Cirad-CP
Rubber Programme

P.T SOCFIN – INDONESIA
(SOCFINDO)

Training session on tapping systems

Theory and practice
Cirad-cp and Socfindo recommendations

Mission from 5 to 10 March 2003

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Abstract

A training session on principles and practice of rubber tree exploitation was organised in March 2003 in Socfindo Tanah Besih Rubber Estate. Theoretical principals and Cirad-cp / Socfindo recommendations regarding fundamentals and specificity of Rubber Tree Exploitation were presented to Socfindo Head Office management, Group managers N°2 and 3, Rubber Estate managers and plantation assistants. Oral presentations were followed by a one-day practice visit on field.

Keywords

Socfindo, Tapping systems, Tapping and stimulation recommendations, Panel management, Opening, Tapping quality, Latex diagnosis, Extra-stimulations, Wind damage, Pruning.

Main conclusions of the mission

Due to the crop repartition of Socfindo plantations (78% oil palm, 22% rubber only), most Socfindo estate managers and assistants spend much more time on oil palm plantations than on rubber plantations during their whole career in PT Socfin Indonesia (Socfindo). As a matter of fact, as the turn-over frequency of the staff remains almost identical on the two crops, the probability for an estate manager or an assistant to be assigned on a rubber estate is about 4 times lower compared to an assignment on an oil palm estate. As a consequence, most Socfindo estate managers, although with seldom exceptions, know much better the oil palm-related agronomic practices than rubber ones.

To participate in solving this evident issue, Cirad and Socfindo agreed in October 2002 to organise in 2003 some theoretical and practical training sessions for the plantation staff of rubber plantations in order to deliver an homogenous and updated presentation of the current knowledge and recommendations (both from Socfindo and Cirad) regarding rubber tree exploitation. This training session was jointly organised in March 2003 on Tanah Besih plantation site.

The specific physiological constraints linked to the rubber tree exploitation were presented and explained, focusing on the artificially induced latex sink that modifies the functioning of the rubber tree upon tapping. All further recommendations given hereafter come from this particularity of the rubber tree, whose production is not seed or fruit, unlike any other industrial tree or annual crop, but latex resulting from human actions (tapping). Accordingly , the interest of using a physiological tool in order to optimise the rubber tree latex production is presented, both regarding the optimisation of exploitation (latex diagnosis) and the assessment of clonal yield potential (clonal metabolic functioning typology and its use for breeding). Physiological conditions under which under-exploitation or over-exploitation are encountered, as well as means to ensure a physiologically balanced tapping intensity were explained.

Detailed practical recommendations and opinions were given to the Socfindo Staff regarding tapping systems recommendations and their optimisation:

- Openings
- Tapping frequency
- Stimulation
- Tapping quality and control procedure
- Pruning

Contents

Introduction

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On 6th March, an updated presentation to the Head office Socfindo management and rubber estate managers was performed in Tanah Besih plantation. This first presentation dealt mainly with the physiological basis of the tapped rubber tree functioning and resulted in a presentation of the recommendations as a consequence of this physiological background.

On the following day (7th March), a more practical presentation, especially forwarded to the rubber estate managers and their plantation assistants was performed, dealing with the recommendations, with emphasis on the practical aspects, methods, as well as on the importance of the tapping quality required to sustain a convenient and high rubber yield during the whole life span of each rubber plantation. An important discussion took place on the tapping quality control procedure as well as on related required incentives.

The consultant wishes to thank Socfindo senior management and staff at Headquarters and in the plantations, for the excellent arrangements made for the seminar and the hospitality and cooperation extended at all times. We thank especially Mr Sinuraya and Mr. Dadang Kurnia, from the Agronomy Department, for the excellent preparation and organisation of the seminar. Our acknowledgements are also forwarded to all attending estate managers and assistants and especially group managers 2 and 3.

1. Fundamentals of rubber tree physiology, carbon partitioning and subsequent practical applications

Performed presentation is enclosed in **Annex N°1**. This presentation shows the specific physiological constraints linked to the rubber tree exploitation, focusing on the artificially induced latex sink that modifies the functioning of the rubber tree upon tapping. All further recommendations given hereafter come from this particularity of the rubber tree, whose production is not seed or fruit, unlike any other industrial tree or annual crop, but latex resulting from human acts (tapping).

Accordingly , the interest of using a physiological tool in order to optimise the rubber tree latex production is presented, both regarding the optimisation of exploitation (latex diagnosis) and the assessment of clonal yield potential (clonal metabolic functioning typology and its use for breeding). Physiological conditions under which under-exploitation or over-exploitation are encountered, as well as means to ensure a physiologically balanced tapping intensity are explained.

2. Recommendations

2.1. Panel management

Current Socfindo recommendations regarding panel management are presented in **Annex N°2.** Compared to the previous management, this schedule recommends from now, for d/4 tapping frequency, opening at 1.30m from the ground instead of former 1.40m. As a matter of fact, with a maximum 15cm of vertical bark consumption in d/4 (#1.8mm/tapping), the downward tapping bark height requirement is only :

- 98 cm on panel A (B0-1) opened at exactly 1.30m (6.5 years of tapping). A 32 cm safety margin remains available on the panel bottom if the normal maximum bark consumption is respected, which should be the case on all newly tapped areas.

- 105 cm on panel B (B0-2) opened at approximately 1.45m (7 years of tapping). A 40 cm margin remains available on the panel bottom if the normal maximum bark consumption is respected.

Compared to previous openings at 1.40m, opening at 1.30m would ease further upward tapping, especially on blocks with low branching. On such problematic blocks, especially planted with RRIC 100, exceptional downward openings at 1.20m on panel A (B0-1) should be considered in order to possibly perform some further upward tapping. As the Cirad general recommendation regarding panel management, presented in annex N°3, plans opening in d/4 at 1.20m from the ground (1.30 m from the ground in d/3) with the same further panel management as that of Socfindo, such "low openings" at 1.20m should be recommended on such low branching RRIC 100 blocks.

Regarding upward tapping implemented from year 11, we would keep on recommending four consecutive years of upward tapping in years 11, 12, 13 and 14. As a matter of fact, a change in this policy (return to downward tapping in year 13 before a restart of upward tapping in year 14 and 15) would result in a decrease of the upward tapping proportion compared to the downward tapping proportion (currently near from 50/50), and therefore in a drop in global annual Socfindo rubber production. One of the conditions regarding sustainability of the yield during consecutive upward tapping years is that the cut should always move upward in order to maximise its latex sugar supply, the reason why Cirad recommends to open in a fixed order first A1 (H0-1), then A2 (H0-2), then B1 (H0-3), then B2 (H0-4), in a spiral pattern from right to left moving upward, as the watch needles, in order to continuously cut a maximum numbers of latex mantels. Any other panel management would results in appearance of isolated panels (island barks) with low productions, especially those tapped lower than previously tapped ones.
Attention should be focused on the bark consumption when upward tapping, which remains a main issue to be addressed by Socfindo. When upward tapping bark consumption raises, the yield of consecutive tapping year decreases, as a result of an artificially induced and nevertheless quite avoidable island bark.

As the recommended tapping system (UTS) is a single quarter upward, the downward quarter should be considered only as a latex recovery cut, only used to collect the latex dripping, and absolutely not as a latex production cut. Therefore, refreshing of this collection cut should not occur more than twice a month (4 mm of maximum consumption / month, leading to a maximum 5 cm annual downward consumption). Added to the maximal authorised upward bark consumption (20 cm in d/4), total vertical (upward + downward) bark consumption of the UTS system should never exceed 25 cm. Moreover, as the downward collection cut is not a production cut, there is no need to modify the initial upward tapping slope of 45°. Therefore, the 25 cm year consumption should be observed both at the upper and at the lower side of the cut. This is not the case for the moment in most of Socfindo blocks, as the downward cut is very often tapped with à 30°-35° angle, instead of recommended 45° angle, which generates a non-useful and excessive bark consumption in the upper part of the cut and which makes non precise the evaluation of upward tapping bark consumption.

Vertical consumption standards (maximum allowed) :

- ½ S d/4 6d/7 downward (N) : 15 cm
- ¼ S d/4 6d/7 upward (UTS) : 20cm (upward)+5cm (downward) = 25 cm

Emphasis is forwarded to the respective evolution of the production pattern along the 10 first downward tapping years with two types of panel management **(Annex N°3)** :

- In general, former panel recommendations with annual panel switch from year 3 show a good production during the first 6 years of tapping. This mainly results from a rather suitable sucrose supply to the tapping cut drained area, as the annual panel switch allows every year to provide some rest and sucrose refill to the resting panel. Problems arise from years 7 and following, as the cut reaches some rather low bark areas, where sucrose supply is more and more inadequate and insufficient, as the height of renewed bark above the cut continuously increases. Moreover, implementation of this panel switch management induces in most of North Sumatra industrial plantations, mostly on clones PB 235 and PB 260, appearance of Bark Necrosis syndrome on the resting panel remaining untapped for one year, especially on panel B (B0-2) when tapping comes back on panel A (B0-1) during tapping year 4. (Eschbach *et al.* 1994) Until 1997, this panel switch policy resulted in bark destruction of almost 30% of panels B (B0-2) on these fragile high metabolism clones, leading to emergency implementation of labour consuming and therefore expensive bark scrapping procedures in Socfindo, in order to try to recover this lost yield potential on B (B0-2) panels. Percentage of actual long term recovery on this scrapped panels remains until now unclear for the consultant, who observed the same syndrome on switched panels both in Gabon and Guatemala. The current hypothesis to explain this kind of bark necrosis phenomenon is that in high rainfall areas (annual rainfall above 2000 mm with no significant "real" dry season) : North Sumatra : 2000-2800 mm, South Cameroon and Gabon : 2800 mm, Guatemala : 3000-4000 mm), continuous presence of stagnant water and related high humidity on the untapped cut might favour the installation of saprophytic contaminants like fungi, bacteria, etc…associated with possible water infiltration inside the exposed bark tissues would lead to bark bursting and resulting bark tissues necrosis. However, it is still unclear why this phenomenon mainly occurs on panel B (B0-2) rather than panel A (B0-1), although the higher height of panel B (B0-2) may have an influence, as the B0-2 cut will collect most of dripping water on the trunk following a heavy rain. Nevertheless, this remains a work hypothesis, rather difficult to prove scientifically.

- From 1998 onwards, the panel management recommended in Socfindo is first a continuous tapping of panel A (B0-1) downwards, for 6.5 years (Year 0 (6 months) + years 1-6 according to Socfindo current agricultural opening practice, followed by a unique panel switch to B (B0-2) in year 7. If cumulative yield from years 1 to 6 might be a little bit lower compared to the panel switch practice (because of the continuous exploitation of the same drained area for 6.5 consecutive years, not allowing a rest and therefore any reconstruction of latex sucrose availability), a high sucrose supply is again encountered when switching the panel to B (B0-2) in year 7, very rich in sucrose and easily activated through tapping. This system therefore provides higher yields from years 7 to 10, leading to a significantly higher cumulative yield from years 1 to 10 if we compare it to the former panel switch policy.

- Nevertheless, this unchanged panel recommendation should be reconsidered upon information coming from production and latex diagnosis data : Poor LD profiles and decreasing productions on panel A (B0-1), showing for instance latex sucrose exhaustion, an anticipated switch to panel B (B0-2) may be envisaged, in order to boost the sucrose sink effect and therefore sucrose supply to the lower panel.

- Interest of unchanged panel policy is confirmed in panel management experiments run by Cirad and CNRA in Côte d'Ivoire, for any studied clones, as well as in a study on Socfindo Yield Database from 1995-1997 (annual panel switch policy) compared with yields from 1998-2001 (unchanged panel policy). As Côte d'Ivoire rainfall climatic conditions (1200-1400 mm/year) are quite different from Socfindo (2800 mm/year), we currently suspect that this unchanged panel policy and recommendation should be extended to all clones and all climatic conditions. A Cirad publication is currently in preparation regarding this aspect (Lacote *et al.* 2003, unpublished).

- The study on Socfindo yield database is presented in Annex N°4. This study represents the respective evolutions of Kg/tree/year, Kg/ha/year and tapped trees/ha depending on panel management policy during years of tapping 3 to 10. Data regarding changed panel policy were extracted from Socfindo Yield Database 1995-1997, as annual panel changing was recommended until 1997 (included). Data regarding unchanged panel policy were extracted from Socfindo Yield Database 1998-2001. The study shows :

    - Regarding Kg/tree : the same cumulative production from years 3 to 8, although with different kinetics. In both cases, maximum yield/tree is observed during the first tapping year on panel B (B0-2) : year 3 with changed panel policy, year 7 with unchanged panel policy

    - Regarding tapped trees/ha : a much more stable stand, especially from years 3 to 6 , in case of unchanged panels. This seems due to the huge drop of the tapped stand in year 5 (panel B, B0-2) : - 42 trees/ha compared to year 4, when annual change over, certainly induced by bark necrosis occurrence panel B. As a consequence, the average stand per ha seemed increased by about 10% from years 3 to 10 after implementation of the unchanged panel policy.

    - As a result, average Kg/ha was also increased by 10% on the same period.

There is no absolute proof that these production patterns are only due to the change in the panel management policy in 1998, as they were obtained during different periods and as different phenomena could interact (difference in root disease occurrence, difference in wind damage incidence…). However, it seems possible to conclude that unchanged panel management has no hindering effect on the cumulative production, just changing its kinetics. It is also unquestioned that the change in panel management solved the bark necrosis issue in Socfindo, quite non significant since 1998.

2.2. Tapping frequency

In order to maximise the output per tapper, d/4 frequency (+ possible extra-tappings if their number remains limited) is currently the only recommended tapping frequency recommended by Cirad under Socfindo conditions. This recommendation mainly regards tappers skill, which is not yet sufficient in average to master the d/3 frequency in Socfindo. As shown in 2002 in our last year's annual report, bark consumption was not under control on most of d/3 blocks, leading to huge bark over consumption (20-25 cm per year with downward tapping).

Nevertheless, would Socfindo implement the d/3 tapping frequency, opening height on panel A (B0-1) should be absolutely restored at 1.40m from the ground on all blocks. With d/3 frequency, any extra tapping policy should be absolutely cancelled, as this extra-tapping practice would inevitably lead to chronic over-exploitation with the currently recommended stimulation rates.

2.3. Stimulation.

The Cirad recommendations for Ethrel® stimulation methods and timings are as follows :

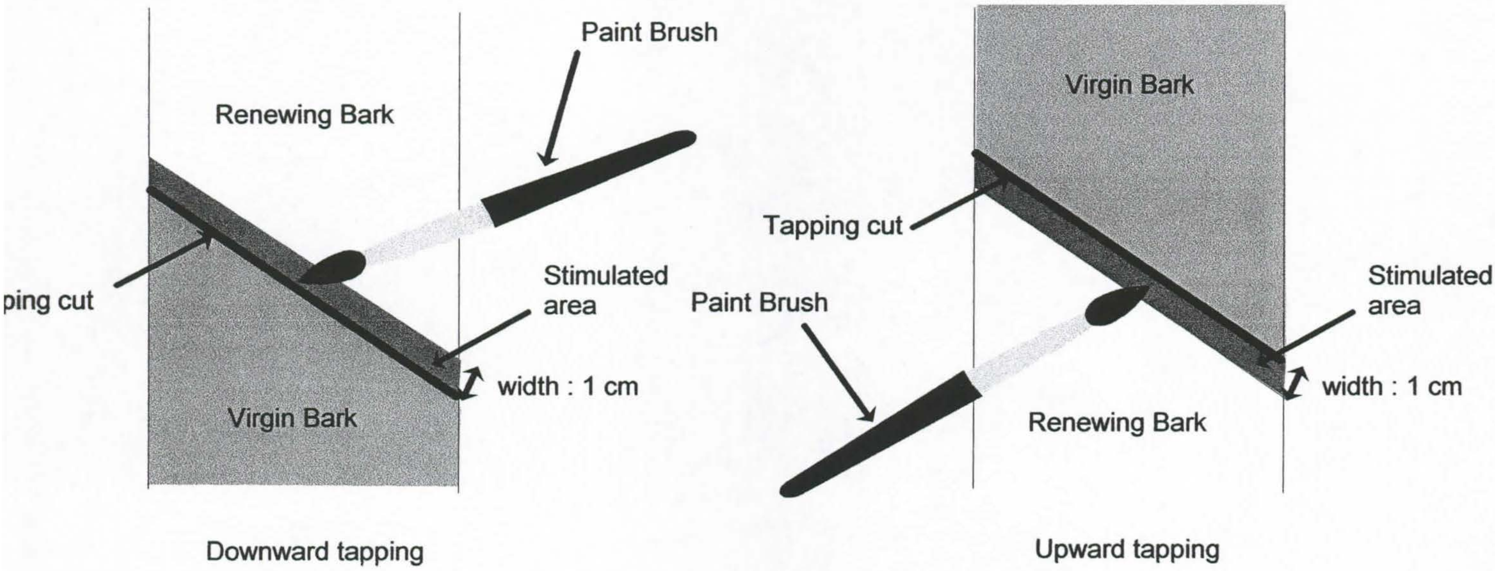
- For downward tapping (1/2 S), the only recommended a.i. (ethephon) concentration is 2.5% (1Volume of Ethrel® 10% or ELS 100 + 3 Volumes of water).

- For upward tapping (1/4 S), the only recommended a.i (ethephon) concentration is 5.0% (1Volume of Ethrel® 10% or ELS 100 + 1Volume of water).

- Ordinary water may be used for Ethrel®dilution (not required to use distilled water, unless a major pollution of ordinary water has been identified)

- Use of CPO (Concentrated Palm Oil) for dilution with Ethrel® is prohibited if use of RTU formulation, which is the case in Socfindo. Cirad recommends to use Rhone Poulenc ELS (Ethrel Latex Stimulant®) formulations, as among other Indonesian available stimulant formulations it is the only one that has been tested and guaranteed by Cirad regarding field stimulation efficiency and "harmlessness", chemical properties (especially stimulant pH) and physical properties (especially Brookfield viscosity before and after water dilution).

- Stimulation is applied on the panel (on young renewing bark), just above the tapping cut for downward tapping or just below the tapping cut for upward tapping, on a 1cm wide band. Application is made using a paintbrush (suitable brush width = 1cm for a better application).



- Application of stimulation has to be made 24 hours before the next tapping (the day before the next tapping) if the tapping frequency is d/3.

- Application of stimulation has to be made 48 hours before the next tapping (two days before the next tapping) if the tapping frequency is d/4.

- The average quantity of stimulant to be applied per tree depends on age of the tree (length of the tapping cut). When downward tapping (1/2 S), we usually consider that the optimum quantity is 0.7g/tree/stimulation during the first four years of tapping. This quantity must be increased afterwards by 0.1g/tree every four years, in order to apply a constant quantity of stimulant per cm of tapping cut.

- When upward tapping (1/4 S), we usually consider that the optimum quantity of stimulant is 0,8 g/tree/stimulation.

Regarding the clonal stimulation recommendations, these depend on the current Cirad rubber clonal typology, given in **Annex N°5**. These recommendations are strictly based on the physiological background stating that (E. Gohet, 1996, PhD Thesis):

1. Stimulation has to be decreased when the clonal latex regeneration metabolism(P_0, Pi_0) increases.
2. Stimulation has to be increased when the clonal latex sugar loading capacity ($Suc_0 = f(P_0,Pi_0)$ increases.

Recommendations are given for d/4 6d/7 (**Annex N°6**) and d/3 6d/7 (**Annex N°7**) tapping frequencies, both regarding downward ½ S (N) and upward ¼ S (UTS) tapping systems.

Regarding clonal metabolism typology, Cirad clonal typology is very near actually from that of IRRI (Indonesian Rubber research Institute), published in 2002 by SUMARMADJI (**Annex N°8**), excepted for clones PR255, PR261, PB 330, described as medium metabolism by IRRI while described as high metabolism or medium-high metabolism by Cirad. IRRI typology nevertheless does not consider sucrose loading clonal capability, which is, independently of clonal metabolism, a key factor determining clonal yield potential, response to stimulation and resistance to related stress (physiological fatigue, over exploitation risk, clonal susceptibility to TPD...).

2.4. Tapping quality and Control procedure

From the discussions that we had with Socfindo managers on 7th March, it appeared clearly to us that the motivation of the tapper could not be sufficient in order to significantly increase the tapping quality. As a matter of fact, it appeared from the discussion that the maximum quality incentive, expressed in Rp per month could reach only 10% of an average production incentive. Under such rewarding conditions, giving an absolute rewarding priority to the rubber output, it will be really a huge task to convince the tappers that they may find some interest to improve their tapping quality, as the quality reward appears quite negligible in their monthly salary (see following example).

A typical monthly tapper's salary might be : 750000 IRp, divided in :

- 500000 IRp as monthly salary (67%)
- 225000 IRp as rubber production incentive (30%)
- 25000 IRp as tapping quality incentive (3%)

From this sharing, it is evident that the tapper will lose almost nothing and will endure almost no penalty even if his performed tapping quality is very bad. In the contrary, improving his quality would force him to worker harder and to spend more time in the fields almost without any reward.

From the discussion, it appeared that an approximate share among quality and production incentives as 1/3 for quality, 2/3 for production might be more motivating for the tappers in order to improve this tapping quality and to care more about their tapping tasks.

Bases for the tapping quality control procedure are as following :

- The observer that makes the control should not be financially interested, from any way, in the result of this control.
- Tapping quality evaluation should concern:
  - panel wounds importance (length and height)
  - respect of healing treatment procedure, if any (petrolatum, grease, evolution since former controls...)
  - bark consumption (3 points : high, medium, low parts of the tapping cut) for the current month.
  - slope of the cut (3 points : high, medium, low parts of the tapping cut)
  - depth of tapping (3 points : high, medium, low parts of the tapping cut)
  - latex drips on panel, panel cleanliness
  - cleanliness of cups, wires and cup holders
  - tapper's equipment maintenance: tapping knife, sharpening stone, latex and cuplumps buckets, grease container, grease, scrapping tool...

Usually, tapping quality control is performed monthly on three to four tapping tasks (in d/4), for each tapper, during tapping time, on five trees randomly selected among already tapped trees. The tapper must be present during the control. The selected trees should be tapped before arrival on field of the control team.

A common method used for tapping quality control consists in offering to the tapper a maximum quality incentive to the tapper before the control starts, under the form of a maximum number of points of a given value (IRp), and to remove points during the tapping quality control for each error encountered. Number of removed points should represent seriousness of each error, and heavy errors should result in a drastic reduction of points, possibly until zero. Possible removal of points should be higher regarding the three "major" mistakes possibly encountered i.e. wounds, bark consumption and tapping depth, with emphasis on the first two (which represent irremediable damage and endanger the future yield potential of the task).

The tapping quality incentive would be the sum of remaining points after the end of the control, performed on 3 or 4 tasks, multiplied by the value of a single point (IRp). We have recommended to Socfindo to take attach with SOGB plantation, in order to finalise and to adapt this tapping quality control procedure to Socfindo standards.

2.5. Dates of openings and panel changes (physiological campaigns)

Since 1994 (Socfindo tapping systems recommendations for 1995, E. Gohet), we recommended that the panel changes (if any) should be performed according to the biological cycles of the rubber tree, included between 2 consecutive refoliations (usually 1st April to 31st March in traditional rubber growing areas in Northern hemisphere), instead of currently in January. As a matter of fact, current Socfindo practice (panel changes occurring in January) lead to abandon highly active panels when their production is still high and to start tapping on new poorly active panels just before the wintering season. This leads to use stimulation when it may be harmful for the physiology of the tree (defoliation-refoliation cycle, possible water stress in February).
In our opinion, this should lead to inevitable losses of production, even if such losses were not found significant on a tapping trial set up in Socfindo especially for this purpose (TB AE 02). Nevertheless, we have to note that trial TB AE 02 was implemented on clone PB 260, active metabolism clone that can easily start a new production cycle (quick starter). Result could have been quite different on clones like PB217 or RRIC 100, much less active (slow-medium starters), requiring stimulations to launch their metabolic process after any opening or panel change. This should be cautiously considered by Socfindo as PB217 and RRIC 100 percentage should increase among the tapped area.

Moreover, impact of Latex Diagnosis related decisions, like extra-stimulations, appears somehow limited when panel switch occurs in January, as the tapping system modification can be applied only in November or December. This practice obviously limits as well the impact on production of routine stimulations applied for instance in December, if any, as their effect on production can be significant in January as well.

As a still more significant effect, stimulation possible application period could be extended until January, as in North Sumatra a huge water stress is never encountered. This would ease to apply stimulation rates on clones with high stimulation intensities like PB 217 (up to 15 stimulations per year), as the possibly suitable application period would be extended from April to January, instead of April to December with the current panel change policy.

2.6. Openings and "wind damage related" practices

During field visit, we were questioned about the efficiency current practice of topping regarding increased resistance to wind damage, which is a major issue for North Sumatra Rubber Estates, and in Socfindo especially on Tanah Besih, Tanjung Maria and Lima Puluh Estates, where wind damage is a major cause of the fast decline of the tapped trees stand/hectare. This is still a problem, as, although topped, some blocks planted with PB 260, PB 235 or PB 330 already showed susceptibility to wind damage. Moreover, topping practice has been proved in Socfindo to reduce the trunk growth compared to non-topped control plots, which is quite logical as the reaction of the tree after topping is to emit a new flush in order to rebuild its canopy. As a consequence, consumed carbohydrates used for this canopy rebuilding are not anymore available for the trunk growth. This competition phenomenon is thought to be more and more significant when topping is made earlier, as the proportion of total removed biomass following topping practice is higher on younger trees.

For the moment, without sufficient background and experience, nobody can really and honestly ensure that "topping practice" will have a significant and positive long term effect on wind damage resistance. Only some possible adverse effects on trunk growth have been described. Observation of the consultant is that this practice, however somehow expensive, is in apparent opposition with the policy of plant material and land preparation currently in place in Socfindo, totally forwarded to obtain a high early growth and homogeneity of the planted trees (nursery techniques : selection rounds and root induction techniques, mechanical land preparation, mechanical holing, polybag planting…) and which appears to the consultant, according its experience, one of the most technically advanced.

