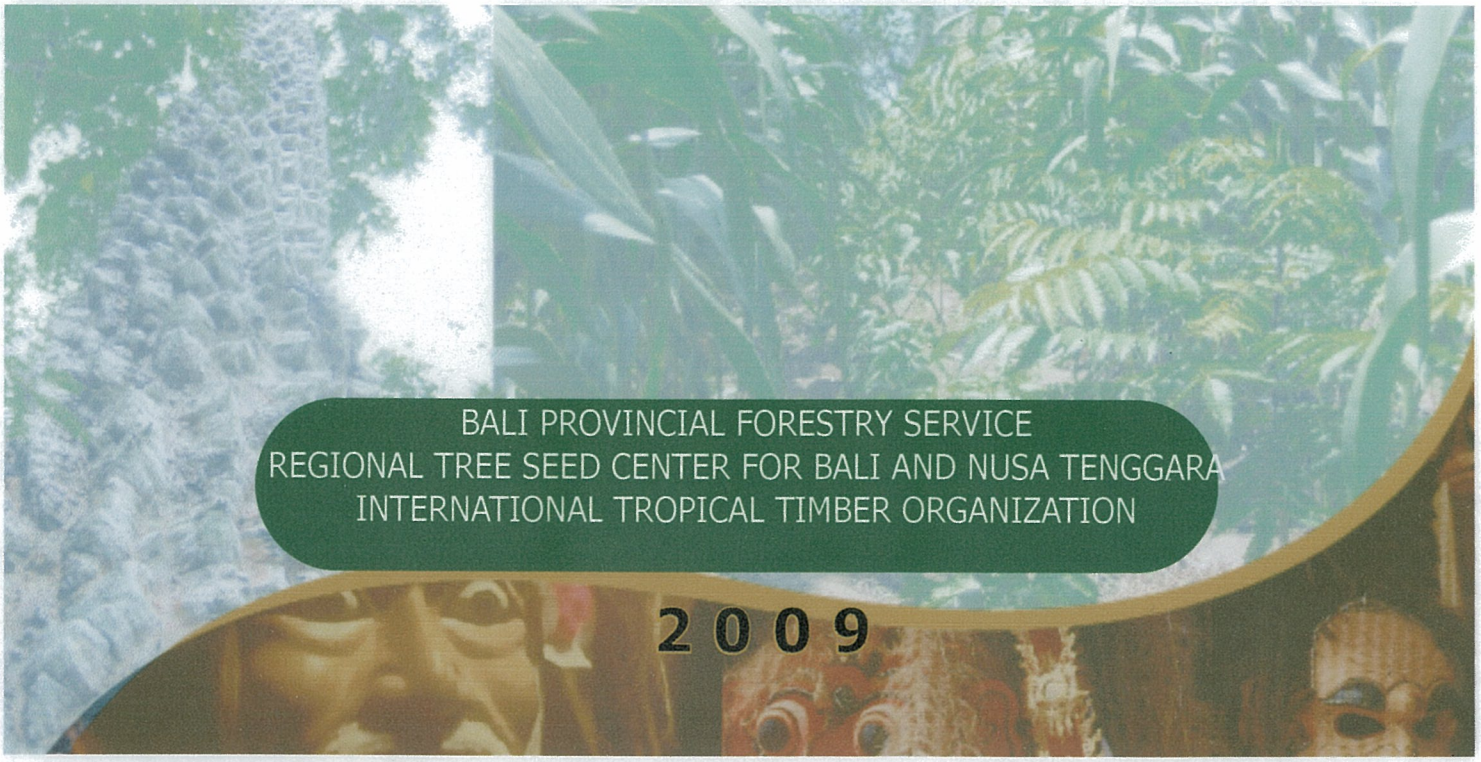
ITTO PD 386/05 Rev.1 (F)

TECHNOLOGICAL DEVELOPMENT FOR THE PRODUCTION OF PLANTING MATERIALS TO SUPPORT SUSTAINABLE PLANTATION OF BALI INDIGENOUS SPECIES THROUGH COMMUNITY PARTICIPATION

REPORTING ACTIVITY 2.1 ESTABLISHMENT OF SEED ORCHARD FOR 3 SPECIES (Alstonia scholaris, Planchonia valida and Dysoxylum densiflorum), 6 Ha

PREPARED BY:
PROJECT EXECUTING TEAM



BALI PROVINCIAL FORESTRY SERVICE
REGIONAL TREE SEED CENTER FOR BALI AND NUSA TENGGARA
INTERNATIONAL TROPICAL TIMBER ORGANIZATION

2009

Reporting
Activity 2.1. Establishment of seed orchard for 3 species (*Alstonia scholaris, Planchonia valida, Dysoxylum densiflorum*), 6 Ha

Project Executing Team ITTO PD 386/05 Rev.1(F)

Bali Provincial Forestry Service and
Regional Tree Seed Center for Bali and Nusa Tenggara and
International Tropical Timber Organization
2009

CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF APPENDIXES

SUMMARY

Seed orchards of *Dysoxylum densiflorum, Alstonia scholaris,* and *Planchonia valida* have been established, located at Tegal Bunder, RTK 19, RPH Sumber Kelampok, Village of Pajarakan, District of Buleleng, Bali Province, with total effective area is about 5,43 hectares. Seed orchard is laid-out using randomized complete block design. Due to time limitation, land preparation and planting practiced using *cemplongan* with line-direction.

