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ADVISORY SERVICE ON OIL PALM BREEDING IN GHANA (OPRI - KUSI)

THIRD VISIT BY THE PLANT BREEDER NOVEMBER 1989

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CONTENTS

SUMMARY - CONCLUSION

1. Considerable progress has been made in the Improvement Division, supervised by the Director, Dr. Wonkyi-Appiah, and headed by Messrs. Afrim and Aboagya.

2. This progress relates mainly to selection techniques:
   - pollen preparation
   - bunch analysis
   - seed storage and germinator.

3. Some minor improvements should be made to record keeping procedures, to pollen control, upkeep and clearing.

4. Significant efforts should be made as regards bunch data analysis and data management.

5. For the trials, it is essential to complete bunch analyses and carry out statistical analyses.

6. For the breeding data, it is important to compile parent and progeny lists, draw up trial protocols and organize a practical and functional filing system.

7. The seed production programme will be continued, with few changes.

8. It is recommended that fields 851, 852 and 853 be abandoned, since they are far from OPRI and the University of Ghana has asked for the land.

9. A course lasting around a month is recommended for one of the breeders in 1990.

10. A minimum work programme has been proposed for 1990, taking account of the various priorities.

We should like to thank Dr. Wonkyi-Appiah for his hospitality, help and interest in the summing-up of our visit. Particular thanks go to Messrs. Afrim and Aboagye for their readiness to help and the interest they showed during our visit.

The reasons for our visit were as follows:

- to look at the way the improvement service at OPRI KUSI is organized;
- to study progress made and developments in improvement programmes;
- updating of the seed production programme.

During our brief visit, we concentrated particularly on defining those aspects that constitute limiting factors for the programme, and which have to be be improved.

I - THE IMPROVEMENT PROGRAMME

The major outlines of the programme were described in IRHO document No. 1940, published in September 1985 (First visit of the plant breeder J.M. Noiret).

The strategy proposed breaks down as follows:

- The general improvement programme, based on reciprocal recurrent selection (RRS).

  This involves:

  1. Splitting material into two complementary groups, based on production components (bunch number and mean bunch weight)
  2. comparative trials of hybrids between individuals from each of the two groups
  3. selection of the best individuals from each group, based on the performance of their progeny in comparative trials
  4. recombination of the best trees within each group to begin a new improvement cycle.

- Seed production, which consists in reproducing the best crosses from hybrid comparative trials.

- Complementary programmes, carried out in liaison with the main programme, in response to particular aims (disease resistance, interspecific hybridization, etc.).

In the medium term, the targets set for OPRI were:

- Exploitation of the material immediately available at the Centre,
- Introduction of new materials to broaden the available genetic base.

I.1. The material available and its utilization

It is obvious that the first task consists in making use of the trials already set up at KUSI.

Previous reports (Docs. 1940, produced in 1985, and 1972, produced in 1986) gave a schedule of general observations to be made and trials to be analysed in more detail.

The observations are listed below:

Starting from the planting year (identified as 0), the following observations should be made systematically for the comparative trials:

1. Observation on and percentage of crown disease per cross (Years 1 and 2).

2. Varietal determination (number of dura, tenera, pisifera, abortive, indeterminate trees) per cross. This is carried out once the trees start bearing, and calls for two concordant observations per tree (a third is necessary if the two observations are contradictory).

3. Observation of bearing trees: this consists of the identification, in the field, of dead or replacement trees, typically abnormal trees (poor nursery culling), diseased or illegitimate trees, etc., in order to exclude them from the files. These trees are not taken into account in production summaries. This should be done during the first production year.

4. Production records (bunch number and weight) for each tree (Years 3 to 9).

5. Bunch analyses: as a rule, 1 bunch is analysed from 40 trees in Year 5 and 1 bunch from the same trees in Year 6.

6. Height measurements: on all trees, the height (to the base of leaf 33) is measured in Years 6 and 10.

I.1.1. Trials analysed

The previous report gave details of the observations to be made and the production groupings and analyses to be carried out on trials K13-1, K13-2, K14-1 and K14-2 in particular.

The current situation is as follows for the parent tests. The trials planted between 1967 and 1977 (K1 to K12) are considered to be finished.

- Trial K2-1 was analysed (Doc. 1940, Annex V.1). It revealed the good performance of 3 Deli x Nigeria crosses.

		t/ha 6-9 years Bunches	Oil	O/M %
5.12D x 14.892T	DE x (AB x AN)	19.6	3.61	18.4
5.1080D x 15.4382T	DE x Ufuma	17.7	3.54	20.0
14.525T x G145D	(AB x CA) x DE	16.2	3.44	21.2

However, these crosses have a low oil per bunch (milling) percentage. This seems to be widespread with this type of material, and is keenly felt on a commercial plantation level (see P. Vandebeeck, 1989, Large-scale oil palm development and management in Nigeria. Int. Conf. on palms and palm products, Benin City 21st-25th Nov. 1989).

- Trials K3-3 and K3-4 (1969), K4-1, K4-5 and K4-6 (1970) were also analysed (Doc. 1940). They do not reveal any progeny of interest for continued improvement or seed production (yields for 6-10 years ranged from 1.26 to 2.84 tonnes of oil per hectare). These trials confirm the low industrial extraction rate of the material studied.

I.1.2. Trials currently being analysed

- Trials K8-1 and K8-2 (1973) would appear to be difficult to exploit, due to missing data and unreliable records. It seems preferable not to waste time on these trials, from which certain crosses could be used to continue the programme.

- Trials K13-1 and K13-2 (1978) are currently being analysed by the Biometry Division. We should like to have the results as soon as possible, in order to modify the seed production programme, if necessary.

- Trial K14-1 (1979) was analysed for the period 83-87. Bunch production results are fairly poor (9 to 14 tonnes/ha), as forecast, since the pedigree of the parents was the same as that of individuals tested in K3 and K4 (Annex I).

Without bunch composition analyses, it is impossible to gain an accurate idea of the value of these crosses. These analyses should be carried out as soon as possible.

I.1.3. Trials since 1980

A list of these trials, with their composition, is given in Annex II.

K16: 1981. Agronomy trial, study of the effect of density, with 8 D x P crosses.

K17: 1984. Trial without replications. Of no interest. Could be cleared, except for D x D.

K18: 1983. Ditto.

K19-1: 1985. Agronomy trial: effect of polybag size in the nursery.

K19-2: 1985. Of no interest except for D x D crosses.

K20: 1986. Agronomy trial: intercropping.

K21-1: 1987. Comparative trial with 12 D x T and D x P treatments, 5 replications of 10 trees/plot.

K21-2: 1987. Comparative trial with 8 D x P treatments, 6 replications of 10 trees/plot.

K22-1: 1988. Comparative trial with 7 D x T and D x P treatments.

K22-2: 1988. Ditto, with 8 D x P treatments.

K22-3: 1988. Ditto with 8 D x T treatments.