In order to provide a possible alternative solution to topping practice, we would like to propose for consideration to Socfindo the following suggestion.

Susceptibility to wind damage, although poorly studied by rubber research institutes, is thought to be correlated with the balance between trunk diameter and tree height. As a matter of fact, rubber clones with low heights (PR107, RRIM 712) are actually those who present lower susceptibility to wind damage (reduced "lever arm"). This hypothesis is used when the topping practice is applied, in order to reduce the height, but it may be proved quite inefficient if at the same time the trunk diameter is reduced. The consultant therefore doubts that a longer term balance between tree height and trunk diameter could be significantly modified in a sustainable way using the topping practice, as the adult height of the tree appears to be genetically determined, with or without topping.

Former works by Cirad in Bimbresso and Hevego rubber research stations (Côte d'Ivoire) seem to have shown in the contrary that this balance between height and trunk diameter might be significantly improved, as well as subsequent resistance to wind damage, by delaying openings. This nevertheless can be recommended only in rare cases, as early rubber yield is often of great importance for the planters. As a matter of fact it is not popular to recommend these delayed openings, as rubber planters often even refuse to consider this possibility. Nevertheless, we believe in the efficiency of this ultimate recommendation in high wind damage areas. Allowing one more year of untapped growth to the trees is to restore a right balance regarding the tree biomass repartition (trunk diameter and tree height).

In the case of Socfindo, this would result as following :

Previous policy (all clones):
Planting : September 2000
Actual opening : July 2004 (50 cm girth 50% trees at least) : # 4 years : 50 cm average trunk girth
Official opening : January 2005 (51 cm average trunk girth) # 4.5 years.

New possible policy (all clones, considering opening in April and not in January):
Planting : September 2000
50 cm average trunk girth in July 2004.
Remains untapped until April 2005.
Opening : April 2005 (56 cm girth) # 5 years.

This new proposed policy would delay the actual opening for about 9 months only but would ensure an estimated extra-trunk girth estimated at 6 cm at least (untapped growth between July 2004 and April 2005), restoring a better balance between trunk diameter and tree height, and therefore an expected increase resistance to wind damage. Furthermore, opening bigger trees, but keeping the 50 cm criteria would lead to an increased proportion of tapped trees / ha and therefore per tapper in year 1. Kg/tapper/day would be increased by two ways : higher Kg/tree/year (bigger trees) and higher tapped trees /task (increase of tappable trees/ha in year 1). Topping practice would not be anymore necessary.

In the present context of replantation of Socfindo, we do think that this strategy might be profitable for the company, as the early yield would be of less importance compared with a newly planted plantation. Therefore, we would recommend to Socfindo to test this strategy , at least on small areas, in comparison with the current practice. This is not in contradiction with the high quality planting material policy currently adopted by Socfindo, as this high growth strategy (nursery selection and agronomic practices) would be valorised by Socfindo not through earlier openings but through opening of bigger trees.

In the present context of Socfindo replantation programme, we actually think that this strategy might be profitable for the company, as the early yield would be of less importance compared with a newly planted plantation, and as longer life span should be ensured through a reduced susceptibility to wind damage.

2.7. Late openings.

During the field visit, the consultant insisted on the necessity to maintain the openings of the "late opening" trees at the average height of the cuts of former openings, as in a rubber field, the panel management becomes much easier when all cuts are approximately on the same position in the plot. Moreover, this normal practice allows to cut longer cuts than late openings at constant heights, and avoids appearance of "full spirals" when switching to panel B (B0-2).

2.8. Pruning policy

For non self-pruning clones (especially PB 217 and RRIC 100), buds should be removed at least up to 2.50 m from the ground, so as not to be hindered when upward tapping. If not, the upward available bark will be insufficient to tap more than 4 years using upward tapping system (1/4 S d/4 UTS), resulting in a high yield potential loss and also reducing the life span of the plantations. The present policy seems to be satisfactory and should be continued.

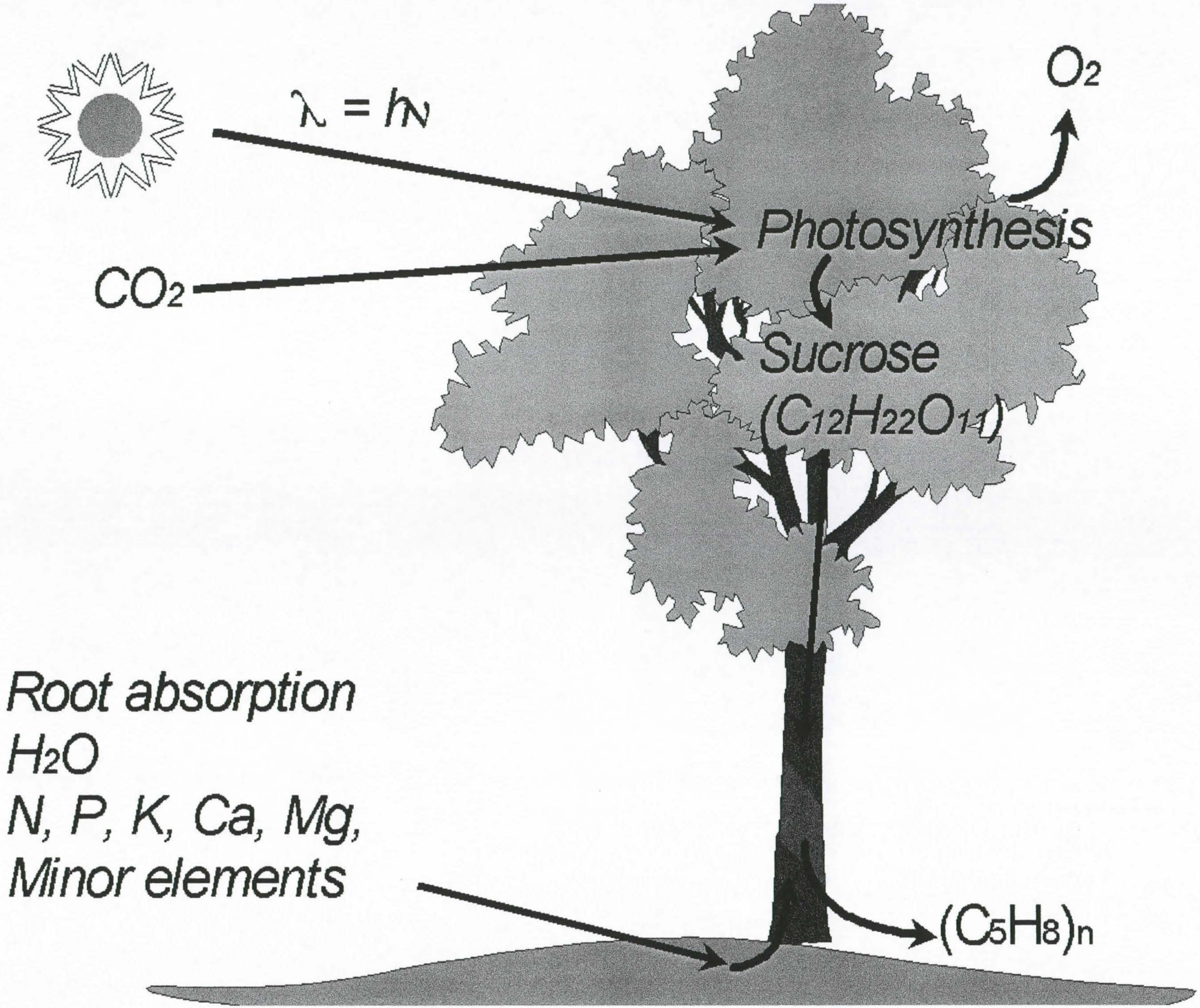
Conclusion

Considering the active participation and accuracy of questions by all participants to this training sessions, we are confident that such training sessions will be profitable for the Socfindo Rubber Estate Management, and therefore for Socfindo as a whole. We expect that this will be renewed from time to time, maybe being extended to the whole staff of Socfindo, including that from oil palm estates, as dual organisation of Socfindo guarantees that all staff will have to deal, sooner or later, with rubber tree exploitation.

Annex N°1

Conference
The Rubber Tree : A natural bioreactor

The rubber tree is a natural "bioreactor" (natural factory) producing rubber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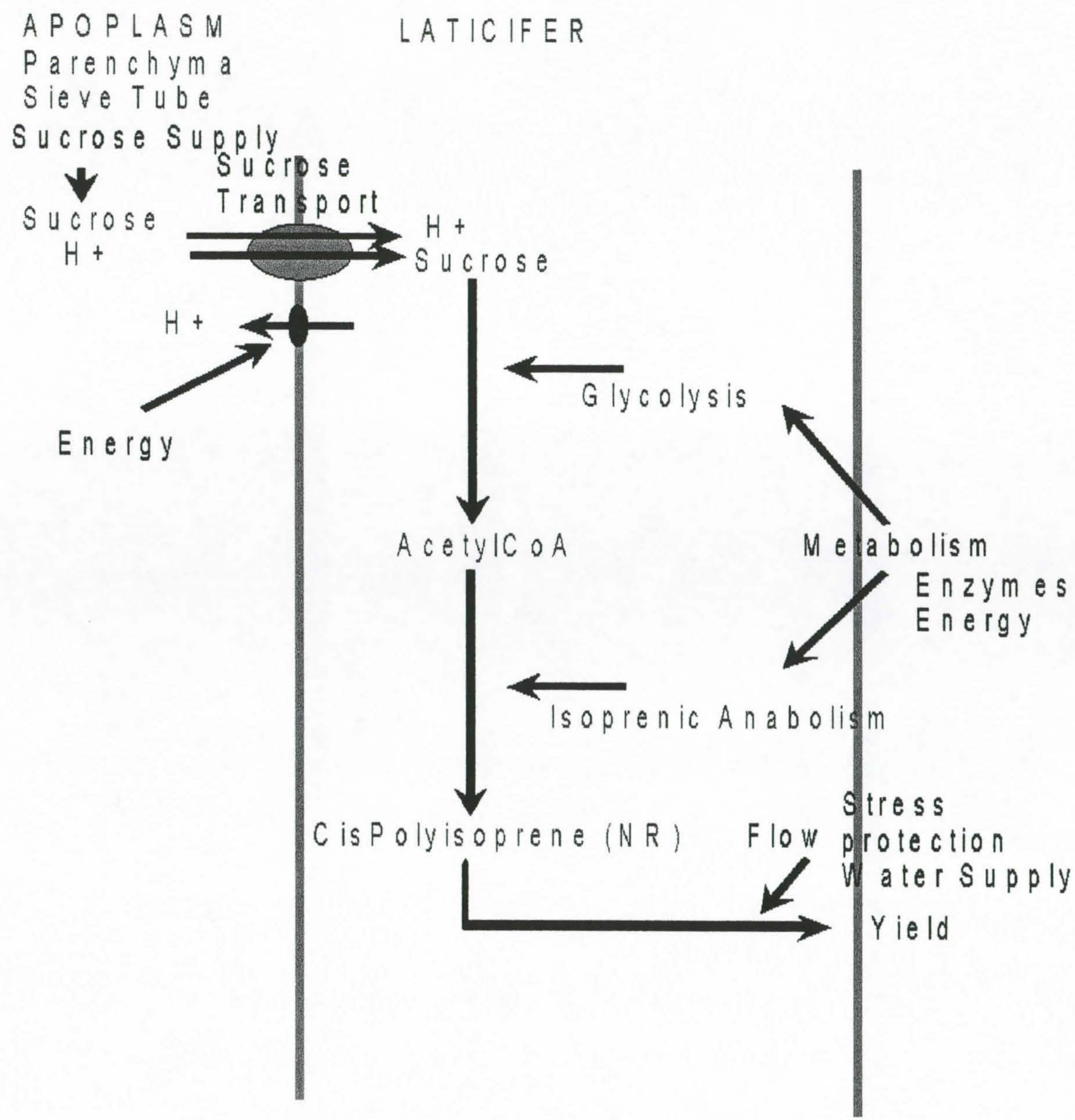
Photosynthesis
CO2
Sucrose
(C12H22O11)
Root absorption
H2O
N, P, K, Ca, Mg,
Minor elements
(C5H8)n


APOPLASM
Parenchyma
Sieve Tube
Sucrose Supply
Sucrose
H +
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Transport
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Energy
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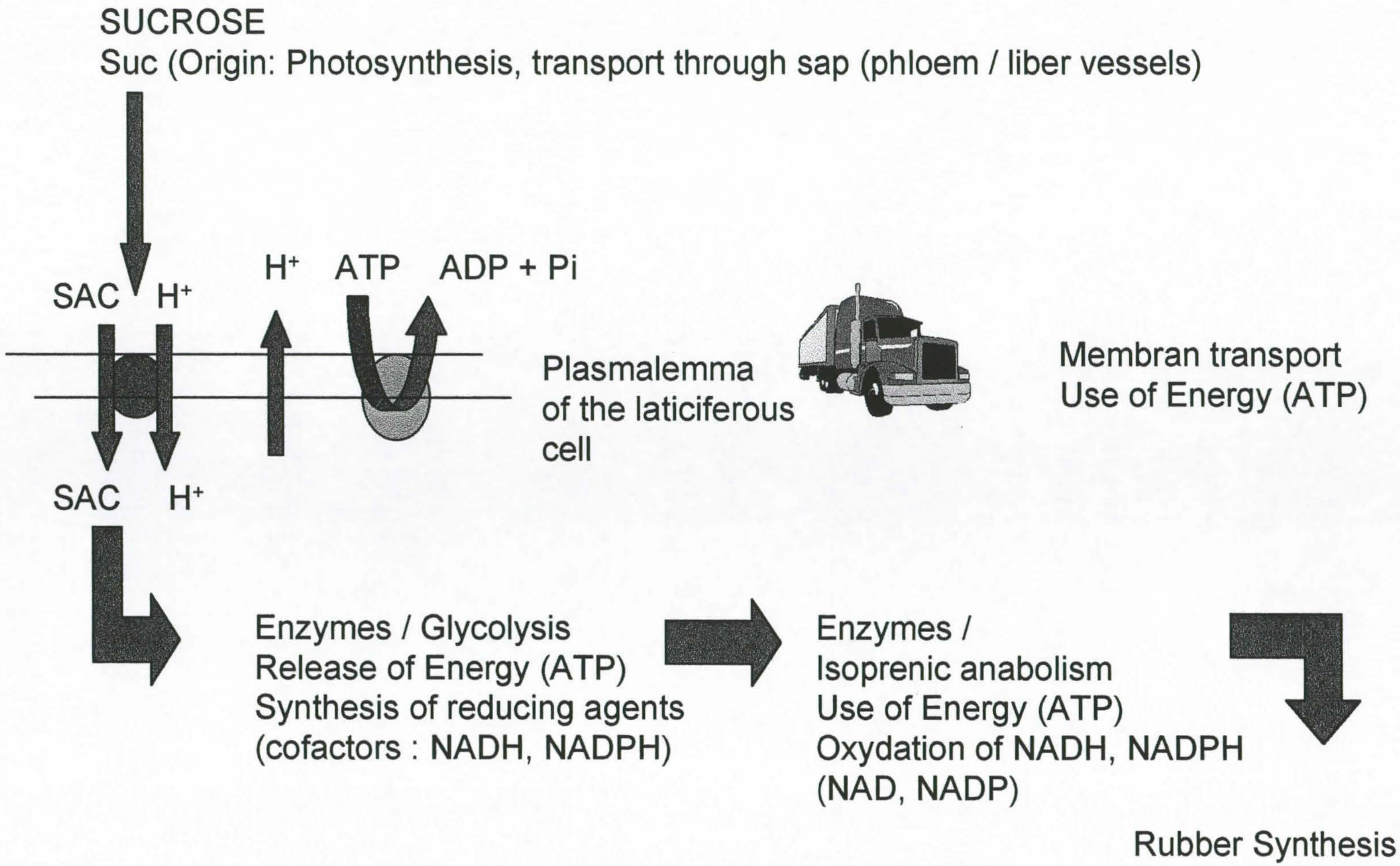
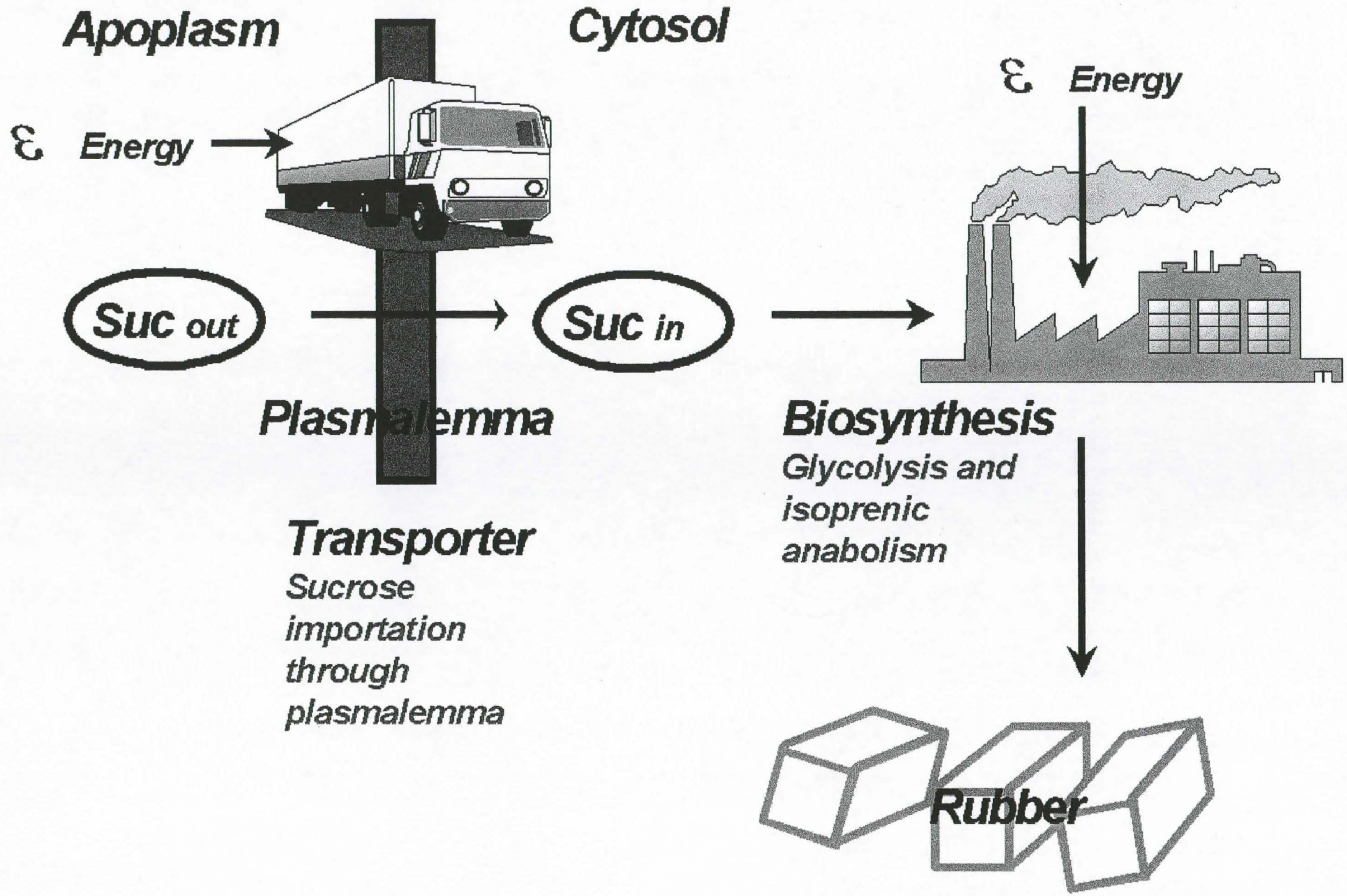
AcetylCoA
Metabolism
Enzymes
Energy
Isoprenic Anabolism
CisPolyisoprene (NR)
Flow
Stress
protection
Water Supply
Yield
LATICIFER


SUCROSE
Suc (Origin: Photosynthesis, transport through sap (phloem / liber vessels)
SAC H+
H+ ATP ADP + Pi
Plasmalemma
of the laticiferous
cell
Membran transport
Use of Energy (ATP)
SAC H+
Enzymes / Glycolysis
Release of Energy (ATP)
Synthesis of reducing agents
(cofactors : NADH, NADPH)
Enzymes /
Isoprenic anabolism
Use of Energy (ATP)
Oxydation of NADH, NADPH
(NAD, NADP)
Rubber Synthesis

- The tree transforms a raw material (sucrose) in a product (*cis*-polyisoprene)

- In order to achieve this transformation, the rubber tree uses high amounts of energy

- The calorific value of the raw material (sucrose) is 2.5 times less compared to the calorific value of the final product : high energy investment during the rubber biosynthesis


Apoplasm
Cytosol
ε Energy
ε Energy
Suc out
Suc in
Plasmalemma
Transporter
Sucrose importation through plasmalemma
Biosynthesis
Glycolysis and isoprenic anabolism
Rubber

First characteristic : Modification of natural metabolism

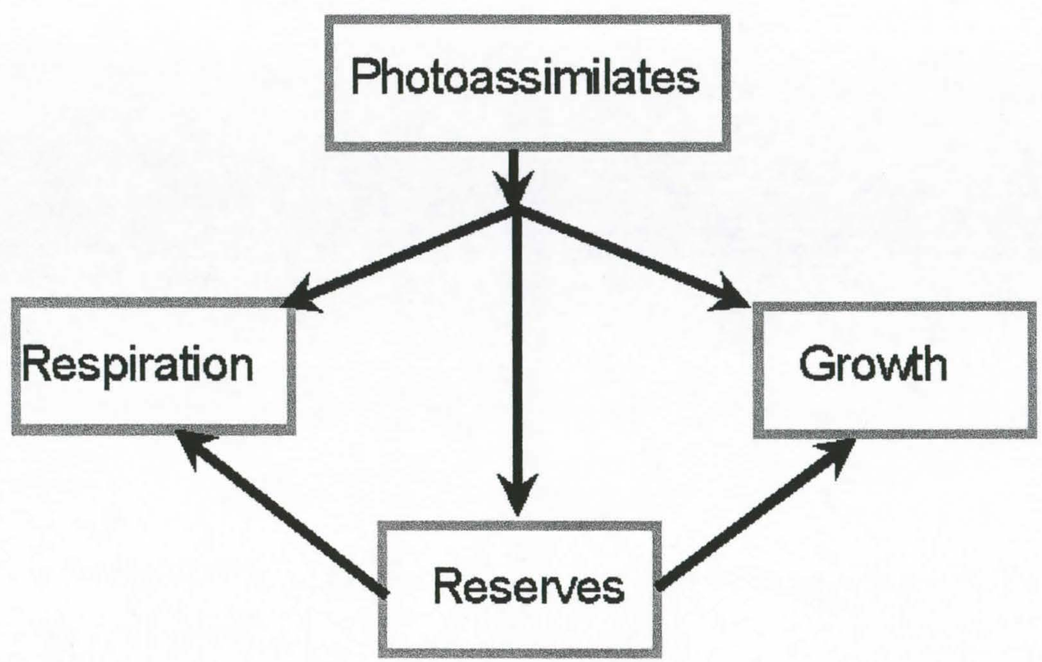
- Tapping diverts photoassimilates to a new sink : the latex regeneration sink.This decreases the amount of assimilates available for growth and reserves

- The more the tree produces, the more its growth is reduced : A high precocious yield will reduce the future yields (Competition between short run yield and long run yield)

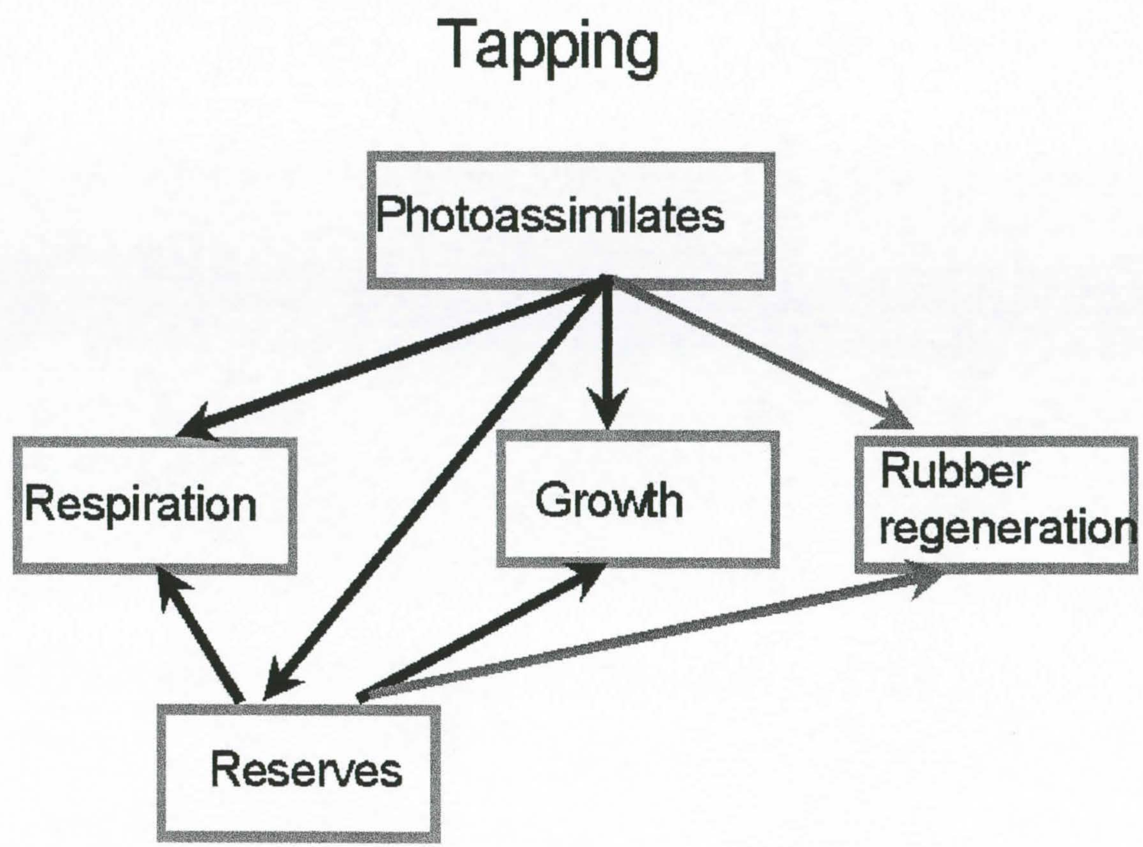
- The balance between radial growth and vertical growth is modified (increased susceptibity to wind damage)

- Tapping the rubber tree modifies the natural metabolism of the tree

No Tapping



- Tapping the rubber tree modifies the natural metabolism of the tree



Second characteristic : Against nature

- The latex is a medium organized to coagulate as soon as it is in contact with the outside (lutoid/hevein/acetylglucosamine system)

- It is now thought that the latex is a defense system, which allows, after coagulation, a good protection and healing of wounds (like animal blood)

- Moreover, antibiotic and antifungic molecules are present inside the latex : glucanases, chitinases...