Seedlings of *D. densiflorum* was growing in project nursery. However, in case of *A. scholaris*, there was any problems regarding the availability of seedling, that is, nursery could not be realized as yet up to 2008. Therefore, the seedlings came from Balai Besar Penelitian Bioteknologi dan Pemuliaan Tanaman Hutan (BBPBPTH) Yogyakarta. In case of *P. valida*, seed collection was not enough. Regarding to this problem, Regional Tree Seed Center for Bali-Nusra decided to use wildlings growing under selected mother trees. Wildlings are then transferred and maintained in nursery.

1. INTRODUCTION

1.1. Background

Establishment of seed orchard for three species: *Alstonia scholaris* (Pulai), *Planchonia valida* (Putat) dan *Dyxosylum densiflorum* (Majegau) is a part of activities 2.1 under ITTO project PD 386/05 Rev. 1 (F). The implementation of the project involves Bali Provincial Forestry Service and Ministry of Forestry c.q. Regional Tree Seed Centre for Bali and Nusa Tenggara. The purpose of activity is to supply genetically improved seed for forest plantation establishment in Bali.

As a part of tree improvement program, seed orchard establishment plays an important role to increase plantation productivity through genetically improved seed production. Related factors will contribute to successful of seed orchard establishment, such as: good site matching and genetic materials, as well as proper breeding strategy.

In most of tree improvement program, seed orchard establishment will have three simultaneous purposes; 1) as progeny test in the beginning, 2) as seed production after rouging, and 3) as base population for the next generation breeding program after selecting plus trees. To support these purposes, assessment which involves activities of measurement and data analysis will play an important role to provide information of genetic parameter from seed orchard. By using this information, precise and accurate selections on individual or family in seed orchard could be made. It means that the genetic gain brought by the tree improvement program is largely depending on the progress of these activities. To support appropriate direction for seed orchard establishment, the following report is prepared as technical report covering site survey and site selection, experimental design, planting, documentation, maintenance, assessment and data analysis, and selection strategy.

1.2. Material and Method

The materials and methods below based on consultancy with National expert for this field, Dr. Arif Nirsatmanto.

1.2.1. Seedling seed orchard

The seedling seed orchards are established in combining function of progeny test and improved seed production. In this scheme, seed orchard will be converted to the

purpose of seed production after completing rouging. Thus, assessment of genetic parameters and genetically improved seed production could be attained using the same population.

Seed orchards are established through some phases, in which each phase will influence successful of establishment. All phases started from mother trees selection and identification, seed collection, site selection, nursery, experimental design, field planting, assessment and data analysis, selection, maintenance should be done appropriately.

1.2.2. Scope of activity

Some phases of seed source establishment, as follows:

1.2.2.1 Site survey and selection

Some aspects required to select seed orchard area are as follows:

- accessibility,
- soil,
- topography,
- water,
- security,
- climate.

Size of area is determined in accordance to proposed experimental design in order to provide compact seed orchard. To get suitable area, therefore, site survey could be done by selecting at least two site candidates.

1.2.2.2. Experimental design

Tentative experimental design is generated before nursery by assuming all of families have complete number of seedling as proposed. Thereafter, permanent design will be generated after getting information of available number of seedling for each family and site area in the field.

Experimental design will cover information of:

- Site map,
- Blocking map,
- Randomized family map,
- List of family distribution in each block,

- Seed orchard border and tree plot planting direction,
- Field-note for measurement.

Tentative seed orchard experimental design for 3 species is presented in Table 1.

Table 1. Proposed seed orchard experimental design for each species

Species	Family	Design *)	Block	Tree/plot	Spacing (m)	Area (ha)
A. scholaris	80	RCBD / IBD	10	4	4 x 2	2.56
P. valida	50	RCBD / IBD	10	4	4 x 2	1.6
D. densiflorum	50	RCBD / IBD	10	4	4 x 2	1.6

Remarks: *) option should be confirmed with the available of site area
RCBD: *Randomized Complete Block Design*
IBD : *In-complete Block Design*

1.2.2.3. Seed orchard establishment

Seed orchard establishment involve some activities as follows:

Seed preparation, covers:

- seed exploration,
- sortation and extraction,
- seed testing,
- seed storage,
- seed packing,
- seed labeling.

Genetic material for seed orchard establishment for each species is presented in Table 2.

Table 2. Proposed number of family tested in seed orchard

Species	Number of family
A. scholaris	80 family
P. valida	50 family
D. densiflorum	50 family

Seed handling and nursery, covers:

- media preparation for germination and pricking-out,
- seed labeling for each family,
- seed sowing,

- pricking-out,
- nursery maintenance,
- monitoring and assessment the available number of seedling for each family.

Field planting covers:

1) Seedling selection. It is to select a number of healthy and uniform seedlings to match with the proposed design (number tree/plot, and block).
2) Family identification and labeling. It is prepared two sets containing information of row and column number position, family number, and blocking number.
3) One set of the label will be attached in seedling, and another set will be attached in stick pole.
4) Planting. During the planting, label number attached at seedling should be match with the label number attached in stick pole.
5) Replanting. Mortality can be only replanted once and maximum until two months after planting. This is to avoid the bias in data analysis due to appearing different effect to the tree growth. Replanting should be done using the same number of family.