K22-4: 1988. Comparative trial with 7 treatments, including 3 commercial D x P treatments (1 OPRI + 2 IRHO).

K23-1: 1989. Comparison of KUSI and IRHO materials.

K23-2: 1989. Comparative trial with 10 D x P and T x D treatments, 5 replications of 12 trees/plot.

Care will be taken with all the trials to carry out the observations recommended in section I.1., particularly the start of individual harvesting of trials K21-1 and 2 on January 1st, 1991.

The number of trials and crosses set up in 1987-88-89 reveals the marked resumption of improvement research work at KUSI. This positive appearance should not overshadow the considerable organizational efforts yet to be made if the trials are to be exploited to the full.

I.2. Future programmes

Developments in OPRI programmes, as described in previous reports, can be summarized as 3 major directions:

- the introduction of genetic material from other research centres, with a view to completing working collections and producing new, improved populations with a wider genetic base
- the use of *Elaeis oleifera* in interspecific hybridization programmes
- the integration into improvement programmes of vegetative propagation by *in vitro* tissue culture.

As regards the first field, OPRI has contacted several organizations:

MARDI	Malaysia
NIFOR	Nigeria
LA ME	Côte d'Ivoire
MARIHAT	Indonesia

For the moment, only NIFOR and MARIHAT have replied positively, which means that exchanges with these organizations can be considered in the near future.

- As for Malaysia, we suggest making another request, this time to PORIM: Palm Oil Research Institute of Malaysia, P.O. Box 10620, Kuala Lumpur, Malaysia MA 31609 (MARDI has not been involved in oil palm for several years).

- We also suggest contacting the Pobé Oil Palm Research Station, B.P. 1, POBE, People's Republic of Benin.

We feel it would be premature to look at the other two points now, and they will be studied in detail during a future visit.

II - THE SEED PRODUCTION PROGRAMME

The seed production programme should be revised each year, taking account of trial results, so as to reproduce only those materials that perform best in comparative trials. This ongoing process leads to steady improvements in the quality of the seeds produced, whilst keeping to the same quantities, by eliminating the crosses considered outclassed and replacing them with crosses that perform better.

The trials currently under way have not yet been analysed sufficiently to enable this updating. We agreed to continue the present programme, with a few minor modifications (see Annex III).

- Elimination of the dura of the following progeny:

851 (3a)	5.368D x G118D	(5 trees)
851 (3b)	5.642D x 201.32D	(6 trees)
853	5.1080D x P522D	(21 trees).

This elimination is warranted by the fact that plots 851 and 853 are so far away, at the Agricultural Research Station of the University of Ghana at Okumaning, making monitoring and supervision operations difficult (see below: organization). Furthermore, it only involves 32 out of 1017 trees.

- Elimination of the dura of the following progeny:

5.1080D x P522D	K1	19 dura
P518D x D128D	K6	8 dura
P518D x D118D	K6	11 "
P526D x D674D	K6	8 "
UR452.2 x UR424.7	K8	7 dura
UR424.12 x UR424.7	K8	6 "
UR555.1545 x UR555.1301	K8	5 "

for which numbers per progeny are insufficient.

- Add the following progeny:

851.215D self (65 dura in K14 and 56 in K15), in addition to the same family planted in K4 and K7, to be used with the same pisifera from 32.3005 T self, 32.2612 T self and 32.3005 T x 32.2612 T, after checking legitimacy.

- the progeny:

 1.2209D self (K1)
 851.465T self and 851.253 self (K4)
 851.168D x 851.464D (K4)

 should not be used, due to their illegitimacy.

Care should also be taken to eliminate the few illegitimate tenera from certain D x D progeny (K9 385, 389, 2022, etc.).

Potential seed production is around 1.5 million seeds per year.

- when a cross is reproduced, the pisifera sample used should be as representative as possible of the progeny used as a pollen source (at least 6 to 12 pisifera). Only 19 pisifera were used from March 1985 to November 1989 for all the families. Steps should be taken to make more balanced use of pisifera for seed production.

- code numbers have been given to each reproduction, making for easier seed management. However, care should be taken not to over-complicate coding, i.e. when the same cross is planted in several different plots, the same code number should apply to all the seeds produced by those mother-trees (e.g. 852.215D self from K4 and K7 crossed with 32.3005T self will have the same code).

III - TECHNIQUES

It is essential to have reliable and standardized techniques when conducting improvement programmes. We noted considerable progress in this field, where the main selection techniques are generally mastered well and used effectively. Only a few small improvements remain to be made.

III.1. Pollen processing

4 people are involved in bagging, and 2 in packing the pollen in the laboratory. The operation appears to be running smoothly, and the laboratory is fully equipped. A few improvements are still necessary:

- care should be taken to make sure the pollen harvest and preparation books are clear. All the necessary data should be kept in one book, from harvesting date to the number of units prepared. A special notebook should be used for monitoring (relative humidity, vacuum, germination, etc.) and record sheets kept for each pisifera parent, to keep track of stock.

- the wooden isolation boxes, disinfected with formol, should be replaced as soon as possible with heat-sterilized metal boxes. It has been shown that residual formol vapours can lead to seed abnormalities. Kusi could order two boxes from the La Mé Station in Côte d'Ivoire, to use as models. Thereafter, boxes could be made locally.

- pollen viability and relative humidity should be checked after each batch of pollen is prepared. The equipment and products needed for these checks are already available. When using them, the vacuum in the bottles and viability should be checked if the pollen is more than 3 months old.

  It should be remembered that pollens with a germination rate of less than 70% by the end of the preparation process are eliminated and that relative humidity during storage should be between 3 and 6%.

- pollen that is too old should be discarded (we found pollen prepared in May 1978!). Attempts should be made to use pollen within 6 months and discard it after 1 year.

III.2. Bunch analyses

The operation as a whole is running smoothly. The oil/mesocarp content is determined using the soxlhet method, in batches of 24. This method is accurate and produces good results. We should merely like to point out the risks of significant errors when attempting to measure small quantities accurately. It is particularly important that the laboratory be air conditioned and that the precision scale be kept clean, in a room at constant temperature and relative humidity. (A new oleometer is available; it would be worth carrying out a few analyses and comparing the results with those for the soxlhet method.

The bunch delivery and stripping area should be kept clean (fertilizer bags removed).

III.3. Seed storage and germinator

The seeds are stored correctly in an air-conditioned room at 25°C and at 70% relative humidity.

The germination method used is satisfactory, as shown by the results of the 1989 campaign, where the batches germinated at rates of between 70 and 90%.

This method involves:

- soaking the seeds for 7 days, with the water renewed daily
- air drying for 24 hours

- heating for 70 days at 39-40°C in plastic bags holding 1000 seeds each
- 3 days' re-soaking with a Dithane treatment (1.5 g/litre)
- 3 hours' drying out of excess moisture and packing in bags kept at ambient temperature for 2 weeks. Weekly sorting for 10 weeks.

