

NBPOL's NURSERY MANAGEMENT SYSTEMS FOR FIELD PLANTING BY PROGENY.

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ABSTRACT

As part of New Britain Palm Oil Limited's (NBPOL) ongoing long term strategy for sustainable growth and improvement in oil palm performance, yield and extraction rates, the management team in conjunction with the research team at Dami Oil Palm Research Station (OPRS) embarked on a system of large scale field planting of palms by identified progeny, starting in 2001. The benefits of field planting by progeny will allow wide scale screening of palms for better adaptation to local environments and will contribute to improve genetic tolerance to drought, to assess reactions to nutrient deficiencies, to test for resistance to diseases and allow us over time to select and multiply the progenies that are most suitable for any particular site.

This paper outlines the management systems that are in place at the NBPOL nurseries to ensure that progeny integrity is maintained from the receipt of germinated seeds from Dami OPRS through the pre-nursery and main nursery and finally to field dispatch.

INTRODUCTION

Background.

At Dami OPRS, the seed production unit has always produced commercial seeds by identified progeny. The pisifera parents used for commercial seed production are all proven through intensive progeny testing in organised trials. The dura parents, however, are too numerous to be tested in this way and only the parents of the dura families are fully proven through progeny testing, whilst the dura parents used for commercial seed production are selected based on their phenotype only.

This has meant that the nursery would receive seeds by identified progeny, however, through the nursery and out to the field that progeny integrity was lost.

Whilst there was anecdotal evidence from the field of varying palm performance and susceptibility to disorders such as crown disease based on progeny and geographic location, it was impossible to determine any progeny linked factors with the management systems that were in place.

It was discussed and agreed between NBPOL management and the Dami research team to embark on the plantation scale planting of seedlings by identified progeny to allow the screening of all progenies produced. This was the driver for change in the methodology of managing in the nurseries and the systems that were developed are described in this paper. The changes were instigated in the NBPOL nurseries during 2000 resulting in the first field planting by identified progeny in 2001.

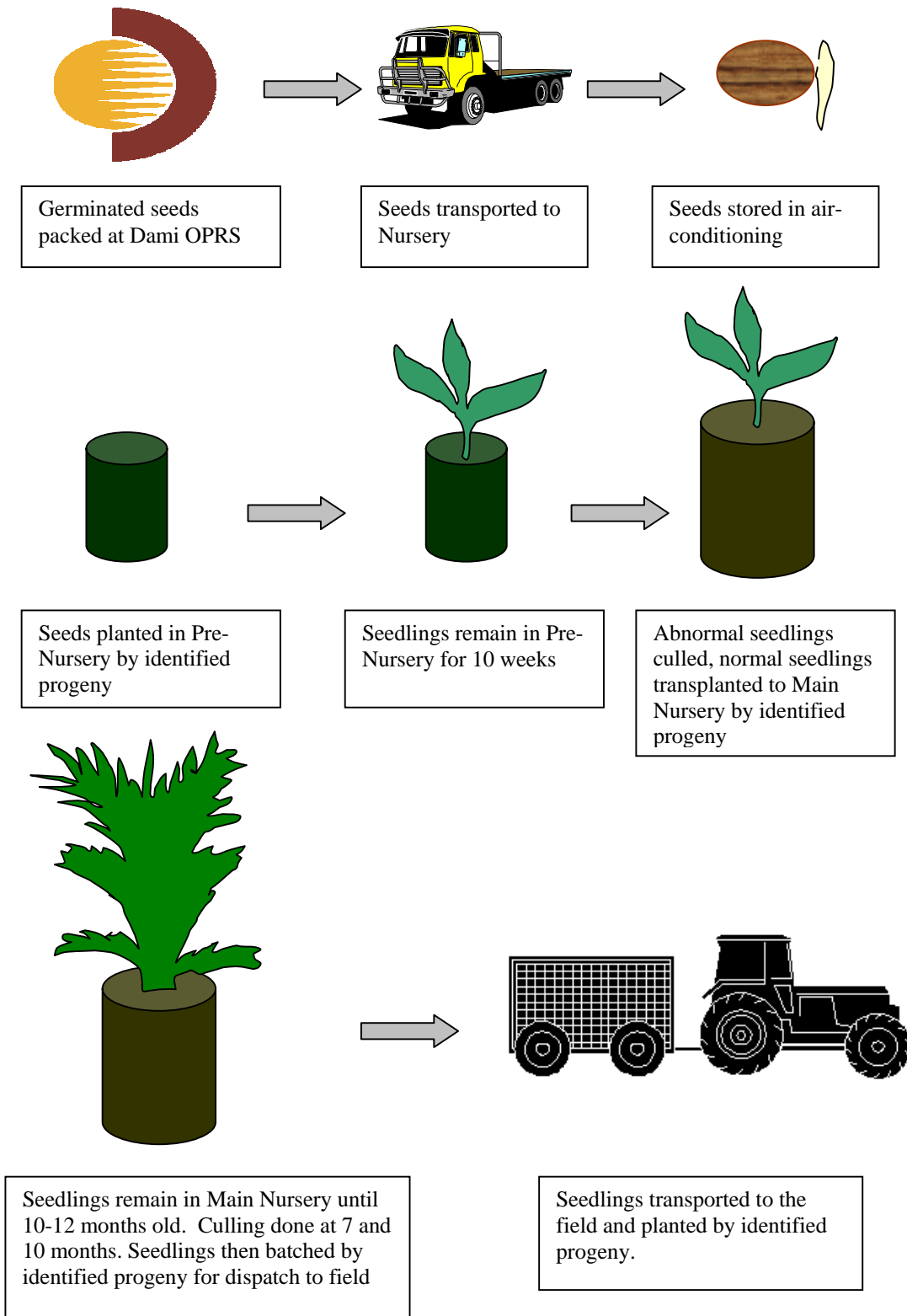
This concept also presents a unique opportunity to identify progenies that are better adapted to particular environments and this is now being carried out using Dami planting material in different parts of the world, for example:

