CIRAD

INDONESIA	OIL PALM

PLANT PATHOLOGY REPORT

MISSION TO PT SMART

1^{ST} – 11^{th} March 2000

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DOC CP N°1245
May 2000

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REPORT ON THE MISSION TO THE PT SMART PLANTATIONS

1st to 11th March 2000

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SUMMARY AND CONCLUSIONS

This mission to PT Smart was primarily devoted to the problem of Basal Stem Rot (BSR), a lethal disease on oil palm caused by *Ganoderma* sp. In Indonesia, the disease is widespread in the plantations of North Sumatra. It is expressed at the end of the first generation, then increasingly early in successive generations.

Padang Halaban Estate is the plantation within the Sinar Mas group that is suffering the severest BSR damage. True losses are difficult to evaluate with precision, since no disease records have been kept since 1990. Partial observations during the mission indicate that the BSR rate exceeds 50% in the blocks planted in the 1980s.

The priority task is therefore to take stock of the situation through palm-by-palm records and disease mapping, beginning in blocks due to be replanted in the coming years. Such a record will enable more effective yield forecasting, but it will also be possible to set up trials in a known environment.

PT Smart is already investing in BSR research. It is primarily geared nowadays towards biological control of the disease using biological fungicides based on *Trichoderma* spp., and particularly *T. koningii*. Culturing of the pathogen and its antagonist in the laboratory is now a routine practice at Libo Research.

In order to establish an integrated control method against BSR, research should not rule out the possibilities of screening for resistance to *Ganoderma,* or cultural practices that slow down disease development.

Proposals are made in this report. Some, notably those concerning cultural techniques, will need to be completed in line with the records compiled. The situation and proposals could therefore be redefined during a second mission that could take place before the end of the year.

DETAILED MISSION SCHEDULE

- **Wednesday 1st March:**

9:30 am :	Arrival at Padang Halaban Estate, accompanied by Messrs Achmad Wahyu and Triyono Widodo. Met by Mr. Caliman. Drafting of the mission schedule and examination of work carried out on *Ganoderma*
11:00 am :	Meeting with Estate Management and discussion with Messrs Rudi Bunadi (Regional Controller), Bambang Irawan (Estate manager) and Lasimane Pane (Crop Protection Manager)
2:00 pm :	General tour of the estate

- **Thursday 2nd March:**

7:00 am :	Field visits
2:00 pm :	Discussion about protocols with Messrs Wahyu and Lasimane

- **Friday 3rd March:**

7:00 am :	Field visits
2:00 pm :	Field visits. Compilation of a partial record in block 19, division IV (1985 planting)

- **Saturday 4th March:**

8:00 am :	Tour of Kanopan Ulu Estate
Afternoon:	Drafting of notes

- **Sunday 5th March:**

Whole day:	Drafting of notes. Preparation for the meeting the following day and production of transparencies.

- **Monday 6th March:**

8:00 am – 1:00 pm :	Talk and meeting at Padang Halaban.
2:30 – 10:30 pm :	Trip from Padang Halaban to Libo

- **Tuesday 7th March:**

7:00 – 9:30 am :	Tour of the Libo Station
9:30 – 11:00 :	Discussion with Mr. Tony Liwang, Research Manager
11:00 – 12:30 :	Discussion about protocols with Mr. Wahyu
2:00 – 4:30 pm :	Tour of seed garden with Messrs Wahyu and Triyono Widodo
4:30 – 7:30 pm :	Discussions with Mr. Wahyu and drafting of notes

- **Wednesday 8th March:**

10:00 am – 9:30 pm :	Trip from Libo to Sungai Bengkal Estate. Met by Mr. Sofyan Nasution, Estate manager

- **Thursday 9th March:**

8:00 – 11:30 am :	Field observations and dissections of diseased palms.
11:30 – 12:30 pm :	Meeting and discussions
2:30 – 6:00 pm :	Trip from Sungai Bengkal to Jambi

- **Friday 10th March:**

8:00 – 12:00 am :	Preparation of notes for summing up meeting
1:30 – 7:00 pm :	Waiting for flight from Jambi to Jakarta
9:00 pm:	Arrival in Jakarta

- **Saturday 11th March:**

10:00 – 12:00 pm :	Final meeting in Jakarta attended by Messrs Saputra, Belsham, Liwang, Wahyu, Caliman and de Taffin, CIRAD representative in Indonesia
7:15 pm:	Flight from Jakarta to Paris

- **Sunday 12th March:**

6:30 am :	Arrival in Paris
9:00 - 10:30 am :	Flight Paris-Montpellier

ACKNOWLEDGEMENTS

This visit proceeded under excellent conditions and we should like to thank Mr. B.C. Belsham for helping to make it so, and for his interest in the summing up at the final meeting in Jakarta.

Our warm thanks go also to Mr. Achmad Wahyu Sulistyanto for the care he took in preparing and organizing the mission and for the time he readily gave up.

We also thank Mr. Lasimane Pane, crop protection manager at PT Smart, along with our colleague, Mr. Jean-Pierre Caliman, for his most valuable assistance.

1. INTRODUCTION

This mission by Mr. Hubert de Franqueville, a senior CIRAD plant pathologist, took place under the contract signed between PT Smart (Sinar Mas Group) and the CIRAD Tree Crops Department, for crop protection. It primarily concentrated on Basal Stem Rot (BSR), a fungal disease caused by *Ganoderma* sp.

The terms of reference for the mission were as follows:

- Draw up the **inventory of diseases** affecting the P.T. SMART oil palm plantings, based on information provided beforehand by the Company's staff. Check for existence in the field wherever necessary.

- Visit the estate(s) affected by BSR, paying particular attention to **Padang Halaban.**

- **Study the spread of BSR** depending on the plantation cycle (1st, 2nd or 3rd generation), the previous crop cover, the material planted and the cultural techniques adopted.

- Propose the introduction of a **phytosanitary monitoring system** based on palm-by-palm mapping of the disease, so as to eventually ensure management of the risks posed by BSR. Integrate other diseases into this monitoring system if necessary.

- Encourage **the organization of a phytosanitary monitoring team**, supervised by an official from a crop protection unit, and start training it.

- **Propose trials** geared towards:
  - A. oil palm resistance to BSR
  - B. the effect of cultural techniques on disease development

- Examine the feasibility of **early BSR resistance tests**, by pathogen inoculation.

- Examine the feasibility of **biological control of BSR**, notably through the antagonistic effect of *Trichoderma* sp. and propose any trials to that end, either in the nursery or in the field.

- Following the visit, **draft a visit report** summarizing the proposals made and the action to be taken.

As suggested by the information gathered prior to the mission, the only disease in the Sinar Mas estates is BSR, apart from a decay disease reported at the Sungai Bengkal estate, for which a special visit was made and which will be discussed later on in this report.

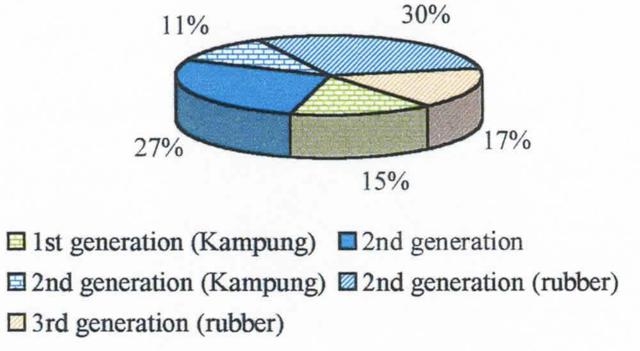
It is at Padang Halaban Estate that BSR causes major damage. The following notes are therefore primarily devoted to that estate. The final section of the document describes how the terms of reference were fulfilled.

2. PADANG HALABAN

The Padang Halaban estate was set up at the end of the 1910s/beginning of the 1920s. It currently occupies 7,259 hectares of first, second and third generation oil palm plantings, most of the blocks being set up after former rubber plantings.

Information gathered at the estate indicates the previous plant cover up to 1999 for 7,007 hectares. Figure 1 summarizes the data according to the oil palm generations represented. Soil occupation prior to oil palm cultivation, where known, is given in brackets..

Figure 1 - Distribution of generations at Padang Halaban

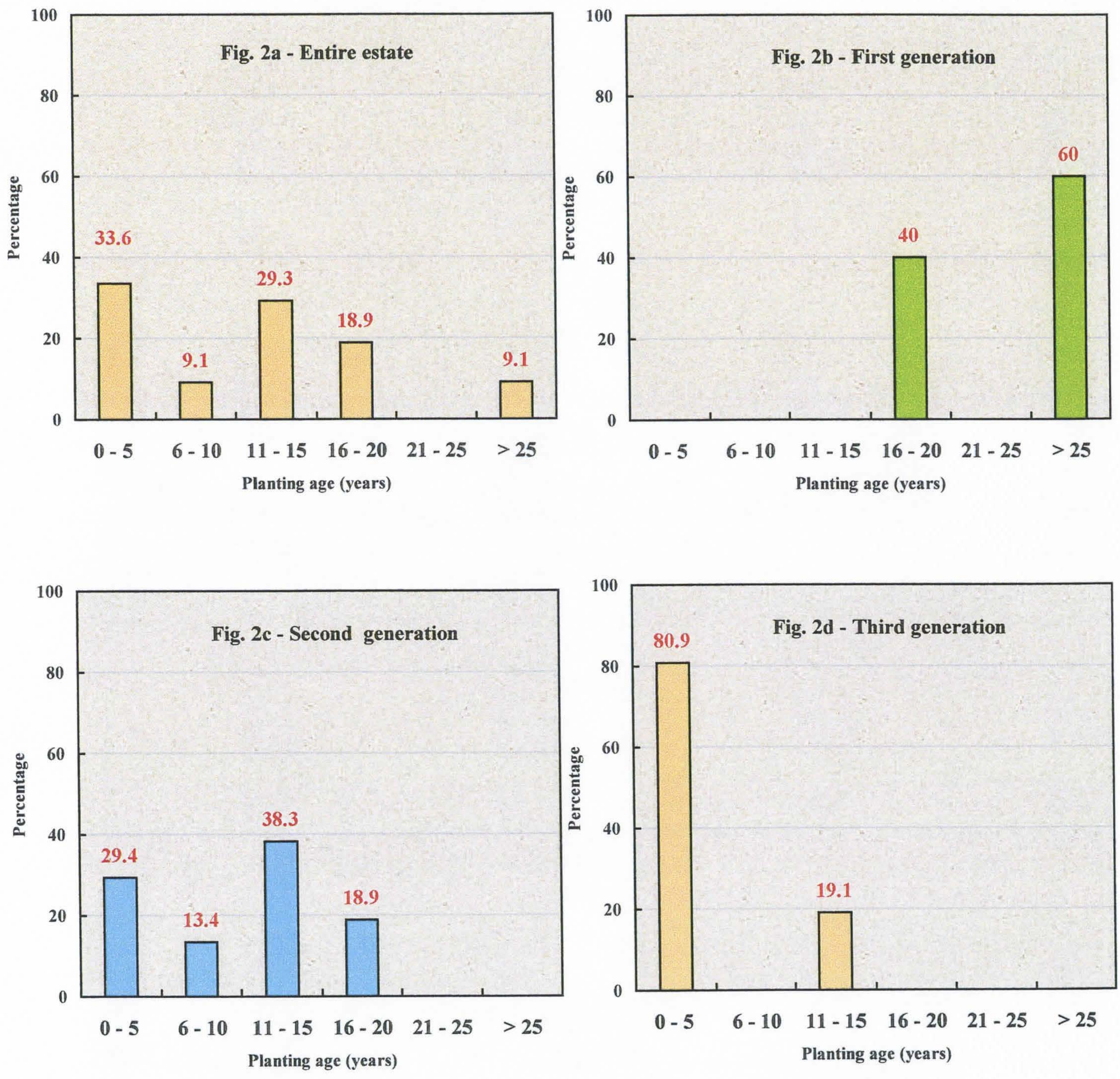


The types of previous plant cover indicated are those planted before oil palm, irrespective of the latter's generation. What remains of the first generation, which is now in a minority, was set up on land formerly given over to *kampung*, occupied by dwellings, backyards and food crops. The second generation, in a 68% majority, is being cultivated after various former crop covers, and the third generation occupies land previously devoted entirely to rubber plantings.

Figures 2a to 2d, show planting distribution by age in 1999 for the entire estate, then for each generation represented, all previous crop covers combined. Figure 2b reveals the ageing of the first generation, 60% of which is over 25 years old. The age groups are better distributed in the second generation (figure 2c), whereas the third generation primarily comprises young palm plantings (figure 2d).

It is important to take this information into account when studying BSR, whose incidence usually depends on the age of the planting and the crop cycle considered.