III.4. Prenursery - nursery

There was little material to be seen during our visit. However, we did note a high number of dead plants (blast) and bags tipped over or poorly filled. We suggest greater care be taken with the setting up, upkeep and cleaning of nurseries and their surroundings, since their appearance always makes a lasting impression on visitors. Well organized nurseries also ensure more effective selection, hence more homogeneous plantings.

IV - MANAGEMENT - ORGANIZATION

Despite the valiant efforts of Messrs. Afrim and Aboagye to ensure that the Breeding Service operates effectively, there is still room for improvement. We would attach particular importance to these organizational problems, which govern the effectiveness and sustainability of the work carried out by the service. We feel that priority should be given to solving them, before any other activities are started on.

IV.1. Parent and progeny catalogues

It is currently difficult to obtain pedigree details quickly for a given tree or family.

For example: taking treatment 20 of trial K22-3, it is very difficult to know to what the cross K1 3905D x K3 735T corresponds. The map of trial K1 has to be consulted and tree No. 3905 found, to see which family it belongs to, then the same thing has to be done for trial K3, etc.

What is difficult now will become extremely complicated once the number of progeny and trees planted and the number of generations increase.

2 catalogues should be drawn up as soon as possible:

- a parent book: this will contain, in numerical order, all the trees chosen and used as parents (numbers are given in chronological order). Alongside the number, the number of the family the parent belongs to and the field identification number of the tree, and possibly its characteristics, are also given.

- the progeny book, in which all the progeny produced are also classified in chronological order. Each cross entry also contains the male and female parent numbers, their identification numbers and the progeny the cross belongs to.

These two catalogues mean that the pedigree of any tree or progeny can be traced easily. Annexes IV.1. and IV.2. give an example of each catalogue used at La Mé, which could be used as models at KUSI (when the catalogues are drawn up, their future computerization should be borne in mind).

IV.2. Protocols and files

Each trial planted should have an experimental protocol including: aims, planting material, planting design, map, planned observations and any information judged useful for conducting the trial.

Annex IV.3. gives an example of such a protocol, drawn up for a trial in Indonesia, which could be used as a model.

Particular efforts should be made as regards filing. In particular, we suggest that a complete file be produced for each genetic trial, including the protocol, various observations on varietal determination, crown disease, height, etc., leaf analyses and fertilizer details, year by year production results and groupings, bunch and oil analyses, end of campaign and end of trial reports, etc.

IV.3. Observation programme

With a view to making work and coordination between the various units easier, it would be useful to draw up an observation programme before the start of each campaign.

- For bunch production: list of trials and number of individually harvested trees, list of trials to be halted, etc.

- For bunch analyses: list of crosses to be analysed, number of trees to be analysed, number of analyses per tree, etc. (this means that the progress made in the programmes can be checked regularly and adjustments made if necessary).

It would also be useful to give the Biometry Service a list of statistical analyses to be carried out, shortly before the end of each campaign.

IV.4. Use of the Okumaning fields

Trials 851-852-853 were planted on University of Ghana land between 1961 and 1966. The fact that they are a long way from the KUSI Centre means they are difficult to monitor, and the University now wants to reclaim the land for other uses.

We feel that these trials could be halted, insofar as the various materials introduced into Ghana are well represented at KUSI (NIFOR material in K1-K2-K3-K4, Deli and Chemara material in K6-K8-K9, etc.) and certain fields are entirely duplicated (Field 853 in K1).

V - STAFF

Under the supervision of the Director of the Institute, the Improvement Division is headed by Messrs. K.B. Afrim (pollination, germination, nurseries, records) and L.M. Aboagye (bunch analyses, seed production), with assistance from technical officers Saban Arma and S.W. Ohene-Tutu.

Messrs. Afrim and Aboagye know their programmes well, and have shown enthusiasm for and interest in all aspects of oil palm improvement. The fact that the services are running smoothly is proof of their efficiency. They should be encouraged in this, and could usefully benefit from work carried out elsewhere, particularly as regards organizing and managing the improvement programme. We suggest that they make a certain number of visits outside Ghana, for example:

- a 15-day visit to NIFOR (Nigeria), 8 days at Pobé (Republic of Benin), 8 days at La Mé (Côte d'Ivoire), concentrating on improvement methods, trial and data management (Mr. Afrim in 1990?)

- a 15-day visit to MARIHAT (Indonesia), 15 days in Malaysia, concentrating on seed production and observation techniques (Mr. Aboagye in 1991?).

We were also impressed by Mr. Tweneboach, the biometrician, and it would also be a good idea for him to visit the IRHO Biometry Division in Montpellier to look at the types of processing and software used for oil palm trials.

We should also like to stress the necessity of installing air conditioning in Mr. Afrim's office.

VI - WORK PROGRAMME

Significant progress has been made in organizing various sections involved in artificial pollination, bunch analyses, seed preparation, etc.

Major efforts should still be made, however, as regards conducting trials and data management and filing. We suggest the following work programme for 1990, in order of priority:

- complete the bunch analyses for trials K13 and K14 (draw up a special programme to catch up on the backlog), produce a summary of results

- finish off the statistical analysis of trials K13-1, K13-2 and K14-1 as regards the characters bunch number, mean bunch weight, total bunch weight and oil production per year and per group of years (means for 82 to 84, 85 to 88 and 82 to 88 for K13 and 83 to 85, 86 to 89 and 83 to 89 for K14)

- set up parent and progeny catalogues, draw up trial protocols and set up a filing system for trials and files

- continue the seed production programme given in the annex

- re-launch contacts with foreign Research Centres for introducing new material

- plan for one of the two breeders to go on a course of around a month.

A N N E X E S

ANNEX I

BUNCH PRODUCTION RESULTS

FOR TRIAL K14-1 (1979)

I.1 - Number of bunches

	Progeny	83	84	85	86	87	Average 83-87
1	3967D x 851.805P	7,5	9,0	8,3	9,2	8,5	9,4
2	491D x 851.106P	6,0	8,0	8,5	9,8	8,5	9,1
3	937D x 851.44P	6,3	8,1	8,5	10,6	13,3	7,8
4	177D x 853.912P	6,2	4,8	8,9	9,4	8,5	8,4
5	739D x 851.115P	9,1	7,0	9,6	8,9	9,0	9,7
6	499D x 853.912P	8,7	10,1	9,6	12,8	11,2	11,6
7	410D x 851.805P	6,2	7,9	6,7	7,5	7,2	7,9
8	757D x 851.106P	5,1	7,6	8,3	8,9	8,3	8,5
9	701D x 851.44P	7,1	5,6	6,7	11,4	8,7	8,8
10	409D x 851.805P	6,2	6,4	6,6	6,4	6,7	7,2
11	875D x 851.115P	7,3	6,3	5,8	7,8	7,8	7,8
12	874D x 851.805P	7,9	7,5	6,1	8,3	8,0	8,4
13	875D x 851.106P	6,5	6,0	6,4	6,7	8,4	7,6
14	660D x 851.805P	7,0	7,0	8,1	9,0	7,4	8,5
15	788D x 851.805P	6,9	7,8	7,2	9,0	8,9	8,9
16	791D x 851.115P	8,4	7,6	8,3	8,4	7,9	9,0
							8,7