- In the contrary, the goal of the rubber planter is to obtain a long latex flow, in order to increase his rubber yield and his income.

Third characteristic : Many possible yields of rubber tree.

- In a given environment (climate, soil, pathogens), there is only one possible yield for other crops : The plant produces what it can produce ; not less, not more. Under-exploitation and Over-exploitation do not exist.

- For the rubber tree, there are a lot of possible yields (as many as possible tapping systems) : Underexploitation and overexploitation can exist

- How to assess the optimal and physiological yield of a tree ?

- How to determine the tapping system which will provide to the planter this optimal and physiological yield ?

A. Many possible yields of rubber tree :
Optimization of tapping systems in order to obtain a physiological yield (short run and long run yield)

B. Against the natural process :
(Early coagulation in order to heal wounds)

C. Modification of the natural metabolism and architecture of the tree

NEED OF A PHYSIOLOGICAL DIAGNOSIS TO :

- OPTIMIZE TAPPING SYSTEMS
- ASSESS THE CLONAL YIELD POTENTIAL

LATEX DIAGNOSIS : use of physiological parameters involved in the regulation of

* Flow mechanism
* Latex regeneration process

Combination of physiological parameters :

- Diagnosis of the metabolic status of latex cells (physiological parameters related to the latex regeneration)

- Diagnosis of the flow characteristics

// Blood analysis of human beings

A. Diagnosis of the metabolic status of latex cells (physiological parameters related to the latex regeneration between two tappings)

- TSC, DRC
- Sucrose
- pH
- Pi (inorganic phosphorus)
- Magnesium
- Thiols (R-SH)
- Redox Potential (pR)

B. Diagnosis of the latex flow characteristics

- TSC, DRC
- Bursting index
- Thiols
- Magnesium

Significance of Sucrose

- Regeneration :

Sucrose is the molecule which initiatesisoprenic synthesis.
(Lynen 1969)

A low sucrose content may indicate
* an inadequate hydrocarbon supply
* an active utilisation of the sugar (active metabolism)

A high sucrose content may indicate
* a very active supply (clonal characteristic)
* a defective utilisation of the sugar (inactive metabolism)

Sucrose is the potential energy of the latex cell. It represents a major component of the clonal yield potential (Lacrotte 1991,Gohet 1996)

Significance of inorganic (or mineral) Phosporus (Pi)

- Regeneration :

Mineral phosphorus (Pi) is tightly associated with the energy metabolism of the latex cell :

* ATP turnover
* Enzymes phosphorylation
* Reducing cofactors (NADPH)
* Rubber chain elongation (production of PPi by rubber transferase, PPi hydrolysis)

High positive correlation with total rubber production (g/t/y)

Significance of Thiols (R-SH)

- Flow :

Status of the antioxydant systems and subcellular membrane protection processes

Low thiols indicate that the in situ peroxidation processes are important and not sufficiently inhibited.
This can lead to destabilization of organelles and in particular of lutoids (bursting), resulting in faster coagulation. (Chrestin 1984, 1985)

- Regeneration :

Activators of key enzymes in the metabolism : invertase, pyruvate kinase. (Jacob and al, 1981, 1982)

Significance of TSC/DRC

- Flow :

High TSC or DRC values increase the latex viscosity and can slow down the latex flow.
(Brzozowska-Hanover *and al.*1979)

- Regeneration :

TSC or DRC reflect in situ metabolic activity.
Too low values indicate inadequate reconstitution of cells materials (rubber and other components) between two tappings.
(Eschbach *and al.*1984, Prevot *and al.*1984)

Significance of Magnesium

- Flow :

Magnesium (cation Mg2+) in high concentration in the latex cytosol can neutralize the negative electric charges of latex organelles and rubber particles and can be a floculation factor, resulting in faster coagulation.
(d'Auzac 1960, Ribaillier 1972)

- Regeneration :

* Activator of key enzymes in the metabolism : ATPases (Chrestin *and al.* 1985, transferases (Skilleter et Kekwick 1971, PEPcarboxylase (Jacob and al, 1978,1979), pyrophosphatase (Jacob *and al*, 1986)
* Inhibitor of key enzymes in the metabolism : invertase (Primot 1977), phosphatase (Jacob and Sontag, 1974)

Compartimentation / Different effects
Interpretation of the parameter is difficult

Significance of pH

- Regeneration :

The cytosol pH is a major regulation factor in glucidic catabolism (glycolysis) and hence in latex regeneration

* invertase activity is very sensitive to pH (Tupy 1973) : an increase of pH activates glycolysis and hence latex metabolic activity.

* phosphoenolpyruvic crossroad (Jacob and al 1983 : Biochemical pHstat) : Pepcarboxylase can divert sucrose to other pathways depending on pH (low pH).

Large amount of latex, iced bottles sampling

Significance of the bursting index (BI)

- Flow :

The bursting index (BI) is associated with lutoid stability (Ribaillier 1972).

It reports the percentage of lutoidic acid phosphatase in the cytosol and consequently the quantity of these burst organelles (lutoids) in the latex.

Since lutoid serum is a major coagulation agent, the higher the bursting index, the more unstable the latex.

Percentage, High incidence of climatic sampling conditions

Significance of the Redox Potential (RP)

- Flow :

* cytosol : negative (reduction) RP : - 5 to - 50 mV
* lutoids: positive (oxidation) RP : > 50 mV
Low values of RP indicate that the lutoid status is correct (low bursting)(Prevot *and al* 1984).

- Regeneration :

The Redox Potential (RP) of latex is a resultant of in situ oxidation (catabolism) and reduction (anabolism).
Low values of RP (highly negative, reduction) indicate that the latex cytosol is a favorable medium for regeneration (high anabolism)(Prevot *and al* 1984).

Large amount of latex, iced bottles sampling, integrated data (difficult to interprete)

Latex Diagnosis : Four main parameters

* clear significance
* 90% of the total information
* simpler interpretation

- TSC, DRC
  - Flow (latex viscosity)
  - Regeneration (dry matter)
- Sucrose (Suc)
  - Regeneration (raw material)
- Inorganic Phosphorus (Pi)
  - Regeneration (metabolic activity)
- Thiols (R-SH)
  - Flow (lutoid membrane protection)

Latex Diagnosis : Applications

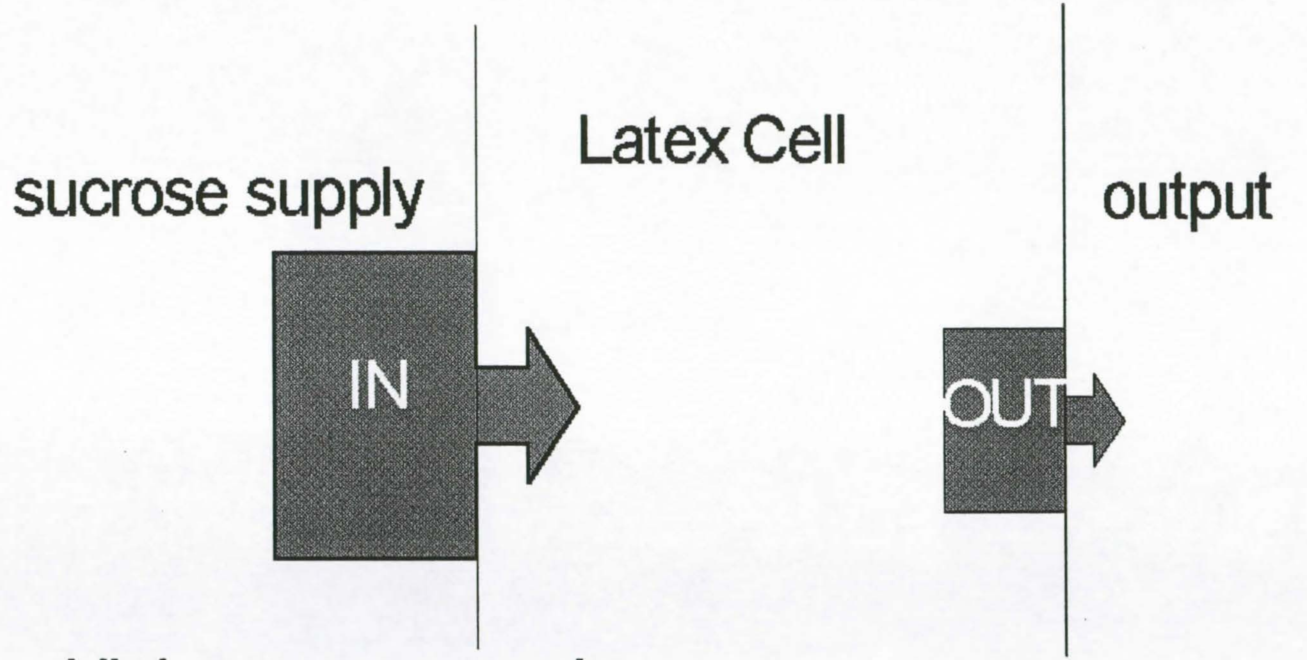
A. Experiments :

* Optimization of tapping systems and recommendations, physiological interpretation of tapping system trials
* Clonal typology (modelization of metabolic functionning of clones, assessment of clonal yield potential, assessment of tools and procedures for the breeding programme)

B. Commercial Plots :

* Diagnosis of overexploitation
  of under-exploitation
* Recommendations to the planters

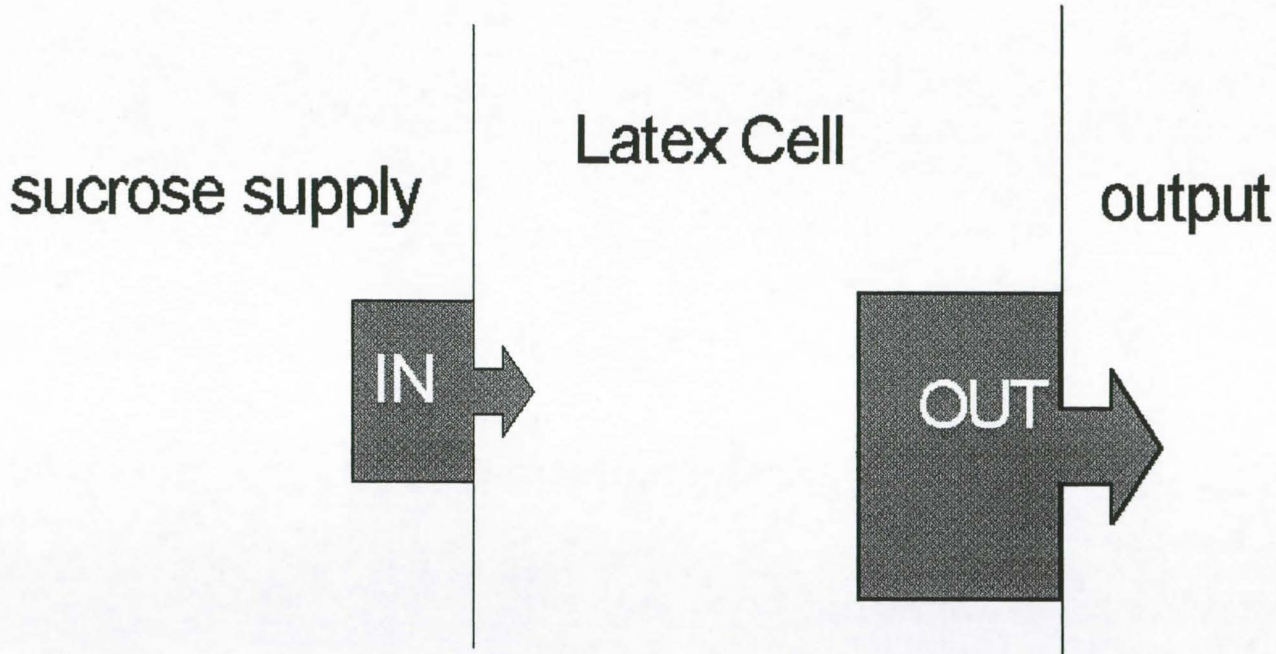
LATEX DIAGNOSIS : INTERPRETATION KEYS



High sucrose supply
Low metabolic demand / low output
Diagnosis of Under Exploitation

TSC DRC	- / = / +	Pi x RSH low
Suc	+	
Pi	-	
RSH	- / = / +	

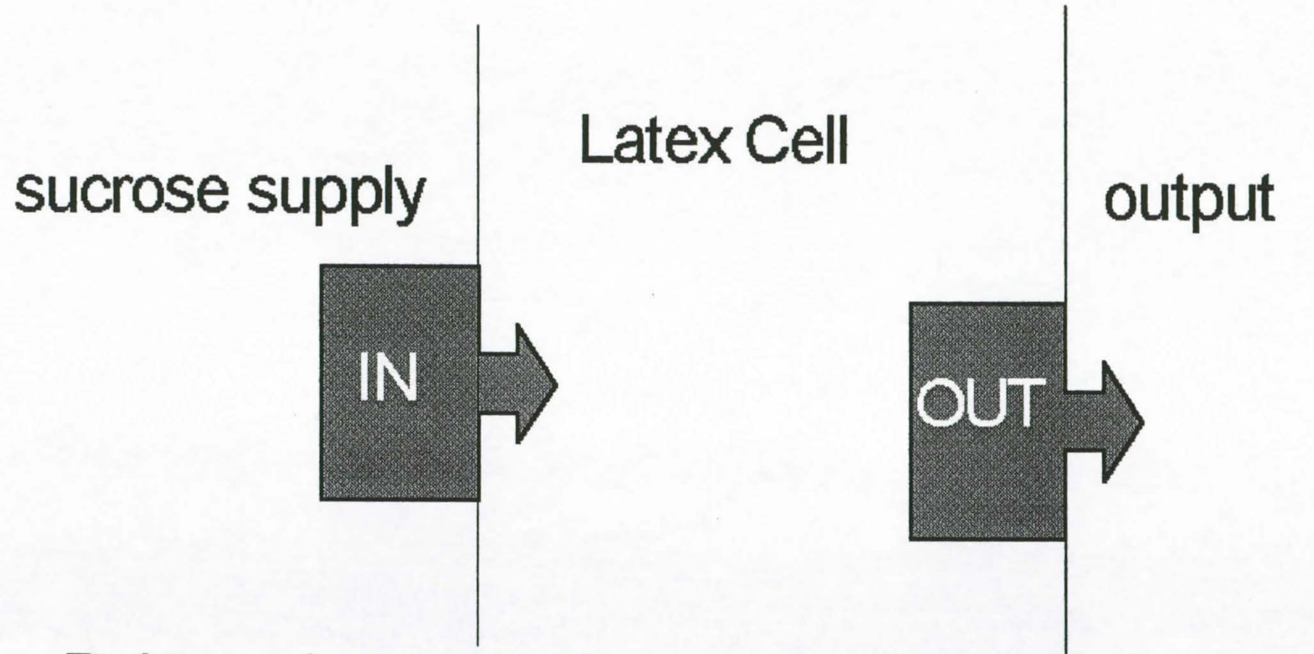
LATEX DIAGNOSIS : INTERPRETATION KEYS



Low sucrose supply
High metabolic demand / High output
Diagnosis of Over Exploitation

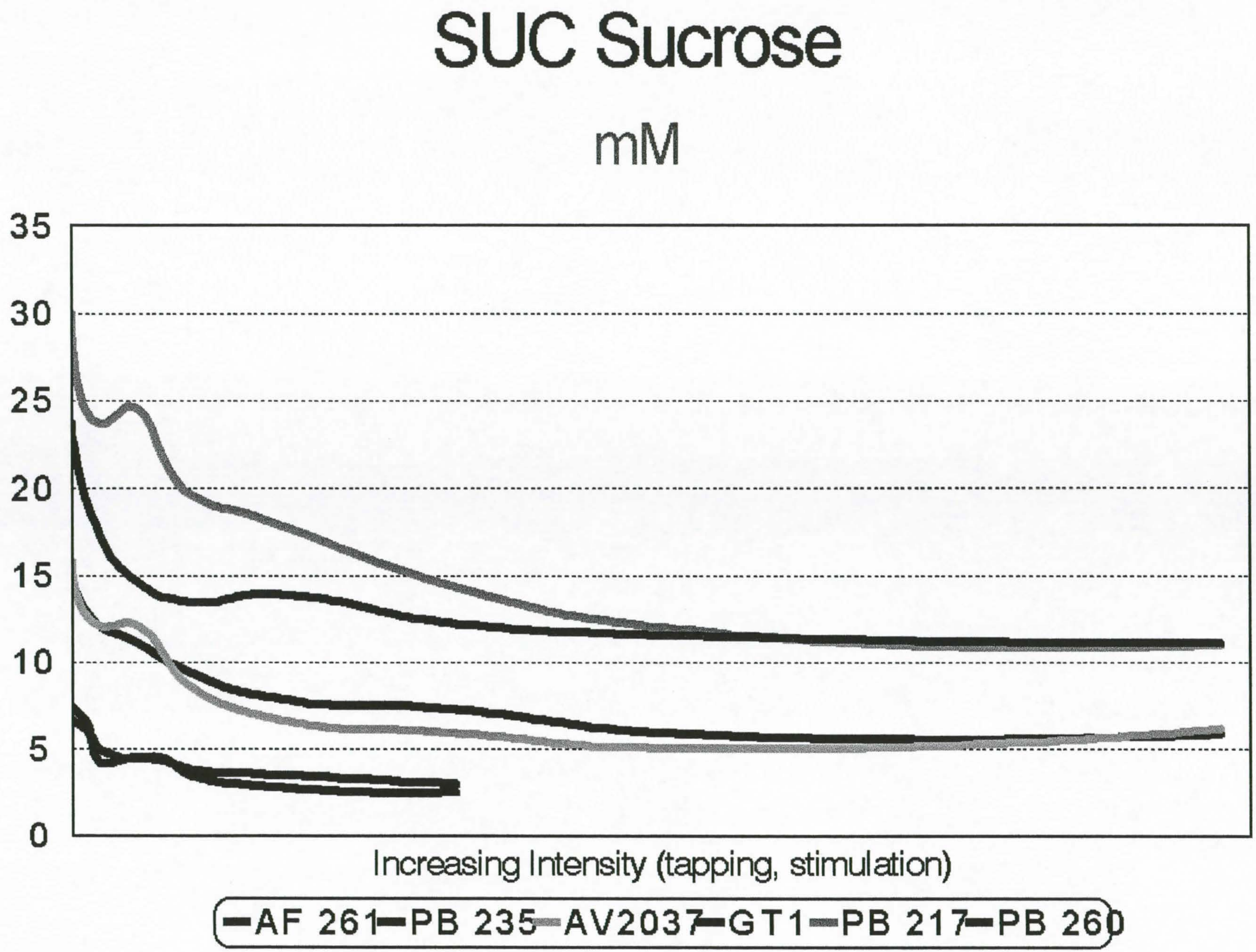
TSC DRC	- / =	Pi x RSH low
Suc	-	
Pi	+ / = / -	
RSH	-	

LATEX DIAGNOSIS : INTERPRETATION KEYS

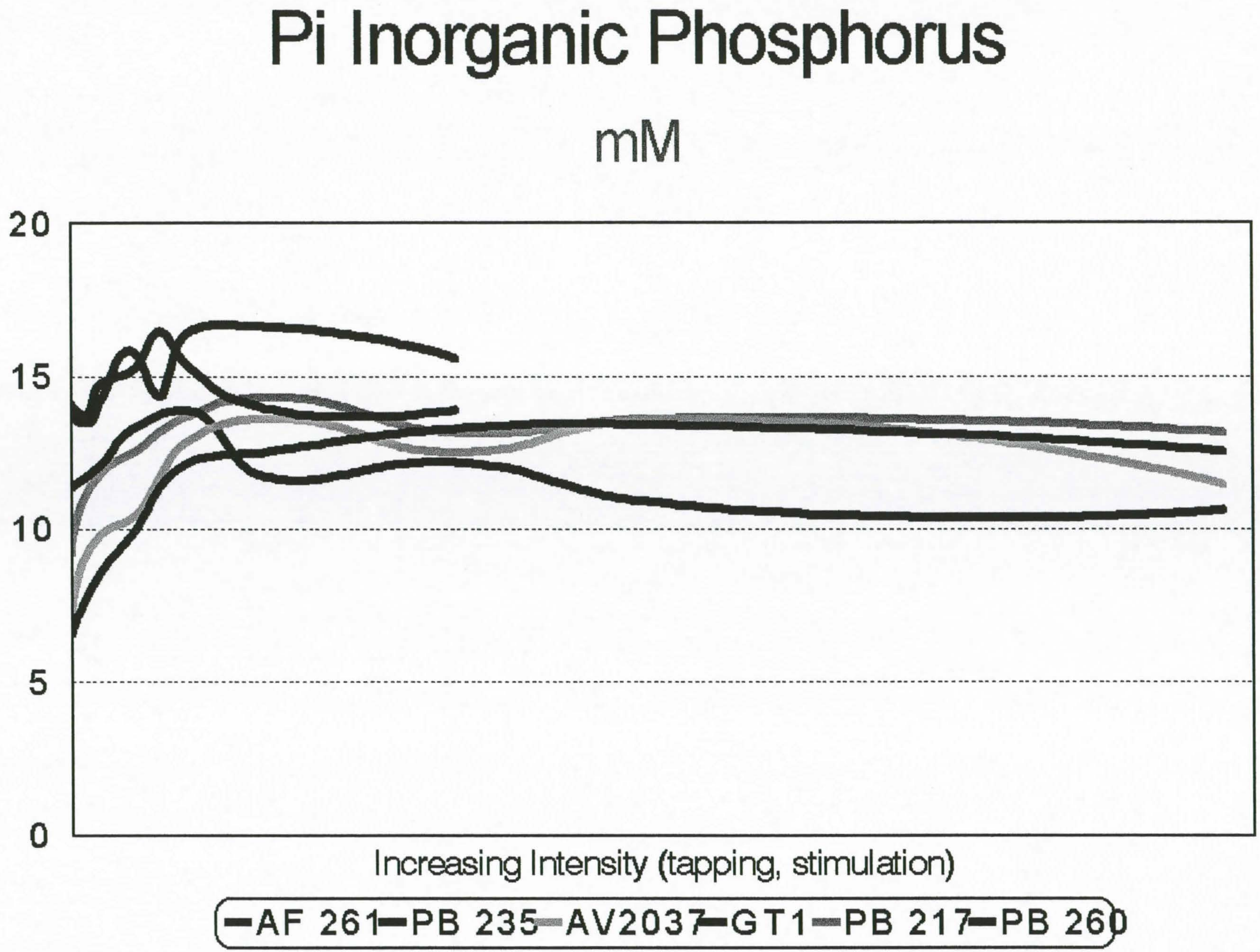


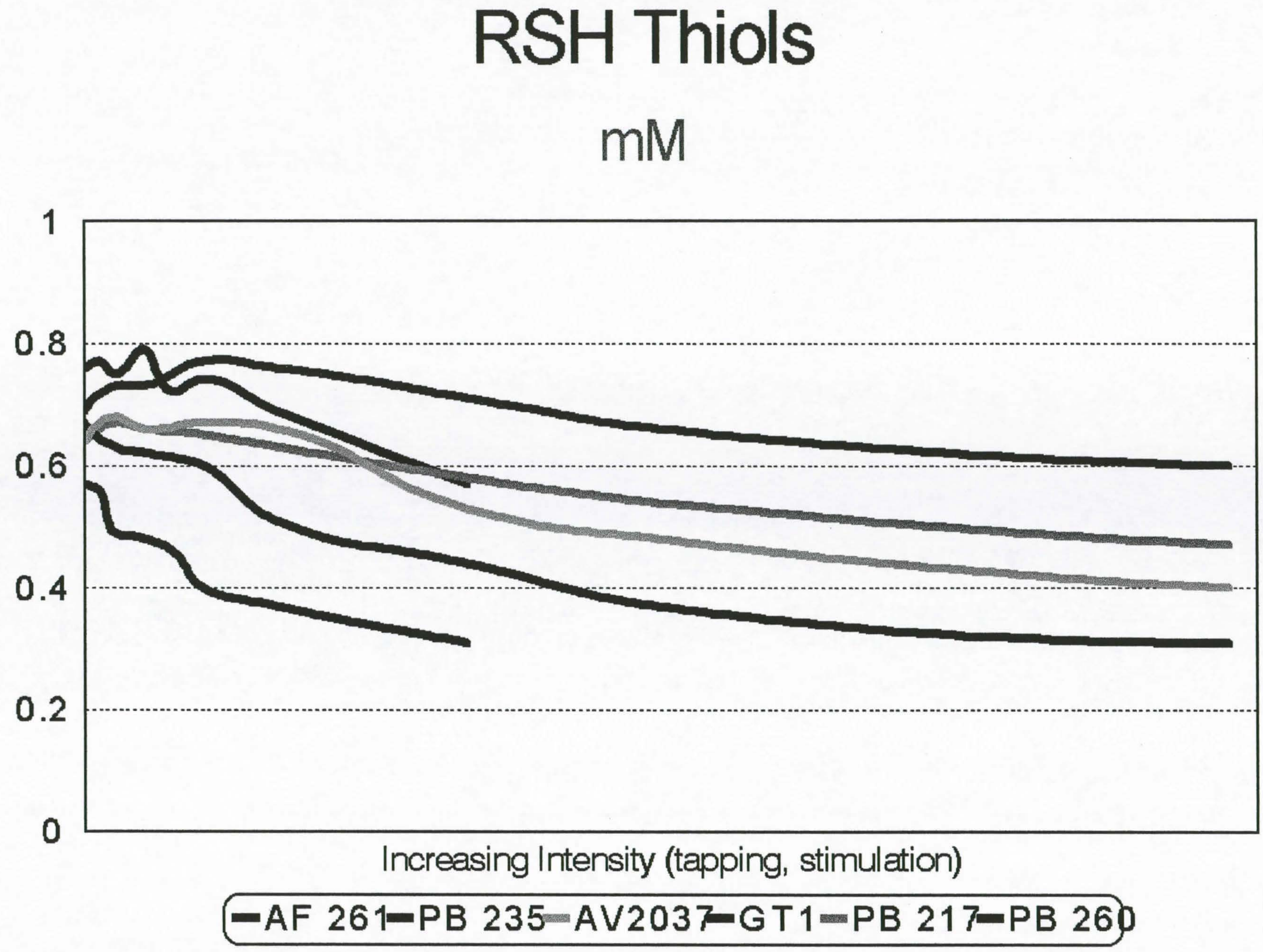
Balance between sucrose supply and metabolic demand
Diagnosis of Balanced Exploitation