Figure 2 – Distribution of planting ages



3. INCIDENCE OF BASAL STEM ROT AT PADANG HALABAN

Like most of the estates planted some time ago in North Sumatra, Padang Halaban is affected by Basal Stem Rot, a lethal disease caused by a rot of the genus *Ganoderma*. *G. boninense* is considered to be the main species involved in the etiology of the disease in Indonesia and Malaysia. Generally speaking, BSR affects ageing palm plantings during the first generation, occurring increasingly early in subsequent generations.

However, there are no recent records of its incidence available at the estate. A fairly general, though not exhaustive, inventory of the affected population was carried out in 1990, but has not been updated since.

Table I gives the results of the inventory according to generation and previous crop cover[1]. The indicated values correspond to: *i)* the percentage of palms affected or killed by *Ganoderma* and missing palms presumed to have been killed by BSR, along with: *ii)* the number of hectares visited (in brackets). The age of the plantings at the time of the inventory is also given. The blocks for which no information about the previous crop cover is shown are assumed to have been set up directly after forest felling.

Table I – Incidence of BSR at the time of the 1990 inventory

Year	Age (years)	**1st generation**			**2nd generation**			**3rd gener.**
		Kampung	*Rubber*	*Forest*	*Kampung*	*Rubber*	*Forest*	*Rubber*
1965	25	16.7 (111)				36.8 (27)		
1967	23					14.8 (58)		
1968	22					21.9 (104)		
1969	21	11.8 (110)				33.4 (55)		
1970	20	7.4 (127)				8.9 (32)		
1971	19	5.4 (504)	22.2 (100)	12.6 (206)		22.3 (218)		
1972	18	0.0 (148)	0.0 (32)			38.7 (172)		
1973	17	1.6 (170)						
1979	11	2.4 (69)						
1980	10	3.6 (264)			3.0 (26)			
1981	9				6.1 (189)		7.2 (87)	
1982	8						6.6 (358)	
1983	7				1.8 (56)	6.5 (174)		
1984	6					4.7 (113)		2.2 (68)
1985	5					3.7 (156)		
1986	4					1.8 (492)		
1987	3					1.4 (573)		
1988	2					3.3 (273)		

Interpreting such a table and drawing conclusions is obviously tricky, insofar as not all the situations are represented within the same planting year. The most representative year for the different situations is 1971.

1 The generations and their previous crop cover do not entirely correspond to the data in fgures 1 and 2, due to replantings after 1990 and the disappearance of part of the inventoried population..

Nevertheless, a few comments can be made:

- The plantings set up in *kampung* zones are less affected by BSR than the others, contrary to the (preconceived?) idea that villages and their surroundings are zones propitious to *Ganoderma* development.

- The previous rubber cover seems to involve a risk factor, be it in the first (1971 plantings) or second generation (1984 plantings). It is interesting to note that the third generation 1984 plantings set up in former rubber zones are only half as affected as the second generation plantings of the same age with an identical previous cover.

- Likewise, the second generation 1971 plantings (22.3%) are not more affected than their first generation counterparts (22.2%). However, that is not the case with the 1972 plantings, though the validity of the zero percentage seen in the first generations is somewhat dubious.

- For a given planting year, which can be assumed to have been planted with equivalent material, the second generations planted in former rubber zones are two to three times more attacked than the first generations planted on *kampung* (case of the 1965 and 1969 plantings).

- The second generation 1988 plantings already had 3.2% losses in 1990.

These records are ten years old and it now appears necessary to consolidate any comment or hypothesis on BSR development with a detailed study of the current situation.

Indeed, disease incidence is taking alarming proportions in most planting years. It is therefore important to ascertain disease dispersion and dynamics, at a time when large foci are appearing and developing. For instance, the partial inventory and mapping carried out in block 19 (division IV, 1985 planting, second generation after rubber) show that there are now only 48.5% of palms with a healthy appearance. It can therefore be considered that over 50% of losses are attributable to BSR, whereas there was only 5.4% in this block in 1990. The situation may be even more serious in the 1983 to 1985 plantings in division III. In 1990, none of the plantings more than 15 years old were suffering from so many losses.

It is commonly accepted that losses due to BSR do not lead to significant production losses, provided they remain below a threshold of 20% dead palms, due to a compensation phenomenon from which surviving palms benefit. This threshold now seems to have been widely exceeded in a large part of the estate.

Such a situation not only leads to substantial economic losses, but also encourages inoculum development and the risks of BSR, which will be increasingly difficult to curb in replantings.

➢ *It is therefore now important to proceed with a new inventory and mapping of the disease, combined with research actions, in order to eventually achieve integrated control of Basal Stem Rot. Proposals are made in the following section.*

4. PROPOSALS AND RECOMMENDATIONS

4.1. DISEASE MONITORING: INVENTORIES AND MAPPING

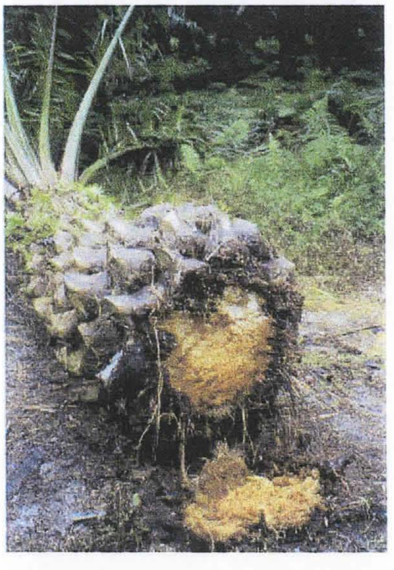
It is strongly recommended that the inventory and mapping of Basal Stem Rot be launched right away, in order to analyse the situation in detail before the end of 2000. Such an analysis should enable estate mangers to improve production forecasts and researchers to set up trials in a known environment. That will also facilitate management of the disease and of its potential risks and enable PT Smart to develop worthwhile long-term BSR research for all its estates.

4.1.1. Scoring criteria

When records are compiled, oil palms are attributed a score reflecting symptom intensity.

- **0** : healthy palms
- **1** : slight symptoms (2 or 3 closed spears, beginning of foliage chlorosis)
- **2** : moderate symptoms (several closed spears and foliage that is not dried out but hanging in a skirt down the stem).
- **3** : severe symptoms (only a few closed spears remain, the dried out foliage hanging down the stem).
- **4** : dead palms, still in place, but which have clearly been killed by BSR. They have usually been toppled by the wind (figure 3), due to basal rot of the stem tissues, or they remain standing and gradually decompose.
- **5** : missing palms, for which the disappearance has not been formally established but which can generally be attribued to BSR.

Most of the time, the assumption of BSR established by examining the foliage symptoms is confirmed by the presence of fruiting bodies at the base of the stem.



◂ Figure 3

Figure 4 ▸

Nevertheless, the observations carried out indicate that there is no direct relation between the severity of symptoms and the presence or absence of fruiting bodies. Palms with advanced symptoms, without fruiting bodies, are frequently seen. Palms with a healthy appearance, whose stem base is colonized by numerous fruiting bodies are just as frequent (figure 4). All possible variations exist between these two extremes.

The role played by fruiting bodies in BSR propagation is still not clearly known. It therefore seems useful, for the time being, to assess their frequency and density, whilst maintaining a clear, easy-to-handle scoring system that can be managed by current database software.

That is why we propose keeping the above scoring scale, completed by one decimal place from 1 to 9, which will indicate the number of fruiting bodies found on the stem.

Scores will be attributed during plot visits on a map indicating the position of each palm. In practice, healthy palms without fruiting bodies will be indicated on the map by a " /" , when proceeding through the plot, and missing palms by an " X", in compliance with the usual symbols for disease recording. Table II summarizes the proposed observation scoring system.

Table II – Proposed scoring of Basal Stem Rot symptoms

Score	Observations
0 : 0.1 – 0.2 – 0.3 -….-0.9 :	Palms with healthy appearance (indicated by a / on the map during the inventory) Palms with a healthy appearance, with 1, 2, 3,…., 9 (or more) fruiting bodies
1 : 1.1 – 1.2 –1.3-…-1.9 :	slight symptoms (2 or 3 closed spears, beginning of foliage chlorosis) without fruiting bodies ditto, but with 1, 2, 3,…., 9 (or more) fruiting bodies
2 : 2.1-2.2-2.3-…-2.9 :	moderate symptoms (several closed spears and foliage not dried out but hanging down the stem in a skirt) without fruiting bodies ditto, but with 1, 2, 3,…., 9 (or more) fruiting bodies
3 : 3.1 – 3.2 – 3.3 - …- 3.9 :	severe symptoms (no longer any foliage but closed spears, dried fronds hanging down the stem), without fruiting bodies ditto, but with 1, 2, 3,…., 9 (or more) fruiting bodies
4.n	Palm killed by BSR (cause identified during a previous inventory or by the presence of n fruiting bodies)
5	Missing palm (X on the record map)

4.1.2. Priorities

Before replanting, it is important to have a record for the blocks due for renewal, so as to locate foci from the previous generation. Priority must therefore be given to the next planting programmes, then to the 1980 plantings. The younger plantings will gradually be covered by an initial inventory.

For information, at the Dabou Plantation in the Ivory Coast, where *Fusarium* incidence is high, a well trained and experienced observer inventories three 6.25 ha plots per day, i.e. 18.75 ha. It will probably be difficult to cover such an area for BSR, due to observation of fruiting bodies, but an area of 10 to 15 hectares per observer per day seems to be a feasible target.

4.1.3. Frequency and utilization of records

For the time being, we propose an annual inventory in the commercial plantings and a quarterly inventory on any field trial planted. These records will be used to identify palms that need to be eradicated (see below).

➢ *In practice, we recommend carrying out as complete an inventory as possible before the next plant pathology mission, during which the need for an annual inventory everywhere will be examined.*

- Inventories on layout drawings, to map the disease, will take two forms: one block will be covered with a spot check sheet, scoring the criteria already proposed, which in fact will indicate the condition of the block at a given moment, and a single summary sheet updated during successive inventories will provide a more dynamic picture of the BSR situation.

- Once these data have been gathered, they can be computerized using an exploitation method yet to be defined in detail. CIRAD is currently developing mapping data which could be used in the study of diseases and their epidemiology. BSR is a disease that lends itself perfectly to this type of exploitation, which could eventually lead to the construction of databases, which could themselves be integrated into a more general estate GIS.

- Teams will have to be trained accordingly; their observations will be supervised and assembled by the Libo Research crop protection unit. The records drawn up with Mr. Wahyu have led to an identical view on how this should actually be done.

4.2. RESEARCH ACTIONS

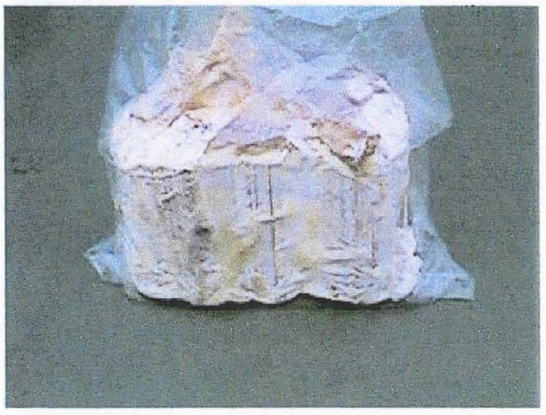
4.2.1. Current situation

The Libo Research Station has been carrying out research on *Ganoderma* for several years, primarily concentrating on rot control in chemical treatment trials, or more extensively, in biological control trials.

Isolation and culturing of *Ganoderma* spp. in the laboratory have now been effectively mastered (figure 5) at the Station, which is appropriately equipped for this type of work, though the equipment is not exclusively reserved for plant pathology work.

◄ *Figure 5:* Ganoderma lucidum *fruiting body obtained in the laboratory* (Photo : Mr. Lasimane Pane)

The inoculum is prepared on rubber tree or Acacia logs, or on fragments of oil palm petioles (figure 6).



