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Publication date:
2003

Document version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Ræbild, A., Graudal, L. O. V., & Ouedraogo, L. G. (2003). *Evaluation of a species and provenance trial of A. seyal and A. tortilis at Gonsé, Burkina Faso: Trial no. 10 in the arid zone series*. Danida Forest Seed Centre. Results and documentation no. 9

Download date: 13. Nov. 2026

Evaluation of a species and provenance trial of *Acacia nilotica, A. seyal* and *A. tortilis* at Gonsé, Burkina Faso

Trial no. 10 in the arid zone series

by

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Results and documentation no. 9

Danida Forest Seed Centre

June 2003

Citation:
A. Ræbild, Lars Graudal and Lambert Georges Ouedraogo. 2003. Evaluation of a species and provenance trial of *Acacia nilotica*, *A. seyal* and *A. tortilis* at Gonsé, Burkina Faso. Trial no. 10 in the arid zone series. Results and Documentation No. 9. Danida Forest Seed Centre, Humlebaek, Denmark.

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ISSN 0902-3224

Cover photo:
Assessment, species and provenance trial of *A. nilotica*, *A. seyal* and *A. tortilis* at Gonsé, Burkina Faso. Trial 10 in the arid zone series. Measurement of Diameter at 0.3 m height. Phot: Lars Graudal, DFSC. 1993.

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www.dfsc.dk/publications/

Technical Editor: Melita Jørgensen

Print:
Toptryk A/S, Graasten

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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 belongs to a new series of analysis reports published by the Danida Forest Seed Centre. It is the intention that the series should serve as a place for publication of trial results for the Centre itself as well as for our collaborators. The reports will be made available from the DFSC publication service and online from the web-site www.dfsc.dk. The scope of the series is in particular the large number of trials from which results have not been made available to the public, and which are not appropriate for publication in scientific journals. We believe that the results from these trials will contribute considerably to the knowledge on genetic variation of tree species in the tropics. Also, the analysis report will allow a more detailed documentation than is possible in scientific journals.

At the same time, the report represents the first results within the framework of the 'International Series of Trials of Arid and Semi-Arid Zone Arboreal Species', initiated by FAO. Following collection and distribution of seed between 1983-87, a large number of trials were established by national institutions during 1984-1989. An international assessment of 26 trials took place from 1990 to 1994. DFSC is responsible for the reporting of this assessment.

This trial was established and maintained by the Centre National de Semences Forestières (CNSF) in Burkina Faso in collaboration with IBN-DLD, the Netherlands. At the first assessment, the assessment team consisted of Traoré Adama, Lambert Ouedraogo from CNSF, Diallo Boukary, Kiemdrébéogo Karim, Kaboré Ousmane and Sawadogo Abel from INERA (IRBET), Agnete Thomsen from FAO, and Lars Graudal from DFSC. At the second assessment, the team included Traore Adama, Bikienga Salamata, Adjaba Ernest, Boukoungou Laurent, Kanzoe Alain, Kalmogo Saidan and Zida Moumani from CNSF, and Anders Ræbild from DFSC.

The authors wish to acknowledge the help of the personnel at CNSF with the establishment, maintenance and assessment of the trials, and thank the personnel of DFSC for their help with the data management and preliminary analyses. Drafts of the manuscript were commented on by Dr. agro. Axel Martin Jensen and Marcus Robbins, consultant to FAO.

Abstract

This report describes results from a trial with 12 provenances, four of each of the species *Acacia nilotica*, *A. seyal* and *A. tortilis*. The provenances were mainly from Burkina Faso, but included three exotic provenances from Senegal, India and Sudan. The trial was established at Gonsé, Burkina Faso with a spacing of 4 x 4 metres in 1988 and assessed after 1, 5, and 11 years in 1989, 1993 and 1999. Different growth parameters were measured and subjected to analyses of variance and multivariate analyses.

The fastest growing provenances had an increment rate of 0.5 m^2 ha^{-1} y^{-1}, corresponding to a dry weight production of 1.6 t ha^{-1} y^{-1}. The best provenances of each species had comparable growth rates. The species differed with respect to height, crown area and number of stems, *A. seyal* being the most tree-like and *A. tortilis* the most bushy, whereas *A. nilotica* was intermediate. In the multivariate analyses, *A. seyal* appeared very distinctly different from the other species.

In *A. nilotica* and *A. tortilis*, there were several significant differences between the provenances, but within the four provenances of *A. seyal* (all from Burkina Faso) there were no significant differences.

The genetic correlations between identical variables from the 1993 and 1999 measurements were high, but low between variables from 1989 and the other assessments. A test for new information revealed that there had been significant changes in the relative growth of the trees between 1993 and 1999, but that this was an accentuation of the differences in growth rather than a change in the rank between provenances.

Résumé en français

Le présent rapport décrit les résultats d'un essai comparatif de douze (12) provenances : quatre (4) provenances de chacune des espèces *Acacia nilotica, A. seyal et A. tortilis.* Ces provenances sont principalement du Burkina Faso et incluent une du Sénégal, une de l'Inde et une du Soudan. L'essai a été mis en place à Gonsé, Burkina Faso, suivant un espacement de 4x4 m entre les plantes en 1988. Les mesures analysées ont été relevées à 1, 5 et 11 ans d'âge soit en 1989, 1993 et 1999. Différents paramètres de croissance ont été mesurés et soumis à des analyses de variance et multi-variable.

Les provenances à croissance la plus rapide avaient une productivité de 0,5 m^2 ha^{-1} an^{-1}, correspondant à une production de matière sèche de 1,6 t ha^{-1} an^{-1}. Les meilleures provenances de chaque espèce avaient des croissances similaires. Les espèces différent cependant dans leur croissance en hauteur, leur surface du houppier et leur nombre de ramification à la base. *A. seyal* a la meilleure caractéristique de l'arbre préféré tandis que. *A tortilis* est la plus bas-branchue pendant que *A. nilotica* occupe une place intermedaire entre les deux. Dans les analyses multivariables, *Acacia seyal* apparaît très distincte des deux autres espèces.

Il y a des différences significatives entre les provenances de *Acacia nilotica* et *A. tortilis*. Cependant, aucune différence significative n'est décelée entre les provenances de *Acacia seyal* (toutes du Burkina Faso).

Les corrélations génétiques entre les variables individuelles des mensurations de 1993 et 1999 sont grandes mais elles sont faibles entre les variables des données de 1989 avec celles des autres années. L'application d'un test nouveau révèle qu'il y a eu des changements significatifs dans la croissance relative des arbres entre 1993 et 1999, mais que ceci est dû plutôt à une accentuation dans la différence de croissance qu'à un changement de rang entre les provenances.

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1. Introduction

This report describes the results from trial no. 10 in a large series of provenance trials within the 'International Series of Trials of Arid and Semi-Arid Zone Arboreal Species'. The main goals of the series were to contribute to the knowledge on the genetic variation of woody species, their adaptability and productivity and to give recommendations for the use of the species. The species included in this series of trials are mainly of the genera *Acacia* and *Prosopis*. A more detailed introduction to the series is given by DFSC (Graudal *et al.* 2003)).

The present trial includes twelve provenances of the species *Acacia nilotica*, *A. seyal* and *A. tortilis* (see Fagg & Greaves (1990a and b) for annotated bibliographies of *A. nilotica* and *A. tortilis*). Parallel trials with almost the same provenances exist in Dori and Djibo, also in Burkina Faso.

A. nilotica is a very variable species with a natural distribution covering large tracts of tropical and subtropical Africa and Asia (Ross 1979). The two subspecies included in this trial, *adansonii* (which is also commonly called *adstrigens*) and *tomentosa* differ in their ecological requirements even though they both prefer moist conditions. The subspecies *adansonii* is found predominantly on deep sandy-loamy soils such as fossil dunes, and on lateritic and calcareous sites. Subsp. *tomentosa* tolerates inundation and is often found on clay or alluvial soils along depressions or riverbeds (von Maydell 1986, Ross 1979, Fagg & Barnes 1990).

The species *A. seyal* is found in the Sahel and the eastern and south-central Africa (von Maydell 1986, Ross 1979).

A. tortilis is widespread in the Sahel, East Africa and Arabia (von Maydell 1986, Ross 1979, Fagg & Barnes 1990). Several subspecies are recognised, but in the current trial only the subspecies *raddiana* is included together with a landrace from India. The landrace from India was introduced from Israel, also of the subspecies *raddiana* (Fagg & Barnes 1990). It should be noted that in the French literature, the subspecies is often referred to as a separate species, *A. raddiana*.

2. Site, material and methods

2.1 Site and establishment of the trial

The trial is located at Gonsé (12°22′N, 01°19′W) in Burkina Faso at an altitude of 300 m. The mean annual temperature is 28.1 °C, and the annual rainfall is 679 mm with a dry period of eight months. Further site information is given in the assessment report (DFSC 1994) and summarised in Annex 1. Recent data from the weather station in Gonsé show that the average annual rainfall in the years 1995 to 1999 was 795 mm, a bit higher than in the preceding period (unpublished data, CNSF 1999).

The soil at the site is leached and sandy with some clay and gravel. In order to facilitate the water infiltration the soil was scarified by sub-soiling with a bulldozer to a depth of 60 cm in July before planting. Seed were sown in April 1988, and the trial was established in August 1988. Beating up took place only in the first 4 weeks after establishment. The trial was weeded once a year.

2.2 Species and provenances

Three species (*Acacia nilotica*, *A. seyal* and *A. tortilis*) are represented with each four provenances (Table 1). Nine of the provenances are from Burkina Faso with the exceptions being one provenance of *A. nilotica* from Sudan and two provenances of *A. tortilis* from Sudan and India. The provenances of *A. nilotica* furthermore represent the subspecies *adansonii* and *tomentosa*. The provenances have been given identification numbers relating to their geographical origin (name of province or country followed by a number). The original seedlot numbers are provided in Annex 2.

2.3 The experimental design

The experimental design is a randomised complete block design with six blocks. Within each block, each provenance is represented by 36 trees in a plot, planted in a square of 6×6 trees. The trees are placed with a spacing of 4×4 m. For the purpose of analysis, only the 16 central trees of each plot were measured. The layout of the trial is shown in Annex 3. Further details are given in DFSC (1994).

2.4 Assessments of the trial

Five months after planting, in January 1989, CNSF undertook the first assessment, measuring the diameters of the plants at the root collar. In March 1993 CNSF, IRBET, FAO and DFSC undertook a joint assessment. The assessment is described in detail by DFSC (Graudal *et al.* 2003) and included the following characters:

- Survival
- Health status
- Vertical height
- Diameter of the three largest stems at 0.3 m
- Number of stems at 0.3 m
- Crown diameter

The last assessment so far was made in November 1999 by CNSF and DFSC (DFSC 1999). Survival, vertical height, diameter of the three largest stems at 0.3 m, health score and the number of stems at 0.3 m was registered.

The single tree data from the assessments in 1989 and 1999 are presented in Annex 4. Raw data from the 1993 assessment are documented in DFSC (1994). For reference the plot data sets on which the statistical analyses in this report are performed are shown in Annex 5A-C. These data sets include directly observed values as well as derived variable values.

Table 1. Seedlots tested in trial no. 10. Seedlot data supplied by the seed collection institution. [1]Rainfall data from Pigeonnière & Jomni (1998), 1966-1995 (before slash) and before 1970 (after slash).

Provenance identification	Species	Seed collection site	Country of origin	Latitude	Longitude	Altitude (m)	Rainfall (mm)	No. of mother trees
Burkina04	*Acacia nilotica* subsp. *adansonii*	Boukouma	Burkina Faso	14°12'N	00°43'W	317	350/450[1]	27
Burkina05	*Acacia nilotica* subsp. *adansonii*	Kossodo	Burkina Faso	12°20'N	02°02'W	341	750/850[1]	100
Burkina06	*A. nilotica* subsp. *tomentosa*	Falagountou	Burkina Faso	14°22'N	00°11'E	250	450/550[1]	27
Senegal14	*A. nilotica* subsp. *tomentosa*	Nayobé	Senegal					
Burkina14	*A. seyal*	Bodole 2, Djibo	Burkina Faso	14°06'N	01°37'W		450/600[1]	76
Burkina15	*A. seyal*	Sao, Tchériba	Burkina Faso	12°15'N	03°00'W	293	750/900[1]	47
Burkina16	*A. seyal*	F.C. Barrage Ouaga	Burkina Faso	12°20'N	01°30'W	300	750/850[1]	26
Burkina17	*A. seyal*	Lery	Burkina Faso	12°49'N	03°12'W	320	700/900[1]	35
Burkina02	*A. tortilis* subsp. *raddiana*	Boukouma	Burkina Faso	14°12'N	00°43'W	320	400/550[1]	27
Burkina19	*A. tortilis* subsp. *raddiana*	Markoye	Burkina Faso	14°38'N	00°02'W	295	350/450[1]	27
Rajasthan06	*A. tortilis*	Ramgaon, Barmer	India	25°45'N	71°23'E	194	310	50
Sudan18	*A. tortilis* subsp. *raddiana*	Elbashiri oasis, Northern Kordofan	Sudan	13°48'N	30°12'E	400	300	25

3. Statistical analyses

3.1 Variables

In this report the following 19 variables are analysed:

1989 data:
- Basal area of the mean tree at root collar
- Total basal area at root collar
- Dry weight of the mean tree
- Total dry weight

1993 data:
- Survival
- Vertical height
- Crown area
- Number of stems at 0.3 m
- Basal area of the mean tree at 0.3 m
- Total basal area at 0.3 m
- Dry weight of the mean tree
- Total dry weight

1999 data:
- Survival
- Vertical height
- Number of stems at 0.3 m
- Basal area of the mean tree at 0.3 m
- Total basal area at 0.3 m
- Dry weight of the mean tree
- Total dry weight

Furthermore a graphic analysis of the health characters registered in 1993 was made, but since the trees at both the 1993 and the 1999 assessments were generally in good health and there were hardly any differences between the provenances, these characters are not analysed further in the present report. Instead a graphical presentation of the health data is given in Annex 6. Note that the calculations of basal area for the 1993 and 1999 data are based on measurements of the three largest stems. It should also be noted that for *A. tortilis* a large proportion of the young shoots and in some cases even primary branches tend to dry out in the dry period. During the vegetative period some shoots may revive, which obviously makes the assessments more difficult and may bias the data.

The values were analysed on a plot basis, i.e. ratio, mean or sum as appropriate. Survival was analysed as the rate of surviving trees to the total number of trees per plot. Height, crown area, health and number of stems were analysed as the mean of surviving trees on a plot, as was the basal area and the dry weight of the mean tree. The total basal area and the total dry weight represent the sum of all remaining trees in a plot, expressed on an area basis. Since survival was close to 100 % at the first assessment, this variable was not analysed.

At the first assessment, the diameter was measured at the root collar. This means that the values for basal area and dry weight are not directly comparable to the values from the later assessments. Measuring at the root collar will result in an over-estimation compared to measuring at 0.3 m. Meanwhile, the values may give an indication of the biomass at an early stage of the trial.

A special problem with the assessment data is that at the measurement in 1993, certain characters were only measured for trees with heights above 1 m. For trees below 1 m, no assessment of diameter, number of stems and crown diameter was made. Out of the total 1152 observations (trees), this occurred for 129, 120 and 119 trees, respectively, corresponding to approximately 11% of the population. Since the omission of these data will produce biased results and lead to an over-estimation of the provenances in question, the values for crown area and basal area for these observations have been set to zero. There is no reasonable way to estimate the number of stems of such trees, and no default value has been set for this variable. In any case, the estimates of these variables will be slightly biased.

The dry weight values were calculated from regressions between biomass and basal area, established in another part of this study (Graudal *et al.* in prep.). For *A. seyal* no such regression has been established, but for *A. nilotica* the regression used was

$$TreeDW = e^{(2.582 \times \ln(basalarea) - 2.518)}$$

where *TreeDW* expresses the dry weight of the tree in kg tree^{-1}, and *basalarea* expresses the basal area of the tree in cm^{-2}. For *A. tortilis* the regression was

$$TreeDW = e^{(1.471 \times \ln(basalarea) - 2.068)}$$

These regressions were established using young trees in the age from 4-8 years. It may not be appropriate to extrapolate to elder trees, but we have chosen to do so anyway in order to get at least an impression of the production at the age of 11 years. Of course these data should be used with caution.

3.2 Statistical model and estimates

The statistical software package used was the Statistical Analysis System (SAS 1988a, 1988b, 1991, Littell *et al.* 1996).

The statistical analysis of the trial was based on a two-step approach. The first step involved a test of species differences, whereas the second step was performed separately for each species and tested whether there were differences between the provenances within the species in question.

The test of species differences was based on the model:

$$X_{ijk} = \mu + species_i + provenance(species)_{ij} + block_k + \varepsilon_{ijk}$$

where X_{ijk} is the value of the trait (e.g. height) in plot

ijk, μ is the grand mean, $species_i$ is the fixed effect of species number *i*, $provenance(species)_{ij}$ is the effect of provenance number *j* nested within species *i*, assumed to be a random effect with an expected value of zero and variance σ_{pr}^2, $block_j$ is the effect of block (replication) *k* in the trial, assumed to be a random effect (or, in the case of calculating least square means, a fixed effect), and ε_{ijk} is the residual of plot *ijk*, and is assumed to follow the normal distribution $N(0, \sigma_e^2)$. The test of species differences was performed using the Satterthwaite method for calculation of the degrees of freedom (SAS 1988b).

The test of significant differences between provenances was performed separately for each species and was based on the model:

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

where X_{jk} is the value of the trait in plot *jk*, μ is the grand mean, $provenance_j$ is the fixed effect of provenance number *j*, $block_k$ is the fixed effect of block *k*, and ε_{jk} is the residual of plot *jk* and is assumed to follow a normal distribution $N(0, \sigma_e^2)$.

In the initial models, the co-variates were distances along the two axes of the trial, plotx and ploty, and squared values of these, plotx2 and ploty2. The co-variates were excluded successively if they were not significant at the 10% level.

Standard graphical methods and calculated standard statistics were applied to test model assumptions of independence, normality and variance homogeneity (Snedecor & Cochran 1980, Draper & Smith 1981, Ræbild *et al.* 2002). Weighting of data with the inverse of the variance for the seedlots was used to obtain normality of the residuals where the seedlots appeared to have different variances. Where large provenances tended to have larger variances (e.g. crown area and basal area) than small provenances, a logarithmic or a square root transformation was used to stabilise variance (ibid.; Afifi & Clark 1996).

The P-values from the tests were corrected for the effect of multiple comparisons by the sequential tablewide Bonferroni method (Holm 1979). The tests were ranked according to their P values. The test corresponding to the smallest P value (P_1) was considered significant on a "table-wide" significance level of α if $P_1 < \alpha/n$, where n is the number of tests. The second smallest P value (P_2) was declared significant if $P_2 < \alpha/(n-1)$, and so on (Kjaer & Siegismund 1996). In the test of species differences the number of tests was set to 19, thus equalling the number of variables analysed. The same was the case for the tests of provenance differences, except for *A. seyal* where no dry weight variables were available, and the number of tests thus was set to 13. The number of tests for new information was six (see below). The significance levels are indicated by (*) (10%), * (5%), ** (1%), *** (1 ‰) and N.S. (not significant).

A multivariate analysis providing canonical variates, and Wilk's lambda and Pillai's trace statistics, complemented the univariate analyses (Chatfield & Collins 1980, Afifi & Clark 1996, Skovgård & Brockdorf 1998).

To compare the development in different variables between 1993 and 1999, a test for new information was performed (Kjaer & Lauridsen 1996). The variables were survival, height, basal area of the mean tree, total basal area, dry weight of the mean tree and total dry weight. No analysis was made for number of stems, since the 1993 measurements of the number of stems were biased because trees with heights below one meter were not measured. The variables analysed were the difference between the value measured at the 1999 assessment and the 1993 assessment, as exemplified for survival below:

Difference in survival = survival 1999 – survival 1993. The model was as follows:

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

where DX_{jk} is the difference between the first and the second variable as calculated above, μ is the grand mean, $provenance_j$ is the fixed effect of provenance *j*, $block_k$ is the random effect of block *k*, X_{jk} is the plot value for the variable in 1993, used as a co-variate, and ε_{jk} is the residual.

The 1993 assessment variable was included as a co-variate to account for variation due to differences in scaling. In the statistical analyses it is usually not allowed to have the same variable on both sides of the equality sign, as actually happens when the difference is analysed with the co-variate. In this case it is justified because the result of subtracting the variables at the two assessments is an increment, or in the case of survival, an increase in mortality.

When this model demonstrated that the effect of provenances was significant, the differences between provenances were investigated further by pair-wise comparisons of the least square means, adjusted for multiple comparisons by the Tukey-Kramer method (SAS 1988b).

Finally, results from the multivariate analysis were used to calculate genetic correlations between the variables that were measured repeatedly in the different assessments (survival, height, basal area of the mean tree, total basal area, dry weight of the mean tree and total dry weight). The genetic correlations r_g were calculated as

$$r_g = \frac{\mathrm{cov}_{prov}(early - late)}{\sqrt{\sigma^2_{prov}(early)\sigma^2_{prov}(late)}}$$

where $\mathrm{cov}_{prov}(early\text{-}late)$ is the co-variance between early and late measurements (e.g. 1993 and 1999) for a variable, and $\sigma^2_{prov}(early)$ and $\sigma^2_{prov}(late)$ are the genetic variances between the provenance means for the early and the late measurement, respectively (Wellendorf et al. 1986, Chatfield & Collins 1980, Falconer & Mackay 1996). The variables that were transformed in the univariate analyses were also transformed in this analysis.

A short description of the analysis of each variable is given in the results section, and a more detailed description of the statistical methods in Ræbild *et al.* (2002).

4. Results

Overall the survival in the trial was high, contributing to an easy analysis and interpretation of the trial. There were several significant differences, both between species and between the provenances within the species. In the following pages, the results from analysis of the variables are presented together with a graphic presentation of the estimates.

4.1 Survival

Survival is regarded as one of the key variables when analysing tree provenance trials, since it indicates the adaptability of the provenance to the environment at the trial site. It should be noted that survival reflects only the conditions experienced during the first few year's growth of the trial and not necessarily the climatic extremes and conditions that may be experienced during the life span of a tree in the field.

Statistical analysis

Since almost all trees were alive at the 1988 assessment, the 1988 survival was not analysed. In the test of species differences for the 1993 data there were signs that some provenances (especially Burkina06 and Senegal14) had larger variance than the rest. However, a weighted model did not improve the results, and the original model without weights was used (Table 3). One co-variable (plotx, the distance on the x-axis along the side of the trial) was close to being significant at the 5% level and was kept in the model. However, this had disappeared in the analysis of data from 1999, and there were no signs of variance heterogeneity, making the analysis straightforward.

In the test for new information, comparing results from the analyses in 1993 and 1999, the residuals were not following a normal distribution after the analysis on the raw data, and the data were transformed with a modified arc sine transformation:

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

Since the difference was negative (survival being either the same or lower at the 1999 assessment), it was necessary to subtract the difference from one before taking the square root.

Results

At the first assessment, survival was 99.7 %. At the later assessments survival remained high for most provenances, averaging 87 % in 1993 and decreasing to 76 % in 1999. At neither of the assessments there were significant differences between the species in the trial (Table 2, Fig. 1 and 2). On the other hand the data indicated that there were differences between the provenances within species: the provenance effect was significant or almost significant for all three species (Table 3), except for *A. seyal* at the 1999 measurement. When the analyses were corrected for multiple comparisons (the sequential Bonferroni tablewide test in last column of Table 4), *A. nilotica* and *A. tortilis* still had significant differences between provenances. Especially the provenances Rajasthan06 of *A. tortilis* and Burkina06 (Falangountou) of *A. nilotica* had low survivals, being below 50 % at the last assessment.

The test for new information revealed no significant changes between provenances in survival at the 1993 and the 1999 assessment.

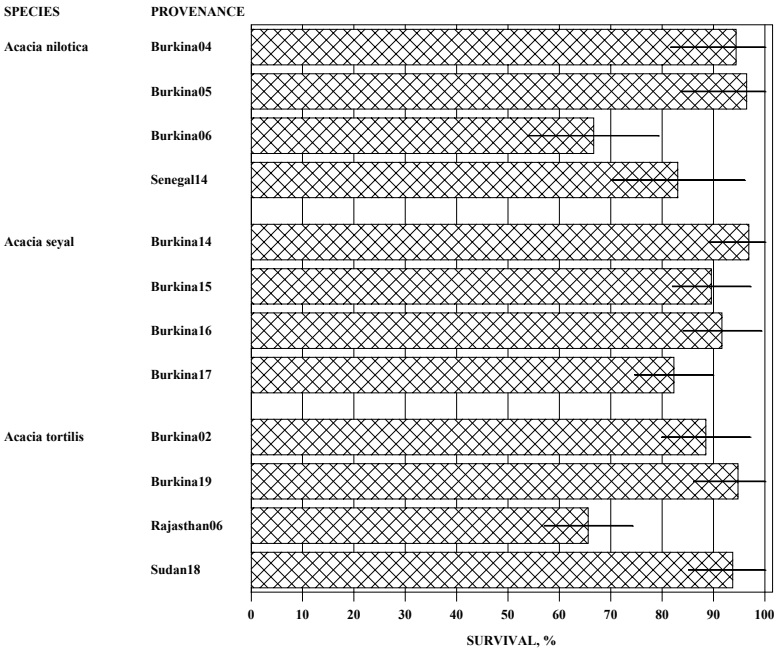


Figure 1. Survival in percent (1993 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Values presented are least square means with 95 % confidence limits (values above 100 % were truncated).

Table 2. Results from analysis of variance of species differences in survival in trial 10, using Satterthwaites test in a model with provenances nested within species. The last part of the table gives the test for new information, which was performed on arcsine-transformed values (see text).

Effect	DF (numerator; denominator)	MS	F-value	P-value	Bonferroni sequential tablewide correction
1993 assessment					
Species	2; 9.37	311.0	0.45	0.65	n.s.
Provenance(species)	9; 54	764.8	6.40	<0.0001	
Block	5; 54	115.9	0.97	0.44	
Plotx	1; 54	390.1	3.26	0.08	
Error	54	119.5			
1999 assessment					
Species	2; 9	0.108	0.68	0.53	n.s.
Provenance(species)	9; 55	0.158	9.44	<0.0001	
Block	5; 55	0.0065	0.39	0.85	
Error	55	0.0167			
Test for new information					
Provenance	54; 11	0.055	1.65	0.11	n.s.
Block	54; 5	0.067	2.02	0.09	
1993 Survival	54; 1	0.041	1.25	0.26	
Error	54	0.033			

Table 3. Results from analysis of provenance differences within species for survival in trial 10.

Species	DF	MS	F-value	P-value	Bonferroni sequential tablewide correction
1993 assessment					
Acacia nilotica	3	1102	5.33	0.01	n.s.
Acacia seyal	3	219	2.88	0.07	n.s.
Acacia tortilis	3	1117	11.45	0.0004	**
1999 assessment					
Acacia nilotica	3	0.309	14.18	<0.0001	**
Acacia seyal	3	0.022	1.74	0.20	n.s.
Acacia tortilis	3	0.144	6.36	0.005	(*)

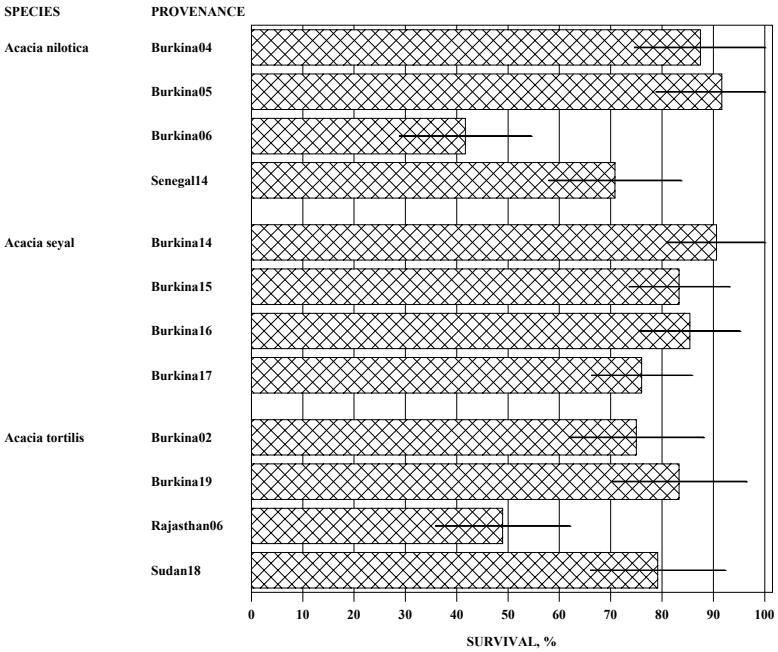


Figure 2. Survival in percent (1999 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Values presented are least square means with 95 % confidence limits (values above 100 % were truncated)

4.2 Height

Height is usually considered an important variable in the evaluation of species and provenances. However, this of course depends on the main uses of the trees. Apart from indicating productivity, height may also be seen as a measure of the adaptability of trees to the environmental conditions, tall provenances/trees usually being better adapted to the site than short provenances/trees. This interpretation need not always be true, however: Cases have been observed where the tallest provenances are suddenly affected by stress subsequent death.

Statistical analysis

The analysis of vertical height for the 1993 data was straightforward, and there were no significant co-variables. The 1999 data were more complicated, as some outliers distorted the analyses. A logarithmic transformation and weighting of the untransformed data did not solve the problems, but an analysis in which the outliers were excluded demonstrated that the conclusions were robust. Thus, the data presented are from the untransformed model with the outliers included. In the test for new information no transformations were needed.

Results

The average height of the trees in the trial was about 2.2 m in 1993 (Fig. 3), increasing to 2.7 m in 1999 (Fig. 4). There were highly significant differences between the species at both assessments (Table 4). *A. seyal* was the highest, attaining values of about 3.5 m at the 1999 assessment. The average height for *A. tortilis* at this time was 2.0 m, whereas *A. nilotica* was intermediary with heights of about 2.7 m.

In *A. nilotica* and *A. seyal* there were no significant differences between the provenances at either assessment, but in *A. tortilis* the provenance effect was significant at the first assessment (Table 5). The provenances Burkina19 and Rajasthan06 were the highest and lowest, respectively. However, since the differences disappeared when corrected for multiple comparisons, and since the provenance effect was not significant in the large model in Table 5, this should be interpreted cautiously. Furthermore, the differences were no longer significant at the 1999 assessment.

The test for new information revealed no significant changes between the provenances (Table 4). However, it is interesting to note that there were significant changes between the blocks, and that the height in 1993 was almost significant as a co-variate, indicating that the largest trees in 1993 also have had the fastest growth rates.

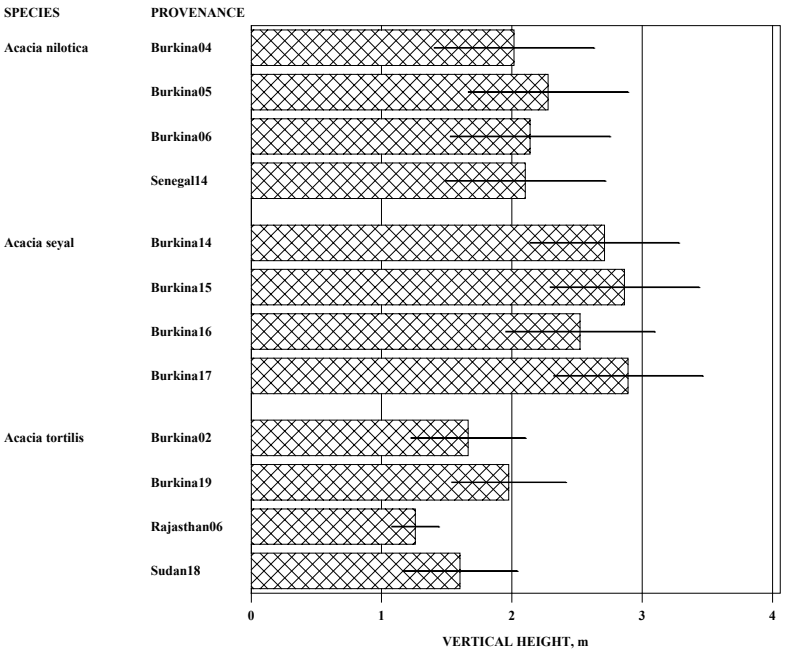


Figure 3. Vertical height (1993 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Values presented are least square means with 95 % confidence limits.