1.2.2.4. Maintenance

Maintenance covers weeding, fertilizer, mounding, pest and disease prevention. Maintenance could be practiced periodically for each four months during first years and thereafter for each six months. The important aspects need to be paid attention during maintenance is the homogeneity of silviculture treatment among the trees. Procedure for maintenance of seed orchard was generally in accordance with the existing guidelines that was published previously; Guidelines for plantation establishment and maintenance (Hardiyanto, 2005).

1.2.2.5 Measurement and data analysis

Periodical measurement should be done for each trees using 100 % sampling intensity at each six months during 2 years age, then once per year. Assessment could be done at least up to half of rotation age. Measured characters involve:

- survival rates,
- height,

- bole length,
- diameter,
- form trait.

Any other additional characters could be also measured as long as they will contribute to increase end-product productivity.

Data analysis would be better to be done immediately after periodic measurement. This is in order to collect as many as possible information related to the trend of growth and genetic parameters of seed orchard. The results of data analysis will be used to practice selection and estimate genetic gain.

1.2.2.6 Selection.

Selection will be practiced to increase genetic gain by retaining high quality trees as seed trees to produce genetically improved seed. High quality trees selection will be determined on the basis of good growth: height, dbh, volume, and also good form traits: multi-stemmed, stem straightness, and branching habit. Selection will be followed by rouging, that is, by culling the inferior trees in the seed orchard. Selection will be practiced step by step by considering the tree growth performance.

2. MAIN TEXT

2.1. Seed Orchard of *Dysoxylum densiflorum*

2.1.1. Site selection

By considering of seed orchard establishment requirement, seed orchard location as follows:

- Tegal Bunder
- RTK : 19
- RPH : Sumber Kelampok
- Village : Pajarakan
- Sub-District : Gerokgak
- District : Buleleng
- Province : Bali

Site is located near to Taman Nasional Bali Barat (West Bali National Park), with the demarcation of:

- Seed production area of *Manilkara kauki*,
- Demonstration plot of *Dysoxylum densiflorum* and *Planchonia valida*

(Site location in detail as presented in Appendix 1.)

Beside good accessibility, other considerations to select this location are good soil fertility (as shown by the growth of trees in demonstration plot), available size area, acceptable topography (flat) and compactness.

2.1.2. Seed orchard experimental design

Based on the availability of selected site and number of seedling (Appendix 2), experimental design has been laid-out as follows:

a) Number of family : 61
b) Design : RCBD (Randomized Complete Block Design)
c) Number of replication : 10
d) Number of tree-plot : 4
e) Spacing : 4 x 2 meter
f) Effective area : 1,95 hectares

2.1.3. Nursery

Nursery was started in 2007, and the seedling was be relatively old (more than 1 year age), and the root of seedling was developed quite long (Figure 1).

Figure 1. (a) Seedling condition of *Dysoxylum densiflorum* in nursery, (b) developed seedling rooting system

Based on the available number of seedling for each family, the total number of tested family is 61 families. In fact that the seedling was relatively old and to avoid mortality during planting, that seedling delivery to the field has been done carefully. Acclimatize the seedling for 1-2 weeks before planting. Seedlings grouped in accordance the family number and select only uniform seedling. To avoid any mistakes during planting, the seedling with the same family number bundled into each four seedling. Thereafter, the bundled seedling attached label containing row, column, replication, and family number in accordance to the design.

2.1.4. Land preparation

Selected site for establishing seed orchard of *D. Densiflorum* is covered by very dense vegetations (Figure 2).

Figure 2. Condition of selected site for seed orchard of *Dysoxylum densiflorum* covering very dense vegetations

Based on conditions mentioned above, the land preparation could be done using complete land clearing. Land preparation is practiced mechanically or combining with 'tumpang sari' as practiced previously in other seed orchards. However, due to time limitation, land preparation and planting practiced using *cemplongan* with line-direction. In consequence to this, the seed orchard should be maintained more intensive.

2.1.5. Planting

Considering land preparation condition mentioned above, planting phase covering line arrangement, spacing, sticking, and planting has been done carefully. Label attachment in each stick-pole match with the design (row, column, replication, family number). Bundled seedling that was attached by label is then delivered to each stick-pole with the same number label identification. Before planting, delivered seedling has been re-checked again to confirm label identification matching (Figure 3).

Figure 3. An example of label identification matching between attached label at seedling and that at stick-poles.

During planting, dig holes and base fertilizer prepared and applied in enough size, quantity and dozes.

2.1.6. Maintenance

Maintenance of seed orchard should be always done by considering the fact that the population is subjected to produce genetically improved seed. Due to these specific characters, therefore, the seed orchard maintenance should be done more intensive and comprehensive than maintenance of ordinary plantation. The maintenance of the plot comprised twice per day of watering, shrubs cleaning, and takes care from attacking by monkeys, deers, and wild boar.

2.1.7. Assessment and data analysis

Considering the characters of *D. densiflorum*, the assessment in the early ages (1-2 years) could be done periodically for each six months with the traits of: survival, height, diameter, stem straightness, multi-stem, and branching habit.

Data collection should be practiced using tally-sheet as prepared. Measurement should be done systematically to reduce any mistakes during data collections.

2.2. Seed Orchard of *Alstonia scholaris*

2.2.1. Site selection

The same as seed orchard of *D. densiflorum*, the seed orchards location at:

- Tegal Bunder
- RTK : 19
- RPH : Sumber Kelampok
- Village : Pajarakan
- Sub-District : Gerokgak
- District : Buleleng
- Province : Bali

Site is located near to Taman Nasional Bali Barat (West Bali National Park), with the demarcation of:

- Candidate site for seed orchard of *D. densiflorum*
- Seed production area of *Manilkara kauki*,
- Demonstration plot of *D. densiflorum* and *P. valida*.

