoners small paths were made at distances of 150 m apart. After this the trees were girdled: trees with a diameter of 20 to 50 cm once, those above 50 cm twice. Trees for wood exploitation were not girdled. Girdling is done by hand, mostly by wood-cutters of the autochthonous population who can acheive a high speed with their typical little hatchets. The girdle should penetrate through the cambium into the sap-wood and has to be complete. The lowest notch should be horizontal, preferably sloping inside a little so that no poison is spoilt when it is applied. Because of the injury of the cambium the poison at once spreads over the vital part of the stem and is transported to the branches, leaves and roots. The injury of the cambium prevents the formation of tissue. Girdling is performed at breastheight or preferably a little lower; when the girdle is cut too low the application of the poison is difficult.

Difficulties which may arise when girdling are:

1. Trees with fancifull stems are difficult to girdle completely;
2. Trees with aerial roots growing around the stem make the poisoning of the stem very difficult, e.g. Waringins;
3. Trees producing latex get wounds from which the latex flow obstructs the penetration of the poison.

The poison is applied by using a brush; this treatment should take place as soon as possible after girdling. The concentrations of the poison during the trial were various. Good results were attained with concentrations of 15 to 20 % for that purpose using 7 liters of a 50 % commercial solution of sodium-arsenite per ha. The numbers of labourers poisoning the trees with a brush and of those girdling are in the proportion of two to one.

One of the heaviest drawbacks of the poisoning lies in the fact that the poison is dangerous to people. Therefore good precautions has to be taken for limiting the danger to a minimum by:

1. Using rubber gloves;
2. Not allowing to smoke during the work;
3. Providing the workers with suitable working-clothes and shoes;
4. Not allowing labourers with wounds to join in the work;
5. Washing thoroughly with soap immediately after the work is done.

The sodium arsenite was mixed with a matter causing a blue colouring of the solution. This has many advantages:

1. Easy supervision of the progress of the work;

2. Control of the distribution of the poison over the girdle;
3. Clear indication whether a tree is treated or not.

After the dying of the poisoned trees and after cutting down and removing the suitable non-poisoned trees, the mechanical-clearing method can take place (MORHAUS, 1959).

4. Investigations

In the period 1955/56

In these years the following trials were made: 1. treatment trials; 2. trials with various poisons and 3. trials on concentration.

Ad 1. Treatment trials

The following treatments were tried out:

a. Girdling in the abovementioned way;
b. Stripping off the bark over a breadth of at least 5 cm;
c. Making notches in the stem as far as the sap-wood;
d. Application of the poison by using a brush;
e. Application of the poison by pouring it in with a nozzle-kettle.

Ad 2. Trials with poisons

a. Sodium arsenite;
b. Ammonium ammate.

Ad 3. Trials on concentration

a. Sodium arsenite 6-10-17-22-25-30 % ;
b. Ammonium ammate 20-30-40-50-60-100 and 150 % (over-saturated) and crystalline ammonium ammate.

Besides these, 4 blank plots were taken in observation one of which was barked and three were girdled. The size of all plots was 1 ha.
The results of these trials are shown in the TABLES 1—3.

Symptoms of poisoning. After a short time already the leaves of several trees slacken, die and fall down. The bark under and above the inflicted wound is attacked by moulds and insects.
In preceding investigations a tree was considered to be dead when the leaves had fallen down and the wood both above and under the inflicted wound did not show any signs of life. It was ascertained that downwards a rather quick dying took place; upwards the proces of dying proceeds very slowly.
Other remarkable symptoms were:

1. After application of sodium-arsenite solutions with higher concentrations than 20 % on trees with a diameter of 15 cm to 1 m the dying processus under the girdle started after ca 5 days.
2. Very heavy trees showed this reaction in a less degree.
3. Above the girdle a local dying was seen after 9 days.
4. The first effect on the cambium mostly had the shape of stripes and spirals.
5. The greatest resistance against poison was seen on the edges of buttresses and plankroots.
6. Great differences in resistance are found with different kinds of trees (Kaju meranti-*Shorea Sp.* dies very quickly, Kaju sempi is very resistant).