I.2 - FFB

	Progeny	83	84	85	86	87	Average 83-87	T/ha 84-87
1	3967D x 851.805P	24	61	78	103	99	12,0	12,6
2	491D x 851.106P	18	41	72	95	89	10,4	11,0
3	937D x 851.44P	19	46	70	98	133	9,7	10,2
4	177D x 853.912P	19	21	80	83	81	9,4	9,9
5	739D x 851.115P	31	52	94	96	103	12,4	12,8
6	499D x 853.912P	27	54	96	130	115	13,9	14,6
7	410D x 851.805P	21	48	64	79	82	9,6	10,1
8	757D x 851.106P	17	42	70	89	87	10,0	10,6
9	701D x 851.44P	27	38	76	137	101	12,5	13,0
10	409D x 851.805P	23	48	72	77	87	10,1	10,5
11	875D x 851.115P	24	45	61	98	105	10,9	11,4
12	874D x 851.805P	30	53	66	99	103	11,5	11,9
13	875D x 851.106P	22	42	59	71	95	9,5	9,9
14	660D x 851.805P	25	44	88	93	90	11,2	11,6
15	788D x 851.805P	24	55	72	105	106	11,9	12,6
16	791D x 851.115P	30	65	98	111	106	13,4	14,0
		24	47	76	98	99	11,1	

I.3 - Bunch weight 84 - 87 according to parental origin

Origin	P parent	No. of crosses	Total weight T/ha	Rank	Dura origin
COLABAR	805P	1	12.6	5	Serdang
		7	10.1	14	Serdang x Deli
		10	10.5	11	Serdang x U.B.
		12	11.9	7	
		14	11.6	8	Serdang
		15	12.6	6	Serdang x Deli
	106P	2	11.0	10	Serdang
		8	10.6	12	"
		13	9.9	15	Deli
	44P	3	10.2	13	Deli
		9	13.0	3	Angola
	115P	5	12.8	4	Serdang
		11	11.4	9	Deli
		16	14.0	2	Nigeria
ABA	912P	4	9.9	16	Serdang
		6	14.6	1	"

Results are difficult to interpret unless specific combining ability is excellent (unlikely). For example, 912P, with 2 Serdang dura, produces both the first and the last-placed cross.

ANNEX II

GENETIC TRIALS AT KUSI

(After 1980)

Progeny n°	Cross	♀ source	♂ source	Origin
Field K17, 1984				
Experiment K17. Unreplicated block (DxD only)				
32	853.743AD x K1.3900D	1.2209AD self	5.2153 Deli x 5.642 Deli	Angola x Deli
34	K1.3905D x 853.743AD	5.2153 Deli x 5.642 Deli	1.2209D self	Deli x Angola
40	851.163D x 851.163D	201.32 x G98	201.32 x G98	Deli x Deli
37	851.429D self	201.32 x G98	201.32 x G98	Deli x Deli
38	853.805AD x K1.2375D	1.2209AD self	5.37 Deli self	Angola x Deli
33	853.803AD x K1.3905D	1.2209AD self	5.2153 Deli x 5.642 Deli	Angola x Deli
35	K1.3749 x 853.684AD	5.2153 Deli x 5.642 Deli	1.2209AD self	Deli x Angola
36	K1.3900D x 853.684AD	5.2153 Deli x 5.642 Deli	1.2209AD self	Deli x Angola
39	K1.3747D x K1.3747D	5.2153 Deli x 5.642 Deli	5.2153 Deli x 5.642 Deli	Deli x Deli
Field K18, 1983				
Experiment K18. Unreplicated block (DxD only)				
1	853.743D x 853.743D	5.2153 Deli x 5.642 Deli	5.2153 Deli x 5.642 Deli	Deli x Deli
3	851.410D x 851.637D	5.642D x 201.32D	5.642 Deli x G98 Deli	Deli x Deli
4	851.637D x 851.637D	5.642 Deli x G98 Deli	5.642 Deli x G98 Deli	Deli x Deli
5	851.410D x 851.410D	5.642D x 201.32D	5.642D x 201.32D	Deli x Deli
6	851.369D x 851.369D	5.642D x 201.32D	5.642D x 201.32D	Deli x Deli
8	K1.3753D x K1.3753D	5.2153 Deli x 5.642 Deli	5.2153 Deli x 5.642 Deli	Deli x Deli
12	K1.3753D x K1.3753D	5.2153 Deli x 5.642 Deli	5.2153 Deli x 5.642 Deli	Deli x Deli
Field K19-2, 1985				
Experiment K19-2. Unreplicated block				
8	K1.3747D x K1.3747D			Deli x Deli
9	K4.621D x K4.621D			Deli x Deli

Progeny n°	Cross	♀ source	♂ source	Origine
Field K21, 1987				
Experiment K21. Unreplicated block				
18	K4.206D x 851.805P			Deli x Cal.
19	K4.538D x 851.805P			Deli x Cal.
20	K1.2793T x K1.3749D			Aba x Deli
21	K1.5041T x K1.3202D			Aba x Deli
22	K1.3747D self			Deli x Deli
23	K1.3749D self			Deli x Deli
24	K1.3900D self			Deli x Deli
25	K1.3905D self			Deli x Deli
26	851.638 Deli self			Deli x Deli
27	K4.41D self			Deli x Deli
28	K1.3774D x K3.782			Deli x Cal
29	K3.879T x K1.3749D			Cal x Deli
30	K3.831T x K1.3749D			Cal x Deli
31	K3.879T x K1.3753D			Cal x Deli
32	K3.734T x K1.3900D			Cal x Deli
33	K3.735T x K1.3900D			Cal x Deli
34	K3.734T x 851.410D			Cal x Deli
35	K2.1441D x K1.3361P			
36	K4.125D x 851.107P			Deli x Cal
Field K21-2, 1987				
Experiment K21-2. Unreplicated block				
11	K4.41D x 851.805P			Deli x Cal
12	K4.125D x 851.805P			Deli x Cal
13	K4.372D x 851.805P			Deli x Cal
14	K4.373D x 851.805P			Deli x Cal
15	K4.374D x 851.805P			Deli x Cal
16	K4.621D x 851.805P			Deli x Cal
17	K4.622D x 851.805P			Deli x Cal
2	K1.3747D x K3.880P STD Cross			Deli x Cal
Field K21-1, 1987				
Experiment K21-1. Unreplicated block				
	Parents			
1	K1.3747D x K3.734T			Deli x Cal
2	K1.3747D x K3.880P Standard			Deli x Cal
3	K1.3749D x K3.782P			Deli x Cal
4	K1.3905D x K3.735T			Deli x Cal
5	851.410D x K3.375T			Deli x Cal
6	K2.1548D x K1.4591T			Deli x (Aba x Ang)
7	K1.3900D x K1.5051P			Deli x Aba
8	K1.5041T x K1.3749D			Aba x Deli
9	K1.3202D x K1.3360P			Deli x Aba
10	K1.2793T x 853.684D			Aba x Ang.
29	K3.879T x K1.3749D			Cal x Deli
37	K1.3905D x K3.831T			Deli x Cal