(Site location in detail as presented in Appendix 1.)

Beside good accessibility, other considerations to select this location are good soil fertility, available size area, acceptable topography (flat) and compactness.

2.2.2. Seed orchard experimental design

Based on the availability of selected site and number of seedling (Appendix 2), experimental design has been laid-out as follows:

g) Number of family : 48
h) design : RCBD (Randomized Complete Block Design)
i) Number of replication : 8
j) Number of tree-plot : 4
k) Spacing : 3 x 2 meter
l) Effective area : 0,92 hectares

Experimental design and other necessary information in detail are presented in Appendix 8 – 11.

2.2.3. Nursery

Some explanations and concepts for nursery are same as described in sub-chapter 2.1.3. However, in case of *A. scholaris*, there was any problems

regarding the availability of seedling, that is, nursery could not be realized as yet up to 2008. Therefore, it was contacted Balai Besar Penelitian Bioteknologi dan Pemuliaan Tanaman Hutan (BBPBPTH) Yogyakarta where the seedling genetic materials for establishing seed orchard of *A. scholaris* is still available. As the results, BBPBPTH was agreed to deliver that seedling with total number of 41 families (Figure 4).

Figure 4. Preparation of seedling delivery of *Alstonia scholaris* from BBPBPTH-Yogyakarta for seed orchard establishment in Bali

Regarding to this situation, research cooperation agreement between BBPBPTH-Yogyakarta and BPTH Bali Nusa-Tenggara would be discussed and formulated to plan a future management of the seed orchard.

2.2.4. Land preparation

Some explanations and concepts for land preparation are same as described in sub-chapter 2.1.4.

2.2.5. Planting

Some explanations and concepts for planting are same as described in sub-chapter 2.1.5.

2.2.6. Maintenance

Some explanations and concepts for nursery are same as described in sub-chapter 2.1.6. Another additional aspect for maintenance is that *A. scholaris* is not tolerant to drought in early growth. Therefore, twice per day of watering has

been done during dry seasons. This is to reduce appearing abnormal growth of trees.

2.2.7. Assessment and data analysis

Some explanations and concepts for assessment and data analysis are same as described in sub-chapter 2.1.7. Field-note for data collection is prepared as shown in Appendix 11.

2.3. Seed orchard of *Planchonia valida*

4.3.1. Site selection

The same as seed orchards of *D. densiflorum* and *A. scholaris*, the seed orchards location at:

- Tegal Bunder
- RTK : 19
- RPH : Sumber Kelampok
- Village : Pajarakan
- Sub-District : Gerokgak
- District : Buleleng
- Province : Bali

(Site location in detail as presented in Appendix 1.)

Beside good accessibility, other considerations to select this location are good soil fertility (as shown by the growth of trees in demonstration plot), available size area, acceptable topography (flat) and compactness. Condition of selected site is shown in Figure 5.

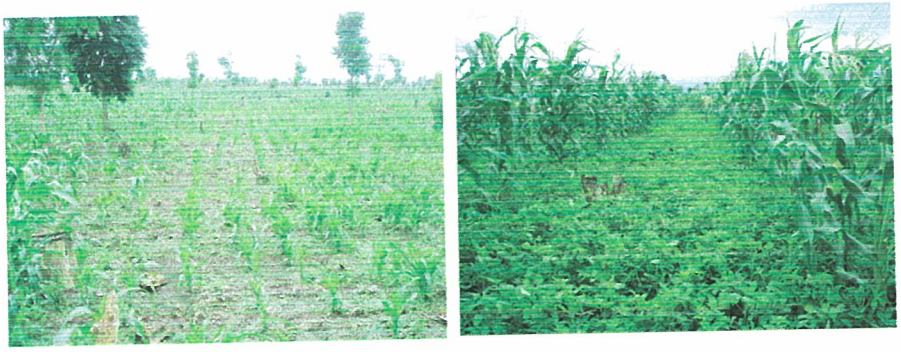


Figure 5. Condition of selected site for seed orchard establishment of *Planchonia valida*

2.3.2. Seed orchard experimental design

Based on the availability of selected site and number of seedling (Appendix 2), experimental design has been laid-out as follows:

m) Number of family : 80
n) design : RCBD (Randomized Complete Block Design)
o) Number of replication : 10
p) Number of tree-plot : 4
q) Spacing : 4 x 2 meter
r) Effective area : 2,56 hectares

2.3.3. Nursery

Some explanations and concepts for nursery are same as described in sub-chapter 2.1.3. However, in case of *P. valida*, there was any problems regarding the availability of seedling, that is, seed collection was not enough. Regarding to this problem, BPTH Bali-Nusra decided to use wildlings growing under selected mother trees. Wildlings are then transferred and maintained in nursery. Seedling packing and labeling is shown in Figure 6.

Figure 6. (a) Labeling on the seedling of *Planchonia valida*, (b) Attached label seedling ready to be transported to the field.

Using wildling as genetic materials for seed orchard establishment was taken as an alternative option due to unavailable of seed collection. However, consequence of this approach is that in future the seed orchard will be categorized as seed production area. This is because the relationship of the wildlings and their mother trees could not be surely controlled. In addition, the uniformity age of wildlings among families could not be detected. In operational

scale, the existence of seed production area of this species is still very important to supply high quality seed.