◂ *Figure 6: inoculum on logs* (Photo : Mr Lasimane Pane)

➢ *The aim is to find out whether it is reasonable to grow and handle the causal agent of Basal Stem Rot in a zone free of the disease, where oil palm cultivation is of paramount importance. All the precautions seem to have been taken to prevent the risk of pathogen propagation, but moving plant pathology work to Padang Halaban should be considered and examined.*

The work carried out since 1994, and work due to be carried out in the short term, is summarized in annex 3, drafted by Mr. A. Wahyu. The broad outlines are as follows:

- trials geared towards chemical control did not give significant results with fungicides (1994-1996),
- different culture media were compared, to define the most appropriate one for pathogen isolation (1995-1996); the composition of the chosen culture medium is given in annex 3 (formula No. 3),
- inoculation preparation was studied and improved (1996-1997),
- antagonism between *Trichoderma koningii* , *T. harzianum, Giocladium virens,* on the one hand and *Ganoderma boninense* on the other hand, was demonstrated *in vitro* and on logs (1996-1997) ;
- artificial inoculation of *Ganoderma* in the nursery was carried out, though not to Mr. Wahyu's complete satisfaction due to high variability in the incubation (3 weeks to 9 months) and the insufficient percentage of diseased plants, at around 50% (1996-1998); however, *Ganoderma* inoculation in the soil gave 90% fruiting bodies (figure 7).

Figure 7 ▸
Fruiting bodies obtained after artificial inoculation in soil (photo : Mr. A. Wahyu)

- trials conducted since 1999 have been entirely devoted to improving biological control investigation methods. The programme Mr Wahyu has set himself starting in 2000 is summarized in table III.

Table III – Research programme for 2000
(proposed by Mr. Wahyu)

No	Title of Trial	Start	End	Treatment	Result
1	How to improve biofungicide colony in the nursery and the toxicity aspect.			*Trichoderma koningii, T. harzianum*, etc.	
2	Biofungicide antagonist effect against *G. boninense* On oil palm nursery to support field trial.			*Trichoderma koningii, T. harzianum*, etc.	
3	Biofungicide antagonist effect against *G. boninense* On oil palm nursery to support field trial.			*Trichoderma koningii, T. harzianum*, etc.	
4	Biofungicide nursery application and correlation with the antagonistic effect against *Ganoderma* attack when the nursery plant is in a BSR endemic area.			*Trichoderma koningii, T. harzianum*, etc.	
5	The effect of surgery on production			Surgery	
6	The combination of surgery and pile up technique for controlling BSR.			Surgery combined with basal stem soil pile up	
7	Biofungicidal nursery and planting hole application (Demo plot treated in 1999)			*Trichoderma koningii, T. harzianum*, etc.	
8	Several field biofungicide trials (to cure diseased palms, destroy source of inoculum etc)			*Trichoderma koningii, T. harzianum*, etc.	

The search for effective biofungicides against BSR is therefore the main thrust of research against the disease for the time being.

➢ *Research needs to be able to maintain an appropriate balance between the three main approaches of integrated control, which were accuratly discussed with Mr. Wahyu :*

- *resistance to BSR*
- *cultural techniques*
- *biological control*

4.2.2. Resistance to BSR

According to numerous field observations, it should be possible to obtain a certain degree of resistance to BSR in oil palm, or at least is should be possible to discard sources of susceptibility in material reserved for BSR risk zones.

The main problem faced by institutions or companies working on this subject lies in the fact that no early test is currently available for selection purposes, unlike for *Fusarium* wilt in West Africa. The selection of resistant planting material in that case takes place in the prenursery by inoculation with the pathogen.

In the nursery, most of the teams attempting to establish differences between crosses come up against high mortality approaching 100% caused by the *Ganoderma* inoculum. We noted at Libo that mortality stands at around 50% and that the incubation period can vary substantially. If such variability in performance can be linked to the type or origin of the planting material, it becomes possible to consider using a selection test. Indeed, it is preferable, roughly speaking, to obtain an average of 50% through crosses at 25% and others at 75%, especially if differences are observed in disease dynamics, rather than total mortality of inoculated material.

➢ Initially, it appears essential to master inoculation, whose effectiveness is partially linked to the amount of inoculum applied.
➢ Secondly, a given range of planting materials should be subjected to *Ganoderma* inoculation using different procedures proposed below.

- **<u>Trial No. 1</u>** : <u>effect of the amount of inoculum</u>
- Nursery trial, incorporating the inoculum in the soil when transferring seedlings from the prenursery to the nursery.
- Inoculum incubated for three weeks after inoculation on rubber tree logs. Three treatments:
  - ½ log
  - 1 log (standard procedure)
  - 2 logs
- 5 replicates: 10 plants per treatment and per replicate, i.e. 150 plants in all belonging to the same cross.
- Observations (types of symptoms, fruiting body development, mortality) every week throughout the nursery period.

- **Trial No. 2**: testing of crosses in the nursery

An initial trial could be set up without waiting for the results of trial No.1, with just the dose of inoculum corresponding to 1 log:

- Nursery trial, incorporating the inoculum in the soil when transferring seedlings from the prenursery to the nursery.
- 5 crosses, 5 replicates: 10 plants per cross and per replicate, i.e. 250 plants in all (50 plants per cross).
- Observations (types of symptoms, fruiting body development, mortality) every week throughout the nursery period.

- **Trial No. 3:** Petiole test

It was interesting to see that it was possible to prepare inoculum by growing *Ganoderma* on petiole fragments. In the case of *Fusarium* wilt, the petiole reacts differently to inoculation of the pathogen's spores depending on the crosses. It would be interesting to see whether the same applies with *Ganoderma*, through a preliminary trial. If such were to be the case, estimation of an individual's resistance could be envisaged.
This trial could be conducted by taking petioles from fronds 9 and 17 on Dura palms in the Libo Research seed garden:

- 5 Dura crosses
- 5 Dura per cross
- petiole samples taken from fronds 9 and 17
- petiole inoculation
- measurement of the internal spread of *Ganoderma* by sectioning the petioles 5 days after inoculation (to be fine-tuned if necessary in additional trials).
-

- **Trial No. 4** : testing of crosses planted around diseased palms

- It is possible to obtain BSR symptoms on seedlings in the nursery by planting them around the stumps of palms killed by BSR or around the stem of diseased palms. This can be tried, by planting different palms in this way. However, a preliminary trial will be required beforehand, with plants of the same cross, to check the importance of distance from the stump, so as not to introduce subsequent bias in a planting material assessment.

- **Planting in identified crosses**

This is not a trial, or even research strictly speaking, but the introduction of a procedure which, in the case of *Fusarium* wilt in West Africa, has proved particularly useful. The Ivorian plantation at Dabou, which has already been mentioned, covers 4,000 hectares, virtually all planted in identified crosses for decades. Regular records of disease spread have provided very valuable information on the field performance of the crosses planted. Of that information, discovery of sources of resistance or susceptibility to *Fusarium* has been a cornerstone for establishing the correlation between performance in the early test, using artificial pathogen inoculation, and peformance in the field. In that way, the validity of the early test was confirmed.

It is not a question of adopting a too heavy procedure, based on a true statistical design. It is merely a matter of making a distinction between crosses, which requires effective identification of seed supplies, their transfer to the nursery, then transfer of the seedlings to the nursery and the field. One cross can then occupy 5 consecutive rows, another the following 5, depending on the number of plant available.

4.2.3. Cultural techniques

Over recent decades, numerous cultural techniques have been adopted, both in Malaysia and Indonesia, in the hope of reducing BSR incidence. It is tricky determining which have really been effective, since the changes adopted have involved adaptive trials to check validity.

It is too early to propose cultural technique trials at Padang Halaban. Indeed, as many records as possible need to be compiled beforehand, to analyse the various situations and make the appropriate choice of trials and the sites where they will be set up.

For the time being, it is strongly recommended that diseased oil palms be eradicated as soon as stage 2 occurs, when the palm no longer produces bunches. It is highly unlikely that such a palm will recover and resume bunch production. This proposal seems to offer a reasonable balance between economic constraints and epidemiological constraints.

In the case of a plantation such as the Kanopan Ulu Estate, where BSR is beginning to occur in the 1985 plantings (including block 6 of division I), the eradication criteria should be applied as strictly as possible and diseased palms should be eliminated as soon as symptoms are seen, irrespective of their severity. It is true that cases are very few in number for the time being, occurring in first generation blocks (after rubber) planted since 1982. The possibility of curbing disease development as much as possible must be seized upon right away.

Particular attention should be paid to windrowing, and planting young palms next to old stumps or windrows must be avoided. Practically speaking, new palms should be planted as far as possible from the former palms, meaning that the same density as in the previous planting has to be maintained.

4.2.4 Biological control

The antagonistic capacity of *Trichoderma koningii*, *Trichoderma harzianum*, *Gliocladium virens* (= *T. virens*) with respect to phytopathogenic fungi has been extensively described for various diseases. These soil-borne fungi have a direct effect on pathogen populations, but also on the host-plant, whose defence reactions they stimulate.

The literature abounds with examples of antagonism obtained *in vitro*, but there are few data available on the sustainability of the protection that *Trichoderma* can provide to a perennial plant.

In Indonesia, control by *Trichoderma* has really caught on, be it for oil palm cultivation (against *Ganoderma*) or rubber cultivation (against *Rigidoporus*). Mass production units have been set up, as at IOPRI, Marihat.

The trials proposed by Mr. Wahyu, summarized in table III, were analysed and discussed with him. We agreed to launch trials intended to consolidate the biological control approach against *Ganoderma*. It is proposed that the following trials, whose numbering follows on from those in section 4.2.2., be set up in the nursery or in the field:

- **Trial No. 5**: effect of *Trichoderma* dose in decontaminated or non-decontaminated soil
Chemical decontamination of a soil before introducing a fungal organism usually enables the organism to develop abundantly. In fact, soil treatment favours elimination of potential

competitors for the introduced organism. Treatment with Cryptonol (potassium hydroxyquinoline sulphate) or Previcur N (propamocarb HCl) should give satisfaction, but their availability in Indoniesia is unsure. More information should be obtained locally. Cryptonol offers the advantage of being easy to use as it is soluble in water, has low toxicity and has a fairly broad spectrum.

The trial would comprise the following elements:

- *Trichoderma*: 4 doses: application of 0g, 5g, 10g and 15g of the Marihat (Marfu) commercial formula per nursery bag (Marihat commercial recommendation: 10g/polybag),
- application of *Trichoderma,* in a decontaminated soil and in a non-decontaminated soil, 5 days before seedling transfer and inoculation with *Ganoderma,*
- 5 replicates of 10 plants per treatment and per replicate. 4 doses x 2 soil treatments x 5 replicates: 400 plants in all,
- observations (types of symptoms, fruiting body development, mortality) every week throughout the nursery stage.

As soon as results begin to show, the trial will be repeated, with the most effective combination, followed by transfer to the field with or without *Trichoderma* in the planting hole.

- **Trial No. 6**: curative effect of *Trichoderma* in adult plantings

Setting up this type of trial satisfies a need widely expressed during the visit, and there is no doubt that its objective and the speed with which it can be launched sets it among the priority operations:

- 1984 or 1985 plantings, severely attacked by BSR,
- after the inventory, choose 60 diseased palms at stage 0 without fruiting boidies, 60 palms at stage 1 and 60 palms at stage 2.,
- Treatments: 0 g, 500 g, 1 kg of the commercial *Trichoderma* formulation
- Agricultural practices: mounded or unmounded palms,
- 3 doses of *Trichoderma* x 2 agricultural practices x 10 palms per symptom stage,
- Fortnightly observation of symptom development and of the number of fruiting bodies.

4.2.5. Comments

Setting up these trials and carrying out the observations is a sufficiently hefty work load for the coming months. Inventories are the main priority, since they will guide future choices, notably for testing cultural techniques. With the inoculation trials, it will be possible to decide whether or not to continue with the search for a BSR tolerance test and the biological control trials will make it possible to pinpoint the role that *Trichoderma* can play in an integrated control system.

- It would be a good thing if most of the proposals made in this document could be implemented before the next plant pathology mission, which could take place sometime before the end of the year. It will not be an easy task, as the crop protection supervisory staff are few in number and the geographical dispersion of the sites is considerable. Of course, the author of this report is prepared to remain in continuous contact with PT Smart by e-mail (hubert.de_franqueville@cirad.fr) or fax (33 467 61 57 93 or 33 467 61 71 20), to simplify the setting up of these trials as much as possible.

5. OTHER DISORDERS OR DISEASES

5.1. DECAY DISEASE AT SUNGAI BENGKAL ESTATE

At the request of PT Smart, the Sungai Bengkal Estate in Jambi province was visited to examine cases of decay observed in the 1996 plantings (planting material of SOCFINDO origin). Such cases of decay have only been recorded on that planting year, and are limited to blocks C3 and C4. They appeared in October 1999 and had affected 52 palms by the time of the visit.

These palms are located in steep zones, in the middle or at the bottom of slopes, and are grouped in foci. Numerous forest tree stumps occupy the land and the palms are often planted against the stumps (figures 8 and 9, photos by Mr. Lasimane Pane).