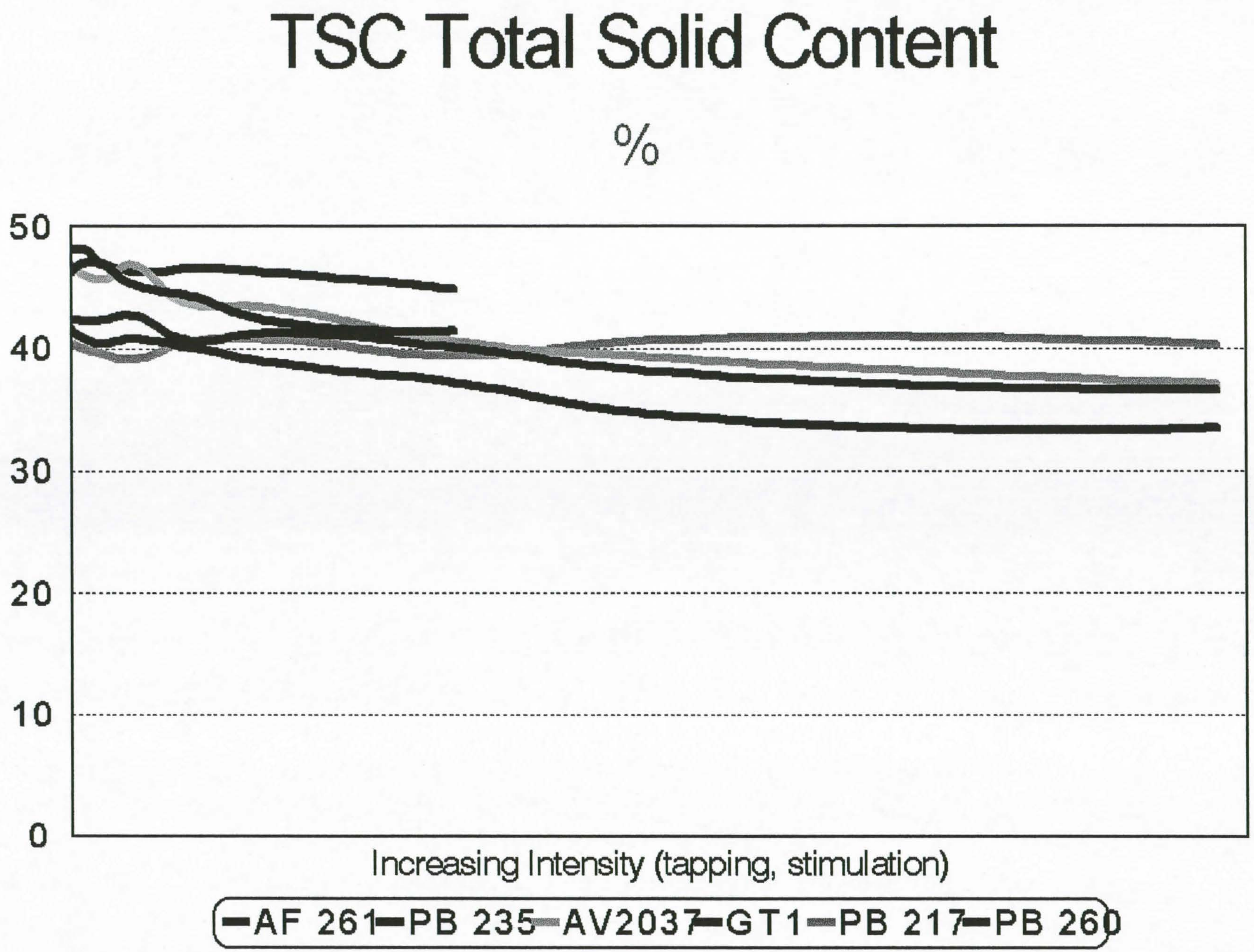
TSC DRC	=	Pi x RSH max
Suc	=	
Pi	+	
RSH	=	



SUC Sucrose
mM
35
30
25
20
15
10
5
0
Increasing Intensity (tapping, stimulation)
AF 261
PB 235
AV2037
GT1
PB 217
PB 260


Pi Inorganic Phosphorus
mM
20
15
10
5
0
Increasing Intensity (tapping, stimulation)
AF 261
PB 235
AV2037
GT1
PB 217
PB 260


RSH Thiols
mM
1
0.8
0.6
0.4
0.2
0
Increasing Intensity (tapping, stimulation)
AF 261
PB 235
AV2037
GT1
PB 217
PB 260



TSC Total Solid Content
%
50
40
30
20
10
0
Increasing Intensity (tapping, stimulation)
AF 261
PB 235
AV2037
GT1
PB 217
PB 260

LATEX DIAGNOSIS : CLONAL TYPOLOGY

Different metabolic clonal characteristics :

* Metabolic types : Metabolic Typology
Production and Pi (without stimulation)
* Hydrocarbon types : Sugar Reserve Typology
Sucrose (without stimulation)

Combination : CLONAL TYPOLOGY
Modelling of latex functionning and
assessment of yield potential

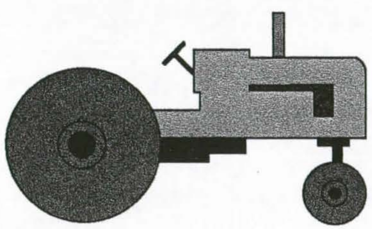
SUCROSE : RAW MATERIAL FOR RUBBER SYNTHESISIN LATEX CELLS

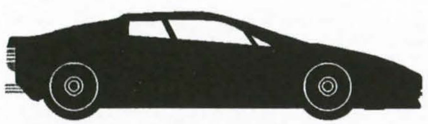
METABOLISM : SPEED OF SUCROSE TO RUBBER TRANSFORMATION
IN LATEX CELLS

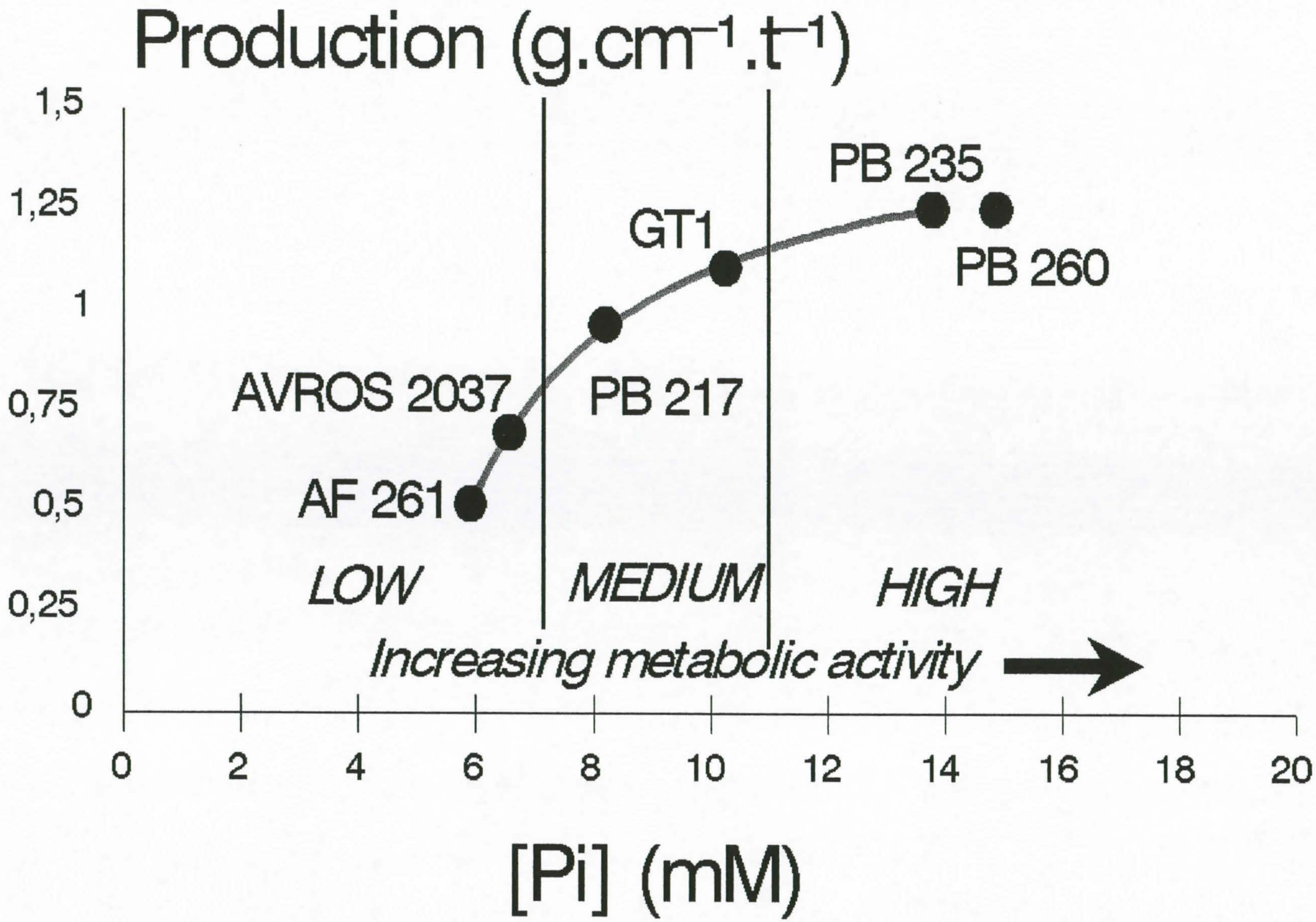
COMBINATION OF SUCROSE AND METABOLISM =
CLONAL TYPOLOGY : CLONES ARE DIFFERENT.

2 Parameters : SUCROSE : Reserve of raw material
INORGANIC PHOSPHORUS : Metabolic activity

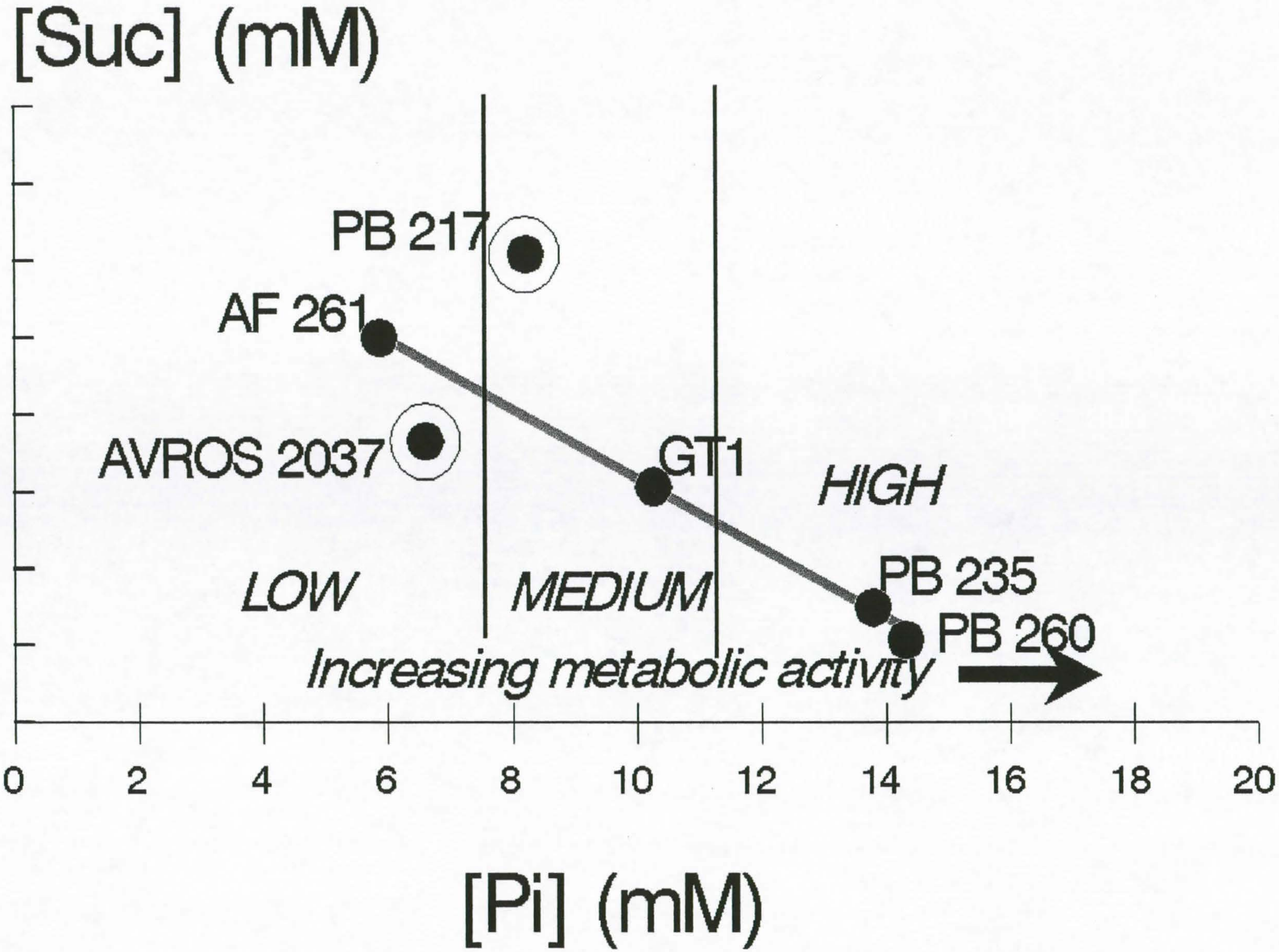
LOW METABOLISM	MEDIUM METABOLISM	HIGH METABOLISM
(low activity)	(medium activity)	(high activity)
(Slow Starters)	SAC =	(Quick starters)
SAC +	Pi =	SAC -
Pi -		Pi +







Production (g.cm-1.t-1)
1,5
1,25
1
0,75
0,5
0,25
0
PB 235
PB 260
GT1
PB 217
AVROS 2037
AF 261
LOW
MEDIUM
HIGH
Increasing metabolic activity
0
2
4
6
8
10
12
14
16
18
20
[Pi] (mM)



[Suc] (mM)
40
35
30
25
20
15
10
5
0
PB 217
AF 261
AVROS 2037
GT1
HIGH
PB 235
PB 260
LOW
MEDIUM
Increasing metabolic activity
0
2
4
6
8
10
12
14
16
18
20
[Pi] (mM)

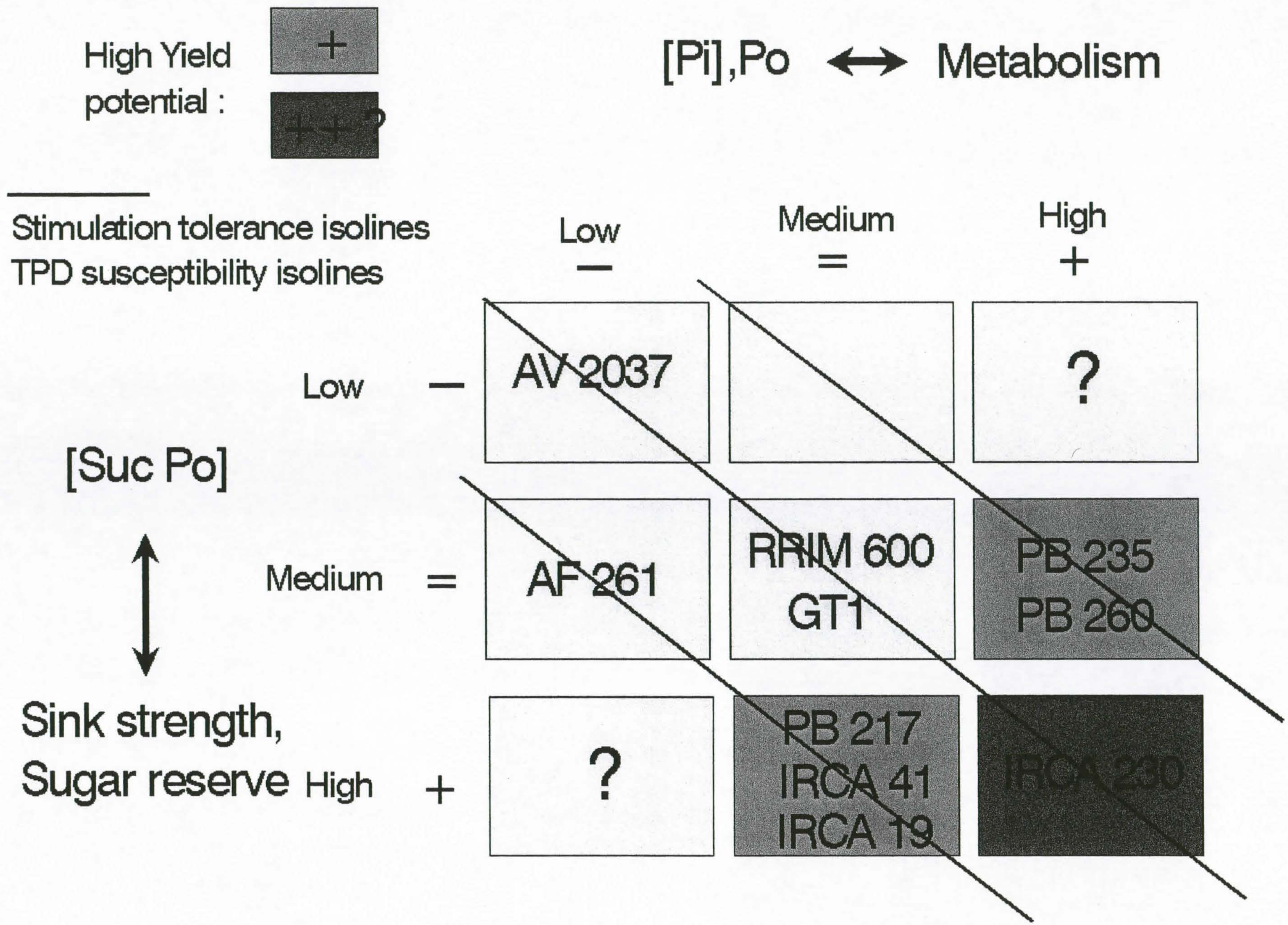
SINK STRENGTH :
Capability of a sink to import sugars, as a function of its metabolic activity

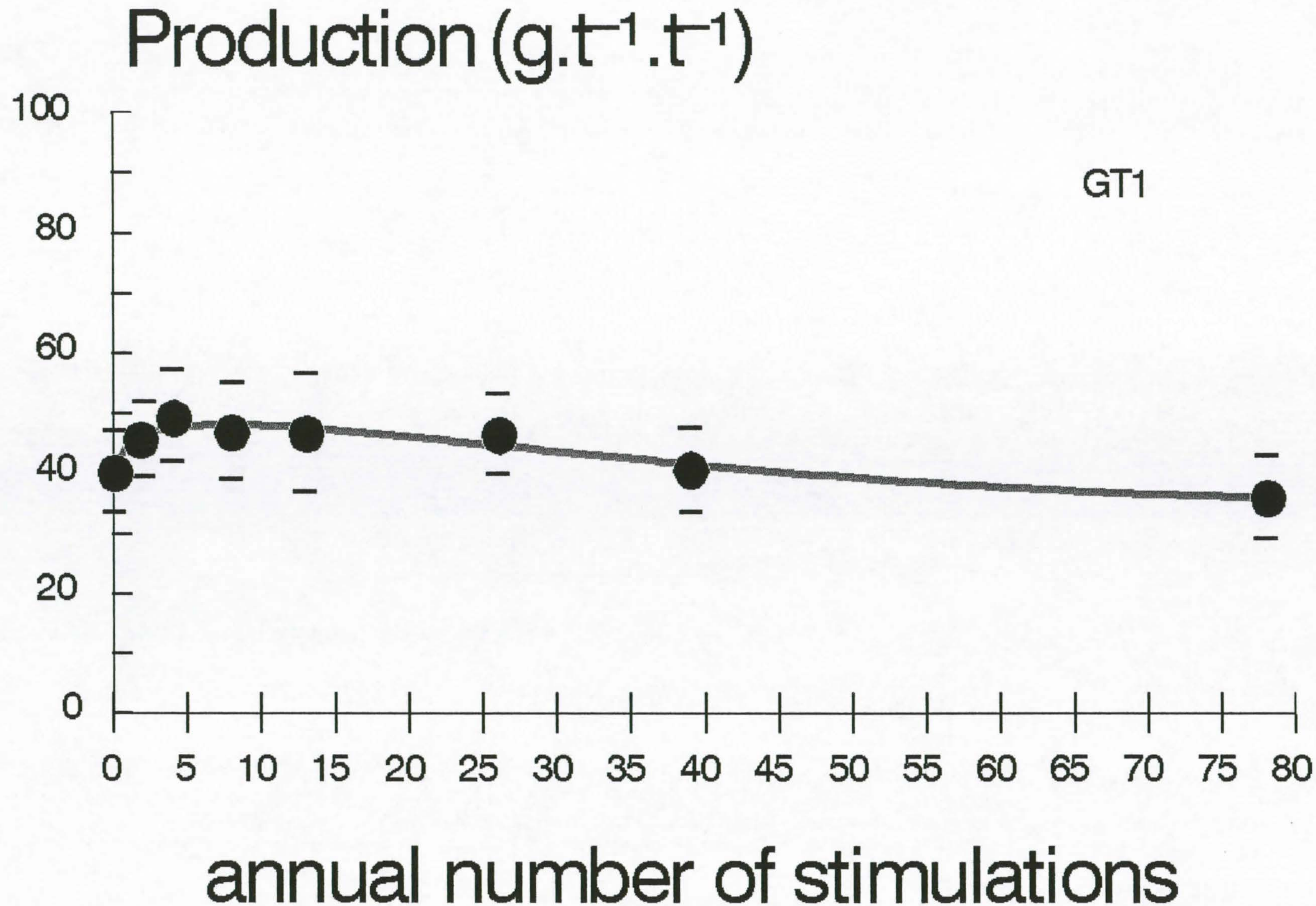
High sink strength : PB 217
Medium sink strength : AF 261, GT1, PB 235, PB 260
Low sink strength : AV 2037

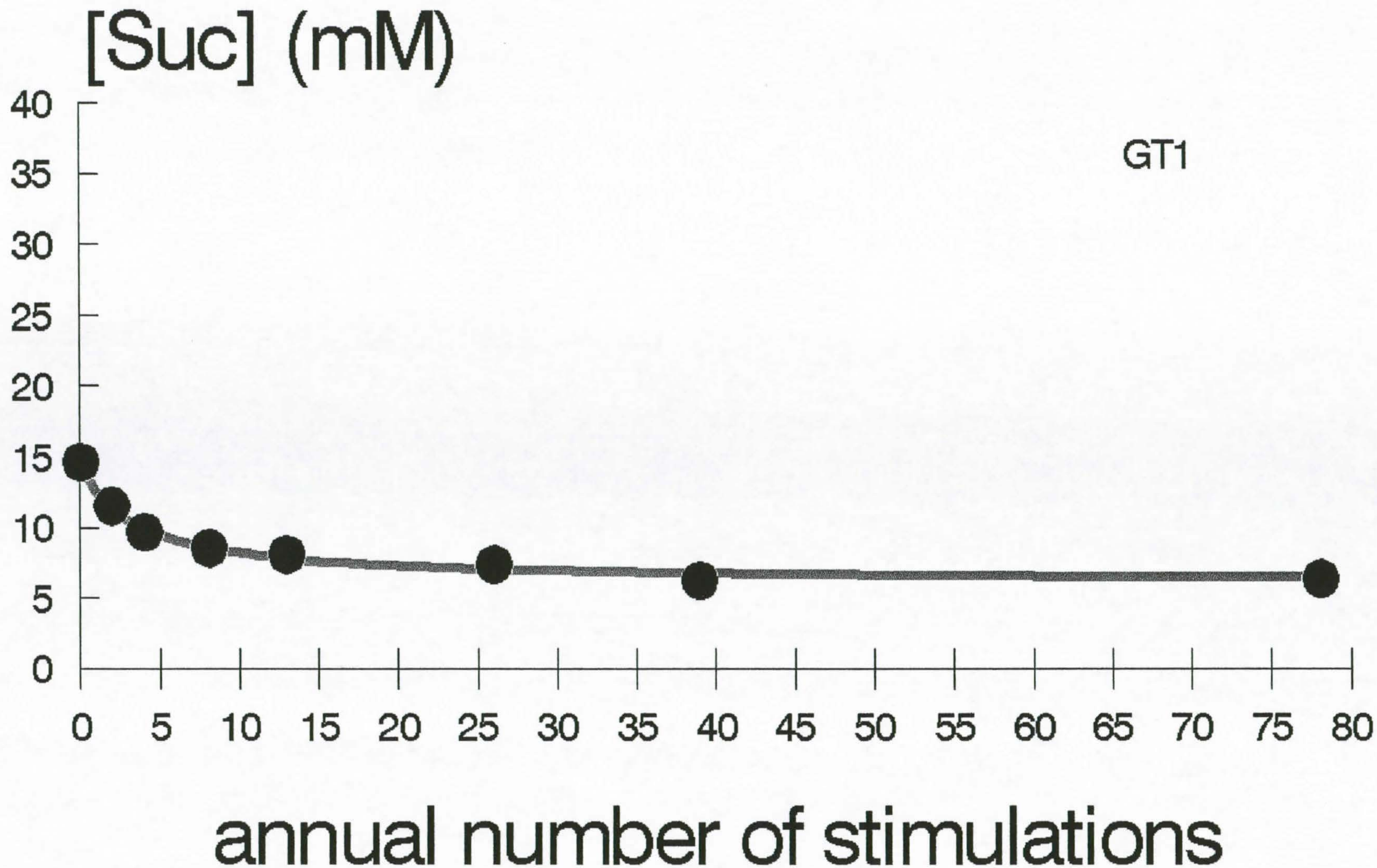
METABOLISM :