2.3.4. Land preparation

Some explanations and concepts for land preparation are same as described in sub-chapter 2.1.4.

2.3.5. Planting

Some explanations and concepts for planting are same as described in sub-chapter 2.1.5.

2.3.6. Maintenance

Some explanations and concepts for nursery are same as described in sub-chapter 2.1.6.

2.3.7. Assessment and data analysis

Some explanations and concepts for assessment and data analysis are same as described in sub-chapter 2.1.7.

3. CLOSING

3.1. Seed orchard of *Dysoxylum densiflorum*

Selected site for seed orchard establishment of *D. densiflorum* is located at Tegal Bunder, RTK 19, RPH Sumber Kelampok, Village of Pajarakan, District of Buleleng, Province of Bali, with total effective area is about 1,95 hectares. Seed orchard is laid-out using randomized complete block design with 61 families, 10 replications, 4 tree-plot and spacing 4 x 2 meters. Due to time limitation, land preparation and planting practiced using *cemplongan* with line-direction. Considering the limitation of rainy season and seedling age, planting has been done carefully.

3.2. Seed orchard of *Alstonia scholaris*

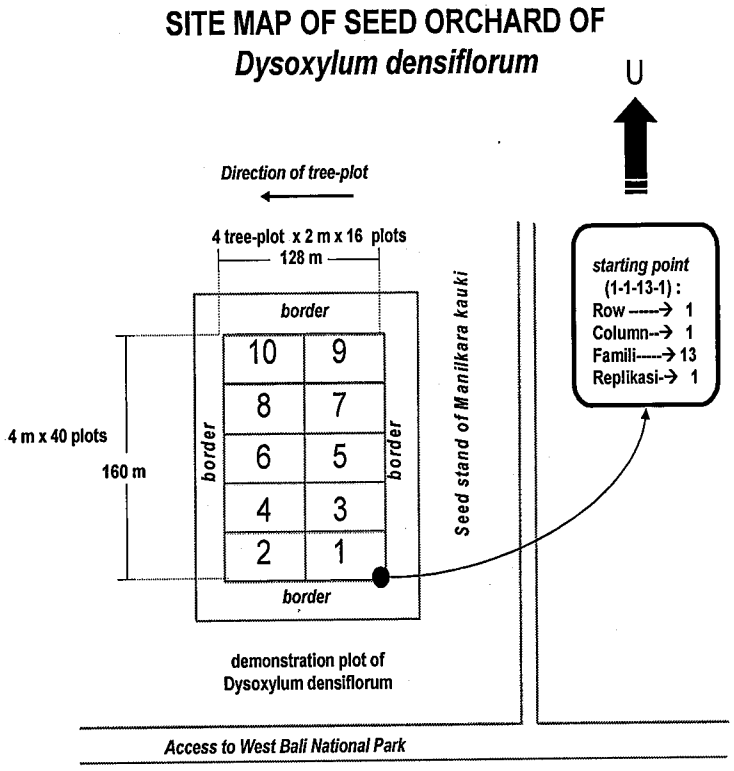
Selected site for seed orchard establishment of *A. scholaris* is located at Tegal Bunder, RTK 19, RPH Sumber Kelampok, Village of Pajarakan, District of Buleleng, Province of Bali, with total effective area is about 0,92 hectares. Due to the seedling prepared by the project was not available; therefore, seedling will be supplied by BBPBPTH Yogyakarta. Seed orchard is laid-out using randomized complete block design with 41 families, 8 replications, 4 tree-plot and spacing 3 x 2 meters. Twice per day watering has been done during dry seasons to stimulate initial growth and to reduce appearing abnormal growth of trees.

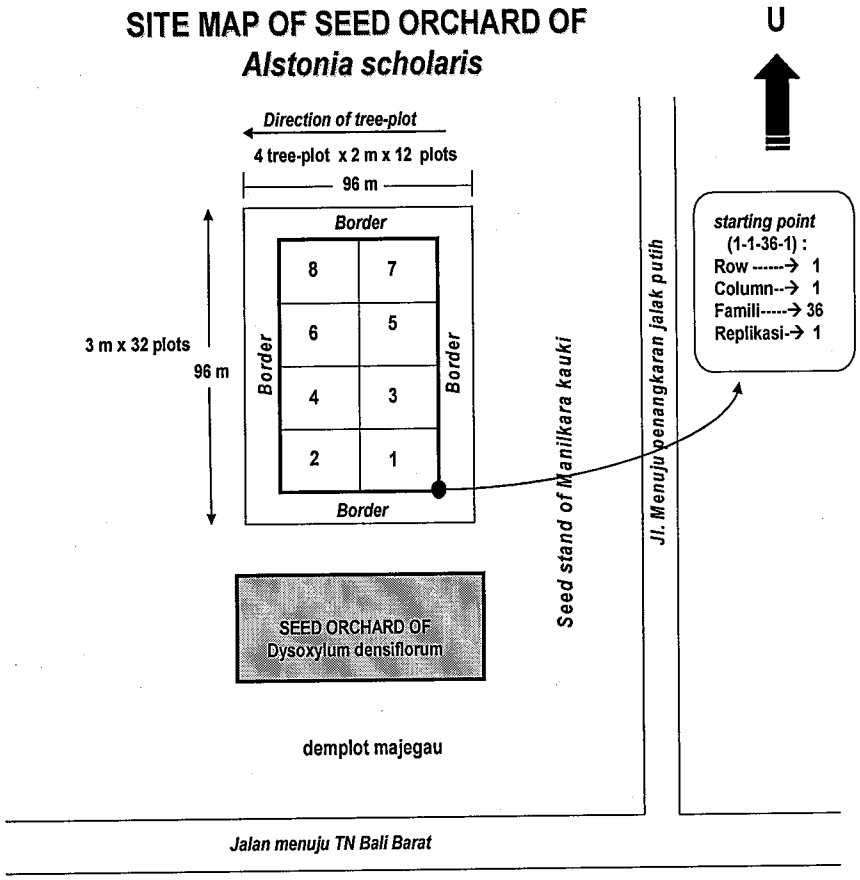
3.3. Seed orchard of *Planchonia valida*