- At NBPOL, screening can help to select progenies more tolerant to Mg or other micronutrient deficiencies.
- At Sinar Mas in Indonesia, the planting by identified progenies is starting with the plantations worst affected by Ganoderma, but once the concept is extended within that Company it will be possible to screen progenies for a wide range of environments.
- At Las Flores in Colombia, replanting by identified progeny can greatly assist to identify progenies with better drought tolerance, which will have a great impact on performance considering the severe water deficit experienced in that part of the country.

THE NURSERY MANAGEMENT SYSTEMS.

NBPOL has been operating 2-stage oil palm nurseries for several years now, generating vigorous and well-grown seedlings ready for field dispatch between 10-12 months of age. With the focus moving to the field planting of seedlings by identified progeny, the nursery management systems needed to be modified to ensure that the progeny integrity was maintained from the receipt of the seeds from Dami OPRS through the upkeep and management systems of both the pre and main nurseries, all the way through to field planting. The basic flow chart for the processes is shown in Figure 1.

Figure 1. Outline of the nursery management system.



Pre-Nursery – Seed Reception.

Dami seeds are dispatched in yellow boxes each containing 3000 seeds. Inside the boxes, the seeds are packed in bags of 200. On receipt of the boxes, they are stored in air-conditioning until ready for planting. The pre-nursery beds are set out to allow blocks of 200 seeds to be planted at a time. Pre-nursery bags filled with Empty Fruit Bunch (EFB) compost are prepared and irrigated for 2 weeks prior to seed planting. The use of compost in the nurseries is now common practice (Lord S. et al, 2002) and forms part of the Company's sustainable development objectives, which are monitored and audited within the Environmental Management System (EMS) framework as part of NBPOL's ISO 14001 certification.

Pre-Nursery – Planting by Identified Progeny.

Our objective is to plant the seeds in such a way that it will promote optimal emergence and seedling growth. In addition, the practice must keep progenies separate and easily identified for transplanting into the main nursery. Seeds are planted in line with the recommendations in the Dami "Nursery Recommendations" brochure. An empty row is left at the end of each progeny before starting the next. The progenies are identified by half burying the progeny identity label in the first bag and by writing the progeny reference number and planting date at each corner bag of individual progenies. This is illustrated in Figures 2 and 3 below.



Figure 2.
Photo showing the half buried labels as well as marked corner bags in the pre-nursery.



Figure 3.
Illustration of markings on the corner bags.

At the time of seed planting, pre-nursery Form 1 (See Appendix 1) is completed by the nursery supervisor and these records are submitted to Dami OPRS for ongoing assessment of progenies in the nursery. This form captures the number of seeds from each progeny that are planted in the pre-nursery, how many emergence failures were experienced and how many seedlings are culled prior to transplanting. It also captures planting date and bed location so that the progenies can be readily found. The figures in the culling and transplanted columns are carried forward onto the next form once the seedlings are transplanted to the main nursery. A typical example shows progeny number 0203317 with 621 seeds planted followed by 8 emergence failures and 146 culls. For that progeny, 455 seedlings were transplanted as identified progeny and 12 seedlings transplanted as mixed. In this example, these progenies were all transplanted to main nursery bed 4B. These records allow Dami OPRS to compare

levels of culling losses between nurseries and for progenies with consistently high culling levels, they can be discarded from seed production. You can see that the overall pre-nursery culling for this group of progenies was 21.5%, we would consider this higher than average.