Figure 8

Figure 9

The symptoms are characterized by more or less generalized yellowing, usually beginning with the oldest fronds (figure 10, photo by Mr. Lasimane Pane). They affect the least vigorous palms, which gradually dry out and end up toppling over. When dissected where the break occurs, the base of the stem reaveals a dry, hard, black rot, forming a zone of necrotic tissues in the root bulb. (figure 11, photo by Mr. Lasimane Pane).

Figure 10

Figure 11

The rot isolates the stem from the root sytem, thus explaining why the palm topples. Most of the roots are rotten, dry, blackish and friable. An outwardly healthy palm was dissected in a "focus", and the tissue at the base of the stem was found to be largely affected. That suggests that once outward symptoms occur, it is already too late to save the palm. Any curative treatment therefore seems to be doomed to failure.

The damage seen on roots can resemble that caused by *Sufetula* attacks (figure 12, photo by Mr. Lasimane Pane). Likewise, traces of termites were found in places, but no preference is given to that hypothesis. The symptoms observed correspond perfectly to those of ***charcoal base rot***, caused by *Ustulina deusta* (= *U. zonata*) described in Indonesia and Malaysia, notably by Turner (1981).

Figure 12

Figure 13

The fungus is a saprophyte on forest tree stumps, but can attack oil palm, rubber, coconut or even tea. It emits flat, greyish fruiting bodies with concentric furrows. The fruiting bodies seen on one stump (figure 13) matched that description. Samples were taken by Mr. Wahyu to isolate and grow the fungus.

Turner confirms that charcoal base rot is a disease of minor economic importance. Curative treatments are not feasible and preventive treatments are unlikely to result in an economically satisfactory response. The only possible recommendation is therefore to eliminate affected palms and replace them with seedlings, which is already done at the estate (figure 14).

Figure 14 : palm killed by Charcoal base rot and replaced by a seedling

Despite the fact that this disease is assumed not to be serious, its development and evolution should be closely monitored.

5.2. SPEAR ROT

Young plantings in some Sumatran plantations are affected by a type of spear rot that can be lethal if the meristem is affected. One case has been observed at Padang Halaban. The distribution of such cases seems to be linked to *Oryctes* outbreaks. It is currently a marginal problem, but a close watch should be maintained.

Cases of spear rot have been seen in the 1982 plantings at Kanopan Ulu Estate (division III, block 02), on a hill of several hectares. They are intermingled with cases of BSR. At the time of the visit, there were no developing cases, as if the disorder had come to a halt. It seems linked to a one-off event lasting several weeks, no doubt due to climatic conditions. The brevity of the visit to Kanopan Ulu Estate and the time given over to BSR prevented our looking at this matter in detail.

GENERAL DISCUSSION

At this stage in the document, it seems appropriate to take stock of the mission, referring back to the terms of reference fixed (see page 4), to check they have been fulfilled.

- Draw up the **inventory of diseases** affecting the P.T. SMART oil palm plantings, based on information provided beforehand by the Company's staff. Check for existence in the field wherever necessary.

  ➢ *In addition to BSR, we noted the existece of charcoal base rot at Sungai Bengkal estate during a visit made to that estate at PT Smart's request (§ 5.2).*

- Visit the estate(s) affected by BSR, paying particular attention to **Padang Halaban.**

  ➢ *Padang Halaban estate provided most of our observations and much of this document is devoted to it. Kanopan Ulu estate was also visited and recommendations were made for the drastic eradication of diseased palms, in order to keep BSR at its current low level (§ 4.2.3.).*

- **Study the spread of BSR** depending on the plantation cycle (1st, 2nd or 3rd generation), the previous crop cover, the material planted and the cultural techniques adopted.

  ➢ *The available data were exploited and analysed (§ 3), but it is essential to update them.*

- Propose the introduction of a **phytosanitary monitoring system** based on palm-by-palm mapping of the disease, so as to eventually ensure management of the risks posed by BSR. Integrate other diseases into this monitoring system if necessary.

  ➢ *This is a high priority action, as indicated throughout the document.*

- Encourage **the organization of a phytosanitary monitoring team**, supervised by an official from a crop protection unit, and start training it.

  ➢ *Inventories were made with Mr Wahyu and Mr Lasimane Pane, during which an agreement was reached on the type of observations to be recorded (§ 4.1). A talk was given at Padang Halaban, attended by estate managers, assistants and chief assistants, who were made aware of the importance of monitoring BSR. A copy of the transparencies projected during the talk can be found in the annex 4.*

- **Propose trials** geared towards:
  C. oil palm resistance to BSR
  D. the effect of cultural techniques on disease development

  ➢ *The first trials to study oil palm resistance to BSR have been proposed (§ 4.2.2.). Those on the effect of cultural techniques will be proposed once the inventories have been carried out. Indeed, it is pointless launching field trials at an inappropriate site.*

Generally speaking, numerous proposals are linked to a clearer understanding of the impact of BSR at Padang Halaban. They could be made during a second mission, which we propose should be carried out before the end of the year.

- Examine the feasibility of **early BSR resistance tests**, by pathogen inoculation.

  ➢ *Culturing of* Ganoderma boninense *in the laboratory seems to have been effectively mastered (§ 4.2.1.) and consideration can now be given to launching inoculation trials geared towards a study of planting material performance (§ 4.2.2). However, it is necessary to examine the possibility of moving the Libo plant pathology laboratory to Padang Halaban, since Libo is located in a BSR-free zone.*

- Examine the feasibility of **biological control of BSR**, notably through the antagonistic effect of *Trichoderma* sp. and propose any trials to that end, either in the nursery or in the field.

  ➢ *The antagonistic virtues of* Trichoderma *kindled considerable interest during the mission. Trials on this subject should be methodically continued, though it should not be the only type of research conducted if PT Smart is to achieve integrated control of BSR (§ 4.2.4.).*

- Following the visit, **draft a visit report** summarizing the proposals made and the action to be taken.

ANNEX 1

PLANTATION INVENTORY

PADANG HALABAN ESTATE

Division	Block	Year	Ha	Gener. of oil palm	Before oil palm (other than forest)
I	1	1987	22	2	Karet *(rubber)*
I	2	1970	54	1	Kampung
I	3	1970	52	1	Kampung
I	4	1986	18	2	Karet
I	5	1986	24	2	Karet
I	6	1986	28	2	Karet
I	7	1979	35	1	Kampung
I	8	1980	36	1	Kampung
I	9	1979	34	1	Kampung
I	10	1980	50	1	Kampung
I	11	1980	57	1	Kampung
I	12	1986	54	2	Karet
I	13	1986	33	2	Karet
I	14	1986	34	2	Karet
I	15	1986	29	2	Karet
I	16	1986	30	2	Karet
I	17	1986	30	2	Karet
I	18	1986	23	2	Karet
I	19	1986	24	2	Karet
I	20	1986	32	2	Karet
I	21	1986	17	2	Karet
I	22	1986	49	2	Karet
I	23	1987	39	2	Karet
I	24	1987	34	2	Karet
I	25	1987	40	2	Karet
II	1	1987	40	2	Karet
II	1	1999	31	2	Kampung
II	2	1987	28	2	Karet
II	3	1987	28	2	Karet
II	4	1987	37	2	Karet
II	5	1987	24	2	Karet
II	6	1987	59	2	Karet
II	7	1987	24	2	Karet
II	8	1986	32	2	Karet
II	9	1986	26	2	Karet
II	10	1986	9	2	Karet
II	11	1987	33	2	Karet
II	12	1987	35	2	Karet
II	13	1988	34	2	Karet
II	14	1983	54	2	Karet
II	21	1999	23	2	Kampung
II	23	1984	33	3	Karet
II	24	1984	35	3	Karet
II	25	1999	48	2	Kampung
II	26	1983	36	2	Karet
II	28	1999	17	2	Kampung
II	29	1999	75	2	Kampung
II	30	1999	62	2	Kampung
II	31	1999	41	2	Kampung
II	32	1999	33	2	Kampung
II	35	1999	16	2	Kampung
III	1	1985	30	3	Karet
III	2	1985	47	3	Karet
III	3	1985	46	3	Karet
III	4	1985	33	3	Karet
III	5	1988	26	2	Karet
III	6	1988	29	2	Karet
III	7	1988	28	2	Karet

PADANG HALABAN ESTATE

Division	Block	Year	Ha	Gener. of oil palm	Before oil palm (other than forest)
III	8	1983	40	2	Karet
III	9	1983	44	2	Karet
III	10	1988	34	2	Karet
III	11	1988	29	2	Karet
III	12	1988	28	2	Karet
III	13	1988	27	2	Karet
III	14	1988	29	2	Karet
III	15	1988	9	2	Karet
III	16	1993	54	2	Karet
III	17	1985	28	2	Karet
III	18	1985	33	2	Karet
III	18	1996	37	3	Karet
III	19	1984	33	2	Karet
III	19	1996	38,5	3	Karet
III	20	1984	29	2	Karet
III	21	1996	52	3	Karet
III	21	1996	44,5	3	Karet
III	23	1996	32	2	Karet
III	26	1984	24	2	Karet
III	27	1984	27	2	Karet
IV	1	1985	37	2	Karet
IV	1	1994	22	2	Karet
IV	2	1994	29	2	Karet
IV	9	1994	27	3	Karet
IV	10	1994	20	3	Karet
IV	11	1994	20	3	Karet
IV	12	1994	31	2	Karet
IV	12	1995	39	3	Karet
IV	13	1994	29	2	Karet
IV	13	1995	37	3	Karet
IV	14	1994	38,5	2	Karet
IV	14	1995	41	3	Karet
IV	15	1994	27	2	Karet
IV	15	1995	40	3	Karet
IV	16	1994	34,5	2	Karet
IV	16	1995	44	3	Karet
IV	17	1995	41	3	Karet
IV	19	1985	22	2	Karet
IV	20	1985	39	2	Karet
IV	21	1987	24	2	Karet
IV	22	1987	17	2	Karet
IV	23	1987	24	2	Karet
IV	24	1987	41	2	Karet
IV	25	1987	24	2	Karet
V	3	1994	34	3	Karet
V	4	1994	34	3	Karet
V	5	1994	17	3	Karet
V	6	1994	19	3	Karet
V	7	1994	29	3	Karet
V	8	1994	29	3	Karet
V	9	1969	63	1	Kampung
V	9	1994	32	3	Karet
V	10	1981	31	2	Kampung
V	10	1994	29	3	Karet
V	11	1981	37	2	Kampung
V	11	1994	26	3	Karet
V	12	1981	34	2	Kampung
V	14	1994	31	3	Karet

PADANG HALABAN ESTATE

Division	Block	Year	Ha	Gener. of oil palm	Before oil palm (other than forest)
V	14	1994	23	3	Karet
V	15	1994	28	3	Karet
V	15	1994	36	3	Karet
V	16	1994	36	3	Karet
V	17	1994	35	3	Karet
V	18	1994	29	3	Karet
V	22	1969	15	1	Kampung
V	23	1980	35	1	Kampung
V	24	1980	34	1	Kampung
VI	1	1997	5	2	Kampung
VI	2	1997	22	2	Kampung
VI	3	1997	20	2	Kampung
VI	4	1997	20	2	Kampung
VI	5	1997	20	2	Kampung
VI	6	1997	19	2	Kampung
VI	7	1997	19	2	Kampung
VI	8	1997	19	2	Kampung
VI	9	1997	19	2	Kampung
VI	10	1997	9	2	Kampung
VI	11	1981	15	2	Kampung
VI	12	1969	32	1	Kampung
VI	13	1981	26	2	Kampung
VI	14	1981	24	2	Kampung
VI	15	1981	22	2	Kampung
VI	16	1971	68	1	Kampung
VI	17	1971	64	1	Kampung
VI	18	1972	41	1	Kampung
Vi	18	1971		1	
VI	19	1971	62	1	Kampung
VI	19	1971		1	
VI	20	1970	21	1	Kampung
VI	20	1971		1	
VI	21	1971	59	1	Kampung
VI	22	1972	63	1	Kampung
VI	23	1983	19	2	Kampung
VI	24	1983	37	2	Kampung
VI	25	1980	26	2	Kampung
VI	26	1972	44	1	Kampung
VI	27	1973	64	1	Kampung
VI	28	1973	58	1	Kampung
VI	29	1980	21	1	Kampung
VII	1	1981	38	2	
VII	2	1982	30	2	
VII	3	1982	41	2	
VII	4	1987	27	2	
VII	5	1987	30	2	
VII	6	1987	15	2	
VII	7	1997	15	2	
VII	8	1997	15	2	
VII	9	1997	15	2	
VII	10	1993	15	2	
VII	11	1993	16	2	
VII	12	1993	15	2	
VII	13	1993	16	2	
VII	14	1993	15	2	
VII	15	1993	16	2	
VII	16	1993	3	2	
VII	17	1993	13	2	