Selected site for seed orchard establishment of *P. valida* is located at Tegal Bunder, RTK 19, RPH Sumber Kelampok, Village of Pajarakan, District of Buleleng, Province of Bali, with total effective area is about 2,56 hectares. Due to seed collection was not available, as alternative BPTH Bali Nusra decided to use wildlings growing under selected mother trees. By this approach, the seed orchard will be categorized as seed production area. Seed orchard is laid-out using randomized complete block design with 80 'families', 10 replications, 4 tree-plot and spacing 4 x 2 meters.

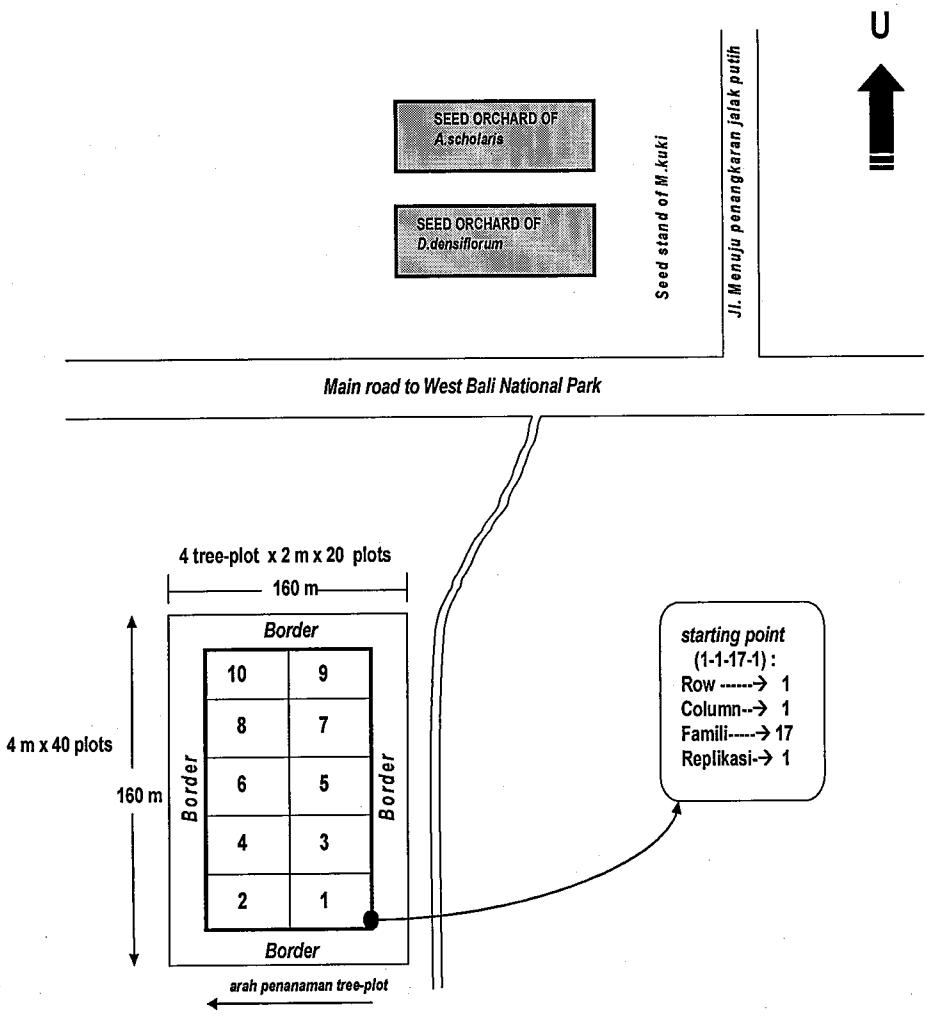
APPENDIXES

Appendix 1. Sites map of seed orchard




SITE MAP OF SEED ORCHARD OF
Alstonia scholaris
U
Direction of tree-plot
4 tree-plot x 2 m x 12 plots
96 m
Border
8
7
6
5
4
3
2
1
Border
Border
3 m x 32 plots
96 m
starting point
(1-1-36-1) :
Row ------> 1
Column---> 1
Famili-----> 36
Replikasi-> 1
Seed stand of Manilkara kauki
Jl. Menuju penangkaran jalak putih
SEED ORCHARD OF
Dysoxylum densiflorum
demplot majegau
Jalan menuju TN Bali Barat