TABLE 1. Blank trials (no poison applied), period 1955/56

Plot		% dead after .... months			
		2	4	6	8
1	Barking	0	0	5	18
2	Girdling	0	5	5	16
3	„	0	0	0	14
4	„	0	0	0	20
Number of trees treated		20	20	20	50

TABLE 2. Trials with sodium arsenite, period 1955/56

Treatment	Concentration of solution	Dry sodium arsenite in kg/ha	% dead after .... months			
			2	4	6	8
Girdling; poisoning by using a brush	5	0,5	0	15	15	58
	6	0,7	20	30	40	58
	10	1,3	10	35	20	62
	10,5	1,1	15	40	50	84
	15	1,6	20	50	60	80
	17,3	2,8	55	75	80	82
	20	2,0	50	70	75	82
	22,4	3,8	55	80	65	90
	25	—	45	55	40	72
	30	2,6	20	65	55	82
Barking; poisoning by using a brush	6	0,7	5	25	40	70
	10,5	1,2	10	25	40	72
	17,3	1,3	10	30	40	72
	22,4	1,9	35	35	30	90
Girdling; poisoning by pouring in	6	1,0	20	5	65	84
	10,5	6,6	35	70	55	88
	17,3	5,2	40	55	75	74
	22,4	3,3	35	60	60	84
Number of trees treated			20	20	20	50

Remarks:

1. Owing to the small number of observations in the plots rather important deviations can be stated;
2. A second reason for the occurrence of deviations might be the fact that each time different trees were checked.

The quantities of crystalline sodium arsenite applied per ha vary very much due to various factors but mainly by differences in the number of trees treated per ha.

Conclusions:

1. The effect of sodium arsenite is clear;
2. Increasing concentration gives a quicker result;
3. Pouring in the poison results in great losses of poison;
4. Girdling and barking have almost the same result.

TABLE 3. Trials with ammonium ammate, period 1955/56

Treatment	Concentration of solution %	Crystalline ammonium ammate in kg	% dead after .... months 2	4	6	8
Girdling; poisoning by using a brush	20	2,7	0	0	10	26
	30	1,7	0	5	15	26
	40	2,7	0	5	15	26
	50	2,6	0	5	15	48
	50	3,3	0	10	5	28
	60	3,5	0	0	10	26
	100	—	0	15	20	48
	150 (over-saturated)	—	0	10	10	28
Barking; poisoning by using a brush	20	3,2	0	5	5	20
	30	2,0	0	0	5	16
	40	2,4	0	5	20	28
	50	3,0	0	5	25	26
	60	3,7	0	15	5	28
Girdling; poisoning by pouring in	20	2,5	0	0	5	12
	30	2,8	0	10	20	22
	40	2,9	10	5	15	32
	50	2,4	0	0	15	48
	60	3,4	0	5	10	28
Notches; with crystalline ammonium ammate		5,7	0	5	0	4
		5,3	0	15	0	0

Remarks:

The same as those with TABLES 1 and 2.

Conclusions:

1. The effect of ammonium ammate can almost be neglected;
2. The dying of trees after application of poison in notches is lower than with girdling or barking only.

Time of poisoning. The trials started in the months of September and October just before the rainy season began.

In the period 1956/57

In this period the following treatments were tried out:
1. Sodium arsenite in concentrations of 5-10-15-20-25-30-50 % ;
2. Ditto, heavy trees just before root-cutting by using a pull-stumper;
3. 2-4-5-T conc. 1,5 and 3 % acid in water;
4. Ditto but in dieseloil;
5. Trioxone (its principal component is also 2-4-5-T) conc. 1,5 and 3 %;
6. Ditto in dieseloil;
7. Blank (girdled only, no poison applied).

The area covered by the experiment was divided into plots of 1 ha each one separated from the others by walking paths. All trees having a diameter smaller than 10 cm were cut down by hand; those larger than 10 cm were numbered and classified in three groups:

I	10—35 cm Ø
II	35—75 cm Ø
III	> 75 cm Ø

The unsuitable trees of the groups I and II were girdled at a height of about 80 cm; those of group III were girdled twice at heights of about 50 and 80 cm.