Pre-Nursery – Maintenance.

Our objective is to provide the seedlings with all of the requirements necessary to promote optimal growth resulting in strong, uniform & vigorous seedlings for transplanting, free of abnormalities and disease. The maintenance operations carried out in the pre-nursery are summarised in Table 1 below.

Practice	Description
Consolidation	Check all seedlings after emergence, consolidate if required (especially after heavy rainfall).
Fertilizer Application	Dissolve 15g Urea in 5 litres water, apply weekly from week 4 Apply at 50mls solution per seedling using a knapsack.
Weeding	Bag and bed weeding are done fortnightly by hand – No herbicides.
Irrigation	Seedlings watered 2x a day, 30 mins each morning and afternoon. No watering done when rainfall exceeds 8mls. Do 3 x/day in dry season
Pests & Diseases	Routine observation for Pests & Diseases with appropriate action taken.
Shade	Starting with 100% shade gradually reducing to 0% shade as follows: Wks 0-5 (100% Shade), Wks 6-7 (Reduced shade 6-9am, 3-6pm), Wks 8-9 (Reduced shade 6-11am, 2-6pm), Wks 10-12 (0% shade).
Mulching	Mulch the tops of bags with fibre at emergence (2 weeks after planting).
Others	Check for Doubletons at 8 weeks after planting, retain strongest leaflet.

Table 1. Summary of pre-nursery maintenance operations.

Pre-Nursery – Culling.

Our objective is to remove all sub-standard and abnormal seedlings before transplanting to the main nursery. This is done and recorded by identified progeny on pre-nursery Form 1 (See Appendix 1). Culling is carried out immediately prior to transplanting. At the time of culling, once the seedlings have been removed, the unpainted bags and compost are recycled. Culling levels in the pre-nursery including emergence failures typically range from 7-15% of the seeds planted but can be higher depending on the performance of individual progenies.

Undesirable characteristics in seedlings include the following:

- Twisted Shoot – Upside down planting
- Rolled Leaf – Cull if narrow leaf as well
- Chimera – Genetic abnormality
- Pest & Disease – Cull if severely affected
- Collante – Caused by poor watering
- Grass Leaf – Uncommon in pre-nursery
- Crinkle Leaf – Uncommon in pre-nursery

Pre-Nursery to Main Nursery – Transplanting by Identified Progeny.

Our objective is to transplant seedlings from the pre-nursery into the main nursery in identified progenies with minimal transplanting shock. This is an important stage in maintaining progeny integrity as the seedlings are physically moved from the pre-nursery location into the main nursery and without close supervision, this is a stage where mistakes can occur. Healthy seedlings are transplanted when they reach the 4-leaf stage at around 10-12 weeks old, although with the use of compost, this is regularly being achieved at 9-10 weeks.

Main nursery beds are prepared a minimum of 2 weeks prior to transplanting. Polybags are $\frac{3}{4}$ filled with compost (Lord S. et al, 2002) and transported to the bed. The polybags are lined at 90cm triangular spacing and then topped up with compost. The beds are then irrigated daily to allow the compost to settle which makes the job of coring out easier.

Once the polybags have settled, a coring auger is used to prepare the transplanting hole in the middle of each bag, which is shown in Figure 4 below.



Figure 4. Coring a hole of the correct size to receive a seedling.

Seedlings are transplanted by identified progeny in full rows into the main nursery, with surplus seedlings planted and labelled separately as “Mixed Progenies”. The pre-nursery seedlings are distributed along each row in the main nursery bed, ensuring that each full row is planted with the same progeny. A recorder indicates the start of a new progeny by inserting the pre-nursery tag with the progeny reference number into the first bag of the first row. A second tag is inserted into the last bag of the last row. Transplanting is done by gently removing the pre-nursery bag, avoiding disturbance to the compost, and placing the seedling into the cored hole. This is illustrated in Figure 5 below.



Figure 5. Transplanting of a pre-nursery seedling into the main nursery.