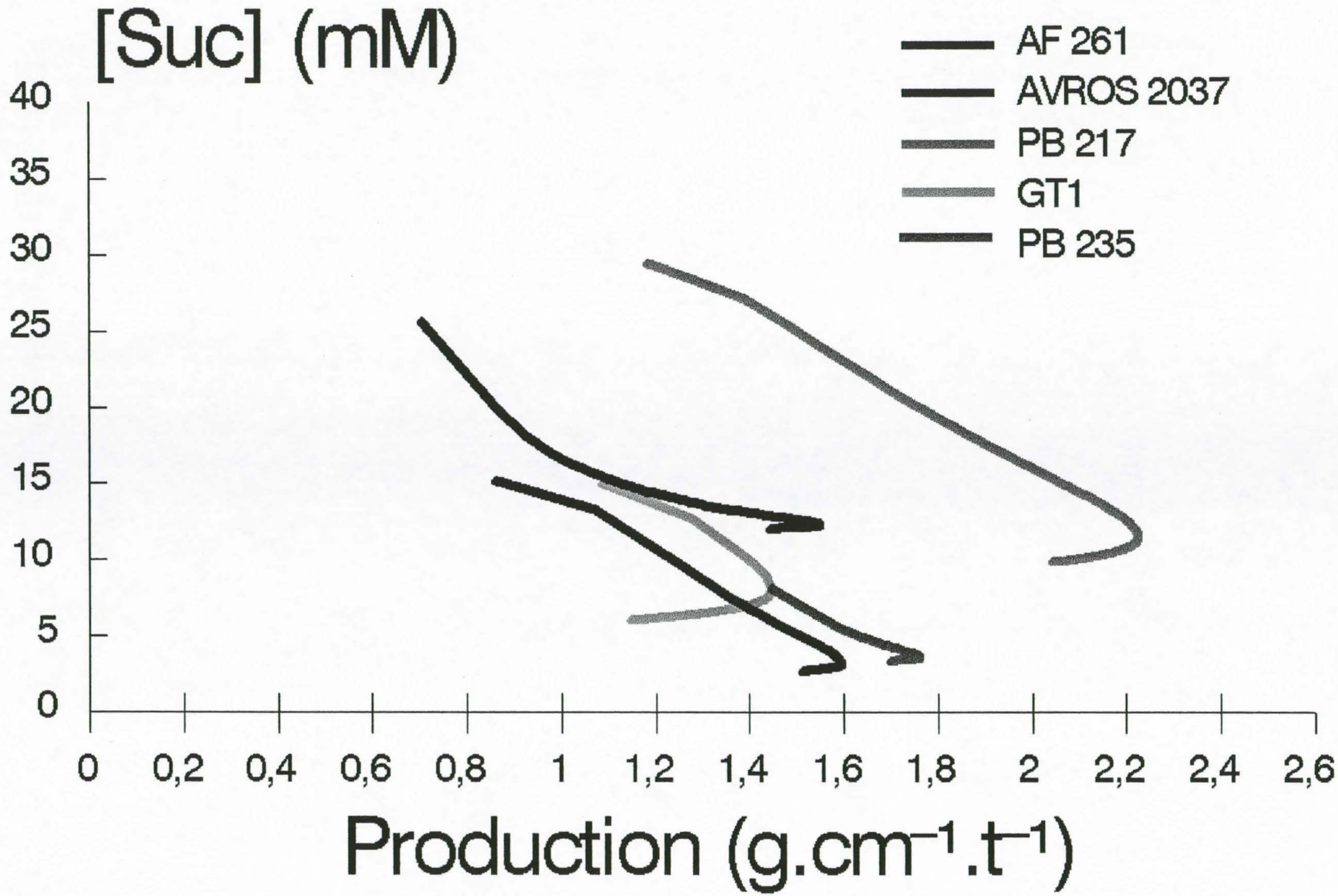
High metabolism : PB 235, PB 260
Medium metabolism : GT1, PB 217
Low metabolism : AV 2037, AF 261

METABOLIC ACTIVITY AND SINK STRENGTH ARE NOT CORRELATED : Double typology (metabolism and reserves)

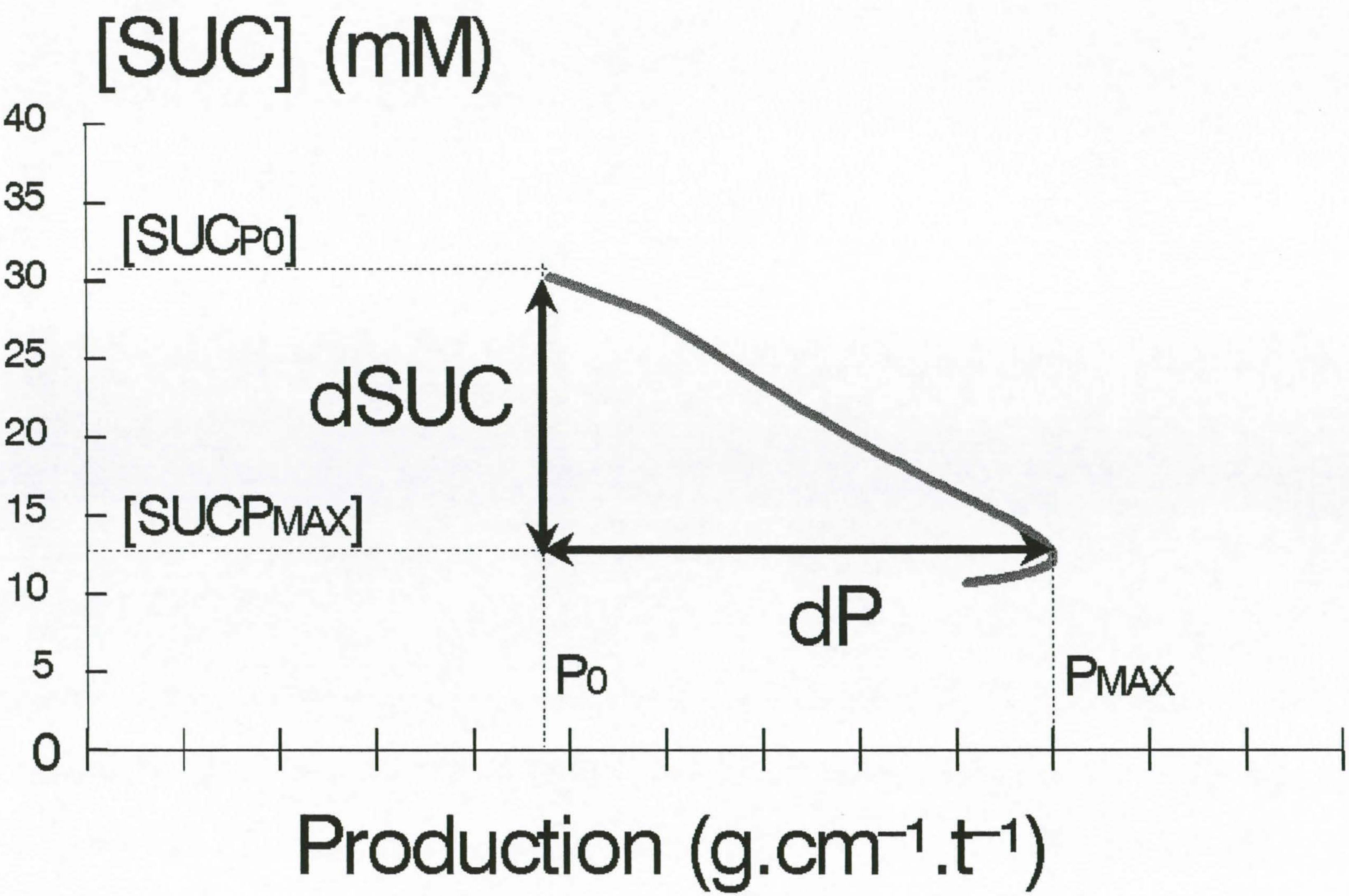

High Yield potential :
+
++?
Stimulation tolerance isolines
TPD susceptibility isolines
[Pi],Po ↔ Metabolism
Low
–
Medium
=
High
+
[Suc Po]
Sink strength,
Sugar reserve
Low –
Medium =
High +
AV 2037
?
AF 261
RRIM 600
GT1
PB 235
PB 260
?
PB 217
IRCA 41
IRCA 19
IRCA 230

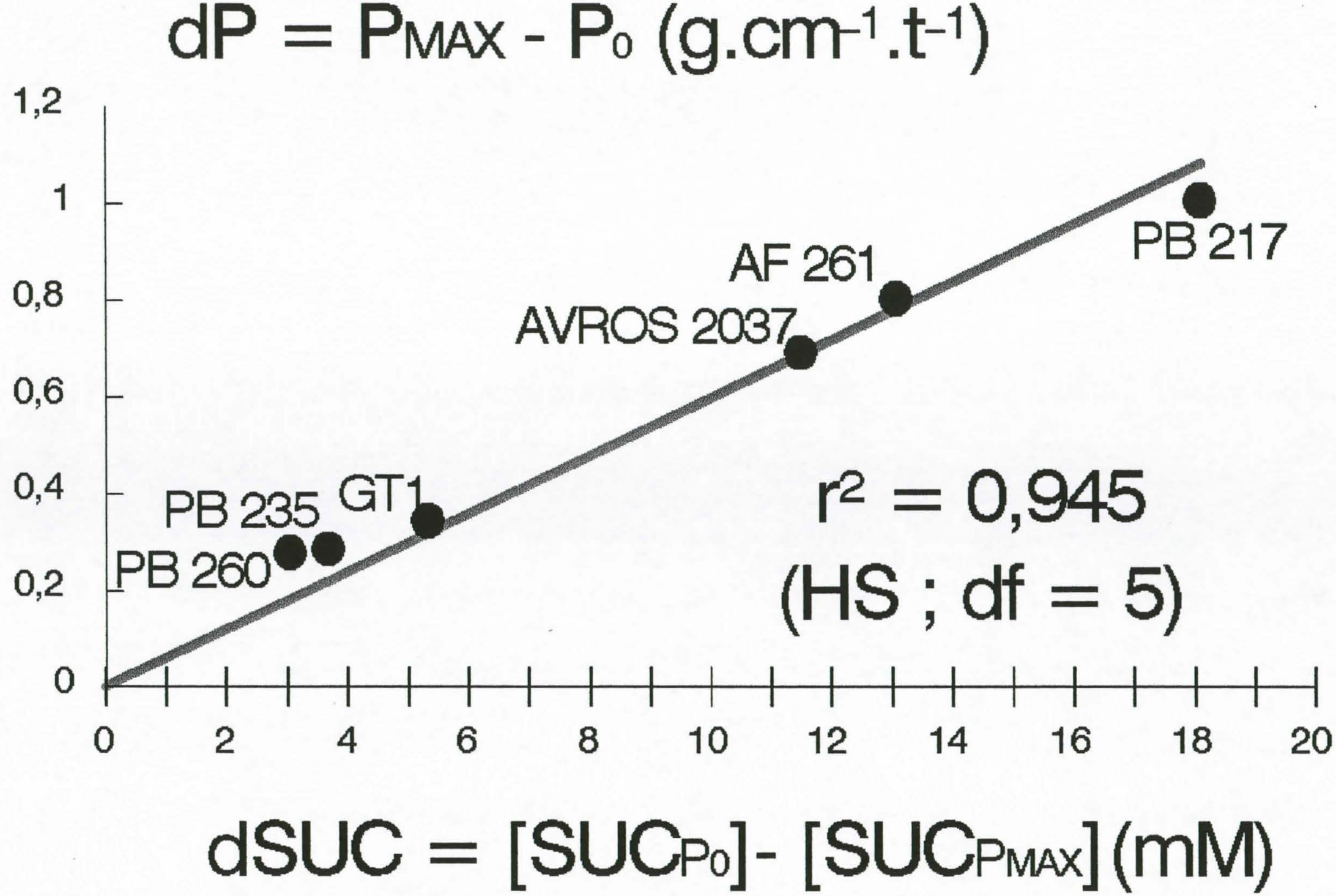

Production (g.t⁻¹.t⁻¹)
100
80
60
40
20
0
GT1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
annual number of stimulations


[Suc] (mM)
40
35
30
25
20
15
10
5
0
GT1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
annual number of stimulations



[Suc] (mM)
40
35
30
25
20
15
10
5
0
AF 261
AVROS 2037
PB 217
GT1
PB 235
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
1,8
2
2,2
2,4
2,6
Production (g.cm⁻¹.t⁻¹)


[SUC] (mM)
40
35
30
25
20
15
10
5
0
[SUCP0]
[SUCPMAX]
dSUC
dP
P0
PMAX
Production (g.cm-1.t-1)



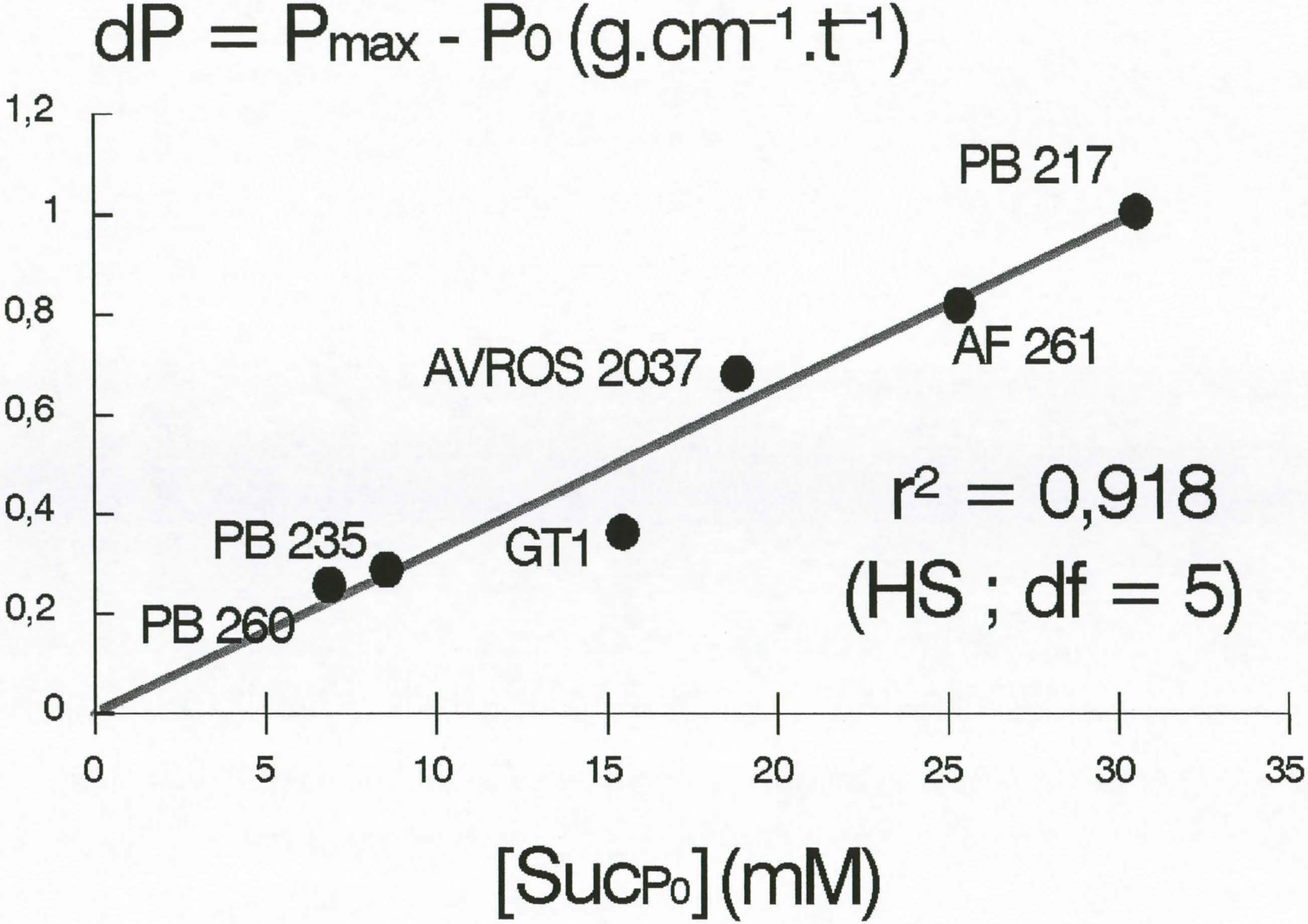
dP = PMAX - P0 (g.cm-1.t-1)
1,2
1
0,8
0,6
0,4
0,2
0
PB 217
AF 261
AVROS 2037
GT1
PB 235
PB 260
r2 = 0,945
(HS ; df = 5)
0
2
4
6
8
10
12
14
16
18
20
dSUC = [SUCP0]- [SUCPMAX] (mM)

$$P_{MAX} = P_0 + a \ dSuc$$

Yield potential	Yield without stimulation	Available Sucrose
(a # 0,06 in Ivory Coast)	Metabolism yield component	Reserve yield component : Possibility of Intensification

Po = f(metabolism)

dSuc = f(SucPo, dPi)



dP = Pmax - P0 (g.cm-1.t-1)
1,2
1
0,8
0,6
0,4
0,2
0
PB 217
AF 261
AVROS 2037
GT1
PB 235
PB 260
r2 = 0,918
(HS ; df = 5)
0
5
10
15
20
25
30
35
[SucP0] (mM)

$$P_{MAX} = P_0 + b\ [Suc_{Po}]$$

Yield potential

Yield without stimulation

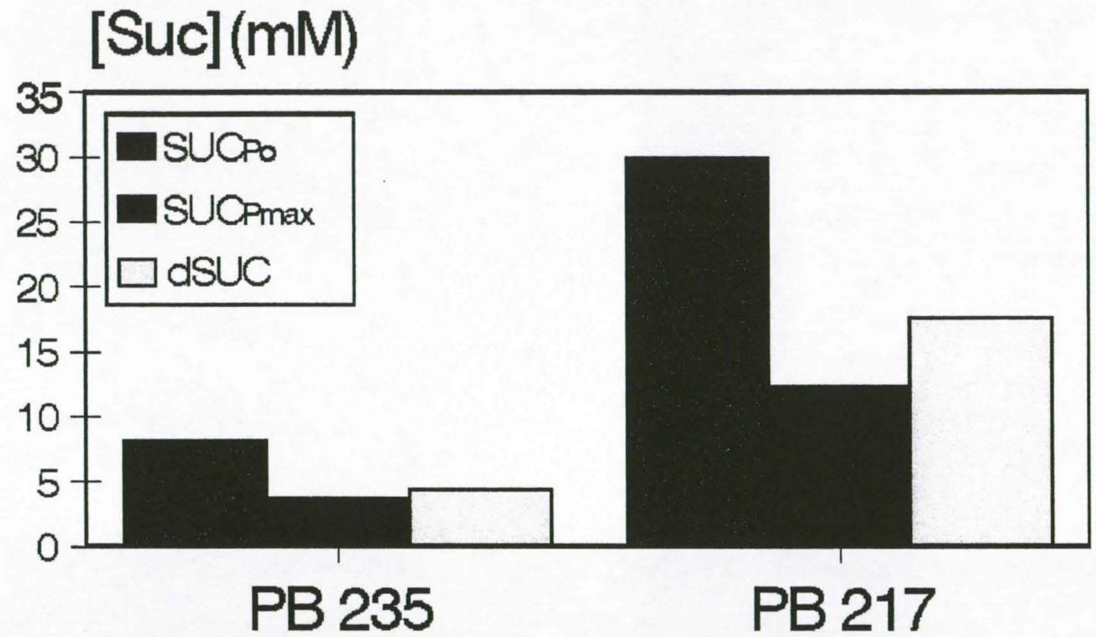
Metabolism yield component

Available Sucrose

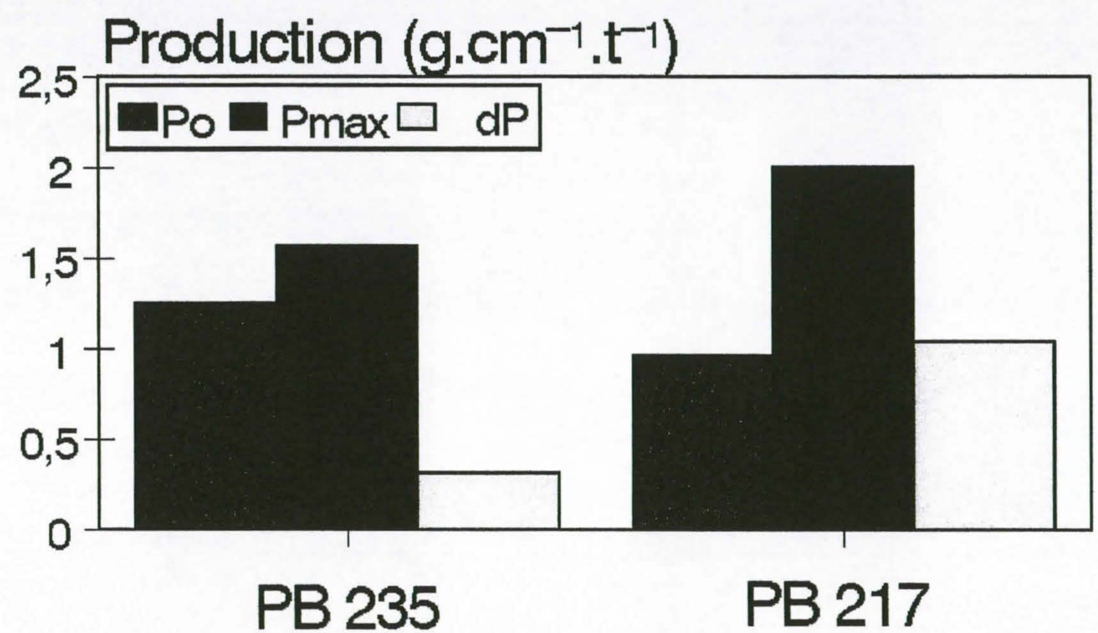
Reserve yield component : Possibility of Intensification

Po # (metabolism)

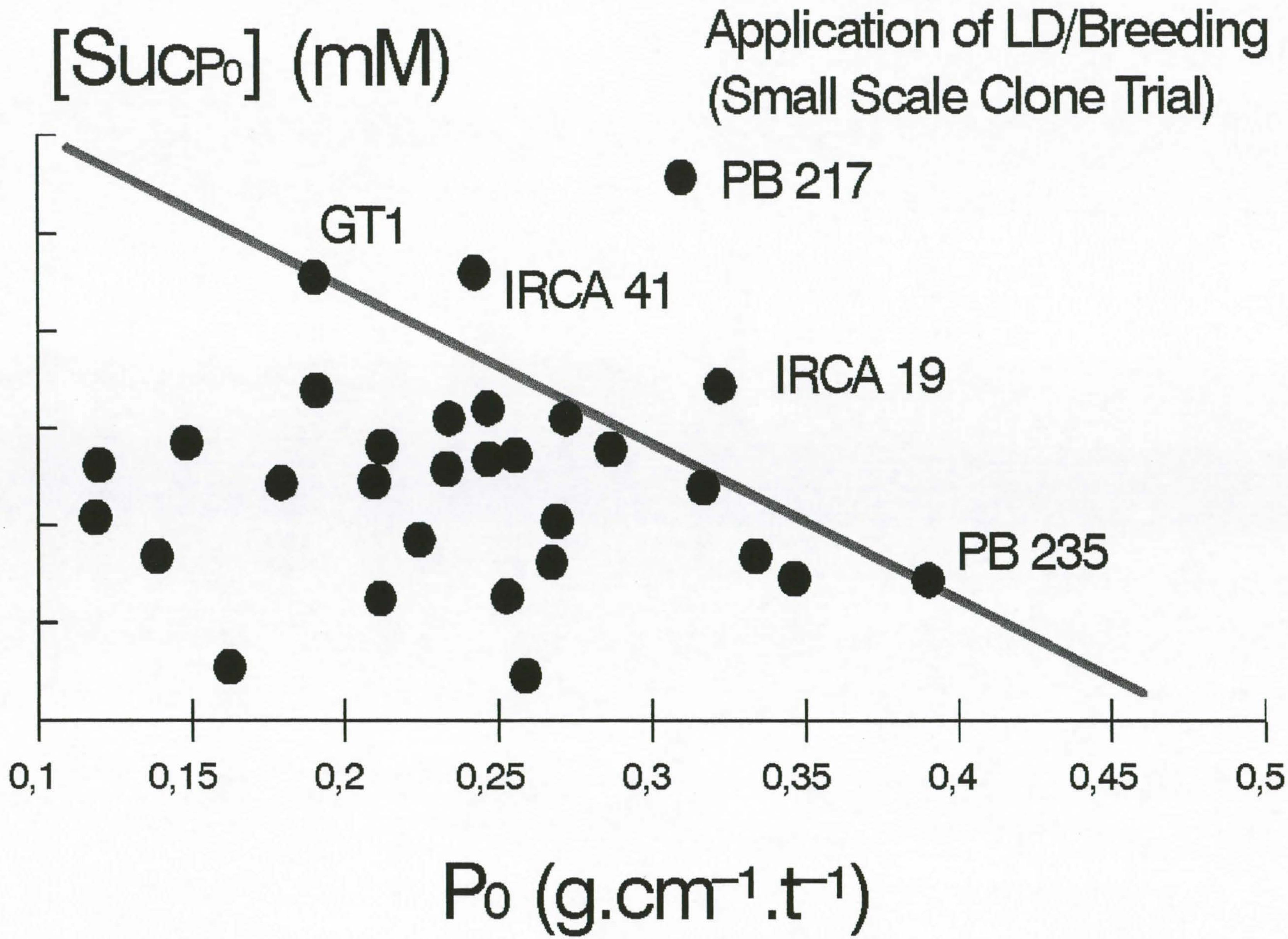
SucPo # sugar reserve (potential energy)