Special remarks. Trioxone emulsifies very well in water to a milky liquid; also in dieseloil one gets a good emulsion which remains clear. 2-4-5-T emulsifies very bad in water; initially a muddy substantion remains at the bottom which cannot easily be emulsified. Emulsifying 2-4-5-T in dieseloil is easier. Both poisons have no colour by which the supervision is made very difficult.
Some of the trees treated with solutions of Trioxone or 2-4-5-T in water show tissue growth at the upper side of the girdle which symptom sometimes is attended by roots resembling folds. If these poisons are emulsified in dieseloil the symptom occurs less. In plots where sodium arsenite was applied in the 15 % and stronger concentrations, due to the quick fall of the leaves much sunlight penetrates to the ground with the result that a dense vegetation develops rapidly.
The root-cutting of the heavier trees should be done by using a pull-stumper *after* poisoning. If it is done *before* the labourers applying the poison meet much trouble with trees which are unintentionally pushed down during the root-cutting activities. The root-cutting just after poisoning also intensifies the effect of the poison.
Root-cutting in a forest the undergrowth of which is cut only a short time before is much easier than in a forest where a dense vegetation has grown up again. Finally the danger of falling trees and branches in a forest poisoned only just before is not present. Pushing down trees of the 10—35 cm group is entailed in the manoeuvring of the tractors for root-cutting; the number of these unintentionally uprooted trees amounts to 50 per ha on an average.

Reading and check. It was intended to read the results of the trials monthly for a duration of 6 months or more, but owing to a tiger-nuisance the readings had to be interrupted for about 2 months; they could be continued again to begin with the 4th-month reading. Three categories were distinguished, viz. dead, withering and alive. Sometimes symptoms of moulting were taken for symptoms of poisoning; the number of these mistakes, however, was so small that it could not exercise any influence on the figures. The figures obtained are shown in TABLE 4.

Number of trees/ha (see TABLE 4). The numbers of trees with a diameter larger than 10 cm were widely divergent, varying from 357 to 683 with an average of 461. The percentages in the various groups also varied very much, diverging

in group I	from 55,7	to 95,2 %
II	from 4,4	to 35,6 %
III	from 0	to 8,7 %

Quantities of solution applied per ha. These diverged from 15 to 22 liters with an average of 17,3 liters. The quantity per tree varied from 28,8 to 55,3 cc with an average of 37,4 cc.