Manual consolidation is then done and the compost taken out by the corer can be used to fill in any gaps. At this stage any leaning bags are straightened up. As each row in the main nursery bed is

planted up, the recorder follows the planting team and paints the progeny reference number, planting date and transplanting date on the first and second bag at each end of the row. For the rows planted with mixed progenies, the word “Mixed” is written on the first 2 bags at each end of the row. This is illustrated in Figure 6 below.



Figure 6. Illustrations of markings on the first 2 bags showing progeny reference or mixed.

The last operation to assure that progeny integrity is maintained after transplanting is to label each bag. This must ideally be done as soon as possible after the initial recording of the progeny numbers at the row ends.

Starting at one side of the bed, the first progeny planted always receives the progeny code “1” and this number is painted on all of the bags containing that progeny. The second progeny receives the progeny code “2” and so on until all of the bags have been labelled. A different paint colour is used for adjacent beds to ensure that there is no possibility of mixing up progenies in the field. Mixed progenies are marked with an “X”. The bag row end marking and progeny number labelling are illustrated in Figure 8.



Figure 7. Photo illustrating row end and progeny number labelling.

At this stage, the nursery supervisor starts to fill in Forms 2a and 2b.

Form 2a (Appendix 2) records the total transfers from the pre-nursery into the main nursery on a main nursery bed basis. This allows the nursery supervisor to project the correct culling dates for the 7 and 10-month rounds. Overall culling rates are entered onto this form which gives an overview of the

performance for the whole bed. In this example, there was an overall culling in the main nursery bed 4B of 18.8%.

Form 2b (Appendix 3) records the number of transplanted seedlings and culling percentages from the pre-nursery Form 1. This form records culling on a progeny basis from pre-nursery all the way through to dispatch. So following our earlier example of progeny number 0203317 we can see that there was 24.8% culling at the pre-nursery, a further 10.1% culling at 7 months and a final cull at dispatch (in this example at 12 months of age) of 3.7%, giving a total culling for that particular progeny of 38.6% which is substantially higher than the average expected culling losses of 20-25%. After each cull, the overall figures are entered onto Form 2a. The form also shows how many seedlings were dispatched as identified progenies and which plantation they were sent to. Again, overall culling rates can be compared between nurseries and progenies with consistently high culling rates are then removed from the seed production process.

Main Nursery – Maintenance.

Our objective is to provide the seedlings with all of the requirements necessary to promote optimal growth resulting in strong, uniform & vigorous seedlings for field planting, free of abnormalities and disease, whilst minimising adverse impacts on the surrounding environment.

The maintenance operations carried out in the main nursery are summarised in Table 2 below.

Practice	Description
Fibre Application	Mill fibre applied straight after transplanting
Fertilizer Application	The schedule below is the current recommendation for NBPOL nurseries.
Age (Wks > planting)	NPK (g/seedling) Timing SOA (g/seedling) Timing
4-12	10 Monthly 6 Fortnightly
13-26	10 Monthly 12 Fortnightly
27 onwards	10 Monthly 24 Fortnightly
Weeding	Bag weeding manually on a monthly round
	Bed spraying monthly using Gramoxone and applied using knapsacks.
Irrigation	Even and sufficient water distribution, seedlings watered if < 8mm rain.
Pests & Diseases	Routine observation for Pests & Diseases with appropriate action taken.
Pruning	Light Pruning (10-12 months old) in preparation for planting
	Top Pruning (+12 months old) if seedlings have to be kept in the nursery

Table 2. Summary of main nursery maintenance operations.

Main Nursery – Culling.

Our objective is to remove all sub-standard and abnormal seedlings before dispatch to the field. This is done and recorded by identified progeny on nursery Forms 2a and 2b (See Appendices 2 & 3) with records returned to Dami OPRS for ongoing assessment of progenies in the nursery.

Culling in the main nursery normally occurs twice:

- 1st round when the majority of the seedlings have differentiated leaflets. This is normally at 7 months old but can be longer if seedling growth is delayed. Typically up to 10% of seedlings planted are culled at this stage.
- 2nd round at 10 months after planting, but before canopy closure to ensure that seedlings can be easily inspected to observe their growth habit. Typically up to 5% of seedlings planted are culled at this stage, resulting in typical maximum culling levels at around 30% of seeds planted.
- A 3rd round may be necessary if seedlings have to be retained in the nursery for longer than 10 months. Culled seedlings are cut off at the top of the polybag with the tops discarded. The bags and compost are used for path building and erosion control within the plantation. In all culling, it is important to consider and compare the growth of other seedlings within the same progeny before confirming a decision to cull a seedling.