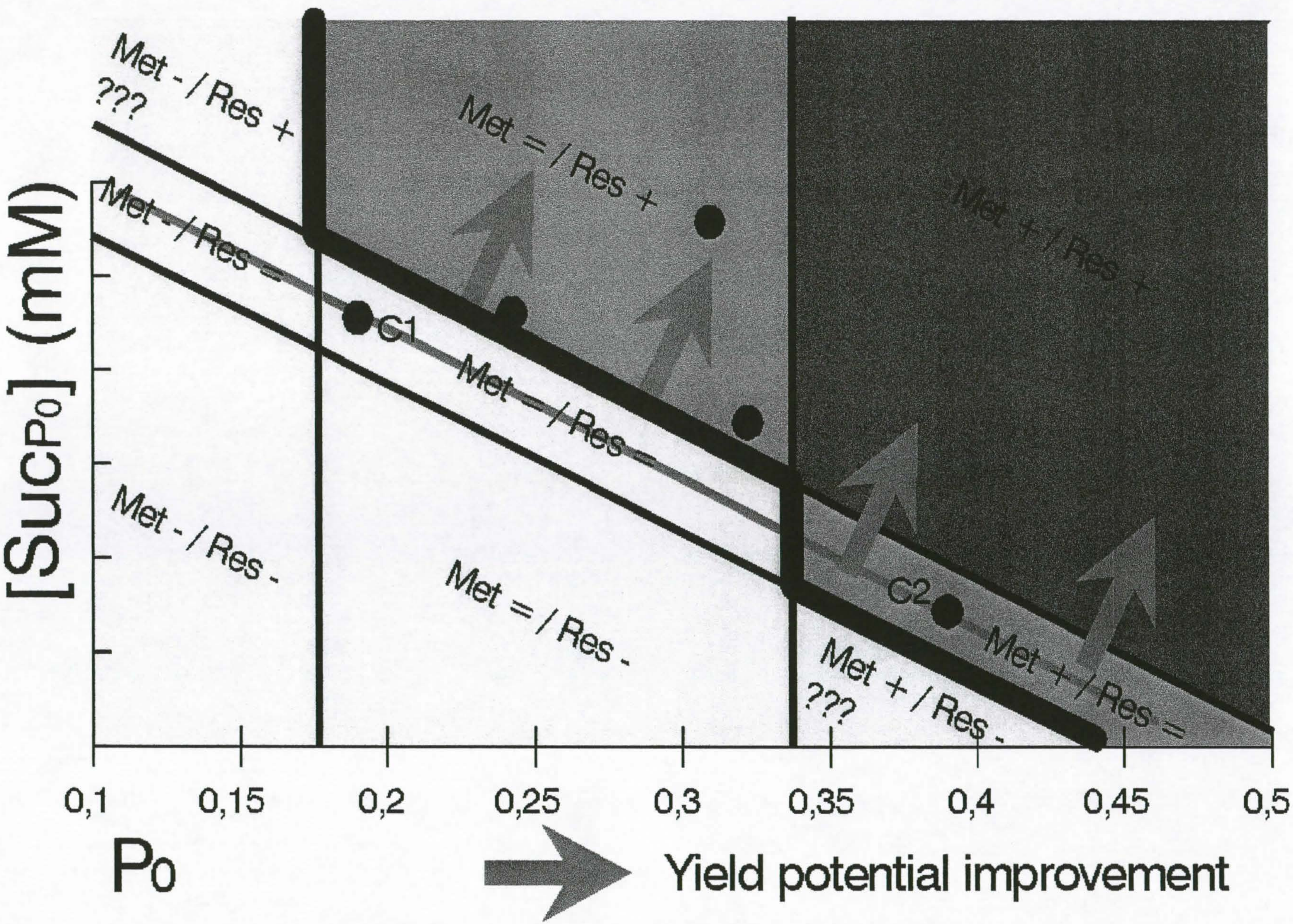


[Suc] (mM)
35
30
25
20
15
10
5
0
SUCPo
SUCPmax
dSUC
PB 235
PB 217



Production (g.cm⁻¹.t⁻¹)
2,5
2
1,5
1
0,5
0
Po
Pmax
dP
PB 235
PB 217


[SucP0] (mM)
Application of LD/Breeding
(Small Scale Clone Trial)
PB 217
GT1
IRCA 41
IRCA 19
PB 235
0,1
0,15
0,2
0,25
0,3
0,35
0,4
0,45
0,5
P0 (g.cm-1.t-1)



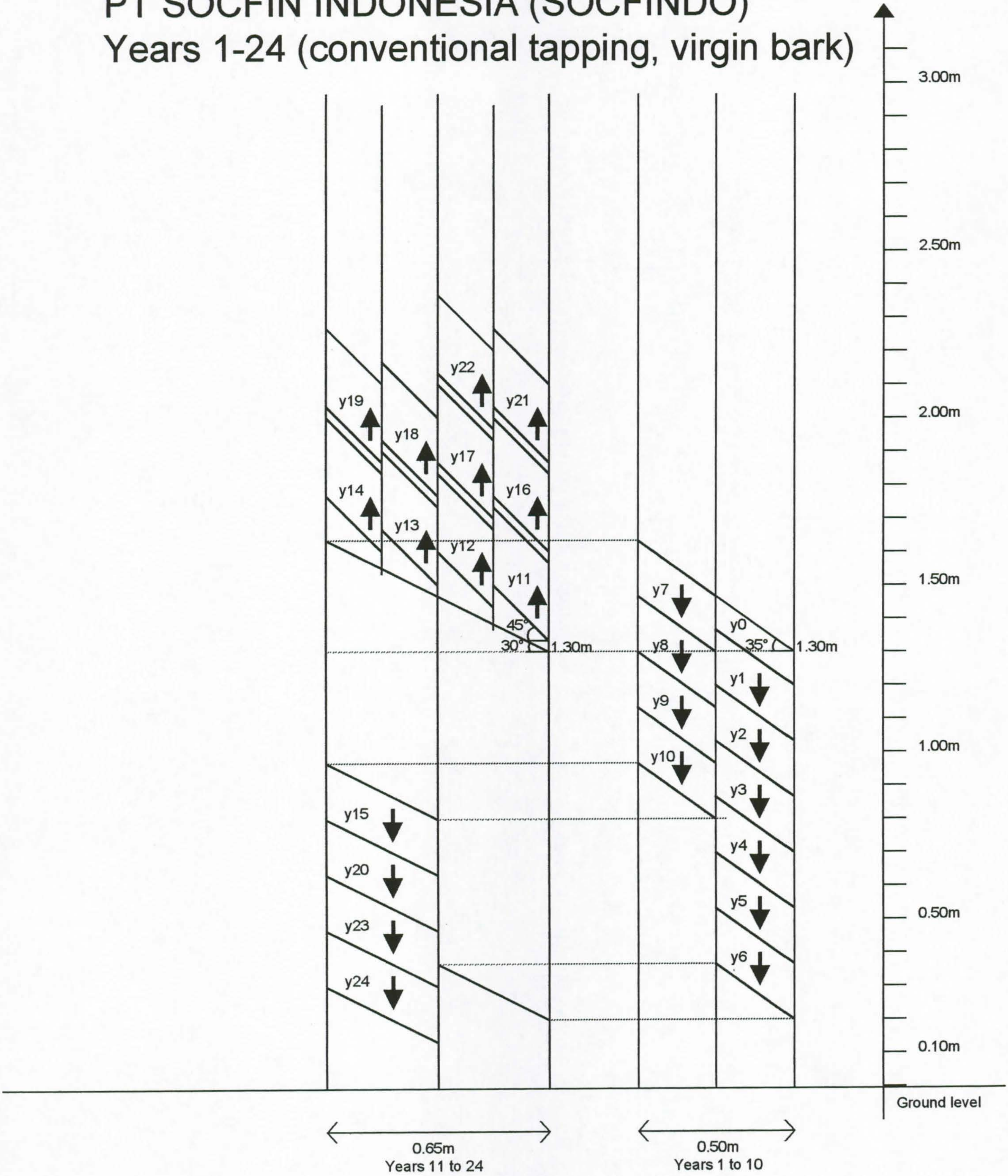
[SucP0] (mM)
Met - / Res +
???
Met = / Res +
Met + / Res +
Met - / Res =
C1
Met = / Res =
C2
Met + / Res =
Met - / Res -
Met = / Res -
Met + / Res -
???
0,1
0,15
0,2
0,25
0,3
0,35
0,4
0,45
0,5
P0
Yield potential improvement

Annex N°2

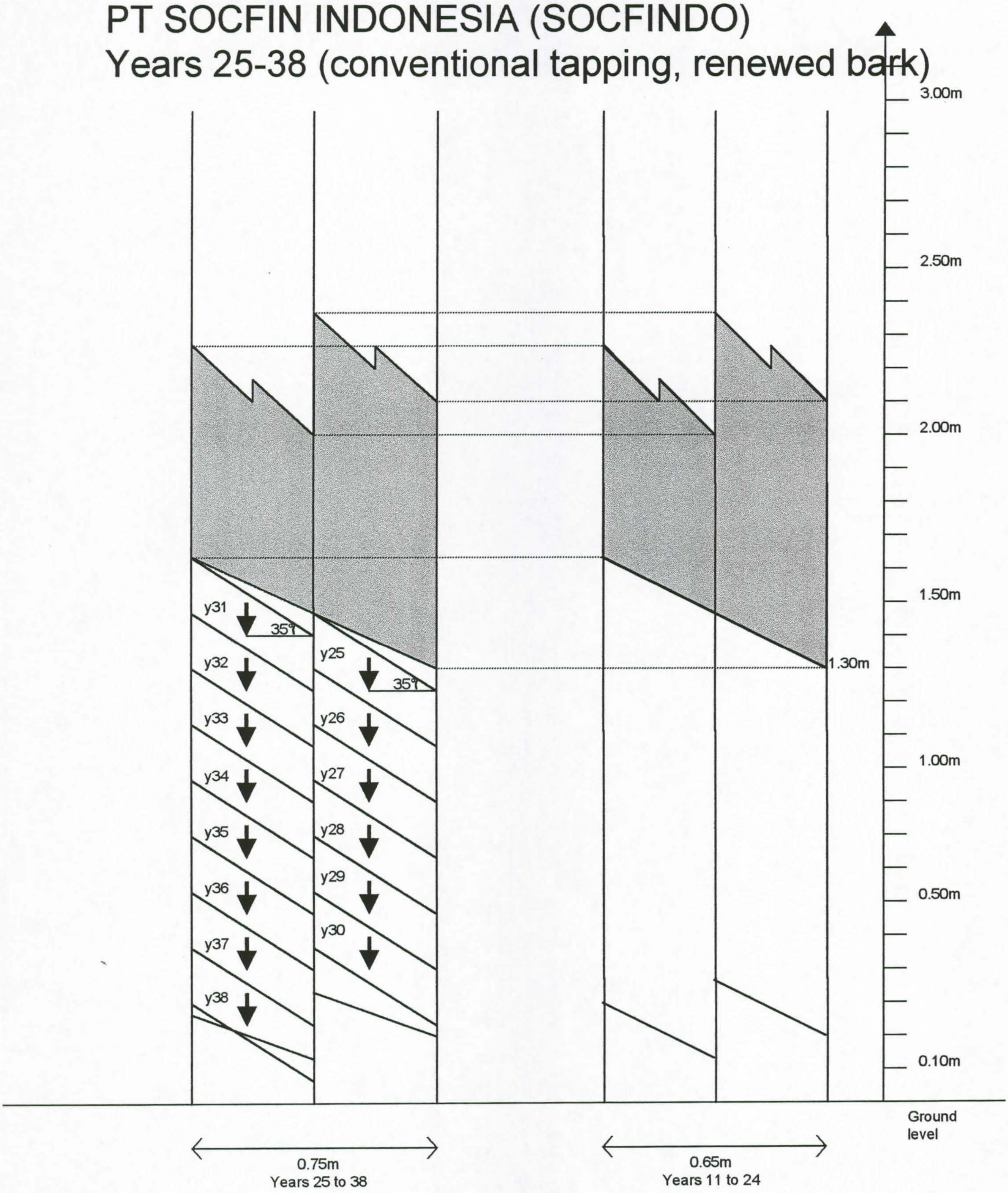
SOCFINDO Standard panel management

(2003)

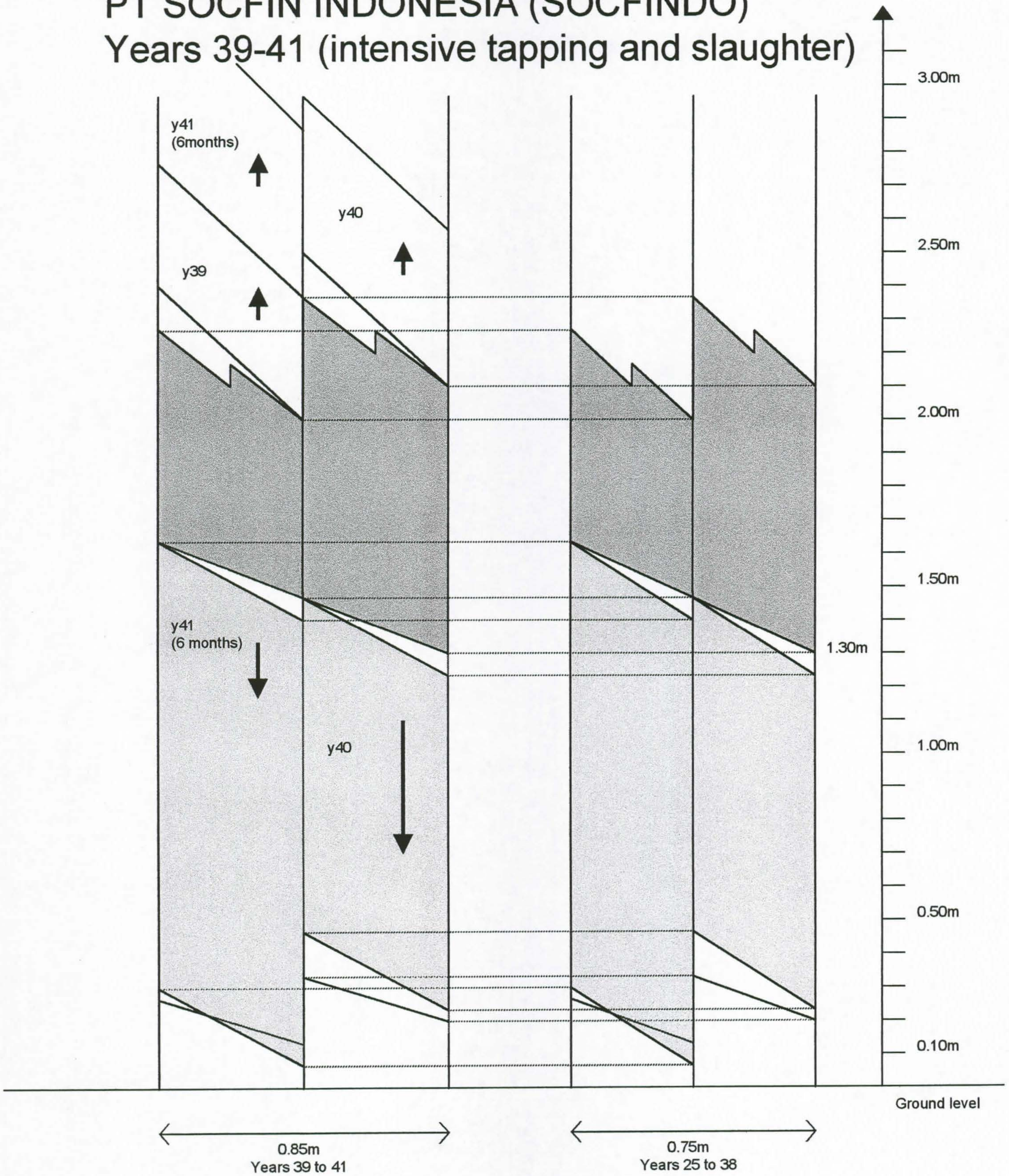
Panel management
PT SOCFIN INDONESIA (SOCFINDO)
Years 1-24 (conventional tapping, virgin bark)



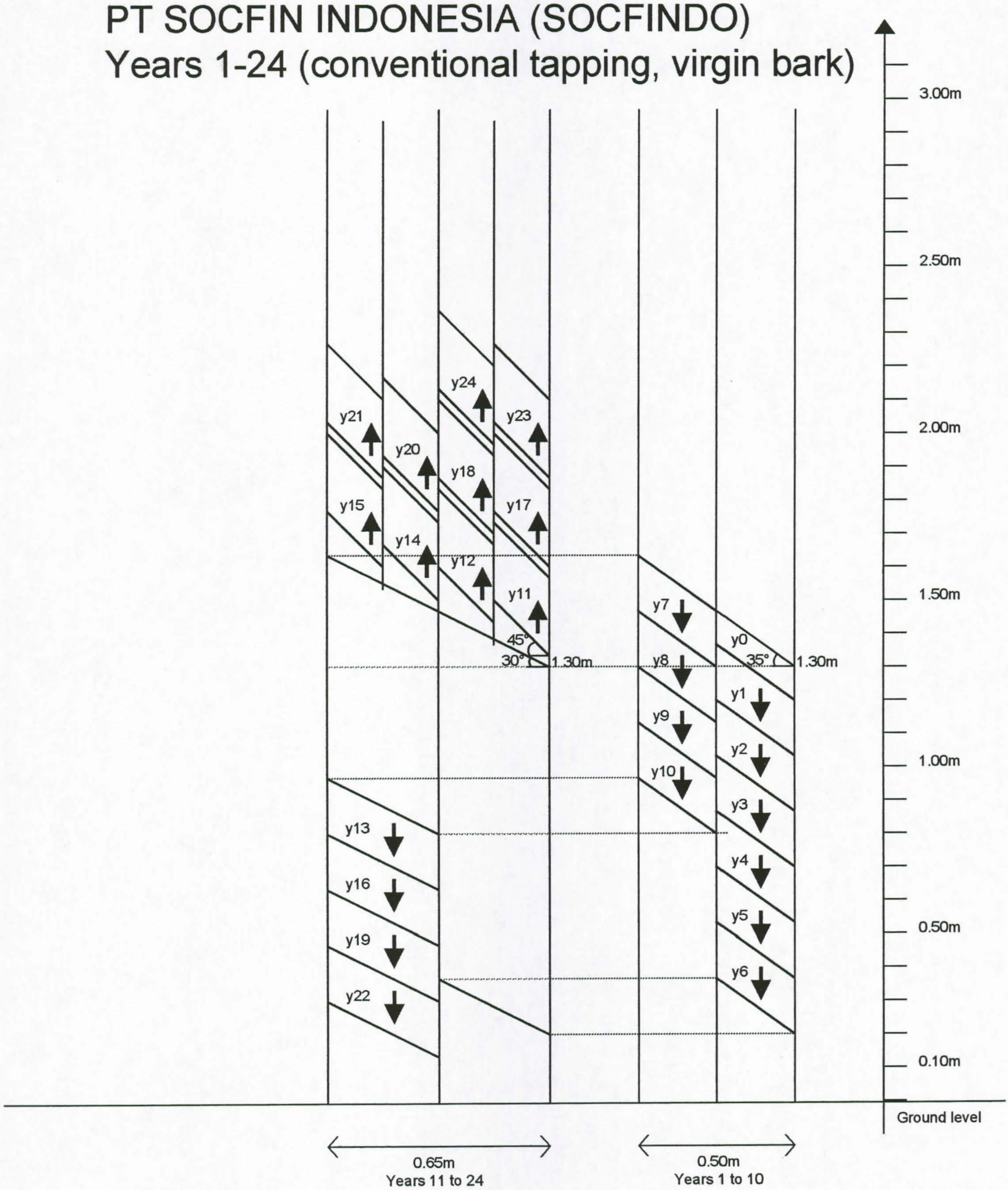
Panel management
PT SOCFIN INDONESIA (SOCFINDO)
Years 25-38 (conventional tapping, renewed bark)



Panel management
PT SOCFIN INDONESIA (SOCFINDO)
Years 39-41 (intensive tapping and slaughter)



Panel management
PT SOCFIN INDONESIA (SOCFINDO)
Years 1-24 (conventional tapping, virgin bark)



Annex N°3

Cirad-cp panel management recommendation (2003)

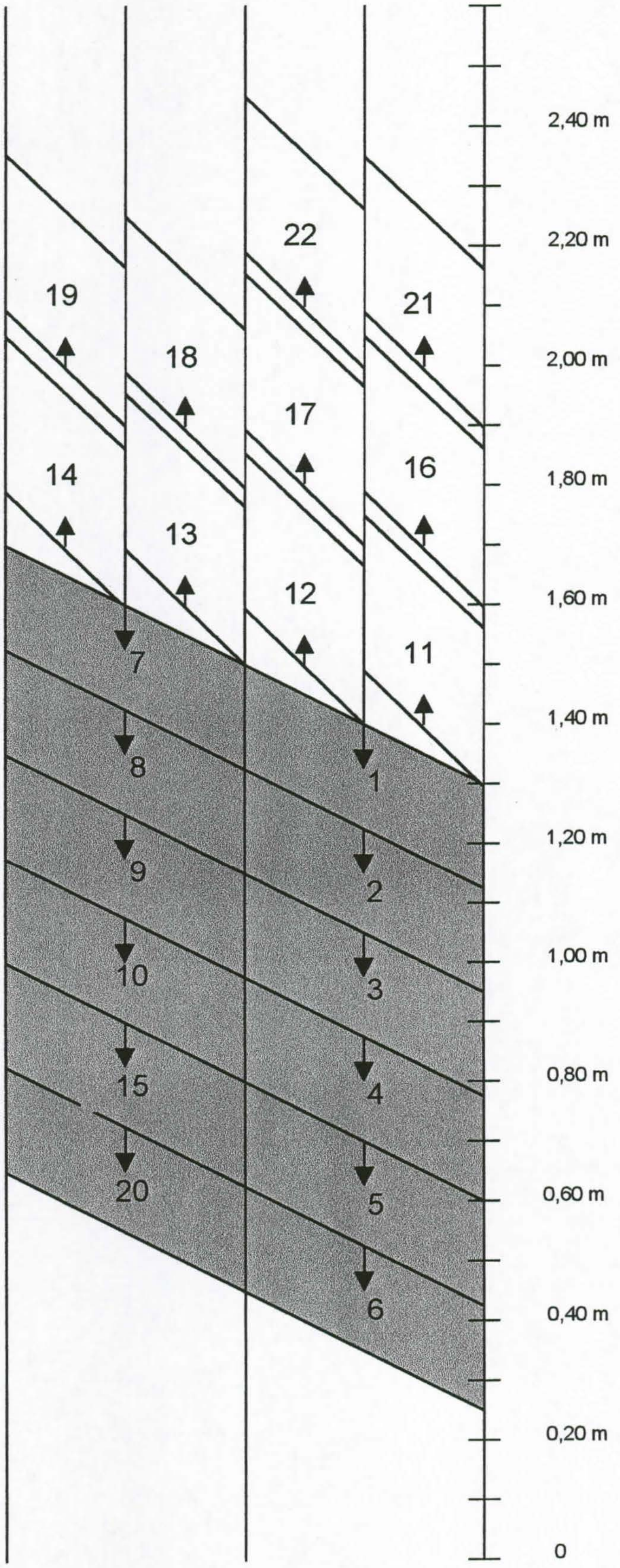
Panel management
Recommendations Cirad-cp
(excluding intensive tapping)