PADANG HALABAN ESTATE

Division	Block	Year	Ha	Gener. of oil palm	Before oil palm (other than forest)
VII	18	1993	30	2	
VII	19	1993	30	2	
VII	20	1993	30	2	
VII	21	1993	30	2	
VII	22	1993	30	2	
VII	23	1993	30	2	
VII	24	1997	29	2	
VII	25	1997	12	2	
VII	26	1997	13	2	
VII	27	1997	28	2	
VII	28	1997	15	2	
VII	29	1997	18	2	
VII	30	1997	30	2	
VII	31	1997	30	2	
VII	32	1997	30	2	
VII	33	1997	30	2	
VII	34	1997	30	2	
VII	35	1997	30	2	
VII	36	1997	29	2	
VII	37	1997	29	2	
VII	38	1997	29	2	
VII	39	1997	30	2	
VII	40	1997	7	2	
VIII	1	1992	47	2	
VIII	2	1992	44	2	
VIII	3	1992	52	2	
VIII	4	1989	28	2	
VIII	5	1989	29	2	
VIII	6	1989	46	2	
VIII	7	1989	29	2	
VIII	8	1995	17	2	
VIII	9	1995	37	2	
VIII	10	1982	30	2	
VIII	11	1982	32	2	
VIII	12	1982	29	2	
VIII	13	1982	31	2	
VIII	14	1982	28	2	
VIII	15	1995	64	2	
VIII	16	1981	49	2	
VIII	18	1982	25	2	
VIII	19	1982	29	2	
VIII	20	1982	30	2	
VIII	21	1982	25	2	
VIII	22	1982	28	2	
VIII	23	1995	35	2	
VIII	24	1987	30	2	
VIII	25	1987	25	2	
VIII	26	1987	25	2	
VIII	27	1987	25	2	
VIII	28	1987	28	2	
VIII	29	1987	13	2	
VIII	30	1989	23	2	

ANNEX 2

RESULTS OF BSR RECORDS IN 1990

RESULTS OF BSR RECORDS IN 1990

Year	Division	Block	Ha	Nb Palms	Gener.	Before oil palm	Planting Material	Affected with Ganoderma		Dead by Ganoderma		Absent		%	Remarks
								Nb	%	Nb	%	Nb	%		
1965	IV	1	22	2992	1	Karet	D x P (S)	44	1,47	112	3,74	300	10,03	15,24	Repl 1994
1965	IV	2	29	3944	1	Karet	D x P (S)	34	0,86	93	2,36	223	5,65	8,87	Repl 1994
1965	IV	12	31	4216	1	Karet	D x P (S)	114	2,70	168	3,98	827	19,62	26,30	Repl 1994
1965	IV	13	29	3944	1	Karet	D x P (S)	15	0,38	142	3,60	436	11,05	15,04	Repl 1994
			111	**15096**				**207**		**515**		**1786**		**16,61**	
1965	IV	9	27	3672	2	Karet	D x P (S)	878	23,91	473	12,88		0,00	36,79	Repl 1994
1965	IV	10	20	2720	2	Karet	D x P (S)								Repl 1994
1965	IV	11	20	2720	2	Karet	D x P (S)								Repl 1994
			67												
1967	V	7	29	3944	2	Karet	D x P (R)	6	0,15	33	0,84	38	0,96	1,95	Repla 1994
1967	V	8	29	3944	2	Karet	D x P (R)	67	1,70	322	8,16	703	17,82	27,69	Repla 1994
			58	**7888**				**73**		**355**		**741**		**14,82**	
1968	V	3	34	4624	2	Karet	D x P (R)	25	0,54	162	3,50	341	7,37	11,42	Repla 1994
1968	V	4	34	4624	2	Karet	D x P (R)	53	1,15	104	2,25	609	13,17	16,57	Repla 1994
1968	V	5	17	2312	2	Karet	D x P (R)	43	1,86	181	7,83	639	27,64	37,33	Repla 1994
1968	V	6	19	2584	2	Karet	D x P (R)	84	3,25	263	10,18	599	23,18	36,61	Repla 1994
			104	**14144**				**205**		**710**		**2188**		**21,94**	
1969	V	9	63	9009	1	Kampung	Dura	61	0,68	0	0,00	768	8,52	9,20	
1969	V	22	15	2145	1	Kampung	Dura	14	0,65	6	0,28	337	15,71	16,64	
1969	VI	12	32	4448	1	Kampung	Dura	35	0,79	16	0,36	603	13,56	14,70	
			110	**15602**				**110**		**22**		**1708**		**11,79**	
1969	V	10	29	3944	2	Karet	D x P (R)	38	0,96	365	9,25	588	14,91	25,13	Repla 1994
1969	V	11	26	3536	2	Karet	D x P (R)	109	3,08	286	8,09	1114	31,50	42,68	Repla 1994
			55	**7480**				**147**		**651**		**1702**		**33,42**	
1970	I	2	54	7722	1	Kampung	D x P (R)	64	0,83	84	1,09	371	4,80	6,72	
1970	I	3	52	7436	1	Kampung	D x P (R)	35	0,47	92	1,24	533	7,17	8,88	
1970	VI	20	21	3003	1	Kampung	Dura	10	0,33	2	0,07	158	5,26	5,66	
			127	**18161**				**109**		**178**		**1062**		**7,43**	
1970	V	9	32	4352	2	Karet	D x P (R)	22	0,51	88	2,02	277	6,36	8,89	Repla 1994
1971	II	29	75	10200	1	Kampung	D x P (R)	4	0,04	23	0,23	598	5,86	6,13	Repl. 1999
1971	II	28	17	2312	1	Kampung	D x P (R)	4	0,17	2	0,09	128	5,54	5,80	Repl. 1999
1971	II	30	62	8432	1	Kampung	D x P (R)	8	0,09	24	0,28	414	4,91	5,29	Repl. 1999
1971	II	31	41	5576	1	Kampung	D x P (R)	9	0,16	44	0,79	480	8,61	9,56	Repl. 1999
1971	II	32	33	4488	1	Kampung	D x P (R)	1	0,02	13	0,29	117	2,61	2,92	Repl. 1999
1971	II	21	23	3128	1	Kampung	D x P (R)	50	1,60	17	0,54	55	1,76	3,90	Repl. 1999
1971	VI	16	68	9724	1	Kampung	D x P (R)	37	0,38	36	0,37	822	8,45	9,20	
1971	VI	17	64	9152	1	Kampung	D x P (R)	34	0,37	13	0,14	860	9,40	9,91	

RESULTS OF BSR RECORDS IN 1990

Year	Division	Block	Ha	Nb Palms	Gener.	Before oil palm	Planting Material	Affected with Ganoderma		Dead by Ganoderma		Absent		%	Remarks
								Nb	%	Nb	%	Nb	%		
1971	VI	19	62	8866	1	Kampung	D x P (R)	0	0,00	0	0,00	0	0,00	0,00	
1971	VI	21	59	8437	1	Kampung	D x P (R)	0	0,00	0	0,00	0	0,00	0,00	
			504	**70315**				**147**		**172**		**3474**		**5,39**	
1971	IV	14	38,5	5236	1	Karet	D x P (S)	56	1,07	173	3,30	715	13,66	18,03	Repl 1994
1971	IV	15	27	3672	1	Karet	D x P (S)	75	2,04	166	4,52	749	20,40	26,96	Repl 1994
1971	IV	16	34,5	4692	1	Karet	D x P (S)	87	1,85	126	2,69	873	18,61	23,15	Repl 1994
			100	**13600**				**218**		**465**		**2337**		**22,21**	
1971	VI	18		9479	1			90	0,95	15	0,16	980	10,34	11,45	
1971	VI	19		9105	1			64	0,70	27	0,30	957	10,51	11,51	
1971	VI	20		9503	1			35	0,37	25	0,26	1333	14,03	14,66	
				28087				**189**		**67**		**3270**		**12,55**	
1971	V	15	28	3808	2	Karet	D x P (R)	42	1,10	80	2,10	589	15,47	18,67	Repla 1994
1971	V	14	31	4216	2	Karet	D x P (R)	59	1,40	85	2,02	821	19,47	22,89	Repla 1994
1971	V	18	29	3944	2	Karet	D x P (S)	59	1,50	85	2,16	821	20,82	24,47	Repla 1994
1971	V	17	35	4760	2	Karet	D x P (S)	42	0,88	80	1,68	859	18,05	20,61	Repla 1994
1971	V	16	36	4896	2	Karet	D x P (S)	57	1,16	126	2,57	873	17,83	21,57	Repla 1994
1971	V	15	36	4896	2	Karet	D x P (S)	75	1,53	166	3,39	749	15,30	20,22	Repla 1994
1971	V	14	23	3128	2	Karet	D x P (S)	56	1,79	173	5,53	715	22,86	30,18	Repla 1994
			218	**29648**				**390**		**795**		**5427**		**22,30**	
1972	VI	18	41	5863	1	Kampung	D x P (R)	0	0,00	0	0,00	0	0,00	0,00	
1972	VI	22	63	9009	1	Kampung	D x P (R)	0	0,00	0	0,00	0	0,00	0,00	
1972	VI	26	44	6292	1	Kampung	D x P (R)	0	0,00	0	0,00	0	0,00	0,00	
			148	**21164**										**0,00**	
1972	III	23	32	4352	1	Karet	D x P (S)	0	0,00	0	0,00	0	0,00	0,00	Repl. 1996
1972	III	18	37	5032	2	Karet	D x P (S)	293	5,82	202	4,01	1280	25,44	35,27	Repl. 1996
1972	III	21	52	7072	2	Karet	D x P (S)	241	3,41	147	2,08	1625	22,98	28,46	Repl. 1996
1972	IV	12	39	5304	2	Karet	D x P (S)	249	4,69	137	2,58	1858	35,03	42,31	Repl. 1995
1972	IV	16	44	5984	2	Karet	D x P (S)	546	9,12	219	3,66	2255	37,68	50,47	Repl. 1995
			172	**23392**				**1329**		**705**		**7018**		**38,70**	
1973	II	25	48	6528	1	Kampung	D x P (R)	0	0,00	0	0,00	386	5,91	5,91	Repl. 1999
1973	VI	27	64	9152	1	Kampung	D x P (R)	0	0,00	0	0,00	0	0,00	0,00	
1973	VI	28	58	8294	1	Kampung	D x P (R)	0	0,00	0	0,00	0	0,00	0,00	
			170	**23974**				**0**		**0**		**386**		**1,61**	
1979	I	7	35	5005	1	Kampung	D x P (R)	0	0,00	1	0,02	107	2,14	2,16	
1979	I	9	34	4862	1	Kampung	D x P (R)	5	0,10	1	0,02	132	2,71	2,84	
			69	**9867**				**5**		**2**		**239**		**2,49**	
1980	I	8	36	5148	1	Kampung	D x P (M)	7	0,14	2	0,04	172	3,34	3,52	
1980	I	10	50	7150	1	Kampung	D x P (M)	6	0,08	5	0,07	123	1,72	1,87	
1980	I	11	57	8151	1	Kampung	D x P (M)	0	0,00	3	0,04	137	1,68	1,72	