Table 4. Results from analysis of variance of species differences in vertical height in trial 10, using Satterthwaite's test in a model with provenances nested within species. The last part of the table gives the test for new information.

Effect	DF (numerator; denominator)	MS	F-value	P-value	Bonferroni sequential tablewide correction
1993 assessment					
Species	2; 9	7.57	29.8	<0.0001	**
Provenance(species)	9; 55	0.25	0.70	0.71	
Block	5; 55	0.53	1.45	0.22	
Error	55	0.37			
1999 assessment					
Species	2; 9	11.89	24.7	0.0002	**
Provenance(species)	9; 55	0.48	0.86	0.56	
Block	5; 55	1.21	2.17	0.07	
Error	55	0.56			
Test for new information					
Provenance	54; 11	0.078	0.81	0.63	n.s.
Block	54; 5	0.29	3.02	0.02	
1993 Height	54; 1	0.33	3.46	0.07	
Error	54	0.096			

Table 5. Results from analysis of provenance differences within species for vertical height in trial 10. Note: For *A. tortilis* the analysis was weighted with values corresponding to the inverse of the variance for the provenances.

Species	DF	MS	F-value	P-value	Bonferroni sequential tablewide correction
1993 assessment					
Acacia nilotica	3	0.49	0.07	0.93	n.s.
Acacia seyal	3	0.17	0.40	0.75	n.s.
Acacia tortilis	3	5.21	4.42	0.02	n.s.
1999 assessment					
Acacia nilotica	3	0.21	0.28	0.84	n.s.
Acacia seyal	3	0.33	0.52	0.68	n.s.
Acacia tortilis	3	0.90	1.97	0.16	n.s.

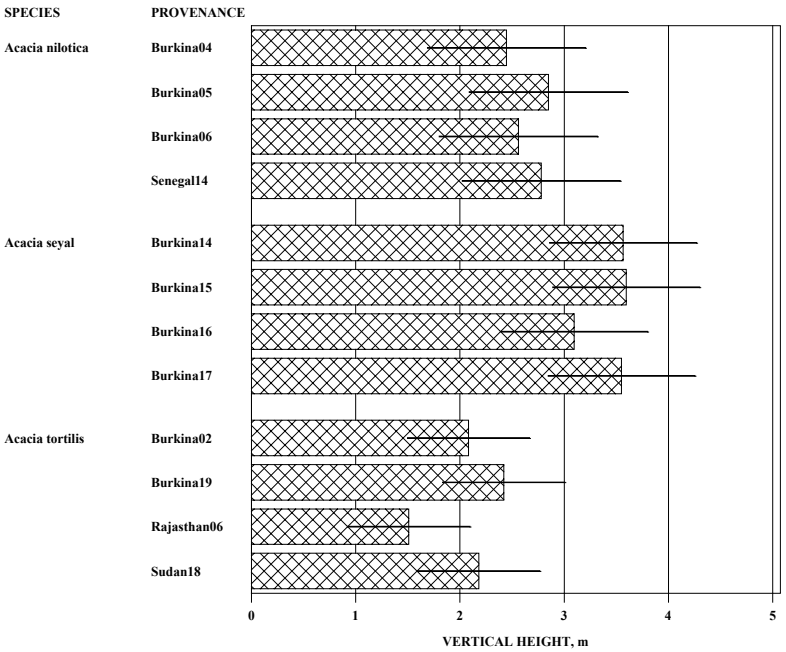


Figure 4. Vertical height (1999 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Values presented are least square means with 95 % confidence limits.

4.3 Crown area

The crown area variable indicates the ability of the trees to cover the ground. The character is of importance in shading for agricultural crops, in evaluating the production of fodder and in protection of the soil against erosion.

Statistical analysis

The crown area in 1993 was analysed on values transformed by the square root, because larger values had larger variances. Transforming with the square root means that the values become proportional to the crown diameter, which seems reasonable. Even after the transformation, there were two-three outliers, but an additional analysis demonstrated that these had no influence on the final result of the model. Therefore the outliers are included in the models, also when the analyses were performed for the species separately. In the model there were no significant co-variables.

Please note that for the 1993 data, 119 trees with heights below 1 m were not assessed. The crown areas for these trees have been set to zero, but there may still be some bias in the estimates.

Results

The differences between the species were highly significant (Table 6), and the average values were 6, 10 and 5 m2/tree for *A. nilotica*, *A. seyal*, and *A. tortilis*, respectively (Fig. 5). If one ignores that some trees were dead, this means that there was still some time till the canopy closed at the time of measurement (the spacing being 4×4 m). Since the survival rate is quite high in this trial it seems allowable to neglect the effect that a low survival (and a large growth space) may have on the size of the crown.

The provenance effects were not significant with the exception of *A. tortilis* where the difference between provenances was marginally significant (Table 7). When corrected for multiple comparisons, this effect disappeared. The provenance from Rajasthan had the lowest value.

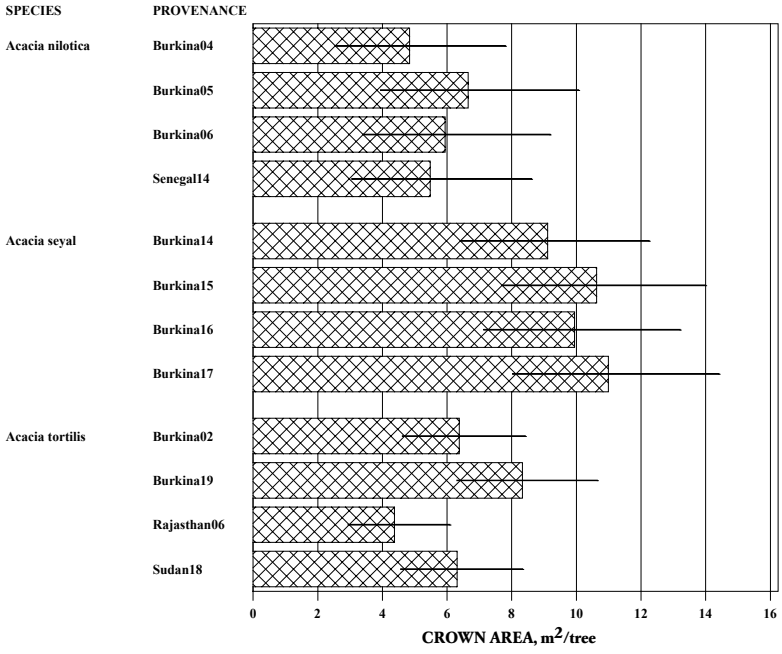


Figure 5. Crown area (1993 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Analysis was made on square root transformed values, and the estimates presented are back-transformed least square means with 95 % confidence limits. Due to the back-transformation the upper and lower confidence intervals are of unequal length.

Table 6. Results from analysis of variance of species differences in crown area (1993 assessment) in trial 10, using Satterthwaite's test in a model with provenances nested within species. Analysis was performed on square root transformed variables.

Effect	DF (numerator; denominator)	MS	F-value	P-value	Bonferroni sequential tablewide correction
Species	2; 9	6.22	13.1	0.002	*
Provenance(species)	9; 55	0.47	1.56	0.15	
Block	5; 55	0.29	1.66	0.16	
Error	55	0.30			

Table 7. Results from analysis of provenance differences within species for crown area (1993 assessment) in trial 10. Analysis was performed on square root transformed variables. Note that the F- and P-values for the tests by coincidence were the same for *A. nilotica* and *A. seyal*.

Species	DF	MS	F-value	P-value	Bonferroni sequential tablewide correction
Acacia nilotica	3	0.15	0.33	0.80	n.s.
Acacia seyal	3	0.10	0.33	0.80	n.s.
Acacia tortilis	3	1.16	4.56	0.02	n.s.

4.4 Number of stems

The number of stems gives an indication of the growth habit of the species. Trees with a large number of stems are considered bushy, whereas trees with only one stem have a more tree-like growth.

Statistical analysis

The analysis of number of stems from the 1993 assessment was difficult. Testing the assumptions of the model, it appeared that the distribution of residuals was odd, and the test for normality of the residuals was close to being rejected. Meanwhile, it did not seem that transformations would help, and the model was accepted for presentation of the data. Even though the assumptions of the model may not be fulfilled, the conclusions were supported by inspection of the raw data. In the model used, the co-variable plotx was significant.

Another limitation to the 1993 data is that number of stems has not been measured on 120 small trees, thus biasing the estimates. There is no simple way to circumvent this, and the interpretation of the results should be cautious.

Difficulties were encountered also in the 1999 data. A logarithmic transformation partly solved the problem, but still one outlier remained (Sudan18, block 4). There was no obvious explanation for the outlier tendency, and since the conclusions were the same without the outlier, the results presented include the outlier.

Results

The model demonstrated that there were significant differences between the species in the number of stems at both assessments (Table 8). In 1993, *A. seyal* had the lowest number of stems, approx. 1.6 stem/tree, whereas *A. nilotica* and *A. tortilis* had 2.1 and 2.8 stems/tree, respectively (Fig. 6). In 1999, the average values had decreased to 1.4, 1.9 and 2.2 for the three species respectively (Fig. 7).

In *A. seyal* there was no significant difference between the provenances at either of the assessments, but in the two other species the effect of provenance was significant in 1993 (Table 9). Note that in *A. nilotica* the significance disappeared when the value was corrected for multiple comparisons, while the difference was at the limit of significance for *A. tortilis*. The two exotic provenances Senegal14 and Sudan18 had more stems than the other provenances within their species. In the 1999 assessment, only *A. tortilis* had significant differences between the provenances, which disappeared when corrected for multiple comparisons.

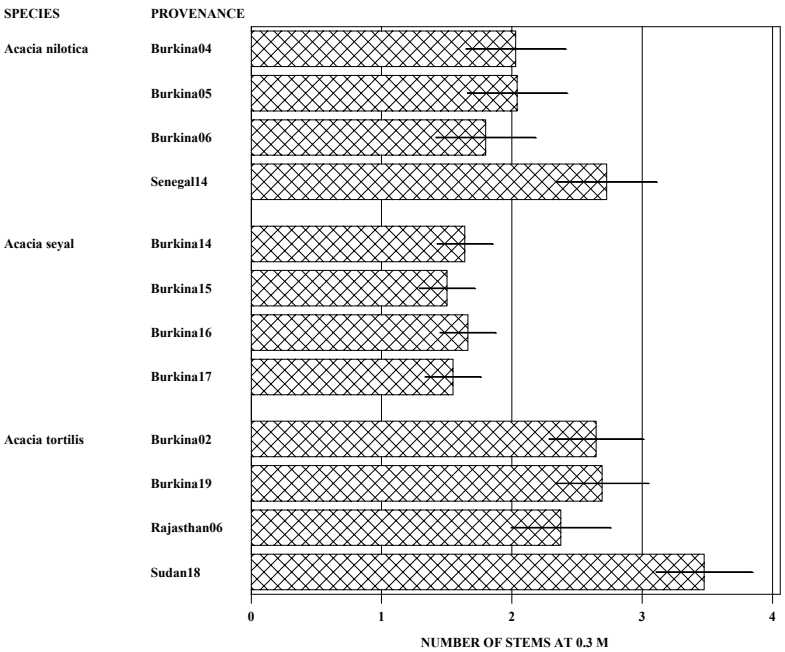


Figure 6. Number of stems (1993 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Values presented are least square means with 95 % confidence limits.

Table 8. Results from analysis of variance of species differences in number of stems in trial 10, using Satterthwaite's test in a model with provenances nested within species. Analysis of the 1999 assessment data was on ln-transformed values. In both analyses there were difficulties in fulfilling the model assumptions (see text).

Effect	DF (numerator; denominator)	MS	F-value	P-value	Bonferroni sequential tablewide correction
1993 assessment					
Species	2; 9	8.95	13.6	0.002	*
Provenance(species)	9; 54	0.65	4.39	0.0002	
Block	5; 54	0.67	4.51	0.002	
Plotx	1; 54	0.65	4.39	0.04	
Error	54	0.15			
1999 assessment					
Species	2; 9.9	0.91	11.0	0.003	*
Provenance(species)	9; 54	0.089	2.44	0.02	
Block	5; 54	0.41	11.3	<0.0001	
Plotx	1; 54	0.15	4.14	0.05	
Error	54	0.0037			

Table 9. Results from analysis of provenance differences within species for number of stems in trial 10.

Species	DF	MS	F-value	P-value	Bonferroni sequential tablewide correction
1993 assessment					
Acacia nilotica	3	0.96	5.02	0.01	n.s.
Acacia seyal	3	0.03	0.57	0.64	n.s.
Acacia tortilis	3	1.14	7.12	0.004	(*)
1999 assessment					
Acacia nilotica	3	0.038	1.46	0.27	n.s.
Acacia seyal	3	0.020	0.99	0.42	n.s.
Acacia tortilis	3	0.16	3.22	0.05	n.s.

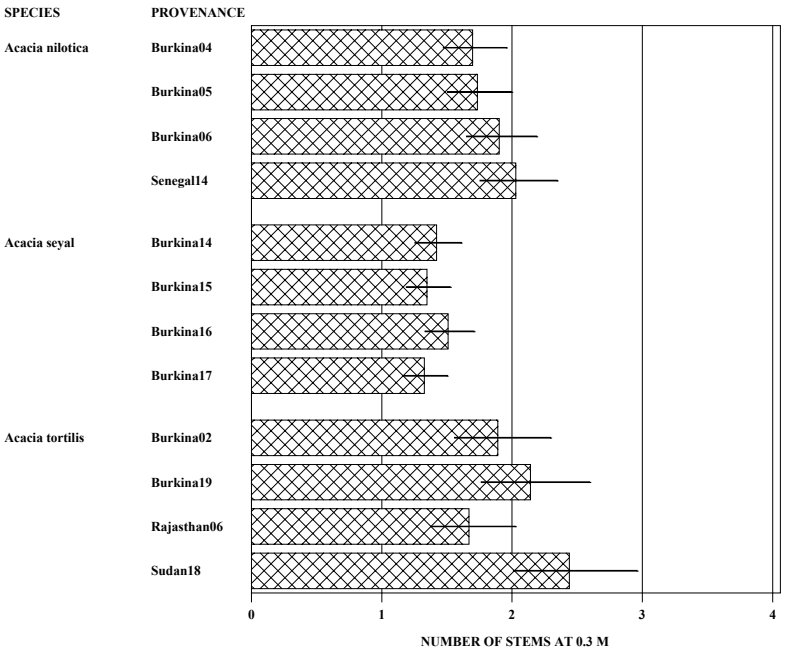


Figure 7. Number of stems (1999 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Analysis was made on ln-transformed values, and the estimates presented are back-transformed least square means with 95 % confidence limits. Due to the back-transformation the upper and lower confidence intervals are of unequal length.

4.5 Basal area of the mean tree

The basal area is often used as a measure of the productivity of stands, since it is correlated with the production of wood. The basal area of the mean tree is calculated on the live trees only and can be interpreted as the potential basal area production of the provenance provided that all trees survive.

Statistical analysis

For the analysis of the basal area of the mean tree from 1988, the data were weighted to compensate for variance heterogeneity. In the analysis of the 1993 data no model seemed to fit the data to fulfil the usual assumptions for the models. A few extreme (high) values gave a skew distribution, and neither logarithmic transformation nor weighting of the data could solve the problems. The results presented here are based on the weighted model, which seemed to fit the data best. Still the results should be interpreted carefully. The same problems appeared for the 1999 data. However, weighting the logarithmic transformed data solved these. In the test for new information it also proved necessary to weight the data.

Note again that for the 1993 data the trees below a height of 1 m were not assessed. In the analysis, the basal areas of these trees were set to zero, and there may be a slight bias in the estimates presented.

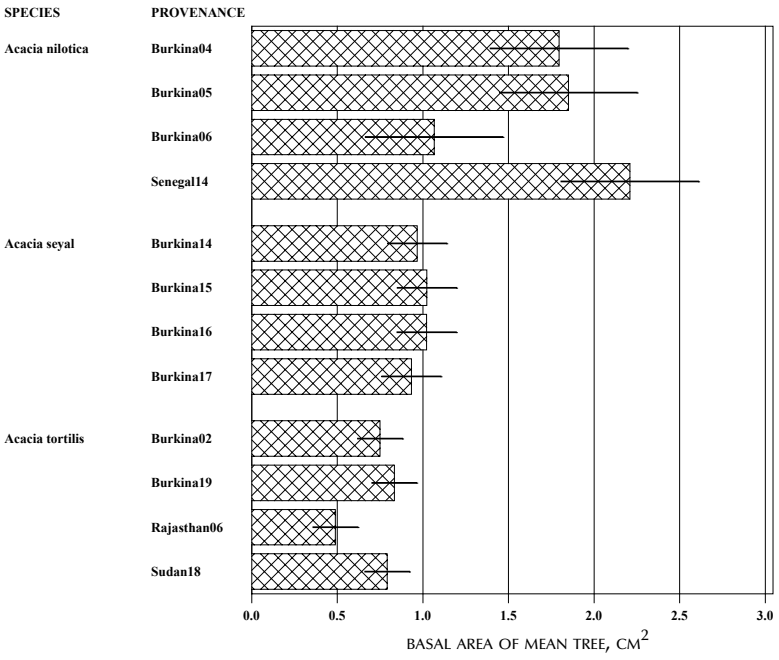


Figure 8. Basal area of the mean tree (1988 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Values presented are least square means with 95 % confidence limits.

Results

After five months of growth at the site there were significant differences among the average basal areas of the species (Table 11, Fig. 8), *A. nilotica* having the highest and *A. seyal* the lowest values. Note, however, that the basal area is still small, being only 1.3 cm^2 on average for the whole trial, even though the diameter was measured at the root collar. Within *A. nilotica* there were significant differences between the provenances, Burkina06 being the smallest and Senegal14 the biggest.

In 1993, the average basal area of the mean tree had increased to 35 cm^2. With the number of replicates and the variation within the provenances it was not possible to detect any differences, neither between species nor between provenances (Tables 10 and 11). It also appears from Fig. 9 that there are no clear differences between the provenances.

In 1999 the provenances had started to separate again, and an analysis considering only the effect of provenances demonstrated that there were highly significant differences ($F=4.75$, $P<0.0001$, analysis not presented). Overall, the average basal area of the mean tree was 62 cm^2. Trying to separate the causes of differences between provenances, it turned out that the effect of species was almost significant, although it was not significant when accounting for multiple comparisons (Table 10). There were significant differences between the provenances of *A. tortilis*, but these were no longer significant when corrected for multiple comparisons (Table 11). It seems that the highly significant differences between provenances in the test referred to above indicate differences between provenances from different species. The lowest ranking provenances were Burkina05 (*A. nilotica*) and Burkina02, Rajasthan06 and Sudan18 (all three *A. tortilis*). The rest of the provenances were more or less at the same level (Fig. 10).

The test for new information demonstrated that there were highly significant changes from the 1993 to the 1999 assessment. When treated as a co-variate, the basal area of the mean tree from 1993 was significant, indicating that the provenances with the largest average basal areas did also have the largest increment in basal area from 1993 to 1999. Furthermore, both the provenance and the block effect were significant, meaning that the provenances reacted differently in the period between the two assessments. This was mainly because the provenances Sudan18 and especially Rajasthan06 had a much slower increment rate in average basal area than the rest of the provenances, even after the correction for size that results from including the value from 1993 as a co-variate.

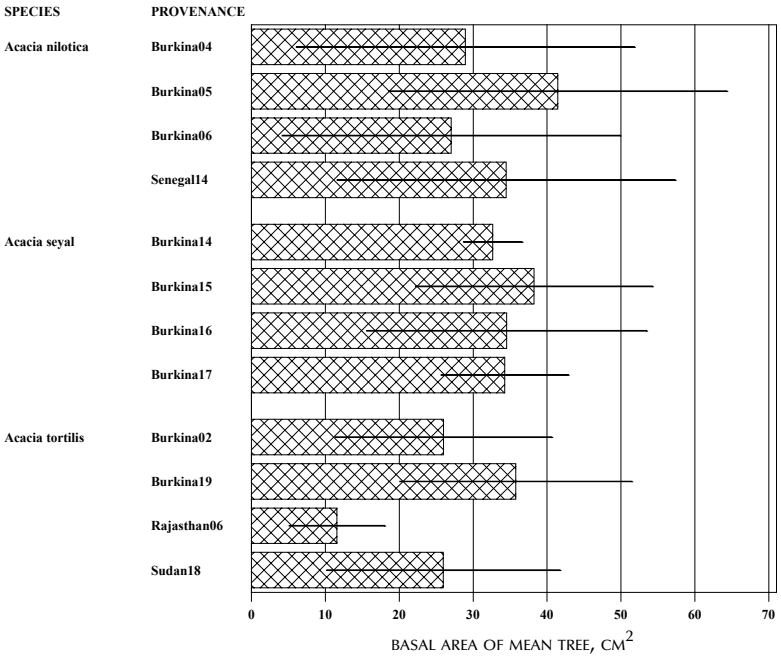


Figure 9. Basal area of the mean tree (1993 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Values presented are least square means with 95 % confidence limits. In the analysis of *A. seyal* the values were weighted, and the confidence intervals are therefore of uneven length.

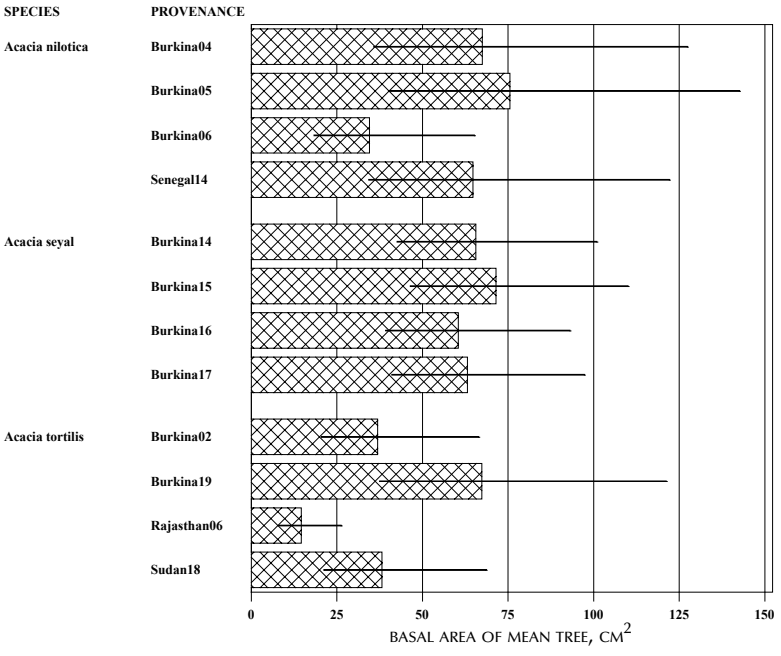


Figure 10. Basal area of the mean tree (1999 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Analysis was made on ln-transformed values, and the estimates presented are back-transformed least square means with 95 % confidence limits. Due to the back-transformation the upper and lower confidence intervals are of unequal length.

Table 10. Results from analysis of variance of species differences in basal area of the mean tree in trial 10, using Satterthwaites test in a model with provenances nested within species. The last part of the table gives the test for new information. Analyses of the 1993 and the 1999 assessment data and the test for new information are based on weighted models.

Effect	DF (numerator; denominator)	MS	F-value	P-value	Bonferroni sequential tablewide correction
1988 assessment					
Species	2; 11.9	29.8	15.0	0.0006	**
Provenance(species)	9; 55	2.32	2.24	0.03	
Block	5; 55	3.11	3.01	0.02	
Error	55	1.03			
1993 assessment					
Species	2; 9	2.68	1.69	0.21	n.s.
Provenance(species)	9; 55	1.95	1.86	0.08	
Block	5; 55	2.32	2.21	0.07	
Error	55	1.05			
1999 assessment					
Species	2; 11.9	8.91	3.68	0.06	n.s.
Provenance(species)	9; 55	3.03	2.88	0.007	
Block	5; 55	1.99	1.88	0.11	
Error	55	1.89			
Test for new information					
Provenance	54; 11	8.86	8.35	<0.0001	***
Block	54; 5	8.05	7.59	<0.0001	
1993 Basal area of mean tree	54; 1	140	132.9	<0.0001	
Error	54	1.06			

Table 11. Results from analysis of provenance differences within species for basal area of mean tree in trial 10. For *A. seyal* and *A. tortilis* the analyses were based on weighted models.

Species	DF	MS	F-value	P-value	Bonferroni sequential tablewide correction
1988 assessment					
Acacia nilotica	3	1.38	6.47	0.005	(*)
Acacia seyal	3	0.011	0.30	0.83	n.s.
Acacia tortilis	3	0.019	0.16	0.92	n.s.
1993 assessment					
Acacia nilotica	3	252	0.36	0.78	n.s.
Acacia seyal	3	0.23	0.21	0.89	n.s.
Acacia tortilis	3	5.07	4.27	0.02	n.s.
1999 assessment					
Acacia nilotica	3	0.75	1.41	0.28	n.s.
Acacia seyal	3	0.03	0.12	0.95	n.s.
Acacia tortilis	3	2.40	5.27	0.01	n.s.

4.6 Total basal area

In comparison to the basal area of the mean tree, the total basal area accounts for missing trees and is thus a better measure of the actual production on the site.

Statistical analysis

At all three assessments there were signs of variance heterogeneity in the total basal area. In the 1988 data, weighting the un-transformed data solved this problem. In data from the second assessment, a logarithmic transformation was applied, and at the assessment in 1999, a logarithmic transformation with subsequent weighting was used. In the test for new information, the data were weighted to compensate for variance heterogeneity.

Results

The average total basal area for all plots was 0.08 $m^2\ ha^{-1}$ in 1988, increasing to 1.7 $m^2\ ha^{-1}$ in 1993 and 3.2 $m^2\ ha^{-1}$ in 1999. It should be noted that due to the logarithmic transformations, the estimates presented in Figs. 12 and 13 are lower than the actual, average values. For example, the average value of the provenance with the highest total basal area in 1999 (Burkina05) was 5.1 $m^2\ ha^{-1}$, whereas the back-transformed least square mean (presented in Fig. 13) was only 4.3 $m^2\ ha^{-1}$. The average annual increment in total basal area thus corresponds to approximately 0.5 $m^2\ ha^{-1}\ y^{-1}$. Even though the estimates presented are biased, they give a precise picture of the differences between the provenances.

In the data from the 1988 assessment, there were highly significant differences between the species (Table 12). *A. seyal* had the lowest total basal area, followed by *A. tortilis* and *A. nilotica* which had the largest total basal area (Fig. 11). Furthermore, there were significant differences between the provenances of *A. nilotica* (Table 14), even though the significance disappeared when using the Bonferroni tablewide tests.

In 1993, the variation within the species was too high to detect any differences between the species (Table 12). It is noteworthy that the *A. seyal* provenances all had high total basal areas, whereas the two other species seemed more variable (Fig. 12). This is also reflected in the fact that there were significant differences between the provenances of *A. tortilis*, the highest being Burkina19 and the lowest being Rajasthan06. At the 1999 assessment, the picture was largely the same: No significant differences between the species, but there were significant differences between the provenances of *A. tortilis* and perhaps also *A. nilotica* (Fig. 13, Table 13).

Again the test for new information demonstrated that there were significant changes both between provenances and between blocks, even after the correction for size effects given by the inclusion of the 1993 total basal area as co-variate. Tests of differences between the provenances demonstrated that the provenance Burkina04 had significantly faster increment rates than the provenances Burkina06, Rajasthan06 and Sudan18.

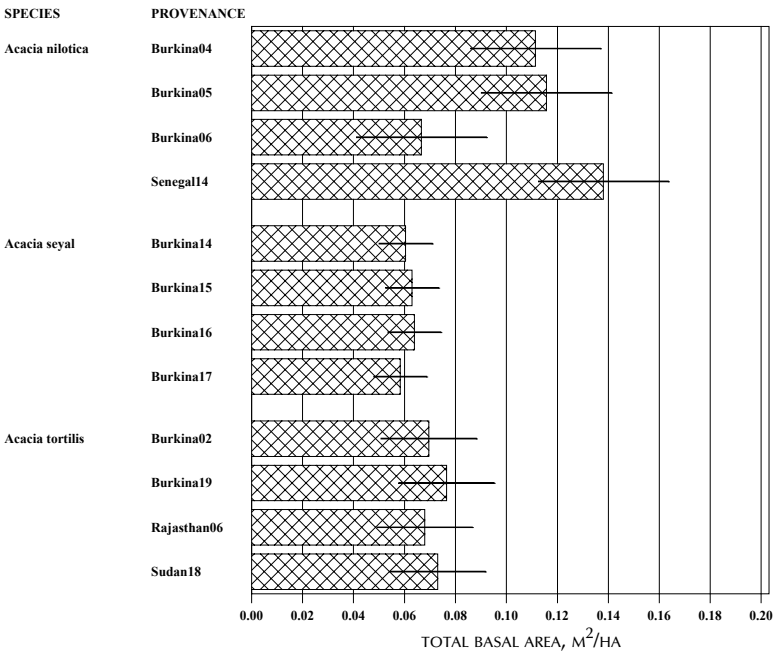


Figure 11. Total basal area (1988 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). The values presented are least square means with 95 % confidence limits.

Table 12. Results from analysis of variance of species differences in total basal area in trial 10, using Satterthwaites test in a model with provenances nested within species. The last part of the table gives the test for new information. The analysis of 1988 data and the test for new information were performed using weighted models. The 1993 and the 1999 data were transformed with the natural logarithm before analysis, with a subsequent weight statement for the 1999 data.

Effect	DF (numerator; denominator)	MS	F-value	P-value	Bonferroni sequential tablewide correction
1988 assessment					
Species	2; 12.3	29.5	15.0	0.0005	**
Provenance(species)	9; 55	2.32	2.26	0.03	
Block	5; 55	2.98	2.91	0.02	
Error	55	1.03			
1993 assessment					
Species	2; 9	1.69	1.45	0.28	n.s.
Provenance(species)	9; 55	1.16	2.88	0.007	
Block	5; 55	0.72	1.79	0.13	
Error	55	0.40			
1999 assessment					
Species	2; 9	10.47	3.24	0.08	n.s.
Provenance(species)	9; 55	4.27	3.99	0.0006	
Block	5; 55	1.24	1.16	0.34	
Error	55	1.07			
Test for new information					
Provenance	54; 11	4.75	4.43	<0.0001	***
Block	54; 5	10.9	10.2	<0.0001	
1993 Total basal area	54; 1	129.4	120.8	<0.0001	
Error	54	1.07			

Table 13. Results from analysis of provenance differences within species for total basal area in trial 10. Transformations and weight statements: See Table 12.

Species	DF	MS	F-value	P-value	Bonferroni sequential tablewide correction
1988 assessment					
Acacia nilotica	3	0.0054	6.26	0.006	n.s.
Acacia seyal	3	0.00004	0.27	0.85	n.s.
Acacia tortilis	3	0.00008	0.19	0.90	n.s.
1993 assessment					
Acacia nilotica	3	1.36	1.66	0.22	n.s.
Acacia seyal	3	0.01	0.05	0.99	n.s.
Acacia tortilis	3	2.11	7.17	0.003	(*)
1999 assessment					
Acacia nilotica	3	3.38	3.73	0.03	n.s.
Acacia seyal	3	0.07	0.25	0.86	n.s.
Acacia tortilis	3	4.56	7.02	0.003	(*)

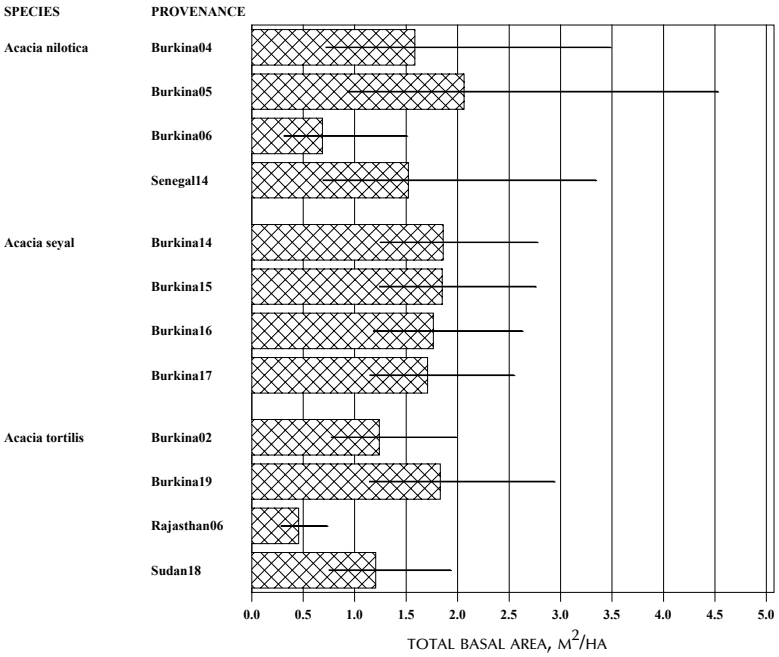


Figure 12. Total basal area (1993 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Analysis was made on ln-transformed values, and the estimates presented are back-transformed least square means with 95 % confidence limits. Due to the back-transformation the upper and lower confidence intervals are of unequal length.