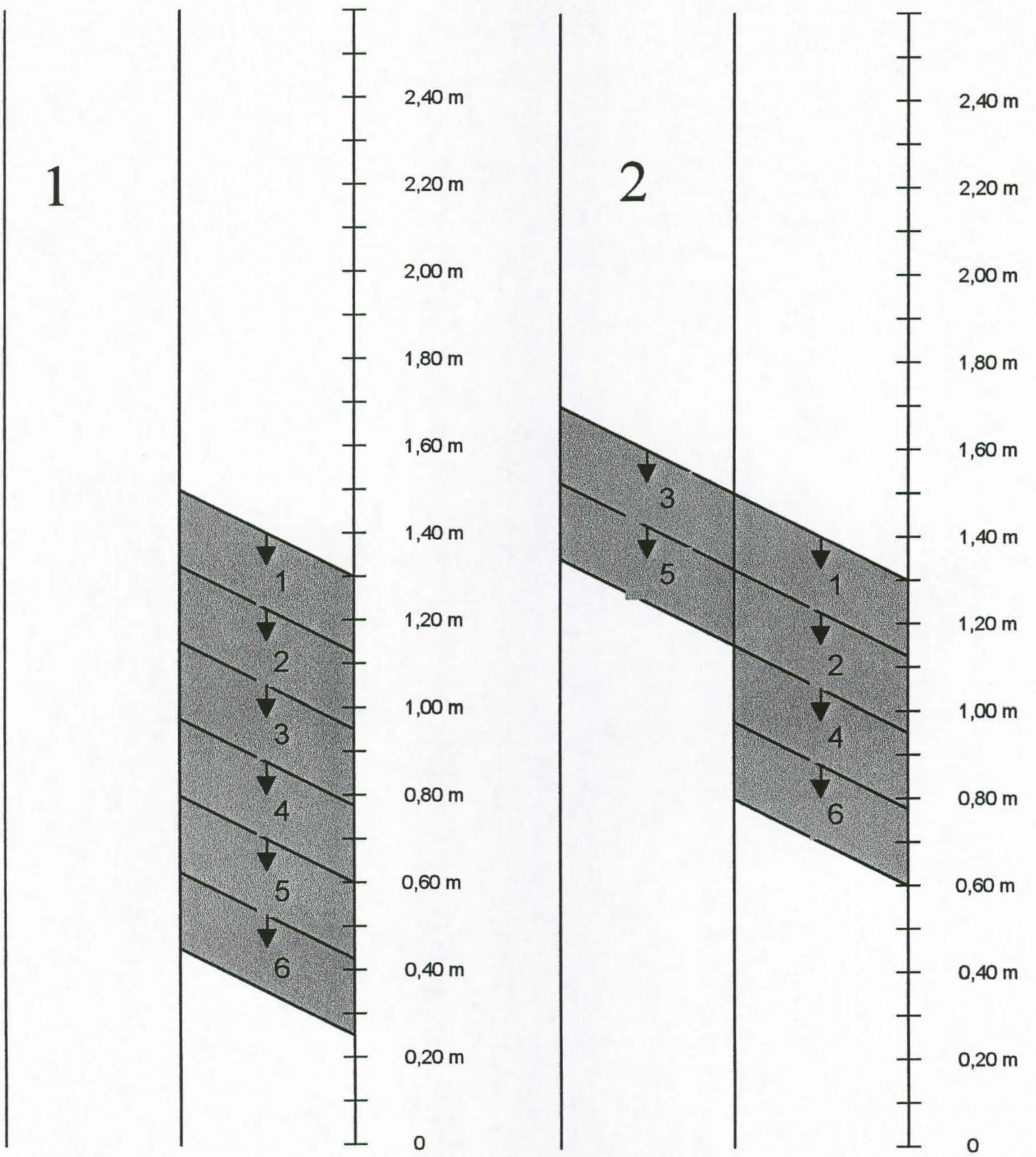
Years 1 to 22 (virgin bark)

Updated 2003

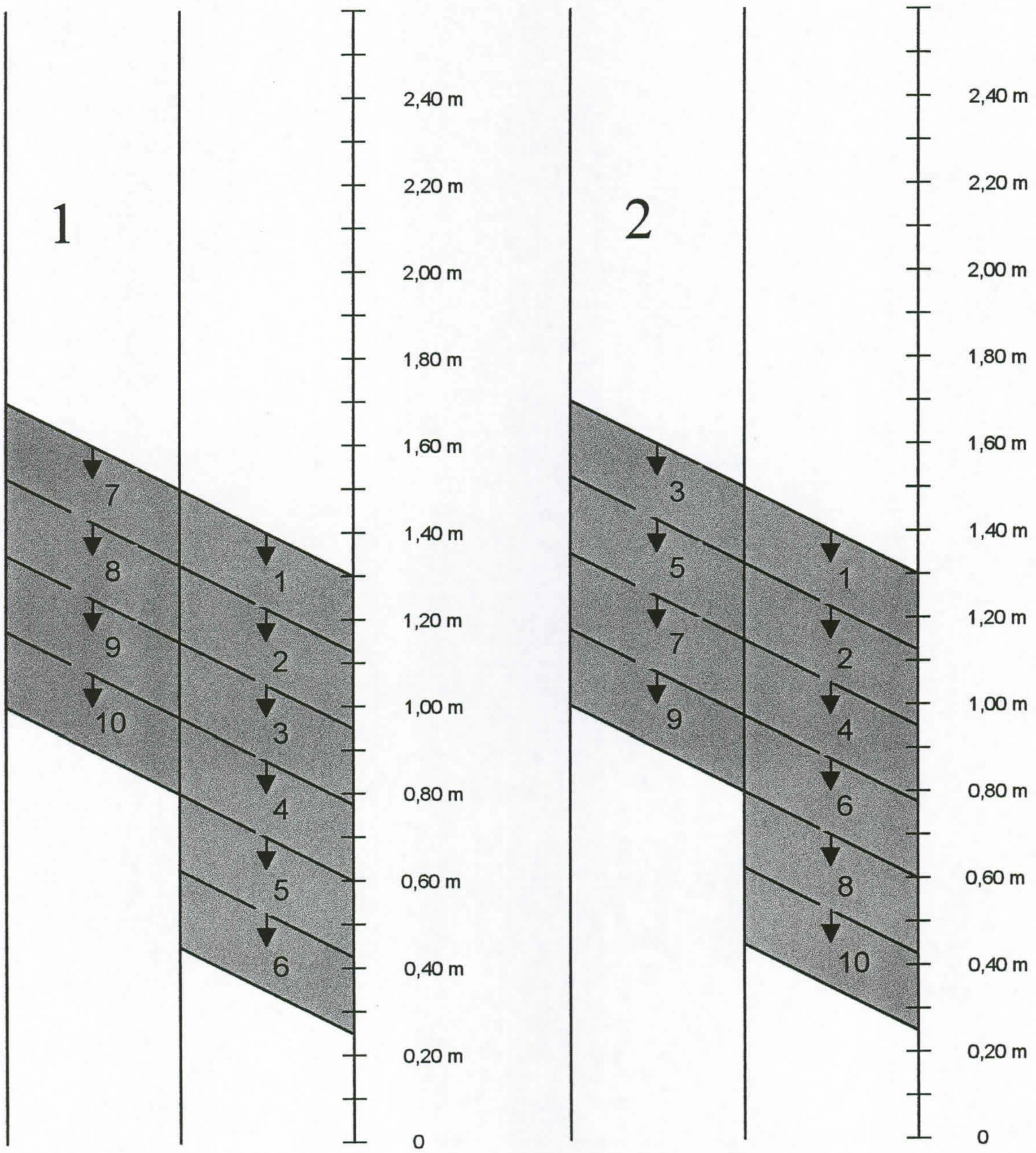
d/3 6d/7 or d/3 7d/7

(NB : d/4 6d/7 ou d/4 7d/7
Same schedule with opening at 1.20m)





After 6 years of tapping, P2 > P1
- Annual rest of regeneration areas due to panel switch : improved sugar supply

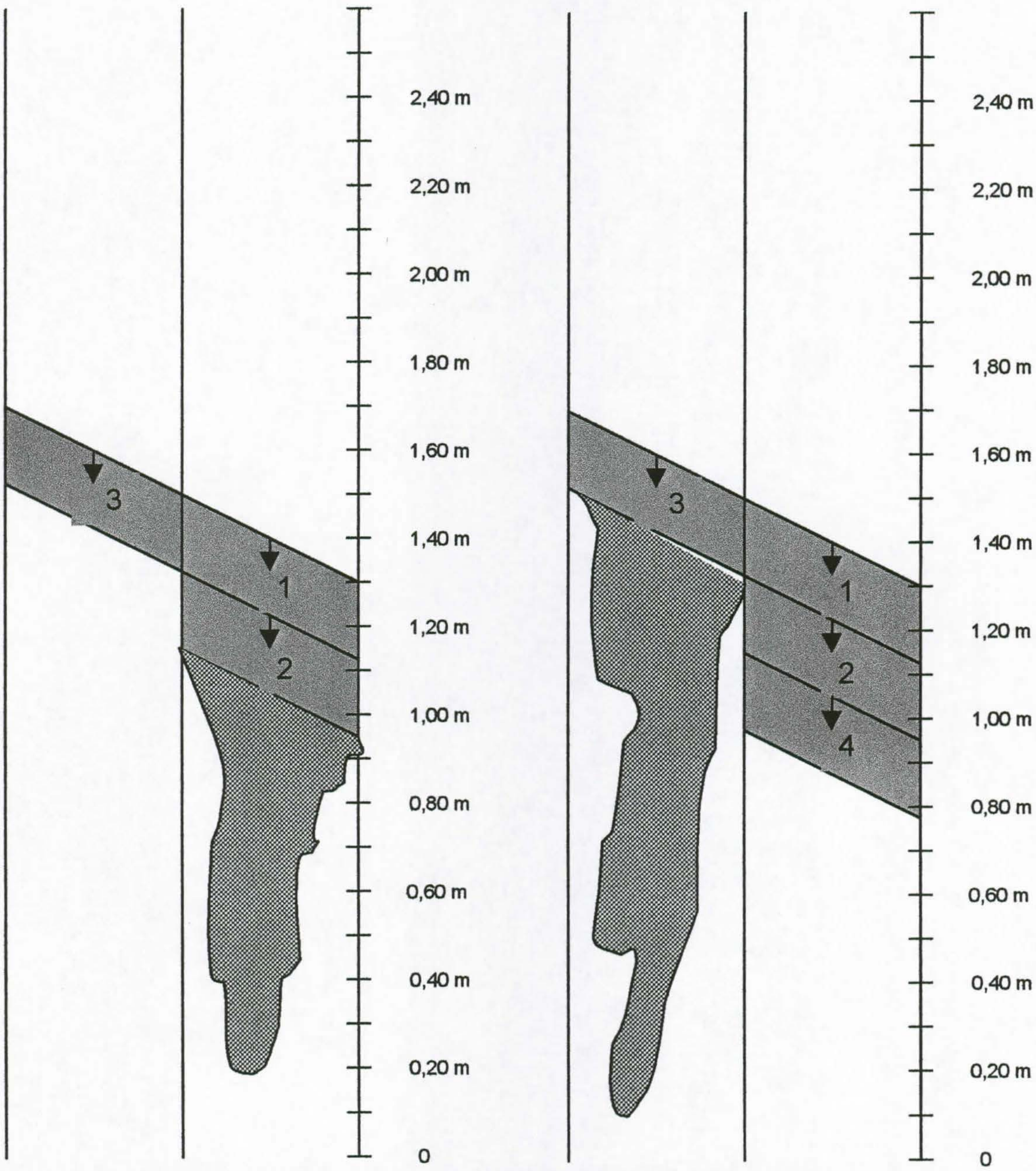


From seventh year of tapping onwards, P1 > P2 (improved sugar supply)

After 10 years of tapping, P1 ≥ P2 (cumulate).

Panel switch can be recommended only when money return on investment must be accelerated

(ex : New plantation, credit and loan interests…)



Annual panel switch may favor appearance of « bark necrosis » on resting panel (panel A in year 3, panel B in year 4)
Active metabolism clones : PB235, PB260,
High annual rainfall : Gabon, Indonesia, Guatemala...

Annex N°4

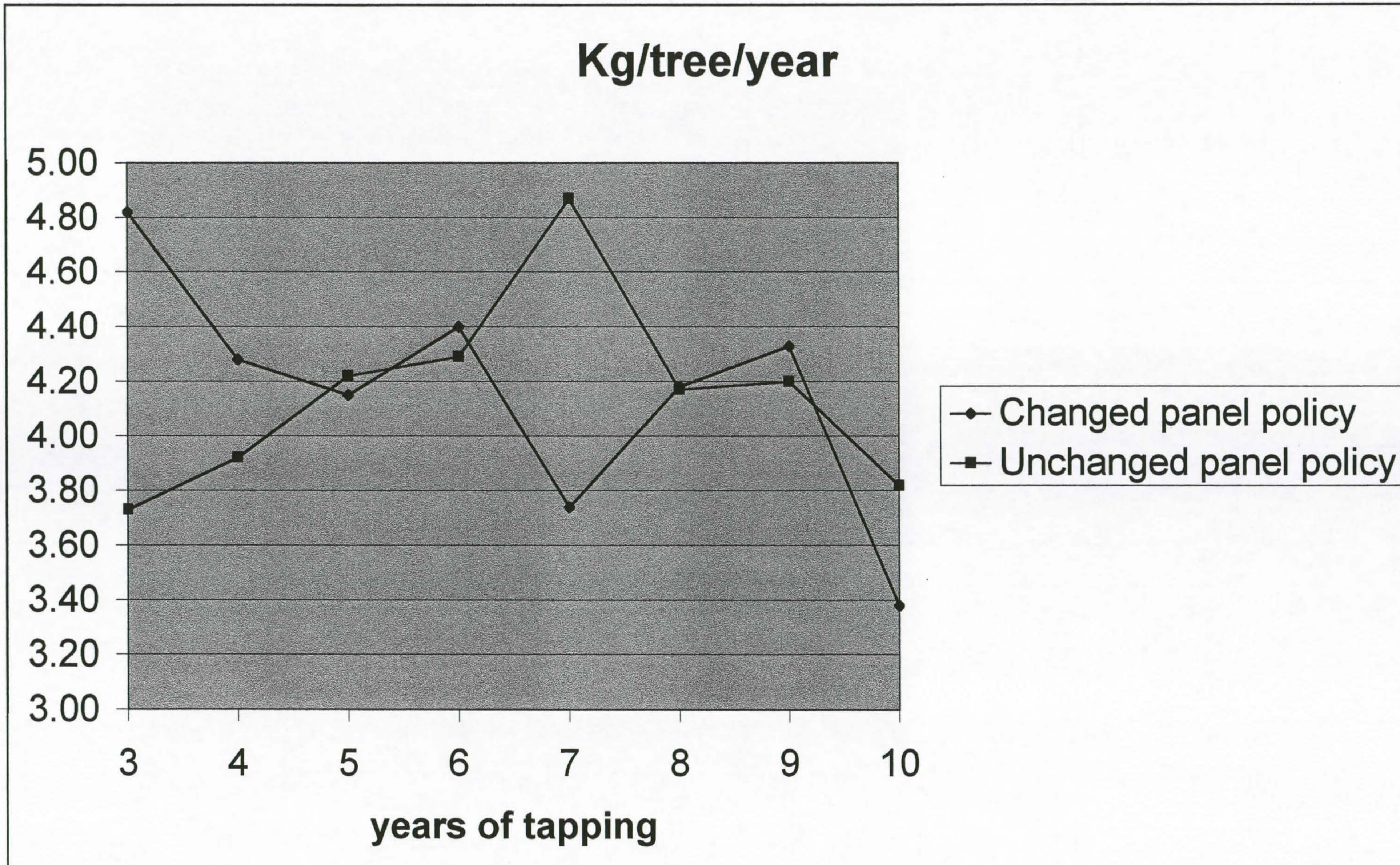
Socfindo Yield Database 1995-2001
Study on effect of panel management

Socfindo Database 1995-1997. Changed panel policy

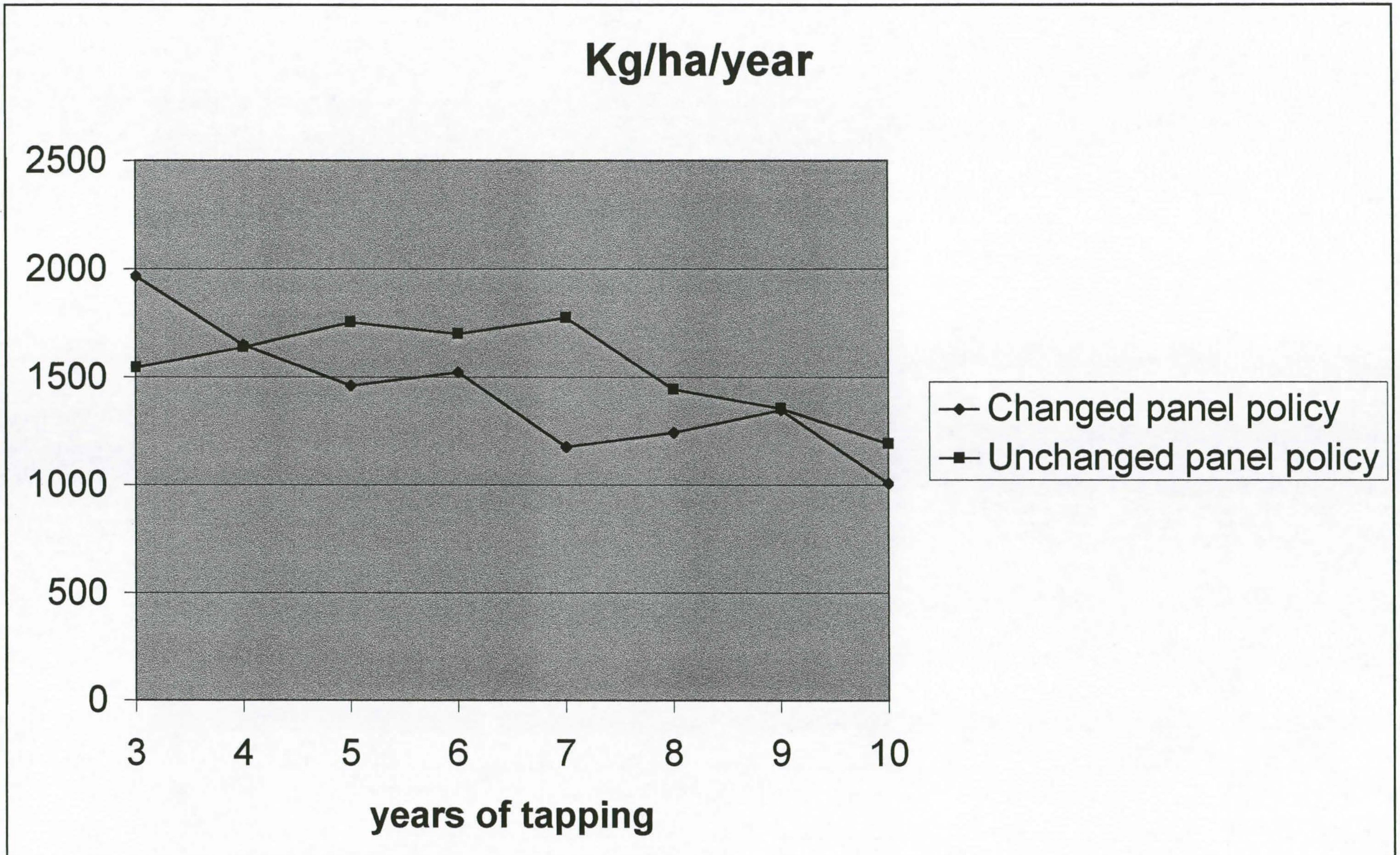
All clones			Kg/tree		Kg/ha		trees/ha	
Year	Panel							
3	Panel B0-2	B	**4.82**	100%	**1968**	100%	406	100%
4	Panel B0-1	A	**4.28**	100%	**1650**	100%	391	100%
5	Panel B0-2	B	4.15	100%	1462	100%	349	100%
6	Panel B0-1	A	**4.40**	100%	1523	100%	345	100%
7	Panel B0-2	B	3.74	100%	1178	100%	314	100%
8	Panel B0-1	A	**4.18**	100%	1244	100%	299	100%
9	Panel B0-2	B	**4.33**	100%	1349	100%	311	100%
10	Panel B0-1	A	3.38	100%	1010	100%	298	100%
	Average 8 years (3-10)		4.16	100%	1423	100%	339	100%

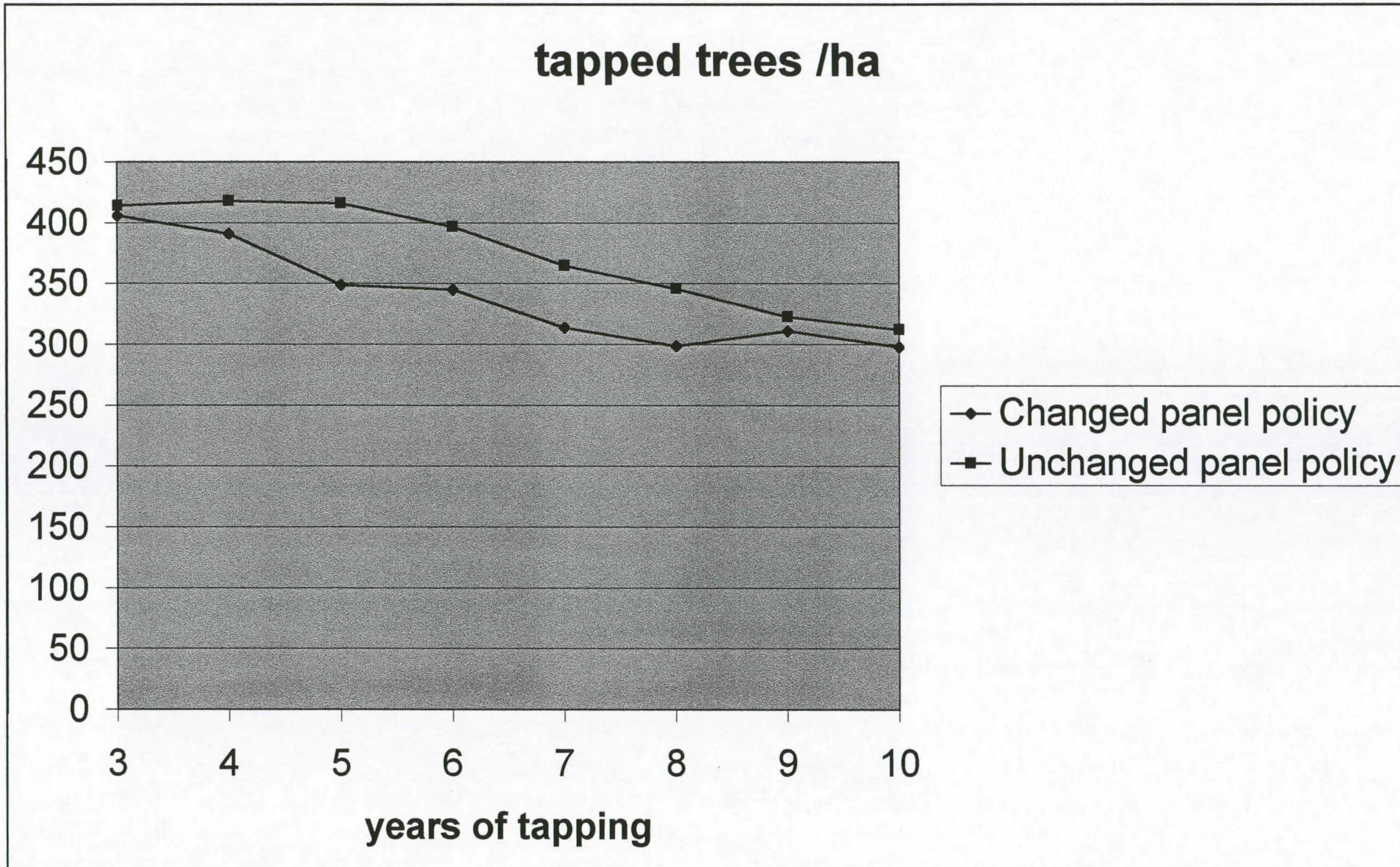
Socfindo Database 1998-2001. Unchanged panel policy

All clones			Kg/tree		Kg/ha		trees/ha	
Year	Panel							
3	Panel B0-1	A	3.73	77%	1545	79%	**414**	102%
4	Panel B0-1	A	3.92	92%	1639	99%	**418**	107%
5	Panel B0-1	A	**4.22**	102%	**1755**	120%	**416**	119%
6	Panel B0-1	A	4.29	98%	**1702**	112%	**397**	115%
7	Panel B0-2	B	**4.87**	130%	**1776**	151%	**365**	116%
8	Panel B0-2	B	4.17	100%	**1443**	116%	**346**	116%
9	Panel B0-2	B	4.20	97%	**1356**	101%	**323**	104%
10	Panel B0-2	B	**3.82**	113%	**1193**	118%	**312**	105%
	Average 8 years (3-10)		4.15	100%	1551	109%	374	110%



Kg/tree/year
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
3
4
5
6
7
8
9
10
years of tapping
Changed panel policy
Unchanged panel policy


Kg/ha/year
2500
2000
1500
1000
500
0
3
4
5
6
7
8
9
10
years of tapping
Changed panel policy
Unchanged panel policy


tapped trees /ha
450
400
350
300
250
200
150
100
50
0
3
4
5
6
7
8
9
10
years of tapping
Changed panel policy
Unchanged panel policy

Annex N°5

Cirad-cp clonal typology 2003

Clonal Metabolic Typology. CIRAD
Physiological basis for tapping systems recommendations (tapping frequency, stimulation)

	Low Metabolism Met-	Low-Medium Metabolism Met -=	Medium Metabolism Met =	Medium-High Metabolism Met =+	High Metabolism Met +
Low Sugar Loading (Suc -)	***Typology c1*** ***Met - Suc -*** AVROS 2037	***Typology c3*** ***Met -= Suc -***	***Typology c6*** ***Met = Suc -***	***Typology c9*** ***Met =+ Suc -***	***Low probability***
Medium Sugar Loading (Suc =)	***Typology c2*** ***Met - Suc =*** AF 261	***Typology c4*** ***Met -= Suc =*** PB 86 PR 107	***Typology c7*** ***Met = Suc =*** GT1 PB 254 RRIC 100	***Typology c10*** ***Met =+ Suc =*** RRIM 600, PB 5/51 BPM 1, IRCA18 BPM 24, IRCA 109 RRIC 110, PB 330 PR 255	***Typology c12*** ***Met + Suc =*** PB 235, RRIM 911 PB 260, PR 261 PB 340, IRCA 111 RRIM 901, IRCA 130 IRCA 209
High Sugar Loading (Suc +)	***Low probability***	***Typology c5*** ***Met -= Suc +*** PB 217	***Typology c8*** ***Met = Suc +*** RRIC 121	***Typology c11*** ***Met =+ Suc +*** IRCA 19 IRCA 41	***Typology c13*** ***Met + Suc +*** IRCA 230 RRIM 712 RRIM 921

in Red : Position confirmed in Ivory Coast, Indonesia and Thailand

in Blue : Position confirmed in Ivory Coast and Indonesia. Confirmation in progress in Thailand

in Black : Position confirmed in Ivory Coast and Indonesia.

