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Assessment and Analysis of two Pinus kesiya Provenance Trials in Swaziland

Trial No. 5, R136 (Block G) and Trial No. 6, R136 (Block J)

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Assessment and analysis report of two *Pinus kesiya* provenance trials in Swaziland

Trial No. 5, R136 (Block G) and Trial No. 6, R136 (Block J)

by

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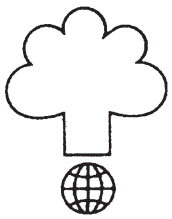

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Danida Forest Seed Centre (DFSC) is a Danish non-profit institute which has been working with development and transfer of know-how in management of tree genetic resources since 1969. The development objective of DFSC is to contribute to improve the benefits of growing trees for the well-being of people in developing countries. DFSC's programme is financed by the Danish International Development Assistance (Danida).

Preface

This report presents the results of a joint assessment of two *Pinus kesiya* provenance trial established by Usutu Pulp, Swaziland in February 1990 as part of an international series of provenance trials of the species.

The joint Usutu/DFSC field assessment took place in August 1998 by a team lead by Milton, research and Development, Usutu Pulp, Dorthe Jøker and Christian Pilegaard Hansen of DFSC.

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Acronyms and abbreviations

BSO	Breeding seed orchard
CAMCORE	Central America and Mexico Coniferous Resources Co-operative, USA
CIEF	Centro de Investigaciones y Experiencias Forestales, Argentina
CSIRO	Commonwealth Scientific and Industrial Research Organisation, Australia
CSO	Clonal seed orchard
Danida	Danish International Development Assistance
DFSC	Danida Forest Seed Centre, Humlebæk, Denmark
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária, Petrolona, Pernambuca, Brazil
FAO	Food and Agriculture Organization of the United Nations, Rome, Italy
FRC	Forest Research Centre, Forestry Commision, Harare, Zimbabwe
ICFRE	Indian Council of Forestry Research and Education, Dehra Dun, India
IF	Instituto Florestal, São Paulo, Brazil
IPEF	Instituto de Pesquiasa e Estudos Florestais, Piracicaba, Brazil
OFI	Oxford Forestry Institute, United Kingdom
RCFTI	Research Centre for Forest Tree Improvement, Forest Science Institute, Vietnam
RFD	Royal Forest Department, Thailand

1. Background

The two trials form part of an international series of provenance trials of *P. kesiya*.

The objective of the international series is to explore and analyse the genetic variation in growth, quality and adaptive traits among provenances of *P. kesiya* throughout the range of the species. The results will facilitate an informed choice of seed source in planting programmes. Furthermore, the results will be useful when planning conservation activities of the species.

Below the background of the international series is briefly described.

Initial research on inter-population differences in *P. kesiya* was undertaken in Zambia in the 1950s. The test material included provenances from the Philippines, Vietnam and Assam (Armitage and Burley 1980).

During 1969, FAO and the Forest Research Institute of Australia sponsored seed collections of 19 seed sources of *P. kesiya* from the Philippines (17 provenance collections and 2 commercial seedlots). The material was complemented by two Zambian land races (of Philippine and Vietnamese origin, respectively). These collections were used for provenance trials in a large number of countries for which the Commonwealth Forestry Institute supplied advice and assisted in data processing and interpretation (Burley and Wood 1976). Results from individual trials were reviewed by Gibson and Barnes (1984). They concluded that neither provenance representation nor test site representation warranted an international evaluation. It was recommended that a more comprehensive exploration and analysis of the genetic variation of *P. kesiya* should be undertaken. Recommendations in this regard was also put forward by the Sixth Session of the FAO Panel of Experts on Forest Gene Resources (FAO 1988).

Exploration of provenance variation and collection of seed for field trials took place in the late 1980s in collaboration between national institutions in Brazil, Myanmar, China, Madagascar, Philippines, Thailand, Vietnam, Zambia, Zimbabwe, Oxford Forestry Institute (OFI) and Danida Forest Seed Centre (DFSC). In 1988, seed collections were complete and distribution to collaborating countries could begin (Barnes et al. 1989). Distribution of seed was co-ordinated by OFI and handled by DFSC. During 1989-93, seed of 42 provenances and land races from the above 9 countries were distributed to 20 institutions in 19 countries. Some seedlots were separated by family to allow testing of individual progenies.

A status on seed distribution and established field trials is found in DFSC (1996) and DFSC (1997). Some 30 trials have been established in 17 countries. Trials in Argentina, Brazil, Colombia, Indonesia, South Africa, Swaziland, Vietnam and Zimbabwe are reported with high survival and are in general in good conditions. Status of trials in Burundi, India, Rwanda and Sri Lanka is unknown, as no information has been received from these countries. Trials established in Fiji, Kenya, Nepal, the Philippines and Thailand have been abandoned because of fire damage, drought and browsing.

In a circular letter sent out by OFI and DFSC in 1996, host institutes were asked about their interest in undertaking a joint evaluation and were at the same time asked about the status of the trials (DFSC 1996). Positive responses in regard to the proposal of undertaking a joint assessment and analysis of trials have been received from all countries where existence of trials has been confirmed. The number, distribution and representation of provenances in these trials were considered sufficient to justify an assessment and analysis of the international series. Of special interest is the possibility of an in-depth analysis of provenance x site interactions, thanks to the representation of the same set of provenances at many trial sites.

A manual was elaborated during 1997-98 with a proposal for a set of characters to be assessed in all trials (DFSC 1998). Field assessment of trials commenced in April 1998 in Vietnam.

2. *P. kesiya* provenance trials in Swaziland

2.1 Earlier trials

Two trials were established in 1972 by Usutu Pulp as part of the first international series of trials as described above. The trial sites represented a low altitude planting site (770 m) and a high altitude site (1460 m). 9 seed lots of *P. kesiya* were tested plus *P. patula* and *P. elliottii* controls. Of the *P. kesiya* sources, 7 originated in the Philippines, one was a land race from Zambia (of Vietnamese origin) and the last source was a landrace from Malawi of unknown origin. Results are presented by Morris (1984). He concluded that

- Ranking of provenances differs depending upon the measure of growth, which is made. Analysis of height, diameter and volume production per ha do not giv the same ranking. This is because of differences in stem taper and survival at establishment;
- Volume production of *P. kesiya* is superior to *P. elliottii* at lower altitudes and slightly inferior to *P. patula* at higher altitudes;
- The stemform of *P. kesiya* is inferior to both *P. patula* and *P. elliottii* and is a serious limit to its value for pulp production at Usutu;
- Although there is some variation in vigour and form between *P. kesiya* provenances this is not so great as to influence the two conclusions stated above;
- Use of *P. kesiya* as a major species in the Usutu Forest is dependant upon a seed source giving trees with acceptable form and upon the long term influence of pine woolly aphid on tree growth (Morris 1984).

2.2 Present series of trials (R136)

Usutu Pulp has established three trials of *P. kesiya* as part of the international series of trials initiated in the late 1980's. The trials are situated in the G-Block, J-Block and A5 respectively. The trial in the G-Block is at low altitude (800 m) and gentle slope. Block J is a higher altitude site (1100 m) and at a steep slope. The A5 trial is also at high altitude (1120m) and represents a different land type to the J-Block. Compared to Block G and J, A5 is a smaller trial with fewer entries and smaller plots. Because of time constraints, the A5 trial had to be left out of the field assessment, and the assessment and analysis hence only encompass the trials in Block G and J.

The same 25 entries are tested in the trials in Block G and J. There are 21 sources of *P. kesiya*/*P. yunnanensis* and 4 controls. The seed lots are summarised in the below table. Information on trial design is in Annex 2 and site information is in Annex 3.

Most of the seedlots originate from un-improved natural sources (collections in the natural forests).

The two seed lots from John Meikle CSO (Zimbabwe), the Zambia CSO seedlot and the two sources from Madagascar are improved sources. Little is known about the level of improvement of the sources from Madagascar, most likely the Bodana populations are seed stands, i.e. stands where inferior trees have been removed. The origin of the material is likely to be from Vietnam. The two seedlots from John Meikle CSO originated from single clones. Seed from all the ramets of this clone in the orchard has been bulked and thus represent half-sibs where the male percentage is (theoretically) a mixture of all the other clones in the seed orchard. It follows that results have to be interpreted with great care as they may not give a fair representation of the seed orchard as such.

Seedlots 1624 (Baoshan), 1632 (Ceheng) and 1633 (Shangsi) are *P. yunnanensis*.

Because of its slow growth, it was decided not to include *P. roxburghii* in the assessment and analysis.

No.	Acc. no. (DFSC)	Provenance	Country	Latitude	Longitude	Altitude m.a.s.l.	Rainfall mm/ year	Temp. °C	No. Coll.
1	01447/84	Mt. Province	Philippines	17 15 N	120 55 E	2300	.	.	83
2	01448/84	Benquet	Philippines	16 35 N	120 30 E	1600	.	.	64
3	01515/85	Dathien	Vietnam	11 58 N	108 27 E	1550	1769	17.9	45
4	01518/85	Thac Prenn	Vietnam	11 52 N	108 27 E	1250	1769	17.9	30
5	01519/85	Lang Hanh	Vietnam	11 37 N	108 16 E	950	2059	21.5	22
6	01521/85	Nong Krating	Thailand	18 05 N	98 35 E	1080	1332	22.2	17
7	01523/85	Doi Inthanon	Thailand	18 32 N	98 35 E	1000	2084	20	30
8	01525/85	Nam Now	Thailand	16 40 N	101 33 E	800	1316	.	35
9	01635/86	Jingdung (1)	China	24 26 N	100 51 E	1300	.	.	30
10	01637/86	Jinghong	China	22 25 N	101 10 E	1250	.	.	24
11	01638/86	Lancang	China	22 40 N	100 03 E	1620	.	.	15
12	01773/88	Aungban	Burma	20 41 N	96 37 E	1350	1303	20.5	61
13	01772/88	Zokhua	Burma	22 25 N	93 40 E	1600	2335	15	20
14	01776/88	John Meikle CSO	Zimbabwe	18 43 S	32 51 E	1268	1725	17.9	1
15	01779/88	John Meikle CSO	Zimbabwe	18 43 N	32 51 E	1268	1725	17.9	1
16	01783/88	Bodana Population A8	Madagascar	20 35 S	47 30 E	1500	.	.	.
17	01784/88	Bodana Population A8	Madagascar	20 35 S	47 30 E	1500	.	.	.
18	01778/88	Clonal Seed Orchard	Zambia	13 00 S	28 00 E	1300	.	.	10
19	01624/86	Baoshan (1)	China	24 51 N	99 12 E	1750	.	.	26
20	01632/86	Ceheng	China	24 24 N	105 34 E	800	.	.	25
21	01633/86	Shangsi	China	21 37 N	107 57 E	530	.	.	25
22	PAT	Select - *P. patula*	Zimbabwe	.	.	.	.	.	.
23	TAE	CSO - *P. taeda*	Zimbabwe	.	.	.	.	.	.
24	ELL	CEO - *P. elliottii*	South Africa	.	.	.	.	.	.
25	ROX	CSO(SAFRI) - *P. roxburghii*	South Africa	.	.	.	.	.	.

Note: 'No. coll.' is the number of mother trees represented in the seed lot.

3. Field assessment and data management

The assessment in general followed the methodology described in DFSC (1998) which involves the characters:

1. Survival;
2. Health;
3. Social status (Kraft);
4. Height;
5. Diameter (DBH);
6. Straightness;
7. No. of whorls;
8. No. of branches in whorl;
9. Branch diameter;
10. Crown length;
11. No. of forks;
12. Position of first fork;
13. Foxtail;
14. Flowering and fruiting;
15. Wood density (Pilodyn);

For a detailed description of the assessment methodology, please refer to DFSC (1998).

In Block G the inner 25 trees were assessed in each plot (total 49 trees in each plot). In Block J, because of time constraints, assessment had to be limited to 15 trees in each plot (three central rows, 5 trees in each row).

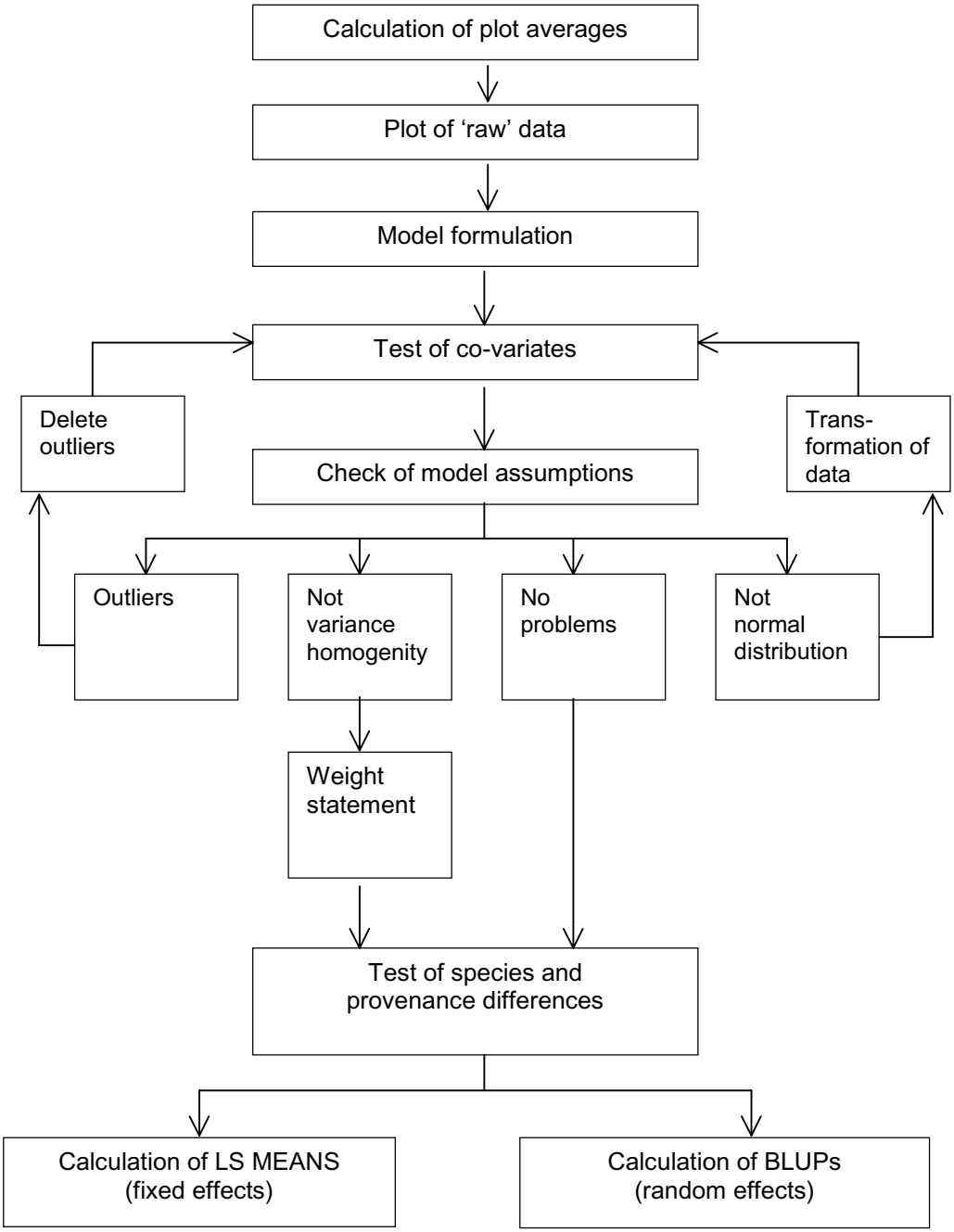
Relative wood density was measured with a Pilodyn wood tester with pin diameter 2.0 mm.

Assessment data was recorded in the field on assessment sheets, see example in DFSC (1998). The data was immediately after the assessment entered to a lap-top computer in spreadsheet format. From the shread-sheet, data was later imported to a SAS-dataset for further analysis.

The trials have been analysed as balanced, incomplete block designs.

4. Statistical analysis

Overview of steps involved in the statistical analysis



The objectives of the statistical analysis are:

- to examine statistically significant differences between seedlots (provenances) in adaptability, growth and quality traits. A list of analysed traits is provided in Chapter 5;
- to conclude and recommend on the practical application of the results (species and provenance recommendations);
- to investigate patterns of genetic variation;
- to provide data for an overall analysis of the international series of provenance trials of *Pinus kesiya*, i.e. analysis across sites. This step will await completion of the analysis of individual trials.

Statistical analysis is done on plot values, e.g. plot averages or plot sums. Calculation of plot values is described in Annex 4.

The SAS analytical package has been used for the analysis (SAS, 1990).

The statistical analysis of each trait follows a sequence of steps. They are:

1. Plot of raw data;
2. Formulation of statistical model;
3. Test of co-variates;
4. Check of model assumptions;
5. When model assumptions are not fulfilled: (a) transformation of data; (b) deletion of outliers; (c) weight statement;
6. Test of differences between species and provenances;
7. Calculation of lsmeans (estimated from a model with fixed effects);
8. Calculation of BLUPs (estimated from a model with random effects).

The statistical analysis is illustrated in the above figure and the steps are further described in the below text.

Generally speaking, two different approaches are applied in the statistical analysis: a fixed effect approach and a random effect approach. The fixed effects approach is concerned with the genetic entries (seedlots) actually in the trial, whereas the random effects approach concerns what would happen if the experiment was to be repeated. Following the fixed effect approach, the estimates are calculated as least square means (lsmeans), whereas the random effect approach gives the best linear unbiased predictors (BLUPs). See further explanation below.

4.1 Plot of raw data

The main purpose of the plots is to indicate the scale of the variable along with a first impression of the variation within the trial. Often the visual inspection of the data reveals clear differences between the provenances, or gives hints regarding proper transformations of the data. Obvious outliers (extreme values) may also be identified already at this stage.

The most useful single plot is probably a plot of the variable against the provenances, marking the values with values identifying the blocks. However, other plots may also be relevant, e.g. plotting the values by block or by the distance along the axis of the trial.

4.2 Statistical model

The test of differences between seedlots (provenances) is based on the model:

$$X_{jk} = \mu + provenance_j + block_k + \varepsilon_{jk}$$

where X_{jk} is the value of the trait in question (e.g. height) in plot *jk*,
μ is the grand mean,
$provenance_j$ is the effect of seedlot number *j* and is assumed to be either a fixed or a random effect, according to which approach is used (see later),
$block_k$ is the effect of block *k* in the trial, assumed to be a random effect, and
ε_{jk} is the residual of plot *jk* and is assumed to follow a normal distribution $N(0, \sigma_\varepsilon^2)$.

Please note that the controls (seedlots not *Pinus kesiya*/*P.yunnanensis*) are considered (analysed) together with these sources not considering that they actually are sources of different species.

4.3 Co-variates

In order to reduce the residual variation in trials with heterogeneous trial conditions (e.g. variation in soil, elevation, slope and exposure within trial), a number of co-variates are included in the model. As a standard routine the following four co-variates are tested:

plotx: Horizontal position of plot within trial (see map of trial);
ploty: Vertical position of plot within trial (see map of trial);

To catch non-linear patterns of site variation vertically and horizontally, plotx2 and ploty2 are applied:

plotx2: $plotx2 = (plotx - mean(plotx))^2$
ploty2: $ploty2 = (ploty - mean(ploty))^2$

In addition to the above four co-variates, additional co-variates are considered in some of the trials:

level: Level of plot in relation to a reference plot within the trial (0);
plotxy $Plotxy = plotx \times ploty$

In testing the effect of co-variates, we start with a model with all co-variates included. Co-variates that are not significant are removed successively

by removing the least significant co-variate and running the model again until all remaining co-variates in the model are significant ($P<0.10$).

4.4 Check of model assumptions

The statistical model rests on a number of standard assumptions. Key assumptions are (see e.g. Box et al. 1978):

(i) that the residuals are independent;
(ii) that the residuals follow a normal distribution;
(iii) that there is variance homogeneity in effects included in the model.

The model assumptions are checked graphically by producing a number of plots:

1. Student's residuals versus predicted values;
2. Cooks distance versus predicted values;
3. Student's residuals versus provenance;
4. Frequency chart of residuals;
5. Student's residuals versus block;
6. Student's residuals versus plotx;
7. Student's residuals versus ploty;
8. Student's residuals versus level (if level is among the considered co-variates).

The residuals represent variation that can not be accounted for by the model. For each observation, the model calculates a predicted value, taking into account the effects of the model (provenance, block and co-variates). The residual variation is then the difference between the observed value and the predicted value.

Student's residuals (also called 'standardised residuals') are calculated as the residual divided by its standard error. If the assumption of normal distributed residuals is valid, the Student's residuals have the property of a normal distribution with mean 0 and variance 1, meaning that 95% of the values should lie within ± 1.96. In cases of trials with imbalance, the Student's residuals correct for imprecision due to low sample numbers, and in models with co-variates they compensate for large deviations at extreme values.

The Student's residual e_t for observation *ij* is given by

$$e_t = \frac{e_{ij}}{s_{ij}} = \frac{X_{ij} - P_{i\bullet} - B_{\bullet j}}{s_{ij}}$$

where e_{ij} is the residual, X_{ij} is the value for observation *ij*, $P_{i\bullet}$ is the effect of provenance *i*, $B_{\bullet j}$ is the effect of block *j*, and s_{ij} is the standard deviation (standard error) of observation *ij*.

Cooks distance gives a measure of the influence of a single observation (plot) on the model, and gives an indication of possible 'outliers' (see below) (Afifi & Clark 1996). A high value indicates an observation with a large influence on the outcome of the model.

In the following, a description of the check of the model assumptions is given.

Independence

The assumption of independence means that the residual of one observation is not dependent on the residual of another. This assumption is typically violated when using pseudo-replicates, e.g. when doing more observations on the same experimental unit and treating them as different experimental units. Another example is when two or more plots of the same provenance within the same block are treated as independent observations. In such cases, an average of the values should be used as the block value for the provenance in question.

The graphical check of the residuals does not reveal possible problems with observations dependent upon each other, and there is no easy method to ensure that the condition of independence is fulfilled. Proper design and planning of the experiment result and application of a correct statistical model is the best insurance to obtain independent observations.

The assumption of independence may also be violated if there is a time- or site-dependency in the data. To check for such dependency, residuals are plotted against the horizontal and vertical axis of the trial (plotx and ploty) and where applicable, also the level of plot, to investigate any systematic environmental variation. Usually there is none, as the co-variates (plotx and ploty) account for this.

Normality

The assumption of normality may be checked in various ways, graphically as well as by statistical tests. In this analysis, we use the frequency chart of residuals as a graphical check. In the frequency chart, the frequencies should be more or less bell-shaped with no large tails at the ends. A formal statistical test, the Shapiro-Wilk statistic, is given in the SAS-procedure UNIVARIATE with the option NORMAL (SAS 1988a). This procedure also offers different kinds of plots of the residuals. However, since the test is usually considered to be conservative, rejecting only severe deviations from normality, the test results should be considered with caution (Brockhoff, pers. comm.).

When the number of observations is low, it becomes increasingly difficult to check the assumption of normality. Even though the frequency chart may show a rather odd and irregular distribution, this need not be a sign of non-normality. At small sample sizes it is not unlikely that odd distributions may result from random variation, and unless the test for normality demonstrates that the assumption is violated, there is no need to reject the model. On the other hand, when the number of samples is very large, the test for normality may become rejected even though the frequency chart of residuals appears to be normal. This is because the power of the test increases with the number

of observations, and even small deviations from normality may result in rejection of the hypothesis of normal distributed residuals. In such cases it should be considered whether the frequency chart indicate that the assumption is fulfilled, or the deviations are so large that transformation of data (see later) is required.

Deviations from the assumption of normality may also be interpreted as a distribution with a large number of outliers (see later).

Variance inhomogeneity
Variance inhomogeneity occurs when different experimental units (blocks and provenances) have different variance. A typical example is when the residuals of some provenances appear very clustered in the diagram of Student's residuals versus provenances, whereas the residuals of other provenances are spread out, often with values of Student's residuals exceeding ±2. This may result from a simple scale effect (larger provenances have larger variance), in which case the plots of Student's residuals and Cook's distance versus predicted values appear funnel-shaped. It may also be related to the provenance itself (some provenances are more variable than others). In this case, the variance inhomogeneity will be displayed in the plot of student's residuals versus provenance.

Outliers
Outliers are extreme observations that do not follow the trends of the remaining data. Such observations may have a large influence on the estimates and statistical tests of the model and should therefore be considered carefully.

Outliers are detected by inspection of the plots of Student's residuals and of Cook's distance. Observations that have values of Student's residuals exceeding ±2.5 (rule of thumb), and observations with large values of Cook's distance, are possible outliers and should be investigated further. Outliers may be due to errors in the recording or typing of data, or due to mislabelling of the seedlots in the nursery or in the field. Poor survival in the plot, leaving only a few trees to use in the calculation of plot means is another source of outliers. However, it also happens that the outliers are due to some unexplained variation, perhaps in soil conditions or other environmental variation. Finally it should be mentioned that a large number of outliers might indicate that the distribution of residuals is not normal, and hence that a transformation of data is required (see later).

When outliers occur as a result of errors, the dataset should of course be corrected, which will solve the problem. It is less obvious what to do in the cases where there are no easy explanations. Outliers should only be excluded if it can be justified, i.e. an explanation can be given. In a few cases, however, explanations were not found, and observations were excluded alone on basis of the extreme nature of the value. Great care is required in the decision to exclude plot values, as it will have great importance for the result of the analysis, especially with few blocks (replications). Running the analysis again without the outlier(s) gives an indication of the sensitivity of the analysis in regard to the outliers, and assist in deciding whether to keep or delete the extreme observation(s).