Grand-parents

1	(5.2153 Deli x 5.642 Deli) x 32.2612T	
2	" x "	
3	" x "	
4	" x "	
5	" x "	
6	5.12 Deli self x 14.892T self	
7	(5.2153 Deli x 5.642 Deli) x 4.1823T self	
8	4.1823T self x (5.2153 Deli x 5.642 Deli)	
9	5.37 Deli self x 4.17T self	
10	4.17T self x 1.2209D self	
29	32.2612T self x (5.2153 Deli x 5.642 Deli)	
37	(5.2153 Deli x 5.642 Deli) x 32.2612T self	

Field K22, 1988

Experiment K22. Unreplicated block

Parents

21	K4.662D x 851.805P	Deli x Cal
25	K1.3749D self	Deli x Deli
26	K1.3900D self	Deli x Deli
27	K1.3202D x 853.743	Deli x Ang
28	K1.3957D x K1.3900D	Deli x Deli
29	K1.2375 self	Deli x Deli
30	K1.3905D self	Deli x Deli
31	851.637D self	Deli x Deli
32	K1.3749D x K3.782P	Deli x Cal
33	K4.372D x 851.805P	Deli x Cal
34	K4.125D x 851.805P	Deli x Cal

Field K22-1, 1988

Experiment K22-1. Unreplicated block

1	K1.3291T x K2.1588D	(Aba x Ang.) x Deli
2	K1.3753D x K3.688P	Deli x Cal
3	K3.831T x K1.3900D	Cal x Deli
4	K3.879T x K1.3749D	Cal x Deli
5	K1.3957D x K3.734T	Deli x Cal
6	K1.3747 x K3.880P Standard	Deli x Cal
7	K1.3905D x K3.831T	Deli x Cal

Field K22-2, 1988

Experiment K22-2. Unreplicated block

8	K4.41D x 851.805P	Deli x Cal
9	K4.206D x 851.107P	Deli
10	K4.125D x 851.107P	Deli
11	K4.374D x 851.805P	Deli x Cal
12	K4.788D x 851.107P	Deli
13	K4.538D x 851.805P	Deli x Cal
14	K4.621D x 851.107P	Deli
6	K1.3747D x K3.880P Standard	Deli x Cal

Field K22-3, 1988

Experiment K22-3. Unreplicated block

15	K1.3480T x K1.3905D	(Aba x Ang) x Deli
16	K1.3900D x K1.2711T	Deli x Aba
17	K1.3480T x K1.3202D	(Aba x Ang) x Deli
18	K1.2375D x K1.2793T	Deli x Aba
19	K1.2793T x 853.684D	Aba x Ang
20	K1.3905D x K3.735T	Deli x Cal
6	K1.3747D x K3.880P Standard	Deli x Cal

Field K22-4, 1988

Experiment K22-4. Unreplicated block

22	OPRC (D x P mixed)	
23	C7128 (D x P IRHO)	
24	C4301 (D x P IRHO)	
6	K1.3747D x K3.880P Standard	Deli x Cal
8	K4.41D x 851.805P	Deli x Cal
10	K4.125D x 851.107P	Deli
2	K1.3753 x K3.688P	Deli x Cal

ANNEX III

CROSSING PLAN FOR SEED PRODUCTION IN 1990

DURA / PISIFERA		32.3005T SELF	32.2612T SELF	32.3005T x 32.2612T	15.4382T SELF	4.1935T x 15.4382T	14.892T SELF
(K1) 5.37D self	100		X	X			
(K1) 5.2153D x 5.642D	114		X	X			
(K2) 5.12D self	40						X
(K4 - K7 - K14 - K15) 851.215D self	242	X	X	X			
(K4) 851.145D x 851.215D	32	X	X	X			
(K4) 5.1225D self	82	X	X	X			
(K6) 5.1080D self	91				X	X	
(K6) 5.1295D self	99	X	X	X			
(K9) UR437.6 x 851.164	32	X	X	X			
UR547 x 851.144	30	X	X	X			
UR665 x 851.410	71	X	X	X			
UR666 x 851.123	54	X	X	X			
" x 851.410	55	X	X	X			

ANNEX IV.1.