RESULTS OF BSR RECORDS IN 1990

Year	Division	Block	Ha	Nb Palms	Gener.	Before oil palm	Planting Material	Affected with Ganoderma		Dead by Ganoderma		Absent		%	Remarks
								Nb	%	Nb	%	Nb	%		
1980	II	1	31	4216	1	Kampung	D x P (M)	42	1,00	15	0,36	150	3,56	4,91	Repl. 1999
1980	V	23	35	5005	1	Kampung	D x P (R)	52	1,04	10	0,20	219	4,38	5,61	
1980	V	24	34	4862	1	Kampung	D x P (R)	98	2,02	7	0,14	142	2,92	5,08	
1980	VI	29	21	3003	1	Kampung	D x P (R)	24	0,80	5	0,17	124	4,13	5,09	
			264	**37535**				**229**		**47**		**1067**		**3,58**	
1980	VI	25	26	3718	2	Kampung	D x P (R)	33	0,89	10	0,27	68	1,83	2,99	
1981	V	12	34	4862	2	Kampung	D x P (R)	78	1,60	5	0,10	97	2,00	3,70	
1981	V	11	37	5291	2	Kampung	D x P (R)	105	1,98	7	0,13	338	6,39	8,51	
1981	V	10	31	4433	2	Kampung	D x P (R)	45	1,02	13	0,29	179	4,04	5,35	
1981	VI	13	26	3718	2	Kampung	D x P (R)	93	2,50	9	0,24	150	4,03	6,78	
1981	VI	14	24	3432	2	Kampung	D x P (R)	90	2,62	12	0,35	156	4,55	7,52	
1981	VI	15	22	3146	2	Kampung	D x P (R)	82	2,61	14	0,45	166	5,28	8,33	
1981	VI	11	15	2145	2	Kampung	D x P (R)	0	0,00	0	0,00	0	0,00	0,00	
			189	**27027**				**493**		**60**		**1086**		**6,06**	
1981	VII	1	38	5434	2		D x P (M)	49	0,90	74	1,36	326	6,00	8,26	
1981	VIII	16	49	7007	2		D x P (M)	41	0,59	15	0,21	390	5,57	6,37	
			87	**12441**				**90**		**89**		**716**		**7,19**	
1982	VII	2	30	4290	2		D x P (R)	195	4,55	6	0,14	216	5,03	9,72	
1982	VII	3	41	5863	2		D x P (R)	87	1,48	27	0,46	334	5,70	7,64	
1982	VIII	14	28	4004	2		D x P (M)	16	0,40	10	0,25	221	5,52	6,17	
1982	VIII	13	31	4433	2		D x P (M)	20	0,45	33	0,74	234	5,28	6,47	
1982	VIII	12	29	4147	2		D x P (M)	57	1,37	24	0,58	164	3,95	5,91	
1982	VIII	11	32	4576	2		D x P (M)	107	2,34	31	0,68	196	4,28	7,30	
1982	VIII	10	30	4290	2		D x P (M)	8	0,19	5	0,12	265	6,18	6,48	
1982	VIII	22	28	4004	2		D x P (M)	6	0,15	8	0,20	139	3,47	3,82	
1982	VIII	21	25	3575	2		D x P (M)	54	1,51	22	0,62	170	4,76	6,88	
1982	VIII	20	30	4290	2		D x P (M)	15	0,35	5	0,12	213	4,97	5,43	
1982	VIII	19	29	4147	2		D x P (M)	0	0,00	6	0,14	217	5,23	5,38	
1982	VIII	18	25	3575	2		D x P (M)	22	0,62	36	1,01	214	5,99	7,61	
			358	**51194**				**587**		**213**		**2583**		**6,61**	
1983	VI	23	19	2717	2	Kampung	D x P (R)	26	0,96	4	0,15	20	0,74	1,84	
1983	VI	24	37	5291	2	Kampung	D x P (R)	31	0,59	5	0,09	59	1,12	1,80	
			56	**8008**				**57**		**9**		**79**		**1,81**	
1983	II	14	54	7722	2	Karet	D x P (R)	107	1,39	44	0,57	342	4,43	6,38	
1983	II	26	36	5148	2	Karet	D x P (R)	45	0,87	19	0,37	185	3,59	4,84	
1983	III	8	40	5720	2	Karet	D x P (R)	66	1,15	49	0,86	420	7,34	9,35	
1983	III	9	44	6292	2	Karet	D x P (R)	118	1,88	40	0,64	182	2,89	5,40	
			174	**24882**				**336**		**152**		**1129**		**6,50**	
1984	III	20	29	3712	2	Karet	D x P (R)	64	1,72	11	0,30	46	1,24	3,26	

RESULTS OF BSR RECORDS IN 1990

Year	Division	Block	Ha	Nb Palms	Gener.	Before oil palm	Planting Material	Affected with Ganoderma		Dead by Ganoderma		Absent		%	Remarks
								Nb	%	Nb	%	Nb	%		
1984	III	19	33	4224	2	Karet	D x P (R)	11	0,26	9	0,21	122	2,89	3,36	
1984	III	26	24	3072	2	Karet	D x P (R)	44	1,43	5	0,16	35	1,14	2,73	
1984	III	27	27	3456	2	Karet	D x P (R)	267	7,73	11	0,32	55	1,59	9,64	
			113	**14464**				**386**		**36**		**258**		**4,70**	
1984	II	23	33	4224	3	Karet	D x P (R)	0	0,00	0	0,00	0	0,00	0,00	
1984	II	24	35	4480	3	Karet	D x P (R)	117	2,61	10	0,22	63	1,41	4,24	
			68	**8704**				**117**		**10**		**63**		**2,18**	
1985	III	17	28	4004	2	Karet	D x P (S)	53	1,32	8	0,20	103	2,57	4,10	
1985	III	18	33	4719	2	Karet	D x P (S)	9	0,19	4	0,08	38	0,81	1,08	
1985	IV	1	37	5291	2	Karet	D x P (S)	270	5,10	169	3,19	4	0,08	8,37	
1985	IV	20	39	5577	2	Karet	D x P (S)	242	4,34	114	2,04	0	0,00	6,38	
1985	IV	19	22	3146	2	Karet	D x P (S)	128	4,07	43	1,37	0	0,00	5,44	
			159	**22737**				**702**		**338**		**145**		**5,21**	
1985	III	4	33	4719	3	Karet	D x P (S)	60	1,27	6	0,13	50	1,06	2,46	
1985	III	3	46	6578	3	Karet	D x P (S)	85	1,29	7	0,11	59	0,90	2,30	
1985	III	2	47	6721	3	Karet	D x P (S)	74	1,10	5	0,07	356	5,30	6,47	
1985	III	1	30	4290	3	Karet	D x P (S)	74	1,72	9	0,21	36	0,84	2,77	
			156	**22308**				**293**		**27**		**501**		**3,68**	
1986	I	4	18	2448	2	Karet	D x P (S)	0	0,00	0	0,00	22	0,90	0,90	
1986	I	5	24	3264	2	Karet	D x P (S)	2	0,06	0	0,00	37	1,13	1,19	
1986	I	6	28	3808	2	Karet	D x P (S)	0	0,00	2	0,05	26	0,68	0,74	
1986	I	12	54	7344	2	Karet	D x P (S)	0	0,00	0	0,00	19	0,26	0,26	
1986	I	13	33	4488	2	Karet	D x P (S)	0	0,00	2	0,04	17	0,38	0,42	
1986	I	14	34	4624	2	Karet	D x P (S)	0	0,00	0	0,00	171	3,70	3,70	
1986	I	15	29	3944	2	Karet	D x P (S)	0	0,00	1	0,03	8	0,20	0,23	
1986	I	16	30	4080	2	Karet	D x P (S)	19	0,47	1	0,02	21	0,51	1,00	
1986	I	17	30	4080	2	Karet	D x P (S)	1	0,02	0	0,00	28	0,69	0,71	
1986	I	18	23	3128	2	Karet	D x P (S)	0	0,00	0	0,00	16	0,51	0,51	
1986	I	19	24	3264	2	Karet	D x P (S)	1	0,03	0	0,00	24	0,74	0,77	
1986	I	20	32	4352	2	Karet	D x P (S)	2	0,05	5	0,11	83	1,91	2,07	
1986	I	21	17	2312	2	Karet	D x P (S)	1	0,04	0	0,00	35	1,51	1,56	
1986	I	22	49	6664	2	Karet	D x P (S)	1	0,02	4	0,06	559	8,39	8,46	
1986	II	8	32	4352	2	Karet	D x P (R)	0	0,00	0	0,00	9	0,21	0,21	
1986	II	9	26	3536	2	Karet	D x P (R)	0	0,00	0	0,00	57	1,61	1,61	
1986	II	10	9	1224	2	Karet	D x P (R)	0	0,00	0	0,00	12	0,98	0,98	
			492	**66912**				**27**		**15**		**1144**		**1,77**	
1987	I	1	22	2992	2	Karet	D x P (R)	1	0,03	0	0,00	32	1,07	1,10	
1987	I	23	39	5304	2	Karet	D x P (R)	2	0,04	1	0,02	387	7,30	7,35	
1987	I	24	34	4624	2	Karet	D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	I	25	40	5440	2	Karet	D x P (S)	1	0,02	0	0,00	139	2,56	2,57	
1987	II	1	40	5440	2	Karet	D x P (S)	0	0,00	0	0,00	67	1,23	1,23	

RESULTS OF BSR RECORDS IN 1990

Year	Division	Block	Ha	Nb Palms	Gener.	Before oil palm	Planting Material	Affected with Ganoderma		Dead by Ganoderma		Absent		%	Remarks
								Nb	%	Nb	%	Nb	%		
1987	II	2	28	3808	2	Karet	D x P (S)	0	0,00	0	0,00	94	2,47	2,47	
1987	II	3	28	3808	2	Karet	D x P (S)	3	0,08	0	0,00	36	0,95	1,02	
1987	II	4	37	5032	2	Karet	D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	II	5	24	3264	2	Karet	D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	II	6	59	8024	2	Karet	D x P (S)	2	0,02	6	0,07	19	0,24	0,34	
1987	II	7	24	3264	2	Karet	D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	II	11	33	4488	2	Karet	D x P (S)	13	0,29	0	0,00	14	0,31	0,60	
1987	II	12	35	4760	2	Karet	D x P (S)	12	0,25	0	0,00	12	0,25	0,50	
1987	IV	21	24	3264	2	Karet	D x P (S)	0	0,00	0	0,00	38	1,16	1,16	
1987	IV	22	17	2312	2	Karet	D x P (S)	0	0,00	0	0,00	31	1,34	1,34	
1987	IV	23	24	3264	2	Karet	D x P (S)	0	0,00	0	0,00	100	3,06	3,06	
1987	IV	24	41	5576	2	Karet	D x P (S)	0	0,00	1	0,02	63	1,13	1,15	
1987	IV	25	24	3264	2	Karet	D x P (S)	0	0,00	0	0,00	37	1,13	1,13	
			573	**77928**				**34**		**8**		**1069**		**1,43**	
1987	VII	4	27	3672	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	VII	5	30	4080	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	VII	6	15	2040	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	VIII	28	28	3808	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	VIII	27	25	3400	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	VIII	26	25	3400	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	VIII	25	25	3400	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	VIII	24	30	4080	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1987	VIII	29	13	1768	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
			218	**29648**				**0**		**0**		**0**		**0,00**	
1988	II	13	34	4624	2	Karet	D x P (S)	0	0,00	0	0,00	58	1,25	1,25	
1988	III	7	28	3808	2	Karet	D x P (S)	0	0,00	0	0,00	38	1,00	1,00	
1988	III	6	29	3944	2	Karet	D x P (S)	0	0,00	0	0,00	86	2,18	2,18	
1988	III	5	26	3536	2	Karet	D x P (S)	0	0,00	0	0,00	55	1,56	1,56	
1988	III	15	9	1224	2	Karet	D x P (S)	0	0,00	0	0,00	122	9,97	9,97	
1988	III	14	29	3944	2	Karet	D x P (S)	0	0,00	0	0,00	187	4,74	4,74	
1988	III	13	27	3672	2	Karet	D x P (S)	0	0,00	0	0,00	157	4,28	4,28	
1988	III	12	28	3808	2	Karet	D x P (S)	0	0,00	0	0,00	32	0,84	0,84	
1988	III	11	29	3944	2	Karet	D x P (S)	0	0,00	0	0,00	50	1,27	1,27	
1988	III	10	34	4624	2	Karet	D x P (S)	0	0,00	0	0,00	435	9,41	9,41	
			273	**37128**				**0**		**0**		**1220**		**3,29**	
1989	II	35	16	2176	1	Kampung	D x P (S)	0	0,00	0	0,00	0	0,00	0,00	Repl. 1999
1989	VIII	4	28	3808	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1989	VIII	5	29	3944	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1989	VIII	6	46	6256	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1989	VIII	7	29	3944	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	
1989	VIII	30	23	3128	2		D x P (S)	0	0,00	0	0,00	0	0,00	0,00	

ANNEX 3

RESULTS AND PROPOSALS REGARDING BSR RESEARCH AT PT SMART (DOCUMENTS DRAFTED BY MR. WAHYU)