In the interpretation of the statistical analysis in this report, it is always mentioned if one or more extreme values have been considered as outliers and omitted from the analysis, and on what grounds.

4.5 What to do when model assumptions are not fulfilled?

In many cases one or more of the model assumptions are not fulfilled. In the below, procedures for correction are described.

Independence
Apart from making sure that the statistical design and the model is correct there is not much to do about dependence between observations. If some clear variation can be observed in the residuals, other co-variates than the ones mentioned above could be considered.

Deviations from normality
Usually deviations from normality are handled by transformation of data. Snedecor & Cochran (1980) and Afifi & Clark (1996) provide guidance on data transformations:

1. Counts (of rare events) often follow a Poisson distribution and are transformed with the square root.
2. Variables having a binomial character (e.g. dead or alive) summarised in a proportion (e.g. living trees in a plot) may be transformed with the arc sine transformation.
3. If the standard deviation varies directly with the mean, a logarithmic transformation may stabilise the variance.

There are theoretical reasons for choosing the above transformations (Snedecor & Cochran 1980), but it follows from Afifi & Clark (1996) that the range of transformations may be seen as a continuum and that various other transformations are available.

None of the variables included in the present assessment have the character of a Poisson distribution, but the square root transformation has nevertheless in some cases been applied.

In many cases the analysis of survival data results in skewed distributions of the residuals, with tails at either the lower or upper end (many trees dead or many trees alive). In such cases an arc sine transformation of data will often prove useful.

The arc sine transformation is given by

$$\arcsin(proportion) = \sin^{-1}\sqrt{proportion}$$

where proportion is a figure between zero and one (e.g. the surviving fraction of trees). An important property of the transformation is that the variance near zero or one is stretched out, thus facilitating the analysis of variance (Snedecor & Cochran 1980).

For many growth variables, the variance increases directly with tree size, and the proper transformation is thus the logarithm. In most cases, the natural logarithm (ln) has been applied to achieve a normal distribution of residuals.

Variance inhomogeneity

In the cases where the variance varies with the size of the variable, a transformation of data is the proper way to solve the problem (see above). However, in some cases the provenances simply have different variances irrespective of size, and it is necessary to weight the observations with weights proportional to the reciprocals of the error variances to ensure variance homogeneity (SAS 1988b, cf. Afifi & Clark 1996). There may also be cases where different blocks have different variances, but this has not been observed in the present trial(s).

Weighting occurs in the following sequence: An ordinary analysis of variance of the variable is performed. The residuals from this analysis are grouped according to provenance, and the variance of the residuals for each provenance is calculated. The inverse of these variances is then used as weights in an analysis of variance. When calculating the sums of squares in the model, the weights are multiplied with the squared value of the deviance of each observation from the predicted value (SAS 1988b). This has the effect that provenances with small variances have a larger influence on the model than provenances with larger variances. In other words, the more stable the provenance, the more it counts in the analysis. Provenances with large uncertainty on the other hand have less influence.

4.6 Fixed or random effects

A special problem relates to the choice between considering the effects in the statistical model as fixed or random. Statistically speaking, fixed effects are considered as *parameters* (unknown constants). Random effects are considered *stochastic variables* with an expected value of zero and a variance (Skovgård 1994). Fixed effects are used when the individual groups (seedlots) are of interest. Models with random effects are used when interest is in the size of the variation between the groups (described by the variance), including groups that are not represented in the trial. In analysis of random effects it is important that the groups are representative of a larger population of groups, and they should preferably be chosen by randomisation (Skovgård 1994). In the words of Stonecypher (1992), 'fixed models address estimating and testing to infer the existence of true differences among means, whereas the random models address estimating and testing to infer the existence of components of variance'.

To choose between a fixed or a random effects model is a choice with no simple answer. Stonecypher (1992) has formulated the following two questions to facilitate a choice:

1. 'Are the conclusion confined to the things actually studied; to the immediate sources of these things; or extended to apply to more general population?'

2. 'In complete repetitions of the experiment would the same things be studied again; would new samples be drawn from the same sources; or would new samples be drawn from the general population?'

When the objective is to estimate components of variance, the effects should be considered as random. If the objective is to estimate differences among means, the effects should be considered as fixed. In some cases fixed and random effects may be combined in the model (mixed models). This is the case when special designs are applied, such as split-plot or nested designs.

In our model with only provenances and blocks, it is necessary to choose between considering the provenance effect as random or as fixed. If the aim is to compare the specific provenances and the actual production on the site, it is natural to consider the provenance effect as fixed. If, on the other hand, (i) the provenances are assumed to be representatives of a population of provenances; (ii) the aim is to expand the conclusions to this population; (iii) to estimate the production and (iv) should the experiment be repeated, then the provenance effect should be considered as random.

The results of the statistical tests are irrespective of whether the provenance effect is considered a fixed or a random effect. However, there are major differences in the estimates resulting from the two approaches (see below). Since it may be argued that both the fixed and the random approaches are relevant in this analysis, both sets of estimates have been calculated.

4.7 Test of differences between provenances

In our statistical model, differences between provenances for a given trait are tested by an F-test comparing the mean square of provenances with the residual mean square. The hypothesis tested is that there is no difference between the provenances. If the F-test is significant, we reject the hypothesis and conclude that there are significant differences between the provenances.

The testing is done using the GLM procedure in SAS (SAS 1990). Since the testing of random vari-

ables may involve combinations of different mean squares (Skovgård 1994), an approximation called Satterthwaites approximation is used in the calculation of degrees of freedom (SAS 1988).

4.8 Lsmeans (estimates from the fixed model)

In the fixed model approach, the estimates for the provenances are calculated as the least square means (lsmeans). The main difference between raw means and lsmeans is that lsmeans account for missing values and imbalanced designs. Thus, in completely balanced designs there are no differences between lsmeans and the raw means. It follows that the lsmeans are the best estimates for the given provenance in the trial.

The confidence intervals and limits are calculated from the formula (Skovgård 1994)

$$X \pm t_{1-\alpha/2,(a-1)(b-1)} \sqrt{s^2 / b}$$

where X is the least square mean, α is the confidence level (in this case 0.05, giving a 95% confidence interval), *a* is the number of provenances and b is the number of replicates (blocks) of each provenance. s^2 is the mean square of the error (MS_e). The confidence limits are calculated directly by SAS in the LSMEANS statement with the CL option.

Since the estimates are calculated individually, different provenances may have different lengths of the confidence intervals (due to different variances). In the cases where the data have been weighted, the confidence intervals are adjusted according to the variance of each provenance and thus are of different lengths.

Special problems arise when the data has been transformed. If the least square means and the confidence limits are calculated on basis of the transformed values, the back-transformed estimates will be geometric means rather than arithmetic means. This implies that the estimates become biased towards lower values, and compared to the real values actually are under-estimates. If on the other hand the estimates are calculated using raw data, the lsmeans will be arithmetic means (comparable to the real mean values), but the confidence limits are based on a faulty distribution and will be wrong. In this analysis we have calculated estimates on the transformed values in order to get a fair representation of the differences between provenances. Usually the figures are presented together with a raw mean to circumvent the problem with under-estimation.

4.9 Best Linear Unbiased Predictors (BLUPs - estimates from the random model)

In the random approach, the provenance effects are seen as coming from a normal distribution with an expected value and a variance. This is in opposition to the fixed effect approach, where the provenance effects are seen as constants. Estimating provenance effects in random models is more complicated than in fixed models, because the observed variation between provenances is contemplated as a mixture between true provenance effects and random error variation (*cf.* White & Hodge 1989). The variation between the provenances is therefore always larger than the true 'genetic' variation, except in cases where the error variation is negligible.

In order to predict the effect of a given provenance, it is necessary to correct the estimates for the part of the variance that is due to random error variation. This is done by calculating the best linear unbiased predictors (BLUPs, White & Hodge 1989). The calculation of BLUPs is cumbersome and only feasible with a suitable software package. In this case, the SAS procedure MIXED has been used. It follows from the above that the predicted values for the provenances fall within a smaller range than the least square means. Often the results are presented as deviations from the mean value to allow for easier comparison between different experiments. The deviations are expressed either in real values (m, cm^2 etc.) or in % deviation from the mean value. Here deviations are presented as % deviations from the mean values.

The problems with transformed values are the same as described for the least square means above. A further complication arises when calculating the deviations from the mean value in percent. If the mean value is calculated on the base of transformed values, and the deviations are calculated on the basis of this back-transformed mean, the deviations from the mean will not sum to zero. In this analysis, we have therefore chosen to base the deviations from the mean value on values calculated after transformation.

The BLUPs are presented with *t*-type confidence intervals. However, these should be interpreted with caution since it is probably wrong to assume that the underlying distribution of the estimates is normal because of the limited sample size (Littell et al. 1996). Confidence intervals are presented to give an impression of the variation between the provenances and should not be interpreted with respect to differences between provenances.

5. Results of statistical analysis of individual traits

The below table displays the traits selected for analysis, grouped into growth traits, adaptive traits and quality traits. For a full description of the traits and their calculation, please refer to Annex 4.

Group	**Trait description**	**Analysed trait**
Growth	Height growth	Height of tree with diameter corresponding to mean basal area (H_G)
	Diameter growth	Diameter of tree corresponding to mean basal area (D_G)
	Mean volume of tree	Average of volumes of trees in plot
	Standing volume per hectare	Volume per hectare
Adaptation	Survival	Survival percentage
	Cone setting	Average score of old, open cones
	Foxtailing	Foxtailing percentage
Quality	Stemform	Stemform score (1-9)
	Relative wood density (Pilodyn)	Diameter adjusted pilodyn readings
	Branch diameter	Diameter of largest branch at whorl at 1/10 of tree height

5.1 Survival

OVERVIEW OF ANALYSIS		
	Block G	**Block J**
Co-variates	PLOTX	PLOTX
Data transformation required	Yes. Arc sin transformation	No
Weight statement	Yes	Yes
Outliers	None	None

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK G				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	36.71	30.03 (***)	0.0001
Block	14	14.62	11.96 (***)	0.0001
PLOTX	1	35.70	29.21 (***)	0.0001
Error	33	1.22		

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK J				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	2.14	1.75 (NS)	0.0691
Block	14	6.03	4.95 (***)	0.0001
PLOTX	1	10.89	8.92 (**)	0.0053
Error	33	1.22		

An arc-sin transformation of data (see Chapter 4) was required for Block G data to fulfil the model requirements, but not for Block J data.

Survival is on the average higher in the Block J trial than in the Block G trial.

There are statistical differences among provenances in Block G but not in Block J (although almost significant). The trial is 8 years of age, trees are large and there is competition between trees in plot. The survival data should therefore be interpreted with care.

It is interesting to note the poor survival of the Zambia seed source in both trials.

Apart from the low survival of the Zambia source, there are no clear patterns of variation. Rather the results present a confusing picture of seed lots having high survival in one trial being ranked low in the other, and vice versa.

In Block G, the Zambia CSO source, the John Meikle CSO from Zimbabwe (1776), the Burmese sources Zok Hua and Aungban, and the Bodana A8 and A9 populations from Madagascar have a poor survival. Best surviving sources are the *Pinus taeda* control, Mt. Province from the Philippines, Nam Now (Thailand) and the *P. elliottii* control.

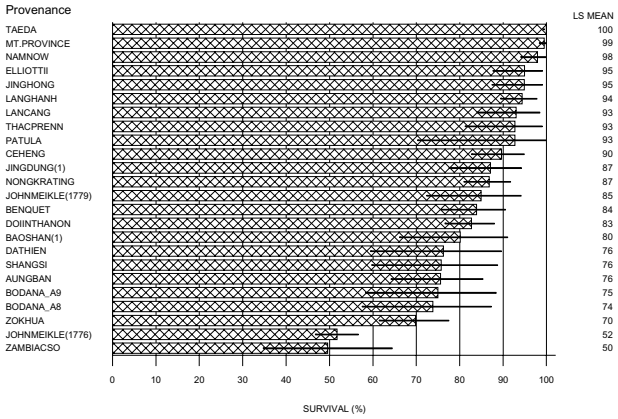
In Block J, where differences as mentioned above are not statistically significant, poorest survival is experienced by Zambia CSO and the *P. patula* control. Best survival rates have Aungban and Zok Hua of Burma (among the poorest in Block G), the Chinese sources Lancang, Jinghong and Ceheng, Dathien (Vietnam) and the *P. elliottii* control.

Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Survival (%)

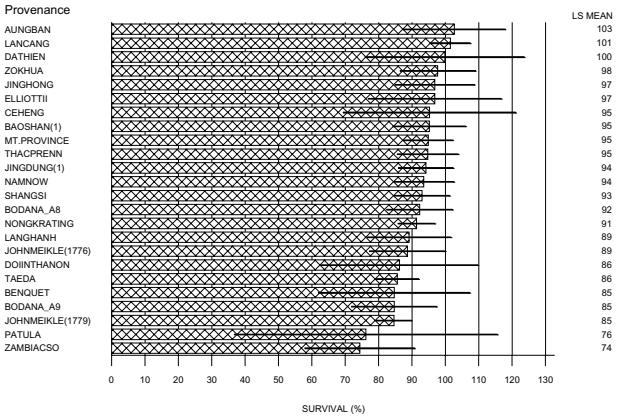


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Survival (%)

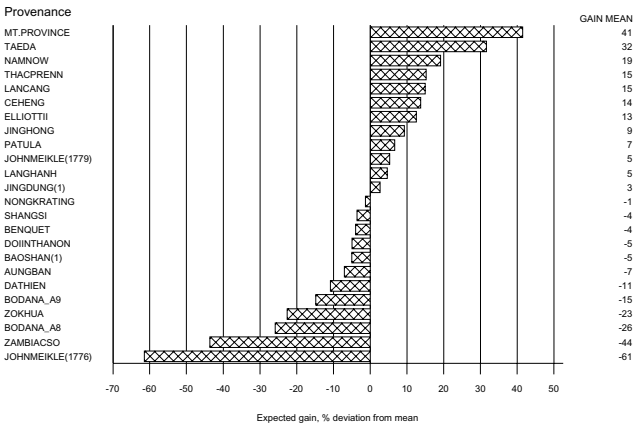


Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Survival. Best linear un-biased predictors (BLUPs)

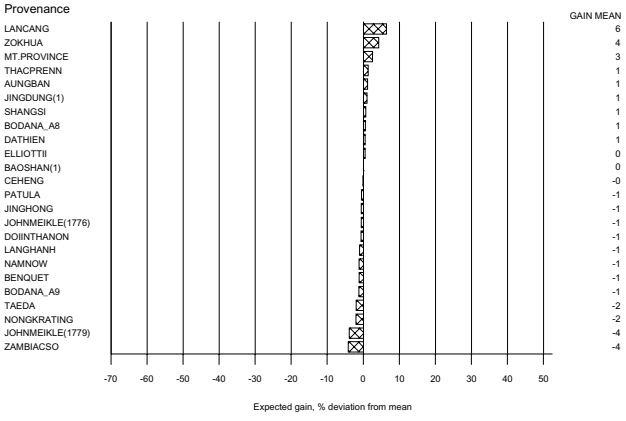


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Survival. Best linear un-biased predictors (BLUPs)



5.2 Height growth

OVERVIEW OF ANALYSIS		
	Block G	**Block J**
Co-variates	PLOTX2	PLOTX and PLOTY2
Data transformation required	No	No
Weight statement	Yes	Yes
Outliers	None	None

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK G				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	152.68	139.65 (***)	0.0001
Block	14	11.50	10.52 (***)	0.0001
PLOTX2	1	12.51	11.45 (**)	0.0019
Error	33	1.09		

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK J				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	60.92	53.45 (***)	0.0001
Block	14	11.26	9.88 (***)	0.0001
PLOTX	1	30.71	26.95 (***)	0.0001
PLOTY2	1	7.86	6.90 (**)	0.0131
Error	32	1.13		

There are highly significant differences among provenances in both trials.

In both trials the poorest height performers are the *P. yunnanensis* sources Shangsi, Baoshan and Ceheng. Also the Burmese sources Aungban and Zokhua are slow growing . Sources from Thailand (Nong Krating, Namnow, and Doi Inthanon) and China (Jingdung, Lancang and Jinghong) are also relatively slow growing.

The best *P. kesiya* sources compare favourable to the controls at both trial sites. Highest ranking is the John Meikle CSO from Zimbabwe although it is not the same seedlot (clone). Other high ranking sources of *P. kesiya* are are the two sources from the Philippines (Mt. Province and Benquet), and the Zambian CSO source.

The best of the controls is *Pinus patula,* ranked second and third respectively in the two trials. *P. elliottii* is intermediate and *P. taeda* a little above average.

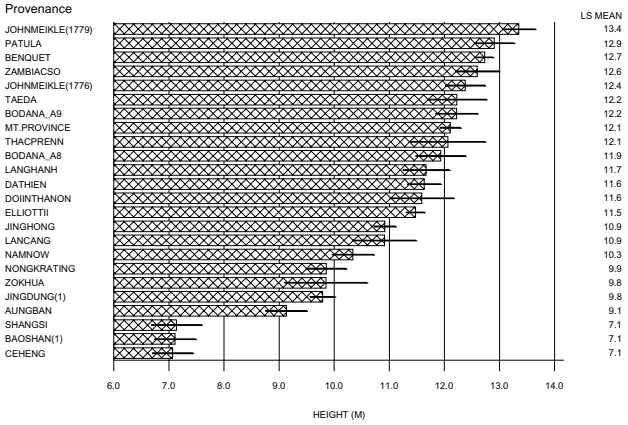
Vietnamese sources (Lang Hanh, Dathien and Thac Prenn) are intermediate, as are the populations from Madagascar.

Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Height (m)

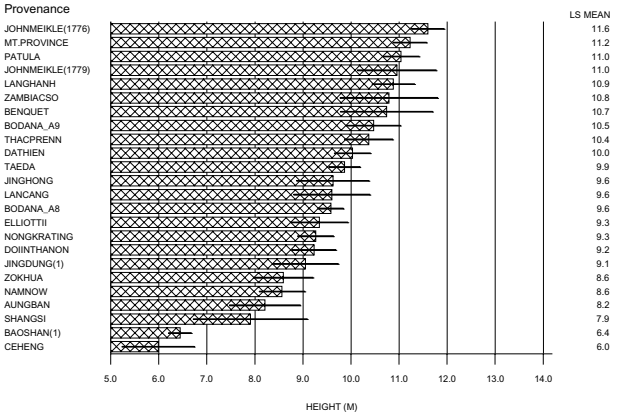


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Height (m)

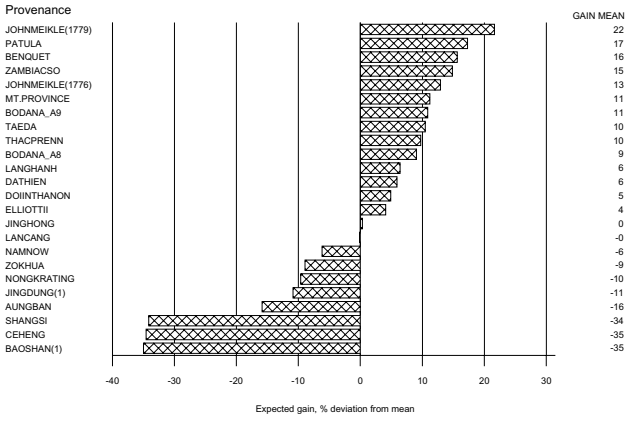


Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Height. Best linear un-biased predictors (BLUPs)

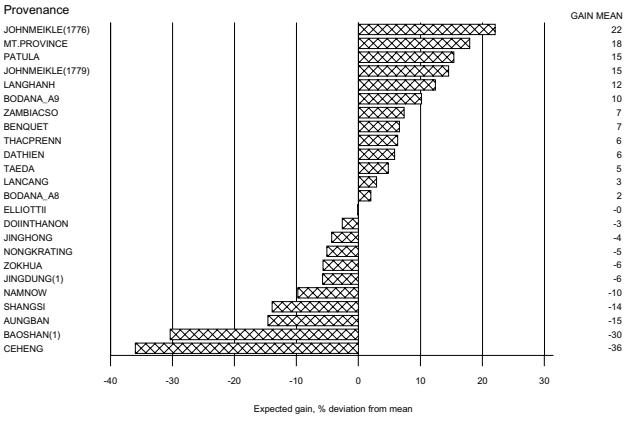


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Height. Best linear un-biased predictors (BLUPs)



5.3 Diameter growth

OVERVIEW OF ANALYSIS		
	Block G	**Block J**
Co-variates	PLOTX2	PLOTX , PLOTX2 and PLOTY2
Data transformation required	No	No
Weight statement	Yes	Yes
Outliers	None	None

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK G				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	39.12	31.71 (***)	0.0001
Block	14	9.13	7.40 (***)	0.0001
PLOTX2	1	15.45	12.52 (**)	0.0012
Error	33	1.23		

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK J				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	52.73	43.42 (***)	0.0001
Block	14	22.61	18.62 (***)	0.0001
PLOTX	1	45.46	37.43 (***)	0.0001
PLOTX2	1	13.83	11.39 (**)	0.0020
PLOTY2	1	25.01	20.59 (***)	0.0001
Error	31	1.21		

There are highly significant differences between seed lots in regard to diameter growth in both trials.

As for height growth, the three *P. yunnanensis* sources, Shangsi, Baoshan and Ceheng, have the poorest diameter growth.

The best performers, however, are not the same in the two trials.

In Block G, the Zambia CSO, the two seed lots from John Meikle CSO in Zimbabwe, and the two Madagascar populations are the best performers. Following these, we find the Vietnamese sources (Thac Prenn, Dathien and Lang Hanh), and the Doi Inthanon source from Thailand. The *P. patula*, *P. taeda* and *P. elliottii* controls all have slower diameter growth than the mentioned *P. kesiya* sources.

The Philippine sources (Benquet and Mt. Province), that were among the top ranking provenances in height growth, are lower ranked in regard to diameter growth. This has also been experienced in other trials.

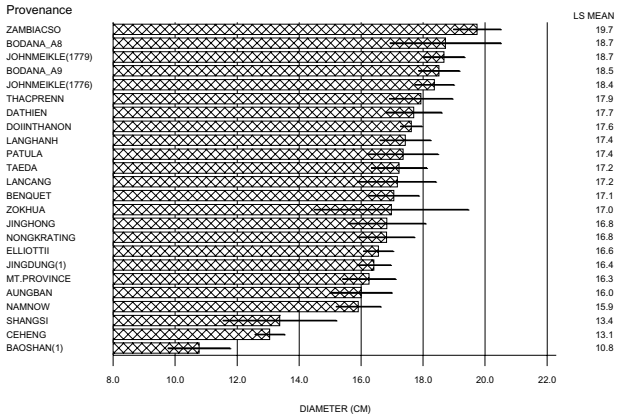
In Block J, the ranking is somewhat different from Block G. Again, we have improved sources at the top: Zambia CSO, John Meikle CSO (1779) and Bodana A9. Bodana A8 and John Meikle CSO (1776) that were also ranked high in Block G are ranked lower here. Among the natural sources, again the Vietnamese sources (Lang Hanh, Dathien and Thac Prenn) are ranked high. The Thai source Doi Inthanon that was performing well at the trial in Block G, are lower ranked here, but another Thai source, Nong Krating, has taken its place. The controls are more or less ranked as in Block G.

Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Diameter (cm)

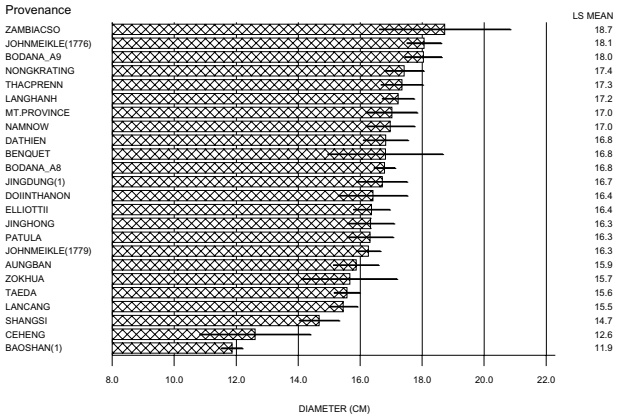


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Diameter (cm)

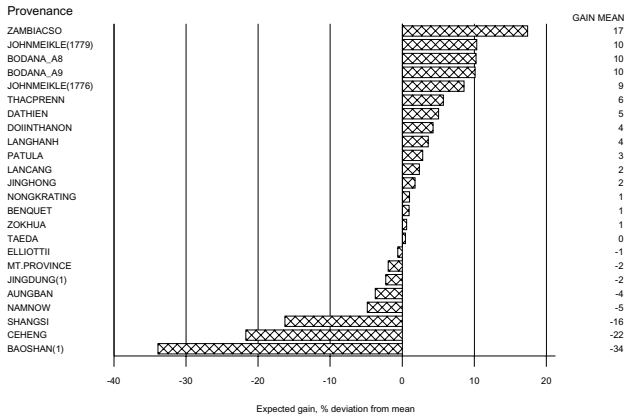


Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Diameter. Best linear un-biased predictors (BLUPs)

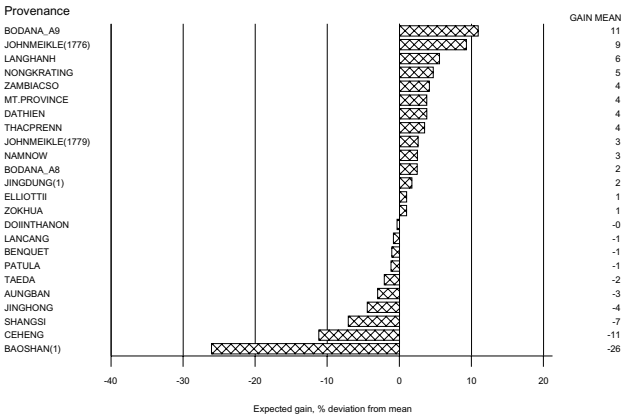


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Diameter. Best linear un-biased predictors (BLUPs)



5.4 Mean volume of tree

OVERVIEW OF ANALYSIS		
	Block G	**Block J**
Co-variates	PLOTX2	PLOTX and PLOTY2
Data transformation required	No	No
Weight statement	Yes	Yes
Outliers	None	None

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK G				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	41.43	33.23 (***)	0.0001
Block	14	6.33	5.07 (***)	0.0001
PLOTX2	1	9.17	7.35 (**)	0.0010
Error	33	1.25		

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK J				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	28.05	23.23 (***)	0.0001
Block	14	13.05	10.81 (***)	0.0001
PLOTX	1	53.07	43.96 (***)	0.0001
PLOTY2	1	18.63	15.43 (***)	0.0004
Error	32	1.21		

Mean volume of tree is calculated as the average of volumes of individual trees. As both height and diameter are included in the volume formula (see annex 4), the trait thus illustrates a combined effect of height and diameter.