Undesirable characteristics in seedlings include the following:

- Sterile, erect habit – Fronds at an acute angle, upright growth habit.
- Runt – Stunted seedlings, normally easy to identify.
- Flat-Top – Seedlings have abnormally short younger fronds which are responsible for the “flat-top” appearance.
- Limp – Seedlings appearing to lack structure and displaying apparent disorganised and weak growth.
- Short Internodes – The fronds and entire seedlings are more compressed with the leaflets generally being wider and shorter, and closely spaced along the rachis.
- Wide Internodes – With pinnae very widely spaced along the rachis (this condition can be confused with etiolation in crowded situations).
- Juvenile – Leaflets remain partially or completely fused permanently.
- Narrow Pinnae – With very narrow leaflets rolled along their axis and generally associated with stress or sterility.
- Acute Pinnae Insertion – With pinnae borne at very acute angles to the rachis.
- Chimaera – With discoloured portion of the leaves. Generally already identified and culled in the Pre-Nursery.

Dispatch to the Field by Identified Progeny.

Our objective is to prepare and dispatch seedlings to the field in an organised way facilitating the planting of full rows from the same progeny and subsequent recording of the progeny location in the field. This is the last step carried out within the main nursery. For the planting of seedlings in flat terrain, the following steps are taken to ensure that the progeny integrity is maintained.

- For each progeny, prepare the seedlings in batches of 34 healthy palms. At a planting stand per hectare of 128, this allows for 2 supplies per row. In this system, supplies are shallow planted in the field at the ends of the rows at the same time as field planting, giving rise to an initial stand per hectare of 136.
- The size of the batch should be the equivalent to the number of planting points per row in the field, plus 2 for the supply palms.
- Any sub-standard seedlings that have been missed during the culling rounds must be culled at this final stage so that the batches all consist of healthy palms.
- For each batch, prepare 4 labels with the progeny reference and the bag code number painted on the bag. Attach the labels onto 4 seedlings in the batch. These seedlings will be planted in the field as the first and last 2 palms of each row. This then allows the permanent recording of the progeny locations in the field on field maps.
- The truck or tractor must be loaded with the painted number on each bag facing the offloading side for ease of identification in the field, especially when batches of different progeny seedlings are being transported in the vehicle.
- Any leftover seedlings from each progeny, which are in insufficient numbers to form a full batch, are grouped together and will be dispatched as “Mixed” seedlings to Smallholders or to the field to fill in small or irregular shaped plantable areas.

For terraced areas or areas planted under the Numundo Half Stand System (Mann et al, 2002), the above steps are identical, except, the batch size depends on advise from the field staff who will have counted planting pickets and made the appropriate adjustment for supplies.

Costs of the Nursery Management Systems.

The typical operating costs for one of NBPOL's nurseries based at Haella Plantation are shown in Table 3 below.

Practice	Cost (Kina per seedling)
Pre-Nursery	
Cost of seed	1.52
Pre Nursery Polybag	0.16
Cost of compost (1.5kg) + transport	0.07
Bag filling	0.02
Bag lining	0.02
Upkeep operations (planting, mulching, bed & bag weeding, shade, irrigation, P&D, culling)	0.06
Manuring (cost of fertilizer + labour)	0.05
Others (security, refuse collection, recording)	0.01
Main Nursery	
Main Nursery Polybag	0.34
Cost of compost (15kg) + transport	0.57
Bag filling	0.05
Bag lining	0.05
Upkeep operations (transplanting, mulching, bed & bag weeding, irrigation plus parts, P&D, culling, pruning,)	0.42
Manuring (cost of fertilizer + labour)	0.32
Others (security, refuse collection, recording)	0.02
TOTAL COST	3.68

Table 3. Nursery cost details (Kina per seedling).

The table above shows the current operational costs at the Haella nursery running at K3.68 per seedling, this equates to US\$ 1.11 per seedling at current exchange rates.

CONCLUSIONS.

The management of the nursery forms a small, but vital, link in the strategy of planting full rows of identified progenies on a commercial basis in the field. The management systems in place now allow for traceability of information from seed production and processing, through the nursery and out to the field. This information will assist in NBPOL's and Dami's objectives to improve overall yields, increase early yields and further raise oil extraction rates. It will also allow for better identification of progenies that are suited to wide and variable environmental and geographical locations. To date, over 6000 hectares of new plantings and replants at NBPOL have been planted by identified progeny.