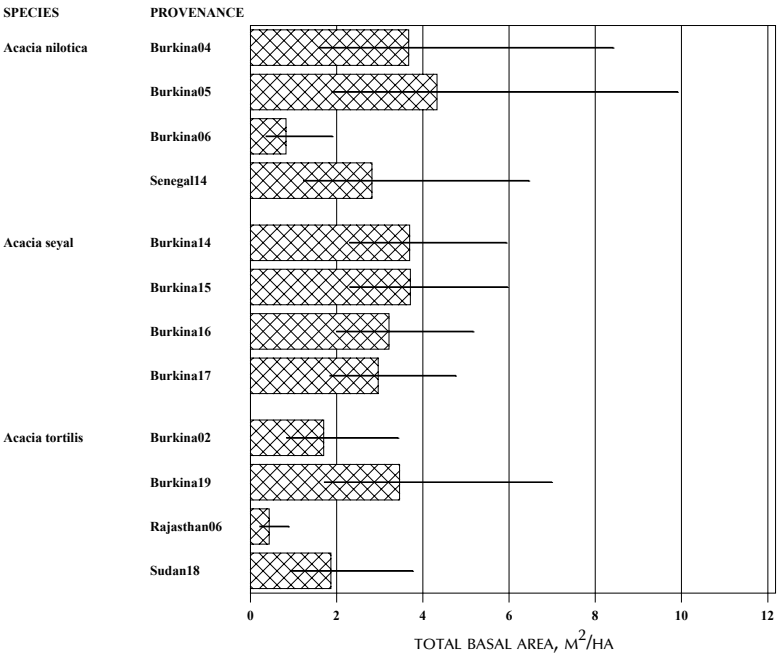


Figure 13. Total basal area (1999 assessment) for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Analysis was made on ln-transformed values, and the estimates presented are back-transformed least square means with 95 % confidence limits. Due to the back-transformation the upper and lower confidence intervals are of unequal length.

4.7 Dry weight of the mean tree

The average dry weight is comparable to the average basal area in that they both are calculated on the live trees only and thus serve as a measure of the potential production at the site, provided that all trees survive. Furthermore, the two variables are linked closely together, as the basis for estimation of the dry weight is the basal area. However, an important difference is that the dry weight includes a cubic term (in comparison to basal area having only a square term), meaning that large trees with a large dry mass are weighted heavily in this variable. The dry weight of the mean tree is thus the best estimate for the potential production of biomass at the site.

Statistical analysis

Due to the lack of a biomass regression no estimates of biomass was made for *A. seyal*, and the results presented include only *A. nilotica* and *A. tortilis*. The analysis of the 1988 data was straightforward without any transformations. In the data from 1993 and 1999, however, there were signs of larger variances with increasing biomass, which is interpreted as variance heterogeneity. In both cases a logarithmic transformation was applied. In the test for new information a weight statement was applied.

There is a methodological concern that should be mentioned: The biomass regressions were established for trees 4-8 years old, and it is problematic to extrapolate to younger or older trees. The data from 1988 and 1999 should thus be considered as indications rather than absolute figures.

Results

The mean value of the dry weight of all trees in the trial increased from 0.16 kg tree^{-1} in 1988 to 8.2 kg tree^{-1} in 1993 and finally to 20 kg tree^{-1} in 1999. Again it should be noted that due to the logarithmic transformation the estimates in Figs. 15 and 16 are low compared to the real, average values. The average dry weight of the provenance with the heaviest trees (Burkina19) was 32 kg tree^{-1} in 1999. This corresponds to an annual increment of 3 kg per tree.

At no point the analyses of variance indicated any differences in the mean dry weight between *A. nilotica* and *A. tortilis* (Table 14). However, at the assessment in 1988 there were signs of differences between provenances of *A. nilotica*, and in 1999 the data indicated possible differences between the provenances of *A. tortilis* (Table 15). In both cases the significance disappeared when accounting for the effect of making multiple tests. At the 1999 assessment, the provenances Rajasthan06 and Burkina06 had the lowest biomass.

Meanwhile, the tests for new information demonstrated that there were significant changes between the 1993 assessment and the 1999 assessment. There was a tendency that provenances being large at the first assessment did in fact also grow faster than the other provenances (seen by high significance of the co-variate 1993 dry weight of the mean tree). However, apart from this the provenance effect was also significant, indicating that there were additional differences between the provenances. Pair-wise comparisons demonstrated that this again was due to the provenance Burkina04, which had significantly larger increment rates than the provenances Burkina06, Rajasthan06 and Sudan18.

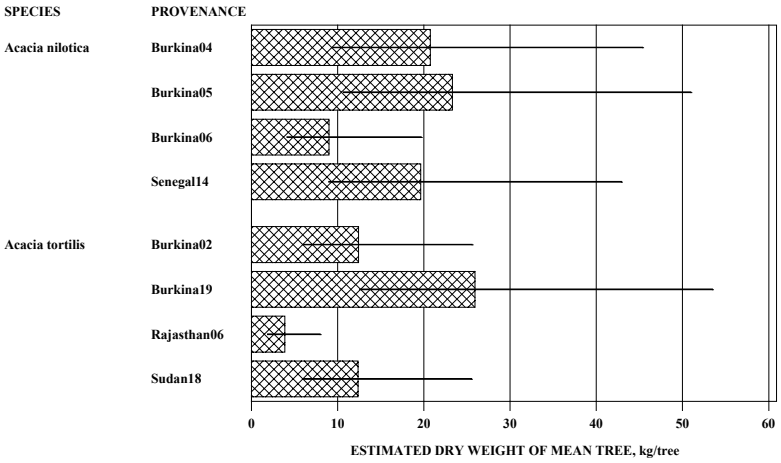


Figure 14. Estimated biomass of the mean tree (1988 assessment) for 8 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). No estimates are available for *A. seyal*. The estimates are least square means with 95 % confidence limits.

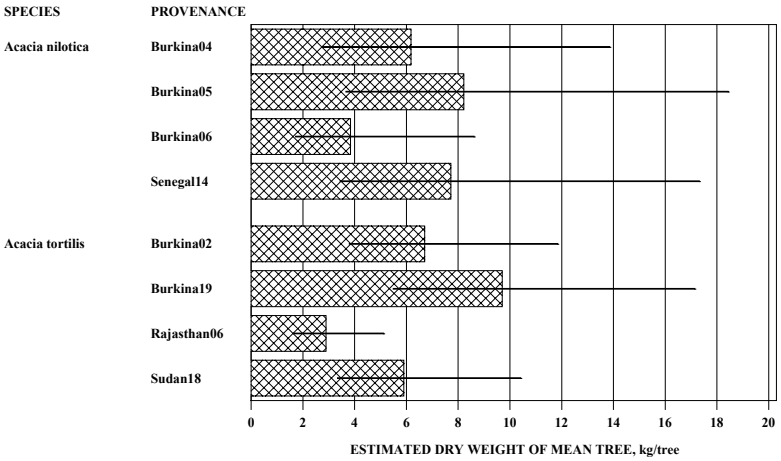


Figure 15. Estimated biomass of the mean tree (1993 assessment) for 8 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). No estimates are available for *A. seyal*. Analysis was made on ln-transformed values, and the estimates presented are back-transformed least square means with 95 % confidence limits. Due to the back-transformation the upper and lower confidence intervals are of unequal length.

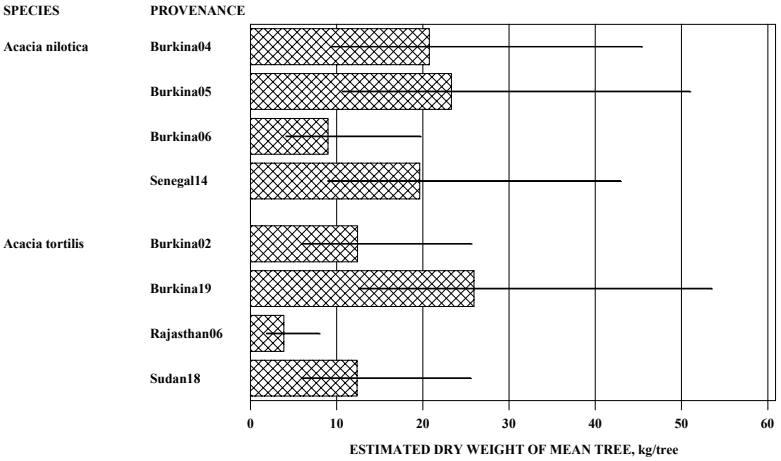


Figure 16. Estimated biomass of the mean tree (1999 assessment) for 8 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). No estimates are available for *A. seyal*. Analysis was made on ln-transformed values, and the estimates presented are back-transformed least square means with 95 % confidence limits. Due to the back-transformation the upper and lower confidence intervals are of unequal length.

Table 14. Results from analysis of variance of species differences in dry weight of the mean tree in trial 10, using Satterthwaites test in a model with provenances nested within species. The last part of the table gives the test for new information. The data from 1993 and 1999 were transformed with the natural logarithm before analysis. In the test for new information a weight statement was applied. Note: only *A. nilotica* and *A. tortilis* were tested.

Effect	DF (numerator; denominator)	MS	F-value	P-value	Bonferroni sequential tablewide correction
1988 assessment					
Species	1; 6	0.0030	0.30	0.60	n.s.
Provenance(species)	6; 35	0.0102	3.28	0.01	
Block	5; 35	0.0070	2.27	0.07	
Error	35	0.0031			
1993 assessment					
Species	1; 6	0.07	0.06	0.81	n.s.
Provenance(species)	6; 35	1.12	1.95	0.10	
Block	5; 35	0.82	1.42	0.24	
Error	35	0.58			
1999 assessment					
Species	1; 6	2.21	0.91	0.38	n.s.
Provenance(species)	6; 35	2.42	3.49	0.008	
Block	5; 35	0.32	0.46	0.80	
Error	35	0.69			
Test for new information					
Provenance	34; 7	16.8	15.1	<0.0001	***
Block	34; 5	9.50	8.56	<0.0001	
1993 Dry weight of mean tree	34; 1	257	231	<0.0001	
Error	34	1.11			

Table 15. Results from analysis of provenance differences within species for dry weight of mean tree in trial 10. See Table 15 for information on transformations.

Species	DF	MS	F-value	P-value	Bonferroni sequential tablewide correction
1988 assessment					
Acacia nilotica	3	0.019	5.91	0.007	n.s.
Acacia tortilis	3	0.0005	0.14	0.93	n.s.
1993 assessment					
Acacia nilotica	3	0.71	0.83	0.50	n.s.
Acacia tortilis	3	1.53	3.59	0.04	n.s.
1999 assessment					
Acacia nilotica	3	1.13	1.39	0.28	n.s.
Acacia tortilis	3	3.72	5.37	0.01	n.s.

4.8 Total dry weight

As with the total basal area, the total dry weight includes missing trees and gives the best measure of the actual production on the site.

Statistical analysis

Again, due to lack of a regression between dry weigh and basal area, there are no estimates of total dry weight of *A. seyal*. The model for the 1988 data was accepted without transformations, but in the datasets from the two later assessments there were variance heterogeneity, and the data were transformed with the natural logarithm before analyses. In the test for new information the variance heterogeneity was handled by weighting the data.

Results

Whereas the mean value for total dry weight for all provenances in 1988 was only approximately 100 kg ha^{-1}, the value was 4.7 t ha^{-1} in 1993 and 10.1 t ha^{-1} in 1999. The provenance with the largest production, Burkina05 had an average dry weight of 17.4 t ha^{-1} in 1999, corresponding to an average annual increment of 1.6 t ha^{-1} y^{-1}. Please recall that the estimates presented in Figs. 18 and 19 are biased due to the logarithmic transformation.

There was no difference between the two species in the total dry weight (Table 17), but the data indicated that within the species there were differences between the provenances (Table 18). The provenances of *A. tortilis* were significantly different at the assessments in 1993 and 1999. On both occasions, Rajasthan06 ranked lowest, and Burkina19 ranked highest (Figs. 18 and 19). Furthermore there were significant differences between the *A. nilotica* provenances at both the first and the last assessment, even though the significance disappeared when using the Bonferroni tablewide test. At the 1999 assessment Burkina06 and Burkina05 had the lowest and the highest biomass, respectively.

Comparing the 1993 and 1999 assessments, the picture is the same as in the basal area variables and in the basal area of the mean tree. The effect of the 1993 measurement as a co-variate was highly significant, indicating that large provenances have grown the most. Also the provenance effect was very significant, indicating that there was an additional difference between provenances. According to the pair-wise comparisons this effect was mainly due the provenances Burkina04 and Burkina05 which had significantly larger increment rates than the provenances Burkina06, Rajasthan06 and Sudan18.

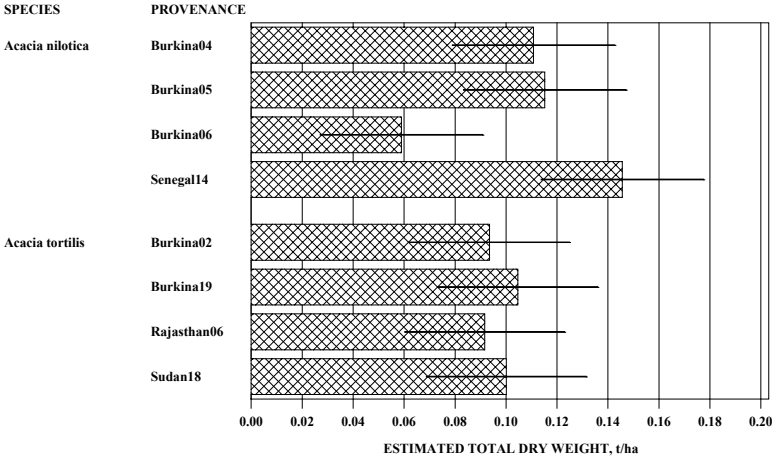


Figure 17. Estimated total biomass (1988 assessment) for 8 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). No estimates are available for *A. seyal*. The values presented are least square means with 95 % confidence limits.

Table 16. Results from analysis of variance of species differences in total dry weight in trial 10, using Satterthwaites test in a model with provenances nested within species. The last part of the table gives the test for new information. The data from 1993 and 1999 were transformed with the natural logarithm before analysis. In the test for new information a weight statement was applied. Note: only *A. nilotica* and *A. tortilis* were tested.

Effect	DF (numerator; denominator)	MS	F-value	P-value	Bonferroni sequential tablewide correction
1988 assessment					
Species	1; 6	0.0012	0.31	0.60	n.s.
Provenance(species)	6; 35	0.0040	3.25	0.01	
Block	5; 35	0.0028	2.26	0.06	
Error	35	0.0012			
1993 assessment					
Species	1; 6	0.036	0.02	0.90	n.s.
Provenance(species)	6; 35	2.17	3.10	0.02	
Block	5; 35	1.23	1.76	0.15	
Error	35	0.70			
1999 assessment					
Species	1; 6	2.11	0.41	0.55	n.s.
Provenance(species)	6; 35	5.18	5.15	0.0007	
Block	5; 35	0.40	0.40	0.85	
Error	35	1.00			
Test for new information					
Provenance	34; 7	6.62	6.34	<0.0001	***
Block	34; 5	6.67	6.39	<0.0001	
1993 Total basal area	34; 1	119	114	<0.0001	
Error	34	1.04			

Table 17. Results from analysis of provenance differences within species for total dry weight in trial 10. See Table 17 for information on transformations.

Species	DF	MS	F-value	P-value	Bonferroni sequential tablewide correction
1988 assessment					
Acacia nilotica	3	0.0078	5.78	0.008	n.s.
Acacia tortilis	3	0.0002	0.16	0.92	n.s.
1993 assessment					
Acacia nilotica	3	1.68	1.43	0.27	n.s.
Acacia tortilis	3	2.69	6.44	0.005	(*)
1999 assessment					
Acacia nilotica	3	4.14	3.33	0.05	n.s.
Acacia tortilis	3	6.21	6.73	0.004	(*)

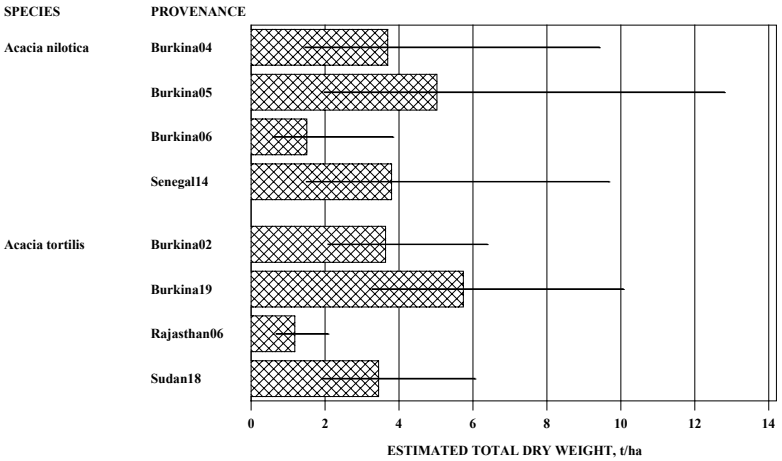


Figure 18. Estimated total biomass (1993 assessment) for 8 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). No estimates are available for *A. seyal*. Analysis was made on ln-transformed values, and the estimates presented are back-transformed least square means with 95 % confidence limits. Due to the back-transformation the upper and lower confidence intervals are of unequal length.

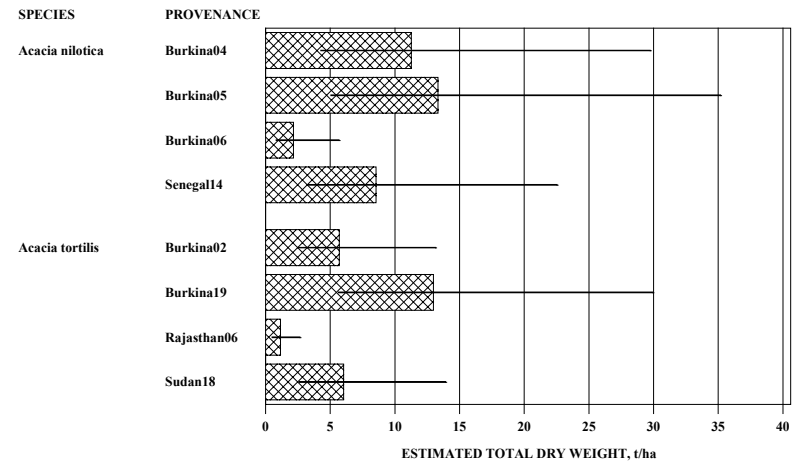


Figure 19. Estimated total biomass (1999 assessment) for 8 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). No estimates are available for *A. seyal*. Analysis was made on ln-transformed values, and the estimates presented are back-transformed least square means with 95 % confidence limits. Due to the back-transformation the upper and lower confidence intervals are of unequal length.

4.9 Results of the multivariate analyses

The multivariate analysis was performed on three sets of data: The data from 1993, the data from 1999 and a combination of the two sets of data. In the analysis of 1993 data the following variables were included: survival, height, basal area of the mean tree, total basal area (ln-transformed), crown area (square root transformed) and number of stems. In the analysis of 1999 data the variables were: survival, height, health, basal area of the mean tree (ln-transformed), total basal area (ln-transformed) and number of stems (ln-transformed). In the combined analysis, all twelve variables were included. The dry weight variables were omitted because analysis of *A. seyal* would not be possible if they were included.

For all three analyses the results demonstrated that three dimensions (or canonical variates) were significant. The proportion of the variation accounted for by the three first canonical variates were 95 %, 90 % and 88 % for the three analyses, respectively. In all three cases the results of the multivariate test demonstrated that the effect of provenance was highly significant ($P<0.0001$). In order to present the data, the scores on the canonical variates were plotted. Since three variates were significant, the plots of can2 versus can1 and can3 versus can1 present all information from the three dimensions (Figs. 20-22).

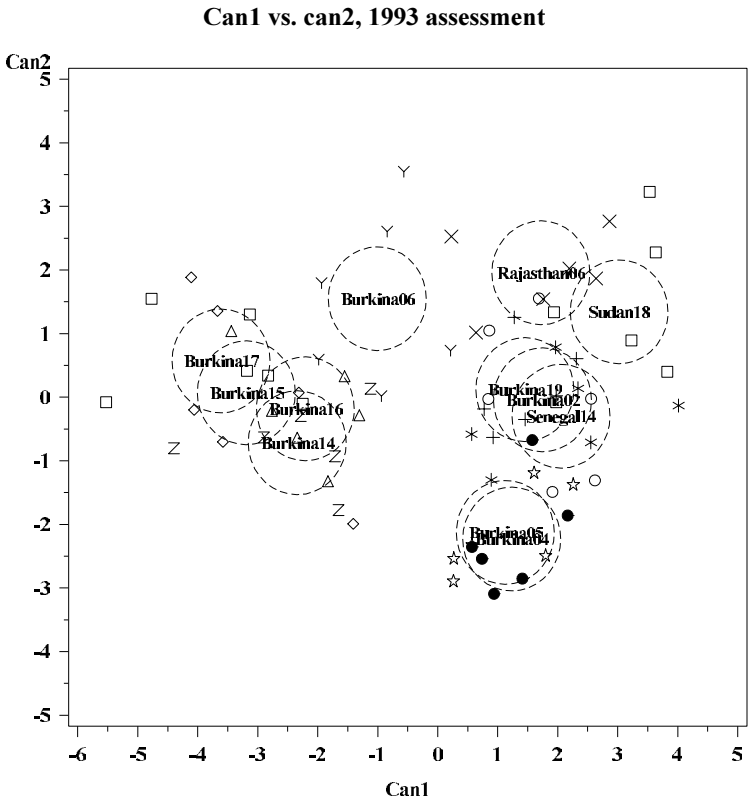
The three analyses do not include the same variables, and they are therefore not directly comparable. However, the analyses show more or less the same results. Starting with the analysis of data from 1993, the scores of the twelve provenances are shown together with the approximate confidence intervals of the provenance means in Fig. 20. The provenances Burkina14, Burkina15, Burkina16 and Burkina17 clearly group together and separate from the rest of the provenances. All these provenances are of *A. seyal*, and it would also be expected from the univariate analyses that this species is more uniform than the two other species. The separation between *A. seyal* and the other species is prominent along the first canonical variate.

For *A. nilotica*, there seems to be one group consisting of the provenances Burkina04 and Burkina05 with Senegal14 and Burkina06 clearly separated from these (Fig. 20, upper). A possible interpretation is that this is due to variety differences, since the provenances Burkina04 and Burkina05 are of the subspecies *adansonii*, whereas Burkina06 and Senegal14 are of subspecies *tomentosa*.

In *A. tortilis* a similar pattern occurred. The two provenances from Burkina Faso (Burkina02 and Burkina19), are almost identical, but the provenances Rajasthan06 and Sudan18 are distinctly different from these. Note that the in the plot of can3 versus can1 (Fig. 20, lower), Sudan18 is clearly separated from other provenances of *A. tortilis*.

Considering the analysis of data from 1999 (Fig. 21), the conclusions are almost the same. The provenances of *A. seyal* form a group, although not as distinctly different from the other species as in the previous analysis. For *A. nilotica*, the pattern was the same as above, but for *A. tortilis*, only Rajasthan06 was clearly separated from the others. Basically the same is seen from the analysis of both sets of data together (Fig. 22). *A. seyal* is in a very distinct group, and there are clear differences between the two provenances of the *A. nilotica* variety *adansonii* and the provenances of the variety *tomentosa*. For *A. tortilis*, the differences are not as pronounced as in the analysis of 1993 data.

Since neither of the analyses demonstrated that there were differences between the provenances of *A. seyal*, it was attempted to separate the provenances in a special multivariate test, run only for this species. However, the test demonstrated that none of the canonical variates were significant, and the hypothesis of no differences between the provenances was accepted ($P=0.79$). Therefore the data do not support that there are significant differences between the provenances, and the impression from the univariate analyses was confirmed.



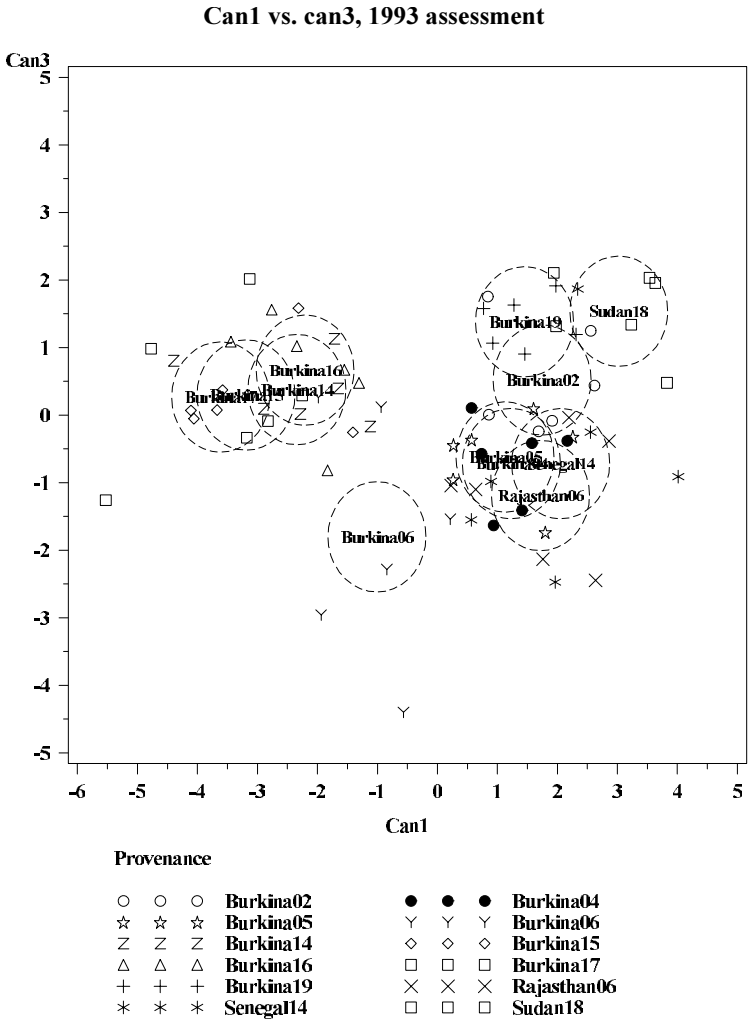
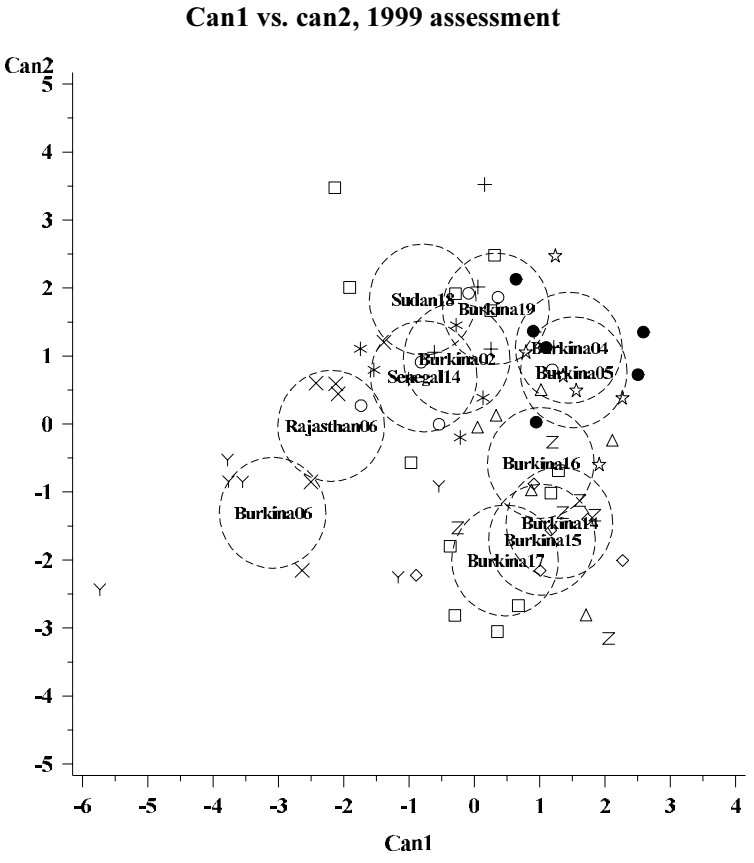


Fig. 20. Score plot of the first and the second canonical variate (upper figure) and of the first and the third canonical variate (lower figure) from the canonical variate analysis for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Data are from the 1993 assessment. The variables survival, height, basal area of the mean tree, total basal area, crown area and number of stems were included. Each provenance is marked at the mean value and surrounded by a 95 % confidence region. The provenances Burkina14 to Burkina17 are all *A. seyal* and group to the left of the diagram. The provenances Rajasthan06, Sudan18, Burkina02 and Burkina19 are *A. tortilis*, whereas the provenances Senegal14 and Burkina04 to Burkina06 are *A. nilotica*.