The statistical analysis reveals large differences among provenances in both trials.

The *P. yunnanensis* sources, Baoshan, Shangsi and Ceheng, have very low volumes and are ranked at the very bottom in both trials.

The ranking at the top, however, differs in the two trials. In Block G, we find the improved seed sources of *P. kesiya* at the top together with the *P. patula* control. Above average is also the Vietnamese seed sources (Thac Prenn, Dathien and Lang Hanh), Benquet (Philippines), followed by the other Philippine seed source Mt. Province and Doi Inthanon of Thailand.

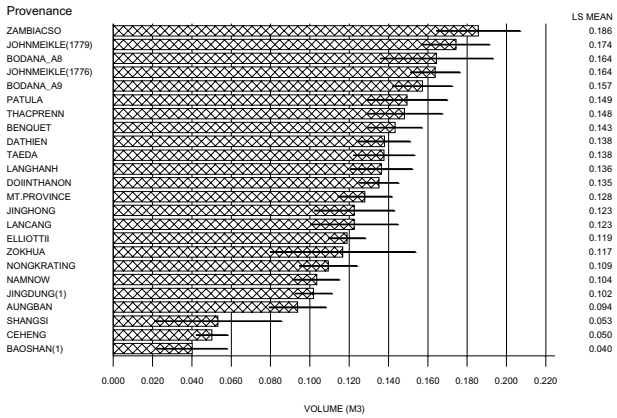
In Block J, we also have the improved sources at the top, but actual ranking is different to Block G. Moreover, the Mt. Province (Philippines) and Lang Hanh (Vietnam) are among the best. The *P. patula* control is lower ranked than in Block G.

Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Volume of mean tree (m3)

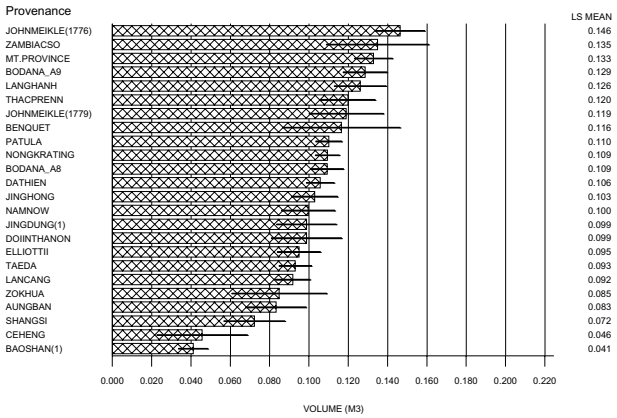


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Volume of mean tree (m3)

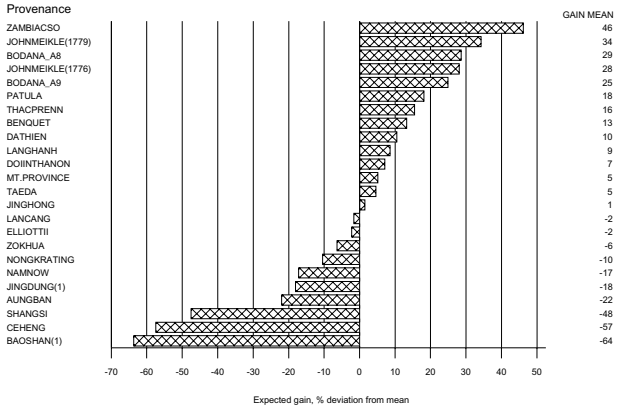


Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Volume of mean tree. Best linear un-biased predictors (BLUPs)

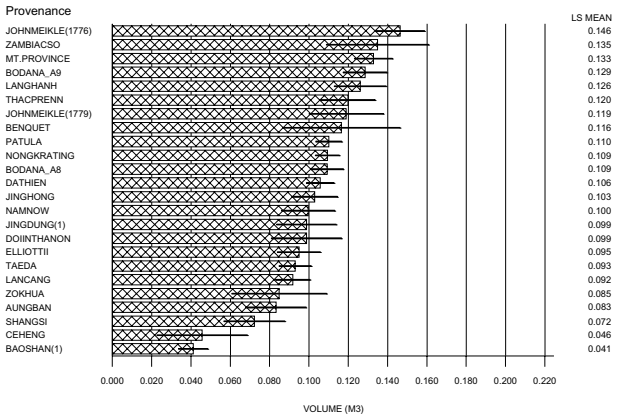


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Volume of mean tree (m3)



5.5 Total volume per hectare

OVERVIEW OF ANALYSIS		
	Block G	**Block J**
Co-variates	PLOTX	PLOTX , PLOTX2 and PLOTY2
Data transformation required	No	No
Weight statement	Yes	Yes
Outliers	None	None

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK G				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	19.37	15.23 (***)	0.0001
Block	14	8.97	7.05 (***)	0.0001
PLOTX	1	9.56	7.51 (*)	0.0098
Error	33	1.27		

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK J				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	22.83	19.70 (***)	0.0001
Block	14	30.95	26.71 (***)	0.0001
PLOTX	1	73.40	63.33 (***)	0.0001
PLOTX2	1	32.51	28.05 (***)	0.0001
PLOTY2	1	49.97	43.11 (***)	0.0001
Error	31	1.21		

The analysis of total volume production can be seen as an analysis summarising survival, height growth and diameter growth in one analysis as all three traits are included in the calculation of volume per hectare.

There are highly significant differences among provenances in both trials. The ranking differs between the two trials.

In Block G, the top sources are the *P. patula* control, the John Meikle CSO source (1779), Mt. Province of Philippines, Thac Prenn (Vietnam). *P. taeda* and *P. elliottii* controls are also above average. The Zambia CSO seed source and the John Meikle CSO (1776) which were ranked high in height and diameter growth are ranked low because of low survival.

In Block J, the Mt. Province (Philippines) is at the top together with the John Meikle CSO sources, the Vietnamese sources, the Bodana A8 and A9 populations from Madagascar, and the other source from the Philippines – Benquet. Compared to Block G, the John Meikle 1776 is doing well, and the seedlot 1779 is ranked lower. As in Block G, the Zambia CSO source is ranked relatively low because of a low survival rate. The *P. patula* control, doing well in Block G, is not among the top-ranking provenances in Block J. *P. taeda* is ranked low in Block J as well.

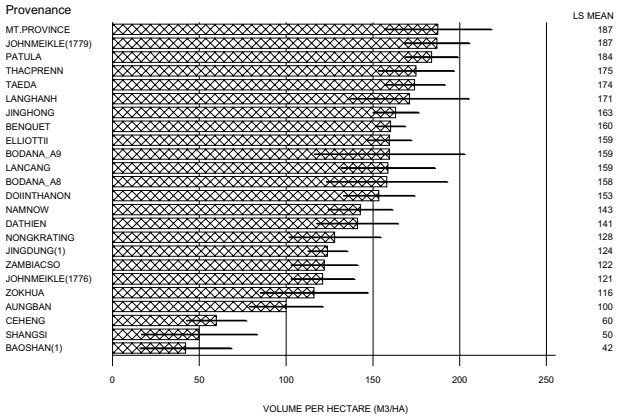
In the bottom end of the ranking, we find – at both trial sites – the sources of *P. yunnanensis*.

Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Volume per hectare (m3/ha)

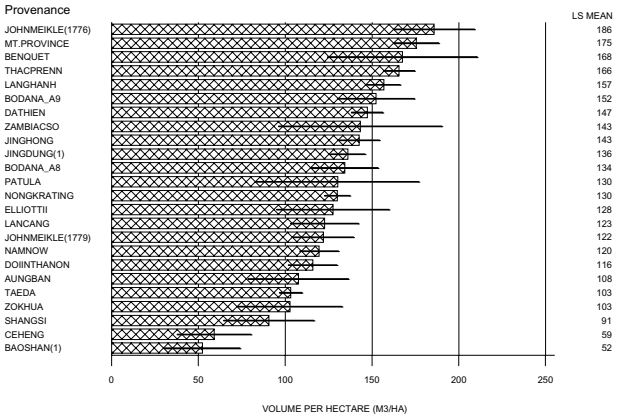


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Volume per hectare (m3/ha)

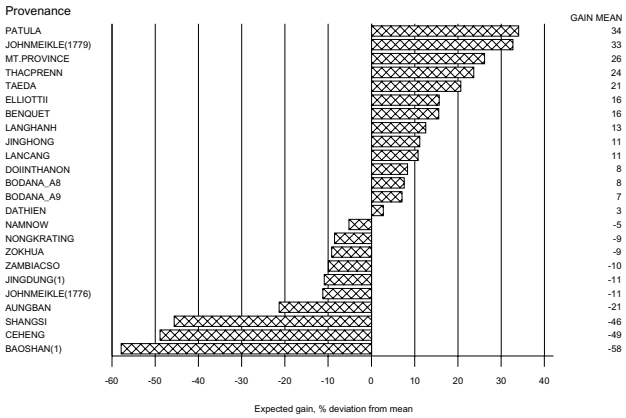


Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Volume. Best linear un-biased predictors (BLUPs)

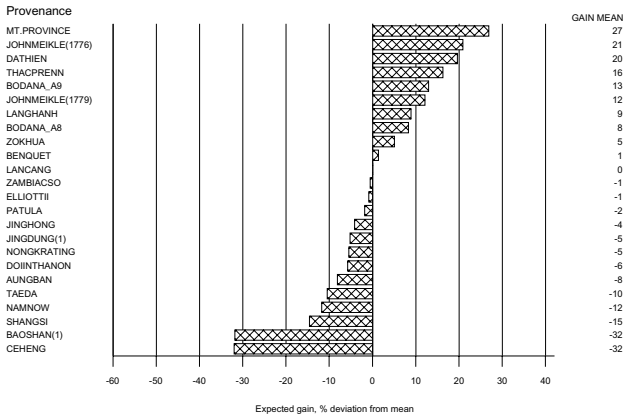


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Volume. Best linear un-biased predictors (BLUPs)



5.6 Stemform

OVERVIEW OF ANALYSIS		
	Block G	**Block J**
Co-variates	PLOTX2	PLOTX2
Data transformation required	No	No
Weight statement	Yes	Yes
Outliers	None	None

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK G				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	77.86	69.35 (***)	0.0001
Block	14	19.47	17.34 (***)	0.0001
PLOTX2	1	19.80	17.64 (***)	0.0002
Error	33	1.06		

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK J				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	22.45	18.41 (***)	0.0001
Block	14	24.99	20.50 (***)	0.0001
PLOTX2	1	28.89	23.69 (***)	0.0001
Error	33	1.22		

There are highly significant differences between provenances in regard to stemform.

Not surprising, the reference seed lots of *P. taeda*, the *P. elliottii*, *P. patula* generally have better stemform than *P. kesiya*. The only *P. kesiya* seedlot that compares to these are Zambia CSO. The actual ranking of top sources differs in the two trials: in Block G the *P. taeda* and *P. elliottii* are at the very top, whereas in Block J, the Zambian CSO and *P. patula* are the best.

Poorest stemform has the *P. yunnanensis* sources and the Burmese *P. kesiya* sources Aungban and Zok Hua.

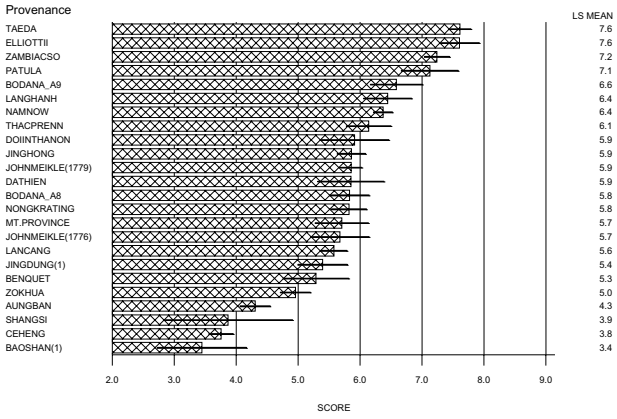
The Vietnamese sources have slightly better stemform than the Philippine sources (not statistically significant). The Bodana populations from Madagascar have stemform scores at the same level as the Vietnamese sources.

Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Stemform (1-9 score)

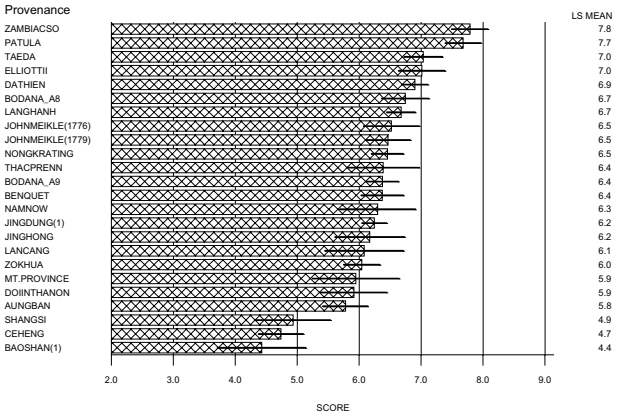


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Stemform (1-9 score)

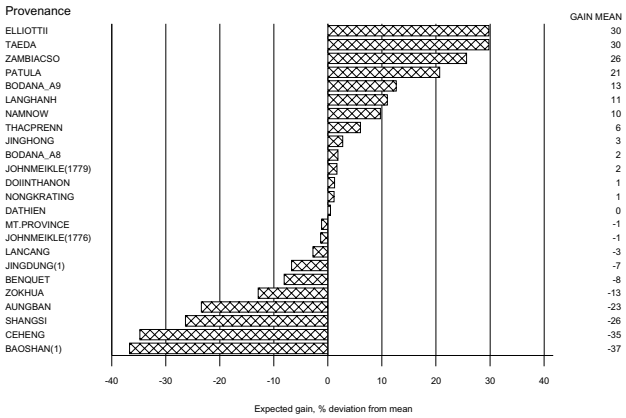


Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Stemform. Best linear un-biased predictors (BLUPs)

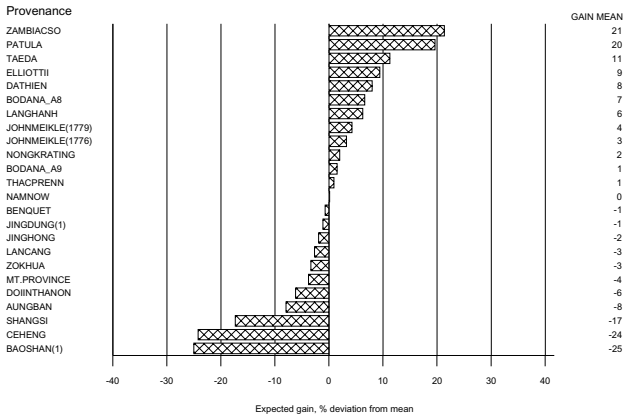


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Stemform. Best linear un-biased predictors (BLUPs)



5.7 Wood density (Pilodyn)

OVERVIEW OF ANALYSIS		
	Block G	**Block J**
Co-variates	None	None
Data transformation required	No	No
Weight statement	Yes	Yes
Outliers	None	None

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK G				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	215.66	19.05 (***)	0.0001
Block	14	27.54	2.43 (*)	0.0172
Error	34	11.32		

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK J				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	17.72	14.83 (***)	0.0001
Block	14	10.22	8.56 (***)	0.0001
Error	34	1.19		

Diameter adjusted pilodyn readings (ref. Annex 4) are used in the analysis.

The analysis of variance reveals highly significant differences among provenances in both trials.

The *P. kesiya* sources generally have lower pilodyn readings (corresponding to higher wood densities) than the reference seedlots of *P. taeda*, *P. elliottii* and *P. patula*.

Doi Inthanon (Thailand) has the highest relative wood density in both trials. Also the three Vietnamese sources Lang Hanh, Thac Prenn and Dathien have high densities, together with the two other Thai sources (Nam Now and Nong Krating) and the Chinese sources Lancang and Jinghong.

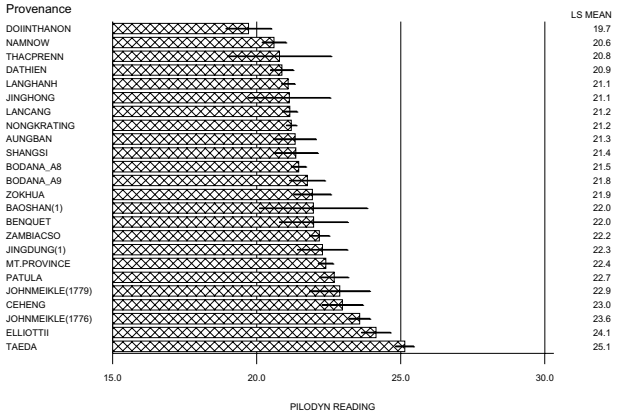
It is interesting to note that the Philippine sources Mt. Province and Benquet are ranked low, and lower than e.g. the Vietnamese and Thai sources. Results from e.g. Zimbabwe have indicated the Philippine sources with relatively high wood densities, but this can not be confirmed from the present trials. Among the improved sources of *P. kesiya*, it is interesting to note the low relative density of the John Meikle CSO seedlots from Zimbabwe.

Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Pilodyn

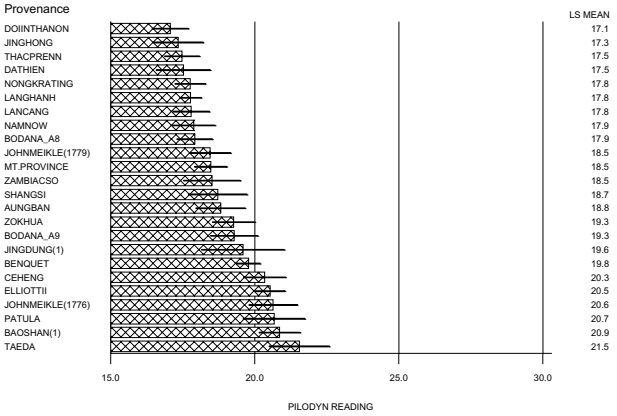


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Pilodyn

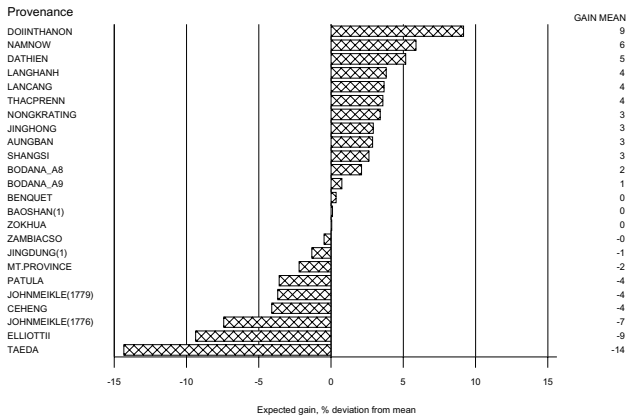


Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Pilodyn. Best linear un-biased predictors (BLUPs)

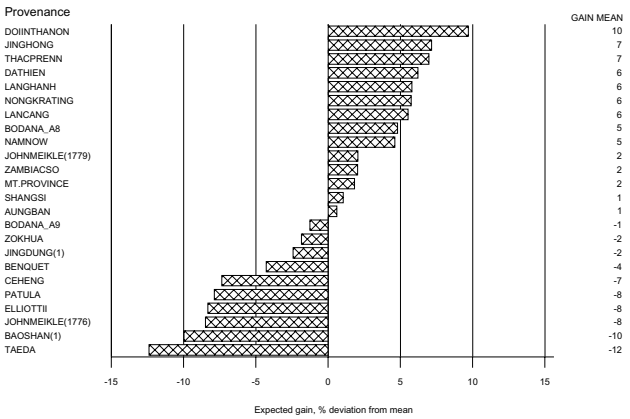


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Pilodyn. Best linear un-biased predictors (BLUPs)



5.8 Foxtailing

OVERVIEW OF ANALYSIS – BLOCK G	
Co-variates	None
Data transformation required	No
Weight statement	Yes
Outliers	None

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK G				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	2.04	1.94 (*)	0.0384
Block	14	3.56	3.38 (**)	0.0018
Error	34	1.05		

Few foxtails have been observed in Block J, and an analysis is only possible on the data from Block G.

Analysis of frequency of foxtails gives an indication of the adaptability of the source to site (lower frequency in general indicates better adaptation). Moreover, and of great practical importance, foxtails is related to the quality of the tree. Trees with foxtails often have ramicorns, i.e. thick branches from a lower whorl growing (co-evolving) vertically along with the main stem. They develop, as there are no whorls on the foxtail to suppress vertical growth of the branches. Trees with coarse branches are thus often a result of foxtails. This means lower quality, especially if timber is the final product. In addition, harvesting operations become more difficult. Apart from leading to coarse branching, foxtails will often result in stem breaks as the wood of the foxtail is of low density. Even slight wind can lead to stem breaks.

There are significant differences among seedlots in regard to foxtail percentage (Block G).

P. elliottii, *P. taeda* and *P. patula* have lower levels of foxtails than most of the *P. kesiya* sources. Lowest levels among the *P. kesiya* sources have Bodana A9 whereas the Bodana A8 on the other hand is ranked among the sources with highest levels of foxtails.

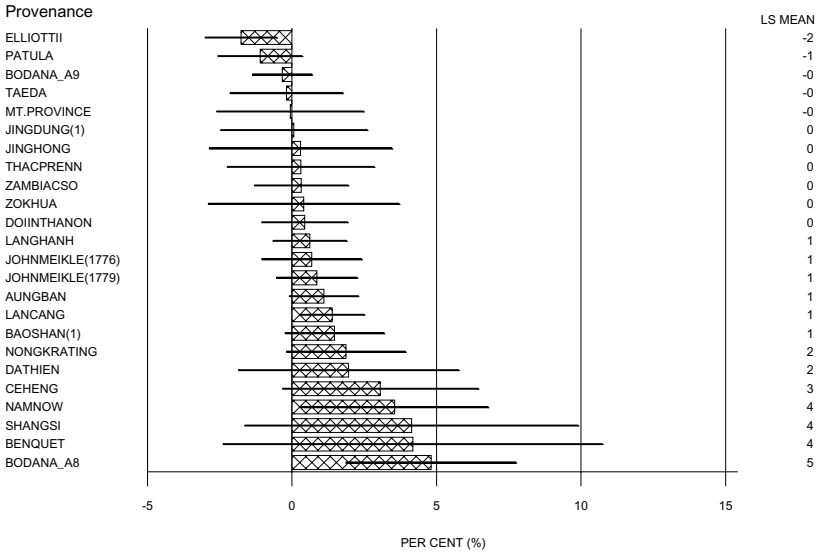
There seem to be no clear patterns of provenance variation. Note also the large size of the confidence intervals of many of the seed lots, indicating that there are only significant differences between the very top and bottom ranked provenances, and no statistically significant differences among the seed lots in-between.

Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Foxtail percentage (%)

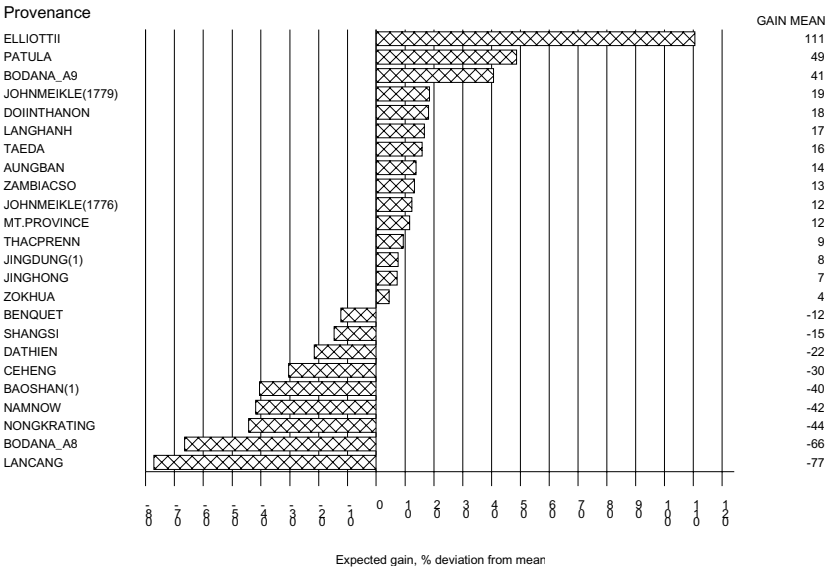


Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Foxtailing. Best linear un-biased predictors (BLUPs)



5.9 Cone setting

OVERVIEW OF ANALYSIS		
	Block G	**Block J**
Co-variates	PLOTX2 and PLOTY2	PLOTX2
Data transformation required	No	No
Weight statement	Yes	Yes
Outliers	None	None

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK G				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	16.76	14.73 (***)	0.0001
Block	14	26.50	23.28 (***)	0.0001
PLOTX2	1	58.15	51.08 (***)	0.0001
PLOTY2	1	6.70	5.88 (*)	0.0211
Error	32	1.14		

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK J				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	30.19	26.76 (***)	0.0001
Block	14	12.49	11.07 (***)	0.0001
PLOTX2	1	16.30	14.45 (***)	0.0006
Error	33	1.13		

Flowering and fruiting gives an indication of the adaptation of source to site. Abundant flowering and fruiting is generally interpreted as a sign of good adaptation to the site, and vice versa.

As the trial is still relatively young, 8 years of age at the time of assessment, flowering and fruiting may only have just commenced and the tested seedlots do not express their full potential for flowering and fruiting. Furthermore, the analysis includes more species, which may have different reproductive cycles. Consequently, the analysis should be interpreted with care.

The analysed trait is average score of old, open cones. Assessments have been done using a 1-9 scale where score 1 refers to no flowers or cones. More details in DFSC (1998).

The analysis of variance shows highly significant differences among provenances in regard to cone setting at both trial sites.

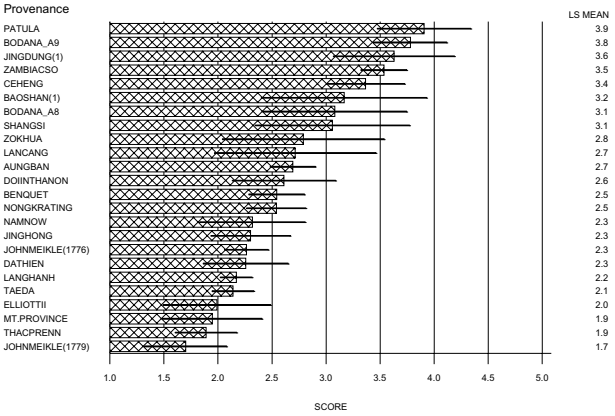
Poorest cone setters are *P. taeda*, *P. elliottii* and John Meikle CSO (1779). Most cones have the *P. patula* control, the Zambia CSO and the *P. yunnanensis* sources Baoshan, Shangsi and Ceheng.

Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Old, open cones (1-9 score)

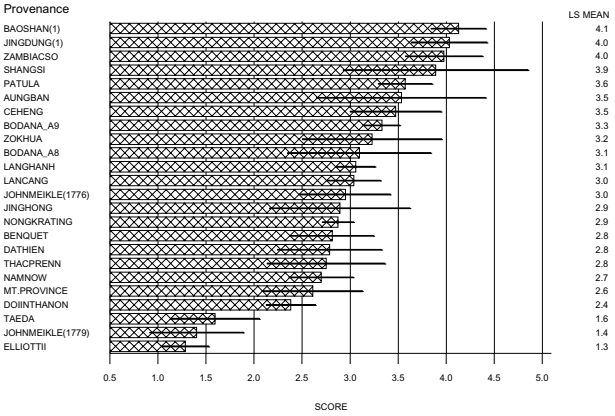


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Old, open cones (1-9 score)

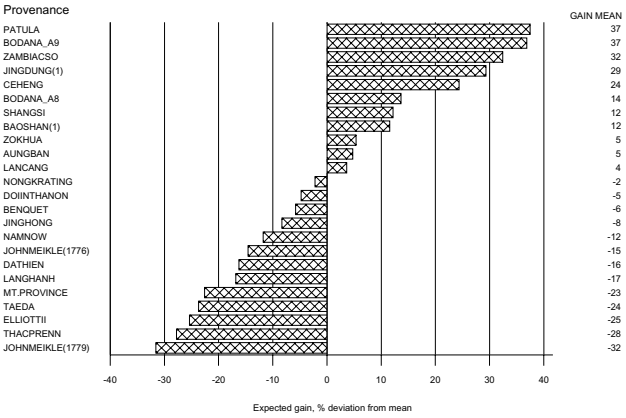


Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Old, open cones. Best linear un-biased predictors (BLUPs)

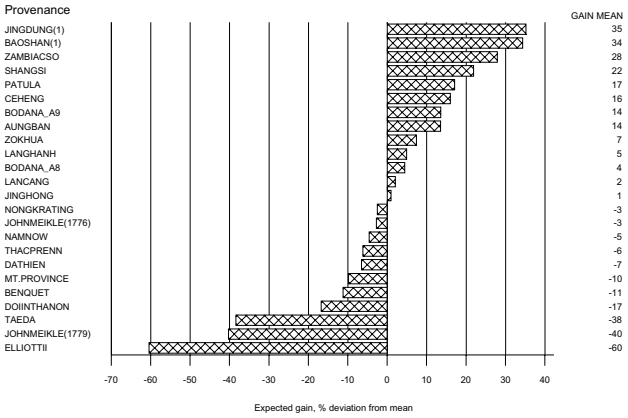


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Old, open cones. Best linear un-biased predictors (BLUPs)



5.10 Branch diameter

OVERVIEW OF ANALYSIS		
	Block G	**Block J**
Co-variates	None	None
Data transformation required	No	No
Weight statement	Yes	Yes
Outliers	None	None

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK G				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	26.51	21.77 (***)	0.0001
Block	14	7.46	6.13 (***)	0.0001
Error	34	1.22		

RESULTS FROM ANALYSIS OF VARIANCE – BLOCK J				
Effect	**DF**	**MS**	**F-value**	**P-value**
Provenance	23	7.00	6.11 (***)	0.0001
Block	14	26.67	23.29 (***)	0.0001
Error	34	1.15		

The analysis of variance reveals statistical significant differences between the tested sources in both trials.

P. elliottii has considerably smaller branches than all other sources. Mt. Province (Philippines) is the best of the *P. kesiya* sources. John Meikle CSO (Zimbabwe) is also among the best, although seedlot 1776 is ranked lower in Block G.

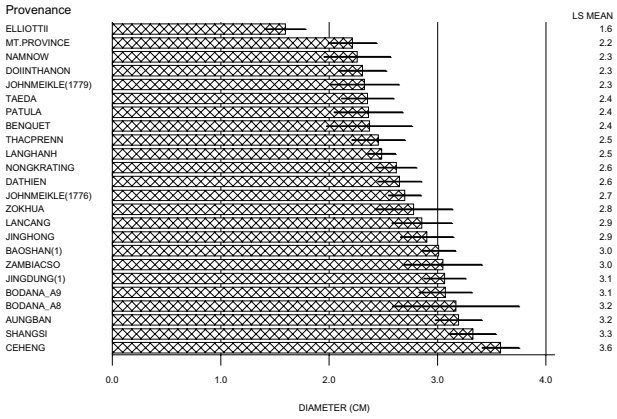
Largest branches have the *P. yunnanensis* sources and the Aungban source from Burma. Also the Zambia CSO source has thick branches. This may be related to the low survival of this source.

Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Branch diameter (cm)

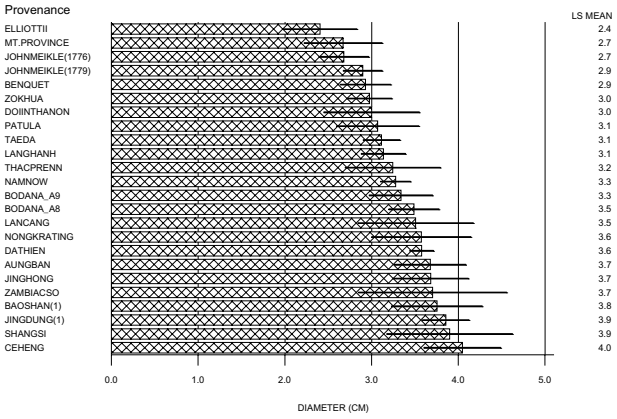


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Branch diameter (cm)

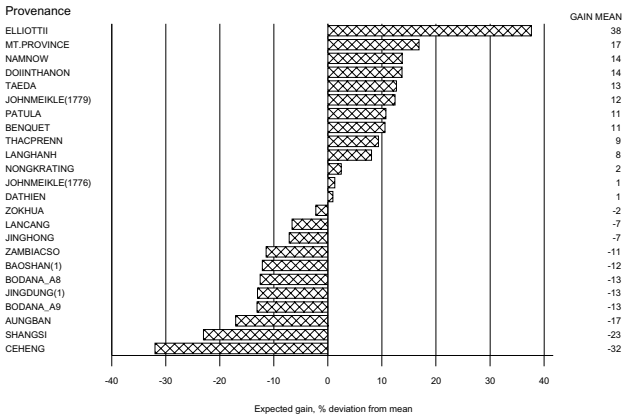


Pinus kesiya provenance trial, Block G, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 5

Established February 1990. Assessed August 1998

Branch diameter. Best linear un-biased predictors (BLUPs)

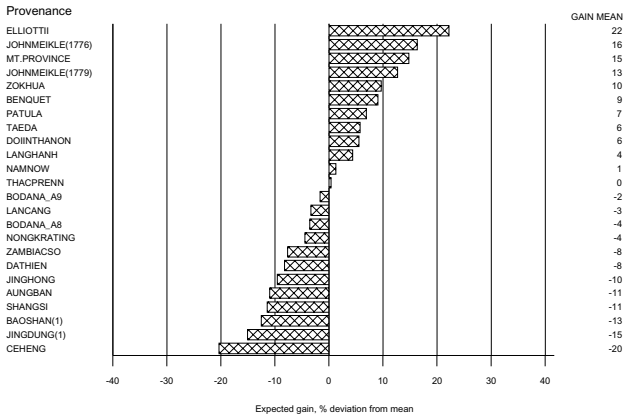


Pinus kesiya provenance trial, Block J, Swaziland

International Series of Pinus kesiya provenance trials, Trial No. 6

Established January 1990. Assessed August 1998

Branch diameter. Best linear un-biased predictors (BLUPs)



6. Discussion and conclusions

6.1 Growth

Growth traits should be given key importance in the interpretation of trial results, as pulpwood is the major product from *P. kesiya*.

The present results confirm the observation of Morris (1984) from the first series of *P. kesiya* trials that the ranking of provenances depends on the observed growth trait. In these trials, this is mainly because of differences in survival.

If height growth is considered, the results of the two trials show a quite consistent picture. The highest ranking sources are the John Meikle CSO (Zimbabwe), the Zambia CSO, the *P. patula* control, the Philippine sources Mt. Province and Benquet, and the Vietnamese sources Thac Prenn and Lang Hanh.

A rather different picture is displayed if total volume production per ha is considered. This trait combines the height, diameter and survival into one figure. The low survival percentage of some of the sources influences the total volume per hectare results. The best overall growth performers based on total volume production per hectare are the Mt. Province source from the Philippines. Also the Benquet source from Philippines and the Vietnamese sources (esp. Thac Prenn and Lang Hanh) are doing well.

The Zambia CSO source, which was top-ranking in height growth, is not among the top ranking sources in regard to volume production. This is because of a low survival percentage in both trials. The low survival raises questions about the growth potential of this source, and the issue should be investigated further (see below).

The sources from the John Meikle CSO express a rather confusing picture. They are – as mentioned above – ranked high in height growth, but the performance differs in volume production, again because of differences in survival. In the Block G trial, the 1779 seed lot is ranked high, and 1776 low. In the trial in Block J the picture is opposite with 1776 at the top and 1779 low. In any case, the seedlots from John Meikle CSO should be interpreted with care as they are single mother tree progenies, and hence not a fair representation of the John Meikle CSO.

The results of the statistical analysis show that the best *P. kesiya* sources are equal to, or better than the controls. Best growth performer among the controls is the *P. patula* source. It is ranked at the top in Block G, but intermediate in Block J, mainly because of a relatively low survival rate in this trial.

The two other controls, *P. taeda* and *P. elliottii*, express above average growth in Block G, but below average growth in Block J. Here especially *P. taeda* is slow growing. These results confirm the unsuitability of *P. taeda* and *P. elliottii* at higher altitude sites.

The Chinese sources (Jinghong, Jingdung and Lancang) are intermediate in regard to growth together with the Thai sources, with Thai sources having slightly slower growth than the Chinese. Doi Inthanon is the best of the Thai sources, especially in Block G.

Poorest growth performers are in both trials the *P. yunnanensis* sources (Baoshan, Shangsi and Ceheng), and the Burmese sources (Zok Hua and Aungban). Volume production of the *P. yunnanensis* sources is less than one third of the best performing *P. kesiya* sources.

Production potential of the best performing *P. kesiya* sources, based on growth in the first 8 years, is 22-23 m3/ha/year.

6.2 Adaptation

Analysed adaptive traits include survival percentage, foxtail frequency and flowering.

The low survival rate expressed in the trials of especially the Zambia CSO source, but also the John Meikle CSO source, raises concerns about the suitability of these sources. The reasons for the poor survival should be investigated further. It would be of particular importance to establish if the low survival of these sources – which in not evident from other trials in the international series – can be confirmed in other trials, and if so, if the low survival is caused by dead of seedlings in the early stage of establishment or later on in the life of the plantation.

Apart from this, there are no clear patterns of provenance variation in regard to survival. The results of the two trials present a rather confusing picture where sources with a good survival in one trial have a poorer survival in the other, and vice versa.

The level of foxtails is relatively low in the two trials, in Block J so low that no analysis is possible. The results from Block G indicate that the *P. kesiya*/*P. yunnanensis* sources set more foxtails than the controls, and that *P. yunnanensis* sources have higher frequencies of foxtails than the *P. kesiya* ones.

Flowering as an indicator of adaptation should be interpreted with care because of the early stage of trial and the different reproductive cycles of the species (i.e. species may flower and set cones earlier or later). There are significant differences among seedlots in both trials, but no clear patterns of provenance variation.

6.3 Quality

Analyzed quality parameters are stemform, relative wood density (pilodyn) and branch diameter.

The *P. kesiya* sources in general have poorer stemform than the controls, but on the other hand have higher wood densities. An exception is the Zambia CSO which compares favourable to the controls in regard to stemform, especially in Block J. This result illustrates that selection and tree improvement can significantly improve the stemform of *P. kesiya*.

The John Meikle CSO is not among the top-ranking sources in stemform. This is somewhat surprising, as a similar effect of selection and tree improvement as observed for the Zambia CSO would be expected. The reason may be that the two tested John Meikle sources are not fair representations of this source. The issue needs further investigation.

In general, the Vietnamese sources have better stemform than the Philippine and Thai source. *P. yunnanensis* and Burmese sources have poor stemform.

The *P. kesiya* sources have higher relative wood densities than the controls. The Thai sources, esp. Doi Inthanon, have high densities, but also the Vietnamese sources are doing well, and better than the Philippine sources.

In regard to branching, especially *P. elliottii* has thin branches. Among the *P. kesiya* sources, John Meikle CSO and Mt. Province are best. The Philippine sources in general have thinner branches than the Vietnamese and Thai sources.

6.4 Conclusions and recommendations

The results indicate that *P. kesiya* presents a potential on sites similar to the test sites provided that the appropriate seed sources are applied. The best *P. kesiya* sources compare favourable to the controls at both trial sites.

The best performing sources (growth) are the Philippines sources (esp. Mt. Province) and the Vietnamese sources (esp. Lang Hanh and Thac Prenn).

The Zambia CSO has a good height and diameter growth and an excellent stemform. Of concern is the poor survival rate expressed at both trial sites. As stressed above the survival, and possible reasons for low survival, should be investigated further before it can be recommended as a major source for plantation establishment.

The John Meikle CSO is another potential source. As the two tested seedlots are single mother tree progenies, the present trials cannot give precise information of the performance of this seed orchard offspring. Further testing is required.

The best un-improved source (seed collection in natural forest) is the Mt. Province source from the Philippines. It has a high survival rate, is a good volume producer, and has small branches. However, results from the trials indicate that the stemform is poorer than the improved sources, and also poorer than many of the other natural sources. Wood density is average.

The Vietnamese sources (esp. Lang Hanh and Thac Prenn) are also promising. They are above average in growth, have good stemform and pilodyn, and have branch diameters about average.

The Chinese, Thai and Madagascar sources are intermediate in growth and wood quality.

The Myanmar sources of *P. kesiya* and the sources of *P. yunnanensis* are very poor in both growth and quality traits and have no potential as sources for plantation establishment.

The trial was 8 years of age at assessment, and it may thus be premature to draw very specific and detailed conclusions based on the results. It is thus recommended that the trials are maintained, and are re-assessed and analyzed 3-5 years from now.

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Personal communication

Brockhoff, P. Lecturer in statistics. The Royal Veterinary and Agricultural University, Copenhagen.

Annex 1. Trial design map

Block G - Swaziland

TRIAL SERIES R136 : Blk. G

PINUS KESIYA PROVENANCE TRIAL

PLOT SIZE 7 x 7 ROWS AT 2·7 m ESPACEMENT

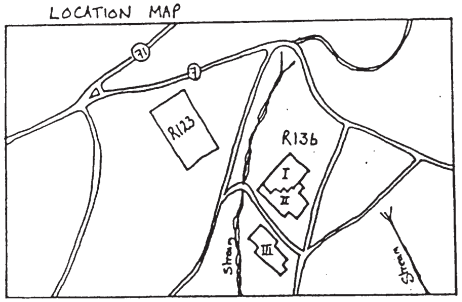
PLANTED : FEBRUARY, 1990

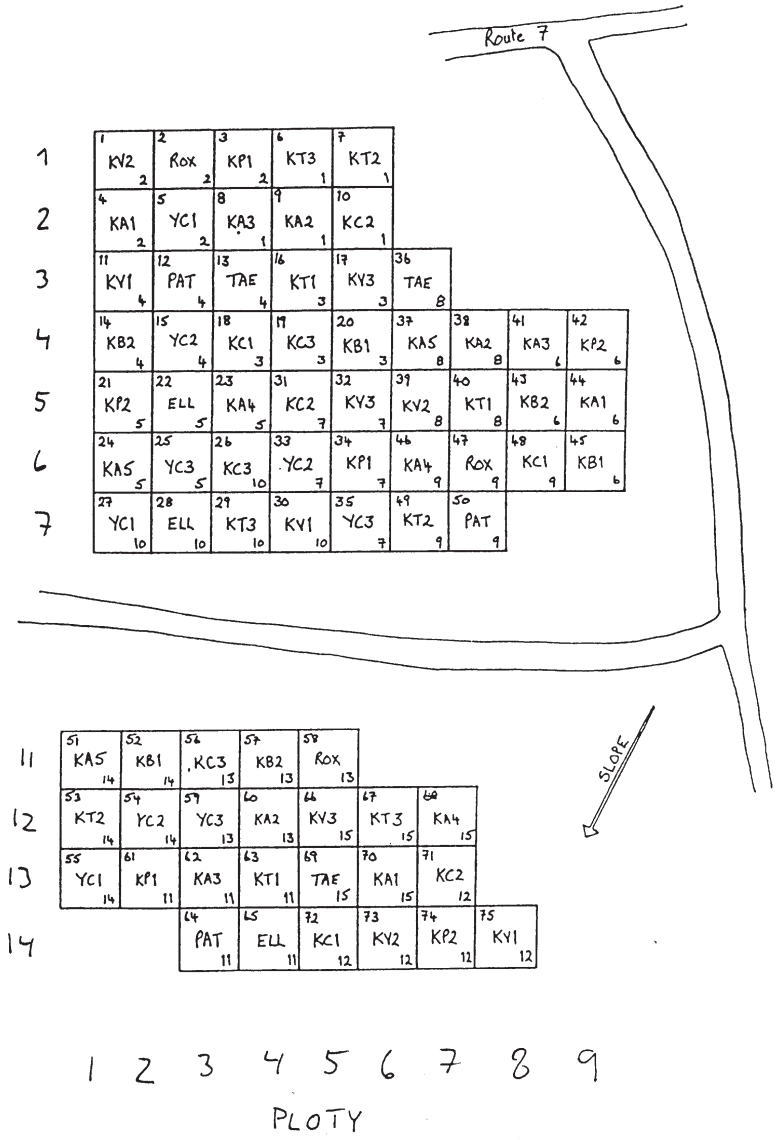
TRIPLE LATTICE DESIGN

SEED SOURCE ORIGINS (Mostly Ex-Danida Forest Seed Centre)

CODE	DFSC No.	SPECIES	PROVENANCE	COUNTRY	LATITUDE	LONGITUDE	ELEVATION
KP1	1447/84	Kesiya	Mt. Province	Philippines	17 15 N	120 55 E	2300 m
KP2	1448/84	Kesiya	Benguet	Philippines	16 35 N	120 30 E	1600 m
KV1	1515/85	Kesiya	Dathien	Vietnam	11 58 N	108 27 E	1550 m
KV2	1518/85	Kesiya	Thac Prenn	Vietnam	11 52 N	108 27 E	1250 m
KV3	1519/85	Kesiya	Lang Hanh	Vietnam	11 37 N	108 16 E	1000 m
KT1	1521/85	Kesiya	Nong Krating	Thailand	18 05 N	98 35 E	1080 m
KT2	1525/85	Kesiya	Doi Inthanon	Thailand	18 32 N	98 35 E	1000 m
KT3	1525/85	Kesiya	Nam Now	Thailand	16 40 N	101 33 E	800 m
KC1	1635/86	Kesiya	Jindung(1)	China	24 26 N	100 51 E	1300 m
KC2	1637/86	Kesiya	Jinghong	China	22 25 N	101 10 E	1250 m
KC3	1638/86	Kesiya	Lancang	China	22 40 N	100 03 E	1620 m
KB1	1773/88	Kesiya	Aungban	Burma	20 41 N	96 37 E	1330 m
KB2	1772/88	Kesiya	Zokhua	Burma	22 25 N	93 40 E	1600 m
KA1	1776/88	Kesiya	CSO (JnFRS)	Zimbabwe	18 43 S	32 51 E	1268 m
KA2	1779/88	Kesiya	CSO (JnFRS)	Zimbabwe	18 43 S	32 51 E	1268 m
KA3	1783/88	Kesiya	Bodana Pop. A8	Madagascar	20 35 S	47 30 E	1500 m
KA4	1784/88	Kesiya	Bodana Pop. A9	Madagascar	20 35 S	47 30 E	1500 m
KA5	1778/88	Kesiya	CSO	Zambia	13 00 S	28 00 E	1300 m
YC1	1624/86	Yunnanensis	Baoshan(1)	China	24 51 N	99 12 E	1750 m
YC2	1632/86	Yunnanensis	Ceheng	China	24 24 N	105 34 E	800 m
YC3	1633/86	Yunnanensis	Shangsi	China	21 37 N	107 57 E	530 m
PAT	-	Patula	Select	Zimbabwe			
TAE	-	Taeda	CSO	Zimbabwe			
ELL	-	Elliottii	CSO(Mondi)	South Africa			
ROX	-	Roxburghii	CSO(SAFRI)	South Africa			

LOCATION MAP



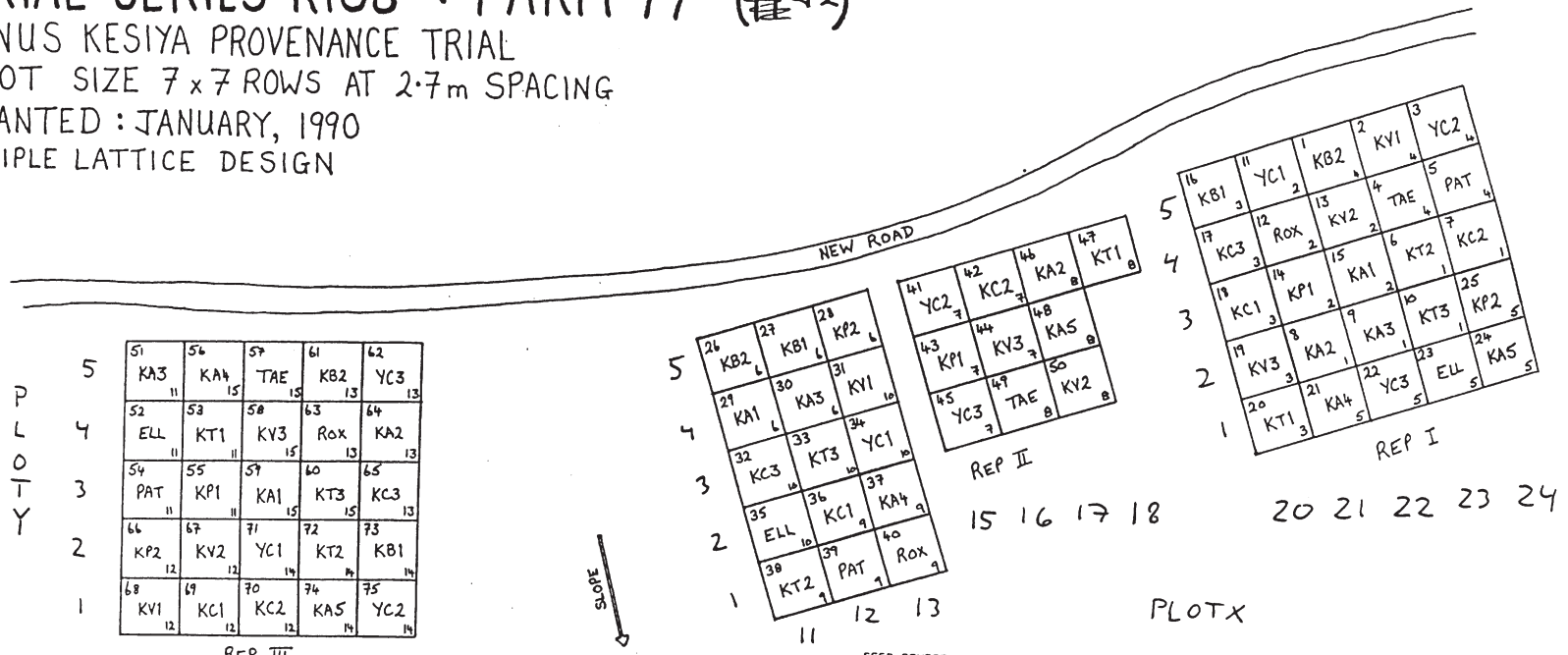


Trial design map

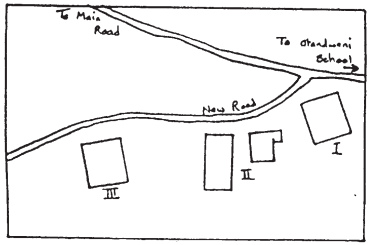
Block J - Swaziland

TRIAL SERIES R136 : FARM 77 (貫T2)