Ganoderma Summary Triall Had been Done By Crop Protection Laboratory SMARTRI

No	Title of Trial	Start	End	Treathment	Result
1	Some Fungicides Trial Against *G. boninense* On Replanting Area	1994	1996	Hexaconazol, Flusilasol,Triadimenol, Tridemorf, Trichoderma	No significant impact
2	Triadimefon and Triadimenol Test By Trunk Injection on Healthy And Sick Palm.	1994	1996	Triadimenol and Triadimefon (30,60 cc/palm) on once, twice and three times application	No Significant impact
3	Triadimenol Granular Test on Healthy Out Look Palm By Spread The Material on The Circle	1994	1996	Triadimenol granular (30,60 gr/palm) on once, twice and three times application	No Significant impact
4	*G. boninense* Isolation From Disease tissue By Semi Selective Medium	1995	1996	Try PDA, and Three kind medium	Successfully get media that available to isolate G. boninense from disease tissue
5	*G. boninense* ready Infect Inoculums Preparing.	1996	1997	Try on some kind of woods	Successfully get the inoculum
6	Antagonism Trial Between *Trichoderma koningii*, *T. harzianum*, and *Gliocladium virens* against *G.boninense* colony In Vitro By Modified Double Culture Method.	1996	1997	T. koningii, T. harzianum, Gliocladium virens against G. boninense	All treatment give the significant effect for G. boninense colony destroying
7	The Expedient To Increase Biocontrol Potential Some Antagonistic Fungus Against Establish *G. boninense* on Wood by Using Active Hiphae Stage on moist Brand Substrat.	1997	1997	Antagonism trial between *T. koningii* vs *G. boninense*, Antagonism trial between *T. harzianum* vs *G. boninense*, Antagonism trial between *Gliocladium virens* vs *G. boninense*, and Control	Get the significant impact by using moist brand media and active antagonist fungus phase
8	*G. boninense* Infection Trial On Oil Palm Nursery	1996	1997	By making direct contact between nursery stem base with *G. boninense* ready infected inoculum on rubber woods.	Artificial infection were successful but the period variant is very high and the successfully rate not more than 50 %

9	The Probability of using *G. boninense* Development In Polybeg Soil As Observation Parameter On Basal Stem Rot Biological Control Research.	1997	1998	Established *G. boninense* inoculum on angsana woods were inoculated into autoclaved polybeg soil.	Artificial infection were successful,. The period is short, and more than 90 % infection are successful
10	The Relationship between Antagonistic Fungus Biocontrol Potential Against G. boninense With The Media Colonized Capability.	1998	1998	Biofungicide(*T. koningii* a.i) vs Establish Ganoderma inoculum in the soil	Getting significant impact about Ganoderma colony degradation
11	Antagonism Trial Between Greemi G (*T. harzianum* a.i.) Against Establish *G. boninense* Colony on PDA by direct contact Methods.	1999	1999	0.5 gr Greemi G (*T. harzianum* a.i. vs G. boninense . (Invitro trial)	Getting significant impact about Ganoderma colony degradation
12	Antagonism Trial Between Greemi G (*T. harzianum* a.i.) Against Establish *G. boninense* Colony on Angsana Woods By Direct Contact Methods	1999	1999	Antagonism trial between 1 gr, 5 gr and 10 gr Greemi G (*T. harzianum a .i.)* against *G. boninense* colony on angsana woods	Trichoderma harzianum in Greemi G had significant efect
13	The Relationship Between Greemi G Capability To Destroy *G. boninense* Colony With The Capability of Greemi G To Colonize The soil.	1999	1999	5 gr, 10 gr and 15 gr Greemi G application/Polybeg against G. boninense inoculum	No significant impact
14	Biofungicide (Trichoderma sp a.i. On Active Fase) Producing In SMARTRI.	1999	2000	Trichoderma sp culture cultivation on autoclaved brand moist substrates. The cultures were stored in dark room or incubator	Getting the suitable method for producing Biofungicide with Trichoderma a.i

THE SUMMARY OF BASAL STEM ROT DISEASE EXPERIMENTS ON OIL PALM CAUSED BY *Ganoderma boninense* IN SMARTRI

1. Some Fungicides Trial against *G. boninense* On Replanting Area That Heavy Infested By Fall Only and Fall-Break Open Replanting Sistem.

Treatmen :

- Hexaconazol 10 cc, 20 cc, 30 cc per hole
- Triadimenol 10 gr, 20 gr, 30 gr per hole
- Tridemorf 10 cc, 20 cc, 30 cc per hole
- Fusilazol 10 cc, 20 cc, 30 cc per hole
- Saco P 10 gr, 20 gr, 30 gr per hole
- Hexaconazol 10 cc, 20 cc, 30 cc per hole
- Control (No fungicide application)

Result:

- No result can get, because since the first year after planting dead plants were found in each treatment and control.
- So After two years old the experiment was cut off.

2. Triadimefon and Triadimenol Test By Trunk Injection on Healthy And Sick Palm.

Treatmen :

- Triadimenol 30 cc/palm (once, twice, and three times application)
- Triadimenol 60 cc/palm (once, twice, and three times application)
- Triadimefon 30 cc/palm (once, twice, and three times application)
- Triadimefon 60 cc/palm (once, twice, and three times application)
- Control (No fungicide application)

Result:

- On healthy palm the treatment can't prevent the palm from *Ganoderma* atack.
- On sick palm the treatment can't give significant effect to make the palm condition better than before application. Otherwise many observation palm became dead after several years.
- So the experiment was cut off after three years.

3. Triadimenol Granular Test on Healthy Out Look Palm By Spread The Material on The Circle

Treatment:

- Triadimenol 30 gr/palm (once, twice, and three times application)
- Triadimenol 60 gr/palm (once, twice, and three times application)
- Control (No fungicide application)

Result:

- On healthy palm the treatment can't prevent the palm from *Ganoderma* attack.
- So the experiment was cut off after three years.

4. *G. boninense* Isolation From Disease tissue By Semi Selective Medium

Treatment:

- Using three kinds medium formulas : formula 1, formula 2 and formula 3.

Tabel 1: Formula Composition.

Formula 1	Formula 2	Formula 3	Keterangan
A. PDA 8 gr Aquades 350 cc B Kemisitin 1kps BenlateT 20 100mg Ridomil25WP 100mg	A.PDA 8 gr Mgso47h20 0.05 gr Aquades 350 cc B.Streptomycin 0.06gr Kemisitin 0.02gr Ridomil25WP 0.026gr Benlate T20 0.03gr Alkohol 4cc Tanic Acid 0.25gr Aquades 16cc As. Lactat 0.4 cc	ADifco Bacto 8 gr Mgso47h20 0.05 gr Aquades 350 cc B.Streptomycin 0.06gr Kemisitin 0.02gr Ridomil25WP 0.026gr Benlate T20 0.03gr Alkohol 4cc Tanic Acid 0.25gr Aquades 16cc As. Lactat 0.4 cc	Group A was boiled before autoclaved Group B was stired until homogen in erlenmeyer.. After the temperature in group A was

Result

It was Succesfull to isolate *G. boninense* from disease tissue by using formula 3, but the other formulas were fail.

5. *G. boninense* ready Infect Inoculums Preparing.

Treatment:

- Ganoderma coloni from PDA was inoculated in rubber woods that autoclaved before. In the next trial we use the other material like acasia woods, angsana woods and oil palm fronds.

Result

- All the materials were tested give the good result to use in *G. boninense* ready infect inoculum preparing.

6. Antagonism Trial Between *Trichoderma koningii, T. harzianum,* and *Gliocladium virens* against *G.boninense* colony In Vitro By Modified Double Culture Method.

Treatment:

- Antagonism trial between *T. koningii* and *G. boninense*
- Antagonism trial between *T. harzianum* and *G. boninense*
- Antagonism trial between *Gliocladium virens* and *G. boninense*
- Control

Result

The result showed that all treatment give the significant effect to Control *G. boninense* colony development. It can see from the media color change, emergeness of antagonistic fungus on reisolates in PDA, and the pursueness of *G boninense* development on the semiselective media reisolates

7. The Expedient To Increase Biocontrol Potential Some Antagonistic Fungus Against Establish *G. boninense* on Wood by Using Active Hiphae Stage on moisture Brand Substrat.

Treatment:

- Antagonism trial between *T. koningii* and *G. boninense*
- Antagonism trial between *T. harzianum* and *G. boninense*
- Antagonism trial between *Gliocladium virens* and *G. boninense*

- Control

Result

- The result showed that by using active stage and moist brand substrat can increase the bio control potential from the antagonistic fungus. It can see from the capability of antagonistic fungus to colonize and destroy establish *G. boninense* colony on woods.
- This result is different when compare with the using antagonistic fungus on PDA or antagonistic fungus on dormant conidia phase in dry brand substrat. It showed that the antagonistic fungus had no significant effect to decrease the *G. boninense* development.

8. *G. boninense* Infection Trial On Oil Palm Nursery

Treatment

- By making direct contact between nursery stem base with *G. boninense* ready infected inoculum on rubber woods. Time application is when the nurseries were transplanted to main nurseries.
- The observation parameters were symptom and capability to isolate the pathogen prom nursery affected.

Result

- The result showed that the artificial infection is successful . It showed by the symptom emergeness and the capability to isolate *G. boninense* from disease tissue and the soil around the disease tissue. In otherwise we can saw the *G. boninense* development in the nursery soil.
- This result is not so good because the symptom emergeness period has too many variety from 3 weeks until 9 months. Beside that this method only not more than 50 % Successfully infected the nursery. So we must look for another observation parameter that can give us more homogenous, shorter period and has bigger successful probability.

9. The Probability of using *G. boninense* Development In Polybag Soil As Observation Parameter On Basal Stem Rot Biological Control Research.

Treatment

- Established *G. boninense* inoculum on angsana woods were inoculated into autoclaved polybag. The soil moisture were kept on good condition by spray water regularly.

Result

- The result showed that the artificial inoculation into the soil is successful. It showed by emergeness of "basidiocarp like structure". This structure can be monitored since 7 – 10 days after inoculation with the successful probability more than 90 %. On 15 – 21 days after inoculation it seem that the basidiocarp like structure is in complete forming (it look like a white button). By that time the structure hadn't opened yet.

10. The Relationship between Antagonistic Fungus Biocontrol Potential Against G. boninense With The Media Colonized Capability.

Treatment

- Antagonistic fungus on active hyphae and conidia stage formulated on moisture brand substrat were inoculated on autoclaved polybag soil 30 days before *Ganoderma boninense* inoculum inoculation into polybag soil.
- After *G. boninense* inoculums were inoculated, The development of *G. boninense* and Antagonistic Fungus on the polybag soil surface were observed.

Result

- The result showed that on the polybag soils were antagonistic fungus can colonize well, *G. boninense* can't grow **(If they can grow the antagonistic fungus will decompose and destroy them)**. When the antagonistic fungus can't grow well (didn't colonize the surface of polybag soil) *G. boninense* still had the capability to develop.

11. Antagonism Trial Between Greemi G (*T. harzianum* a.i.) Against Establish *G. boninense* Colony on PDA by direct contact Methods.

Treatment

- Antagonism trial between ± 0.5 gr Greemi G (*T. harzianum a. i.)* and *G. boninense*
- Control

Result

The result showed that al treatment give the significan efect to Control *G. boninense* colony development. It can see from the Ganoderma colony lisis emergeness of antagonistic fungus on reisolates in PDA, and the pursueness of *G boninense* development on the semiselective media reisolates

12. Antagonism Trial Between Greemi G (*T. harzianum* a.i.) Against Establish *G. boninense* Colony on Angsana Woods By Direct Contact Methods.

Treatment

- Antagonism trial between 1 gr, 5 gr and 10 gr Greemi G (*T. harzianum a .i.)* against *G. boninense* colony on angsana woods
- Control

Result

Tabel 2: *G. boninense* Inoculum Condition 1 Month After Treatment

Treatment (gr Greemi G /inoculum)	% *G. boninense* invasion	% *Trichoderma* invasion	G. *boninense* colony lisis	Replication
1	60	46.7	93.3	15
5	80	53	86.7	15
10	40	60	86.7	15
Kontrol (0)	100	0	0	10

Tabel 3: G. boninense Inoculum Development 1 Month After supressed Into Polybag soil(2 months After Treatment)

Treatment (gr Greemi G/inoculum)	%*G.boninense appear*	%*Trichoderma appear*	Replication
1	26.7	46.7	15
5	0	60	15
10	0	46.6	15
Control (0)	20	0	10

This result showed that *T. harzianum* in Greemi G had the antagonist effect to *G. boninense*. The antagonist activity can see from the pursueness of *G. boninense* inoculum development by *Trichoderma* colony. The most important aspect is the antagonistic fungus development capability. If the antagonistic fungus can colonized well in the soil *G. boninense* colony can not develop (very pursued). The antagonistic fungus capability to colonize soil was very affected by the antagonistic fungus invasion to *Ganoderma* colony on direct contact trial.

13. The Relationship Between Greemi G Capability To Degradate *G. boninense* Colony With The Capability of Greemi G To Colonize The soil.

Treatment

- 5 gr, 10 gr and 15 gr Greemi G application/Polybeg. Biofungicide were applied in the base of polybag. 1.5 months afther that, the soil in polybags were inoculated with establish *G. boninense* inoculums on woods by suppressed the inoculum in polybag soil. Antagonism trial between ± 0.5 gr Greemi G (*T. harzianum a.i.)* and *G. boninense*
- Control (without Greemi G application, only G. boninense inoculation)

Result

The result showed that Greemi G application (in origin formula) can't colonize the soil, and had no efect to decrease G. boninese colony development in the soil.