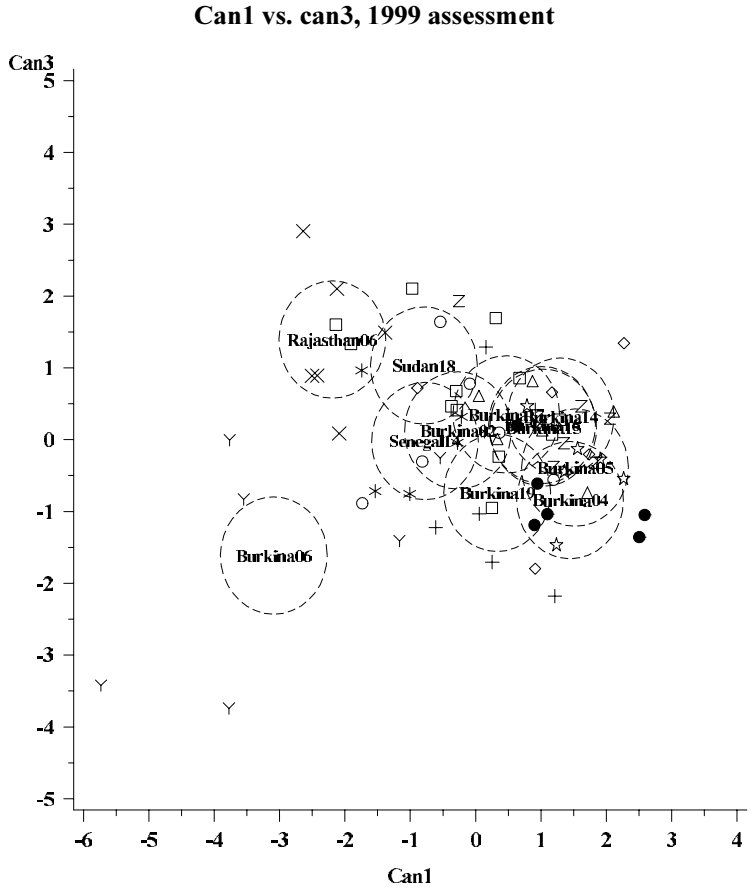
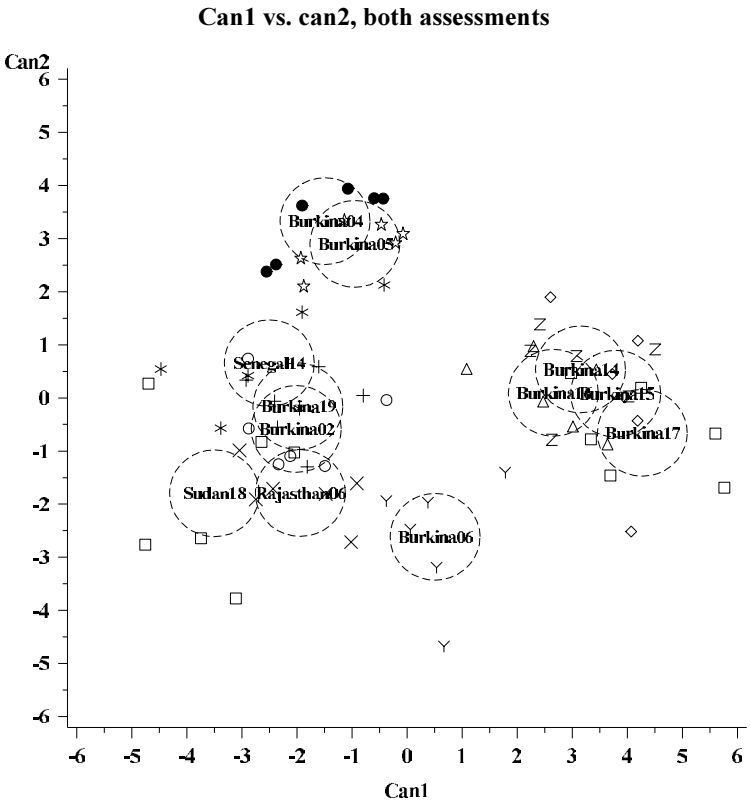


Figure 21. Score plot of the first and the second canonical variate (upper figure) and of the first and the third canonical variate (lower figure) from the canonical variate analysis for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Data are from the 1999 assessment. The variables survival, height, basal area of the mean tree, total basal area, crown area and number of stems were included. Each provenance is marked at the mean value and surrounded by a 95 % confidence region. The provenances Burkina14 to Burkina17 are all *A. seyal* and group to the lower right of the diagram. The provenances Rajasthan06, Sudan18, Burkina02 and Burkina19 are *A. tortilis*, whereas the provenances Senegal14 and Burkina04 to Burkina06 are *A. nilotica*.



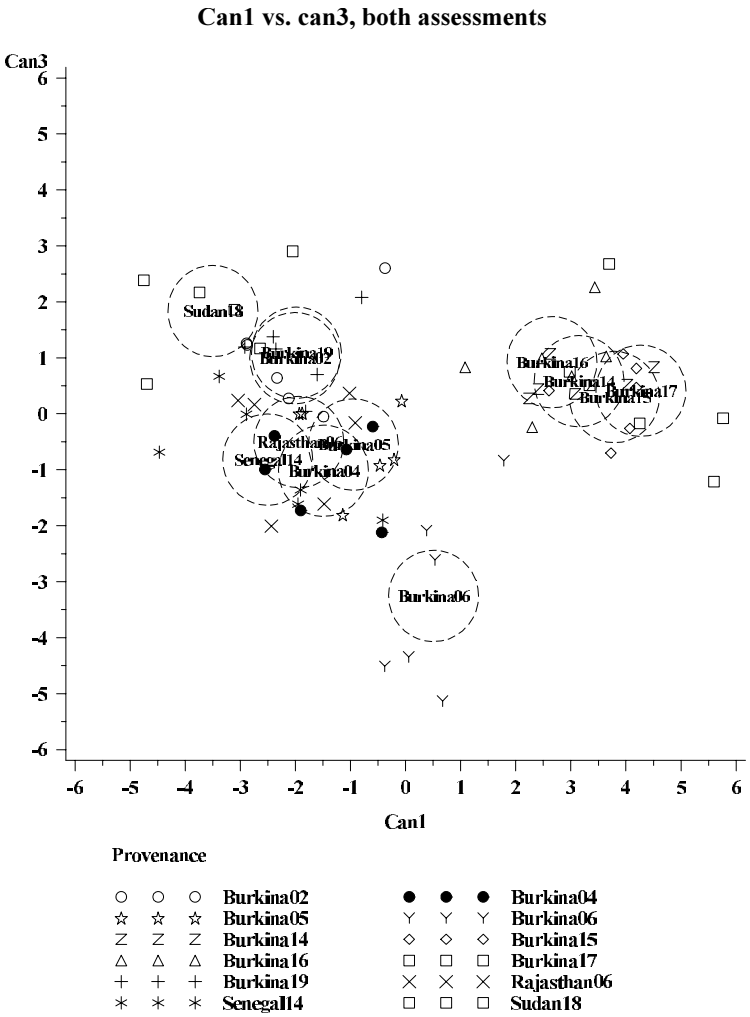


Figure 22. Score plot of the first and the second canonical variate (upper figure) and of the first and the third canonical variate (lower figure) from the canonical variate analysis for the 12 provenances in the species and provenance trial at Gonsé, Burkina Faso (Trial no. 10 in the arid zone series). Data are from both the 1993 and the 1999 assessment. The variables survival, height, basal area of the mean tree, total basal area, crown area and number of stems were included. Each provenance is marked at the mean value and surrounded by a 95 % confidence region. The provenances Burkina14 to Burkina17 are all *A. seyal* and group to the right of the diagram. The provenances Rajasthan06, Sudan18, Burkina02 and Burkina19 are *A. tortilis*, whereas the provenances Senegal14 and Burkina04 to Burkina06 are *A. nilotica*.

4.10 Genetic correlations

Analysing provenance and species trials is often a compromise between getting early and getting reliable results. Clearly the results become more reliable as the trial grows older and has experienced a variety of the climatic conditions at the site. On the other hand it is important to maximise the benefit from the trial, and early results may give valuable information on the choice of provenances.

The genetic correlations between different sets of measurements were calculated on the basis of variances and co-variances obtained from multivariate analyses. All species were included in the analyses, and the genetic correlations are therefore composite measures of the relationship between early and late measurements in all provenances taken together. This implies that the genetic correlations are not expressed for each species separately. For the calculations of the correlations for dry weight, *A. seyal* was not included.

First, survival, basal areas and dry weights from the 1989 measurement were compared with measurements taken in 1993 and 1999. Second, survival, height, basal area and dry weight from the 1993 and 1999 measurements were compared. The resulting genetic correlations are given in table 18.

The genetic correlations between data from 1989 and the later data are small, although the dry weight variables give the impression that there is some connection between the measurements. However, there may be some uncertainty associated with the values, and more confidence should probably be given to the genetic correlations for basal area, since they are not derived variables. For survival, almost all trees were alive at the 1989 assessment, and as there was no variation between the seedlots, it was not possible to calculate genetic correlations with the later measurements.

On the contrary, the genetic correlations between 1993 and 1999 are high. For survival, height and total basal area the correlations are 1, meaning that there has been close to no change between the growth of the provenances between the two assessments. This also implies that it would be possible to base a selection of provenances on the 1993 data, at least if the rotation age is around 11 years and the 1999 data can be considered as the mature or final stage.

The same conclusions can be drawn from Figs. 23 and 24, displaying the variable's least square means from the three assessments against each other. Whereas the 1988 variables plotted against variables from 1993 and 1999 appear scattered (Fig. 23), the 1993 and 1999 variables appear as almost straight lines when plotted against each other (Fig. 24).

Table 18. Genetic correlations between variables from three measurements. Height data from 1989 were not available. n.a.: calculation not possible due to estimated variance components with value 0.

	Period		
Variable	**1989-1993**	**1989-1999**	**1993-1999**
Survival	n.a.	n.a.	1.0
Height			1.0
Basal area of the mean tree	n.a.	0.3	n.a.
Total basal area	0.1	0.3	1.0
Dry weight of the mean tree	0.6	0.6	0.6
Total dry weight	0.6	0.7	0.8

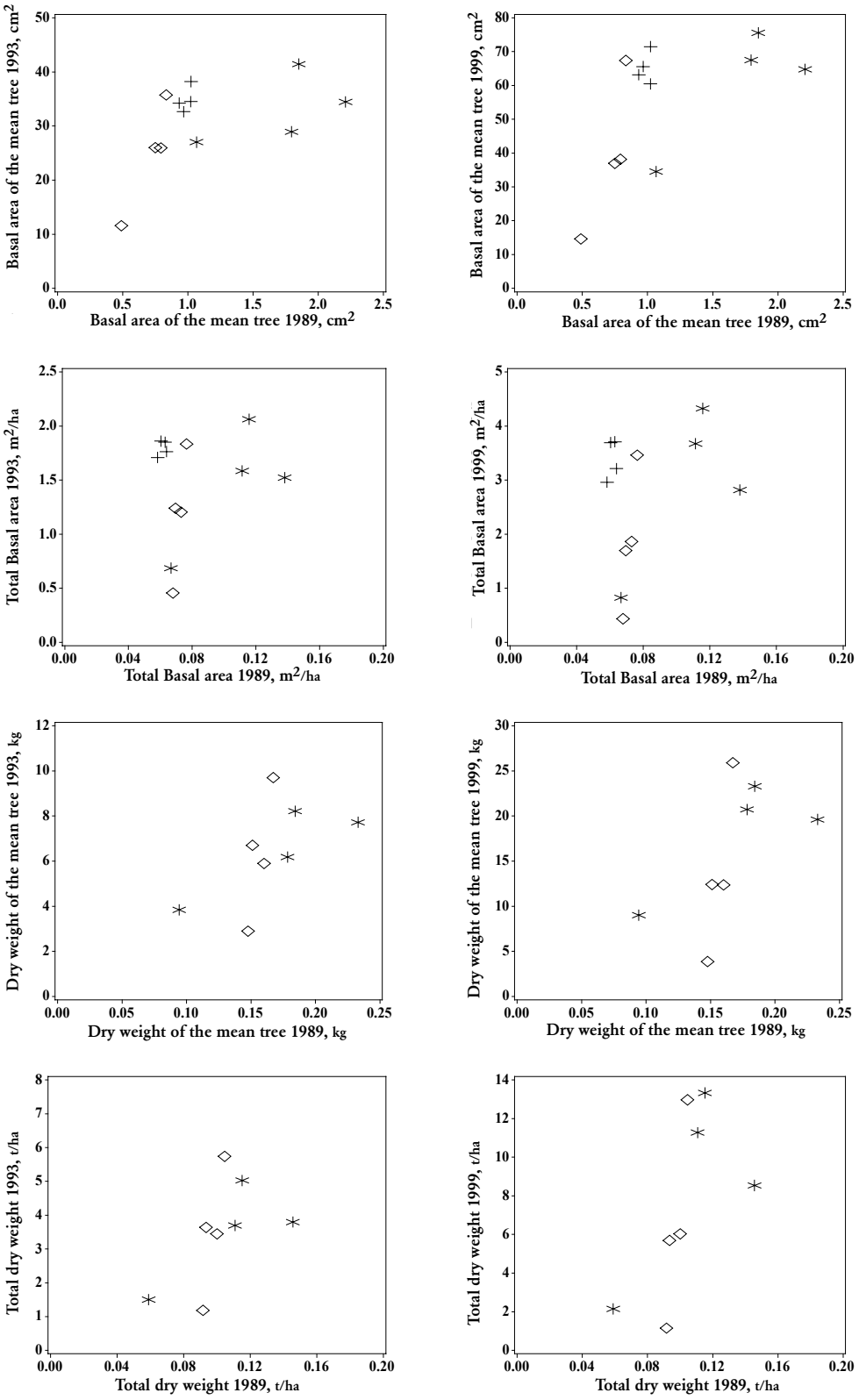


Figure 23. Least square means for four variables measured in 1989 plotted against the least square means for the same variables measured in 1993 (left column) and 1999 (right column). Stars represent *A. nilotica*, plus represent *A. seyal* and diamonds represent *A. tortilis*.

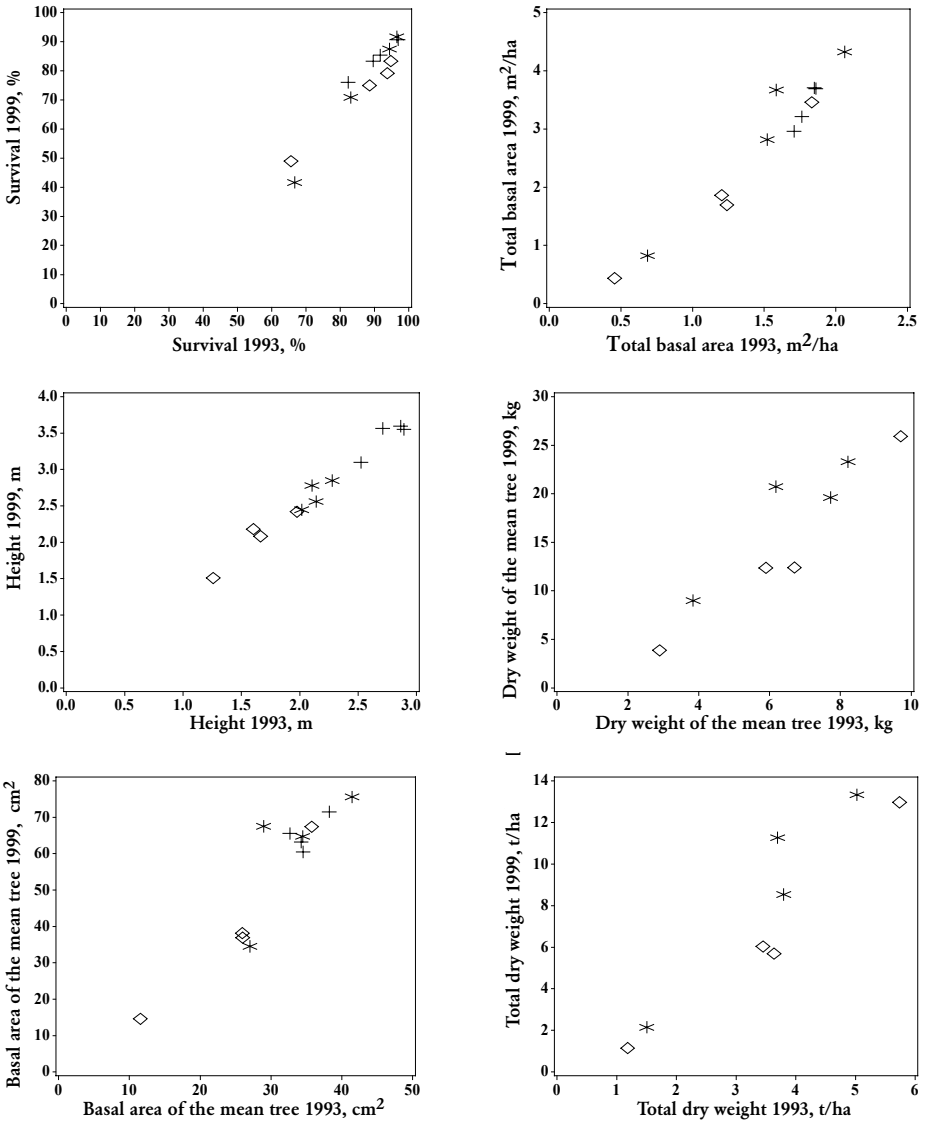


Figure 24. Least square means for six variables measured in 1993 plotted against least square means for the same variables measured in 1999. Stars represent *A. nilotica*, plus represent *A. seyal* and diamonds represent *A. tortilis*.

5. Discussion and conclusion

Productivity

The data shows that there was an initial fast growth in height (from age 0 to 5 years), but that the growth rate had slowed down considerably at the last assessment (at age 11). During the six years from 1993 to 1999 the average height growth was only 0.5 m, corresponding to less than 10 cm per year. On the contrary, the increment in dry weight per year was almost constant in the two periods. For Burkina05, which had the largest growth rate, there were even signs that it was increasing, being 1.4 t ha^{-1} y^{-1} in the first period and 1.6 ha^{-1} y^{-1} in the second.

In a nearby trial, also at Gonsé, both *A. tortilis* and *A. nilotica* had a much slower growth (trial no. 11 in this series). These differences could be because of differences in the micro-environment at the two sites, but also because different provenances were represented.

A similar trial with the same species was established at Dori in Northern Burkina Faso (trial no. 7 in this series). The production of dry weight at Dori was only about half of the production in the current trial, probably because of the smaller precipitation. However, apart from a poorer survival in *A. seyal* at Dori, the species had a very similar behaviour in the two trials.

Species differences

The species differed significantly with respect to height (in 1993 and 1999), crown area (1993) and number of stems (1993 and 1999). Furthermore there were significant differences in basal area of the mean tree (1988) and total basal area (1988), but these differences disappeared at the later assessments and are of little value from the point of view of choosing species. *A. seyal* had the largest height growth, the largest crown areas and the smallest number of stems. *A. tortilis* had the smallest height growth and the largest number of stems, whereas *A. nilotica* was intermediate in all three characters. These observations all support the impression that *A. seyal* has the most tree-like growth habit whereas *A. tortilis* is bushy, and that *A. nilotica* is intermediate to the other species.

There was no difference between the species in the main indicators for production of biomass, basal area and dry weight. However, since there was no estimates of biomass for *A. seyal*, it cannot be excluded that this species would have a larger (or smaller) dry weight production than the two other species. The basic density for *A. seyal* was 750 kg m^{-3} for trees in Burkina Faso (Nygård & Elfving 2000). In the trees used for detemination of biomass in this series of trials (Graudal *et al.* in prep), the average specific gravities were 690 and 700 kg m^{-3} for *A. nilotica* and *A. tortilis*, respectively.

There are no natural populations of the species *A. tortilis* in the soudanian and the soudano-sahelian climate zones, including the forests surrounding the trial at Gonsé. However, with the changing (dryer) climate, the species is spreading gradually from the north, the seed being dispersed mainly with animal manure as cattle are being transported from the north towards markets in the south. On the other hand, the two other species are natural in the area. It could therefore be hypothesised that that in contrast to the two other species, no provenances of *A. tortilis* would as yet have adapted to the site conditions in the climate corresponding to Gonsé. This would be accentuated with the increase in rainfall observed after 1995.

Whereas this seemed to be true for the *A. tortilis* provenances Burkina02, Rajasthan06 and Sudan18, it appeared that Burkina19 had a growth comparable to the best provenances of the other species. Thus making species recommendations for the site is difficult. It appeared that there was less variation between the provenances of *A. seyal* than between the provenances of the other species, and if it is the aim to provide a secure choice of regeneration material, this species could be considered instead of the two others.

Provenance differences

Significant differences between the provenance of *A. nilotica* were found in the variables survival (1993 and 1999), number of stems (1993, but not 1999), and the basal area and dry weight variables in 1988. At the later assessments there were no significant differences in basal area and dry weight variables, although there were small signs of differences between in the provenances in total dry weight in 1999. The provenance Burkina06 (Falagountou) had a low survival, and Senegal14 had a high number of stems. Furthermore the multivariate analysis indicated that Burkina06 differed from the others. Even though the differences in basal area and dry weight were not significant, Burkina06 was low in all the variables, and the use of this provenance at Gonsé is not recommended.

The number of provenances of *A. nilotica* in the trial is too small to give meaningful information on the genetic structure, but the multivariate analysis could indicate differences between the varieties *adansonii* and *tomentosa*. Both Burkina06 and Senegal14 are of the subspecies *tomentosa*, whereas the two other provenances (Burkina04 and Burkina05) are of the subspecies *adansonii*. The two subspecies occupy different ecological niches, *adansonii* pre-

ferring deep sandy-loamy soils, whereas *tomentosa* prefers alluvial clayey soils and tolerates inundation (von Maydell 1986). *Tomentosa* is not found in the soudanian or the soudano-sahelian vegetation zones. The present policy of CNSF is to recommend *adansonii* for the southern zones and *tomentosa* only for the sahelian zone. The results from this trial are not in opposition with these guidelines. Interestingly there is not much difference between Burkina04 and Burkina05 even though their origins differ with respect to rainfall.

As mentioned above there seemed to be little variation between the provenances of *A. seyal*, and there were no significant differences between the provenances, even in the multivariate test. Thus the trial does not warrant recommendation of the use of one provenance instead of the others.

There were several differences between the provenances of *A. tortilis*. The provenance Rajasthan06 had the lowest rank in all variables and is not recommended for future use. The reason for the poor performance of this provenance could be that it was introduced to India from Israel and may have a narrow genetic base (Fagg & Barnes 1990). On the other hand, the other exotic provenance, Sudan18, was comparable with the two provenances from Burkina Faso. Overall, the provenance Burkina19 ranked best with respect to survival, height, crown area as well as basal area and dry weight variables, and although it did not differ significantly from Burkina02, it would be natural to recommend use of this provenance.

When giving overall provenance recommendations for wood production, the best variable to use is in this case the total basal area (in the lack of a biomass regression for *A. seyal*). Fig. 13 demonstrates that the best provenances from each of the three species have comparable total basal areas, and best choice of planting material would be likely to be one of the following: Burkina04 and Burkina05 (*A. nilotica*), Burkina14 and Burkina15 (*A. seyal*) or Burkina19 (*A. tortilis*).

Test for new information and genetic correlations

The test for new information demonstrated that there were significant changes for the provenances in all the basal area and dry weight variables. Usually the variable at the 1993 assessment, used as co-variate, was significant, meaning that there was a general tendency that the largest provenances also had the largest increments. The significant provenance effects in the variables can be interpreted as accentuations of the differences, since it was obvious that some provenances had above average increment rates while others did not grow as fast as would be expected, considering the size of the trees/provenance at the 1993 assessment. Thus it can be concluded that the re-assessment have in fact contributed with new knowledge. In general, this seems only natural: since the trees are long-living organisms and they live in a stressfull environment, differences between genetic units may only show after several years of exposure.

Judged from the genetic correlations, however, it seems relatively safe to select provenances on the basis of the measurement after 5 years (1993). The genetic correlations between the 1993 and 1999 data were all high, implying a close relationship between the growth characteristics at the two assessments. Data from the assessment in 1988 were much less efficient in predicting growth at later stages, and it would be dangerous to use such early data for selection of provenances.

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Annex 1. Description of the trial site (from DFSC 1994)

Name of site:	Gonsé, Burkina Faso (Bureau National des Sols, 1990): Latitude: 12°22'N Longitude: 01°19'W Altitude: 300 m
Meteorological stations:	Regionde Gonsé (Bureau National des Sols, 1990) Ouagadougou (12°21'N, 01°31'W, 306 (FAO 1984, Bureau National des Sols, 1990)
Rainfall:	Annual mean (period): 862 mm FAO 1984) 678.55 (1985-88 (Bureau National des Sols, 1990)) Yearly registrations: 1985: 633.5 1986: 695.55 1987: 626.1 1988: 759.45 Month of establishment: 226.77
Potential evapotranspiration:	(Oct.-Apr), Penman 1985: 1057.8 1986: 1119.6 1987: 1021.8 1988: 1052.8
Rainy season:	June-September Type: Normal with dry period
Dry months/year:	No. of dry months (<50 mm): 8 No. of dry periods: 1
Temperature:	(°C (FAO 1984)): Annual mean: 28.1 Coldest month: 15.8 (mean minimum) Hottest month: 38.5 (mean maximum)
Wind:	Prevailing directions: L'harmattan (March-April) Speed at 2 m: 2.3 m/s (FAO 1984)
Topography:	Flat
Soil:	Type: Ferruginous tropical leached soil, sandy with some clay/ leached gravel soil Depth: varying (Shallow-deep) (> 1 m)
Climatic/agroecological zone:	Semi-arid, Sudano-Sahelian zone.
Dominant natural vegetation:	Woody savanna (Butyrospermum parkii, Terminalia avicennoides).
Koeppen classification:	BSh.

Annex 2. Seedlots of *Acacia* tested in trial no. 10 at Gonsé, Burkina Faso

The plot numbers refer to the seedlots in the map of the trial, see Annex 3.

Species codes: aniada=*Acacia nilotica* subsp. *adansonii*, anito=*A. nilotica* subsp. *tomentosa*, asey=*A. seyal*, ato=*A. tortilis*, atora=*A. tortilis* subsp. *raddiana*. Seedlot data supplied by the seed collection institution.
[1]Rainfall data from Pigeonnière & Jomni (1998), 1966-1995 (before slash) and before 1970 (after slash).

Seedlot numbers					**Provenance information**						
Provenance	**Species code**	**Plot**	**DFSC**	**Country of origin**	**Seed collection site**	**Country of origin**	**Latitude**	**Longitude**	**Altitude (m)**	**Rainfall (mm)**	**No. of mother trees**
Burkina04	aniada	1		885	Boukouma	Burkina Faso	14°12'N	00°43'W	317	350/450[1]	27
Burkina05	aniada	2		921	Kossodo	Burkina Faso	12°20'N	02°02'W	341	750/850[1]	100
Burkina06	anito	3		926	Falagountou	Burkina Faso	14°22'N	00°11'E	250	450/550[1]	27
Senegal14	anito	4		118	Nayobé	Senegal					
Burkina14	asey	9		27	Bodole 2, Djibo	Burkina Faso	14°06'N	01°37'W		450/600[1]	76
Burkina15	asey	11		369	Sao, Tchériba	Burkina Faso	12°15'N	03°00'W	293	750/900[1]	47
Burkina16	asey	10		909	F.C. Barrage Ouaga	Burkina Faso	12°20'N	01°30'W	300	750/850[1]	26
Burkina17	asey	12		916	Lery	Burkina Faso	12°49'N	03°12'W	320	700/900[1]	35
Burkina02	atora	6		868	Boukouma	Burkina Faso	14°12'N	00°43'W	320	400/550[1]	27
Burkina19	atora	5		920	Markoye	Burkina Faso	14°38'N	00°02'W	295	350/450[1]	27
Rajasthan06	ato	8	1085/82		Ramgaon, Barmer	India	25°45'N	71°23'E	194	310	50
Sudan18	atora	7	1240/84	6/1983	Elbashiri oasis, Northern Kordofan	Sudan	13°48'N	30°12'E	400	300	25

Annex 3. Layout of the trial

Layout of blocks and plots in the field (each provenance is indicated by the plot number given in Annex 2):

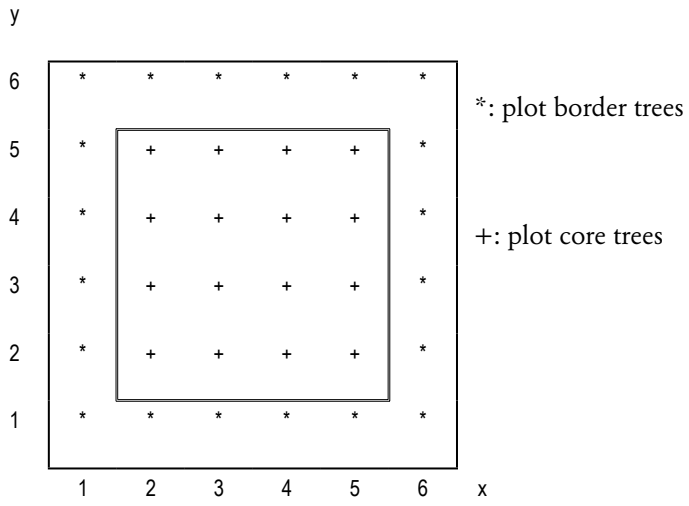
N

y	BLOCK 5			BLOCK 4			BLOCK 1		
8	3	11	2	4	9	6	12	5	9
7	10	5	1	11	3	7	3	1	7
6	8	6	9	10	2	8	4	6	2
5	12	4	7	1	12	5	11	10	8
4	3	1	7	11	12	3	6	2	7
3	2	4	6	1	10	5	10	8	1
2	12	11	9	4	7	6	12	11	5
1	10	8	5	2	9	8	9	4	3
	1	2	3	4	5	6	7	8	9

x

BLOCK 6 BLOCK 3 BLOCK 2

Individual tree positions in each plot:



Annex 4. Single tree data sets from 1989 and 1999

The plot numbers refer to the seedlots in the map of the trial, see Annex 3.

Species codes: aniada=*Acacia nilotica* subsp. *adansonii*, anito=*A. nilotica* subsp. *tomentosa*, asey=*A. seyal*, ato=*A. tortilis*, atora=*A. tortilis* subsp. *raddiana*.