PINUS KESIYA PROVENANCE TRIAL
PLOT SIZE 7 x 7 ROWS AT 2·7m SPACING
PLANTED : JANUARY, 1990
TRIPLE LATTICE DESIGN



LOCATION MAP



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YC2	1632/86	Yunnanensis	Ceheng	China	24 24 N	105 34 E	800 m
YC3	1633/86	Yunnanensis	Shangsi	China	21 37 N	107 57 E	530 m
PAT	-	Patula	Select	Zimbabwe			
TAE	-	Taeda	CSO	Zimbabwe			
ELL	-	Elliottii	CSO(Mondi)	South Africa			
ROX	-	Roxburghii	CSO(SAFRI)	South Africa			

Annex 2

Trial description - Block G, Swaziland

TRIAL ESTABLISHMENT AND MANAGEMENT

Year and month of establishment: *February 1990*

Area (ha): *2.7 ha*

Initial spacing (m x m): *2.7m x 2.7m*

Soil preparation (time, method/intensity): *Digging of planting pits 40 x 20 cm*

Planting method (age of seedlings, type): *8 months old container seedlings*

Beating up (time, %): *No beating up*

Irrigation (time, amount): *None*

Fertilization (time, type, amount): *None*

Weeding (time, intensity): *Weedings carried out in January 91, June 91, June 92, February 93, May 94 and July 95*

Thinning (time, intensity): *No thinning, but pruning to 1.5 m of height in May 1994*

Firelines: *Yes*

TRIAL DESIGN

Statistical design: *Triple lattice design*

No. of replications (blocks): *3 replications*

No. of treatments (provenances): *25 provenances (see attached list)*

Plot size (No. of trees in plot): *49 (7 x 7)*

Demarcation (blocks, plots):

PROTECTION STATUS

Status (describe any disturbances/damages): *Trial in good conditions at time of assessment. No fire disturbances., no disturbances by man*

Guarding (permanent, regular, none): *Regular*

Trial description - Block J, Swaziland

TRIAL ESTABLISHMENT AND MANAGEMENT

Year and month of establishment: *January 1990*

Area (ha): *2.7 ha*

Initial spacing (m x m): *2.7 x 2.7m*

Soil preparation (time, method/intensity): *Digging of planting pits*

Planting method (age of seedlings, type): *Container seedlings, 7 months old*

Beating up (time, %): *None*

Irrigation (time, amount): *None*

Fertilization (time, type, amount): *None*

Weeding (time, intensity): *None*

Thinning (time, intensity): *No thinning, but pruning in May 1995*

Firelines: *Yes*

TRIAL DESIGN

Statistical design: *Triple lattice design*

No. of replications (blocks): *3 replications*

No. of treatments (provenances): *25 provenances (see attached list)*

Plot size (No. of trees in plot): *49 (7 x 7)*

Demarcation (blocks, plots):

PROTECTION STATUS:

Status (describe any disturbances/damages): *Trial in good conditions at time of assessment. No fire damage*

Guarding (permanent, regular, none): *Regular*

LOCATION

Province:

Annex 3.

Site description - Block G, Swaziland

District:
Latitude (degrees and minutes): *26°32'*
Longitude (degrees and minutes):
Altitude (m above sea level): *Approx. 800 m above sea level*

Managing office/institution: *Usutu Pulp*
Owner: Do.
User(s): Do.

Distance to nearest office responsible for management of the trial (km): *15 km*
Distance to nearest villages/towns (km):
Number of inhabitants in the nearest villages/towns:

Type of area (e.g. research station, managed forest, etc.): *Plantation estate*

CLIMATE

Nearest weather station:
Name of the station: *Climate information from 'Forest land types of the Usutu forest'*
Pallett (1990) – site is land type 101
Latitude (degrees and minutes):
Longitude (degrees and minutes):
Altitude (m a.s.l.):

Climatic data[1]	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Rainfall (mm)	178	140	94	65	23	1	14	20	44	93	128	141	951
Temp. mean (°C)													19.3
Temp. mean max.[2] (°C)	28.0	27.3	26.6	25.0	23.7	21.7	22.0	23.5	24.8	25.1	25.5	27.5	25.1
Temp. mean min.[3] (°C)	17.8	17.5	16.8	14.1	11.0	7.9	8.1	9.8	12.4	14.0	15.5	16.9	13.5
Evapotranspiration[4] (mm)													

[1] Period of observations Unknown
[2] Average of daily maximum temperatures
[3] Average of daily minimum temperatures
[4] Potential evapotranspiration (ETP) - Penman's formula

Rainy season:

Number/type of seasons: [x] one [ ] two [ ] even/irregular

Period(s): October-March (specify months)

Length of rainy season:
No. of intermediate days: *90 (pre- and posthumid period of the growing season)*
No. of wet days: *120 (growing season)*

Number of dry months per year (< 50 mm rain/month): *5 months*
Frost (number of days/year): *None*
Prevailing winds (direction, period, speed): *No information available*

TOPOGRAPHY (slope) of trial site

[ ] Flat/gentle (0-8%) [X] Intermediate (9-30%) [x] Steep (>30%)

GENERAL SOIL DESCRIPTION

Soil texture		Soil depth		Soil drainage/ n		Gravel content, topsoil	
1. Light/sandy		1. Shallow (< 50 cm)		1. Well drained	X	1. None (< 15 %)	
2. Medium/loamy	X	2. Deep (50-100 cm)	X	2. Seasonal		2. Gravelly (15-35 %)	
3. Heavy/clayey		3. Very deep (> 100 cm)		3. Permanent		3. Stony (> 35 %)	

Organic matter content		Reaction (pH)		Soil salinity		Groundwater	
1. Poor (< 2 % DM)	X	1. Acid (pH < 6.5)	X	1. None	X	1. Shallow (< 50 cm)	
2. Medium (2-5 % DM)		2. Neutral (6.5-7.5)		2. Moderate		2. Deep (50 - 150 cm)	
3. Rich (> 5 %)		3. Alkaline (pH> 7.5)		3. High		3. Very deep (>150 cm)	X

Specify soil unit, soil association and phases (subdivisions of soil units) according to the Soil map of the world (FAO-Unesco 1971-1979), if known:

VEGETATION

Natural (original) vegetation type:.

Dominant natural (original) genera/species:

Land use history: *Trial established after second generation P. elliottii*

RESULTS OF SOIL SAMPLE

Data in the below table is based on the laboratory analysis of the soil sample taken at the trial site.

Description	Unit	Result
Depth of sample	m	1.2
Clay (<2 µm)	%	19.2
Fine silt (2-20 µm)	%	4.9
Coarse silt (20-63 µm)	%	9.0
Fine sand (63-125 µm)	%	30.7
Fine medium sand (125-250 µm)	%	30.3
Coarse medium sand (250-500 µm)	%	5.4
Coarse sand (500-2000 µm)	%	0.4
Org. mat.	%	0.4
Lime	%	0.0
pH-H_2O	-	5.1
P		- 1

Results noted as - 1: Amount not detectable

The variables are:

Depth:	Soil sample depth
Clay:	Particle size less than 2 μm (0.002 mm) in diameter
Fine silt	Particle size between 2 and 20 μm (0.002 - 0.020 mm) in diameter
Coarse silt	Particle size between 20 and 63 μm (0.020 - 0.063 mm) in diameter
Fine sand	Particle size between 63 and 125 μm (0.063 - 0.125 mm) in diameter
Fine medium sand	Particle size between 125 and 250 μm (0.125 - 0.250 mm) in diameter
Coarse medium sand	Particle size between 250 and 500 μm (0.250 - 0.500 mm) indiameter
Coarse sand	Particle size between 500 and 2000 μm (0.500 - 2.0 mm) in diameter
Gravel	Particle size between 0.2 and 2 cm in diameter
Org. mat.	Organic material in various stages of decomposition
Lime	Lime content
pH-H2O	Reaction (pH)
P	Phosphorus content

Site description – Block J, Swaziland

LOCATION

Province:
District:
Latitude (degrees and minutes): *26°37'*
Longitude (degrees and minutes):
Altitude (m above sea level): *1100 m above sea level*

Managing office/institution: *Usutu Pulp*
Owner: Do.
User(s): Do.

Distance to nearest office responsible for management of the trial (km):
Distance to nearest villages/towns (km):
Number of inhabitants in the nearest villages/towns:

Type of area (e.g. research station, managed forest, etc.): *Trial area within plantation estate*

CLIMATE

Nearest weather station:
Name of the station: *Climate information from 'Forest land types of the Usutu forest'*
Pallett (1990) – site is land type 201
Latitude (degrees and minutes):
Longitude (degrees and minutes):
Altitude (m a.s.l.):

Climatic data[1]	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Year**
Rainfall (mm)	162-197	133-166	95-114	57-73	29-30	10-15	10-17	19-23	48-59	95-114	141-171	141-170	950-1150
Temp. mean (°C)													17.0
Temp. mean max.[2] (°C)	25.1	24.2	24.3	22.4	21.2	19.2	19.7	21.2	22.6	22.8	23.0	24.6	20.9
Temp. mean min.[3] (°C)	15.5	14.9	14.5	11.9	9.2	6.4	6.4	8.0	10.5	12.0	13.3	14.7	11.4
Evapotranspiration[4] (mm)													

[1] Period of observations Unknown
[2] Average of daily maximum temperatures
[3] Average of daily minimum temperatures
[4] Potential evapotranspiration (ETP) - Penman's formula

Rainy season:

Number/type of seasons: [X] one [ ] two [ ] even/irregular

Period(s): October-March (specify months)

Length of rainy season:
No. of intermediate days: *120 (pre- and posthumid period of the growing season)*
No. of wet days: *120 (growing season)*

Number of dry months per year : *4 (< 50 mm rain/month):*
Frost (number of days/year): *None*
Prevailing winds (direction, period, speed):

TOPOGRAPHY (slope) of trial site

[ ] Flat/gentle (0-8%) [ ] Intermediate (9-30%) [x] Steep (>30%)

GENERAL SOIL DESCRIPTION

Soil texture		Soil depth		Soil drainage/ n		Gravel content, topsoil	
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3. Heavy/clayey		3. Very deep (> 100 cm)		3. Permanent		3. Stony (> 35 %)	

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1. Poor (< 2 % DM)	X	1. Acid (pH < 6.5)	X	1. None	X	1. Shallow (< 50 cm)	
2. Medium (2-5 % DM)		2. Neutral (6.5-7.5)		2. Moderate		2. Deep (50 - 150 cm)	
3. Rich (> 5 %)		3. Alkaline (pH> 7.5)		3. High		3. Very deep (>150 cm)	X

Specify soil unit, soil association and phases (subdivisions of soil units) according to the Soil map of the world (FAO-Unesco 1971-1979), if known:

VEGETATION

Natural (original) vegetation type:

Dominant natural (original) genera/species:.

Land use history:

RESULTS OF SOIL SAMPLE

Data in the below table is based on the laboratory analysis of the soil sample taken at the trial site.

Description	Unit	Result
Depth of sample	m	1.2
Clay (<2 µm)	%	24.7
Fine silt (2-20 µm)	%	13.1
Coarse silt (20-63 µm)	%	1.0
Fine sand (63-125 µm)	%	7.6
Fine medium sand (125-250 µm)	%	12.3
Coarse medium sand (250-500 µm)	%	13.8
Coarse sand (500-2000 µm)	%	27.6
Org. mat.	%	1.2
Lime	%	0.0
pH-H_2O	-	5.0
P		- 1

Results noted as - 1: Amount not detectable

The variables are:

Depth:	Soil sample depth
Clay:	Particle size less than 2 µm (0.002 mm) in diameter
Fine silt	Particle size between 2 and 20 µm (0.002 - 0.020 mm) in diameter
Coarse silt	Particle size between 20 and 63 µm (0.020 - 0.063 mm) in diameter
Fine sand	Particle size between 63 and 125 µm (0.063 - 0.125 mm) in diameter
Fine medium sand	Particle size between 125 and 250 µm (0.125 - 0.250 mm) in diameter
Coarse medium sand	Particle size between 250 and 500 µm (0.250 - 0.500 mm) in diameter
Coarse sand	Particle size between 500 and 2000 µm (0.500 - 2.0 mm) in diameter
Gravel	Particle size between 0.2 and 2 cm in diameter
Org. mat.	Organic material in various stages of decomposition
Lime	Lime content
pH-H2O	Reaction (pH)
P	Phosphorus content

Annex 4. Plot data sets

Aggregated data set at plot level. This annex describes the variables in the plot dataset, and displays the data. The plot data set has been prepared from the individual tree dataset and holds the following parameters.

PARAMETER NAME	EXPLANATION
BLOCK	Block No.
SEEDLOT	Seedlot No.
PROVNAME	Name of seedlot/provenance
SITE	Name of site
DATEEST	Establishment data of trial (MM/YY)
DATEASS	Date of assessment (MM/YY)
PLOTX	Co-variate
PLOTY	Co-variate
PLOTX2	Co-variate
PLOTY2	Co-variate
DBH1	Average of diameters (arithmetic mean)
HEIGHT	Average height (arithmetic mean)
SURV	Survival percentage (%)
GMEAN	Mean basal area per tree (m2)
GSUM	Total basal area in plot (m2)
MEANPILO	Mean pilodyn for plot
WHORLS	Average number of whorls
BRANCH	Average number of branches in whorl
DIABRA	Diameter of largest branch (cm)
FORK	Frequency of trees with one or more forks (%)
FOXTAIL	Frequency of foxtails in plot (%)
NO_TOTAL	Number of trees in plot
NO_G	Number of trees in basal area calculation
NOHEIGHT	Number of trees in height-diameter regression
KRAFT1.. KRAFT5	Frequency of individual Kraft scores 1 to 5 (%)
KRAFT	Average Kraft index
STEM	Average stemform
STEM1..STEM9	Frequency of individual stemform scores 1 to 9 (%)
BRARATIO	Branch ratio
FO_INDEX	Forking index
INTNODE	Average distance between whorls (m)
CROWNPCT	Crown percentage (not calculated in this trial)
FO_POS	Average position of lower fork (m above ground)
TOP	Percentage of trees with broken top
VTREE	Average volume of tree in plot
MF	Average score of male flowers
FF	Average score of female flowers
CL	Average score of conelets
CC	Average score of closed cones
OC	Average score of old, open cones
LOTH	Percentage of 'leaning trees'
APHID	Percentage of trees with woolly aphid
DG	Diameter corresponding to mean basal area at breast height (cm)
HG	Height for tree with diameter corresponding to mean basal area (m)
PILOCORR	Mean pilodyn reading adjusted for diameter effect
VHA	Volume per ha

DG- Diameter corresponding to mean basal area at breast height (1.3 m)

DG is calculated using the following formula:

$$DG = \left(\sqrt{\frac{\sum_{i=1}^{n} \pi \times \left(Di/2\right)^2}{n}} \over \pi \right) \times 2$$

where
D_i is the diameter at breast height of tree No. i (in cm);
n is the total number of trees in plot.

GHA - Basal area per hectare

Basal area in m^2 per hectare is calculated using the formula:

$$GHA = \frac{\sum_{i=1}^{n} \pi \times \left(Di/2 \times 100\right)^2}{n \times sp^2} \times 10000$$

where
D_i is the diameter at breast height of tree no. i (in cm);
n is the total number of trees in plot; and
sp is the spacing in m;

HG- Height of tree with diameter corresponding to mean basal area

A linear regression per plot is prepared using the model:

$$Height = \beta + \alpha \times \ln(DBH1)$$

where
DBH1 is the diameter of stem (first stem if more than one stem) in cm;
α is the slope of the regression line;
β is the intercept with y-axis;

For each plot, α and β are estimated using PROC REG (SAS 1990).

HG for the plot is then calculated using the linear regression estimates (α and β) and plot DG (as previously calculated).

PILOCORR - Correction of pilodyn readings

Tree diameter (ring width) influences the pilodyn reading, i.e. trees with larger diameter (rings) will normally have larger pilodyn readings (deeper penetration of the pilodyn pin) than trees with smaller diameter, all other factors equal (ceteris paribus).

In order to adjust pilodyn readings for the variation in diameter, a correction factor has been introduced. By doing so, we are reducing the variance due to differences in individual tree size, and the provenances are in the subsequent analysis compared assuming that they have the same average tree size. In other words, we compare the level of the trait rather than the actual value.

The adjustment has been made using the GLM procedure in SAS (SAS 1990). The following model is applied:

. . .

PROC GLM;
CLASS plot;
MODEL pilo = plot DBH1;
LSMEANS plot OUT=A;

. . .

Forking index (not used in the analysis of the present trial)

The forking index is calculated using the formula:

$$FO_INDEX = \frac{\sum_{i=1}^{n} FORK_i / FO_POS_i}{n}$$

where
$_{FORKi}$ is the number of forks observed on tree i
FO_POS_i is position above ground of first fork (in m) on tree i; and
n is the total number of trees with forking data in the plot

Branching index (not used in the analysis of the present trial)

The branching index is calculated using the formula:

$$BR_INDEX = \frac{\sum_{i=1}^{n} BRANCH_i \times DIABRA_i}{n \times 10}$$

where
$BRANCH_i$ is the number of branches on tree i;
$DIABRA_i$ is the branch diameter on tree i; and
n is the total number of trees with branching data in the plot.

INTNODE - Average distance between whorls

The INTNODE parameter is calculated using the formula:

$$INTNODE = \frac{\sum_{i=1}^{n} (HEIGHT_i - 0.5) / WHORLS_i}{n}$$

where

$HEIGHT_i$ is the height of tree i
$WHORLS_i$ is the number of whorls on tree i; and
n is the total number of trees with observations on whorls in the plot.