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NBPOL Plantation Management Guidelines, Oil Palm Nursery Practice (NBPOL – EMP – MG02)

Appendix 1 – Form 1

Bed	Planting Date	Progeny Reference	Nbr seedlings planted	Emergence Failure Nbr culled	Transplant Nbr culled	Total Nbr culled	% culled at 3 months(*)	nbr transplanted as identified progeny (*)	nbr transplanted as Mixed progenies
18	16/1/03	0203198N	404	1	24	25	6.2%	350	29
18	16/1/03	0202004N	404	4	71	75	18.6%	315	14
18/19	16/1/03	0202169N	614	1	190	191	31.1%	420	3
19	16/1/03	0201239N	612	7	117	124	20.3%	455	33
19	16/1/03	0203049N	607	7	108	115	18.9%	490	2
19	16/1/03	0203317N	621	8	146	154	24.8%	455	12
19	16/1/03	0202266N	405	1	113	114	28.1%	280	11
19	16/1/03	0204338N	408	4	157	161	39.5%	245	2
19/20	16/1/03	0202022N	835	15	150	165	19.8%	665	5
20	16/1/03	0203092N	1212	5	185	190	15.7%	1015	7
	TOTAL		6122	53	1261	1314	21.5%	4690	118

Appendix 2 – Form 2a

NURSERY: Hadla Nursery

Last Update

BED	Nbr seedlings transplanted	Prenursary		Mainnursary	Due Date for 2nd culling (230 days)	ntr culled (*)	% culled (*)	Due Date for 3rd culling (10 months)	ntr culled (*)	% culled (*)	Date of Dispatch	Nbr culled	% culled (*)	Total Despatched	Total Nbr Culled
		In	out	In											
1B	2753	31-Dec-02	8-Apr-03	8-Apr-03	18-Aug-03	408	14.8%	01-Nov-03		0.0%	31-Dec-03	78	2.8%	2343	486
2B	3828	7-Jan-03	11-Apr-03	11-Apr-03	25-Aug-03	530	13.8%	08-Nov-03		0.0%	07-Jan-04	97	2.5%	3481	627
3A	5553	7-Jan-03	16-Apr-03	16/43	25-Aug-03	651	11.7%	08-Nov-03		0.0%	07-Jan-04	344	6.2%	4555	995
3B	4530	7-Jan-03	24-Apr-03	24-Apr-03	25-Aug-03	825	18.2%	08-Nov-03		0.0%	07-Jan-04	150	3.3%	3459	975
4A	5796	16-Jan-03	30-Apr-03	30-Apr-03	03-Sep-03	1032	17.8%	17-Nov-03		0.0%	16-Jan-04	212	3.7%	4290	1244
4B	4808	16-Jan-03	5-May-03	5-May-03	03-Sep-03	734	15.3%	17-Nov-03		0.0%	16-Jan-04	169	3.5%	3905	903

Appendix 3 – Form 2b

Date Transplant:	START:	05/05/03
	Finish:	07/05/03

2003 intake.

Progeny Number	Ex- Damii seeds.	Number on Bag	Number of seedlings	pre-nursery culling %	Culling records in main nursery						Total % Cull	Dispatch			Plantation Issued
					at 7 months		at 10 months		at dispatch			Groups of 34	Identified Progenies	Mixed	
					Nbr	%	Nbr	%	Nbr	%					
(1)	No. of seeds.	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	
0203198	404	1	350	6.2%	113	32.3%			1	0.3%		6	204	32	Sapuri
Mix pro	x	x	118	0.0%	26	22.0%			12	10.2%		0	0	80	VOP
0202169	614	2	420	31.1%	115	27.4%			0	0.0%		8	272	33	Numondo
0202004	404	3	315	18.6%	63	20.0%			0	0.0%		7	238	14	Numondo
0203049	607	4	490	18.9%	56	11.4%			81	16.5%		10	340	13	Sapuri
0201239	612	5	455	20.3%	83	18.2%			19	4.2%		10	340	13	Numondo
0203317	621	6	455	24.8%	46	10.1%			17	3.7%		11	374	18	Sapuri
0202266	405	7	280	28.1%	34	12.1%			14	5.0%		6	204	28	Sapuri
0202022	835	8	665	19.8%	20	3.0%			0	0.0%		18	612	33	Sapuri
0204338	408	9	245	39.5%	32	13.1%			1	0.4%		6	204	8	Sapuri
0203092	1212	10	1015	15.7%	146	14.4%			24	2.4%		24	816	29	Numondo
TOTAL	6122		4808	21.5%	734	15.3%			169	3.5%			3604	301	