								1989 data		1999 data			
Block	**Plot**	**Plotx**	**Ploty**	**Treex**	**Treey**	**Species**	**Provenance**	**Basal area**	**Tree dry weight**	**Height**	**Number of stems**	**Basal area**	**Tree dry weight**
								$cm^2\ tree^{-1}$	**$kg\ tree^{-1}$**	**m**	**no. $tree^{-1}$**	**$cm^2\ tree^{-1}$**	**$kg\ tree^{-1}$**
1	1	8	7	2	2	aniada	Burkina04	1.53	0.14				
1	1	8	7	2	3	aniada	Burkina04	3.12	0.35	3.3	2	144.4	49.5
1	1	8	7	2	4	aniada	Burkina04	3.44	0.40	3.3	1	112.4	35.8
1	1	8	7	2	5	aniada	Burkina04	2.26	0.23	3.5	2	189.2	70.2
1	1	8	7	3	2	aniada	Burkina04	0.78	0.06	2.7	2	48.8	12.2
1	1	8	7	3	3	aniada	Burkina04	2.26	0.23	0.9	1	12.5	2.1
1	1	8	7	3	4	aniada	Burkina04	1.53	0.14	2.3	2	99.9	30.8
1	1	8	7	3	5	aniada	Burkina04	2.00	0.20	3.2	1	86.0	25.4
1	1	8	7	4	2	aniada	Burkina04	1.32	0.12				
1	1	8	7	4	3	aniada	Burkina04	2.26	0.23	2.4	1	38.2	8.9
1	1	8	7	4	4	aniada	Burkina04	2.00	0.20	2.2	1	23.6	4.8
1	1	8	7	4	5	aniada	Burkina04	2.26	0.23	2.9	2	98.5	30.2
1	1	8	7	5	2	aniada	Burkina04	2.26	0.23	2.8	2	89.4	26.6
1	1	8	7	5	3	aniada	Burkina04	2.53	0.27	2.7	1	49.9	12.6
1	1	8	7	5	4	aniada	Burkina04	2.53	0.27				
1	1	8	7	5	5	aniada	Burkina04	2.26	0.23	2.5	1	33.0	7.4
1	2	9	6	2	2	aniada	Burkina05	1.53	0.14	2.9	1	70.4	19.6
1	2	9	6	2	3	aniada	Burkina05	1.32	0.12	2.5	1	38.2	8.9
1	2	9	6	2	4	aniada	Burkina05	2.00	0.20	3.1	2	61.8	16.6
1	2	9	6	2	5	aniada	Burkina05	1.76	0.17	2.8	1	38.2	8.9
1	2	9	6	3	2	aniada	Burkina05	1.76	0.17	2.8	1	38.2	8.9
1	2	9	6	3	3	aniada	Burkina05	1.12	0.09				
1	2	9	6	3	4	aniada	Burkina05	1.53	0.14	3.0	2	51.7	13.1
1	2	9	6	3	5	aniada	Burkina05	2.00	0.20	2.5	1	23.6	4.8
1	2	9	6	4	2	aniada	Burkina05	1.53	0.14	3.2	1	94.4	28.6
1	2	9	6	4	3	aniada	Burkina05	1.53	0.14	2.8	1	78.0	22.4
1	2	9	6	4	4	aniada	Burkina05	1.32	0.12	1.0	1	19.5	3.7
1	2	9	6	4	5	aniada	Burkina05	0.94	0.07				
1	2	9	6	5	2	aniada	Burkina05	0.94	0.07	1.8	2	35.3	8.0
1	2	9	6	5	3	aniada	Burkina05	1.12	0.09	2.8	1	43.9	10.6
1	2	9	6	5	4	aniada	Burkina05	1.53	0.14	2.7	1	43.9	10.6
1	2	9	6	5	5	aniada	Burkina05	2.26	0.23	3.0	2	103.4	32.2
1	3	7	7	2	2	anito	Burkina06	0.63	0.04				
1	3	7	7	2	3	anito	Burkina06	0.50	0.03				
1	3	7	7	2	4	anito	Burkina06	0.78	0.06				
1	3	7	7	2	5	anito	Burkina06	0.63	0.04	3.8	5	85.5	25.1
1	3	7	7	3	2	anito	Burkina06	0.50	0.03				
1	3	7	7	3	3	anito	Burkina06	0.38	0.02				

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
1	3	7	7	3	4	anito	Burkina06	0.50	0.03	4.0	2	226.3	88.4
1	3	7	7	3	5	anito	Burkina06	1.32	0.12				
1	3	7	7	4	2	anito	Burkina06	0.38	0.02				
1	3	7	7	4	3	anito	Burkina06	0.50	0.03				
1	3	7	7	4	4	anito	Burkina06	0.63	0.04	1.7	1	7.0	1.0
1	3	7	7	4	5	anito	Burkina06	1.76	0.17				
1	3	7	7	5	2	anito	Burkina06	1.12	0.09	2.7	1	9.6	1.5
1	3	7	7	5	3	anito	Burkina06	1.53	0.14				
1	3	7	7	5	4	anito	Burkina06	0.50	0.03				
1	3	7	7	5	5	anito	Burkina06	0.38	0.02	2.5	1	38.2	8.9
1	4	7	6	2	2	anito	Senegal14	2.00	0.20	3.6	1	103.2	32.1
1	4	7	6	2	3	anito	Senegal14	2.26	0.23	3.6	2	84.5	24.8
1	4	7	6	2	4	anito	Senegal14	0.63	0.04	1.9	2	11.9	2.0
1	4	7	6	2	5	anito	Senegal14	3.44	0.40	4.0	1	175.6	63.7
1	4	7	6	3	2	anito	Senegal14	1.32	0.12	3.3	2	32.0	7.1
1	4	7	6	3	3	anito	Senegal14	1.53	0.14	3.5	1	63.2	17.0
1	4	7	6	3	4	anito	Senegal14	2.26	0.23	3.7	1	86.0	25.4
1	4	7	6	3	5	anito	Senegal14	0.07	0.00				
1	4	7	6	4	2	anito	Senegal14	1.76	0.17	4.0	3	89.9	26.9
1	4	7	6	4	3	anito	Senegal14	1.53	0.14	4.9	5	145.3	49.9
1	4	7	6	4	4	anito	Senegal14	1.76	0.17	3.1	1	33.0	7.4
1	4	7	6	4	5	anito	Senegal14	0.94	0.07	4.0	2	61.1	16.3
1	4	7	6	5	2	anito	Senegal14	2.82	0.31	5.7	4	314.1	135.0
1	4	7	6	5	3	anito	Senegal14	0.94	0.07	5.7	2	119.6	38.8
1	4	7	6	5	4	anito	Senegal14	2.00	0.20	5.9	3	301.8	128.2
1	4	7	6	5	5	anito	Senegal14	1.53	0.14	3.8	2	111.0	35.3
1	5	8	8	2	2	atora	Burkina19	2.00	0.30	3.8	2	47.8	15.0
1	5	8	8	2	3	atora	Burkina19	1.12	0.15	3.2	2	61.8	20.6
1	5	8	8	2	4	atora	Burkina19	0.78	0.09	1.7	1	12.5	2.9
1	5	8	8	2	5	atora	Burkina19	0.28	0.03	1.1	1	3.1	0.5
1	5	8	8	3	2	atora	Burkina19	0.38	0.04	2.4	2	42.5	13.0
1	5	8	8	3	3	atora	Burkina19	1.32	0.18	2.4	1	28.1	7.8
1	5	8	8	3	4	atora	Burkina19	0.50	0.05	2.0	1	12.5	2.9
1	5	8	8	3	5	atora	Burkina19	0.63	0.07	2.5	1	12.5	2.9
1	5	8	8	4	2	atora	Burkina19	0.78	0.09	2.3	1	28.1	7.8
1	5	8	8	4	3	atora	Burkina19	1.32	0.18	3.0	2	72.0	24.9
1	5	8	8	4	4	atora	Burkina19	1.53	0.21	2.6	2	78.0	27.5
1	5	8	8	4	5	atora	Burkina19	2.53	0.40	3.0	4	149.4	61.4
1	5	8	8	5	2	atora	Burkina19	0.94	0.12	2.3	1	38.2	11.4
1	5	8	8	5	3	atora	Burkina19	0.78	0.09	1.2	1	38.2	11.4
1	5	8	8	5	4	atora	Burkina19	1.12	0.15				
1	5	8	8	5	5	atora	Burkina19	0.94	0.12				
1	6	8	6	2	2	atora	Burkina02	1.53	0.21	4.6	2	144.4	58.8
1	6	8	6	2	3	atora	Burkina02	2.00	0.30	5.0	1	121.9	47.7
1	6	8	6	2	4	atora	Burkina02	2.82	0.45	4.9	4	345.3	172.8
1	6	8	6	2	5	atora	Burkina02	0.94	0.12	3.8	2	119.6	46.6

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
1	6	8	6	3	2	atora	Burkina02	1.53	0.21	4.5	1	187.5	81.2
1	6	8	6	3	3	atora	Burkina02	1.32	0.18	3.5	2	94.6	34.9
1	6	8	6	3	4	atora	Burkina02	1.12	0.15	3.6	4	110.4	42.2
1	6	8	6	3	5	atora	Burkina02	1.76	0.25	2.9	1	38.2	11.4
1	6	8	6	4	2	atora	Burkina02	2.26	0.35	3.2	1	112.4	43.2
1	6	8	6	4	3	atora	Burkina02	2.53	0.40	3.5	2	67.5	23.0
1	6	8	6	4	4	atora	Burkina02	1.12	0.15	3.3	2	82.1	29.3
1	6	8	6	4	5	atora	Burkina02	1.32	0.18	2.5	2	24.4	6.5
1	6	8	6	5	2	atora	Burkina02	1.53	0.21	3.0	3	85.8	31.0
1	6	8	6	5	3	atora	Burkina02	1.76	0.25	3.4	1	38.2	11.4
1	6	8	6	5	4	atora	Burkina02	0.50	0.05	3.4	1	43.9	13.5
1	6	8	6	5	5	atora	Burkina02	1.12	0.15	2.5	1	25.4	6.9
1	7	9	7	2	2	atora	Sudan18	2.26	0.35	2.4	2	61.8	20.6
1	7	9	7	2	3	atora	Sudan18	1.12	0.15				
1	7	9	7	2	4	atora	Sudan18	0.78	0.09				
1	7	9	7	2	5	atora	Sudan18	2.26	0.35				
1	7	9	7	3	2	atora	Sudan18	0.63	0.07	1.1	1	3.1	0.5
1	7	9	7	3	3	atora	Sudan18	0.94	0.12	2.2	1	7.0	1.4
1	7	9	7	3	4	atora	Sudan18	1.12	0.15	2.6	5	27.5	7.6
1	7	9	7	3	5	atora	Sudan18	1.32	0.18	4.0	2	76.9	27.0
1	7	9	7	4	2	atora	Sudan18	0.50	0.05	2.6	5	33.8	9.8
1	7	9	7	4	3	atora	Sudan18	0.78	0.09	1.2	6	29.1	8.1
1	7	9	7	4	4	atora	Sudan18	0.94	0.12	1.7	2	8.0	1.6
1	7	9	7	4	5	atora	Sudan18	1.76	0.25	4.1	2	189.2	82.2
1	7	9	7	5	2	atora	Sudan18	0.94	0.12	1.3	4	23.8	6.3
1	7	9	7	5	3	atora	Sudan18	0.63	0.07				
1	7	9	7	5	4	atora	Sudan18	0.78	0.09	2.3	7	37.8	11.3
1	7	9	7	5	5	atora	Sudan18	0.94	0.12	0.6	1	0.8	0.1
1	8	9	5	2	2	ato	Rajasthan06	1.32	0.18				
1	8	9	5	2	3	ato	Rajasthan06						
1	8	9	5	2	4	ato	Rajasthan06	0.38	0.04				
1	8	9	5	2	5	ato	Rajasthan06	0.50	0.05	1.2	2	11.3	2.5
1	8	9	5	3	2	ato	Rajasthan06	0.78	0.09				
1	8	9	5	3	3	ato	Rajasthan06	0.63	0.07				
1	8	9	5	3	4	ato	Rajasthan06	0.94	0.12				
1	8	9	5	3	5	ato	Rajasthan06	0.78	0.09	0.9	1	0.8	0.1
1	8	9	5	4	2	ato	Rajasthan06	0.78	0.09	1.0	1	15.8	3.8
1	8	9	5	4	3	ato	Rajasthan06	0.63	0.07	2.3	1	19.5	5.0
1	8	9	5	4	4	ato	Rajasthan06	1.12	0.15	0.8	1	3.1	0.5
1	8	9	5	4	5	ato	Rajasthan06	0.94	0.12				
1	8	9	5	5	2	ato	Rajasthan06	1.12	0.15				
1	8	9	5	5	3	ato	Rajasthan06	0.63	0.07				
1	8	9	5	5	4	ato	Rajasthan06	1.32	0.18				
1	8	9	5	5	5	ato	Rajasthan06	0.78	0.09	1.0	1	1.8	0.3
1	9	9	8	2	2	asey	Burkina14	0.38		4.0	1	33.0	
1	9	9	8	2	3	asey	Burkina14	2.00		3.7	1	121.9	

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
1	9	9	8	2	4	asey	Burkina14	2.53		2.7	1	12.5	
1	9	9	8	2	5	asey	Burkina14	0.63		3.6	1	63.2	
1	9	9	8	3	2	asey	Burkina14	0.63		3.5	1	28.1	
1	9	9	8	3	3	asey	Burkina14	1.32		4.6	2	82.1	
1	9	9	8	3	4	asey	Burkina14	0.50		5.0	1	28.1	
1	9	9	8	3	5	asey	Burkina14	0.78		5.3	1	78.0	
1	9	9	8	4	2	asey	Burkina14	0.94		4.0	1	94.4	
1	9	9	8	4	3	asey	Burkina14	0.63		3.8	2	88.2	
1	9	9	8	4	4	asey	Burkina14	0.94		3.7	1	94.4	
1	9	9	8	4	5	asey	Burkina14	1.12		3.6	1	19.5	
1	9	9	8	5	2	asey	Burkina14	0.78		4.0	2	236.6	
1	9	9	8	5	3	asey	Burkina14	1.32		4.0	2	89.4	
1	9	9	8	5	4	asey	Burkina14	0.94		3.9	2	100.3	
1	9	9	8	5	5	asey	Burkina14	0.94		4.6	2	69.5	
1	10	8	5	2	2	asey	Burkina16	0.63		0.3	2	1.6	
1	10	8	5	2	3	asey	Burkina16	0.38		2.6	1	19.5	
1	10	8	5	2	4	asey	Burkina16	0.63		3.8	1	63.2	
1	10	8	5	2	5	asey	Burkina16	2.82		4.0	1	187.5	
1	10	8	5	3	2	asey	Burkina16	0.78		3.0	1	28.1	
1	10	8	5	3	3	asey	Burkina16	1.53		1.6	1	28.1	
1	10	8	5	3	4	asey	Burkina16	0.38		4.3	1	94.4	
1	10	8	5	3	5	asey	Burkina16	0.78		5.1	1	63.2	
1	10	8	5	4	2	asey	Burkina16	0.63		1.7	1	12.5	
1	10	8	5	4	3	asey	Burkina16	2.53		1.9	1	19.5	
1	10	8	5	4	4	asey	Burkina16	0.94		3.4	1	33.0	
1	10	8	5	4	5	asey	Burkina16	0.78		3.0	1	19.5	
1	10	8	5	5	2	asey	Burkina16	0.94		2.3	1	19.5	
1	10	8	5	5	3	asey	Burkina16	1.32		3.3	1	56.4	
1	10	8	5	5	4	asey	Burkina16	0.78					
1	10	8	5	5	5	asey	Burkina16	0.50		2.1	2	32.0	
1	11	7	5	2	2	asey	Burkina15	1.12		4.6	1	33.0	
1	11	7	5	2	3	asey	Burkina15	0.94		5.7	1	187.5	
1	11	7	5	2	4	asey	Burkina15	0.94		5.2	1	112.4	
1	11	7	5	2	5	asey	Burkina15	0.63		3.4	1	56.4	
1	11	7	5	3	2	asey	Burkina15	1.12		4.7	2	126.8	
1	11	7	5	3	3	asey	Burkina15	0.28					
1	11	7	5	3	4	asey	Burkina15	0.63					
1	11	7	5	3	5	asey	Burkina15	0.50					
1	11	7	5	4	2	asey	Burkina15	1.32		5.2	1	164.1	
1	11	7	5	4	3	asey	Burkina15	1.53		5.0	2	124.3	
1	11	7	5	4	4	asey	Burkina15	1.76		4.8	1	121.9	
1	11	7	5	4	5	asey	Burkina15	3.12		5.0	2	148.5	
1	11	7	5	5	2	asey	Burkina15	1.53		4.7	4	189.6	
1	11	7	5	5	3	asey	Burkina15	1.32		5.3	2	166.4	
1	11	7	5	5	4	asey	Burkina15	0.07					
1	11	7	5	5	5	asey	Burkina15	0.94		5.8	2	189.2	

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
1	12	7	8	2	2	asey	Burkina17	0.38		4.0	1	86.0	
1	12	7	8	2	3	asey	Burkina17	1.12					
1	12	7	8	2	4	asey	Burkina17	1.12		5.0	1	112.4	
1	12	7	8	2	5	asey	Burkina17	0.63		3.8	1	70.4	
1	12	7	8	3	2	asey	Burkina17	0.94					
1	12	7	8	3	3	asey	Burkina17	0.78		4.8	2	47.6	
1	12	7	8	3	4	asey	Burkina17	0.63		5.1	1	239.0	
1	12	7	8	3	5	asey	Burkina17	1.12					
1	12	7	8	4	2	asey	Burkina17	1.53		6.0	2	164.1	
1	12	7	8	4	3	asey	Burkina17	0.63		2.1	1	7.0	
1	12	7	8	4	4	asey	Burkina17	0.50		4.8	1	94.4	
1	12	7	8	4	5	asey	Burkina17	0.94		4.5	1	38.2	
1	12	7	8	5	2	asey	Burkina17	1.53		5.1	1	112.4	
1	12	7	8	5	3	asey	Burkina17	0.63		5.0	1	78.0	
1	12	7	8	5	4	asey	Burkina17	0.94		4.2	1	70.4	
1	12	7	8	5	5	asey	Burkina17	0.78		3.4	1	19.5	
2	1	9	3	2	2	aniada	Burkina04	2.53	0.27	3.7	1	117.1	37.8
2	1	9	3	2	3	aniada	Burkina04	2.82	0.31	3.5	2	259.3	105.4
2	1	9	3	2	4	aniada	Burkina04	4.13	0.50	3.4	1	147.5	50.9
2	1	9	3	2	5	aniada	Burkina04	3.78	0.45	3.3	2	191.6	71.3
2	1	9	3	3	2	aniada	Burkina04	1.12	0.09	1.8	1	9.6	1.5
2	1	9	3	3	3	aniada	Burkina04	2.26	0.23	2.5	1	98.8	30.3
2	1	9	3	3	4	aniada	Burkina04	3.78	0.45	3.7	1	153.0	53.3
2	1	9	3	3	5	aniada	Burkina04	3.44	0.40	3.8	1	175.6	63.7
2	1	9	3	4	2	aniada	Burkina04	2.82	0.31	3.0	1	121.9	39.8
2	1	9	3	4	3	aniada	Burkina04	3.12	0.35	2.4	4	114.8	36.8
2	1	9	3	4	4	aniada	Burkina04	2.82	0.31	2.4	3	50.3	12.7
2	1	9	3	4	5	aniada	Burkina04	1.32	0.12	3.6	2	77.3	22.1
2	1	9	3	5	2	aniada	Burkina04	2.26	0.23	3.2	3	158.3	55.7
2	1	9	3	5	3	aniada	Burkina04	1.76	0.17	1.7	3	42.2	10.1
2	1	9	3	5	4	aniada	Burkina04	2.00	0.20	3.0	3	89.6	26.8
2	1	9	3	5	5	aniada	Burkina04	0.78	0.06	2.9	1	74.2	21.0
2	2	8	4	2	2	aniada	Burkina05	1.76	0.17	1.0	2	4.1	0.5
2	2	8	4	2	3	aniada	Burkina05	2.26	0.23	2.5	1	25.8	5.4
2	2	8	4	2	4	aniada	Burkina05	0.94	0.07	1.0	1	3.1	0.4
2	2	8	4	2	5	aniada	Burkina05	1.53	0.14	0.5	2	22.3	4.4
2	2	8	4	3	2	aniada	Burkina05	4.13	0.50	2.9	1	35.6	8.1
2	2	8	4	3	3	aniada	Burkina05	2.53	0.27	2.2	1	4.9	0.6
2	2	8	4	3	4	aniada	Burkina05	1.76	0.17	1.9	1	9.6	1.5
2	2	8	4	3	5	aniada	Burkina05	2.53	0.27				
2	2	8	4	4	2	aniada	Burkina05	2.53	0.27	1.7	1	12.5	2.1
2	2	8	4	4	3	aniada	Burkina05	2.26	0.23	2.1	3	157.3	55.3
2	2	8	4	4	4	aniada	Burkina05	2.53	0.27	3.1	2	52.3	13.4
2	2	8	4	4	5	aniada	Burkina05	2.82	0.31	2.7	2	136.0	45.8
2	2	8	4	5	2	aniada	Burkina05	2.26	0.23	2.6	2	39.0	9.1
2	2	8	4	5	3	aniada	Burkina05	2.82	0.31	4.3	2	213.8	82.2

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
2	2	8	4	5	4	aniada	Burkina05	2.26	0.23	3.3	2	81.2	23.5
2	2	8	4	5	5	aniada	Burkina05	1.76	0.17	3.2	1	63.2	17.0
2	3	9	1	2	2	anito	Burkina06	0.50	0.03				
2	3	9	1	2	3	anito	Burkina06	1.32	0.12				
2	3	9	1	2	4	anito	Burkina06	0.50	0.03				
2	3	9	1	2	5	anito	Burkina06	0.94	0.07				
2	3	9	1	3	2	anito	Burkina06	1.32	0.12				
2	3	9	1	3	3	anito	Burkina06	1.32	0.12	0.3	1	0.2	0.0
2	3	9	1	3	4	anito	Burkina06	1.12	0.09				
2	3	9	1	3	5	anito	Burkina06	0.78	0.06	0.2	2	1.0	0.1
2	3	9	1	4	2	anito	Burkina06	0.50	0.03	2.1	3	22.0	4.4
2	3	9	1	4	3	anito	Burkina06	1.12	0.09				
2	3	9	1	4	4	anito	Burkina06	0.78	0.06				
2	3	9	1	4	5	anito	Burkina06	0.63	0.04	2.1	2	28.3	6.0
2	3	9	1	5	2	anito	Burkina06	0.78	0.06				
2	3	9	1	5	3	anito	Burkina06	1.12	0.09				
2	3	9	1	5	4	anito	Burkina06	0.94	0.07				
2	3	9	1	5	5	anito	Burkina06	0.50	0.03	2.4	2	28.3	6.0
2	4	8	1	2	2	anito	Senegal14	3.78	0.45	3.8	4	127.0	41.9
2	4	8	1	2	3	anito	Senegal14	2.53	0.27				
2	4	8	1	2	4	anito	Senegal14	2.00	0.20	1.7	1	28.1	6.0
2	4	8	1	2	5	anito	Senegal14	3.12	0.35	2.2	1	33.0	7.4
2	4	8	1	3	2	anito	Senegal14	3.78	0.45	3.3	9	145.4	49.9
2	4	8	1	3	3	anito	Senegal14	3.44	0.40				
2	4	8	1	3	4	anito	Senegal14	3.12	0.35	2.4	3	82.9	24.2
2	4	8	1	3	5	anito	Senegal14	2.53	0.27	0.4	1	7.0	1.0
2	4	8	1	4	2	anito	Senegal14	4.13	0.50				
2	4	8	1	4	3	anito	Senegal14	3.44	0.40				
2	4	8	1	4	4	anito	Senegal14	3.78	0.45				
2	4	8	1	4	5	anito	Senegal14	3.12	0.35				
2	4	8	1	5	2	anito	Senegal14	3.44	0.40	3.5	1	78.0	22.4
2	4	8	1	5	3	anito	Senegal14	1.76	0.17				
2	4	8	1	5	4	anito	Senegal14	4.49	0.56	3.9	1	69.7	19.3
2	4	8	1	5	5	anito	Senegal14	4.49	0.56	1.5	2	17.0	3.1
2	5	9	2	2	2	atora	Burkina19	0.63	0.07	3.0	3	99.6	37.2
2	5	9	2	2	3	atora	Burkina19	1.12	0.15	2.2	4	30.2	8.5
2	5	9	2	2	4	atora	Burkina19	0.63	0.07				
2	5	9	2	2	5	atora	Burkina19	0.38	0.04				
2	5	9	2	3	2	atora	Burkina19	2.00	0.30	4.8	3	370.7	188.6
2	5	9	2	3	3	atora	Burkina19	0.94	0.12	3.0		78.0	27.5
2	5	9	2	3	4	atora	Burkina19	1.53	0.21	0.0	1	0.0	
2	5	9	2	3	5	atora	Burkina19	0.78	0.09				
2	5	9	2	4	2	atora	Burkina19	3.12	0.52	4.4	2	320.2	157.4
2	5	9	2	4	3	atora	Burkina19	0.78	0.09	4.1	2	119.6	46.6
2	5	9	2	4	4	atora	Burkina19	1.53	0.21	2.2	4	36.4	10.7
2	5	9	2	4	5	atora	Burkina19	0.94	0.12	1.8	1	17.6	4.4

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
2	5	9	2	5	2	atora	Burkina19	2.00	0.30	3.8	3	248.6	115.1
2	5	9	2	5	3	atora	Burkina19	1.76	0.25	3.8	5	189.0	82.1
2	5	9	2	5	4	atora	Burkina19	2.00	0.30	0.6	3	16.4	4.0
2	5	9	2	5	5	atora	Burkina19	0.63	0.07	1.5	3	38.1	11.4
2	6	7	4	2	2	atora	Burkina02	1.32	0.18	1.8	1	8.2	1.7
2	6	7	4	2	3	atora	Burkina02	2.26	0.35	4.0	2	370.3	188.3
2	6	7	4	2	4	atora	Burkina02	0.63	0.07				
2	6	7	4	2	5	atora	Burkina02	0.78	0.09	2.8	3	71.5	24.7
2	6	7	4	3	2	atora	Burkina02	0.78	0.09	1.7	2	25.0	6.7
2	6	7	4	3	3	atora	Burkina02	0.50	0.05	1.3	2	1.0	0.1
2	6	7	4	3	4	atora	Burkina02	0.94	0.12	0.7	1	0.8	0.1
2	6	7	4	3	5	atora	Burkina02	1.32	0.18	1.7	3	13.5	3.1
2	6	7	4	4	2	atora	Burkina02	1.12	0.15	2.5	2	37.7	11.2
2	6	7	4	4	3	atora	Burkina02	0.78	0.09	1.9	3	16.5	4.0
2	6	7	4	4	4	atora	Burkina02	0.94	0.12	1.9	5	32.0	9.1
2	6	7	4	4	5	atora	Burkina02	1.12	0.15				
2	6	7	4	5	2	atora	Burkina02	0.78	0.09				
2	6	7	4	5	3	atora	Burkina02	0.50	0.05	0.7	4	2.4	0.4
2	6	7	4	5	4	atora	Burkina02	1.32	0.18	1.1	1	19.9	5.1
2	6	7	4	5	5	atora	Burkina02	1.12	0.15	2.1	1	28.1	7.8
2	7	9	4	2	2	atora	Sudan18	1.53	0.21	3.2	4	64.0	21.6
2	7	9	4	2	3	atora	Sudan18	2.26	0.35	3.0	3	103.2	38.8
2	7	9	4	2	4	atora	Sudan18	1.32	0.18	1.8	3	35.6	10.4
2	7	9	4	2	5	atora	Sudan18	1.12	0.15	2.1	3	37.1	11.0
2	7	9	4	3	2	atora	Sudan18	3.12	0.52	2.1	3	29.4	8.2
2	7	9	4	3	3	atora	Sudan18	2.00	0.30	1.9	4	42.0	12.8
2	7	9	4	3	4	atora	Sudan18	2.53	0.40				
2	7	9	4	3	5	atora	Sudan18	2.26	0.35	2.5	4	94.1	34.7
2	7	9	4	4	2	atora	Sudan18	0.63	0.07				
2	7	9	4	4	3	atora	Sudan18	1.53	0.21	2.4	3	33.8	9.8
2	7	9	4	4	4	atora	Sudan18	0.78	0.09	2.8	4	41.2	12.5
2	7	9	4	4	5	atora	Sudan18	0.94	0.12				
2	7	9	4	5	2	atora	Sudan18	0.63	0.07				
2	7	9	4	5	3	atora	Sudan18	2.26	0.35	2.6	5	44.8	13.9
2	7	9	4	5	4	atora	Sudan18	1.76	0.25	3.4	2	87.9	31.9
2	7	9	4	5	5	atora	Sudan18	1.53	0.21	2.8	6	69.7	23.9
2	8	8	3	2	2	ato	Rajasthan06	1.53	0.21				
2	8	8	3	2	3	ato	Rajasthan06	0.78	0.09	0.5	2	2.5	0.4
2	8	8	3	2	4	ato	Rajasthan06	0.63	0.07				
2	8	8	3	2	5	ato	Rajasthan06	1.32	0.18	0.3	1	1.8	0.3
2	8	8	3	3	2	ato	Rajasthan06	1.53	0.21				
2	8	8	3	3	3	ato	Rajasthan06	2.26	0.35				
2	8	8	3	3	4	ato	Rajasthan06	0.78	0.09	1.5	3	26.4	7.2
2	8	8	3	3	5	ato	Rajasthan06	0.63	0.07				
2	8	8	3	4	2	ato	Rajasthan06	1.53	0.21				
2	8	8	3	4	3	ato	Rajasthan06	1.32	0.18				

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
2	8	8	3	4	4	ato	Rajasthan06	2.26	0.35				
2	8	8	3	4	5	ato	Rajasthan06	1.53	0.21				
2	8	8	3	5	2	ato	Rajasthan06	1.12	0.15	0.6	1	17.6	4.4
2	8	8	3	5	3	ato	Rajasthan06	2.26	0.35				
2	8	8	3	5	4	ato	Rajasthan06	1.53	0.21	0.5	2	5.7	1.1
2	8	8	3	5	5	ato	Rajasthan06	1.76	0.25	1.5	2	26.5	7.3
2	9	7	1	2	2	asey	Burkina14	0.78		4.9	2	164.4	
2	9	7	1	2	3	asey	Burkina14	1.76		5.3	2	141.2	
2	9	7	1	2	4	asey	Burkina14	0.94		6.4	2	203.1	
2	9	7	1	2	5	asey	Burkina14	1.32		4.2	1	78.0	
2	9	7	1	3	2	asey	Burkina14	1.12		5.8	1	142.2	
2	9	7	1	3	3	asey	Burkina14	0.94		5.1	1	74.2	
2	9	7	1	3	4	asey	Burkina14	1.32		5.4	2	113.6	
2	9	7	1	3	5	asey	Burkina14	1.53		4.8	1	121.9	
2	9	7	1	4	2	asey	Burkina14	0.94		4.0	1	98.8	
2	9	7	1	4	3	asey	Burkina14	1.76		4.6	2	94.0	
2	9	7	1	4	4	asey	Burkina14	0.63		3.2	1	35.6	
2	9	7	1	4	5	asey	Burkina14	1.32		4.5	1	103.2	
2	9	7	1	5	2	asey	Burkina14	0.38		3.4	2	54.0	
2	9	7	1	5	3	asey	Burkina14	1.32		4.2	1	63.2	
2	9	7	1	5	4	asey	Burkina14	0.50		3.6	1	66.8	
2	9	7	1	5	5	asey	Burkina14	1.76		2.6	2	94.1	
2	10	7	3	2	2	asey	Burkina16	2.00		3.0	1	49.9	
2	10	7	3	2	3	asey	Burkina16	0.94		1.6	1	12.5	
2	10	7	3	2	4	asey	Burkina16	1.76		3.2	3	150.1	
2	10	7	3	2	5	asey	Burkina16	1.53		2.2	3	54.1	
2	10	7	3	3	2	asey	Burkina16	0.94		0.3	1	0.2	
2	10	7	3	3	3	asey	Burkina16	0.94		0.5	1	7.0	
2	10	7	3	3	4	asey	Burkina16	0.78					
2	10	7	3	3	5	asey	Burkina16	0.78		3.5	1	38.2	
2	10	7	3	4	2	asey	Burkina16	1.32					
2	10	7	3	4	3	asey	Burkina16	1.12					
2	10	7	3	4	4	asey	Burkina16	1.53		1.8	3	73.4	
2	10	7	3	4	5	asey	Burkina16	1.76		2.4	2	82.4	
2	10	7	3	5	2	asey	Burkina16	0.94					
2	10	7	3	5	3	asey	Burkina16	1.32		1.8	1	38.2	
2	10	7	3	5	4	asey	Burkina16	0.94		0.3	1	0.2	
2	10	7	3	5	5	asey	Burkina16	1.53		2.2	1	9.6	
2	11	8	2	2	2	asey	Burkina15						
2	11	8	2	2	3	asey	Burkina15	1.53		4.4	1	158.5	
2	11	8	2	2	4	asey	Burkina15	2.26		5.1	3	194.4	
2	11	8	2	2	5	asey	Burkina15	1.12		4.6	2	101.9	
2	11	8	2	3	2	asey	Burkina15	2.00		4.5	2	225.6	
2	11	8	2	3	3	asey	Burkina15	0.94					
2	11	8	2	3	4	asey	Burkina15	1.53		4.5	1	63.2	
2	11	8	2	3	5	asey	Burkina15	2.00		3.0	1	21.5	

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
2	11	8	2	4	2	asey	Burkina15	2.82		4.1	2	244.3	
2	11	8	2	4	3	asey	Burkina15	0.50		3.1	1	49.9	
2	11	8	2	4	4	asey	Burkina15	1.53		3.2	1	33.0	
2	11	8	2	4	5	asey	Burkina15	1.32		5.3	1	112.4	
2	11	8	2	5	2	asey	Burkina15	1.32		3.0	1	14.1	
2	11	8	2	5	3	asey	Burkina15	1.53		2.6	2	64.6	
2	11	8	2	5	4	asey	Burkina15	2.00		4.4	2	131.9	
2	11	8	2	5	5	asey	Burkina15	0.94					
2	12	7	2	2	2	asey	Burkina17	1.53					
2	12	7	2	2	3	asey	Burkina17	1.32					
2	12	7	2	2	4	asey	Burkina17	1.12		2.8	1	46.9	
2	12	7	2	2	5	asey	Burkina17	1.32		3.3	1	49.9	
2	12	7	2	3	2	asey	Burkina17	0.94					
2	12	7	2	3	3	asey	Burkina17	1.32		4.0	2	144.6	
2	12	7	2	3	4	asey	Burkina17	1.53					
2	12	7	2	3	5	asey	Burkina17	0.78					
2	12	7	2	4	2	asey	Burkina17	0.78		3.8	1	66.8	
2	12	7	2	4	3	asey	Burkina17	0.28					
2	12	7	2	4	4	asey	Burkina17	1.12					
2	12	7	2	4	5	asey	Burkina17	1.32		4.5	1	147.5	
2	12	7	2	5	2	asey	Burkina17	0.94		2.7	1	70.4	
2	12	7	2	5	3	asey	Burkina17	0.63		2.7	1	11.0	
2	12	7	2	5	4	asey	Burkina17	0.94		3.4	1	70.4	
2	12	7	2	5	5	asey	Burkina17	1.12		3.1	1	49.9	
3	1	4	3	2	2	aniada	Burkina04	0.63	0.04	0.9	1	3.1	0.4
3	1	4	3	2	3	aniada	Burkina04						
3	1	4	3	2	4	aniada	Burkina04	1.32	0.12	4.4	1	199.8	75.3
3	1	4	3	2	5	aniada	Burkina04	1.12	0.09	1.7	1	4.9	0.6
3	1	4	3	3	2	aniada	Burkina04	1.32	0.12				
3	1	4	3	3	3	aniada	Burkina04	2.00	0.20	1.7	2	11.9	2.0
3	1	4	3	3	4	aniada	Burkina04	1.32	0.12	0.8	1	7.0	1.0
3	1	4	3	3	5	aniada	Burkina04	1.12	0.09	2.0	1	19.5	3.7
3	1	4	3	4	2	aniada	Burkina04	0.38	0.02	3.5	2	82.7	24.1
3	1	4	3	4	3	aniada	Burkina04	0.20	0.01	1.2	1	3.1	0.4
3	1	4	3	4	4	aniada	Burkina04	0.63	0.04	2.6	2	19.5	3.7
3	1	4	3	4	5	aniada	Burkina04	0.50	0.03	3.2	2	93.8	28.4
3	1	4	3	5	2	aniada	Burkina04	2.82	0.31	3.7	2	78.0	22.4
3	1	4	3	5	3	aniada	Burkina04	1.12	0.09	0.6	1	0.8	0.1
3	1	4	3	5	4	aniada	Burkina04	1.76	0.17				
3	1	4	3	5	5	aniada	Burkina04	2.00	0.20	2.6	2	87.8	26.0
3	2	4	1	2	2	aniada	Burkina05	2.00	0.20	3.4	2	126.8	41.9
3	2	4	1	2	3	aniada	Burkina05	1.76	0.17	0.4	2	10.1	1.6
3	2	4	1	2	4	aniada	Burkina05	1.53	0.14	3.8	2	128.0	42.4
3	2	4	1	2	5	aniada	Burkina05	1.32	0.12	2.4	2	61.8	16.6
3	2	4	1	3	2	aniada	Burkina05	3.44	0.40	3.8	3	278.2	115.4
3	2	4	1	3	3	aniada	Burkina05	2.26	0.23	2.8	2	32.0	7.1