Sent by DSE/SEL 505 dated 27th October 1977

sheet N° 101

LA ME PARENT CATALOGUE

Family	Parent	I.D. No.	TO kg	PO kg	NB	FFB	MBW	Na	%NF	%M	%K	% O	No. Oa	%PO	%TO	FW	KW	Age observed
LM 1037	L3650D	E.42.15.23	6,3	3,9	4,5	25	5,6	4	68,9	73,3	4,4	46,5	4	23,5	25,0	12,3	0,5	6-7 yrs
"	L3651D	E.42.16.24	19,7	18,6	11,0	70	6,4	4	70,2	75,5	4,9	-	4	26,5	28,2	13,9	0,7	"
"	L3652D	E.42.33.6	13,0	11,9	9,0	60	6,7	2	69,4	68,1	5,5	42,0	2	19,8	21,7	16,2	0,8	"
"	L3653D	E.42.33.8	7,9	7,2	4,5	29	6,4	2	76,3	67,8	6,1	47,9	2	24,8	27,1	11,8	0,7	"
LM1263	L3654D	D.55.22.2						2	70,8	70,9	5,3	-	2	25,1	27,0	14,1	0,8	"
"	L3655D	D.55.22.13						2	76,0	63,2	7,4	48,2	2	23,2	26,0	12,7	0,9	"
"	L3656D	D.55.23.2	4,4	4,1	3,8	15	3,9	3	73,2	69,5	5,7	53,1	3	27,0	29,1	13,1	0,7	"
"	L3657D	D.55.23.7	1,7	1,5	2,3	8	3,5	3	70,3	65,7	6,6	41,3	3	19,1	21,4	14,4	0,9	"
"	L3658D	D.55.24.7						3	65,9	69,7	5,9	46,6	3	21,4	23,3	14,7	0,9	"
"	L3659D	D.55.26.24	9,2	8,4	0,5	4	8,0	2	72,3	65,1	5,6	44,7	2	21,0	23,0	10,3	0,6	"
	L3660D	D.55.26.28						2	71,0	66,0	6,4	-	2	23,4	25,7	13,6	0,9	"
"	L3661D	D.55.27.17						1	60,0	61,3	8,9	52,8	1	19,4	22,1	13,1	1,2	"
PO 355	L3662D	E.41.4.3	18,4	16,3	7,3	83	11,4	7	61,9	67,4	8,3	46,9	7	19,6	22,2	12,2	1,0	6-8 yrs
PO 367	L3663D	E.42.27.17	8,9	7,7	5,5	40	7,3	3	66,3	63,8	8,1	45,6	3	19,3	22,3	16,8	1,5	6-7 yrs
"	L3664D	E.42.27.27	6,8	5,7	3,0	36	12,0	5	67,6	61,6	9,6	37,8	5	15,7	18,9	13,4	1,3	"
"	L3665D	E.42.28.16	5,2	4,7	5,0	20	4,0	4	67,4	65,9	6,7	52,9	4	23,5	25,8	17,4	1,2	"
PO 437	L3666D	F.51.11.17	7,0	6,3	6,7	26	3,9	2	66,7	66,8	7,2	54,8	2	24,4	26,8	16,6	1,2	3÷5 yrs
WA 10	L3667T	E.40.22.01	29,9	27,7	15,3	119	7,8	8	57,0	83,7	6,2	48,8	8	23,3	25,1	11,7	0,7	"
"	L3668T	E.40.22.09	42,2	39,5	13,3	160	12,0	5	58,3	87,4	6,0	48,4	5	24,7	26,4	15,6	0,9	"
"	L3669T	E.40.22.11	32,4	30,2	14,7	135	9,2	8	54,3	86,8	5,9	47,5	8	22,4	24,0	13,0	0,8	"
"	L3670T	E.40.22.20	37,2	35,6	16,0	132	8,3	7	65,9	90,3	3,7	45,4	7	27,0	28,2	15,9	0,6	"
"	L3671T	E.40.23.4	38,6	35,2	17,0	153	9,0	10	58,4	84,4	7,4	46,6	10	23,0	25,2	7,9	0,6	"
WA 11	L3672T	E.40.18.7	33,1	29,0	15,7	123	7,8	9	70,0	82,5	9,3	40,8	9	23,6	26,9	10,5	1,0	"
"	L3673T	E.40.29.23	32,8	30,7	15,0	129	8,6	10	60,0	88,9	5,4	44,6	10	23,8	25,4	10,7	0,6	"
299	L3674T	E.53.17.21	24,3	20,2	21,3	111	5,2	4	57,5	71,8	12,7	44,1	4	18,2	21,9	8,0	1,0	
"	L3675T	E.52.30.9						1	65,2	74,3	10,0	49,6	1	24,0	27,3	6,9	0,7	
DA 501	L3676D	E.50.4.5	15,9	13,6	10,5	77	7,3	8	67,3	61,9	9,2	42,3	8	17,6	20,7	11,0	1,0	6-9 yrs
DA 528	L3677D	E.50.21.11	11,9	10,3	4,8	44	9,2	2	71,4	60,8	10,2	53,8	2	23,4	27,0	11,6	1,2	"
DA 552	L3678D	E.50.17.16	10,6	9,1	4,0	50	12,5	4	65,3	64,1	9,2	43,4	4	18,2	21,2	9,3	0,9	"
"	L3679D	E.50.17.22	9,3	8,0	4,5	44	9,8	2	58,2	63,4	10,2	49,4	2	18,2	21,2	12,5	1,3	"
DA 564	L3680D	E.50.21.26	11,1	10,1	4,8	45	9,4	2	65,3	68,8	6,8	-	2	22,3	24,7	10,6	0,7	"
DA 568	L3681D	E.50.24.11	14,3	12,7	5,0	53	10,6	2	72,6	66,3	7,7	-	2	24,1	26,9	10,9	0,8	"
DA 572	L3682D	E.50.26.17	12,9	11,1	4,8	49	10,2	2	70,6	64,3	10,1	-	2	22,7	26,3	10,9	1,1	"
DA 580	L3683D	E.50.13.14	16,1	13,0	4,3	72	16,7	1	68,8	61,9	12,3	42,4	1	18,1	22,3	13,3	1,6	"
DA 681	L3684D	H.64.11.13	15,4	12,8	7,0	75	10,7	6	67,0	61,1	10,3	41,6	6	17,0	20,5	9,5	1,0	6-8 yrs
DA 715	L3685D	H.64.34.6	34,5	28,5	10,5	147	14,0	3	66.4	58,7	12,3	49.9	3	19,4	23,5	14,7	1,8	6-7 yrs
DA 737	L3686D	H.64.3.24	23,2	20,5	6,7	105	15,7	5	59,5	63,1	8,6	51,9	5	19,5	22,1	14,0	1,2	6-8 yrs
DA 739	L3687D	E.50.28.26		= L 2017 D														

REGISTER OF FAMILIES PRODUCED

ANNEX IV.2.

I.R.H.O.
LA ME Station

19 - 19 Campaign

Family Numbers	PARENTS						Parent variety	Pollination year and number	Planting year and location. Similar or opposite families
	Mother-tree			Pollinator					
	No.	I.D. No.	Origin	No.	I.D. No.	Origin			
LM 11971	L5431D	E74.28.12	DA 2747	L2262P	E40.40.17	LM 722	D X P	82 S 9445	
LM 11972	L 2 T	BRT 10.19	BRT 10	D 10 D		DABOU	T X D	82 S 9474	
LM 11973	L5437T	I03.15.19	LM 2764	L4702D	I14. 5. 1	LM 2911	T X D	82 S 9470	
LM 11974	M 15 D	H05.21.28	MEO	L2466P	E41.32.34	LM 848	D X P	82 S 9468	
LM 11975	L5012T	E72.22.22	LM 3131	L3051D	H64.13. 8	DA 681	T X D	82 S 9463	
LM 11976	M 16 D	H05.21.27	MEO	L4406P	I03.15.13	LM 2764	D X P	82 S 9472	
LM 11977	L5003T	I03.15.21	LM 2764	L4627D	I04. 6.10	DA 2356	T X D	82 S 9471	
LM 11978	L5005T	E72.21. 2	LM 3131	L3032D	H64.11. 8	DA 681	T X D	82 S 9469	
LM 11979	L5323D	E74.24.14	DA 2747	L2234P	E40.34.19	LM 722	D X P	82 S 9480	
LM 11980	L5434D	E74.30.19	DA 2747	L2227P	E40.32. 3	LM 722	D X P	82 S 9477	
LM 11981	L4939D	I04. 6.26	DA 2356	L2227P	E40.32. 3	LM 722	D X P	82 S 9478	
LM 11982	L4866D	I14. 4. 7	LM 2911	L2032T	E51.24. 6	LM 495	D X T	82 S 9467	
LM 11983	L4063D	E40.29.20	WA 11	L5593T	I24.17.21	LM 3123	D X T	82 S 9489	
LM 11984	L5156D	I14.15.20	LM 2911	L1584P	E51.17. 6	LM 495	D X P	82 S 9422	
LM 11985	L5587T	I24.21.13	LM 3255	L5628D	E40.22.15	WA 10	T X D	82 S 9483	
LM 11986	L5002T	I03.15.17	LM 2764	L4702D	I14. 5. 1	LM 2911	T X D	82 S 9481	
LM 11987	L5593T	I24.17.21	LM 3123	L4063D	E40.29.20	WA 11	T X D	82 S 9479	
LM 11988	L 10 T	BRT 10.27	BRT 10	L 404D	I20.35. 3	SOC 3237	T X D	82 S 9485	
LM 11989	L 9 T	BRT 10.66	BRT 10	L 7 T	BRT 10.15	BRT 10	T X T	82 S 9486	
LM 11990	L5439T	I03.15.24	LM 2764	L5439T	I03.15.24	LM 2764	T X T	82 S 9461	

ANNEX IV.3.