TABLE 4. Investigations in 1956/57

Nr. of plot	Poison used and its concentration	Quantity applied		Number of trees/ha ø > 10 cm		ø of trees treated in cm			Reading after 1 month											
									Dead				Withering				Alive			
		l/ha	cc/tree	total	treated	gr. I 10-35 %	gr. II 35-75 %	gr. III > 75 %	Total	I	II	III	Total	I	II	III	Total	I	II	III
1.	Sodium arsenite 5 %	18,1	40,6	446	446	91,0	8,5	0,5	5,6	5,9	2,7	0,0	24,4	25,6	13,1	0,0	70,0	68,5	89,2	100,0
2.	,, ,, 10 %	19,4	38,8	500	500	93,6	5,6	0,8	12,6	14,3	7,1	0,0	24,0	23,9	25,0	25,0	63,4	61,8	67,9	75,0
3.	,, ,, 15 %	17,0	30,2	564	563	94,9	4,6	0,5	10,9	18,3	0,0	0,0	24,6	24,8	15,4	66,6	64,5	56,8	84,6	33,4
7.	,, ,, 20 %	17,0	36,9	460	460	89,6	6,0	4,4	18,5	19,1	14,3	10,5	62,8	62,2	67,8	63,1	18,7	18,7	17,9	26,4
8.	,, ,, 25 %	16,8	34,9	482	482	93,3	4,4	2,3	20,2	19,4	47,2	18,2	64,9	66,2	38,0	81,8	14,1	14,8	14,8	0,0
9.	,, ,, 30 %	18,0	42,1	429	429	66,4	27,0	6,6	47,2	50,1	41,2	39,3	32,2	28,6	38,6	42,8	20,6	21,3	20,2	17,9
10.	,, ,, 50 %	15,0	39,8	378	377	55,7	35,6	8,7	60,8	62,2	61,2	48,5	20,0	20,6	20,1	15,1	19,2	16,9	18,7	36,4
4.	,, ,, 5 %	17,2	47,6	361	335	93,7	6,0	0,3	10,9	11,0	10,5	0,0	19,4	18,8	31,6	0,0	69,7	70,2	57,9	100,0
5.	,, ,, 9 %	17,1	41,7	410	374	93,6	6,1	0,3	23,6	23,8	20,8	0,0	40,2	36,0	39,1	100,0	36,2	40,2	40,1	0,0
6.	,, ,, 15 %	19,0	53,2	357	336	89,6	8,9	1,5	25,2	28,0	3,2	0,0	32,1	31,3	38,7	40,0	42,7	40,7	58,1	60,0
11.	,, ,, 20 % [1]	18,3	45,2	405	338	91,1	8,3	0,6	24,0	24,0	20,7	50,0	61,4	61,1	58,6	50,0	14,6	14,9	20,7	0,0
12.	,, ,, 25 %	22,0	55,3	398	354	58,2	33,3	8,5	28,7	31,7	22,7	33,3	46,8	41,3	54,7	42,4	24,5	27,0	23,1	24,3
13.	,, ,, 30 %	17,0	39,8	427	375	62,9	30,7	6,4	40,9	42,7	37,8	41,6	48,4	48,3	48,0	50,0	10,7	9,0	14,2	8,4
14.	,, ,, 50 %	18,0	38,0	473	423	87,0	9,2	3,8	57,0	61,2	53,7	35,4	32,3	28,5	39,0	31,2	10,7	10,3	7,3	33,4
15.	Trioxone 1,5 % in water ...	15,2	31,0	490	490	91,6	6,1	2,3	3,8	4,0	0,0	9,1	13,2	13,5	6,6	18,2	83,0	82,5	93,4	72,7
17.	2-4-5-T 1,5 % in water	12,5	28,9	433	433	78,8	16,6	4,6	1,8	2,3	0,0	0,0	12,5	15,2	1,4	5,0	85,7	82,5	98,6	95,0
16.	Trioxone 3 % in water	21,4	37,0	579	579	78,4	16,2	5,4	1,0	1,1	1,0	0,0	15,8	17,8	8,5	6,4	83,2	81,1	90,5	93,6
18.	2-4-5-T 3 % in water	15,0	34,2	439	439	92,9	7,1	—	1,3	1,4	0,0	—	12,3	13,2	16,1	—	86,4	85,4	83,9	—
19.	Trioxone 1,5 % in Dieseloil .	15,2	33,1	459	459	93,7	5,7	0,6	4,5	4,9	0,0	0,0	9,1	9,5	3,8	0,0	86,4	85,6	96,2	100,0
21.	2-4-5-T 1,5 % in ,, .	15,0	28,8	520	520	83,5	11,9	4,6	4,4	5,3	0,0	0,0	15,4	17,0	13,0	8,3	80,2	77,7	87,0	91,7
20.	Trioxone 3 % in ,, .	15,5	33,5	463	463	78,4	13,4	8,2	5,0	5,7	1,6	2,6	17,9	19,3	9,7	10,5	77,1	75,0	88,7	86,9
22.	2-4-5-T 3 % in ,, .	20,0	29,3	683	683	95,2	4,5	0,3	7,9	7,8	6,4	0,0	16,4	16,5	9,6	50,0	75,7	75,7	84,0	50,0
23/26.	Blank (only girdled)	—	—	1040	1040	76,5	19,2	4,3	0,5	0,5	0,5	0,0	0,4	0,4	0,5	0,0	99,1	99,1	99,0	100,0