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
3	2	4	1	3	4	aniada	Burkina05	2.53	0.27	2.2	1	23.6	4.8
3	2	4	1	3	5	aniada	Burkina05	0.94	0.07	0.7	1	3.1	0.4
3	2	4	1	4	2	aniada	Burkina05	2.82	0.31	4.6	2	148.5	51.3
3	2	4	1	4	3	aniada	Burkina05	3.12	0.35	4.6	3	179.1	65.4
3	2	4	1	4	4	aniada	Burkina05	2.82	0.31	3.8	2	111.0	35.3
3	2	4	1	4	5	aniada	Burkina05	1.53	0.14	2.1	2	19.5	3.7
3	2	4	1	5	2	aniada	Burkina05	2.00	0.20	3.6	1	225.5	88.0
3	2	4	1	5	3	aniada	Burkina05	2.26	0.23				
3	2	4	1	5	4	aniada	Burkina05	3.12	0.35	4.2	3	331.9	144.9
3	2	4	1	5	5	aniada	Burkina05	4.13	0.50	3.4	2	71.2	19.9
3	3	6	4	2	2	anito	Burkina06	1.32	0.12	0.6	1	0.8	0.1
3	3	6	4	2	3	anito	Burkina06	0.63	0.04				
3	3	6	4	2	4	anito	Burkina06	1.76	0.17	2.7	1	19.5	3.7
3	3	6	4	2	5	anito	Burkina06	0.94	0.07				
3	3	6	4	3	2	anito	Burkina06	0.12	0.01				
3	3	6	4	3	3	anito	Burkina06	1.12	0.09				
3	3	6	4	3	4	anito	Burkina06	0.63	0.04	3.6	2	89.4	26.6
3	3	6	4	3	5	anito	Burkina06	0.94	0.07	3.6	1	38.2	8.9
3	3	6	4	4	2	anito	Burkina06	1.12	0.09				
3	3	6	4	4	3	anito	Burkina06	1.32	0.12	4.4	1	38.2	8.9
3	3	6	4	4	4	anito	Burkina06	1.32	0.12	2.8	1	23.6	4.8
3	3	6	4	4	5	anito	Burkina06	0.78	0.06	2.8	2	50.7	12.8
3	3	6	4	5	2	anito	Burkina06	1.53	0.14	3.8	1	121.9	39.8
3	3	6	4	5	3	anito	Burkina06	2.00	0.20	3.8	1	38.2	8.9
3	3	6	4	5	4	anito	Burkina06	4.13	0.50	4.1	2	136.0	45.8
3	3	6	4	5	5	anito	Burkina06	3.44	0.40				
3	4	4	2	2	2	anito	Senegal14	2.00	0.20	2.2	2	47.6	11.8
3	4	4	2	2	3	anito	Senegal14	2.82	0.31				
3	4	4	2	2	4	anito	Senegal14	0.63	0.04	1.7	1	3.1	0.4
3	4	4	2	2	5	anito	Senegal14	1.76	0.17				
3	4	4	2	3	2	anito	Senegal14	2.26	0.23				
3	4	4	2	3	3	anito	Senegal14	1.32	0.12	1.1	1	9.6	1.5
3	4	4	2	3	4	anito	Senegal14	1.12	0.09	3.6	3	101.4	31.4
3	4	4	2	3	5	anito	Senegal14	1.76	0.17	3.3	1	33.0	7.4
3	4	4	2	4	2	anito	Senegal14	1.32	0.12				
3	4	4	2	4	3	anito	Senegal14	0.78	0.06	3.6	1	38.2	8.9
3	4	4	2	4	4	anito	Senegal14	1.12	0.09	4.1	1	94.4	28.6
3	4	4	2	4	5	anito	Senegal14	1.53	0.14				
3	4	4	2	5	2	anito	Senegal14	3.44	0.40	4.5	1	131.9	44.0
3	4	4	2	5	3	anito	Senegal14	2.26	0.23	4.3	2	108.7	34.3
3	4	4	2	5	4	anito	Senegal14	4.49	0.56	5.6	2	180.5	66.0
3	4	4	2	5	5	anito	Senegal14	4.13	0.50	4.5	1	103.2	32.1
3	5	6	3	2	2	atora	Burkina19	1.32	0.18	3.3	2	78.0	27.5
3	5	6	3	2	3	atora	Burkina19	1.12	0.15	3.0	1	33.0	9.5
3	5	6	3	2	4	atora	Burkina19	1.32	0.18	2.1	2	71.2	24.6
3	5	6	3	2	5	atora	Burkina19	2.00	0.30	3.6	1	103.2	38.9

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
3	5	6	3	3	2	atora	Burkina19	1.32	0.18				
3	5	6	3	3	3	atora	Burkina19	1.76	0.25	2.2	1	43.9	13.5
3	5	6	3	3	4	atora	Burkina19	1.32	0.18				
3	5	6	3	3	5	atora	Burkina19	1.53	0.21				
3	5	6	3	4	2	atora	Burkina19	0.94	0.12	0.5	1	0.8	0.1
3	5	6	3	4	3	atora	Burkina19	1.53	0.21				
3	5	6	3	4	4	atora	Burkina19	2.00	0.30	2.3	2	94.6	34.9
3	5	6	3	4	5	atora	Burkina19	1.12	0.15	1.2	2	39.4	11.8
3	5	6	3	5	2	atora	Burkina19	0.28	0.03	2.2	1	19.5	5.0
3	5	6	3	5	3	atora	Burkina19	0.50	0.05				
3	5	6	3	5	4	atora	Burkina19	0.78	0.09				
3	5	6	3	5	5	atora	Burkina19	1.12	0.15				
3	6	6	2	2	2	atora	Burkina02	1.53	0.21				
3	6	6	2	2	3	atora	Burkina02	0.63	0.07				
3	6	6	2	2	4	atora	Burkina02	0.78	0.09	1.1	1	15.8	3.8
3	6	6	2	2	5	atora	Burkina02	0.94	0.12				
3	6	6	2	3	2	atora	Burkina02	1.12	0.15				
3	6	6	2	3	3	atora	Burkina02	1.12	0.15	6.0	1	7.0	1.4
3	6	6	2	3	4	atora	Burkina02	2.00	0.30	1.3	2	19.5	5.0
3	6	6	2	3	5	atora	Burkina02	0.78	0.09	1.1	1	0.8	0.1
3	6	6	2	4	2	atora	Burkina02	1.53	0.21	0.7	1	7.0	1.4
3	6	6	2	4	3	atora	Burkina02	2.00	0.30	2.6	2	19.8	5.1
3	6	6	2	4	4	atora	Burkina02	1.32	0.18	1.0	1	7.0	1.4
3	6	6	2	4	5	atora	Burkina02	0.94	0.12	0.9	2	11.9	2.7
3	6	6	2	5	2	atora	Burkina02	2.00	0.30	2.3	1	38.2	11.4
3	6	6	2	5	3	atora	Burkina02	1.53	0.21				
3	6	6	2	5	4	atora	Burkina02	2.82	0.45	1.7	1	12.5	2.9
3	6	6	2	5	5	atora	Burkina02	1.76	0.25	0.8	1	7.0	1.4
3	7	5	2	2	2	atora	Sudan18	2.26	0.35	4.4	3	129.5	51.5
3	7	5	2	2	3	atora	Sudan18	2.26	0.35	4.7		214.0	95.7
3	7	5	2	2	4	atora	Sudan18	3.12	0.52	5.8	2	209.9	93.4
3	7	5	2	2	5	atora	Sudan18	2.26	0.35				
3	7	5	2	3	2	atora	Sudan18	2.53	0.40	3.2	2	114.3	44.1
3	7	5	2	3	3	atora	Sudan18	1.76	0.25	4.9	3	216.4	97.0
3	7	5	2	3	4	atora	Sudan18	1.76	0.25	5.0	2	142.4	57.8
3	7	5	2	3	5	atora	Sudan18	1.53	0.21	2.3	2	22.8	6.0
3	7	5	2	4	2	atora	Sudan18	1.32	0.18	1.7	2	28.3	7.9
3	7	5	2	4	3	atora	Sudan18	2.00	0.30	3.5	2	89.4	32.5
3	7	5	2	4	4	atora	Sudan18	1.76	0.25	2.8	2	71.2	24.6
3	7	5	2	4	5	atora	Sudan18	2.00	0.30	1.7	2	23.6	6.3
3	7	5	2	5	2	atora	Sudan18	1.53	0.21	2.7	3	39.0	11.7
3	7	5	2	5	3	atora	Sudan18	1.32	0.18	1.2	1	7.0	1.4
3	7	5	2	5	4	atora	Sudan18	1.53	0.21	1.2	1	7.0	1.4
3	7	5	2	5	5	atora	Sudan18	1.12	0.15				
3	8	6	1	2	2	ato	Rajasthan06	1.12	0.15	0.6	1	12.5	2.9
3	8	6	1	2	3	ato	Rajasthan06	1.76	0.25	1.3	1	12.5	2.9

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
3	8	6	1	2	4	ato	Rajasthan06	0.94	0.12				
3	8	6	1	2	5	ato	Rajasthan06	0.63	0.07				
3	8	6	1	3	2	ato	Rajasthan06	0.94	0.12	1.3	1	7.0	1.4
3	8	6	1	3	3	ato	Rajasthan06	1.12	0.15				
3	8	6	1	3	4	ato	Rajasthan06	1.12	0.15				
3	8	6	1	3	5	ato	Rajasthan06	0.94	0.12				
3	8	6	1	4	2	ato	Rajasthan06	0.94	0.12	1.3	1	7.0	1.4
3	8	6	1	4	3	ato	Rajasthan06	0.63	0.07				
3	8	6	1	4	4	ato	Rajasthan06	1.12	0.15	1.3	1	3.1	0.5
3	8	6	1	4	5	ato	Rajasthan06	0.94	0.12	1.2	1	12.5	2.9
3	8	6	1	5	2	ato	Rajasthan06	0.63	0.07				
3	8	6	1	5	3	ato	Rajasthan06	0.78	0.09				
3	8	6	1	5	4	ato	Rajasthan06	0.94	0.12	1.0	2	10.1	2.2
3	8	6	1	5	5	ato	Rajasthan06	0.50	0.05	11.0	2	8.0	1.6
3	9	5	1	2	2	asey	Burkina14	0.63		1.7	1	7.0	
3	9	5	1	2	3	asey	Burkina14	0.94		2.4	1	28.1	
3	9	5	1	2	4	asey	Burkina14	0.78		1.9	2	15.6	
3	9	5	1	2	5	asey	Burkina14	1.32		2.9	2	82.9	
3	9	5	1	3	2	asey	Burkina14	0.50					
3	9	5	1	3	3	asey	Burkina14	0.63		3.8	2	40.6	
3	9	5	1	3	4	asey	Burkina14	0.63		11.0	1	3.1	
3	9	5	1	3	5	asey	Burkina14	1.76		2.8	1	86.0	
3	9	5	1	4	2	asey	Burkina14	0.94		3.4	1	23.6	
3	9	5	1	4	3	asey	Burkina14	0.78		1.2	1	4.9	
3	9	5	1	4	4	asey	Burkina14	0.38					
3	9	5	1	4	5	asey	Burkina14	0.94					
3	9	5	1	5	2	asey	Burkina14	0.12		3.6	1	33.0	
3	9	5	1	5	3	asey	Burkina14	0.50		2.3	1	12.5	
3	9	5	1	5	4	asey	Burkina14	0.38		2.2	1	12.5	
3	9	5	1	5	5	asey	Burkina14	0.94					
3	10	5	3	2	2	asey	Burkina16	1.12		5.9	2	157.6	
3	10	5	3	2	3	asey	Burkina16	0.78		3.1	1	63.2	
3	10	5	3	2	4	asey	Burkina16	0.20					
3	10	5	3	2	5	asey	Burkina16	0.94		3.2	2	76.5	
3	10	5	3	3	2	asey	Burkina16	0.38		1.7	1	15.8	
3	10	5	3	3	3	asey	Burkina16	1.32		4.6	2	101.4	
3	10	5	3	3	4	asey	Burkina16	0.50		4.0	1	94.4	
3	10	5	3	3	5	asey	Burkina16	0.94		1.2	1	7.0	
3	10	5	3	4	2	asey	Burkina16	0.50		4.3	2	128.0	
3	10	5	3	4	3	asey	Burkina16	1.12		3.4	1	38.2	
3	10	5	3	4	4	asey	Burkina16	1.32		2.2	2	32.0	
3	10	5	3	4	5	asey	Burkina16	0.50		3.5	1	28.1	
3	10	5	3	5	2	asey	Burkina16	0.38		1.0	2	16.6	
3	10	5	3	5	3	asey	Burkina16	1.32					
3	10	5	3	5	4	asey	Burkina16	1.12		4.6	2	66.3	
3	10	5	3	5	5	asey	Burkina16	0.07					

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
3	11	4	4	2	2	asey	Burkina15	0.94		3.4	1	131.9	
3	11	4	4	2	3	asey	Burkina15	1.12		3.6	1	70.4	
3	11	4	4	2	4	asey	Burkina15	0.50		3.8	1	78.0	
3	11	4	4	2	5	asey	Burkina15	0.50		2.9	1	94.4	
3	11	4	4	3	2	asey	Burkina15	0.38		4.0	1	164.1	
3	11	4	4	3	3	asey	Burkina15	0.28					
3	11	4	4	3	4	asey	Burkina15	0.38		3.2	1	56.4	
3	11	4	4	3	5	asey	Burkina15	0.12		2.8	2	30.6	
3	11	4	4	4	2	asey	Burkina15	0.78					
3	11	4	4	4	3	asey	Burkina15	1.12		3.5	2	82.9	
3	11	4	4	4	4	asey	Burkina15	0.78					
3	11	4	4	4	5	asey	Burkina15	1.32		3.5	1	49.9	
3	11	4	4	5	2	asey	Burkina15	1.53		4.6	1	131.9	
3	11	4	4	5	3	asey	Burkina15	0.78		3.8	2	126.8	
3	11	4	4	5	4	asey	Burkina15	0.94		5.0	2	142.4	
3	11	4	4	5	5	asey	Burkina15	0.63		3.1	1	63.2	
3	12	5	4	2	2	asey	Burkina17	0.78		4.4	1	94.4	
3	12	5	4	2	3	asey	Burkina17	0.50		3.6	1	19.5	
3	12	5	4	2	4	asey	Burkina17	0.38					
3	12	5	4	2	5	asey	Burkina17	0.63		2.3	1	7.0	
3	12	5	4	3	2	asey	Burkina17	0.50					
3	12	5	4	3	3	asey	Burkina17	1.32		4.0	2	107.1	
3	12	5	4	3	4	asey	Burkina17	0.78		3.9	1	38.2	
3	12	5	4	3	5	asey	Burkina17	0.94		3.6	1	49.9	
3	12	5	4	4	2	asey	Burkina17	0.63		1.7	1	12.5	
3	12	5	4	4	3	asey	Burkina17	0.94		4.4	2	144.4	
3	12	5	4	4	4	asey	Burkina17	0.63		2.8	1	19.5	
3	12	5	4	4	5	asey	Burkina17	0.50		4.8	1	38.2	
3	12	5	4	5	2	asey	Burkina17	0.63		3.1	2	43.9	
3	12	5	4	5	3	asey	Burkina17	0.50		1.0	1	3.1	
3	12	5	4	5	4	asey	Burkina17	0.94		2.9	1	19.5	
3	12	5	4	5	5	asey	Burkina17	2.53		4.6	1	94.4	
4	1	4	5	2	2	aniada	Burkina05	1.12	0.09	3.2	2	66.3	18.1
4	1	4	5	2	3	aniada	Burkina05	0.94	0.07	1.7	1	7.0	1.0
4	1	4	5	2	4	aniada	Burkina05	0.94	0.07	2.3	1	23.6	4.8
4	1	4	5	2	5	aniada	Burkina05	1.12	0.09	2.6	3	136.8	46.1
4	1	4	5	3	2	aniada	Burkina05	1.32	0.12	2.2	3	60.1	16.0
4	1	4	5	3	3	aniada	Burkina05	1.53	0.14	0.8	1	3.1	0.4
4	1	4	5	3	4	aniada	Burkina05	2.00	0.20	2.3	1	19.5	3.7
4	1	4	5	3	5	aniada	Burkina05	2.82	0.31	2.6	1	43.9	10.6
4	1	4	5	4	2	aniada	Burkina05	0.50	0.03				
4	1	4	5	4	3	aniada	Burkina05	1.12	0.09	1.0	1	3.1	0.4
4	1	4	5	4	4	aniada	Burkina05	0.50	0.03	2.3	1	33.0	7.4
4	1	4	5	4	5	aniada	Burkina05	0.50	0.03	2.8	2	91.3	27.4
4	1	4	5	5	2	aniada	Burkina05	1.76	0.17	2.4	2	43.1	10.4
4	1	4	5	5	3	aniada	Burkina05	0.94	0.07				

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
4	1	4	5	5	4	aniada	Burkina05	1.32	0.12	3.2	3	74.3	21.0
4	1	4	5	5	5	aniada	Burkina05	1.32	0.12	2.2	1	12.5	2.1
4	2	5	6	2	2	aniada	Burkina05	1.53	0.14	3.0	1	63.2	17.0
4	2	5	6	2	3	aniada	Burkina05	0.94	0.07	3.8	2	71.2	19.9
4	2	5	6	2	4	aniada	Burkina05	1.32	0.12	2.8	2	56.6	14.8
4	2	5	6	2	5	aniada	Burkina05	1.32	0.12				
4	2	5	6	3	2	aniada	Burkina05	1.32	0.12	2.4	1	12.5	2.1
4	2	5	6	3	3	aniada	Burkina05	1.53	0.14	2.4	2	37.7	8.7
4	2	5	6	3	4	aniada	Burkina05	1.12	0.09	3.0	1	33.0	7.4
4	2	5	6	3	5	aniada	Burkina05	0.50	0.03	1.3	1	7.0	1.0
4	2	5	6	4	2	aniada	Burkina05	0.94	0.07				
4	2	5	6	4	3	aniada	Burkina05	1.53	0.14	2.8	1	28.1	6.0
4	2	5	6	4	4	aniada	Burkina05	0.94	0.07	3.0	1	78.0	22.4
4	2	5	6	4	5	aniada	Burkina05	1.32	0.12	2.8	1	23.6	4.8
4	2	5	6	5	2	aniada	Burkina05	2.00	0.20	2.8	2	56.6	14.8
4	2	5	6	5	3	aniada	Burkina05	2.82	0.31	2.7	2	84.5	24.8
4	2	5	6	5	4	aniada	Burkina05	2.53	0.27	0.6	1	9.6	1.5
4	2	5	6	5	5	aniada	Burkina05	1.12	0.09	2.3	2	16.6	3.0
4	3	5	7	2	2	anito	Burkina06	2.00	0.20	4.6	2	173.6	62.8
4	3	5	7	2	3	anito	Burkina06	2.82	0.31				
4	3	5	7	2	4	anito	Burkina06	1.76	0.17	5.0	1	142.2	48.5
4	3	5	7	2	5	anito	Burkina06	4.13	0.50	5.1	1	164.1	58.4
4	3	5	7	3	2	anito	Burkina06	0.50	0.03	5.2	1	187.5	69.3
4	3	5	7	3	3	anito	Burkina06	0.38	0.02				
4	3	5	7	3	4	anito	Burkina06	2.53	0.27	5.2	1	142.2	48.5
4	3	5	7	3	5	anito	Burkina06	1.53	0.14	4.4	1	164.1	58.4
4	3	5	7	4	2	anito	Burkina06	0.94	0.07	3.6	1	43.9	10.6
4	3	5	7	4	3	anito	Burkina06	2.53	0.27	5.1	2	197.6	74.2
4	3	5	7	4	4	anito	Burkina06	2.26	0.23	4.0	2	198.6	74.7
4	3	5	7	4	5	anito	Burkina06	1.32	0.12	4.3	2	114.3	36.6
4	3	5	7	5	2	anito	Burkina06	0.78	0.06				
4	3	5	7	5	3	anito	Burkina06	2.53	0.27				
4	3	5	7	5	4	anito	Burkina06	1.12	0.09				
4	3	5	7	5	5	anito	Burkina06	0.94	0.07				
4	4	4	8	2	2	anito	Senegal14	2.00	0.20	2.9	1	28.1	6.0
4	4	4	8	2	3	anito	Senegal14	1.53	0.14				
4	4	4	8	2	4	anito	Senegal14	1.76	0.17	2.7	1	49.9	12.6
4	4	4	8	2	5	anito	Senegal14	1.12	0.09				
4	4	4	8	3	2	anito	Senegal14	1.76	0.17				
4	4	4	8	3	3	anito	Senegal14	2.82	0.31				
4	4	4	8	3	4	anito	Senegal14	1.53	0.14				
4	4	4	8	3	5	anito	Senegal14	1.53	0.14	2.2	2	43.9	10.6
4	4	4	8	4	2	anito	Senegal14	0.78	0.06				
4	4	4	8	4	3	anito	Senegal14	1.76	0.17	2.1	1	3.1	0.4
4	4	4	8	4	4	anito	Senegal14	2.82	0.31	1.0	1	0.8	0.1
4	4	4	8	4	5	anito	Senegal14	3.12	0.35	2.9	2	133.6	44.8

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
4	4	4	8	5	2	anito	Senegal14	1.76	0.17	0.7	1	3.1	0.4
4	4	4	8	5	3	anito	Senegal14	2.82	0.31				
4	4	4	8	5	4	anito	Senegal14	1.53	0.14	1.7	1	19.5	3.7
4	4	4	8	5	5	anito	Senegal14	2.00	0.20	2.1	2	40.6	9.6
4	5	6	5	2	2	atora	Burkina19	1.12	0.15	4.0	2	181.2	77.9
4	5	6	5	2	3	atora	Burkina19	0.94	0.12	3.8	2	101.4	38.0
4	5	6	5	2	4	atora	Burkina19	0.78	0.09				
4	5	6	5	2	5	atora	Burkina19	1.32	0.18	2.8	1	131.9	52.6
4	5	6	5	3	2	atora	Burkina19	2.00	0.30	3.2	1	187.5	81.2
4	5	6	5	3	3	atora	Burkina19	1.12	0.15	3.7	2	148.5	60.9
4	5	6	5	3	4	atora	Burkina19	1.32	0.18	3.2	2	66.3	22.5
4	5	6	5	3	5	atora	Burkina19	1.12	0.15	3.9	2	136.0	54.6
4	5	6	5	4	2	atora	Burkina19	1.53	0.21	2.9	1	63.2	21.2
4	5	6	5	4	3	atora	Burkina19	1.32	0.18	2.9	2	72.0	24.9
4	5	6	5	4	4	atora	Burkina19	2.26	0.35	4.0	3	235.3	107.6
4	5	6	5	4	5	atora	Burkina19	0.50	0.05	2.9	1	38.2	11.4
4	5	6	5	5	2	atora	Burkina19	1.53	0.21	3.6	2	126.4	49.9
4	5	6	5	5	3	atora	Burkina19	1.12	0.15	3.6	1	131.9	52.6
4	5	6	5	5	4	atora	Burkina19	1.53	0.21	2.6	1	43.9	13.5
4	5	6	5	5	5	atora	Burkina19	2.26	0.35	4.0	2	247.4	114.4
4	6	6	8	2	2	atora	Burkina02	0.94	0.12	0.7	1	0.8	0.1
4	6	6	8	2	3	atora	Burkina02	0.78	0.09				
4	6	6	8	2	4	atora	Burkina02	0.63	0.07				
4	6	6	8	2	5	atora	Burkina02	0.78	0.09	1.0	1	3.1	0.5
4	6	6	8	3	2	atora	Burkina02	1.12	0.15				
4	6	6	8	3	3	atora	Burkina02	1.32	0.18	1.7	2	43.9	13.5
4	6	6	8	3	4	atora	Burkina02	2.00	0.30	1.1	1	19.5	5.0
4	6	6	8	3	5	atora	Burkina02	0.63	0.07	1.3	1	7.0	1.4
4	6	6	8	4	2	atora	Burkina02	0.38	0.04				
4	6	6	8	4	3	atora	Burkina02	0.78	0.09	1.1	1	7.0	1.4
4	6	6	8	4	4	atora	Burkina02	0.78	0.09	2.5	4	39.0	11.7
4	6	6	8	4	5	atora	Burkina02	1.76	0.25	3.4	3	105.0	39.7
4	6	6	8	5	2	atora	Burkina02	0.63	0.07	2.2	1	23.6	6.3
4	6	6	8	5	3	atora	Burkina02	0.50	0.05	2.2	1	28.1	7.8
4	6	6	8	5	4	atora	Burkina02	0.94	0.12	1.3	1	3.1	0.5
4	6	6	8	5	5	atora	Burkina02	0.78	0.09	2.6	1	49.9	15.9
4	7	6	7	2	2	atora	Sudan18	0.63	0.07				
4	7	6	7	2	3	atora	Sudan18	1.53	0.21	2.1	1	12.5	2.9
4	7	6	7	2	4	atora	Sudan18	0.63	0.07				
4	7	6	7	2	5	atora	Sudan18	0.78	0.09	2.3	1	28.1	7.8
4	7	6	7	3	2	atora	Sudan18	0.63	0.07	1.5	1	19.5	5.0
4	7	6	7	3	3	atora	Sudan18	0.38	0.04				
4	7	6	7	3	4	atora	Sudan18	0.63	0.07				
4	7	6	7	3	5	atora	Sudan18	0.94	0.12	1.2	1	0.8	0.1
4	7	6	7	4	2	atora	Sudan18	0.50	0.05	0.3	1	3.1	0.5
4	7	6	7	4	3	atora	Sudan18	0.63	0.07				

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
4	7	6	7	4	4	atora	Sudan18	0.63	0.07				
4	7	6	7	4	5	atora	Sudan18	0.50	0.05	2.2	1	7.0	1.4
4	7	6	7	5	2	atora	Sudan18	0.78	0.09				
4	7	6	7	5	3	atora	Sudan18	0.63	0.07	1.2	1	9.6	2.1
4	7	6	7	5	4	atora	Sudan18	0.94	0.12	2.1	1	12.5	2.9
4	7	6	7	5	5	atora	Sudan18	0.78	0.09	1.0	1	1.8	0.3
4	8	6	6	2	2	ato	Rajasthan06	0.94	0.12	1.0	1	12.5	2.9
4	8	6	6	2	3	ato	Rajasthan06	0.78	0.09	1.7	2	29.1	8.1
4	8	6	6	2	4	ato	Rajasthan06	0.63	0.07				
4	8	6	6	2	5	ato	Rajasthan06	0.78	0.09				
4	8	6	6	3	2	ato	Rajasthan06	0.94	0.12				
4	8	6	6	3	3	ato	Rajasthan06	0.78	0.09				
4	8	6	6	3	4	ato	Rajasthan06	0.28	0.03	2.5	2	47.6	14.9
4	8	6	6	3	5	ato	Rajasthan06	0.63	0.07				
4	8	6	6	4	2	ato	Rajasthan06	0.94	0.12	1.2	1	0.8	0.1
4	8	6	6	4	3	ato	Rajasthan06	0.63	0.07	1.0	1	3.1	0.5
4	8	6	6	4	4	ato	Rajasthan06	0.78	0.09				
4	8	6	6	4	5	ato	Rajasthan06	0.63	0.07				
4	8	6	6	5	2	ato	Rajasthan06	0.50	0.05				
4	8	6	6	5	3	ato	Rajasthan06	0.63	0.07	1.7	1	9.6	2.1
4	8	6	6	5	4	ato	Rajasthan06	0.63	0.07				
4	8	6	6	5	5	ato	Rajasthan06	0.50	0.05	1.1	1	15.8	3.8
4	9	5	8	2	2	asey	Burkina14	0.63		3.8	1	103.2	
4	9	5	8	2	3	asey	Burkina14	1.12		3.3	1	49.9	
4	9	5	8	2	4	asey	Burkina14	1.76		2.3	2	14.0	
4	9	5	8	2	5	asey	Burkina14	0.94		3.3	1	38.2	
4	9	5	8	3	2	asey	Burkina14	1.32		4.0	3	119.8	
4	9	5	8	3	3	asey	Burkina14	0.94		4.3	1	49.9	
4	9	5	8	3	4	asey	Burkina14	0.63		3.1	1	28.1	
4	9	5	8	3	5	asey	Burkina14	0.38		2.4	1	12.5	
4	9	5	8	4	2	asey	Burkina14	0.78		4.0	2	88.2	
4	9	5	8	4	3	asey	Burkina14	0.94		3.8	2	140.9	
4	9	5	8	4	4	asey	Burkina14	0.50		3.0	1	28.1	
4	9	5	8	4	5	asey	Burkina14	0.63		2.8	1	28.1	
4	9	5	8	5	2	asey	Burkina14	0.94		3.0	1	38.2	
4	9	5	8	5	3	asey	Burkina14	0.78		2.8	1	63.2	
4	9	5	8	5	4	asey	Burkina14	1.32		4.2	1	103.2	
4	9	5	8	5	5	asey	Burkina14	0.63					
4	10	4	6	2	2	asey	Burkina16	0.38		2.7	1	38.2	
4	10	4	6	2	3	asey	Burkina16	1.32		3.0	2	47.6	
4	10	4	6	2	4	asey	Burkina16	0.78		1.7	2	26.5	
4	10	4	6	2	5	asey	Burkina16	0.63		1.4	1	0.8	
4	10	4	6	3	2	asey	Burkina16	0.78					
4	10	4	6	3	3	asey	Burkina16	0.28					
4	10	4	6	3	4	asey	Burkina16	0.63		6.0	1	70.4	
4	10	4	6	3	5	asey	Burkina16	0.63			4		