AEK KWASAN

AK-GP 3
1975

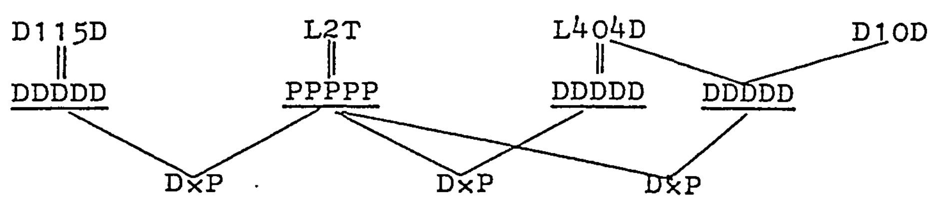
AK - GP 3

SECOND CYCLE OF RRS
IMPROVEMENT OF HYBRIDS
D115D × L2T
L2T × L404D
L2T × D10D

Protocol

I - OBJECT

To look for hybrids outyielding D115D × L2T, L2T × L404D and L2T × D10D. These hybrids are obtained according to the following schema :



Hybrid testing

II - BREEDING MATERIAL

II.1 - PARENTS

II.1.1 - Duras (see annex 1 for list and characteristi

22 duras were chosen from 3 progenies planted at La Mé :

DA 507	(1962)	:	D115D self	7 parents
LM 1037	(1964)	:	L404D self	7 parents
LM 1053	(1964)	:	L404D × D10D	8 parents

./.

II.1.2 - Pisiferas (see annex 2)

13 pisiferas belonging to LM 495, LM 722 and LM 848 (L2T selfed).

II.1.3 - (see annex 2)

II.2 CROSSES

24 D x P progenies (see annex 3 for crossing plan and the control L2T x D10D.

III - PLANTING

III.1 - LOCATION AND DATE

Aek Kwasan (Sumatra), Bloc 490 rows 76 to 93, Block 491 rows 1 to 32, Block 540 rows 84 to 93 and Block 541 rows 1 to 32.

Blocks 490 and 491 are subdivisions of Block 49 (more than 99 rows) and rows with 43 or 44 trees ; Blocks 540 and 541 are subdivisions of Block 54 S, rows have 9 or 10 trees.

Planting : October 1975.

III.2 - PLANTED PROGENIES

Order number	Progenies	Parents
D115D AF x L2T AF		
4	LM 5372	L3005D x L1594P
6	LM 5374	L3394D x L2250P
7	LM 5375	L2346D x L1587P
9	LM 5371	L2507D x L1607P
11	LM 5376	L2531D x L2255P
12	LM 5354	L2346D x L1600P
14	LM 5373	L2345D x L1571P
25	LM 5397	L2526D x L1601P
L404D AF x L2T AF		
2	LM 5403	L3512D x L1596P
5	LM 5404	L3262D x L2466P
13	LM 5405	L3455D x L1571P
17	LM 5407	L3261D x L1576P
18	LM 5401	L3446D x L1607P

Order number	Progenies	Parents
20	LM 5398	L3261D x L1600P
23	LM 5406	L3349D x L1594P
24	LM 5399	L3360D x L1574P
(L404D x D10D) x L2T AF		
3	LM 5415	L2941D x L1601P
8	LM 5411	L3309D x L1596P
10	LM 5410	L2946D x L1587P
15	LM 5414	L2932D x L1589P
16	LM 5408	L2938D x L1607P
19	LM 5412	L2935D x L1594P
21	LM 5409	L2912D x L1574P
22	LM 5413	L3101D x L2255P
Témoin		
1	LM 4947	L2T x D10D

./.

III.3 - EXPERIMENTAL DESIGN

- Balanced, 5 x 5 square lattice, 6 replications
- Treatments : 25 progenies
- Elementary plot : 2 rows of 6 trees = 12 palms
- Per cross : 6 x 12 = 72 trees.

III.4 - PLANTING PLAN (see annex 4)

III.5 - TREE NUMBER AND ACREAGE

25 progenies x 72 palms = 1 800 trees
= 12,6 ha (31,3 acres) (143 trees/ha)

IV - OBSERVATIONS (according to IGK)

- Varietal determinations
- FFB yield
- Bunch and fruit quality
- Fatty acid composition
- Growth.