SITE MAP OF SEED ORCHARD OF *Planchonia valida*



Appendix 2, Randomized family allocation map

RANDOMIZED FAMILY ALLOCATION MAP
SEEDLING SEED ORCHARD OF MAJEGAU IN BALI

No. family : 61
No. block : 10
No. tree plot : 4
spacing : 4 m x 2 m

→ *tree-plot direction*

(4 pohon x 2 m x 16 plot)

128 m

Row \ Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	13	23	26	41	30	37	7	21	27	24	59	22	17	29	9	62
2	39	5	48	51	46	42	50	11	3	45	16	25	39	46	4	62
3	27	43	9	17	6	19	25	52	34	13	2	33	36	41	31	62
4	62	24	15	58	60	31	59	35	15	49	23	7	14	56	21	42
5	61	57	36	34	16	56	33	4	57	30	44	47	19	28	54	52
6	62	8	18	53	20	40	3	12	20	11	60	35	53	38	5	37
7	62	55	1	49	29	32	22	54	58	6	55	32	51	12	62	26
8	62	45	28	14	47	38	44	2	48	40	18	8	61	1	50	43
9	62	14	21	44	34	15	59	26	52	31	56	46	14	40	9	36
10	62	12	5	62	50	19	40	42	16	19	28	60	54	20	24	41
11	62	55	8	41	31	6	3	20	37	29	5	2	13	6	15	33
12	45	27	38	17	56	25	47	24	27	51	12	23	30	62	35	25
13	57	61	36	4	29	33	52	58	42	22	45	43	4	39	7	61
14	37	11	30	23	9	48	2	39	18	11	50	17	57	1	47	62
15	18	22	54	7	1	32	35	43	21	8	55	53	32	59	38	62
16	60	49	46	28	13	16	53	51	49	34	58	44	26	48	3	62
17	20	26	57	2	22	38	18	56	9	52	60	7	23	16	18	62
18	33	52	4	30	51	3	35	29	47	22	32	20	14	11	33	62
19	12	15	9	36	32	45	58	39	41	43	40	3	50	53	46	62
20	44	37	28	25	8	61	23	53	49	15	12	54	6	17	55	35
21	13	6	40	31	27	16	50	62	29	2	62	31	34	4	24	59
22	62	34	14	46	5	11	41	48	56	27	51	37	39	13	26	38
23	62	17	43	19	49	60	21	1	58	36	42	21	1	61	19	5
24	62	47	59	55	24	42	7	54	45	25	57	30	44	48	8	28
25	62	22	33	35	9	34	20	14	28	31	60	19	6	47	52	15
26	62	54	25	3	38	12	23	62	8	38	22	26	61	41	50	12
27	62	7	18	57	42	29	51	21	29	33	1	58	9	59	54	7
28	27	45	49	2	17	44	40	56	45	48	42	11	53	37	46	21
29	32	28	4	59	26	47	60	16	40	13	24	17	55	23	34	44
30	53	41	6	11	13	61	39	8	30	18	32	35	3	5	62	62
31	1	36	48	24	5	15	37	58	27	57	4	56	14	49	36	62
32	52	55	19	30	31	43	50	46	2	16	43	51	25	39	20	62
33	21	26	51	17	28	36	25	13	30	35	26	22	19	60	25	28
34	59	55	9	15	6	42	54	40	38	18	4	40	16	14	6	49
35	52	12	37	18	23	31	2	46	59	11	31	1	8	33	54	42
36	7	30	62	35	14	41	20	50	3	39	45	43	20	17	27	23
37	47	16	57	44	39	60	33	53	37	52	29	2	47	36	12	58
38	43	38	8	3	34	11	4	1	21	7	62	57	44	53	24	5
39	62	29	22	58	49	19	45	5	41	46	13	32	9	55	50	34
40	62	62	62	62	62	27	32	24	15	62	62	62	62	62	62	62

160 m

(4 m x 40 plot)

Note 62 is filler for empty plot

RANDOMIZED OF FAMILY ALLOCATION MAP
SEED ORCHARD OF PULAI IN BALI

No. family : 48
No. block : 8
No. tree plot : 4
Spacing : 3 x 2 m

tree-plot direction →

(4 pohon x 2 m x 12 plot)

96 m

Row	Column 1	2	3	4	5	6	7	8	9	10	11	12
1	36	15	7	49	16	13	36	4	34	24	18	49
2	4	23	20	42	35	31	33	12	10	31	2	35
3	29	14	3	37	5	44	9	39	22	28	14	43
4	26	38	11	9	47	34	7	16	11	40	19	30
5	12	8	33	25	45	17	46	41	38	42	21	25
6	40	2	39	1	19	10	27	1	6	23	17	47
7	43	24	18	22	28	21	13	37	8	20	49	5
8	48	6	27	41	46	30	26	29	44	3	45	15
9	2	11	6	19	33	14	43	2	38	41	18	42
10	15	13	34	29	40	47	25	23	10	5	11	14
11	36	42	3	18	1	16	9	6	49	34	24	1
12	21	39	8	35	5	31	21	15	27	36	29	49
13	25	4	26	41	22	45	13	17	33	44	46	49
14	43	12	38	17	37	9	19	26	8	12	7	49
15	27	23	20	10	44	24	3	28	31	20	40	49
16	49	30	28	46	7	49	22	35	4	45	16	49
17	49	8	13	16	10	25	19	9	26	21	5	49
18	49	20	34	27	18	21	41	1	15	17	42	49
19	49	6	23	14	12	4	29	7	24	46	25	49
20	49	11	3	43	19	9	20	16	12	10	4	49
21	49	35	40	17	41	44	23	34	43	36	22	49
22	49	22	7	5	2	46	6	3	40	28	8	49
23	49	15	45	36	42	33	14	27	38	13	2	49
24	1	28	38	29	26	24	11	18	44	35	45	49
25	6	12	16	21	10	19	4	6	22	1	9	49
26	43	2	44	5	25	13	15	25	46	27	41	49
27	23	14	18	28	20	38	17	2	16	14	38	49
28	11	46	7	40	9	4	12	5	21	44	7	49
29	41	36	27	3	22	1	19	10	28	13	11	49
30	49	15	24	17	49	34	24	40	18	23	3	49
31	49	49	49	49	49	49	49	49	49	49	49	49
32	49	49	49	49	49	49	49	49	49	49	49	49