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
4	10	4	6	4	2	asey	Burkina16	1.53		4.0	2	93.8	
4	10	4	6	4	3	asey	Burkina16	1.53		2.2	1	12.5	
4	10	4	6	4	4	asey	Burkina16	1.32		4.6	1	78.0	
4	10	4	6	4	5	asey	Burkina16	1.12		1.2	1	7.0	
4	10	4	6	5	2	asey	Burkina16	0.63		4.6	1	121.9	
4	10	4	6	5	3	asey	Burkina16	0.78		2.6	1	28.1	
4	10	4	6	5	4	asey	Burkina16	0.63		2.3	1	12.5	
4	10	4	6	5	5	asey	Burkina16	0.63		4.0	1	78.0	
4	11	4	7	2	2	asey	Burkina15	0.78		2.6	1	12.5	
4	11	4	7	2	3	asey	Burkina15	0.94		3.4	1	49.9	
4	11	4	7	2	4	asey	Burkina15	0.50		3.0	1	43.9	
4	11	4	7	2	5	asey	Burkina15	0.94		3.8	1	56.4	
4	11	4	7	3	2	asey	Burkina15	0.94		4.0	2	66.3	
4	11	4	7	3	3	asey	Burkina15	0.78		2.8	1	19.5	
4	11	4	7	3	4	asey	Burkina15	0.63					
4	11	4	7	3	5	asey	Burkina15	0.78		1.7	1	7.0	
4	11	4	7	4	2	asey	Burkina15	1.12		3.8	1	49.9	
4	11	4	7	4	3	asey	Burkina15	0.28		5.1	1	153.0	
4	11	4	7	4	4	asey	Burkina15	2.53		3.8	1	164.1	
4	11	4	7	4	5	asey	Burkina15	3.12		3.8	1	28.1	
4	11	4	7	5	2	asey	Burkina15	0.94		3.6	1	43.9	
4	11	4	7	5	3	asey	Burkina15	0.78		5.2	1	94.4	
4	11	4	7	5	4	asey	Burkina15	0.94		4.2	1	70.4	
4	11	4	7	5	5	asey	Burkina15	0.38		4.0	1	70.4	
4	12	5	5	2	2	asey	Burkina17	0.20		3.4	2	76.5	
4	12	5	5	2	3	asey	Burkina17	0.78		2.5	2	35.3	
4	12	5	5	2	4	asey	Burkina17	0.50		2.4	1	28.1	
4	12	5	5	2	5	asey	Burkina17	0.50					
4	12	5	5	3	2	asey	Burkina17	0.50					
4	12	5	5	3	3	asey	Burkina17	0.63		4.8	1	78.0	
4	12	5	5	3	4	asey	Burkina17	0.94		2.8	1	23.6	
4	12	5	5	3	5	asey	Burkina17	0.63		3.8	1	56.4	
4	12	5	5	4	2	asey	Burkina17	1.12					
4	12	5	5	4	3	asey	Burkina17	0.63		8.0	1	121.9	
4	12	5	5	4	4	asey	Burkina17	0.78		4.0	2	45.5	
4	12	5	5	4	5	asey	Burkina17	0.94		6.4	1	56.4	
4	12	5	5	5	2	asey	Burkina17	2.53		4.8	1	153.0	
4	12	5	5	5	3	asey	Burkina17	2.82		8.4	1	199.8	
4	12	5	5	5	4	asey	Burkina17	1.12		5.6	1	164.1	
4	12	5	5	5	5	asey	Burkina17	0.78		5.3	2	99.9	
5	1	3	7	2	2	aniada	Burkina04	2.82	0.31	2.5	3	109.4	34.6
5	1	3	7	2	3	aniada	Burkina04	2.53	0.27	2.1	2	33.2	7.4
5	1	3	7	2	4	aniada	Burkina04	1.76	0.17	2.9	1	103.2	32.1
5	1	3	7	2	5	aniada	Burkina04	1.53	0.14	1.9	3	23.1	4.7
5	1	3	7	3	2	aniada	Burkina04	2.26	0.23	2.6	3	85.8	25.3
5	1	3	7	3	3	aniada	Burkina04	2.26	0.23	2.8	1	78.0	22.4

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
5	1	3	7	3	4	aniada	Burkina04	1.76	0.17	1.8	3	35.0	7.9
5	1	3	7	3	5	aniada	Burkina04	0.94	0.07	2.3	1	28.1	6.0
5	1	3	7	4	2	aniada	Burkina04	0.94	0.07	3.3	3	191.5	71.3
5	1	3	7	4	3	aniada	Burkina04	1.76	0.17	2.4	3	127.3	42.1
5	1	3	7	4	4	aniada	Burkina04	1.32	0.12	2.1	1	38.2	8.9
5	1	3	7	4	5	aniada	Burkina04	1.53	0.14	2.7	4	78.9	22.7
5	1	3	7	5	2	aniada	Burkina04	1.32	0.12	0.3	2	1.6	0.1
5	1	3	7	5	3	aniada	Burkina04	0.94	0.07	2.3	1	28.1	6.0
5	1	3	7	5	4	aniada	Burkina04	1.76	0.17	2.9	1	169.8	61.0
5	1	3	7	5	5	aniada	Burkina04	1.32	0.12	0.3	1	0.2	0.0
5	2	3	8	2	2	aniada	Burkina05	1.76	0.17	2.6	2	78.0	22.4
5	2	3	8	2	3	aniada	Burkina05	1.32	0.12	2.1	3	65.2	17.7
5	2	3	8	2	4	aniada	Burkina05	1.76	0.17	1.9	1	46.9	11.6
5	2	3	8	2	5	aniada	Burkina05	1.53	0.14	1.9	3	19.7	3.8
5	2	3	8	3	2	aniada	Burkina05	1.32	0.12	2.6	2	80.0	23.1
5	2	3	8	3	3	aniada	Burkina05	2.26	0.23	2.4	2	28.6	6.1
5	2	3	8	3	4	aniada	Burkina05	1.76	0.17	2.1	1	15.8	2.8
5	2	3	8	3	5	aniada	Burkina05	2.00	0.20	2.6	3	77.7	22.3
5	2	3	8	4	2	aniada	Burkina05	0.94	0.07	2.8	2	67.2	18.4
5	2	3	8	4	3	aniada	Burkina05	1.12	0.09	2.7	2	149.9	52.0
5	2	3	8	4	4	aniada	Burkina05	1.53	0.14	2.7	4	87.6	26.0
5	2	3	8	4	5	aniada	Burkina05	1.76	0.17	2.7	2	116.3	37.4
5	2	3	8	5	2	aniada	Burkina05	1.12	0.09	2.0	1	78.0	22.4
5	2	3	8	5	3	aniada	Burkina05	2.26	0.23				
5	2	3	8	5	4	aniada	Burkina05	1.53	0.14				
5	2	3	8	5	5	aniada	Burkina05	0.94	0.07	2.6	2	36.1	8.3
5	3	1	8	2	2	anito	Burkina19	0.94	0.07				
5	3	1	8	2	3	anito	Burkina19	0.63	0.04	1.6	5	23.6	4.8
5	3	1	8	2	4	anito	Burkina19	0.94	0.07				
5	3	1	8	2	5	anito	Burkina19	0.12	0.01	0.9	1	0.8	0.1
5	3	1	8	3	2	anito	Burkina19	0.63	0.04				
5	3	1	8	3	3	anito	Burkina19	0.94	0.07				
5	3	1	8	3	4	anito	Burkina19	0.78	0.06				
5	3	1	8	3	5	anito	Burkina19	0.94	0.07				
5	3	1	8	4	2	anito	Burkina19	0.63	0.04				
5	3	1	8	4	3	anito	Burkina19	0.50	0.03				
5	3	1	8	4	4	anito	Burkina19	0.94	0.07				
5	3	1	8	4	5	anito	Burkina19	0.94	0.07				
5	3	1	8	5	2	anito	Burkina19	0.78	0.06				
5	3	1	8	5	3	anito	Burkina19	0.94	0.07	1.5	2	1.0	0.1
5	3	1	8	5	4	anito	Burkina19	0.63	0.04				
5	3	1	8	5	5	anito	Burkina19	0.78	0.06				
5	4	2	5	2	2	anito	Senegal14	2.00	0.20	0.5		0.8	0.1
5	4	2	5	2	3	anito	Senegal14	1.53	0.14	1.2	3	54.9	14.2
5	4	2	5	2	4	anito	Senegal14	3.44	0.40	2.1	5	8.6	1.3
5	4	2	5	2	5	anito	Senegal14	3.12	0.35	3.5	2	103.4	32.2

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
5	4	2	5	3	2	anito	Senegal14	1.12	0.09	3.2	4	125.5	41.3
5	4	2	5	3	3	anito	Senegal14	0.63	0.04				
5	4	2	5	3	4	anito	Senegal14	3.44	0.40	2.5	4	72.0	20.2
5	4	2	5	3	5	anito	Senegal14	2.00	0.20	3.1	4	80.5	23.3
5	4	2	5	4	2	anito	Senegal14	0.78	0.06				
5	4	2	5	4	3	anito	Senegal14	2.82	0.31				
5	4	2	5	4	4	anito	Senegal14	1.32	0.12	2.6	1	38.2	8.9
5	4	2	5	4	5	anito	Senegal14	1.53	0.14	2.7	2	132.7	44.4
5	4	2	5	5	2	anito	Senegal14	2.26	0.23	1.5	3	7.1	1.0
5	4	2	5	5	3	anito	Senegal14	1.76	0.17	3.8	5	168.8	60.6
5	4	2	5	5	4	anito	Senegal14	2.53	0.27	2.9	2	99.7	30.7
5	4	2	5	5	5	anito	Senegal14	3.44	0.40	3.3	2	67.6	18.6
5	5	2	7	2	2	atora	Burkina19	0.78	0.09	1.5	3	6.1	1.2
5	5	2	7	2	3	atora	Burkina19	0.94	0.12	0.3	1	0.8	0.1
5	5	2	7	2	4	atora	Burkina19	0.94	0.12	2.1	5	58.0	19.1
5	5	2	7	2	5	atora	Burkina19	1.12	0.15	0.3	3	9.6	2.1
5	5	2	7	3	2	atora	Burkina19	0.78	0.09	1.5	4	11.6	2.6
5	5	2	7	3	3	atora	Burkina19	0.63	0.07	1.5	4	12.1	2.8
5	5	2	7	3	4	atora	Burkina19	1.12	0.15	2.2	2	82.9	29.7
5	5	2	7	3	5	atora	Burkina19	0.94	0.12	1.7	4	15.8	3.8
5	5	2	7	4	2	atora	Burkina19	1.53	0.21	1.7	3	17.7	4.4
5	5	2	7	4	3	atora	Burkina19	0.28	0.03				
5	5	2	7	4	4	atora	Burkina19	1.76	0.25	0.3	5	4.0	0.7
5	5	2	7	4	5	atora	Burkina19	1.53	0.21	0.4	3	10.2	2.2
5	5	2	7	5	2	atora	Burkina19	0.63	0.07	0.5	4	7.9	1.6
5	5	2	7	5	3	atora	Burkina19	1.53	0.21	1.5	4	13.5	3.2
5	5	2	7	5	4	atora	Burkina19	0.50	0.05	0.3	5	2.8	0.4
5	5	2	7	5	5	atora	Burkina19	1.76	0.25	2.7	3	178.1	76.2
5	6	2	6	2	2	atora	Burkina02	0.94	0.12				
5	6	2	6	2	3	atora	Burkina02	1.12	0.15	2.6	1	103.2	38.9
5	6	2	6	2	4	atora	Burkina02	1.32	0.18	1.8	1	15.8	3.8
5	6	2	6	2	5	atora	Burkina02	1.53	0.21				
5	6	2	6	3	2	atora	Burkina02	0.78	0.09	2.7	2	111.4	42.7
5	6	2	6	3	3	atora	Burkina02	1.32	0.18	2.0	4	22.3	5.9
5	6	2	6	3	4	atora	Burkina02	0.78	0.09				
5	6	2	6	3	5	atora	Burkina02						
5	6	2	6	4	2	atora	Burkina02	2.26	0.35	0.7	2	4.7	0.9
5	6	2	6	4	3	atora	Burkina02	0.78	0.09				
5	6	2	6	4	4	atora	Burkina02	0.63	0.07	2.1	3	46.5	14.5
5	6	2	6	4	5	atora	Burkina02	0.20	0.02				
5	6	2	6	5	2	atora	Burkina02	0.63	0.07	1.5	2	11.3	2.5
5	6	2	6	5	3	atora	Burkina02	1.53	0.21				
5	6	2	6	5	4	atora	Burkina02	1.76	0.25	1.8	4	38.7	11.6
5	6	2	6	5	5	atora	Burkina02	1.53	0.21				
5	7	3	5	2	2	atora	Sudan18	1.53	0.21	0.7	6	5.1	1.0
5	7	3	5	2	3	atora	Sudan18	0.50	0.05	1.5	2	23.5	6.2

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
5	7	3	5	2	4	atora	Sudan18	0.63	0.07				
5	7	3	5	2	5	atora	Sudan18	1.53	0.21	2.3	5	51.6	16.5
5	7	3	5	3	2	atora	Sudan18	0.78	0.09	2.0	5	35.0	10.2
5	7	3	5	3	3	atora	Sudan18	0.50	0.05	1.9	4	35.3	10.3
5	7	3	5	3	4	atora	Sudan18	0.94	0.12	0.7	3	10.8	2.4
5	7	3	5	3	5	atora	Sudan18	0.38	0.04	0.6	1	0.4	0.0
5	7	3	5	4	2	atora	Sudan18	0.50	0.05	1.5	3	10.5	2.3
5	7	3	5	4	3	atora	Sudan18	0.28	0.03	2.1	2	51.2	16.3
5	7	3	5	4	4	atora	Sudan18	0.38	0.04	2.1	2	28.9	8.1
5	7	3	5	4	5	atora	Sudan18	0.94	0.12	1.5	4	59.2	19.6
5	7	3	5	5	2	atora	Sudan18	0.63	0.07	2.5	1	49.9	15.9
5	7	3	5	5	3	atora	Sudan18	0.94	0.12	1.8	3	25.0	6.7
5	7	3	5	5	4	atora	Sudan18	0.63	0.07	1.9	4	22.9	6.0
5	7	3	5	5	5	atora	Sudan18	0.50	0.05	2.3	2	54.9	17.8
5	8	1	6	2	2	ato	Rajasthan06	2.26	0.35	2.5	4	46.1	14.4
5	8	1	6	2	3	ato	Rajasthan06	4.49	0.81	2.3	2	50.8	16.2
5	8	1	6	2	4	ato	Rajasthan06	2.53	0.40				
5	8	1	6	2	5	ato	Rajasthan06	3.12	0.52	0.7	3	11.5	2.6
5	8	1	6	3	2	ato	Rajasthan06	0.94	0.12	2.4	2	28.9	8.1
5	8	1	6	3	3	ato	Rajasthan06	0.63	0.07				
5	8	1	6	3	4	ato	Rajasthan06	0.94	0.12				
5	8	1	6	3	5	ato	Rajasthan06	0.78	0.09	0.7	4	6.5	1.3
5	8	1	6	4	2	ato	Rajasthan06	0.78	0.09	0.6	3	1.8	0.3
5	8	1	6	4	3	ato	Rajasthan06	2.26	0.35	0.5	1	0.2	0.0
5	8	1	6	4	4	ato	Rajasthan06	0.94	0.12				
5	8	1	6	4	5	ato	Rajasthan06	1.12	0.15				
5	8	1	6	5	2	ato	Rajasthan06	1.12	0.15				
5	8	1	6	5	3	ato	Rajasthan06	0.63	0.07	0.7	1	4.0	0.7
5	8	1	6	5	4	ato	Rajasthan06	1.53	0.21	2.9	3	12.5	2.9
5	8	1	6	5	5	ato	Rajasthan06	0.63	0.07				
5	9	3	6	2	2	asey	Burkina14	2.26		3.7	4	73.4	
5	9	3	6	2	3	asey	Burkina14	0.63		3.3	3	112.8	
5	9	3	6	2	4	asey	Burkina14	0.63		3.6	1	63.2	
5	9	3	6	2	5	asey	Burkina14	0.50		3.4	2	98.5	
5	9	3	6	3	2	asey	Burkina14	0.50		4.2	1	112.4	
5	9	3	6	3	3	asey	Burkina14	0.63		3.5	1	78.0	
5	9	3	6	3	4	asey	Burkina14	1.32		2.9	1	78.0	
5	9	3	6	3	5	asey	Burkina14	0.63		3.4	2	133.5	
5	9	3	6	4	2	asey	Burkina14	0.63					
5	9	3	6	4	3	asey	Burkina14	0.38		2.6	2	45.3	
5	9	3	6	4	4	asey	Burkina14	0.63		2.7	1	12.5	
5	9	3	6	4	5	asey	Burkina14	0.50		3.8	2	101.4	
5	9	3	6	5	2	asey	Burkina14	1.32		3.9	1	126.9	
5	9	3	6	5	3	asey	Burkina14	0.63		4.6	1	131.9	
5	9	3	6	5	4	asey	Burkina14	0.28		2.2	3	51.6	
5	9	3	6	5	5	asey	Burkina14	0.38		3.7	2	79.3	

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
5	10	1	7	2	2	asey	Burkina16	0.78		3.9	3	176.5	
5	10	1	7	2	3	asey	Burkina16	0.63		3.9	1	193.6	
5	10	1	7	2	4	asey	Burkina16	0.78		4.5	2	121.9	
5	10	1	7	2	5	asey	Burkina16	1.12		4.2	1	46.9	
5	10	1	7	3	2	asey	Burkina16	2.26		3.7	1	63.2	
5	10	1	7	3	3	asey	Burkina16	1.76		4.3	1	175.6	
5	10	1	7	3	4	asey	Burkina16	2.00		6.7	3	230.8	
5	10	1	7	3	5	asey	Burkina16	1.12		5.3	1	103.2	
5	10	1	7	4	2	asey	Burkina16	0.50		7.0	3	254.6	
5	10	1	7	4	3	asey	Burkina16	2.53		2.9	4	54.8	
5	10	1	7	4	4	asey	Burkina16	2.00		6.5	2	252.9	
5	10	1	7	4	5	asey	Burkina16	1.76		3.6	2	106.3	
5	10	1	7	5	2	asey	Burkina16	1.12		5.0	3	364.6	
5	10	1	7	5	3	asey	Burkina16	2.26		4.6	1	147.5	
5	10	1	7	5	4	asey	Burkina16	1.76		5.2	1	212.5	
5	10	1	7	5	5	asey	Burkina16	1.12		4.6	2	103.1	
5	11	2	8	2	2	asey	Burkina15	0.78		2.6	2	34.6	
5	11	2	8	2	3	asey	Burkina15	0.50		2.1	1	12.5	
5	11	2	8	2	4	asey	Burkina15	0.38		3.1	1	23.6	
5	11	2	8	2	5	asey	Burkina15	0.78		2.4	2	16.9	
5	11	2	8	3	2	asey	Burkina15	0.38		2.2	2	31.8	
5	11	2	8	3	3	asey	Burkina15	0.63		3.0	1	86.0	
5	11	2	8	3	4	asey	Burkina15	0.38		2.7	1	21.5	
5	11	2	8	3	5	asey	Burkina15	0.28		1.9	2	16.6	
5	11	2	8	4	2	asey	Burkina15	2.00		3.6	1	53.1	
5	11	2	8	4	3	asey	Burkina15	0.50		2.3	1	8.2	
5	11	2	8	4	4	asey	Burkina15	0.63		2.7	2	32.5	
5	11	2	8	4	5	asey	Burkina15	0.63		3.6	1	25.8	
5	11	2	8	5	2	asey	Burkina15	2.26		1.5	1	7.0	
5	11	2	8	5	3	asey	Burkina15	1.12		2.5	1	30.5	
5	11	2	8	5	4	asey	Burkina15	1.76					
5	11	2	8	5	5	asey	Burkina15	2.00		3.6	1	46.9	
5	12	1	5	2	2	asey	Burkina17	1.53		0.9	1	0.2	
5	12	1	5	2	3	asey	Burkina17	0.78		3.6	1	126.9	
5	12	1	5	2	4	asey	Burkina17	0.94					
5	12	1	5	2	5	asey	Burkina17	0.78					
5	12	1	5	3	2	asey	Burkina17	1.12		3.2	2	32.0	
5	12	1	5	3	3	asey	Burkina17	2.26		3.6	1	56.4	
5	12	1	5	3	4	asey	Burkina17	0.78		1.5	3	2.7	
5	12	1	5	3	5	asey	Burkina17	0.50		2.7	2	67.5	
5	12	1	5	4	2	asey	Burkina17	0.78		1.7	2	5.7	
5	12	1	5	4	3	asey	Burkina17	0.94					
5	12	1	5	4	4	asey	Burkina17	0.50					
5	12	1	5	4	5	asey	Burkina17	0.78					
5	12	1	5	5	2	asey	Burkina17	1.32		4.3	1	59.7	
5	12	1	5	5	3	asey	Burkina17	1.12					

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Spe-cies	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
5	12	1	5	5	4	asey	Burkina17	0.94		2.9	1	30.5	
5	12	1	5	5	5	asey	Burkina17	0.78		3.1	3	68.7	
6	1	2	4	2	2	aniada	Burkina04	1.53	0.14	3.7	2	129.2	42.9
6	1	2	4	2	3	aniada	Burkina04	2.26	0.23	2.7	3	150.5	52.2
6	1	2	4	2	4	aniada	Burkina04	1.53	0.14	0.4	1	0.8	0.1
6	1	2	4	2	5	aniada	Burkina04	1.76	0.17	2.7	1	103.2	32.1
6	1	2	4	3	2	aniada	Burkina04	1.53	0.14	0.4	1	1.6	0.1
6	1	2	4	3	3	aniada	Burkina04	1.76	0.17	2.7	1	82.0	23.8
6	1	2	4	3	4	aniada	Burkina04	1.12	0.09				
6	1	2	4	3	5	aniada	Burkina04	2.26	0.23	2.1	1	19.5	3.7
6	1	2	4	4	2	aniada	Burkina04	1.76	0.17				
6	1	2	4	4	3	aniada	Burkina04	2.26	0.23				
6	1	2	4	4	4	aniada	Burkina04	1.76	0.17	2.8	2	128.0	42.4
6	1	2	4	4	5	aniada	Burkina04	2.00	0.20				
6	1	2	4	5	2	aniada	Burkina04	2.00	0.20	2.9	2	52.3	13.4
6	1	2	4	5	3	aniada	Burkina04	2.82	0.31	2.7	2	59.7	15.8
6	1	2	4	5	4	aniada	Burkina04	2.82	0.31	2.6	2	54.8	14.2
6	1	2	4	5	5	aniada	Burkina04	2.26	0.23	2.3	1	53.1	13.6
6	2	1	3	2	2	aniada	Burkina05	0.78	0.06	3.8	2	208.0	79.3
6	2	1	3	2	3	aniada	Burkina05	0.94	0.07	4.2	4	327.4	142.4
6	2	1	3	2	4	aniada	Burkina05	0.38	0.02	4.7	2	173.6	62.8
6	2	1	3	2	5	aniada	Burkina05	1.12	0.09	4.4	3	212.0	81.3
6	2	1	3	3	2	aniada	Burkina05	0.94	0.07	4.2	1	187.5	69.3
6	2	1	3	3	3	aniada	Burkina05	2.53	0.27	4.7	1	193.6	72.3
6	2	1	3	3	4	aniada	Burkina05	2.26	0.23	4.2	2	172.1	62.1
6	2	1	3	3	5	aniada	Burkina05	3.12	0.35	3.8	2	91.0	27.3
6	2	1	3	4	2	aniada	Burkina05	0.78	0.06	4.3	1	169.8	61.0
6	2	1	3	4	3	aniada	Burkina05	2.53	0.27	4.7	2	309.2	132.3
6	2	1	3	4	4	aniada	Burkina05	2.00	0.20	4.9	3	284.5	118.8
6	2	1	3	4	5	aniada	Burkina05	2.82	0.31	3.2	2	55.1	14.3
6	2	1	3	5	2	aniada	Burkina05	3.78	0.45	3.6	2	133.6	44.8
6	2	1	3	5	3	aniada	Burkina05	3.12	0.35	3.8	2	165.8	59.2
6	2	1	3	5	4	aniada	Burkina05	2.26	0.23	3.6	1	90.2	27.0
6	2	1	3	5	5	aniada	Burkina05	2.26	0.23	3.6	1	239.0	94.9
6	3	1	4	2	2	anito	Burkina06	1.32	0.12	1.8	1	8.2	1.2
6	3	1	4	2	3	anito	Burkina06	0.78	0.06				
6	3	1	4	2	4	anito	Burkina06	0.38	0.02				
6	3	1	4	2	5	anito	Burkina06	0.63	0.04				
6	3	1	4	3	2	anito	Burkina06	1.76	0.17	0.3	1	0.8	0.1
6	3	1	4	3	3	anito	Burkina06	0.63	0.04	1.5	5	15.7	2.8
6	3	1	4	3	4	anito	Burkina06	0.78	0.06	2.4	2	59.7	15.8
6	3	1	4	3	5	anito	Burkina06	0.94	0.07				
6	3	1	4	4	2	anito	Burkina06	0.50	0.03				
6	3	1	4	4	3	anito	Burkina06	0.63	0.04	1.5	2	3.2	0.4
6	3	1	4	4	4	anito	Burkina06	0.38	0.02	2.3	3	29.1	6.3
6	3	1	4	4	5	anito	Burkina06	0.28	0.02				

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
6	3	1	4	5	2	anito	Burkina06	1.32	0.12	2.8	3	24.4	5.0
6	3	1	4	5	3	anito	Burkina06	0.78	0.06				
6	3	1	4	5	4	anito	Burkina06	0.78	0.06				
6	3	1	4	5	5	anito	Burkina06	0.94	0.07				
6	4	2	3	2	2	anito	Senegal14	0.94	0.07	1.6	3	23.1	4.7
6	4	2	3	2	3	anito	Senegal14	1.76	0.17	2.7	3	56.6	14.8
6	4	2	3	2	4	anito	Senegal14	3.44	0.40				
6	4	2	3	2	5	anito	Senegal14	2.00	0.20	1.9	5	33.6	7.5
6	4	2	3	3	2	anito	Senegal14	1.53	0.14	2.5	2	68.5	18.9
6	4	2	3	3	3	anito	Senegal14	1.32	0.12	1.6	1	8.2	1.2
6	4	2	3	3	4	anito	Senegal14	1.32	0.12				
6	4	2	3	3	5	anito	Senegal14	2.26	0.23				
6	4	2	3	4	2	anito	Senegal14	2.26	0.23	2.6	4	92.2	27.7
6	4	2	3	4	3	anito	Senegal14	4.13	0.50				
6	4	2	3	4	4	anito	Senegal14	2.26	0.23	2.9	4	95.9	29.2
6	4	2	3	4	5	anito	Senegal14	2.53	0.27	2.9	2	115.2	37.0
6	4	2	3	5	2	anito	Senegal14	2.53	0.27				
6	4	2	3	5	3	anito	Senegal14	2.26	0.23	1.5	1	4.9	0.6
6	4	2	3	5	4	anito	Senegal14	2.53	0.27	0.6	3	2.3	0.2
6	4	2	3	5	5	anito	Senegal14	2.26	0.23	1.7	1	23.6	4.8
6	5	3	1	2	2	atora	Burkina19	0.50	0.05	1.7	2	26.8	7.3
6	5	3	1	2	3	atora	Burkina19	1.76	0.25				
6	5	3	1	2	4	atora	Burkina19	0.63	0.07	0.1		0.0	0.0
6	5	3	1	2	5	atora	Burkina19	2.82	0.45	2.8	3	172.9	73.5
6	5	3	1	3	2	atora	Burkina19	1.76	0.25	3.4	3	91.2	33.4
6	5	3	1	3	3	atora	Burkina19	1.53	0.21	2.5	2	111.0	42.5
6	5	3	1	3	4	atora	Burkina19	1.76	0.25	3.4	2	74.0	25.8
6	5	3	1	3	5	atora	Burkina19	2.53	0.40	2.6	2	76.9	27.0
6	5	3	1	4	2	atora	Burkina19	1.12	0.15	3.0	3	138.8	56.0
6	5	3	1	4	3	atora	Burkina19	0.94	0.12	3.2	2	119.1	46.4
6	5	3	1	4	4	atora	Burkina19	1.76	0.25				
6	5	3	1	4	5	atora	Burkina19	0.63	0.07	2.2	2	35.1	10.3
6	5	3	1	5	2	atora	Burkina19	0.94	0.12	2.6	3	87.0	31.5
6	5	3	1	5	3	atora	Burkina19	0.78	0.09	3.3	2	162.4	68.0
6	5	3	1	5	4	atora	Burkina19	0.94	0.12	1.7	5	47.8	15.0
6	5	3	1	5	5	atora	Burkina19	0.78	0.09	2.7	2	97.2	36.1
6	6	3	3	2	2	atora	Burkina02	0.50	0.05	0.5	2	7.3	1.5
6	6	3	3	2	3	atora	Burkina02	0.63	0.07	2.1	4	30.1	8.5
6	6	3	3	2	4	atora	Burkina02	0.50	0.05	0.4	2	4.9	0.9
6	6	3	3	2	5	atora	Burkina02	1.53	0.21	1.8	2	29.8	8.4
6	6	3	3	3	2	atora	Burkina02	0.20	0.02				
6	6	3	3	3	3	atora	Burkina02	0.63	0.07				
6	6	3	3	3	4	atora	Burkina02	0.38	0.04				
6	6	3	3	3	5	atora	Burkina02	0.94	0.12	0.5	3	6.6	1.3
6	6	3	3	4	2	atora	Burkina02	0.63	0.07				
6	6	3	3	4	3	atora	Burkina02	0.50	0.05	1.8	3	43.1	13.2

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Spe-cies	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
6	6	3	3	4	4	atora	Burkina02	0.63	0.07	1.6	3	10.6	2.3
6	6	3	3	4	5	atora	Burkina02	0.94	0.12	3.1	3	74.6	26.0
6	6	3	3	5	2	atora	Burkina02	0.63	0.07	2.6	2	56.2	18.4
6	6	3	3	5	3	atora	Burkina02	0.78	0.09	2.7	2	98.5	36.7
6	6	3	3	5	4	atora	Burkina02	0.63	0.07	1.7	1	15.8	3.8
6	6	3	3	5	5	atora	Burkina02	0.63	0.07	0.4	1	1.8	0.3
6	7	3	4	2	2	atora	Sudan18	1.76	0.25	1.5	3	49.0	15.5
6	7	3	4	2	3	atora	Sudan18	1.53	0.21	2.2	2	32.0	9.1
6	7	3	4	2	4	atora	Sudan18	2.00	0.30	2.5	1	90.2	32.9
6	7	3	4	2	5	atora	Sudan18	0.50	0.05	2.9	3	120.1	46.9
6	7	3	4	3	2	atora	Sudan18	0.94	0.12	1.9	3	44.8	13.9
6	7	3	4	3	3	atora	Sudan18	2.00	0.30	1.5	3	15.8	3.8
6	7	3	4	3	4	atora	Sudan18	0.94	0.12	2.3	3	59.4	19.6
6	7	3	4	3	5	atora	Sudan18	0.50	0.05	1.8	2	24.0	6.4
6	7	3	4	4	2	atora	Sudan18	0.63	0.07	2.9	4	87.8	31.8
6	7	3	4	4	3	atora	Sudan18	0.50	0.05	2.2	5	27.8	7.7
6	7	3	4	4	4	atora	Sudan18	0.63	0.07	1.5	3	12.1	2.8
6	7	3	4	4	5	atora	Sudan18	0.94	0.12	1.5	3	21.8	5.7
6	7	3	4	5	2	atora	Sudan18	0.78	0.09	1.6	3	11.5	2.6
6	7	3	4	5	3	atora	Sudan18	0.50	0.05	0.3	1	0.8	0.1
6	7	3	4	5	4	atora	Sudan18	0.38	0.04				
6	7	3	4	5	5	atora	Sudan18	0.50	0.05				
6	8	2	1	2	2	ato	Rajasthan06	0.63	0.07				
6	8	2	1	2	3	ato	Rajasthan06	1.12	0.15	3.2	4	89.9	32.8
6	8	2	1	2	4	ato	Rajasthan06	0.63	0.07				
6	8	2	1	2	5	ato	Rajasthan06	0.38	0.04	1.3	2	10.1	2.2
6	8	2	1	3	2	ato	Rajasthan06	0.63	0.07	1.1	2	5.7	1.1
6	8	2	1	3	3	ato	Rajasthan06	0.94	0.12	0.7	6	4.3	0.8
6	8	2	1	3	4	ato	Rajasthan06	1.12	0.15	3.6	2	119.6	46.6
6	8	2	1	3	5	ato	Rajasthan06	0.94	0.12	1.9	3	31.4	8.9
6	8	2	1	4	2	ato	Rajasthan06	0.94	0.12	0.9	1	3.1	0.5
6	8	2	1	4	3	ato	Rajasthan06	2.00	0.30	0.9	1	3.1	0.5
6	8	2	1	4	4	ato	Rajasthan06	1.53	0.21	2.2	3	28.1	7.8
6	8	2	1	4	5	ato	Rajasthan06	0.94	0.12				
6	8	2	1	5	2	ato	Rajasthan06	2.00	0.30				
6	8	2	1	5	3	ato	Rajasthan06	1.53	0.21	2.3	1	33.0	9.5
6	8	2	1	5	4	ato	Rajasthan06	2.53	0.40	0.9	2	1.6	0.2
6	8	2	1	5	5	ato	Rajasthan06	0.20	0.02				
6	9	3	2	2	2	asey	Burkina14	2.00		3.8	2	186.6	
6	9	3	2	2	3	asey	Burkina14	2.26					
6	9	3	2	2	4	asey	Burkina14	0.94		3.9	1	131.9	
6	9	3	2	2	5	asey	Burkina14	0.63		2.7	1	23.6	
6	9	3	2	3	2	asey	Burkina14	1.76		2.9	2	38.3	
6	9	3	2	3	3	asey	Burkina14	0.63		3.5	2	105.0	
6	9	3	2	3	4	asey	Burkina14	0.50		2.8	1	23.6	
6	9	3	2	3	5	asey	Burkina14	0.78		0.9	1	1.8	