ANNEX 1

DURA PARENT CHARACTERISTICS

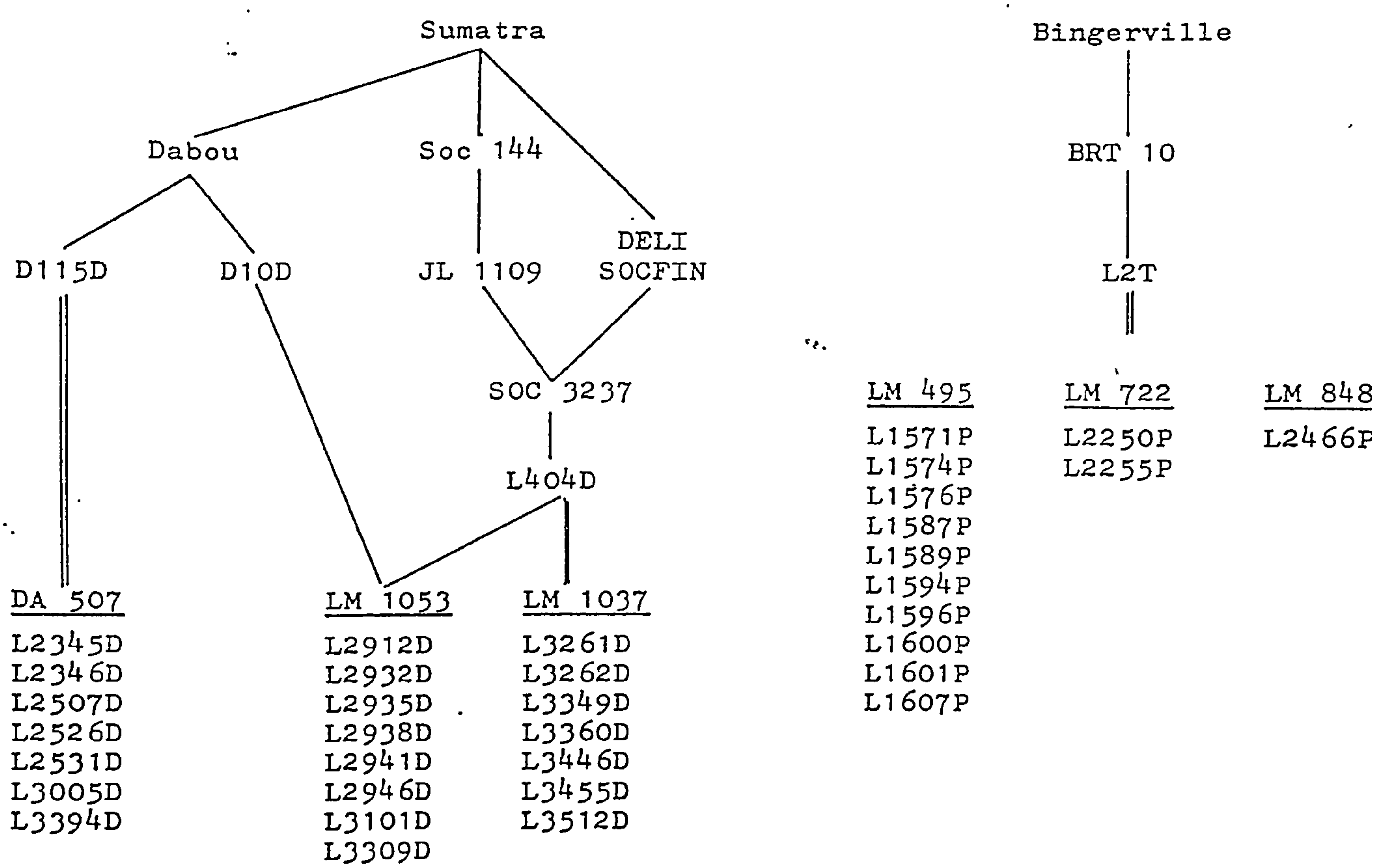
Family	Parent	TO	PO	NB	FFB	MBW	Na	% F	% M	% K	% O	No Oa	% PO	% TO	F	K	Age observed (yrs)	Parent I.D.	Observations
DA 507	L2345D			6,0	60	10,0	6	60,6	67,7	8,2	51,5	5	20,6		11,6	0,9	6-9	E51.15.24	
	L2346D			8,3	98	11,8	1	56,7	72,0	5,3	58,0	1	23,7		17,9	1,0	"	16.21	
	L2507D			5,3	42	7,9	6	61,0	67,8	8,5	50,6	6	20,9		10,3	0,9	"	12.4	
	L2526D			3,0	46	15,3	2	70,3	62,2	9,2	45,6	2	19,9		10,9	1,0	"	16.19	
	L2531D			6,0	63	10,5	2	52,6	72,3	6,7	56,0	2	21,3		11,7	0,8	"	21.8	
LM 1053	L2912D			7,0	76	10,9	6	66,1	69,2	6,3	53,7	6	24,6		13,6	0,9	6-7	H54.5.3	
	L2932D			8,5	63	7,4	13	72,0	66,1	8,7	51,1	13	24,3		13,0	1,1	"	6.25	
	L2935D			9,5	79	8,3	8	69,0	67,5	6,8	50,0	8	22,7		16,3	1,1	"	7.11	
	L2938D			8,0	63	7,9	4	70,2	61,6	9,0	54,2	4	23,3		13,6	1,2	"	7.15	
	L2941D			6,5	49	7,5	5	71,3	70,5	6,8	52,7	5	26,5		12,2	0,8	"	7.20	
	L2946D			9,5	66	6,9	8	69,0	66,0	7,4	50,7	8	23,3		12,5	0,9	"	8.8	
DA 507	L3005D			4,5	52	11,6	3	68,2	68,5	10,2	55,1	1	25,5		11,9	1,2	6-9	E51.12.16	
LM 1053	L3101D			9,0	46	5,1	7	71,5	63,4	7,7	46,0	7	20,8		13,4	1,0	6-7	H54.6.11	
LM 1037	L3261D			4,0	24	6,0	3	68,6	75,3	5,0	49,1	3	25,4		14,2	0,7	"	E42.11.13	
	L3262D			7,0	37	5,3	5	69,6	68,1	6,3	43,0	2	18,5		14,3	0,9	"	12.2	
LM 1053	L3309D			5,5	49	8,9	8	70,9	65,3	7,4	47,1	8	21,8		12,7	0,9	"	H54.7.1	
LM 1037	L3349D			7,5	48	6,4	4	69,8	69,3	6,4	45,4	3	21,8		13,0	0,8	"	E42.15.26	
	L3360D			5,5	34	6,2	4	70,4	72,3	4,9	45,2	4	22,9		15,6	0,8	"	34.12	
DA 507	L3394D			6,0	74	12,3	3	63,4	65,4	11,2	50,9	2	21,0		11,9	1,3	6-9	E51.22.11	
LM 1037	L3446D			12,5	72	5,8	4	67,7	66,2	7,3	49,6	3			13,2	0,9	6-7	E42.15.20	Dead
	L3455D			4,5	20	4,4	4	61,8	74,3	4,7	45,8	2	22,4		18,0	0,9	"	22.18	
	L3512D			9,0	53	5,9	6	67,3	72,9	5,1	45,6	1	21,8		20,0	1,0	"	16.27	

DA 507 D115D self
LM 1037 L404D self
LM 1053 L404D × D10D

ANNEX 2

PARENT PEDIGREE

DURA　　　　　　　　　　PISIFERA



CROSSING PLAN

DURA \ PISIFERA		LM 495, LM 722, LM 848 (L2T												
		L1571P	L1574P	L1576P	L1587P	L1589P	L1594P	L1596P	L1600P	L1601P	L1607P	L2250P	L2255P	L2466P
DA 507	L2345D	LM 5373 (14)												
	L2346D				LM 5375 (7)				LM 5354 (12)					
D115D	L2507D										LM 5371 (9)			
self	L2526D									LM 5397 (25)				
	L2531D												LM 5376 (11)	
	L3005D						LM 5372 (4)							
	L3394D											LM 5374 (6)		
LM 1037	L3261D			LM 5407 (17)					LM 5398 (20)					
	L3262D													LM 5404 (5)
L404D	L3349D						LM 5406 (23)							
self	L3360D		LM 5399 (24)											
	L3446D										LM 5401 (18)			
	L3455D	LM 5405 (13)												
	L3512D							LM 5403 (2)						
LM 1053	L2912D		LM 5409 (21)											
	L2932D					LM 5414 (15)								
L404D	L2935D						LM 5412 (19)							
×	L2938D										LM 5408 (16)			
D10D	L2941D									LM 5415 (3)				
	L2946D				LM 5410 (10)									
	L3101D												LM 5413 (22)	
	L3309D							LM 5411 (8)						

A N N E X 4

AK-GP 3 (oct. 1975)