Plot Data Set - Block G

BLOCK	SEEDLOT	PROVNAME	SITE	DATEESTS	DATEASSS	PLOTX	PLOTY	PLOT2	_TYPE	_FREQ	DBH	HEIGHT	SURV	GMEAN	GSUM	MEANPILO	WHORLSH	BRANCHAR	DIABR	FORKAIL	NOTOTALS	NOHEIGHT	KRAFT1	KRAFT2	KRAFT3	KRAFT4	KRAFT5	KRAFTM	KRAFT1	KRAFT2	KRAFT3	KRAFT4	KRAFT5	KRAFTM	STEM1	STEM2	STEM3	STEM4	STEM5
1	01523/85	DOIINTHANON	BlockG	290	898	1	5	36	0.25	0	25	16.841176	10.49375	68	0.02286	0.38866	19.75	15.1875	4.470588	2.36471	0.176471	0	25	17	16	0	0	81.25	18.75	0	3.1875	5.75	0	0	6.25	0	12.5		
1	01525/85	NAMNOW	BlockG	290	898	1	4	36	0.25	0	25	14.531818	9.5	88	0.01759	0.38708	20.84211	14.772727	4.545455	2.29091	0.045455	0	25	22	22	9.09091	9.0909091	59.09091	22.727273	0	2.95455	6.190476	0	0	4.761905	0	0		
1	01637/86	JINGHONG	BlockG	290	898	2	5	25	0.25	0	25	14.7375	10.4125	96	0.02048	0.49159	21.73913	12.958333	4.75	2.88333	0.333333	0	25	24	24	4.16667	0	54.16667	20.833333	20.83333	3.54167	6	0	0	4.166667	0	12.5		
1	01779/88	JOHNMEIKLE(1779)	BlockG	290	898	2	4	25	0.25	0	25	18.161111	13.044444	72	0.02911	0.52396	24.55556	18.944444	5.166667	2.12778	0.444444	0	25	18	18	0	33.333333	50	16.666667	0	2.83333	6	0	5.555556	0	0	11.11111		
1	01783/88	BODANA_A8	BlockG	290	898	2	3	25	2.25	0	25	19.552941	12.117647	68	0.03175	0.53981	22.11765	16.588235	5.176471	3.03529	0.176471	5.882353	25	17	17	0	11.764706	41.17647	35.294118	11.76471	3.47059	5.941176	0	5.882353	5.882353	11.7647	0		
2	01447/84	MT.PROVINCE	BlockG	290	898	1	2	36	6.25	0	25	14.695833	11.6	96	0.01866	0.44783	23	18.208333	3.541667	1.94167	0.333333	0	25	24	24	0	41.666667	41.66667	16.666667	0	2.75	5.333333	0	4.166667	12.5	4.16667	16.66667		
2	01518/85	THACPRENN	BlockG	290	898	1	1	36	12.25	0	25	16.757895	10.405263	76	0.02489	0.47299	19.68421	15.789474	4.157895	2.01053	0.210526	0	25	19	19	5.26316	21.052632	31.57895	31.578947	10.52632	3.21053	5.368421	0	10.52632	0	0	36.84211		
2	01624/86	BAOSHAN(1)	BlockG	290	898	2	2	25	6.25	0	25	8.3454545	6.0590909	88	0.0097	0.21347	24	5.3181818	3.818182	2.74545	1.363636	0	25	22	22	0	27.272727	45.45455	4.5454545	22.72727	3.22727	2.954545	4.5455	27.27273	50	4.54545	13.63636		
2	01776/88	JOHNMEIKLE(1776)	BlockG	290	898	2	1	25	12.25	0	25	18.2	12.092308	52	0.02849	0.37035	24.16667	22.615385	4.307692	2.35385	0.461538	0	25	13	13	7.69231	7.6923077	30.76923	53.846154	0	3.30769	5.538462	0	0	7.692308	0	38.46154		
3	01519/85	LANGHANH	BlockG	290	898	3	5	16	0.25	0	25	16.977273	11.818182	88	0.02372	0.52179	21.28571	16.409091	5.090909	2.53182	0	0	25	22	22	4.54545	9.0909091	40.90909	31.818182	13.63636	3.40909	6.272727	0	4.545455	0	0	13.63636		
3	01521/85	NONGKRATING	BlockG	290	898	3	4	16	0.25	0	25	16.23	10.1	80	0.02484	0.49688	21.2	14.6	4.6	2.635	0.35	0	25	20	20	0	34.782609	43.47826	8.6956522	13.04348	3	3.956522	0	8.695652	43.47826	8.69565	21.73913		
3	01635/86	JINGDUNG(1)	BlockG	290	898	4	3	9	2.25	0	25	14.868182	9.8318182	88	0.02187	0.48106	22.8	12.5	4.045455	2.98636	0.409091	0	25	22	22	4.54545	18.181818	22.72727	27.272727	27.27273	3.54545	5.136364	0	9.090909	4.545455	13.6364	9.090909		
3	01638/86	LANCANG	BlockG	290	898	4	4	9	0.25	0	25	15.343478	10.509091	92	0.02223	0.51125	21.18182	14.782609	4.956522	2.93043	0.347826	0	25	23	22	0	13.043478	52.17391	30.434783	4.347826	3.26087	5.478261	0	0	4.347826	4.34783	30.43478		
3	01773/88	AUNGBAN	BlockG	290	898	4	5	9	0.25	0	25	15.929412	9.5	68	0.02401	0.40822	20.82353	12.470588	4.588235	3.05882	0.470588	0	25	17	17	0	0	47.05882	41.176471	11.76471	3.64706	4.294118	0	11.76471	17.64706	23.5294	23.52941		
4	01515/85	DATHIEN	BlockG	290	898	3	1	16	12.25	0	25	15.940909	11.857895	88	0.02364	0.52012	21.33333	13.863636	4.409091	2.45455	0.272727	5.555556	25	22	19	10	25	35	15	15	3	5.35	0	5	5	15	10		
4	01632/86	CEHENG	BlockG	290	898	4	2	9	6.25	0	25	11.695652	6.973913	92	0.01508	0.34682	23.42857	5.5217391	4.304348	3.49565	1	8.695652	25	23	23	0	34.782609	43.47826	8.6956522	13.04348	3	3.956522	0	8.695652	43.47826	8.69565	21.73913		
4	01772/88	ZOKHUA	BlockG	290	898	4	1	9	12.25	0	25	14.319048	9.8333333	84	0.02648	0.55599	22	16.285714	4.47619	2.69048	0.761905	0	25	21	21	0	14.285714	57.14286	28.571429	0	3.14286	5.238095	0	0	14.28571	4.7619	23.80952		
4	PAT	PATULA	BlockG	290	898	3	2	16	6.25	0	25	17.947619	13.095238	84	0.02691	0.56505	23.42857	31.761905	4.285714	2.37143	0.238095	0	25	21	21	0	9.5238095	57.14286	28.571429	4.761905	3.28571	7.285714	0	0	0	0	0		
4	TAE	TAEDA	BlockG	290	898	3	3	16	2.25	0	25	16.48	12.092	100	0.02199	0.54983	25.33333	22.12	3.56	2.376	0.08	0	25	25	25	4	16	72	8	0	2.84	7.6	0	0	0	0	0		
5	01448/84	BENQUET	BlockG	290	898	5	1	4	12.25	0	25	17.135	12.447368	80	0.02563	0.51267	21.7	19.368421	3.052632	2.68947	0.315789	0	25	20	19	0	21.052632	42.10526	36.842105	0	3.15789	5.421053	0	15.78947	0	0	15.78947		
5	01633/86	SHANGSI	BlockG	290	898	6	2	1	6.25	0	25	12.922222	7.0055556	72	0.01444	0.25991	21.5	7.0555556	3.888889	3.33333	0.222222	11.11111	25	18	18	5.55556	16.666667	50	22.222222	5.555556	3.05556	2.944444	0	50	27.77778	11.1111	0		
5	01778/88	ZAMBIACSO	BlockG	290	898	6	1	1	12.25	0	25	19.533333	12.425	48	0.03662	0.43944	21.83333	19.416667	4.5	2.80833	0.166667	0	25	12	12	0	16.666667	16.66667	33.333333	33.33333	3.83333	6.916667	0	0	0	0	8.333333		
5	01784/88	BODANA_A9	BlockG	290	898	5	3	4	2.25	0	25	18.538095	12.371429	84	0.0312	0.6553	21.61905	16.238095	4.571429	2.87143	0.333333	0	25	21	21	0	4.7619048	47.61905	38.095238	9.52381	3.52381	6.666667	0	0	0	0	0		
5	ELL	ELLIOTTII	BlockG	290	898	5	2	4	6.25	0	25	17.495833	11.5625	96	0.02487	0.59695	23.41667	18.541667	3.875	1.69167	0.125	0	25	24	24	0	33.333333	37.5	29.166667	0	2.95833	7.625	0	0	0	0	0		
6	01448/84	BENQUET	BlockG	290	898	4	9	9	20.25	0	25	16.4	12.275	80	0.02241	0.44828	20.63158	19.157895	4.210526	2.17895	0.368421	0	25	20	20	5	5	25	45	20	3.7	5.789474	0	5.263158	10.52632	5.26316	21.05263		
6	01772/88	ZOKHUA	BlockG	290	898	5	8	4	12.25	0	25	14.778947	9.7263158	76	0.02508	0.47644	22.31579	15	4.631579	2.85789	0.631579	0	25	19	19	0	10.526316	63.15789	26.315789	0	3.15789	5.947368	0	0	0	10.5263	15.78947		
6	01773/88	AUNGBAN	BlockG	290	898	6	9	1	20.25	0	25	13.065217	8.3652174	92	0.01805	0.41511	21.59091	13.26087	3.869565	3.1087	0.478261	0	25	23	23	4.34783	17.391304	39.13043	26.086957	13.04348	3.26087	5.565217	0	0	17.3913	4.34783	13.04348		
6	01776/88	JOHNMEIKLE(1776)	BlockG	290	898	5	9	4	20.25	0	25	17.60625	12.225	64	0.02479	0.39671	23.25	19.625	3.875	2.40625	0.25	0	25	16	16	0	0	31.25	37.5	31.25	4	7.125	0	0	0	0	12.5		
6	01783/88	BODANA_A8	BlockG	290	898	4	8	9	12.25	0	25	16.190476	11.76	84	0.02121	0.44539	21.38095	15.238095	4.47619	2.50952	0.142857	0	25	21	20	0	0	19.04762	38.095238	42.85714	4.2381	7.047619	0	0	0	4.7619	0		
7	01447/84	MT.PROVINCE	BlockG	290	898	6	5	1	0.25	0	25	15.404167	11.821739	96	0.02319	0.55661	22.72727	17.625	4.041667	2.1625	0.416667	0	25	24	23	0	20.833333	33.33333	16.666667	29.16667	3.54167	5.125	0	0	16.66667	12.5	12.5		
7	01519/85	LANGHANH	BlockG	290	898	5	5	4	0.25	0	25	17.010526	11.452632	76	0.02397	0.45538	21.36842	16.631579	4.631579	2.4	0.157895	0	25	19	19	0	0	33.33333	44.444444	22.22222	3.88889	5.833333	0	0	5.555556	5.55556	11.11111		
7	01632/86	CEHENG	BlockG	290	898	6	4	1	0.25	0	25	12.735	6.6380952	84	0.01541	0.30821	22.5625	6.6	4.05	3.51	0.714286	0	25	20	21	14.2857	33.333333	42.85714	4.7619048	4.761905	2.52381	3.47619	0	33.33333	28.57143	14.2857	4.761905		
7	01633/86	SHANGSI	BlockG	290	898	7	5	0	0.25	0	25	11.918182	6.7090909	88	0.01491	0.32794	20.7619	5.7727273	4.227273	3.11818	0.363636	0	25	22	22	9.09091	27.272727	22.72727	22.727273	18.18182	3.13636	4.590909	0	9.090909	22.72727	9.09091	27.27273		
7	01637/86	JINGHONG	BlockG	290	898	5	4	4	0.25	0	25	15.725	10.62	80	0.02547	0.50943	22.23529	14.15	5.55	2.645	0.5	0	25	20	20	10	10	30	30	20	3.4	5.4	0	5	5	10	15		
8	01518/85	THACPRENN	BlockG	290	898	5	6	4	2.25	0	25	17.504167	12.545833	96	0.02561	0.61459	21.33333	16.5	4.875	2.4875	0.125	0	25	24	24	0	0	20.83333	37.5	41.66667	4.20833	6.958333	0	0	0	0	0		
8	01521/85	NONGKRATING	BlockG	290	898	5	7	4	6.25	0	25	15.221739	9.4391304	92	0.01986	0.45667	21.52381	14.217391	4.956522	2.26957	0.086957	0	25	23	23	4.34783	0	21.73913	26.086957	47.82609	4.13043	6.173913	0	0	0	0	4.347826		
8	01778/88	ZAMBIACSO	BlockG	290	898	4	6	9	2.25	0	25	18.266667	12.192857	60	0.02722	0.40829	22.66667	17.866667	4.285714	2.70714	0.133333	0	25	15	14	0	0	23.07692	7.6923077	69.23077	4.46154	7.666667	0	0	0	0	0		
8	01779/88	JOHNMEIKLE(1779)	BlockG	290	898	4	7	9	6.25	0	25	17.42	13.085	80	0.02436	0.48712	22.5	15.65	4.75	2.445	0.15	0	25	20	20	0	0	15	25	60	4.45	6.2	0	0	5	0	10		
8	TAE	TAEDA	BlockG	290	898	3	6	16	2.25	0	25	16.0375	11.966667	96	0.02065	0.49552	25.5	20.041667	4	1.95833	0.041667	0	25	24	24	0	4.1666667	25	4.1666667	66.66667	4.33333	7.791667	0	0	0	0	0		
9	01523/85	DOIINTHANON	BlockG	290	898	7	6	0	2.25	0	25	16.513043	11.321739	92	0.02302	0.5294	20.45455	17.478261	4.869565	2.0913	0.304348	0	25	23	23	0	0	34.78261	30.434783	34.78261	4	6.347826	0	0	0	0	0		
9	01635/86	JINGDUNG(1)	BlockG	290	898	6	8	1	12.25	0	25	15.213043	9.0826087	92	0.02003	0.46066	22.81818	12.434783	4.478261	2.96522	0.173913	0	25	23	23	4.34783	0	30.43478	13.043478	52.17391	4.08696	5.782609	0	0	0	0	4.34783	30.43478	
9	01784/88	BODANA_A9	BlockG	290	898	6	6	1	2.25	0	25	17.555556	11.527778	72	0.02597	0.46747	22.82353	17.222222	5.444444	3.05	0.111111	0	25	18	18	5.55556	0	22.22222	22.222222	50	4.11111	6.333333	0	5.555556	0	0	5.555556		
9	PAT	PATULA	BlockG	290	898	7	7	0	6.25	0	25	16.434783	12.091304	92	0.02266	0.52121	23.04348	27.304348	4.695652	2.39565	0.173913	0	25	23	23	0	8.6956522	21.73913	17.391304	52.17391	4.13043	6.826087	0	0	0	0	0		
10	01515/85	DATHIEN	BlockG	290	898	7	4	0	0.25	0	25	17.22	11.14	60	0.02757	0.41353	20.8	16.4	4.4	3.12667	0.4	0	25	15	15	6.66667	6.6666667	40	26.666667	20	3.46667	5.733333	0	0	0	13.3333	13.33333		
10	01525/85	NAMNOW	BlockG	290	898	7	3	0	2.25	0	25	16.708696	10.247826	92	0.02358	0.54231	20.69565	14.695652	4.26087	2.8087	0.26087	8.695652	25	23	23	0	13.043478	47.82609	30.434783	8.695652	3.34783	5.956522	0	0	0	4.34783	13.04348		
10	01624/86	BAOSHAN(1)	BlockG	290	898	7	1	0	12.25	0	25	9.9315789	6.3	76	0.00945	0.17964	21.625	5.8947368	4.052632	3.32632	0.473684	5.555556	25	19	17	11.1111	11.111111	55.55556	16.666667	5.555556	2.94444	2.526316	10.526	36.84211	42.10526	10.5263	0		
10	01638/86	LANCANG	BlockG	290	898	6	3	1	2.25	0	25	16.586364	10.613636	88	0.02564	0.56417	21.09091	12.954545	4.454545	3.03182	0.636364	4.761905	25	22	22	0	31.818182	22.72727	9.0909091	36.36364	3.5	5.318182	0	0	9.090909	13.6364	18.18182		
10	ELL	ELLIOTTII	BlockG	290	898	7	10	0	30.25	0	25	17.182609	11.077273	92	0.02395	0.5509	24.36364	17.521739	3.695652	1.87391	0.217391	0	25	23	22	4.34783	21.73913	52.17391	21.73913	0	2.91304	7.130435	0	0	0	0	8.695652		
11	01447/84	MT.PROVINCE	BlockG	290	898	13	2	36	6.25	0	25	16.325	12.033333	96	0.02555	0.61322	21.83333	17.625	4.666667	2.34167	0.416667	0	25	24	24	0	8.3333333	58.33333	33.333333	0	3.25	5.5	0	0	0	20.8333	25		
11	01521/85	NONGKRATING	BlockG	290	898	13	4	36	0.25	0	25	16.811111	10.027778	72	0.02417	0.43508	20.82353	15.5	4.055556	2.96111	0.111111	5.555556	25	18	18	5.55556	11.111111	66.66667	16.666667	0	2.94444	5.833333	0	0	0	5.55556	22.22222		
11	01783/88	BODANA_A8	BlockG	290	898	13	3	36	2.25	0	25	19.85	11.908333	48	0.03228	0.38734	21	15.583333	5.166667	3.95	0.25	8.333333	25	12	12	0	0	50	33.333333	16.66667	3.66667	5.416667	0	0	0	16.6667	25		
11	ELL	ELLIOTTII	BlockG	290	898	14	4	49	0.25	0	25	16.75	11.377273	88	0.02246	0.49403	23.81818	18.545455	3.727273	1.80455	0.227273	0	25	22	22	0	31.818182	59.09091	9.0909091	0	2.77273	6.818182	0	0	0	0	0		
11	PAT	PATULA	BlockG	290	898	14	3	49	2.25	0	25	16.144	12.916	100	0.02166	0.54148	22.16667	30.68	4.32	2.36	0.2	0	25	25	25	0	12	64	20	4	3.16	6.72	0	0	0	4	4		
12	01448/84	BENQUET	BlockG	290	898	14	7	49	6.25	0	25	15.445833	12.429167	96	0.01975	0.47395	22.34783	17.75	3.708333	2.05	0	12.5	25	24	24	4.16667	25	37.5	20.833333	12.5	3.125	5.625	0	4.166667	0	8.33333	37.5		
12	01515/85	DATHIEN	BlockG	290	898	14	8	49	12.25	0	25	16.82381	11.32	84	0.02377	0.49927	20.1	13.8	4.65	2.65	0.095238	5	25	21	20	0	15	40	35	10	3.4	6.35	0	5	0	5	10		
12	01518/85	THACPRENN	BlockG	290	898	14	6	49	2.25	0	25	15.792	11.841667	100	0.02098	0.52438	21.58333	16.64	4.8	2.344	0.16	0	25	25	24	0	32	36	24	8	3.08	6.28	0	0	0	8	4		
12	01635/86	JINGDUNG(1)	BlockG	290	898	14	5	49	0.25	0	25	14.878261	9.4652174	92	0.01976	0.45459	21.04348	13.304348	4.521739	3.17826	0.391304	0	25	23	23	0	13.043478	47.82609	34.782609	4.347826	3.30435	5.478261	0	0	0	4.34783	43.47826		
12	01637/86	JINGHONG	BlockG	290	898	13	7	36	6.25	0	25	16.618182	10.845455	92	0.02392	0.52626	19.45455	12.909091	4.636364	3.08636	0.181818	0	25	22	22	0	0	50	27.272727	22.72727	3.72727	6.545455	0	0	0	0	4.545455		
13	01633/86	SHANGSI	BlockG	290	898	12	3	25	2.25	0	25	12.091304	6.2521739	92	0.01462	0.33623	21.42857	7.173913	4.73913	3.54783	0.652174	0	25	23	23	0	39.130435	43.47826	8.6956522	8.695652	2.86957	3.478261	0	21.73913	34.78261	26.087	8.695652		
13	01638/86	LANCANG	BlockG	290	898	11	3	16	2.25	0	25	16.025	11.070833	96	0.02306	0.55344	21.16667	14.208333	4.75	3.07083	0.291667	0	25	24	24	0	16.666667	45.83333	29.166667	8.333333	3.29167	5.625	0	0	0	12.5	25		
13	01772/88	ZOKHUA	BlockG	290	898	11	4	16	0.25	0	25	13.12381	9.125	84	0.01539	0.32313	21.6	15.571429	4.285714	2.59524	0.142857	0	25	21	20	4.7619	19.047619	57.14286	14.285714	4.761905	2.95238	5.190476	0	9.52381	4.761905	14.2857	9.52381		
13	01779/88	JOHNMEIKLE(1779)	BlockG	290	898	12	4	25	0.25	0	25	15.396	12.356	100	0.02251	0.56282	22.54545	16.84	4.36	2.28	0.4	0	25	25	25	0	40	36	20	4	2.88	5.8	0	0	0	8	24		
14	01523/85	DOIINTHANON	BlockG	290	898	12	1	25	12.25	0	25	17.090909	11.327273	88	0.02383	0.52418	19.36364	16.090909	4.318182	2.59545	0.454545	0	25	22	22	0	18.181818	50	22.727273	9.090909	3.22727	5.772727	0	0	4.545455	4.54545	22.72727		
14	01624/86	BAOSHAN(1)	BlockG	290	898	13	1	36	12.25	0	25	9.2285714	6.1380952	84	0.00891	0.18705	19.57895	5.5714286	4.1	3.23	0.571429	0	25	21	21	9.52381	19.047619	47.61905	23.809524	0	2.85714	4.142857	0	14.28571	23.80952	9.52381	38.09524		
14	01632/86	CEHENG	BlockG	290	898	12	2	25	6.25	0	25	11.729167	6.0208333	96	0.01256	0.30153	22.52174	5.2916667	4.083333	3.79167	0.291667	0	25	24	24	0	29.166667	50	16.666667	4.166667	2.95833	3.958333	4.1667	4.166667	25	41.6667	16.66667		
14	01773/88	AUNGBAN	BlockG	290	898	11	2	16	6.25	0	25	14.955	8.8	80	0.02028	0.40552	20.63158	12.95	4.75	3.435	0.3	0	25	20	20	0	20	50	20	10	3.2	4.75	0	5	15	15	35		
14	01778/88	ZAMBIACSO	BlockG	290	898	11	1	16	12.25	0	25	19.85	11.99	40	0.03137	0.31366	21.4	20	4.777778	3.65556	0.1	0	25	10	10	0	0	60	40	0	3.4	7.9	0	0	0	0	0		
15	01519/85	LANGHANH	BlockG	290	898	12	5	25	0.25	0	25	17.281818	11.640909	88	0.02451	0.53914	20.90909	16.818182	4.954545	2.52727	0.409091	0	25	22	22	0	22.727273	27.27273	50	0	3.27273	6.272727	0	4.545455	0	4.54545	0		
15	01525/85	NAMNOW	BlockG	290	898	12	6	25	2.25	0	25	14.829167	9.5521739	96	0.01847	0.44333	20.66667	14.565217	4.173913	2.11304	0.083333	4.166667	25	24	23	8.69565	21.73913	47.82609	17.391304	4.347826	2.86957	6.173913	0	0	0	0	4.347826		
15	01776/88	JOHNMEIKLE(1776)	BlockG	290	898	13	6	36	2.25	0	25	16.575	11.609091	48	0.02276	0.27309	23.83333	22.833333	4.333333	2.89167	0.166667	0	25	12	11	0	33.333333	50	16.666667	0	2.83333	4.666667	8.3333	16.66667	0	8.33333	25		
15	01784/88	BODANA_A9	BlockG	290	898	12	7	25	6.25	0	25	17.530769	11.523077	52	0.02446	0.31799	21.07692	14.307692	3.923077	3.30769	0.076923	0	25	13	13	0	0	53.84615	38.461538	7.692308	3.53846	6.307692	0	0	0	0	0		
15	TAE	TAEDA	BlockG	290	898	13	5	36	0.25	0	25	15.948	11.848	100	0.02065	0.51619	25.2	23.32	3.76	2.516	0	0	25	25	25	0	20	56	24	0	3.04	7.04	0	0	0	0	4		