(3 m x 32 plot)

96 m

Note 49 is filler for empty plot

RANDOMIZED OF FAMILY ALLOCATION MAP
SEED ORCHARD OF PUTAT IN BALI

No. family : 80
No. block : 10
No. tree plot : 4
Spacing : 4 x 2 m

(4 pohon x 2 m x 20 plot)

Column ⟶ *tree-plot direction*

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	17	45	64	15	65	71	50	47	61	79	44	72	34	3	31	4	77	56	24	74
2	51	76	19	3	27	7	4	59	8	12	30	78	47	21	67	62	32	75	37	39
3	35	11	25	41	18	32	39	73	40	24	58	76	61	14	73	28	66	19	7	71
4	13	38	31	23	14	74	55	26	20	53	68	64	8	40	49	70	43	16	2	46
5	80	62	2	52	72	78	21	28	60	57	35	18	80	12	5	23	41	6	33	65
6	30	66	42	48	46	75	54	9	5	70	45	38	63	36	25	20	57	1	29	10
7	6	36	16	56	67	49	22	33	63	77	51	79	11	48	50	54	26	60	9	17
8	58	29	68	10	37	44	1	43	69	34	27	59	42	53	13	52	69	15	55	22
9	55	65	74	41	62	76	4	7	37	80	29	16	78	68	32	37	77	58	31	72
10	19	12	23	72	27	14	54	33	53	9	5	39	12	2	10	46	36	14	3	43
11	42	70	18	25	69	11	24	30	79	38	45	66	79	75	70	4	73	33	26	9
12	29	26	52	61	8	66	5	3	60	32	52	19	47	17	57	6	38	21	67	30
13	50	10	56	17	68	40	15	64	35	28	25	48	62	34	13	71	60	63	80	49
14	39	75	58	45	20	51	46	49	43	21	41	8	54	44	42	28	22	56	40	53
15	34	16	71	1	31	44	2	22	13	73	15	27	18	51	61	74	76	23	20	50
16	36	78	48	67	77	47	59	63	6	57	55	1	69	65	7	59	35	11	64	24
17	44	72	25	18	52	3	54	78	65	26	37	49	79	10	78	15	45	27	29	69
18	74	14	50	4	9	58	41	43	80	46	14	70	31	23	66	36	3	17	9	75
19	21	39	76	29	69	17	1	67	20	16	5	59	62	80	21	13	76	53	42	46
20	71	6	31	56	7	19	11	34	75	40	55	63	7	73	26	52	71	22	50	64
21	15	24	12	48	60	5	30	32	64	23	40	51	35	2	33	18	58	43	61	8
22	22	33	28	8	10	62	55	51	77	73	57	4	48	25	28	72	77	68	38	56
23	79	57	49	38	59	66	42	35	13	37	12	54	20	39	41	34	6	30	65	47
24	68	47	36	27	61	70	63	2	45	53	19	60	32	16	11	1	24	44	74	67
25	46	25	5	45	58	50	40	33	6	41	49	5	74	45	36	8	69	14	55	31
26	30	70	15	48	16	22	42	24	47	26	29	51	38	64	19	75	73	57	4	77
27	66	13	37	64	4	68	44	55	78	14	44	17	27	42	58	33	62	79	37	16
28	18	9	3	10	75	72	79	35	27	2	76	23	3	20	80	47	26	66	60	63
29	28	56	80	7	20	54	12	17	49	73	25	48	32	18	53	22	10	68	21	12
30	74	52	69	21	38	60	32	34	77	65	30	39	67	35	71	24	61	9	34	43
31	19	76	62	59	8	57	51	29	67	1	7	13	46	11	52	15	59	65	6	40
32	36	31	11	23	43	53	39	61	71	63	54	41	70	78	50	72	2	56	1	28
33	43	22	1	68	48	26	30	76	47	12	48	3	27	5	20	7	63	80	41	14
34	18	13	38	33	73	14	25	69	35	58	23	79	40	75	49	58	28	26	64	39
35	77	59	5	70	63	9	44	3	74	62	8	11	35	65	53	21	77	34	50	33
36	55	28	8	61	57	32	11	31	6	37	51	31	69	46	73	16	13	55	1	4
37	15	67	78	10	29	65	2	75	80	42	2	57	18	74	30	52	10	61	37	9
38	49	17	41	56	24	50	21	60	23	27	47	54	36	32	24	43	78	44	59	19
39	54	7	66	71	36	16	52	4	72	40	38	45	60	71	29	15	70	17	68	25
40	45	34	53	39	64	51	19	46	20	79	12	6	62	56	42	67	76	66	22	72

(4 m x 40 plot)

160 m

160 m