Tabel 4 : Greemi G Colonization And *G. boninense* Development In The Soil.

Treatment	% Bio fungicide Colonization on 1.5 month after Ganoderma inoculation	% Biofungicide Colonization on 1.5 month after Ganoderma inoculation	% *Ganoderma* degradation by Biofungicide on 1.5 month after inoculation	% *Ganoderma* degradation by Biofungicide on 2.5 month after inoculation	Replication
5 gr	0	0	0	10	15
10 gr	0	0	0	40	15
15 gr	0	0	0	40	15
Control	0	0	0	70	15

14. Biofungicide (*Trichoderma* sp a.i. On Active Phase) Producing In SMARTRI.

Treatment

- By *Trichoderma* sp culture cultivation on autoclaved brand moist substrates. The cultures were stored in dark room or incubator.
- The growth condition of biofungicides culture were controlled everyday.

Result

The result showed that the method was suitable to produce good quality of *Trichoderma* sp a. i. biofungicides. From the antagonistic material test the material showed that they had good activity to destroy establish *G. boninense* colony on woods by direct contact method.

GANODERMA RESEARCH PROGRAM ON 2000

- **How To Improve Biofungicide Colony In The Nursery And The Toxicity Aspect.**
- **Biofungicide antagonist efect agains *G. boninense* On Oil Palm Nursery To Support Field Triall.**
- **The Probability Of Micoriza Using On Basal Stem Rot Controlling Program.**
- **Biofungicide Nursery Application and The correlation With The antagonistict Effect Against Ganoderma atack When the Nursery Plant In BSR Endemic Area.**
- **The Effect Of Surgery against Production**
- **The Combination Between Surgery and Pile up Technique For Controlling BSR.**
- **Biofungicidal Nursery and planting hole application (Demplot had been done on Last 1999)**
- **Several Field Biofungicides Trial (to make disease palm better, Destroy Source of inoculum etc)**

ANNEX 4

COPY OF THE TRANSPARENCIES PRESENTED AT THE 6 MARCH 2000 MEETING AT PADANG HALABAN

MAJOR OIL PALM DISEASES

Hubert de Franqueville
Cirad

- **OIL PALM CULTIVATION MUST FACE SEVERAL DISEASES THROUGHOUT THE WORLD. EACH CONTINENT HAS ITS OWN CONSTRAINT :**

- ***AFRICA* : THE MAIN CONSTRAINT IS VASCULAR WILT, CAUSED BY *FUSARIUM OXYSPORUM* f.sp. *ELAEIDIS*, A SOIL-BORNE PATHOGEN**

- ***LATIN AMERICA* : OIL PALM PLANTATIONS ARE HIGHLY THREATENED BY A LETHAL BUD ROT, WHOSE THE CAUSAL AGENT REMAINS SO FAR UNKNOWN**

- ***SOUTH EAST ASIA* : CULTURES ARE ENDANGERED BY ANOTHER SOIL-BORNE PLANT PATHOGEN , *GANODERMA* spp. ,CAUSING A BASAL STEM ROT (BSR). IN NORTH SUMATRA, *GANODERMA BONINENSE* IS THE MAIN SPECIES INVOLVED**

Vascular wilt disease in Africa

Basal stem rot disease in North Sumatra

AN INTEGRATED CONTROL STRATEGY MUST BE IMPLEMENTED IN ORDER TO DECREASE THE DAMAGES CAUSED BY THESE DISEASES. SOME ACTIONS CAN BE UNDERTAKEN, AMONG WHICH :

- BREEDING FOR DISEASE RESISTANCE
- BIOLOGICAL CONTROL
- AGRICULTURAL PRACTICES

FOR EACH DISEASE ?

	VASCULAR WILT	LETHAL BUD ROT	BASAL STEM ROT
BREEDING FOR RESISTANCE	HIGH EFFECT	VERY POSSIBLE	VERY POSSIBLE
BIOLOGICAL CONTROL	NO EFFECT	UNKNOWN	VERY POSSIBLE
AGRICULTURAL PRACTICES	SOME EFFECT	ERADICATION ONLY	EFFECT

- THE BREEDING STRATEGY IS HIGHLY SUCCESSFULL IN THE CASE OF VASCULAR WILT , WITH AN EARLY SCREENING TEST :

Inoculation test at the prenursery stage

WHAT ABOUT BASAL STEM ROT (*GANODERMA*) ?

- BSR IS AN ENDEMIC DISEASE IN INDONESIA AND MALAYSIA , ALTHOUGH ALSO KNOWN IN SOME PARTS OF AFRICA (CAMEROON AND ZAIRE)
- IT GENERALLY APPEARS AT THE END OF THE FIRST OIL PALM GENERATION BUT ITS INCIDENCE INCREASES ON THE FOLLOWING PLANTINGS, SOONER AND SOONER
- AMONG THE INDONESIAN ESTATES , SOME ARE CURRENTLY RUNNING THE THIRD AND SOMETIMES THE FOURTH GENERATION
- BSR THEREFORE IS A MAJOR THREAT FOR THE OIL PALM PRODUCTIVITY , SPECIALLY IN NORTH SUMATRA

BREEDING ?

- THERE IS SO FAR NO BREEDING FOR RESISTANCE , LIKE IN THE CASE OF *FUSARIUM* WILT , MAINLY BECAUSE AN EARLY AND RELIABLE SCREENING TEST IS MISSING
- THIS IS PARTLY DUE FOR THE TIME BEING TO A LACK OF KNOWLEDGE OF THE COMPLETE LIFE CYCLE OF THE FUNGUS
- BUT OBSERVATIONS IN SEVERAL ESTATES OR RESEARCH STATIONS SHOW A GENETIC DIVERSITY WITHIN THE PLANTING MATERIAL WHICH WILL ALLOW BREEDING FOR RESISTANCE
- THESE OBSERVATIONS REQUIRE A DESIGN OF PLANTATION WITH KNOWN PROGENIES TO ASSESS THE SOURCES OF RESISTANCE OR SUSCEPTIBILITY TO BE CORRELATED WITH A FUTUR EARLY SCREENING TEST
- LIKE ANY BASIC INFORMATION ON THE BASAL STEM ROT , IT SUPPOSES A FIELD SURVEY AND MONITORING BY REGULAR CENSUSES AND THROUGH A PLOT MAPPING OF THE DISEASE

BIOLOGICAL CONTROL ?

- **SOME EVIDENCE, FOR OIL PALM AND OTHER CROPS OR PATHOGENS, ON THE EFFECT OF *TRICHODERMA* SPECIES HAS BEEN SUPPLIED**

- **AS FAR AS *GANODERMA* AND OIL PALM ARE CONCERNED,THIS HAS TO BE FULLY AND RIGOROUSLY CONFIRMED BY RELEVANT TRIALS, IMPLEMENTED IN NURSERY AS WELL AS IN FIELD, FOR DISEASE CONTAINMENT MEASURES AND/OR REPLANTING STRATEGY**

- **AS THE PREVIOUS GENERATION CAN INTERACT WITH THE ON-GOING GENERATION, THESE TRIALS MUST BE IMPLEMENTED IN A VERY WELL KNOWN ENVIRONMENT FOR A THOROUGH COMPARISON WITH THE CONTROL**

- **LIKE ANY BASIC INFORMATION ON THE BASAL STEM ROT, IT SUPPOSES A FIELD SURVEY AND MONITORING BY REGULAR CENSUSES AND THROUGH A PLOT MAPPING OF THE DISEASE**

AGRICULTURAL PRACTICES

- **ERADICATION OF DISEASED PALMS EARLY ENOUGH CAN REDUCE THE DEVELOPMENT OF THE BASAL STEM ROT, IN TERMS OF EXPANSION AND AMOUNT OF INOCULUM**

- **IT ALLOWS ALSO TO DECREASE THE AGRESSIVITY OF THE FOCI FOR THE FOLLOWING GENERATION**

- **BEFORE REPLANTING, UPROOTING OF THE OLD STUMPS AND BOLES MAY DECREASE OR DELAY THE FUTURE DEVELOPMENT OF THE DISEASE. SPECIAL ATTENTION ALSO MUST BE PAID TO AVOID REPLANTING SEEDLINGS CLOSE TO THE WINDROWS**

- **ON THAT ASPECT, MORE TRIALS ARE NEEDED BUT LIKE ANY BASIC INFORMATION ON THE BASAL STEM ROT, IT SUPPOSES A FIELD SURVEY AND MONITORING BY REGULAR CENSUSES AND THROUGH A PLOT MAPPING OF THE DISEASE**

PROPOSALS FOR PT SMART IN GENERAL AND PADANG HALABAN ESTATE IN PARTICULAR

- BASAL STEM ROT IS OF HIGH INCIDENCE IN PADANG HALABAN , LIKE IN MOST OF THE ESTATES OF THE REGION

- SOME OF THE '80s PLANTINGS SUFFER FROM HIGH DAMAGE DUE TO BASAL STEM ROT. A RAPID SURVEY SHOWS THAT LESS THAN 50 % OF THE PLANTED PALMS CAN STILL BE MET

- BUT LITTLE IS KNOWN ABOUT THE REAL INCIDENCE AND LOCATION OF BSR,

- IT IS THEREFORE URGENT TO DEVELOP A MONITORING OF THE ESTATE THROUGH CENSUSES AND ACCURATE MAPPING OF THE DISEASE ON THE FOLLOWING BASES :

  - ONCE A YEAR FOR COMMERCIAL PLANTINGS
  - EVERY THREE MONTHS FOR ANY FIELD TRIAL

- A SCORE COULD BE GIVEN TO EACH PALM :

  - 0 = HEALTHY PALM
  - 1 = LIGHT SYMPTOMS
  - 2 = MEDIUM SYMPTOMS
  - 3 = HEAVY SYMPTOMS
  - 4 = DEAD PALM
  - x = ABSENT PALM (REASONS FOR DEATH ARE UNKNOWN BUT THERE IS GENERALLY A STRONG ASSUMPTION OF BSR)

- THESE SCORES CAN BE COMPLETED BY THE NUMBER OF FRUITING BODIES , E.G. 2 = MEDIUM SYMPTOMS WITHOUT FRUITING BODIES AND 3.5 = HEAVY SYMPTOMS AND 5 FRUITING BODIES OBSERVED

- CENSUS AND MAPPING ARE OF PARAMOUNT IMPORTANCE FOR DISEASE CONTAINMENT , REPLANTING STRATEGY AND TRIAL IMPLEMENTATION

- **TRIAL IMPLEMENTATION WILL BE PROPOSED AT THE END OF THE CONSULTANCY VISIT, IN CLOSE AGREEMENT WITH PT SMART TEAMS BUT THE FOLLOWING TOPICS MAY BE INVESTIGATED :**

  - ***SCREENING FOR RESISTANCE* :**
    - ***GANODERMA* ARTIFICIAL INOCULATION PROCEDURES ARE AVAILABLE AND MUST BE IMPROVED, IF NECESSARY, TO SEE IF IT IS FEASABLE TO EXPLOIT THE GENETIC DIVERSITY OF THE PLANTING MATERIAL AT AN EARLY STAGE (NURSERY)**
    - **REPLANT THE BLOCKS, AS SOON AS POSSIBLE, WITH IDENTIFIED PROGENIES BUT WITHOUT STATISTICAL DESIGN FOR COMMERCIAL PLANTINGS**

  - ***BIOLOGICAL CONTROL* :**
    - **IMPLEMENTATION OF TRIALS ON *TRICHODERMA* AND IMPROVMENT OF THE EFFECT OF THE BIOFUNGICIDE THROUGH RELEVANT FERTILISATION , DOSES , AND APPLICATION PROCEDURES IN NURSERY , REPLANTATION (PLANTING HOLE), MATURE PLANTATION , PREVENTIVE AND/OR CURATIVE EFFECT**

  - ***AGRICULTURAL PRACTICES* :**
    - **COMBINATION BETWEEN CONVENTIONAL OR NON CONVENTIONAL PRACTICES AND BIOLOGICAL CONTROL MUST BE SEEKED : ERADICATION AND SANITATION , UTILISATION OF EMPTY BUNCHES , OF COMPOST , MOUNDING OF AFFECTED PALMS**

CONCLUSION

- **WITHIN A FEW YEARS, PT SMART CAN REACH TO AN INTEGRATED APPROACH OF *GANODERMA* MANAGEMENT THROUGH RELEVANT PROCEDURES IN PADANG HALABAN AND THEN DEVELOP KNOWLEDGE AND MODELS FOR THE OTHER ESTATES OF THE GROUP**

THANK YOU FOR YOUR ATTENTION