Plot Data Set - Block G

STEM 6	STEM 7	STEM 8	STEM 9	BRANATIO	FO_INDEX	INNODE	CROWNPCT	FO_POS	TOP	VTREE	MF	FF	CL	CC	OC	LOTH	APHID	DG	HG	PILCORR	VHA
75	6.25	0	0	0.13801338	2.91066341	0.67535295	45.625	4.5	4	0.11781784	1	1	1	1	1.88235294	0	0	17.0579462	10.5713271	19.7314198	109.898675
61.9047619	33.3333333	0	0	0.15508514	2.10416667	0.61275533	51.3636364	4.8	0	0.08753182	1	1	1	1	2.18181818	0	0	14.9642453	9.77731759	20.8504202	105.662555
62.5	16.6666667	4.16666667	0	0.20014419	38.3578731	0.7826868	43.75	2.37142857	0	0.10917676	1	1	1	1	2.16666667	0	0	16.1460134	10.840353	21.7605316	143.771866
50	33.3333333	0	0	0.11767839	33.9136741	0.67378491	46.6666667	2.72857143	0	0.18589016	1	1	1	1	1.94444444	0	0	19.2477704	13.3736553	24.5032646	183.59522
29.4117647	35.2941176	11.7647059	0	0.16282152	26.968	0.77550196	61.1764706	4.36666667	0	0.1844884	1	1	1	1	2.82352941	0	0	20.1031019	12.1477591	22.0316583	172.087944
50	12.5	0	0	0.13168331	33.9504883	0.63097223	49.1666667	3.78571429	0	0.1090442	1	1	1	1	1.58333333	0	0	15.4105754	11.8185455	23.0316076	143.597295
36.8421053	15.7894737	0	0	0.11877031	4.06103896	0.65109475	52.1052632	5.66666667	4	0.13980268	1	1	1	1	1.68421053	0	0	17.7998522	11.0498701	19.6658932	145.747649
0	0	0	0	0.33870804	47.3968159	1.09683442	68.6363636	1.145	0	0.04404435	1	1	1	1	4	0	0	11.1129327	7.23942196	24.1742254	53.1673859
38.4615385	15.3846154	0	0	0.13190152	33.8456586	0.51767101	58.4615385	4.575	0	0.17280728	1	1	1	1	2.84615385	0	0	19.0416345	12.5675147	24.0878107	123.264451
36.3636364	31.8181818	13.6363636	0	0.1603594		0.72030014	38.6363636		0	0.1397429	1	1	1	1	2.04545455	0	0	17.3741056	12.0480764	21.2488532	168.688275
50	10	0	0	0.16110509	40.8472222	0.67958967	53	0.36666667	0	0.12674639	1	1	1	1	2.55	0	0	17.7819431	10.3357124	21.1944636	139.090692
63.6363636	0	0	0	0.21284312	53.0150997	0.77796816	55.9090909	1.24444444	0	0.11213247	1	1	1	1	3.27272727	0	0	16.6823124	10.4361852	22.8087482	135.358808
60.8695652	0	0	0	0.18738027	35.9986264	0.69300681	51.3043478	1.61428571	4	0.11643604	1	1	1	1	3.26086957	0	0	16.8197994	10.9523145	21.1892238	146.942608
23.5294118	0	0	0	0.19260667	46.568254	0.78449199	52.9411765	1.74	0	0.1163075	1	1	1	1	2.94117647	0	0	17.4820412	9.81582541	20.8252706	108.489853
55	10	0	0	0.15070625	42.1680098	0.82983422	44.2105263	1.11666667	16	0.13849992	1	1	1	1	1.42105263	0	0	17.3462991	12.3990006	21.3246034	167.187837
17.3913043	0	0	0	0.30323734	41.1081022	1.19312629	66.0869565	1.76470588	0	0.0631515	1	1	1	1	3.43478261	0	0	13.8533154	7.97625263	23.5225661	79.6973602
57.1428571	0	0	0	0.19069052	59.704932	0.59389332	47.1428571	0.28571429	0	0.13690491	1	1	1	1	1.66666667	0	0	18.3566129	10.7279023	22.04073	157.750517
14.2857143	47.6190476	33.3333333	4.76190476	0.13620419	2.16447891	0.4002168	48.0952381	6.62	0	0.17567723	1	1	1	1	3.52380952	0	0	18.5055847	13.4216495	23.3814494	202.426437
0	52	36	12	0.14963877	1.15224809	0.53124469	49.2	10	0	0.13305247	1	1	1	1	1.64	0	0	16.7305708	12.3048756	25.3131895	182.513676
47.3684211	21.0526316	0	0	0.15478037	24.7650774	0.63595489	51.0526316	2.4	4	0.16442201	1	1	1	1	1.63157895	0	0	18.0621843	12.8954259	21.6725525	180.435676
11.1111111	0	0	0	0.26699746	1.58501553	0.96771244	76.1111111	4.425	0	0.05749235	1	1	1	1	2.05555556	0	0	13.5563843	7.17093248	21.5551126	56.7825715
25	33.3333333	33.3333333	0	0.14323682	93.25	0.65639558	61.6666667	0.15	0	0.22877838	1	1	1	1	2.66666667	0	0	21.5888281	13.1829867	21.7478193	150.635968
38.0952381	57.1428571	4.76190476	0	0.15549757	80.3776128	0.78126148	50	1.83333333	0	0.18780877	1	1	1	1	3.0952381	0	0	19.9287182	12.5439753	21.5576295	216.40517
0	45.8333333	45.8333333	8.33333333	0.09779642	35.9603922	0.62119287	50	5.63333333	0	0.14042973	1	1	1	1	1.125	0	0	17.792297	11.6458481	23.3804829	184.928034
0	52.6315789	5.26315789	0	0.12842371	22.9169511	0.65384067	54.7368421	5.47142857	0	0.13949906	1	1	1	1	2.22222222	0	0	16.889997	12.6543676	20.6076548	153.085385
42.1052632	31.5789474	0	0	0.19437577	43.1249601	0.67563442	51.5789474	1.47272727	0	0.12764058	1	1	1	1	3.42105263	0	0	17.8646225	10.4834861	22.3453848	133.068374
39.1304348	21.7391304	4.34782609	0	0.24519191	39.4053066	0.61214533	58.6956522	0.77777778	0	0.08202376	1	1	1	1	3	0	0	15.1560578	9.00069242	21.6528999	103.514206
25	18.75	25	18.75	0.13718497	2.1249184	0.61535557	60	7.83333333	0	0.14830013	1	1	1	1	2.1875	0	0	17.7641669	12.3249089	23.2111429	130.194899
14.2857143	52.3809524	23.8095238	4.76190476	0.1534829	2.67814283	0.77671624	46.1904762	4.66666667	0	0.12495961	1	1	1	1	2.66666667	0	0	16.429677	11.8594297	21.3763729	143.986381
58.3333333	0	0	0	0.14121918	52.8613928	0.66099017	42.9166667	2.2875	0	0.14730991	1	1	1	1	2.5	0	0	17.1805243	12.5026445	22.7245536	193.988354
61.1111111	11.1111111	5.55555556	0	0.14042521	5.07307395	0.69758365	50	3.16666667	0	0.13467248	1	1	1	1	2.27777778	0	0	17.4654094	11.561266	21.3439872	140.399294
19.047619	0	0	0	0.28061268	26.859139	0.92470238	77.5	2.08888889	0	0.06329104	1	1	1	1	3.61904762	0	0	14.0047492	7.56321493	22.6070202	69.4551826
22.7272727	9.09090909	0	0	0.26897753	25.3606061	1.1370689	71.3636364	0.6	0	0.05946847	1	1	1	1	2.95454545	0	0	13.7737233	7.41245112	20.8530171	71.7863601
55	10	0	0	0.17089278	36.9553427	0.73280533	49.5	1.67777778	0	0.13997961	1	1	1	1	2.35	0	0	18.0051382	11.2454433	22.2020003	153.612744
45.8333333	20.8333333	25	8.33333333	0.14077596	25.3960429	0.77028546	39.5833333	2.66666667	0	0.15689476	1	1	1	1	2.70833333	0	0	18.0532199	12.7277539	21.2969478	206.610383
73.9130435	21.7391304	0	0	0.14879455	25.3409091	0.63953243	43.0434783	0.65	0	0.09649976	1	1	1	1	3.04347826	0	0	15.8966773	9.69513756	21.5226888	121.782967
6.66666667	26.6666667	60	6.66666667	0.15069113	1.6689773	0.66457537	46.6666667	7.1	4	0.16484413	1	1	1	1	3.84615385	0	0	18.6126838	12.4526246	22.6118201	135.674179
45	35	5	0	0.13681013	3.66584257	0.85546156	43	3.46666667	0	0.15634342	1	1	1	1	1.95	0	0	17.6063341	13.2255604	22.4656523	171.570287
4.16666667	16.6666667	75	4.16666667	0.12483799	101	0.5814951	53.75	0.1	0	0.12182781	1	1	1	1	2.04166667	0	0	16.2102848	12.0570465	25.4991242	160.431689
73.9130435	17.3913043	8.69565217	0	0.12690934	12.6931777	0.63384674	32.6086957	4.17142857	0	0.12963372	1	1	1	1	3.30434783	0	0	17.1157314	11.5036096	20.4338881	163.59811
47.826087	17.3913043	0	0	0.19247375	28.7878788	0.75387963	45.6521739	0.93333333	0	0.09453335	1	1	1	1	3.65217391	0	0	15.9659148	9.35170822	22.8262477	119.301349
44.4444444	27.7777778	16.6666667	0	0.18846507	25.3106061	0.66985769	51.6666667	1.25	0	0.15282036	1	1	1	1	3.77777778	0	0	18.1806827	12.0112358	22.7678758	150.933692
39.1304348	39.1304348	21.7391304	0	0.1475689	1.69136176	0.43475072	38.6956522	7.35	0	0.13873903	1	1	1	1	3.82608696	0	0	16.9828302	12.3705241	23.0329838	175.089037
60	13.3333333	0	0	0.18172344	30.0077856	0.6999185	58	3.96	0	0.15047583	1	1	1	1	2.26666667	0	0	18.7316132	11.2361312	20.7704945	123.848419
65.2173913	17.3913043	0	0	0.17064816	8.6536944	0.72580645	49.1304348	2.46	0	0.12097082	1	1	1	1	1.60869565	0	0	17.3232064	10.4770125	20.678526	152.665509
0	0	0	0	0.33663213	21.574351	1.02644473	63.3333333	1.63333333	4	0.03851896	1	1	1	1	1.83333333	0	0	10.9695991	6.6364687	21.7581938	40.1569414
54.5454545	4.54545455	0	0	0.19230541	23.5931986	0.80975547	48.6363636	3.61428571	4	0.13700875	1	1	1	1	2.63636364	0	0	18.0660153	10.9128249	21.0767447	165.387788
8.69565217	47.826087	30.4347826	4.34782609	0.11856327	1.96896907	0.62010051	60.4545455	7.08	4	0.13179411	1	1	1	1	1.04347826	0	0	17.4598919	11.296949	24.3230598	166.324527
45.8333333	4.16666667	0	4.16666667	0.14701655	72.3641353	0.692465	57.5	2.23333333	0	0.15255736	1	1	1	1	1.875	0	0	18.033083	12.491083	21.8254969	200.898584
55.5555556	16.6666667	0	0	0.17706113	54.9537037	0.62515419	53.3333333	2.75	0	0.1233064	1	1	1	1	2.44444444	0	0	17.5393843	10.365577	20.7912325	121.784099
58.3333333	0	0	0	0.19939929	21.5494186	0.7693321	63.3333333	5.5	0	0.18531004	1	1	1	1	3.66666667	0	0	20.2686745	12.0049682	20.9068191	122.014838
40.9090909	36.3636364	22.7272727	0	0.10868094	3.30190663	0.64018202	57.7272727	6.1	0	0.1267125	1	1	1	1	1.09090909	0	0	16.9056876	11.4956737	23.8000556	152.958848
40	24	24	4	0.14606815	3.58135164	0.41009027	45.2	7.325	0	0.14008105	1	1	1	1	3	0	0	16.6031322	13.1968412	22.1541897	192.155077
16.6666667	33.3333333	0	0	0.13222249		0.71514359	50		0	0.12344381	1	1	1	1	2.625	0	0	15.8536931	12.6829352	22.3502794	162.559749
15	55	10	0	0.15931165	62.8478261	0.81772164	47	1.2	0	0.1340705	1	1	1	1	2.05	0	0	17.3950321	11.6461103	20.082358	154.484525
44	40	4	0	0.15147951	5.88524078	0.71346188	44.4	4.96666667	0	0.12277563	1	1	1	1	2	0	0	16.3388739	12.1073227	21.5802382	168.416502
52.173913	0	0	0	0.21518245	46.5835805	0.72923466	54.3478261	1.91428571	0	0.09604762	1	1	1	1	4.39130435	0	0	15.860369	9.74004592	21.0706691	121.212361
36.3636364	59.0909091	0	0	0.18593565	56.7310606	0.82209654	49.0909091	1.75	0	0.13072228	1	1	1	1	3.54545455	0	0	17.4485087	11.1858251	19.4396107	157.799188
8.69565217	0	0	0	0.30576956	15.975712	0.82409671	71.3043478	2.425	0	0.06149063	1	1	1	1	3.7826087	0	0	13.6402059	7.25297229	21.5068865	77.6013423
50	12.5	0	0	0.19529765	53.5897436	0.77025324	47.0833333	0.92857143	0	0.12755299	1	1	1	1	2.66666667	0	0	17.1315012	11.2774815	21.1660936	167.971016
52.3809524	9.52380952	0	0	0.19583465	42.6666667	0.57676736	62.8571429	0.2	0	0.075778	1	1	1	1	3.76190476	0	0	13.9941484	9.19800757	21.6595917	87.3162129
48	20	0	0	0.15156191	70.2275351	0.76423107	44.4	2.54444444	0	0.14430309	1	1	1	1	1.52	0	0	16.9270435	13.0240674	22.537453	197.946631
45.4545455	22.7272727	0	0	0.15046442	14.7479599	0.69458573	47.7272727	4.88	0	0.13273201	1	1	1	1	2.45454545	0	0	17.4139051	11.4321624	19.3372563	160.2252
14.2857143	0	0	0	0.39179046	41.625	1.05873016	60.952381	0.62222222	0	0.03706056	1	1	1	1	3.28571429	0	0	10.6471548	6.48277635	19.7338038	42.7035308
4.16666667	0	4.16666667	0	0.32493172	25.9223628	1.06145833	65.8333333	2.15714286	0	0.04472639	1	1	1	1	3.54166667	0	0	12.6453219	6.34956145	22.6204056	58.898954
25	5	0	0	0.23090302	32.6591121	0.66506481	53	2.66666667	0	0.09244133	1	1	1	1	3.6	0	0	16.0641526	9.05684443	20.6477944	101.444531
10	10	60	20	0.18776804	1.64935065	0.5980364	66	7.7	0	0.18066865	1	1	1	1	4.4	0	0	19.9802152	12.0301503	21.3068191	99.1323171
50	27.2727273	13.6363636	0	0.14605153	22.4403626	0.71605838	51.3636364	4.41428571	0	0.14040157	1	1	1	1	2.90909091	0	0	17.6607294	11.7819631	20.8780887	169.483376
73.9130435	21.7391304	0	0	0.14500405	4.74358974	0.63239534	49.5652174	4.7	0	0.09098964	1	1	1	1	2.95652174	0	0	15.3330118	9.86019371	20.6788044	119.821754
33.3333333	0	8.33333333	0	0.18709093	1.95363636	0.47583886	72.5	8	0	0.1406294	1	1	1	1	2.33333333	0	0	17.0189845	11.669271	23.8194441	92.595489
69.2307692	30.7692308	0	0	0.18617715	1.09677419	0.783808	63.0769231	12.4	0	0.13660584	1	1	1	1	4.46153846	0	0	17.6442407	11.5301478	21.0398935	97.4417535
12	60	24	0	0.16090056		0.49678565	53.6		0	0.12188786	1	1	1	1	2.2	0	0	16.2106508	11.9915696	25.2012912	167.198712

Plot Data Set - Block J

BLOCK	SEEDLOT	PROVNAME	SITE	DATESS	DATEASTX	PLOTS	PLOTX	PLOTY	PLOT2	REPLICA	_TYPE	_FREQ	DBH1	HEIGHT	SURV	GMEAN	GSUM	MEANPLOT	WHORLS	BRANCH	DIAB	FOXTAIL	NOTAG	NOEIGHT	KRAIL	KRAIL	KRAIL	KRAIL	KRAIL	KRAIL	KRAIL	STEM
1	01523/85	DOIINTHANON	BlockJ	190	898	23	3	121	0.25	1	0	15	15.41333333	8.992857143	100	0.01901921	0.285288143	18.35714286	16.07142857	4.357142857	2.364285714	0.142857143	0	15	15	14	0	14.28571429	85.71428571	0	0	2.857142857	6.214285714
1	01525/85	NAMNOW	BlockJ	190	898	23	2	121	0.25	1	0	15	15.40666667	7.933333333	100	0.019751757	0.296276357	18.53333333	15.06666667	4.066666667	3.14	0.133333333	0	15	15	15	0	40	33.33333333	26.66666667	0	2.866666667	6.666666667
1	01637/86	JINGHONG	BlockJ	190	898	24	3	144	0.25	1	0	15	14.20769231	7.961538462	86.66666667	0.017983852	0.233790071	19.33333333	14.23076923	3.846153846	3.9	0.230769231	0	15	13	13	7.692307692	7.692307692	69.23076923	15.38461538	0	2.923076923	5.692307692
1	01779/88	JOHNMEIKLE(1779)	BlockJ	190	898	21	2	81	0.25	1	0	15	17.25	11.88571429	93.33333333	0.025560128	0.357841786	18.85714286	18	4.214285714	2.842857143	0.142857143	0	15	14	14	0	7.142857143	64.28571429	28.57142857	0	3.214285714	7
1	01783/88	BODANA_A8	BlockJ	190	898	22	2	100	0.25	1	0	15	15.96428571	9.9	93.33333333	0.023814046	0.333396643	18.92857143	14.5	4.285714286	3.292857143	0.357142857	0	15	14	14	0	7.142857143	50	42.85714286	0	3.357142857	6.857142857
2	01447/84	MT.PROVINCE	BlockJ	190	898	21	3	81	0.25	1	0	15	15.93333333	11.18666667	100	0.023854443	0.357816643	19.93333333	18.33333333	4.4	2.706666667	0.333333333	0	15	15	15	0	33.33333333	53.33333333	13.33333333	0	2.8	6.2
2	01518/85	THACPRENN	BlockJ	190	898	22	4	100	0.25	1	0	15	15.97333333	9.793333333	100	0.023317538	0.349763071	18.46666667	15.2	4.133333333	3.073333333	0.333333333	0	15	15	15	0	13.33333333	73.33333333	13.33333333	0	3	5.466666667
2	01624/86	BAOSHAN(1)	BlockJ	190	898	21	5	81	6.25	1	0	15	10.66	6.18	100	0.014643148	0.219647214	22.73333333	6.266666667	3.733333333	4.24	1.333333333	0	15	15	15	0	26.66666667	26.66666667	40	6.666666667	3.266666667	3.4
2	01776/88	JOHNMEIKLE(1776)	BlockJ	190	898	22	3	100	0.25	1	0	15	17.36428571	11.29285714	93.33333333	0.025846969	0.361857571	21.07142857	19.07142857	5.142857143	3.014285714	0.133333333	0	15	14	14	7.142857143	21.42857143	57.14285714	14.28571429	0	2.785714286	6.214285714
3	01519/85	LANGHANH	BlockJ	190	898	20	2	64	0.25	1	0	15	15.56428571	10.07142857	93.33333333	0.024675806	0.345461286	17.53846154	15.28571429	5	3.028571429	0.428571429	0	15	14	14	7.142857143	21.42857143	64.28571429	7.142857143	0	2.714285714	6.071428571
3	01521/85	NONGKRATING	BlockJ	190	898	20	1	64	2.25	1	0	15	18	9.061538462	86.66666667	0.026975868	0.350686286	17.92307692	15.61538462	4.461538462	3.769230769	0.384615385	0	15	13	13	0	23.07692308	46.15384615	23.07692308	7.692307692	3.153846154	5.923076923
3	01635/86	JINGDUNG(1)	BlockJ	190	898	20	3	64	0.25	1	0	15	17.28461538	9.507692308	86.66666667	0.025347143	0.329512857	18.30769231	13.84615385	4.923076923	3.792307692	0.307692308	0	15	13	13	0	7.692307692	46.15384615	30.76923077	15.38461538	3.538461538	5.692307692
3	01638/86	LANCANG	BlockJ	190	898	20	4	64	2.25	1	0	15	16.38666667	9.726666667	100	0.022263162	0.333947429	17.8	15.06666667	5.333333333	3.326666667	0.066666667	0	15	15	15	6.666666667	13.33333333	53.33333333	26.66666667	0	3	5.666666667
3	01773/88	AUNGBAN	BlockJ	190	898	20	5	64	6.25	1	0	15	16.05	8.192857143	93.33333333	0.023224255	0.325139571	19.07142857	13.28571429	4.428571429	4.014285714	0.428571429	0	15	14	14	0	0	42.85714286	57.14285714	0	3.571428571	4.928571429
4	01515/85	DATHIEN	BlockJ	190	898	23	5	121	6.25	1	0	15	16.81333333	9.521428571	100	0.023245148	0.348677214	19.85714286	13.14285714	5.071428571	3.628571429	0.357142857	0	15	15	14	0	7.142857143	64.28571429	21.42857143	7.142857143	3.285714286	5.785714286
4	01632/86	CEHENG	BlockJ	190	898	24	5	144	6.25	1	0	15	9.373333333	4.873333333	100	0.008458895	0.126883429	21.64285714	4.933333333	4	3.846666667	0.533333333	0	15	15	15	0	40	46.66666667	13.33333333	0	2.733333333	3.066666667
4	01772/88	ZOKHUA	BlockJ	190	898	22	5	100	6.25	1	0	15	13.76666667	8.52	100	0.026274443	0.394116643	20.4	13.93333333	4.866666667	2.793333333	0.733333333	0	15	15	15	0	0	40	33.33333333	26.66666667	3.866666667	5.333333333
4	PAT	PATULA	BlockJ	190	898	24	4	144	2.25	1	0	15	15.125	9.875	26.66666667	0.018075161	0.072300643	23	25.75	3	3.375	0	0	15	4	4	0	0	75	25	0	3.25	6
4	TAE	TAEDA	BlockJ	190	898	23	4	121	2.25	1	0	15	15.21818182	9.290909091	73.33333333	0.018358	0.201938	22.36363636	20.63636364	3.636363636	3.227272727	0.363636364	0	15	11	11	0	9.090909091	72.72727273	18.18181818	0	3.090909091	6.090909091
5	01448/84	BENQUET	BlockJ	190	898	24	2	144	0.25	1	0	15	11.7	7.871428571	46.66666667	0.011198786	0.0783915	19	14	3.714285714	3.3	0	0	15	7	7	0	57.14285714	28.57142857	14.28571429	0	2.571428571	5.714285714
5	01633/86	SHANGSI	BlockJ	190	898	22	1	100	2.25	1	0	15	12.89166667	5.791666667	80	0.014303339	0.171640071	17.08333333	8.916666667	4.272727273	4.563636364	0.416666667	8.333333	15	12	12	0	8.333333333	50	41.66666667	0	3.333333333	4.75
5	01778/88	ZAMBIACSO	BlockJ	190	898	24	1	144	2.25	1	0	15	17.575	9.7375	53.33333333	0.024600125	0.196801	18.25	15.75	3.375	4.9625	0	0	15	8	8	0	0	75	25	0	3.25	7
5	01784/88	BODANA_A9	BlockJ	190	898	21	1	81	2.25	1	0	15	17.41428571	10.25714286	93.33333333	0.025662776	0.359278857	18.85714286	16.28571429	5.142857143	3.521428571	0.285714286	0	15	14	14	0	7.142857143	57.14285714	28.57142857	7.142857143	3.357142857	6.5
5	ELL	ELLIOTTII	BlockJ	190	898	23	1	121	2.25	1	0	15	14.96666667	8.406666667	100	0.017825081	0.267376214	19.4	14.6	4	2.586666667	0.066666667	0	15	15	15	0	40	60	0	0	2.6	6.933333333
6	01448/84	BENQUET	BlockJ	190	898	13	5	1	6.25	2	0	15	16.66428571	11.35	93.33333333	0.025174903	0.352448643	19.07142857	16.07142857	4.357142857	2.928571429	0.357142857	0	15	14	14	0	14.28571429	42.85714286	28.57142857	14.28571429	3.428571429	6.357142857
6	01772/88	ZOKHUA	BlockJ	190	898	11	5	1	6.25	2	0	15	13.30666667	8.62	100	0.019448576	0.291728643	19.13333333	13	4.866666667	2.953333333	0.8	0	15	15	15	0	26.66666667	60	13.33333333	0	2.866666667	6.266666667
6	01773/88	AUNGBAN	BlockJ	190	898	12	5	0	6.25	2	0	15	15.76666667	8.253333333	100	0.021874338	0.328115071	17.4	14	4.933333333	3.213333333	0.333333333	0	15	15	15	0	20	33.33333333	46.66666667	0	3.266666667	6.266666667
6	01776/88	JOHNMEIKLE(1776)	BlockJ	190	898	11	4	1	2.25	2	0	15	17.33846154	11.87692308	86.66666667	0.027527016	0.357851214	20.61538462	17	4.615384615	2.361538462	0.461538462	0	15	13	13	0	30.76923077	53.84615385	15.38461538	0	2.846153846	6.846153846
6	01783/88	BODANA_A8	BlockJ	190	898	12	4	0	2.25	2	0	15	16.76666667	9.78	100	0.022530462	0.337956929	16.86666667	13.93333333	5.066666667	3.593333333	0.066666667	0	15	15	15	0	0	53.33333333	40	6.666666667	3.533333333	6.933333333
7	01447/84	MT.PROVINCE	BlockJ	190	898	15	4	9	2.25	2	0	15	17.35333333	11.16	100	0.025711138	0.385667071	18.26666667	17.4	3.8	2.746666667	0.2	6.666667	15	15	15	0	6.666666667	73.33333333	20	0	3.133333333	6.133333333
7	01519/85	LANGHANH	BlockJ	190	898	16	4	16	2.25	2	0	15	18.10909091	10.78181818	73.33333333	0.025953714	0.285490857	18	14.54545455	4.727272727	3.545454545	0.090909091	0	15	11	11	0	0	36.36363636	45.45454545	18.18181818	3.818181818	6.909090909
7	01632/86	CEHENG	BlockJ	190	898	15	5	9	6.25	2	0	15	12.35333333	5.446666667	100	0.017448986	0.261734786	21.07142857	5.866666667	4.133333333	4.26	0.4	0	15	15	15	6.666666667	0	0	66.66666667	26.66666667	4.066666667	5.4
7	01633/86	SHANGSI	BlockJ	190	898	15	3	9	0.25	2	0	15	14.70714286	7.157142857	93.33333333	0.019232995	0.269261929	19	8.214285714	4.714285714	4.564285714	0.357142857	0	15	14	14	0	21.42857143	28.57142857	21.42857143	28.57142857	3.571428571	4.928571429
7	01637/86	JINGHONG	BlockJ	190	898	16	5	16	6.25	2	0	15	16.43571429	9.778571429	93.33333333	0.024209036	0.3389265	17.14285714	14	4.714285714	3.692857143	0.285714286	0	15	14	14	0	0	21.42857143	78.57142857	0	3.785714286	6.928571429
8	01518/85	THACPRENN	BlockJ	190	898	17	3	25	0.25	2	0	15	17.24	10.65333333	100	0.024185124	0.362776857	17.06666667	14	5	3.846666667	0.133333333	13.33333	15	15	15	0	13.33333333	20	60	6.666666667	3.6	7
8	01521/85	NONGKRATING	BlockJ	190	898	18	5	36	6.25	2	0	15	16.26428571	9.278571429	93.33333333	0.024620133	0.344681857	17.35714286	13.78571429	4.928571429	3.921428571	0.285714286	0	15	14	14	0	7.142857143	35.71428571	57.14285714	0	3.5	6.214285714
8	01778/88	ZAMBIACSO	BlockJ	190	898	17	4	25	2.25	2	0	15	17.26	10.85333333	100	0.024480762	0.367211429	17.46666667	17.46666667	4.2	3.113333333	0.2	0	15	15	15	0	6.666666667	60	26.66666667	6.666666667	3.333333333	7.733333333
8	01779/88	JOHNMEIKLE(1779)	BlockJ	190	898	17	5	25	6.25	2	0	15	16.00714286	10.56428571	93.33333333	0.022345209	0.312832929	18.61538462	17.42857143	4.642857143	2.921428571	0.357142857	0	15	14	14	0	28.57142857	50	21.42857143	0	2.928571429	6.285714286
8	TAE	TAEDA	BlockJ	190	898	16	3	16	0.25	2	0	15	16.10666667	10.36666667	100	0.02057859	0.308678857	22.13333333	21.26666667	3.6	3.033333333	0	0	15	15	15	0	13.33333333	60	20	6.666666667	3.2	7.266666667
9	01523/85	DOIINTHANON	BlockJ	190	898	11	1	1	2.25	2	0	15	17.47272727	10.19090909	73.33333333	0.025804929	0.283854214	15.45454545	14.54545455	4.545454545	3.327272727	0.363636364	0	15	11	11	0	36.36363636	54.54545455	9.090909091	0	2.727272727	6.181818182
9	01635/86	JINGDUNG(1)	BlockJ	190	898	12	2	0	0.25	2	0	15	15.93333333	9.04	100	0.020947195	0.314207929	19.73333333	11.86666667	5	3.673333333	0.066666667	0	15	15	15	0	0	46.66666667	40	13.33333333	3.666666667	6.266666667
9	01784/88	BODANA_A9	BlockJ	190	898	13	2	1	0.25	2	0	15	16.81818182	9.8	73.33333333	0.022695143	0.249646571	17.54545455	15.27272727	4.454545455	3.354545455	0.090909091	0	15	11	11	0	9.090909091	45.45454545	45.45454545	0	3.363636364	6.363636364
9	PAT	PATULA	BlockJ	190	898	12	1	0	2.25	2	0	15	15.81333333	11.72	100	0.0201212	0.301818	19.26666667	23.8	3.933333333	2.646666667	0	0	15	15	15	0	13.33333333	40	33.33333333	13.33333333	3.466666667	7.866666667
10	01515/85	DATHIEN	BlockJ	190	898	13	4	1	2.25	2	0	15	15.50666667	10.2	100	0.021144619	0.317169286	17.26666667	12.66666667	4.133333333	3.466666667	0.333333333	0	15	15	15	6.666666667	26.66666667	33.33333333	33.33333333	0	2.933333333	6.866666667
10	01525/85	NAMNOW	BlockJ	190	898	12	3	0	0.25	2	0	15	17.53846154	9.092307692	86.66666667	0.025399121	0.330188571	18.76923077	14.30769231	5.230769231	3.238461538	0.384615385	0	15	13	13	0	7.692307692	61.53846154	15.38461538	15.38461538	3.384615385	5.846153846
10	01624/86	BAOSHAN(1)	BlockJ	190	898	13	3	1	0.25	2	0	15	9.241666667	6.058333333	80	0.010631958	0.1275835	21.09090909	4.583333333	3.833333333	3.85	0.75	0	15	12	12	0	33.33333333	66.66666667	0	0	2.666666667	4.916666667
10	01638/86	LANCANG	BlockJ	190	898	11	3	1	0.25	2	0	15	15.70666667	10.84666667	100	0.021131524	0.316972857	18.4	14.6	3.866666667	2.96	0.266666667	0	15	15	15	6.666666667	20	40	33.33333333	0	3	6.466666667
10	ELL	ELLIOTTII	BlockJ	190	898	11	2	1	0.25	2	0	15	16.96923077	10.33846154	86.66666667	0.023109912	0.300428857	21.15384615	13.30769231	3.692307692	2.292307692	0.153846154	0	15	13	13	0	23.07692308	61.53846154	15.38461538	0	2.923076923	7
11	01447/84	MT.PROVINCE	BlockJ	190	898	2	3	100	0.25	3	0	15	16.05333333	11.24285714	100	0.022130219	0.331953286	18.66666667	15	4.5	2.535714286	0.285714286	0	15	15	14	0	14.28571429	28.57142857	57.14285714	0	3.428571429	6.285714286
11	01521/85	NONGKRATING	BlockJ	190	898	2	4	100	2.25	3	0	15	15.3	8.853333333	100	0.021015867	0.315238	17.53333333	12.8	4.066666667	2.453333333	0.133333333	0	15	15	15	6.666666667	26.66666667	20	26.66666667	20	3.266666667	7.133333333
11	01783/88	BODANA_A8	BlockJ	190	898	1	5	121	6.25	3	0	15	16.05333333	10.56666667	100	0.022419729	0.336295929	18.26666667	13.53333333	5	2.8	0.2	0	15	15	15	0	33.33333333	13.33333333	53.33333333	0	3.2	7.333333333
11	ELL	ELLIOTTII	BlockJ	190	898	1	4	121	2.25	3	0	15	15.28666667	9.553333333	100	0.018719014	0.280785214	20.6	14.26666667	3.533333333	2	0	0	15	15	15	0	53.33333333	40	6.666666667	0	2.533333333	7.066666667
11	PAT	PATULA	BlockJ	190	898	1	3	121	0.25	3	0	15	15.40666667	11.22666667	100	0.018948129	0.284221929	19.73333333	18.73333333	4.333333333	2.56	0.066666667	0	15	15	15	0	7.142857143	42.85714286	35.71428571	14.28571429	3.571428571	8.133333333
12	01448/84	BENQUET	BlockJ	190	898	1	2	121	0.25	3	0	15	15.21333333	10.40714286	100	0.020944786	0.314171786	19.92857143	13.6	3.4	2.873333333	0.133333333	0	15	15	14	0	20	33.33333333	40	6.666666667	3.333333333	6.266666667
12	01515/85	DATHIEN	BlockJ	190	898	1	1	121	2.25	3	0	15	15.5	9.707692308	86.66666667	0.021198511	0.275580643	17.46153846	13.38461538	3.846153846	3.653846154	0.307692308	0	15	13	13	0	7.692307692	38.46153846	46.15384615	7.692307692	3.538461538	6.615384615
12	01518/85	THACPRENN	BlockJ	190	898	2	2	100	0.25	3	0	15	15.40666667	9.286666667	100	0.019710795	0.295661929	18	12.33333333	4.133333333	3.14	0.133333333	0	15	15	15	0	0	40	53.33333333	6.666666667	3.666666667	6.133333333
12	01635/86	JINGDUNG(1)	BlockJ	190	898	2	1	100	2.25	3	0	15	14.84	8.106666667	100	0.018207881	0.273118214	19.26666667	12	4.666666667	4.04	0.133333333	0	15	15	15	0	0	33.33333333	33.33333333	33.33333333	4	6.266666667
12	01637/86	JINGHONG	BlockJ	190	898	3	1	81	2.25	3	0	15	14.43333333	8.633333333	100	0.017756933	0.266354	17.06666667	12.66666667	5	3.713333333	0.066666667	0	15	15	15	6.666666667	0	40	40	13.33333333	3.533333333	6.133333333
13	01633/86	SHANGSI	BlockJ	190	898	5	5	49	6.25	3	0	15	15.11333333	9.146666667	100	0.020787695	0.311815429	18.66666667	14.2	4.8	3.006666667	0.333333333	0	15	15	15	0	6.666666667	46.66666667	40	6.666666667	3.466666667	6.4
13	01638/86	LANCANG	BlockJ	190	898	5	3	49	0.25	3	0	15	14.23333333	8.246666667	100	0.018236481	0.273547214	16.86666667	11.8	4.071428571	3.9	0.466666667	0	15	15	15	0	53.33333333	33.33333333	13.33333333	0	2.6	6.466666667
13	01772/88	ZOKHUA	BlockJ	190	898	4	5	64	6.25	3	0	15	13.72666667	8.493333333	100	0.022820914	0.342313714	18.53333333	12.73333333	4.666666667	2.926666667	0.666666667	0	15	15	15	0	6.666666667	66.66666667	26.66666667	0	3.2	6.666666667
13	01779/88	JOHNMEIKLE(1779)	BlockJ	190	898	5	4	49	2.25	3	0	15	16.61538462	10.87692308	86.66666667	0.02189556	0.284642286	17.84615385	14.53846154	5	2.623076923	0	0	15	13	13	0	7.692307692	61.53846154	30.76923077	0	3.230769231	7.615384615
14	01523/85	DOIINTHANON	BlockJ	190	898	4	2	64	0.25	3	0	15	14.49230769	8.246153846	86.66666667	0.018067258	0.234874357	16.53846154	11.76923077	4.538461538	3.607692308	0.307692308	0	15	13	13	0	38.46153846	30.76923077	15.38461538	15.38461538	3.076923077	5.230769231
14	01624/86	BAOSHAN(1)	BlockJ	190	898	3	2	81	0.25	3	0	15	9.44	5.853333333	100	0.010493633	0.1574045	20.71428571	6.4	3.8	3.826666667	1	0	15	15	15	0	13.33333333	73.33333333	13.33333333	0	3	4.266666667
14	01632/86	CEHENG	BlockJ	190	898	5	1	49	2.25	3	0	15	12.02222222	5.8625	60	0.014256611	0.1283095	20	5	5.625	4.9125	0.375	0	15	9	8	11.11111111	11.11111111	33.33333333	33.33333333	11.11111111	3.222222222	4.75
14	01773/88	AUNGBAN	BlockJ	190	898	5	2	49	0.25	3	0	15	14.88666667	7.646666667	100	0.018745048	0.281175714	18.73333333	11.53333333	5.666666667	4.206666667	0.2	0	15	15	15	0	13.33333333	40	33.33333333	13.33333333	3.466666667	5.866666667
14	01778/88	ZAMBIACSO	BlockJ	190	898	4	1	64	2.25	3	0	15	17.775	10.0625	53.33333333	0.025016161	0.200129286	18	16.5	4.25	3.9125	0	0	15	8	8	0	0	12.5	62.5	25	4.125	7.75
15	01519/85	LANGHANH	BlockJ	190	898	3	4	81	2.25	3	0	15	16.17333333	10.42	100	0.021569952	0.323549286	17.66666667	14.2	4.214285714	2.807142857	0.333333333	0	15	15	15	0	20	26.66666667	53.33333333	0	3.333333333	7.533333333
15	01525/85	NAMNOW	BlockJ	190	898	4	3	64	0.25	3	0	15	14.50769231	7.738461538	86.66666667	0.01970511	0.256166429	17.76923077	12.76923077	4.769230769	2.923076923	0.230769231	0	15	13	13	0	30.76923077	53.84615385	15.38461538	0	2.846153846	7.384615385
15	01776/88	JOHNMEIKLE(1776)	BlockJ	190	898	3	3	81	0.25	3	0	15	16.34	10.98666667	100	0.022272957	0.334094357	20.53333333	16.33333333	4.333333333	2.5	0.133333333	0	15	15	15	0	13.33333333	46.66666667	33.33333333	6.666666667	3.333333333	6.933333333
15	01784/88	BODANA_A9	BlockJ	190	898	2	5	100	6.25	3	0	15	17.68571429	11	93.33333333	0.026523077	0.371323071	18.78571429	15	4.5	3.057142857	0.142857143	0	15	14	14	7.142857143	0	21.42857143	28.57142857	42.85714286	4	7
15	TAE	TAEDA	BlockJ	190	898	3	5	81	6.25	3	0	15	15.06428571	9.792307692	93.33333333	0.01884373	0.263812214	21.21428571	13.35714286	3.285714286	2.842857143	0.071428571	0	15	14	13	0	21.42857143	57.14285714	21.42857143	0	3	7.5