Updated 2003

.... Diagonals of the [5x3] matrix : Homogenous stimulation recommendations

Annex N°6

Stimulation recommendations : d/4

(2003)

Stimulation recommendations. CIRAD
(Panel application)

A. Recommendations for 1/2 S d/4 (N) : 2,5% Ethephon only (2,5% Et).

Clonal Typology classes (Met x Suc)		c2 Met - Suc = c5 Met -= Suc +			c1 Met - Suc - c4 Met -= Suc = c8 Met = Suc +			c3 Met -= Suc - c7 Met = Suc = c11 Met =+ Suc +			c6 Met = Suc - c10 Met =+ Suc = c13 Met + Suc +			c9 Met =+ Suc - c12 Met + Suc =		
Year of tapping	g stim /tree	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y
1	0.7	12	2.5	210	10	2.5	175	6	2.5	105	4	2.5	70	3	2.5	53
2	0.7	12	2.5	210	10	2.5	175	6	2.5	105	4	2.5	70	3	2.5	53
3	0.7	12	2.5	210	10	2.5	175	6	2.5	105	4	2.5	70	3	2.5	53
4	0.7	12	2.5	210	10	2.5	175	6	2.5	105	4	2.5	70	3	2.5	53
5	0.8	12	2.5	240	10	2.5	200	8	2.5	160	6	2.5	120	5	2.5	100
6	0.8	12	2.5	240	10	2.5	200	8	2.5	160	6	2.5	120	5	2.5	100
7	0.8	12	2.5	240	10	2.5	200	8	2.5	160	6	2.5	120	5	2.5	100
8	0.8	12	2.5	240	10	2.5	200	8	2.5	160	6	2.5	120	5	2.5	100
9	0.9	15	2.5	338	12	2.5	270	10	2.5	225	8	2.5	180	6	2.5	135
10	0.9	15	2.5	338	12	2.5	270	10	2.5	225	8	2.5	180	6	2.5	135
11	0.9	15	2.5	338	12	2.5	270	10	2.5	225	8	2.5	180	6	2.5	135
12	0.9	15	2.5	338	12	2.5	270	10	2.5	225	8	2.5	180	6	2.5	135
13	1	15	2.5	375	12	2.5	300	10	2.5	250	8	2.5	200	6	2.5	150
14	1	15	2.5	375	12	2.5	300	10	2.5	250	8	2.5	200	6	2.5	150
15	1	15	2.5	375	12	2.5	300	10	2.5	250	8	2.5	200	6	2.5	150
16	1	15	2.5	375	12	2.5	300	10	2.5	250	8	2.5	200	6	2.5	150
17	1.1	15	2.5	413	12	2.5	330	10	2.5	275	8	2.5	220	6	2.5	165
18	1.1	15	2.5	413	12	2.5	330	10	2.5	275	8	2.5	220	6	2.5	165
19	1.1	15	2.5	413	12	2.5	330	10	2.5	275	8	2.5	220	6	2.5	165
20	1.1	15	2.5	413	12	2.5	330	10	2.5	275	8	2.5	220	6	2.5	165
21	1.2	15	2.5	450	12	2.5	360	10	2.5	300	8	2.5	240	6	2.5	180
22	1.2	15	2.5	450	12	2.5	360	10	2.5	300	8	2.5	240	6	2.5	180
23	1.2	15	2.5	450	12	2.5	360	10	2.5	300	8	2.5	240	6	2.5	180
24	1.2	15	2.5	450	12	2.5	360	10	2.5	300	8	2.5	240	6	2.5	180
25	1.3	15	2.5	488	12	2.5	390	10	2.5	325	8	2.5	260	6	2.5	195
26	1.3	15	2.5	488	12	2.5	390	10	2.5	325	8	2.5	260	6	2.5	195
27	1.3	15	2.5	488	12	2.5	390	10	2.5	325	8	2.5	260	6	2.5	195
28	1.3	15	2.5	488	12	2.5	390	10	2.5	325	8	2.5	260	6	2.5	195
29	1.4	15	2.5	525	12	2.5	420	10	2.5	350	8	2.5	280	6	2.5	210
30	1.4	15	2.5	525	12	2.5	420	10	2.5	350	8	2.5	280	6	2.5	210
CLONES		c5 PB 217 c2 AF 261			c4 PR 107 c1 AVROS 2037 c4 PB 86 c8 RRIC 121			c7 GT1 c7 RRIC 100 c7 PB 254 c11 IRCA 19 c11 IRCA 41			c10 RRIM 600 c13 RRIM 712 c13 RRIM 921 c10 BPM 1 c10 BPM 24 c10 PB330 c10 RRIC 110 c10 PR 255 c10 IRCA 18 c10 IRCA 109 c13 IRCA 230 c10 PB 5/51			c12 PB 235 c12 PB 260 c12 PB 340 c12 RRIM 901 c12 RRIM 911 c12 PR 261 c12 IRCA 111 c12 IRCA 130 c12 IRCA 209		

Stimulation recommendations. CIRAD
(Panel application)

B. Recommendations for 1/4 S d/4 (UTS) : 5% Ethephon only (5,0% Et).

Clonal Typology classes (Met x Suc)		c2 Met - Suc = c5 Met -= Suc +			c1 Met - Suc - c4 Met -= Suc = c8 Met = Suc +			c3 Met -= Suc - c7 Met = Suc = c11 Met =+ Suc +			c6 Met = Suc - c10 Met =+ Suc = c13 Met + Suc +			c9 Met =+ Suc - c12 Met + Suc =		
Year of tapping	g stim /tree	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y
10	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
11	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
12	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
13	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
14	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
15	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
16	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
17	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
18	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
19	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
20	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
21	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
22	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
23	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
24	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
25	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
26	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
27	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
28	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
29	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
30	0.8	15	5.0	600	15	5.0	600	12	5.0	480	10	5.0	400	8	5.0	320
CLONES		c5 PB 217 c2 AF 261			c4 PR 107 c1 AVROS 2037 c4 PB 86 c8 RRIC 121			c7 GT1 c7 RRIC 100 c7 PB 254 c11 IRCA 19 c11 IRCA 41			c10 RRIM 600 c13 RRIM 712 c13 RRIM 921 c10 BPM 1 c10 BPM 24 c10 PB330 c10 RRIC 110 c10 PR 255 c10 IRCA 18 c10 IRCA 109 c13 IRCA 230 c10 PB 5/51			c12 PB 235 c12 PB 260 c12 PB 340 c12 RRIM 901 c12 RRIM 911 c12 PR 261 c12 IRCA 111 c12 IRCA 130 c12 IRCA 209		

Annex N°7

Stimulation recommendations : d/3

(2003)

Stimulation recommendations. CIRAD
(Panel application)

A. Recommendations for 1/2 S d/3 (N) : 2,5% Ethephon only (2,5% Et).

Clonal Typology classes (Met x Suc)		c2 Met - Suc = c5 Met -= Suc +			c1 Met - Suc - c4 Met -= Suc = c8 Met = Suc +			c3 Met -= Suc - c7 Met = Suc = c11 Met =+ Suc +			c6 Met = Suc - c10 Met =+ Suc = c13 Met + Suc +			c9 Met =+ Suc - c12 Met + Suc =		
Year of tapping	g stim /tree	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y
1	0.7	10	2.5	175	8	2.5	140	5	2.5	88	3	2.5	53	2	2.5	35
2	0.7	10	2.5	175	8	2.5	140	5	2.5	88	3	2.5	53	2	2.5	35
3	0.7	10	2.5	175	8	2.5	140	5	2.5	88	3	2.5	53	2	2.5	35
4	0.7	10	2.5	175	8	2.5	140	5	2.5	88	3	2.5	53	2	2.5	35
5	0.8	10	2.5	200	8	2.5	160	6	2.5	120	4	2.5	80	3	2.5	60
6	0.8	10	2.5	200	8	2.5	160	6	2.5	120	4	2.5	80	3	2.5	60
7	0.8	10	2.5	200	8	2.5	160	6	2.5	120	4	2.5	80	3	2.5	60
8	0.8	10	2.5	200	8	2.5	160	6	2.5	120	4	2.5	80	3	2.5	60
9	0.9	12	2.5	270	10	2.5	225	8	2.5	180	6	2.5	135	4	2.5	90
10	0.9	12	2.5	270	10	2.5	225	8	2.5	180	6	2.5	135	4	2.5	90
11	0.9	12	2.5	270	10	2.5	225	8	2.5	180	6	2.5	135	4	2.5	90
12	0.9	12	2.5	270	10	2.5	225	8	2.5	180	6	2.5	135	4	2.5	90
13	1	12	2.5	300	10	2.5	250	8	2.5	200	6	2.5	150	4	2.5	100
14	1	12	2.5	300	10	2.5	250	8	2.5	200	6	2.5	150	4	2.5	100
15	1	12	2.5	300	10	2.5	250	8	2.5	200	6	2.5	150	4	2.5	100
16	1	12	2.5	300	10	2.5	250	8	2.5	200	6	2.5	150	4	2.5	100
17	1.1	12	2.5	330	10	2.5	275	8	2.5	220	6	2.5	165	4	2.5	110
18	1.1	12	2.5	330	10	2.5	275	8	2.5	220	6	2.5	165	4	2.5	110
19	1.1	12	2.5	330	10	2.5	275	8	2.5	220	6	2.5	165	4	2.5	110
20	1.1	12	2.5	330	10	2.5	275	8	2.5	220	6	2.5	165	4	2.5	110
21	1.2	12	2.5	360	10	2.5	300	8	2.5	240	6	2.5	180	4	2.5	120
22	1.2	12	2.5	360	10	2.5	300	8	2.5	240	6	2.5	180	4	2.5	120
23	1.2	12	2.5	360	10	2.5	300	8	2.5	240	6	2.5	180	4	2.5	120
24	1.2	12	2.5	360	10	2.5	300	8	2.5	240	6	2.5	180	4	2.5	120
25	1.3	12	2.5	390	10	2.5	325	8	2.5	260	6	2.5	195	4	2.5	130
26	1.3	12	2.5	390	10	2.5	325	8	2.5	260	6	2.5	195	4	2.5	130
27	1.3	12	2.5	390	10	2.5	325	8	2.5	260	6	2.5	195	4	2.5	130
28	1.3	12	2.5	390	10	2.5	325	8	2.5	260	6	2.5	195	4	2.5	130
29	1.4	12	2.5	420	10	2.5	350	8	2.5	280	6	2.5	210	4	2.5	140
30	1.4	12	2.5	420	10	2.5	350	8	2.5	280	6	2.5	210	4	2.5	140
CLONES		c5 PB 217 c2 AF 261			c4 PR 107 c1 AVROS 2037 c4 PB 86 c8 RRIC 121			c7 GT1 c7 RRIC 100 c7 PB 254 c11 IRCA 19 c11 IRCA 41			c10 RRIM 600 c13 RRIM 712 c13 RRIM 921 c10 BPM 1 c10 BPM 24 c10 PB330 c10 RRIC 110 c10 PR 255 c10 IRCA 18 c10 IRCA 109 c13 IRCA 230 c10 PB 5/51			c12 PB 235 c12 PB 260 c12 PB 340 c12 RRIM 901 c12 RRIM 911 c12 PR 261 c12 IRCA 111 c12 IRCA 130 c12 IRCA 209		

Stimulation recommendations. CIRAD
(Panel application)

B. Recommendations for 1/4 S d/3 (UTS) : 5% Ethephon only (5,0% Et).

Clonal Typology classes (Met x Suc)		c2 Met - Suc = c5 Met -= Suc +			c1 Met - Suc - c4 Met -= Suc = c8 Met = Suc +			c3 Met -= Suc - c7 Met = Suc = c11 Met =+ Suc +			c6 Met = Suc - c10 Met =+ Suc = c13 Met + Suc +			c9 Met =+ Suc - c12 Met + Suc =		
Year of tapping	g stim /tree	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y	n/y	[C]%	mg Et/t/y
10	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
11	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
12	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
13	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
14	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
15	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
16	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
17	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
18	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
19	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
20	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
21	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
22	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
23	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
24	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
25	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
26	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
27	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
28	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
29	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
30	0.8	12	5.0	480	12	5.0	480	10	5.0	400	8	5.0	320	6	5.0	240
CLONES		c5 PB 217 c2 AF 261			c4 PR 107 c1 AVROS 2037 c4 PB 86 c8 RRIC 121			c7 GT1 c7 RRIC 100 c7 PB 254 c11 IRCA 19 c11 IRCA 41			c10 RRIM 600 c13 RRIM 712 c13 RRIM 921 c10 BPM 1 c10 BPM 24 c10 PB330 c10 RRIC 110 c10 PR 255 c10 IRCA 18 c10 IRCA 109 c13 IRCA 230 c10 PB 5/51			c12 PB 235 c12 PB 260 c12 PB 340 c12 RRIM 901 c12 RRIM 911 c12 PR 261 c12 IRCA 111 c12 IRCA 130 c12 IRCA 209		

Annex N° 8

Clonal Typology IRRI (2002)

Sumarmadji

EG

LAPORAN AKHIR

STUDI KARAKTER FISIOLOGI LATEKS SEBAGAI DASAR PENETAPAN SISTEM EKSPLOITASI KLON ANJURAN TANAMAN KARET

Oleh :

SUMARMADJI

Proyek/Bagian Pengkajian Teknologi Pertanian Partisipatif
The Participatory Development of Agricultural Technology Project/PAATP

PUSAT PENELITIAN KARET

BADAN PENELITIAN DAN PENGEMBANGAN PERTANIAN
DEPARTEMEN PERTANIAN
2002

EXECUTIVE SUMMARY

STUDY OF PHYSIOLOGICAL LATEX CHARACTERS TO DETERMINING THE EXPLOITATION SYSTEM ON RECOMMENDED RUBBER CLONES

Indonesian Rubber Research Institute. *Sumarmadji.*
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Background. *In order to gain the optimal rubber productivity, implementing on exploitation system are better done specifically on clone typology, seasonal variation, plant age, and the local agro ecosystem condition. Therefore it is necessary to create the guidelines to revise the current implementation of exploitation system. Some physiological study on determinant factor of latex production (latex flow duration and latex regeneration) is urgently done. This study is focused in clone grouping of latex metabolism nature and physiological identification on rubber age development. So, the definitive objectives are 1). To group rubber clones under response of exploitation intensity mainly stimulant application and tapping frequency, and 2). To identify physiological characters of latex towards age change of plant. The expected output is: The current guidelines to revise the implementation of exploitation system of rubber tree which are optimal, specific, and discriminative to group of clone nature, age, and seasonal variation*

Methodology. *There are 2 research activities with the title 1). Grouping of rubber clones on physiological characters which supported the capacity of rubber production, and 2). Identification of change on rubber plant age based on production and physiological character variables. The trial was carried out in North Sumatra rubber estates (PTP Nusantara III) of Membang Muda, Silau Dunia, Sarang Giting estate, KP Sungei Putih; and in the laboratory of Indonesian Rubber Research Institute, Sungei Putih, North Sumatra; for 3 years and started in May 2001. The first trial is using13 types of recommended rubber clone (PR 300, PR 303, PB 330, TM 2, TM 6, RRIC 100, RRIM 717, IRR 104, IRR 105, IRR 107, IRR 109, IRR 111 and IRR 112), tapping panel of B0-2 with 2 exploitation systems namely ½ S d/3.ET2.5% and ½ S d/2. The second trial is using clone of BPM 1 and tapping panels of B0-1/immature tree, B0-1, B0-2 and BI; with exploitation system of ½ S d/3.ET2.5% with the exception on the immature tree. The variables observed are rubber production (latex & lump) in g/t/t and estimated productivity of kg/ha/yr, dry rubber content, tapping panel dryness, plugging index (or duration of latex flow), and physiological characters of latex mainly content of sucrose, inorganic phosphates, and thiols; also K, Ca and Mg for the second trial.*

Result and Conclusion. *Based on the first trial data showed that change of exploitation treatments affect to each clone tested specifically. Agronomically and physiologically, description of 13 clones tested there are grouped in the high metabolism were 4 clones (IRR 104, IRR 105, IRR 111 and IRR 112), in the moderate metabolism were 6 clones (PR 300, PB 330, RRIC 100, RRIM 717, IRR 107 and IRR*

109), and in the low metabolism were 3 clones (PR 303, TM 2, and TM 6). So the appropriate exploitation system estimated for 8 clones (PB 330, RRIC 100, IRR 104, IRR 105, IRR 107, IRR 109, IRR 111 and IRR 112) are ½ S d/2, for 4 clones (PR 300, PR 303, TM 2, and TM 6) are ½ S d/3.ET2.5%, and for 1 clones (RRIM 717) are the both of the exploitation systems. On the second trial, showed that the changes of variable response were dominated by conditioning of tapping, not by plant age effect. So the experiment still need many confirmation, also analysis of compounds, which are important for plant growth to overcome the phenomenon.

ke ½ S d/3.ET2.5% nyata meningkatkan KKK dari 34,6 % menjadi 40.1%. Data LAL sedang (5,08 jam) dan nyata meningkat (7,00 jam) dengan stimulasi. Kadar sukrosa dan FA tergolong agak tinggi, sementara tiol sedang (0,39 – 0,42 mM). Nilai KAS dilaporkan masih rendah (0,15 – 0,40%). Klon ini sesuai dengan sistem eksploitasi ½ S d/2 dengan taksiran produktivitas 1800 kg/ha/th.

13. Klon IRR 112 adalah klon produksi tinggi yang sangat tidak responsif terhadap pemberian stimulan. KKK tergolong tinggi (42,6%) pada kedua sistem eksploitasi. Data LAL sedang (5,42 jam) dan nyata meningkat (7,33 jam) bila distimulasi. Kadar sukrosa tergolong tinggi (18 mM) dan nyata menurun (14 mM) bila distimulasi. Kadar FA tinggi (19 – 20 mM) dan tiol tergolong sedang (0,33 – 0,38 mM). Nilai KAS dilaporkan sedang (3,30 – 5,00%). Klon ini sesuai dengan sistem eksploitasi ½ S d/2 dengan taksiran produktivitasnya yang tinggi mencapai 3060 kg/ha/th.

Tabel 8. Hasil pengelompokan klon-klon dalam sifat metabolisme lateks

Metabolisme tinggi	Metabolisme sedang	Metabolisme rendah
PB 235	**GT 1**	**AVROS 2037**
PB 260	**BPM 1**	**PB 217**
PB 340	**BPM 24**	**RRIC 102**
RRIM 712	**PR 255**	PR 303
IRR 104	**PR 261**	TM 2
IRR 105	PR 300	TM 6
IRR 111	PB 330	**TM 8**
IRR 112	RRIC 100	**TM 9**
	RRIM 717	
rapide	IRR 107	
	IRR 109	
	moyen	lent

Keterangan : Huruf tebal : sudah diketahui secara umum atau hasil kajian sebelumnya

Dari diskripsi agronomis dan fisiologis ke-13 klon yang dikaji maka dapatlah dikelompokkan 4 klon (IRR 104, IRR 105, IRR 111 dan IRR 112) sebagai klon metabolisme tinggi, 6 klon (PR 300, PB 330, RRIC 100, RRIM 717, IRR 107 dan IRR 109) sebagai klon metabolisme sedang, dan 3 klon (PR 303, TM 2 dan TM 6) sebagai klon metabolisme rendah. Hasil klasifikasi ini (Tabel 8) kiranya mengoreksi dan melengkapi inventarisasi yang sudah diketahui sebelumnya.

memperlakukan sistem eksploitasi yang spesifik-diskriminatif dalam rangka produksi optimal. Secara detil kemauan tanaman dalam sintesis lateks dapat dikenali sehingga memudahkan manajemen budidaya di perkebunan secara umum. Berikutnya akan dikaji klon-klon baru sehingga makin membantu kemajuan industri perkebunan karet di masa mendatang.

2. Identifikasi perubahan umur tanaman sementara menunjukkan peubah-peubah penting yang membedakan tanaman TBM dengan TM. Perubahan dinamis karakter fisiologi diharapkan dapat memandu para pekebun untuk memperlakukan sistem eksploitasi sesuai gradasi umurnya. Ke depan pekebun juga akan terbantu untuk memastikan kapan tanaman secara fisiologi telah matang untuk dieksploitasi, bukan hanya berdasarkan kriteria visual saja.

DAFTAR PUSTAKA

Buku

Chrestin, H. 1989. Biochemical aspects of bark dryness induced by overstimulation of rubber trees with Ethrel. p.431-439. *In* J. d'Auzac, J. L. Jacob & H. Chrestin (eds) Physiology of Rubber Tree Latex, CRC Press, Boca Raton.

Jacob, J. L., J. C. Prevot, and R. G. O. Kekwick. 1989. General metabolism Hevea brasiliensis latex. p.102-141. *In* J. d'Auzac and H. Chrestin (eds). Physiology of Rubber Tree Latex. CRC Press, Boca Raton.

Kekwick, R. G. O. 1989. The information of isoprenoid in *Hevea brasiliensis*. p.146-164. *In* J. d'Auzac, J. L. Jacob and H. Chrestin (eds). Physiology of Rubber Tree Latex. CRC Press, Boca Raton.

Jurnal

Dische, Z. M. 1962. Carbohydrate Chem. Acad. Press 1:488.

Gohet, E., J. E. Prevot, J. M. Eschbach, A. Clement and J. L. Jacob. 1996. Clone, croisance et stimulation, facteurs de la production de latex. *Plantations, recherche, developpement*. p: 30-38.

Jacob, J. L., J. C. Prevot, R. Lacrotte, A. Clement, E. Serres and E. Gohet. 1995. Typologie clonale du fonctionnement des laticiferes chez *Hevea brasiliensis*. *Plantations, recherche, developpement* p: 43-49.

Jacob J. L, J. C. Prevot, R. Lacrote, E. Gohet, A. Clement, R. Gallois, T. Joet, V. Pujade-Renaud, and J. d'Auzac. 1998. Les mecanismes biologiques de la production de cautchouc par *Hevea brasiliensis*. p.8-17. *In* Plantations, recherche, developpement.

McMullen, A. I. 1960. Thiols of low molecular weight in *Hevea brasiliensis* latex.

LeRoux, Y., E. Ehabe, J. Sainte-Beuve, J. Nkengafac, J. Nkeng, F. Ngolemasango, and S. Gobina. 2000. Seasonal and clonal variations in the latex and raw rubber of *Hevea brasiliensis*. J. Rubb. Res., 3(3), 142-156.

Sumarmadji. 2000. Sistem eksploitasi tanaman karet yang spesifik-diskriminatif. Warta Perkaretan. 19 (1-3): 31-39.

Taussky H. H. and E. Shorr. 1953. A micro colorimetric methods for the determination of inorganic phosphorus. *J. Biol. Chem*. 202: 675-685.

Prosiding

Aidi-Daslin, I. Suhendry dan R. Azwar. 1998. Kinerja dan adaptasi klon karet anjuran dan harapan 1996-1998. Pros. Lok. Nas. Pemuliaan Karet 1998, Medan, 8-9 Desember 1998. Puslit Karet, APPI. Pp: 157-171.

Anas, A., R. Raswil dan B. Handoko. 1998. Mutu lateks dan sifat karet klon anjuran dan harapan. Pros. Lok. Nas. Pemuliaan Karet 1998, Medan, 8-9 Desember 1998. Puslit Karet, APPI. Pp: 138-151.

Junaidi, U., Kuswanhadi dan A. Tjasadihardja. 1995. Respons klon karet anjuran terhadap berbagai sistem sadap. Pros. Lok. Nas. Pemuliaan Tanaman Karet, Medan, 29 – 30 Nop. 1995.

Junaidi, U. dan Kuswanhadi. 1998. Optimasi produktivitas klon melalui sistem eksploitasi. Pros. Lok. Nas. Pemuliaan Karet dan Diskusi Nasional Prospek Karet Alam Abad 21, Medan, 8 – 9 Des. 1998.

Biochem. Biophys. Acta 41: 152-154.

Puslit Karet. 1995. Hasil Rumusan Lokakarya Nasional Pemuliaan Tanaman Karet 1995. Pros. Lok. Nas. Pemuliaan Tanaman Karet. Medan, 29-30 Nopember.

Sembiring, P. 1994. Penerapan lateks diagnosis di perkebunan London Sumatra. Makalah pada Konferensi Nasional Karet, Medan 15-17 Nov. 1994. Pusat Penelitian Karet.

Sumarmadji, Siswanto, and S. Yahya. 2000. Use of physiological latex parameters to optimize exploitation system. Proc. Indonesian Rubber Conference & IRRDB Symposium, 12-14 September, 2000, Bogor.

Sumarmadji, N. Siagian, dan Karyudi. 2001. Pengusahaan tanaman karet populasi tinggi dan sistem eksploitasi untuk optimasi hasil lateks dan kayu. Suatu konsepsi untuk diterapkan dalam skala terbatas. Paper Lok. Nas. Pemuliaan Karet, Palembang, 5-6 Nopember 2001. 17p.

Woelan, S., R. Azwar, Aidi-Daslin, dan I. Suhendry. 1995. Klon-klon harapan baru IRR seri 00 dan IRR seri 100. p.57-68. *Dalam* Pros. Lok. Nas. Pemuliaan Tanaman Karet. Medan, 29-30 Nopember.

Laporan dan Lain-lain

Siregar, T. H. S. 2001. Evaluasi produksi dan respons karakter fisiologi lateks beberapa klon karet IRR terhadap sistem eksploitasi. Tesis S2, Program Pascasarjana, IPB.

Sumarmadji. 1999. Respons karakter fisiologi dan produksi lateks beberapa klon tanaman karet terhadap stimulasi etilen. Disertasi Doktor. Program Pascasarjana, IPB. 123p.

Sumarmadji. 2001. Konsepsi tentang bagaimana sebaiknya sistem eksploitasi tanaman karet dilakukan. Makalah dalam Evaluasi Hasil Penelitian dan Pemantapan Program Kerja tahun 2001 lingkup Puslit Karet, 25-27 Januari, 2001, Salatiga. 10p.

Sumarmadji. 2001. Kajian karakter fisiologi klon unggul dan harapan tanaman karet. Laporan Hasil Penelitian. Pusat Penelitian Karet, APPI. 20p.

Sumarmadji. 2001. Pengelompokan sifat-sifat klon berdasarkan karakter fisiologi yang mendukung kapasitas produksi lateks. Laporan Hasil Penelitian. Pusat Penelitian Karet, APPI. 18p.

Sumarmadji. 2001. Identifikasi perubahan umur tanaman karet berdasarkan peubah produksi dan karakter fisiologi. Laporan Hasil Penelitian. Pusat Penelitian Karet, APPI. 12p.