Nr. of plot	Reading after 4 months											
	Dead				Withering				Alive			
	Total	I	II	III	Total	I	II	III	Total	I	II	III
1.	14,1	15,0	5,3	0,0	17,0	17,8	10,5	0,0	68,9	67,2	84,2	100,0
2.	30,4	29,2	42,9	75,0	22,0	22,7	14,2	0,0	47,6	48,1	42,9	25,0
3.	36,9	36,5	46,2	33,3	23,3	23,6	11,5	66,7	39,8	39,9	42,3	0,0
7.	45,4	45,1	42,9	55,0	25,7	26,2	32,1	5,0	28,9	28,7	25,0	40,0
8.	61,4	61,3	61,9	63,6	22,6	22,7	14,3	36,4	16,0	16,0	23,8	0,0
9.	65,7	62,2	73,9	67,9	18,0	19,6	15,7	10,7	16,3	18,2	10,4	21,4
10.	89,4	88,6	91,1	88,3	2,7	2,9	1,5	6,0	7,9	8,5	7,4	6,0
4.	24,5	22,6	50,0	100,0	10,7	10,8	10,0	0,0	64,8	66,6	40,0	0,0
5.	48,6	48,0	56,5	100,0	28,9	29,4	21,8	0,0	22,5	22,6	21,7	0,0
6.	59,9	59,0	70,0	50,0	22,0	23,8	3,3	25,0	18,2	17,2	26,7	25,0
11.	62,4	61,7	67,8	100,0	24,3	25,3	14,3	0,0	13,3	13,0	17,9	0,0
12.	65,5	65,5	62,7	76,7	16,1	17,5	15,3	10,0	18,4	17,0	22,0	13,3
13.	70,1	68,2	70,5	87,5	15,5	18,6	10,4	8,3	14,4	13,2	19,1	4,2
14.	82,3	81,3	89,5	87,5	8,5	9,2	5,1	0,0	9,2	9,5	5,2	12,5
15.	6,3	6,5	3,3	9,1	11,2	10,8	16,7	18,2	82,5	82,7	80,0	72,7
17.	4,7	5,9	0,0	0,0	15,9	17,3	10,0	15,0	79,4	76,8	90,0	85,0
16.	5,7	5,9	5,3	3,3	13,6	14,3	9,6	16,7	80,7	79,8	85,1	80,0
18.	6,8	6,4	12,9	—	17,1	17,6	9,7	—	76,1	76,0	77,4	—
19.	9,6	9,7	7,7	0,0	15,5	15,6	15,4	0,0	74,9	74,7	76,9	100,0
21.	16,5	17,5	14,5	4,2	11,0	11,5	6,5	12,5	72,5	71,0	79,0	83,3
20.	18,6	19,3	12,9	21,0	24,4	25,9	21,0	23,4	57,0	54,8	66,1	55,3
22.	21,5	21,8	16,1	0,0	13,9	14,0	12,9	0,0	64,6	64,2	71,0	100,0
23/26.	2,0	2,3	1,5	0,0	0,9	0,6	2,0	0,0	97,1	97,1	96,5	100,0

Nr. of plot	Reading after 5 months											
	Dead				Withering				Alive			
	Total	I	II	III	Total	I	II	III	Total	I	II	III
1.	19,5	20,9	5,3	0,0	15,5	15,3	15,8	50,0	65,0	63,8	78,9	50,0
2.	34,4	33,6	42,9	75,0	18,6	19,0	14,2	0,0	47,0	47,4	42,9	25,0
3.	44,4	44,4	46,1	33,3	17,6	17,4	15,4	66,7	38,2	38,0	38,5	0,0
7.	59,8	59,7	57,1	65,0	16,1	16,3	21,4	5,0	24,1	24,0	21,5	30,0
8.	66,4	66,2	61,9	81,8	18,0	18,2	14,3	18,2	15,6	15,6	23,8	0,0
9.	70,2	68,1	75,0	71,4	14,0	14,4	14,7	7,2	15,8	17,5	10,3	21,4
10.	91,5	90,9	92,5	91,0	1,3	1,0	1,5	3,0	7,2	8,1	6,0	6,0
4.	30,1	28,7	50,0	100,0	9,3	9,2	10,0	0,0	60,6	62,1	40,0	0,0
5.	57,2	56,6	65,1	100,0	20,6	20,9	17,5	0,0	22,2	22,5	17,4	0,0
6.	65,5	65,1	70,0	60,0	15,8	17,0	3,3	20,0	10,7	17,9	26,7	20,0
11.	83,4	83,8	78,6	100,0	5,3	5,5	3,6	0,0	11,3	10,7	17,8	0,0
12.	69,8	69,4	67,8	80,0	11,9	13,1	11,0	6,7	18,3	17,5	21,2	13,3
13.	74,1	72,8	73,1	91,6	11,2	13,6	7,8	4,2	14,7	13,6	19,1	4,2
14.	83,0	82,3	87,2	87,5	8,0	87,0	5,1	9,0	9,0	9,0	7,7	12,5
15.	12,7	12,9	10,0	9,1	10,8	10,3	16,2	18,2	76,5	76,8	73,3	72,7
17.	13,6	16,4	4,2	0,0	12,5	12,9	9,7	15,0	73,9	70,7	86,1	85,0
16.	17,3	19,4	10,7	6,5	8,3	8,1	7,4	12,9	74,4	72,5	81,9	80,6
18.	10,2	10,0	12,9	—	15,9	16,4	9,7	—	73,8	73,6	77,4	—
19.	19,0	18,8	23,1	0,0	13,7	14,0	11,5	0,0	67,3	67,2	65,4	100,0
21.	23,1	23,0	21,0	29,2	12,3	13,4	6,4	8,3	64,6	63,6	72,6	62,5
20.	32,0	34,2	19,4	31,7	20,5	20,1	19,3	26,3	47,5	45,7	61,3	42,1
22.	26,9	27,2	22,6	0,0	13,6	13,8	9,7	0,0	59,5	59,0	67,7	100,0
23/26.	4,7	4,4	6,0	4,4	1,1	1,0	1,5	0,0	94,2	94,6	92,5	95,6

[1] poisoning followed my pull-stumping.