Plot Data Set - Block J

STEM 1	STEM 2	STEM 3	STEM 4	STEM 5	STEM 6	STEM 7	STEM 8	STEM 9	BRANCH RATIO	FO_INDEX	INTNODE	CROWNPCT	FO_POS	TOP	VTREE	MF	FF	CL	CC	OC	LOTH	APHID	DG	HG	PILOCORR	VHA
0	0	0	0	7.1428571	64.2857143	28.5714286	0	0	0.15603223	9.75	0.54248611	47.1428571	1.6	6.66667	0.08576635	1	1	1	1	3	0	0	15.5583632	9.05117086	18.3504677	117.649315
0	0	0	0	0	33.3333333	66.6666667	0	0	0.20573878	33.6	0.50338434	56.6666667	0.5	0	0.08118643	1	1	1	1	3.13333333	0	0	15.8551569	8.08669798	18.5293417	111.366847
7.692308	0	0	0	0	84.6153846	7.69230769	0	0	0.27707384	22.1923077	0.52470362	58.4615385	0.75	0	0.07688313	1	1	1	1	3.30769231	0	0	15.1289585	8.35202576	19.3130154	91.4019843
0	0	0	0	0	28.5714286	42.8571429	28.5714286	0	0.16191965	29.875	0.65447033	50	2.7	0	0.14968255	1	1	1	1	1.92857143	0	0	18.036372	12.0913562	18.922869	191.637461
0	0	0	0	0	35.7142857	42.8571429	21.4285714	0	0.27724264	17.4924111	0.66502681	69.2857143	3.92	0	0.11710491	1	1	1	1	3.85714286	0	0	17.4094186	9.79698726	18.9456698	149.92855
0	0	0	0	20	40	40	0	0	0.16858837	35.9355556	0.65253853	46	1.1	0	0.13210066	1	1	1	1	2.6	0	0	17.4241786	11.3635924	19.9492611	181.208043
0	0	0	6.666667	46.666667	40	6.66666667	0	0	0.18882151	29.4622721	0.63708893	33.3333333	1.2	0	0.11548026	1	1	1	1	2.53333333	0	0	17.226975	10.3288119	18.4841073	158.40913
0	13.33333	53.33333	13.33333	20	0	0	0	0	0.41076585	51.3510053	0.93023016	64	1.053333	0	0.05943044	1	1	1	1	4.06666667	0	0	13.6516421	7.1439148	22.5498154	81.5232366
7.142857	0	0	14.28571	7.1428571	21.4285714	21.4285714	14.2857143	14.285714	0.17411215	17.2928571	0.57914225	44.2857143	1.95	0	0.14547981	1	1	1	1	2.5	0	0	18.1372939	11.5861955	21.1414771	186.25673
0	0	0	0	0	92.8571429	7.14285714	0	0	0.19972096	63.1477623	0.63914774	45	1.266667	0	0.13003732	1	1	1	1	3.28571429	0	0	17.7216171	10.7946668	17.5743668	166.485828
0	0	0	7.692308	7.6923077	69.2307692	15.3846154	0	0	0.20978201	3.42824465	0.55820137	53.0769231	4.08	0	0.12278553	1	1	1	1	3.15384615	0	0	18.5291454	9.24997924	18.0171692	145.97274
0	0	0	0	38.461538	53.8461538	7.69230769	0	0	0.22103088	23.352381	0.6550983	46.9230769	1.633333	0	0.12035907	1	1	1	1	4.15384615	0	0	17.961069	9.67461228	18.3747276	143.088052
0	0	0	6.666667	26.666667	60	6.66666667	0	0	0.20007644	26.6666667	0.62318733	31.3333333	0.3	0	0.1094626	1	1	1	1	3.2	0	0	16.8329835	9.92362729	17.8330735	150.154452
0	0	0	35.71429	35.714286	28.5714286	0	0	0	0.25232363	14.2663968	0.59824476	40	1.56	0	0.09652447	1	1	1	1	4.5	0	0	17.1924817	8.30998751	19.0917688	123.579562
0	0	7.142857	7.142857	28.571429	21.4285714	28.5714286	7.14285714	0	0.21334167	13.2505486	0.71247308	48.5714286	3.55	6.66667	0.10983608	1	1	1	1	3.21428571	0	0	17.2002132	9.57148655	19.9080105	150.66678
0	40	26.66667	20	13.333333	0	0	0	0	0.43091837	17.5706011	0.88633333	78	1.333333	0	0.02999678	1	1	1	1	2.86666667	0	0	10.3758694	5.36913441	21.4233006	41.1478476
0	0	0	13.33333	46.666667	33.3333333	6.66666667	0	0	0.20185813	53.8590909	0.58740078	50	0.209091	0	0.11866467	1	1	1	1	3.53333333	0	0	18.2866618	9.08969983	20.333981	162.777319
0	0	0	0	0	100	0	0	0	0.22623671		0.3693679	72.5		0	0.08948499	1	1	1	1	3	0	0	15.1673168	9.90441847	22.9853553	32.7334193
0	0	0	0	18.181818	54.5454545	27.2727273	0	0	0.20629655	2.32875	0.42746769	56.3636364	5.325	0	0.08566974	1	1	1	1	1.45454545	0	0	15.2855249	9.30985487	22.3525159	86.1789807
0	0	0	0	28.571429	71.4285714	0	0	0	0.30095505		0.58033417	61.4285714		0	0.04794283	1	1	1	1	2.14285714	0	0	11.9385929	7.92736106	18.8558165	30.6904269
0	0	0	25	75	0	0	0	0	0.35548494	8.47467428	0.61266023	70	2.2	0	0.04750301	1	1	1	1	4.83333333	0	6.666667	13.4923126	6.10434049	16.9842205	52.1295064
0	0	0	0	0	25	50	25	0	0.27762965		0.60917727	70		0	0.11928181	1	1	1	1	3.375	0	0	17.69442	9.83722535	18.3280181	87.2660693
0	0	0	0	0	50	50	0	0	0.20446724	8.57097554	0.61399535	49.2857143	5.725	0	0.12870887	1	1	1	1	3.57142857	0	0	18.0725522	10.3402902	18.9290825	164.78502
0	0	0	0	0	33.3333333	40	26.6666667	0	0.17331461	1.2125	0.55250011	64.6666667	8	0	0.07704882	1	1	1	1	1	0	0	15.0620273	8.48170033	19.3793669	105.691107
0	0	0	0	14.285714	50	21.4285714	14.2857143	0	0.17582356	24.8954545	0.6909232	53.5714286	1.1	0	0.13972218	1	1	1	1	3	0	0	17.8999401	11.6562852	19.1150021	178.885273
0	0	0	0	0	80	13.3333333	6.66666667	0	0.22503199	33.172448	0.63155678	56.6666667	1.277778	0	0.090655	1	1	1	1	2.66666667	0	0	15.7330014	9.16148568	19.0499164	124.355285
0	0	0	0	0	73.3333333	26.6666667	0	0	0.20227849	34.8529412	0.56444821	53.3333333	1.05	0	0.09286431	1	1	1	1	3.73333333	0	0	16.6853429	8.50073895	17.4096241	127.385888
0	0	0	7.692308	7.6923077	23.0769231	23.0769231	30.7692308	7.6923077	0.13586226	40.3541295	0.68686405	60.7692308	2.24	0	0.16105377	1	1	1	1	2.76923077	0	0	18.7174744	12.2776585	20.6844565	191.467677
0	0	0	0	0	33.3333333	40	26.6666667	0	0.21420257	1.59701493	0.68388449	50	6.7	0	0.1105968	1	1	1	1	3.73333333	0	0	16.9337336	9.9004481	16.9141124	151.71029
0	0	0	20	0	33.3333333	40	6.66666667	0	0.15950413	30.489899	0.62578329	54	2.366667	0	0.14242839	1	1	1	1	2.42857143	0	0	18.0895734	11.3678004	18.336301	195.375014
0	0	0	0	18.181818	9.09090909	36.3636364	36.3636364	0	0.19485072	1.87755102	0.71748937	60	4.9	0	0.13611584	1	1	1	1	3.27272727	0	0	18.1747077	10.8117353	18.0982183	136.924941
0	0	0	26.66667	13.333333	53.3333333	6.66666667	0	0	0.3639762	25.7727273	0.84831746	64.6666667	0.7	0	0.05373717	1	1	1	1	3.6	0	0	14.9022817	5.69970632	20.9734414	73.7135362
0	0	7.142857	14.28571	57.142857	21.4285714	0	0	0	0.30833305	11.3732456	0.83061224		1.9	0	0.07504894	1	1	1	1	4.07142857	0	0	15.6455608	7.53770052	18.9695513	96.0846097
0	0	0	0	7.1428571	28.5714286	28.5714286	35.7142857	0	0.22594392	56.875	0.66757303	51.4285714	0.175	0	0.11805958	1	1	1	1	3.57142857	0	0	17.5532048	10.1122057	17.1777857	151.150818
0	0	0	0	0	0	100	0	0	0.22899421	1.39094909	0.81216214		8	0	0.12989291	1	1	1	1	2.13333333	0	0	17.5445338	10.8649386	17.1320146	178.179572
0	0	0	0	14.285714	57.1428571	21.4285714	7.14285714	0	0.24538278	15.3884058	0.65029468	56.4285714	1.3	0	0.11528111	1	1	1	1	2.57142857	0	0	17.7016141	9.51123918	17.3855877	147.593552
0	0	0	0	0	0	26.6666667	73.3333333	0	0.18119105	35.0791528	0.60343398	56.6666667	6.9	0	0.13070278	1	1	1	1	3.66666667	0	0	17.65144	10.9723696	17.532771	179.290511
0	0	0	7.142857	28.571429	7.14285714	42.8571429	14.2857143	0	0.18997496	17.2902894	0.58940347	43.5714286	2.62	0	0.12036829	1	1	1	1	1.57142857	0	0	16.8639726	10.9036448	18.6608907	154.10664
0	0	0	0	0	0	73.3333333	26.6666667	0	0.18751041		0.4662738			0	0.10596656	1	1	1	1	1.86666667	0	0	16.1836131	10.4225086	22.1558168	145.358789
0	0	0	0	18.181818	45.4545455	36.3636364	0	0	0.18813879	12.2097701	0.68235439	50	2.866667	0	0.13018302	1	1	1	1	2.81818182	0	0	18.1225375	10.3243338	15.5286955	130.956858
0	0	0	0	0	73.3333333	26.6666667	0	0	0.23214205	28	0.75528196	56	0.3	0	0.09499676	1	1	1	1	4.33333333	0	0	16.3279107	9.16608637	19.7492611	130.311055
0	0	9.090909	0	0	45.4545455	27.2727273	18.1818182	0	0.19725817	1.70149254	0.62839633	50.9090909	6.7	0	0.1108511	1	1	1	1	3.63636364	0	0	16.9955074	9.87834278	17.5948486	111.510018
0	0	0	0	0	0	26.6666667	60	13.333333	0.16905012		0.48528051	47.5		0	0.11581798	1	1	1	1	4.06666667	0	0	16.0027498	11.7517475	19.2780558	158.872398
0	0	0	0	6.6666667	20	53.3333333	20	0	0.22570714	13.4417961	0.81211082	56.6666667	3.98	0	0.10981799	1	1	1	1	2.33333333	0	0	16.4046741	10.5117108	17.2664572	150.641965
0	0	0	0	38.461538	38.4615385	23.0769231	0	0	0.18215824	5.47168424	0.62379058	60.7692308	2.4	0	0.11461612	1	1	1	1	2.76923077	0	0	17.9794755	9.22201391	18.8458669	136.260588
0	0	8.333333	25	33.333333	33.3333333	0	0	0	0.42626797	64.0277778	1.28486111	82.5	0.416667	0	0.04389404	1	1	1	1	3.75	0	0	11.6325334	6.75778381	20.8642058	48.1690391
0	0	0	0	0	60	33.3333333	6.66666667	0	0.18731327	40.6412698	0.7340384	50.6666667	1.8	0	0.11608114	1	1	1	1	2.93333333	0	0	16.3995935	11.1245293	18.4073548	159.233391
0	0	0	0	30.7692308	53.8461538	0	15.384615	0	0.13884603	2.26164596	0.78630495	60.7692308	6	0	0.11883503	1	1	1	1	1	0	0	17.1501065	10.4371946	21.2089531	141.276215
0	0	0	0	7.1428571	64.2857143	21.4285714	7.14285714	0	0.15850509	30.2669779	0.70801762	47.8571429	2.9	6.66667	0.12323521	1	1	1	1	2.85714286	0	0	16.7826498	11.3416122	18.687133	169.046926
0	0	0	0	0	26.6666667	33.3333333	40	0	0.18271623	23.5588235	0.65369488	58.6666667	0.95	0	0.09849606	1	1	1	1	2.73333333	0	0	16.3546528	9.42185165	17.5253074	135.111197
0	0	0	0	0	20	26.6666667	53.3333333	0	0.17187259	86	0.77524449	46.6666667	0.133333	0	0.11577505	1	1	1	1	2.13333333	0	0	16.8920691	10.2680192	18.287133	158.813507
0	0	0	0	0	26.6666667	40	33.3333333	0	0.13414999		0.6707421	58		0	0.08970713	1	1	1	1	1	0	0	15.4350899	9.59755726	20.5914698	123.055053
0	0	0	0	0	0	13.3333333	60	26.666667	0.17095151	3.66666667	0.5783374	43.5714286	2.7	0	0.10615114	1	1	1	1	3.2	0	0	15.5292627	11.3147576	19.7293417	145.611984
0	6.666667	0	6.666667	6.6666667	26.6666667	33.3333333	20	0	0.19507537	17.40625	0.73519037	54	1	0	0.11396299	1	1	1	1	2.73333333	0	0	16.3269716	10.8975314	19.9451295	156.327833
0	0	0	7.692308	7.6923077	23.0769231	46.1538462	7.69230769	7.6923077	0.23817013	15.4413876	0.72012645	46.1538462	1.825	0	0.10403831	1	1	1	1	2.30769231	0	0	16.4255664	10.0223174	17.4610768	123.685237
0	0	0	0	13.333333	60	26.6666667	0	0	0.2056781	24.3227273	0.73017839	45.3333333	2.85	0	0.09311408	1	1	1	1	3.26666667	0	0	15.8387079	9.46311234	17.9960084	127.7285
0	0	0	6.666667	6.6666667	46.6666667	33.3333333	6.66666667	0	0.2702505	20.6730769	0.65836878	47.3333333	2.7	0	0.07534597	1	1	1	1	4.4	0	0	15.2228994	8.11824316	19.2412428	103.355234
0	0	6.666667	0	20	33.3333333	26.6666667	13.3333333	0	0.25417486	44.5	0.65026956	52	0.2	0	0.0805305	1	1	1	1	2.6	0	0	15.0332077	8.91649004	17.0258621	110.467075
0	0	0	0	6.6666667	60	20	13.3333333	0	0.19883873	19.1945826	0.61913782	52	3.22	0	0.09737944	1	1	1	1	3.13333333	0	0	16.2656284	9.47517619	18.8515807	133.579476
0	0	0	0	6.6666667	53.3333333	26.6666667	13.3333333	0	0.28910402	41.6821267	0.67020427	52	1.95	0	0.07989011	1	1	1	1	3.13333333	0	0	15.2348504	8.63310537	16.8182977	109.588627
0	0	0	0	0	46.6666667	40	13.3333333	0	0.21097262	34.6044974	0.64593814	50.6666667	1.155556	0	0.10188708	1	1	1	1	3.53333333	0	0	17.042535	9.0409678	18.4658015	139.762795
0	0	0	0	0	0	46.1538462	46.1538462	7.6923077	0.1571012		0.73837796	54.6153846		0	0.11615287	1	1	1	1	1.61538462	0	0	16.6934349	10.8679082	17.8878778	138.087542
0	0	7.692308	23.07692	23.076923	30.7692308	15.3846154	0	0	0.25409986	1.87216354	0.67442756	60.7692308	5.8	0	0.07993759	1	1	1	1	2	0	0	15.1640009	8.54652837	16.4998874	95.033258
0	6.666667	40	0	26.66667	26.6666667	0	0	0	0.40061999	39.3912338	0.91284921	64.6666667	1.081818	6.66667	0.04199338	1	1	1	1	3.86666667	0	0	15.5566143	6.37608809	20.4939187	57.6040851
0	0	25	12.5	25	37.5	0	0	0	0.38826898	10.9077649	1.0775	80	1.566667	0	0.05274258	1	1	1	1	3.75	0	0	13.4702553	5.88439566	19.8988385	43.4095278
0	0	0	6.666667	13.333333	66.6666667	13.3333333	0	0	0.2860305	13.4179894	0.63245163	60	3.5	0	0.07597787	1	1	1	1	2.66666667	0	0	15.4458193	7.88943836	18.7096745	104.222047
0	0	0	0	0	0	0	25	75	0.22051389		0.5877117	55		0	0.12267969	1	1	1	1	4	0	0	17.8434162	10.0669421	18.0855824	89.7519416
0	0	0	0	0	6.66666667	40	46.6666667	6.6666667	0.17440952	53.2953216	0.74308101	49.3333333	1.475	0	0.11171514	1	1	1	1	3	0	0	16.5688463	10.5032499	17.6916716	153.244358
0	0	0	0	0	15.3846154	38.4615385	38.4615385	7.6923077	0.19684011	27.2296296	0.61780908	62.3076923	0.5	0	0.08052694	1	1	1	1	2.61538462	0	0	15.8364235	8.09904281	17.7312385	95.7339026
0	0	0	0	0	33.3333333	40	26.6666667	0	0.15203243	28.0647059	0.65617893	56	4.35	0	0.12092544	1	1	1	1	3.26666667	0	0	16.8366861	11.1090442	20.5646418	165.87852
0	0	0	0	0	21.4285714	57.1428571	21.4285714	0	0.17416474	28.5743243	0.72592914	50	1.95	0	0.1449318	1	1	1	1	3.07142857	0	0	18.3729809	11.2856102	18.8679198	185.555122
0	0	0	0	0	0	57.1428571	35.7142857	7.1428571	0.20544257	43.5	0.7750847	54.2857143	0.2	0	0.09278827	1	1	1	1	1.14285714	0	0	15.4864226	9.87834453	21.1973447	118.79614