Remarks concerning the trials in TABLE 4.

1. Although only few diverging figures are found in the quantities of sodium arsenite solution applied per tree, the figures of the quantities used per ha diverge much more and do not correlate, e.g. with the number of heavy trees in group III;
2. It is striking that with the sodium arsenite concentrations of 5-10-15-20 and 25 % the doses per tree are larger on the plots where poisoning was followed by root-cutting. Certainly this has to be attributed to casual factors for it is only in the case of the 25 % concentration that this might be caused by a greater number of heavier trees;
3. The average number of trees having a diameter of 10—35 cm amounts to 80—90 %. Accidentally these figures have an average of 50—70 % in plots treated with a high sodium arsenite concentration.

5. Conclusions

With regard to the effect of poisoning

1. Trioxone and 2-4-5-T in water have only a slight effect;
2. Trioxone and 2-4-5-T in dieseloil still have unsatisfactory results;
3. Trioxone and 2-4-5-T have better results on smaller trees than on heavy ones;
4. When poisoning with sodium arsenite the influence of the concentration is evident; the stronger the concentration, the quicker and better the effect;
5. There appears to be some influence of root-cutting but the figures are not fully reliable because the quantities of poison applied per tree are greater in the root-cutting plots;
6. Anyway, it is stated that the influence of root-cutting is greater at low than at high concentrations, which could be expected;
7. When applying the poison in a 20 % concentration the percentage of dead trees after 5 months amounts to more than 60. Using a concentration of 25 % this result is already gained after 4 months;
8. Probably owing to the double girdle more than 60 % of the heavy trees are dead after 5 months when concentrations higher than 20 % are used.

With regard to the selective-poisoning method

1. In the poisoned forest with its undergrowth cut the non-poisoned suitable wood is easily detected and dragged away;
2. Poisoning the forest has many advantages with regard to the forthcoming reclamation:

a. Less energy is needed;
b. Slight damage brought about to the soil;
c. Less repairs of equipment;
d. Low costs of reclamation per ha.

Ad a. Less energy is needed. The mechanical activities, such as the root-cutting and the making of turning-strips, are easier to perform in a forest where the undergrowth is cut and take less labour-hours.
The cutting of poisoned trees requires considerably less power owing to their light weight. The same holds good for windrowing.
Therefore, the number of tractor-hours needed from reclamation up to and including sowing amounts only 11 to 12 tractor-hours/ha, whereas 16,5 to 18 tractor-hours/ha are needed in a non-poisoned forest.

Ad b. Slight damage brought about to the soil. This is due to:
1. Less tractor-hours, so less driving to and fro on the soil;
2. Less energy is needed, so less skidding of caterpillars which brings the subsoil on top and presses the topsoil down;
3. A layer of branches and leaves protects the soil against all activities of the machinery;
4. A new vegetation comes easily into existance enriching the soil afterwards.

Ad c. Less repairs of equipment. The clearing of the undergrowth enables an easy survey of the area and a better co-operating of the tractors.
While manoeuvring the tractors the drivers and their machines run less risks of receiving damage by falling branches and trees, unless the dead trees have been left mouldering for a very long time, and this of course can be avoided by good organisation of the work.

Ad d. Low costs of reclamation per ha. As mentioned under a. the number of tractor-hours is reduced to ca 50 % which means a considerable saving of costs; the savings due to less repairs of equipment (see under c.) come to it.
The input of hand labour increases with the selective-poisoning method, but this increase of costs is amply compensated by the saving of tractor-hours.

6. Final conclusion

The method of selective-poisoning of tropical, primeval forests enables an easy exploitation of the suitable wood. It is a quick and cheap method which can be performed in less privileged countries for the purpose of migrating the inhabitants of over-populated regions to not yet reclaimed forest-covered districts.

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