								1989 data		1999 data			
Block	Plot	Plotx	Ploty	Treex	Treey	Species	Provenance	Basal area	Tree dry weight	Height	Number of stems	Basal area	Tree dry weight
								$cm^2\ tree^{-1}$	$kg\ tree^{-1}$	m	$no.\ tree^{-1}$	$cm^2\ tree^{-1}$	$kg\ tree^{-1}$
6	9	3	2	4	2	asey	Burkina14	1.12		1.5	1	7.0	
6	9	3	2	4	3	asey	Burkina14	0.94					
6	9	3	2	4	4	asey	Burkina14	0.78		3.6	1	33.0	
6	9	3	2	4	5	asey	Burkina14	0.63		4.7	1	121.9	
6	9	3	2	5	2	asey	Burkina14	0.94		2.8	2	33.6	
6	9	3	2	5	3	asey	Burkina14	0.94		3.9	1	107.7	
6	9	3	2	5	4	asey	Burkina14	3.78					
6	9	3	2	5	5	asey	Burkina14	1.12		0.1	2	35.3	
6	10	1	1	2	2	asey	Burkina16	0.78		1.0	1	3.1	
6	10	1	1	2	3	asey	Burkina16	1.12		1.7	1	7.0	
6	10	1	1	2	4	asey	Burkina16	0.28		3.1	1	142.2	
6	10	1	1	2	5	asey	Burkina16	0.94		2.4	2	31.6	
6	10	1	1	3	2	asey	Burkina16	0.50		4.0	2	100.3	
6	10	1	1	3	3	asey	Burkina16	0.63		2.4	2	26.7	
6	10	1	1	3	4	asey	Burkina16	0.38					
6	10	1	1	3	5	asey	Burkina16	1.12					
6	10	1	1	4	2	asey	Burkina16	1.53		3.1	1	49.9	
6	10	1	1	4	3	asey	Burkina16	0.50		3.5	3	91.5	
6	10	1	1	4	4	asey	Burkina16	0.78					
6	10	1	1	4	5	asey	Burkina16	0.28		1.9	1	12.5	
6	10	1	1	5	2	asey	Burkina16	0.63		3.7	1	38.2	
6	10	1	1	5	3	asey	Burkina16	0.78		3.8	2	82.1	
6	10	1	1	5	4	asey	Burkina16	0.78		1.7	2	18.9	
6	10	1	1	5	5	asey	Burkina16	0.94		3.1	1	63.2	
6	11	2	2	2	2	asey	Burkina15	0.78		1.4	1	12.5	
6	11	2	2	2	3	asey	Burkina15	0.94		2.8	1	28.1	
6	11	2	2	2	4	asey	Burkina15	0.78		2.8	1	41.0	
6	11	2	2	2	5	asey	Burkina15	0.28		4.2	1	74.2	
6	11	2	2	3	2	asey	Burkina15	0.63		3.2	2	97.0	
6	11	2	2	3	3	asey	Burkina15	1.12					
6	11	2	2	3	4	asey	Burkina15	0.50		1.9	1	9.6	
6	11	2	2	3	5	asey	Burkina15	0.63					
6	11	2	2	4	2	asey	Burkina15	0.94		1.7	1	8.2	
6	11	2	2	4	3	asey	Burkina15	0.63					
6	11	2	2	4	4	asey	Burkina15	0.38		2.5	1	66.8	
6	11	2	2	4	5	asey	Burkina15	0.63		3.2	1	107.7	
6	11	2	2	5	2	asey	Burkina15	0.63		4.3	2	125.9	
6	11	2	2	5	3	asey	Burkina15	0.63		2.4	2	37.5	
6	11	2	2	5	4	asey	Burkina15	0.78					
6	11	2	2	5	5	asey	Burkina15	1.76		2.0	1	17.6	
6	12	1	2	2	2	asey	Burkina17	1.12					
6	12	1	2	2	3	asey	Burkina17	0.50		2.8	1	41.0	
6	12	1	2	2	4	asey	Burkina17	2.00		2.2	1	15.8	
6	12	1	2	2	5	asey	Burkina17	0.63		3.8	1	49.9	
6	12	1	2	3	2	asey	Burkina17	0.63		2.7	2	69.1	
6	12	1	2	3	3	asey	Burkina17	0.63		1.8	2	39.0	

								1989 data		1999 data			
Block	**Plot**	**Plotx**	**Ploty**	**Treex**	**Treey**	**Species**	**Provenance**	**Basal area**	**Tree dry weight**	**Height**	**Number of stems**	**Basal area**	**Tree dry weight**
								$cm^2\ tree^{-1}$	**$kg\ tree^{-1}$**	**m**	**$no.\ tree^{-1}$**	**$cm^2\ tree^{-1}$**	**$kg\ tree^{-1}$**
6	12	1	2	3	4	asey	Burkina17	2.00		2.3	1	12.5	
6	12	1	2	3	5	asey	Burkina17	0.63		2.6	1	41.0	
6	12	1	2	4	2	asey	Burkina17	0.38		2.5	2	130.6	
6	12	1	2	4	3	asey	Burkina17	0.78		2.7	2	61.0	
6	12	1	2	4	4	asey	Burkina17	0.63		1.6	1	4.9	
6	12	1	2	4	5	asey	Burkina17	0.78		2.2	2	25.0	
6	12	1	2	5	2	asey	Burkina17	0.94		2.5	3	84.7	
6	12	1	2	5	3	asey	Burkina17	0.50					
6	12	1	2	5	4	asey	Burkina17	0.78		3.2	2	64.6	
6	12	1	2	5	5	asey	Burkina17	0.94		3.4	1	74.2	

Annex 5A. Plot data set from 1989

The plot numbers refer to the seedlots in the map of the trial, see Annex 3.

Species codes: aniada=*Acacia nilotica* subsp. *adansonii*, anito=*A. nilotica* subsp. *tomentosa*, asey=*A. seyal*, ato=*A. tortilis*, atora=*A. tortilis* subsp. *raddiana*.

Block	Plot	Plotx	Ploty	Species	Provenance	Basal area of the mean tree $cm^2\ tree^{-1}$	Total basal area $m^2\ ha^{-1}$	Dry weight of the mean tree $kg\ tree^{-1}$	Total dry weight $tons\ ha^{-1}$
1	1	8	7	aniada	Burkina04	2.14	0.13	0.22	0.14
1	2	9	6	aniada	Burkina05	1.51	0.09	0.14	0.09
1	3	7	7	anito	Burkina06	0.75	0.05	0.06	0.04
1	4	7	6	anito	Senegal14	1.67	0.10	0.16	0.10
1	5	8	8	atora	Burkina19	1.06	0.07	0.14	0.09
1	6	8	6	atora	Burkina02	1.57	0.10	0.23	0.14
1	7	9	7	atora	Sudan18	1.11	0.07	0.15	0.09
1	8	9	5	ato	Rajasthan06	0.84	0.05	0.10	0.06
1	9	9	8	asey	Burkina14	1.03	0.06		
1	10	8	5	asey	Burkina16	1.02	0.06		
1	11	7	5	asey	Burkina15	1.11	0.07		
1	12	7	8	asey	Burkina17	0.89	0.06		
2	1	9	3	aniada	Burkina04	2.54	0.16	0.28	0.17
2	2	8	4	aniada	Burkina05	2.29	0.14	0.24	0.15
2	3	9	1	anito	Burkina06	0.89	0.06	0.07	0.04
2	4	8	1	anito	Senegal14	3.31	0.21	0.38	0.24
2	5	9	2	atora	Burkina19	1.30	0.08	0.18	0.11
2	6	7	4	atora	Burkina02	1.01	0.06	0.13	0.08
2	7	9	4	atora	Sudan18	1.64	0.10	0.24	0.15
2	8	8	3	ato	Rajasthan06	1.42	0.09	0.20	0.12
2	9	7	1	asey	Burkina14	1.15	0.07		
2	10	7	3	asey	Burkina16	1.26	0.08		
2	11	8	2	asey	Burkina15	1.56	0.09		
2	12	7	2	asey	Burkina17	1.06	0.07		
3	1	4	3	aniada	Burkina04	1.22	0.07	0.11	0.06
3	2	4	1	aniada	Burkina05	2.35	0.15	0.25	0.16
3	3	6	4	anito	Burkina06	1.44	0.09	0.14	0.09
3	4	4	2	anito	Senegal14	2.05	0.13	0.21	0.13
3	5	6	3	atora	Burkina19	1.25	0.08	0.17	0.11
3	6	6	2	atora	Burkina02	1.43	0.09	0.20	0.13
3	7	5	2	atora	Sudan18	1.88	0.12	0.28	0.17
3	8	6	1	ato	Rajasthan06	0.94	0.06	0.12	0.07
3	9	5	1	asey	Burkina14	0.76	0.05		
3	10	5	3	asey	Burkina16	0.78	0.05		
3	11	4	4	asey	Burkina15	0.76	0.05		
3	12	5	4	asey	Burkina17	0.82	0.05		
4	1	4	5	aniada	Burkina04	1.23	0.08	0.11	0.07
4	2	5	6	aniada	Burkina05	1.42	0.09	0.13	0.08

Block	Plot	Plotx	Ploty	Species	Provenance	Basal area of the mean tree $cm^2\ tree^{-1}$	Total basal area $m^2\ ha^{-1}$	Dry weight of the mean tree $kg\ tree^{-1}$	Total dry weight $tons\ ha^{-1}$
4	3	5	7	anito	Burkina06	1.75	0.11	0.18	0.11
4	4	4	8	anito	Senegal14	1.91	0.12	0.19	0.12
4	5	6	5	atora	Burkina19	1.36	0.09	0.19	0.12
4	6	6	8	atora	Burkina02	0.92	0.06	0.12	0.07
4	7	6	7	atora	Sudan18	0.72	0.05	0.09	0.05
4	8	6	6	ato	Rajasthan06	0.69	0.04	0.08	0.05
4	9	5	8	asey	Burkina14	0.89	0.06		
4	10	4	6	asey	Burkina16	0.85	0.05		
4	11	4	7	asey	Burkina15	1.03	0.06		
4	12	5	5	asey	Burkina17	0.96	0.06		
5	1	3	7	aniada	Burkina04	1.67	0.10	0.16	0.10
5	2	3	8	aniada	Burkina05	1.56	0.10	0.14	0.09
5	3	1	8	anito	Burkina06	0.76	0.05	0.06	0.04
5	4	2	5	anito	Senegal14	2.11	0.13	0.22	0.14
5	5	2	7	atora	Burkina19	1.05	0.07	0.14	0.09
5	6	2	6	atora	Burkina02	1.14	0.07	0.15	0.09
5	7	3	5	atora	Sudan18	0.73	0.05	0.09	0.05
5	8	1	6	ato	Rajasthan06	1.55	0.10	0.23	0.14
5	9	3	6	asey	Burkina14	0.74	0.05		
5	10	1	7	asey	Burkina16	1.47	0.09		
5	11	2	8	asey	Burkina15	0.94	0.06		
5	12	1	5	asey	Burkina17	0.99	0.06		
6	1	2	4	aniada	Burkina04	1.96	0.12	0.19	0.12
6	2	1	3	aniada	Burkina05	1.98	0.12	0.20	0.13
6	3	1	4	anito	Burkina06	0.80	0.05	0.06	0.04
6	4	2	3	anito	Senegal14	2.21	0.14	0.23	0.14
6	5	3	1	atora	Burkina19	1.32	0.08	0.19	0.12
6	6	3	3	atora	Burkina02	0.67	0.04	0.08	0.05
6	7	3	4	atora	Sudan18	0.94	0.06	0.12	0.08
6	8	2	1	ato	Rajasthan06	1.13	0.07	0.15	0.10
6	9	3	2	asey	Burkina14	1.24	0.08		
6	10	1	1	asey	Burkina16	0.75	0.05		
6	11	2	2	asey	Burkina15	0.75	0.05		
6	12	1	2	asey	Burkina17	0.87	0.05		

Annex 5B. Plot data set from 1993

The plot numbers refer to the seedlots in the map of the trial, see Annex 3.

Species codes: aniada=*Acacia nilotica* subsp. *adansonii*, anito=*A. nilotica* subsp. *tomentosa*, asey=*A. seyal*, ato=*A. tortilis*, atora=*A. tortilis* subsp. *raddiana*.

Block	Plot	Plotx	Ploty	Species	Provenance	Survival %	Height m	Crown area m^2	Number of stems no $tree^{-1}$	Basal area of the mean tree cm^2 $tree^{-1}$	Total basal area m^2 ha^{-1}	Dry weight of the mean tree kg $tree^{-1}$	Total dry weight tons ha^{-1}
1	1	8	7	aniada	Burkina04	94	2.35	6.15	1.87	36.2	2.12	8.79	5.15
1	2	9	6	aniada	Burkina05	100	2.20	6.03	1.47	27.2	1.70	6.21	3.88
1	3	7	7	anito	Burkina06	69	2.28	6.47	2.20	23.3	1.00	5.42	2.33
1	4	7	6	anito	Senegal14	100	3.14	9.86	3.06	65.0	4.06	19.23	12.02
1	5	8	8	atora	Burkina19	100	1.93	8.21	2.33	26.6	1.66	7.83	4.89
1	6	8	6	atora	Burkina02	100	2.61	12.52	2.56	55.8	3.49	19.84	12.40
1	7	9	7	atora	Sudan18	88	1.46	6.50	3.64	20.3	1.11	6.21	3.40
1	8	9	5	ato	Rajasthan06	69	1.10	2.95	2.27	7.0	0.30	1.52	0.65
1	9	9	8	asey	Burkina14	100	3.46	10.96	1.94	43.1	2.70		
1	10	8	5	asey	Burkina16	100	2.33	10.83	1.31	25.9	1.62		
1	11	7	5	asey	Burkina15	81	4.00	18.14	1.77	67.3	3.42		
1	12	7	8	asey	Burkina17	88	3.39	11.30	1.71	38.3	2.09		
2	1	9	3	aniada	Burkina04	100	2.66	8.72	1.81	54.5	3.40	14.55	9.10
2	2	8	4	aniada	Burkina05	100	2.13	6.27	1.56	30.5	1.91	7.26	4.54
2	3	9	1	anito	Burkina06	69	0.96	4.06	1.00	4.6	0.20	0.86	0.37
2	4	8	1	anito	Senegal14	69	1.88	6.70	3.00	46.9	2.02	13.46	5.78
2	5	9	2	atora	Burkina19	100	2.17	9.48	2.87	45.7	2.86	16.13	10.08
2	6	7	4	atora	Burkina02	94	1.63	5.87	2.43	30.0	1.76	9.73	5.70
2	7	9	4	atora	Sudan18	88	1.85	7.22	3.33	35.1	1.92	10.88	5.95
2	8	8	3	ato	Rajasthan06	69	1.35	5.06	1.83	13.8	0.59	3.86	1.66
2	9	7	1	asey	Burkina14	100	3.31	10.95	1.56	44.3	2.77		
2	10	7	3	asey	Burkina16	88	2.06	8.43	1.54	26.5	1.45		
2	11	8	2	asey	Burkina15	81	3.58	14.96	1.69	57.6	2.93		
2	12	7	2	asey	Burkina17	81	3.06	14.23	1.31	39.2	1.99		
3	1	4	3	aniada	Burkina04	94	1.57	4.87	2.30	17.5	1.02	3.90	2.29
3	2	4	1	aniada	Burkina05	94	2.37	9.61	2.50	53.5	3.13	15.40	9.03
3	3	6	4	anito	Burkina06	88	2.77	10.58	2.08	36.4	1.99	9.10	4.98
3	4	4	2	anito	Senegal14	88	2.16	6.50	2.20	31.5	1.72	8.65	4.73
3	5	6	3	atora	Burkina19	88	1.94	9.36	3.00	34.1	1.87	10.83	5.92
3	6	6	2	atora	Burkina02	100	1.38	4.78	2.15	18.1	1.13	5.00	3.12
3	7	5	2	atora	Sudan18	94	2.59	9.64	3.71	63.1	3.70	22.00	12.89
3	8	6	1	ato	Rajasthan06	63	1.45	4.23	2.50	13.8	0.54	3.67	1.43
3	9	5	1	asey	Burkina14	88	1.86	7.07	1.71	17.9	0.98		
3	10	5	3	asey	Burkina16	88	2.52	11.91	1.62	29.7	1.63		
3	11	4	4	asey	Burkina15	88	2.97	12.47	1.21	39.8	2.18		
3	12	5	4	asey	Burkina17	94	2.36	8.89	1.64	24.7	1.45		
4	1	4	5	aniada	Burkina04	100	1.54	3.93	2.62	17.6	1.10	3.72	2.32
4	2	5	6	aniada	Burkina05	100	1.67	3.92	2.86	17.5	1.10	3.64	2.28

Annex 5C. Plot data set from 1999

The plot numbers refer to the seedlots in the map of the trial, see Annex 3.

Species codes: aniada=*Acacia nilotica* subsp. *adansonii*, anito=*A. nilotica* subsp. *tomentosa*, asey=*A. seyal*, ato=*A. tortilis*, atora=*A. tortilis* subsp. *raddiana*.

Block	Plot	Plotx	Ploty	Species	Provenance	Survival	Height	Crown area	Number of stems	Basal area of the mean tree	Total basal area	Dry weight of the mean tree	Total dry weight
						%	m	m^2	no $tree^{-1}$	cm^2 $tree^{-1}$	m^2 ha^{-1}	kg $tree^{-1}$	tons ha^{-1}
4	3	5	7	anito	Burkina06	94	3.50	14.77	2.64	77.1	4.52	24.09	14.12
4	4	4	8	anito	Senegal14	56	1.67	4.12	2.89	19.0	0.67	3.99	1.40
4	5	6	5	atora	Burkina19	100	2.83	12.72	2.94	69.5	4.34	24.90	15.56
4	6	6	8	atora	Burkina02	100	1.46	5.11	3.29	18.3	1.15	4.99	3.12
4	7	6	7	atora	Sudan18	100	0.99	4.28	4.00	8.2	0.51	2.02	1.26
4	8	6	6	ato	Rajasthan06	63	1.22	4.64	3.57	14.1	0.55	3.65	1.43
4	9	5	8	asey	Burkina14	100	2.84	10.94	1.44	30.1	1.88		
4	10	4	6	asey	Burkina16	88	2.16	6.69	1.64	21.0	1.15		
4	11	4	7	asey	Burkina15	94	2.76	10.21	1.64	30.9	1.81		
4	12	5	5	asey	Burkina17	81	3.82	12.60	1.46	45.0	2.28		
5	1	3	7	aniada	Burkina04	100	2.11	5.13	2.08	22.4	1.40	5.11	3.19
5	2	3	8	aniada	Burkina05	94	1.85	4.61	1.86	18.6	1.09	3.76	2.20
5	3	1	8	anito	Burkina06	31	1.30	3.36	1.50	6.9	0.13	1.14	0.22
5	4	2	5	anito	Senegal14	94	1.91	6.27	3.30	25.6	1.50	6.17	3.62
5	5	2	7	atora	Burkina19	94	1.17	4.50	2.22	11.2	0.66	3.10	1.82
5	6	2	6	atora	Burkina02	56	1.63	6.01	2.88	22.3	0.79	6.29	2.21
5	7	3	5	atora	Sudan18	94	1.29	5.35	3.00	12.3	0.72	3.07	1.80
5	8	1	6	ato	Rajasthan06	56	1.11	4.74	2.00	8.2	0.29	2.16	0.76
5	9	3	6	asey	Burkina14	94	2.85	9.24	1.80	39.8	2.33		
5	10	1	7	asey	Burkina16	100	3.73	16.42	1.94	78.5	4.90		
5	11	2	8	asey	Burkina15	100	2.03	5.14	1.33	14.3	0.89		
5	12	1	5	asey	Burkina17	63	2.20	9.52	1.38	26.6	1.04		
6	1	2	4	aniada	Burkina04	88	1.87	4.92	1.50	25.5	1.39	5.86	3.21
6	2	1	3	aniada	Burkina05	100	3.45	13.49	2.00	101.4	6.34	32.39	20.24
6	3	1	4	anito	Burkina06	50	2.03	5.81	1.38	13.9	0.43	2.75	0.86
6	4	2	3	anito	Senegal14	75	1.86	5.04	1.91	18.7	0.88	3.84	1.80
6	5	3	1	atora	Burkina19	88	1.83	6.91	3.08	27.4	1.50	7.91	4.32
6	6	3	3	atora	Burkina02	81	1.28	5.27	2.11	11.5	0.58	3.00	1.52
6	7	3	4	atora	Sudan18	100	1.43	5.52	2.58	16.7	1.05	4.54	2.84
6	8	2	1	ato	Rajasthan06	75	1.33	4.81	2.83	12.3	0.58	3.45	1.62
6	9	3	2	asey	Burkina14	100	1.94	8.20	1.38	20.6	1.29		
6	10	1	1	asey	Burkina16	88	2.35	8.84	1.92	25.6	1.40		
6	11	2	2	asey	Burkina15	94	1.85	9.35	1.36	19.4	1.14		
6	12	1	2	asey	Burkina17	88	2.53	12.72	1.79	31.7	1.73		

Block	Plot	Plotx	Ploty	Species	Provenance	Sur vival	Height	Number of stems	Basal area of the mean tree	Total basal area	Dry weight of the mean tree	Total dry weight
						proportion	m	no tree^{-1}	cm^2 tree^{-1}	m^2 ha^{-1}	kg tree^{-1}	tons ha^{-1}
1	1	8	7	aniada	Burkina04	0.81	2.67	1.46	78.9	4.01	24.3	12.4
1	2	9	6	aniada	Burkina05	0.88	2.64	1.29	52.9	2.89	14.1	7.7
1	3	7	7	anito	Burkina06	0.31	2.94	2.00	73.3	1.43	25.0	4.9
1	4	7	6	anito	Senegal14	0.94	4.05	2.13	115.5	6.77	40.6	23.8
1	5	8	8	atora	Burkina19	0.88	2.39	1.57	44.6	2.44	15.0	8.2
1	6	8	6	atora	Burkina02	1.00	3.60	1.88	102.6	6.41	41.3	25.8
1	7	9	7	atora	Sudan18	0.75	2.18	3.17	41.6	1.95	14.7	6.9
1	8	9	5	ato	Rajasthan06	0.38	1.20	1.17	8.7	0.20	2.0	0.5
1	9	9	8	asey	Burkina14	1.00	4.00	1.38	77.5	4.84		
1	10	8	5	asey	Burkina16	0.94	2.83	1.13	45.2	2.65		
1	11	7	5	asey	Burkina15	0.75	4.95	1.67	135.0	6.33		
1	12	7	8	asey	Burkina17	0.81	4.45	1.15	87.7	4.45		
2	1	9	3	aniada	Burkina04	1.00	2.99	1.88	117.6	7.35	40.0	25.0
2	2	8	4	aniada	Burkina05	0.94	2.33	1.60	57.4	3.36	18.0	10.5
2	3	9	1	anito	Burkina06	0.31	1.42	2.00	16.0	0.31	3.3	0.6
2	4	8	1	anito	Senegal14	0.56	2.52	2.56	65.3	2.30	19.5	6.8
2	5	9	2	atora	Burkina19	0.81	2.71	2.83	120.4	6.11	57.8	27.1
2	6	7	4	atora	Burkina02	0.81	1.86	2.31	48.2	2.45	20.2	10.3
2	7	9	4	atora	Sudan18	0.75	2.55	3.67	56.9	2.67	19.1	9.0
2	8	8	3	ato	Rajasthan06	0.38	0.82	1.83	13.4	0.31	3.4	0.8
2	9	7	1	asey	Burkina14	1.00	4.50	1.44	103.0	6.44		
2	10	7	3	asey	Burkina16	0.75	1.90	1.58	43.0	2.02		
2	11	8	2	asey	Burkina15	0.81	3.98	1.54	108.9	5.53		
2	12	7	2	asey	Burkina17	0.56	3.37	1.11	73.1	2.57		
3	1	4	3	aniada	Burkina04	0.81	2.22	1.46	47.1	2.39	14.5	7.3
3	2	4	1	aniada	Burkina05	0.94	3.05	2.00	116.7	6.84	42.6	24.9
3	3	6	4	anito	Burkina06	0.63	3.22	1.30	55.7	2.17	16.0	6.3
3	4	4	2	anito	Senegal14	0.69	3.50	1.45	77.4	3.33	24.2	10.4
3	5	6	3	atora	Burkina19	0.56	2.27	1.44	53.7	1.89	18.4	6.5
3	6	6	2	atora	Burkina02	0.69	1.77	1.27	13.3	0.57	3.3	1.4
3	7	5	2	atora	Sudan18	0.88	3.22	2.08	93.9	5.14	37.9	20.8
3	8	6	1	ato	Rajasthan06	0.50	2.38	1.25	9.1	0.28	2.0	0.6
3	9	5	1	asey	Burkina14	0.75	3.27	1.25	29.2	1.37		
3	10	5	3	asey	Burkina16	0.81	3.28	1.54	63.5	3.22		
3	11	4	4	asey	Burkina15	0.81	3.63	1.31	94.1	4.78		
3	12	5	4	asey	Burkina17	0.88	3.36	1.21	49.4	2.70		
4	1	4	5	aniada	Burkina04	0.88	2.26	1.64	44.1	2.41	12.1	6.6
4	2	5	6	aniada	Burkina05	0.88	2.55	1.43	41.3	2.26	10.6	5.8

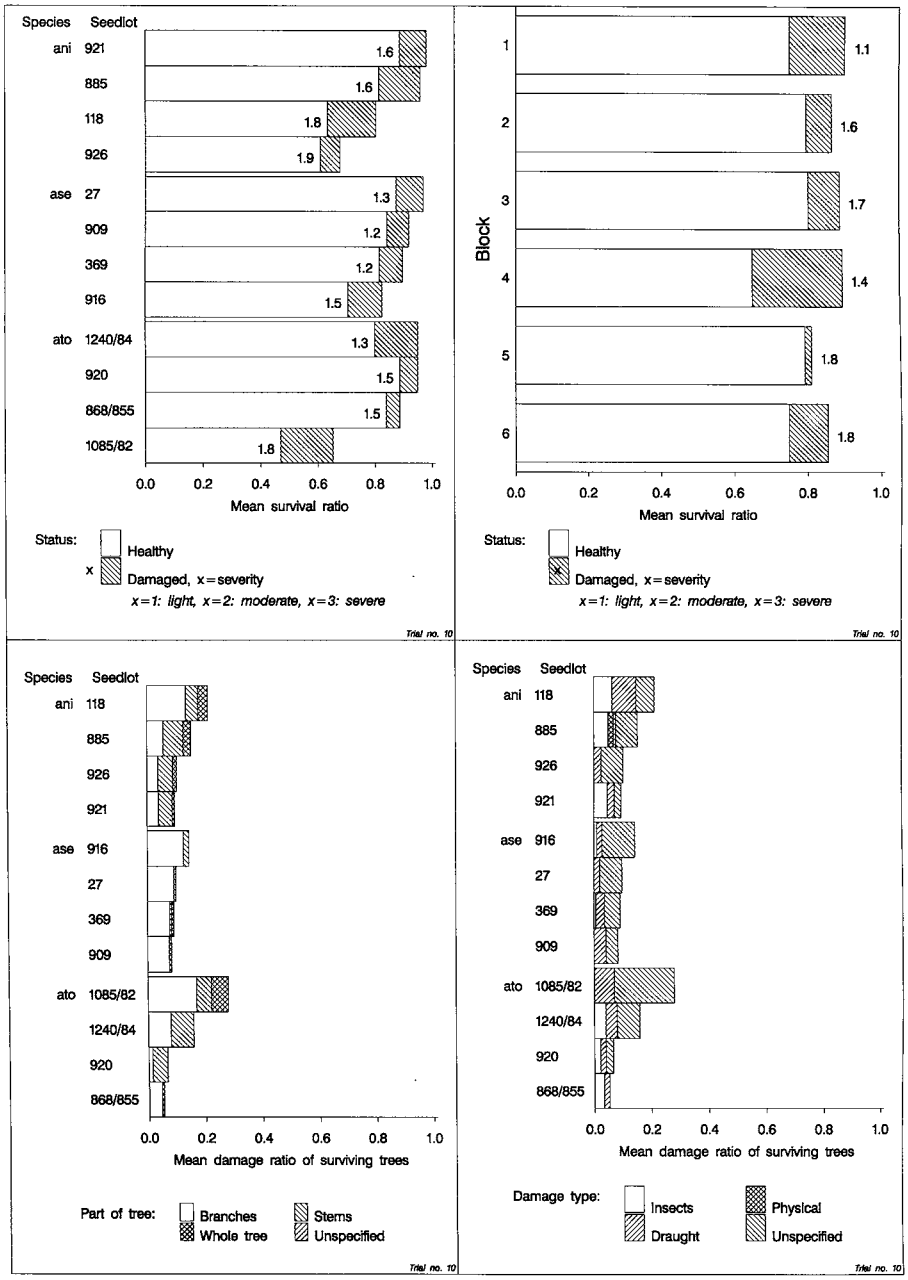
Block	Plot	Plotx	Ploty	Species	Provenance	Survival	Height	Number of stems	Basal area of the mean tree	Total basal area	Dry weight of the mean tree	Total dry weight
						proportion	m	no tree^{-1}	cm^2 tree^{-1}	m^2 ha^{-1}	kg tree^{-1}	tons ha^{-1}
4	3	5	7	anito	Burkina06	0.63	4.65	1.40	152.8	5.97	54.2	21.2
4	4	4	8	anito	Senegal14	0.56	2.03	1.33	35.9	1.26	9.8	3.4
4	5	6	5	atora	Burkina19	0.94	3.41	1.67	127.4	7.47	52.2	30.6
4	6	6	8	atora	Burkina02	0.75	1.76	1.50	27.5	1.29	8.6	4.1
4	7	6	7	atora	Sudan18	0.56	1.54	1.00	10.5	0.37	2.5	0.9
4	8	6	6	ato	Rajasthan06	0.44	1.46	1.29	16.9	0.46	4.6	1.3
4	9	5	8	asey	Burkina14	0.94	3.34	1.33	60.4	3.54		
4	10	4	6	asey	Burkina16	0.81	3.10	1.43	47.3	2.40		
4	11	4	7	asey	Burkina15	0.94	3.65	1.07	62.0	3.63		
4	12	5	5	asey	Burkina17	0.81	4.78	1.31	87.6	4.45		
5	1	3	7	aniada	Burkina04	1.00	2.20	2.06	70.7	4.42	22.0	13.8
5	2	3	8	aniada	Burkina05	0.88	2.41	2.14	67.6	3.70	19.6	10.7
5	3	1	8	anito	Burkina06	0.19	1.33	2.67	8.5	0.10	1.6	0.2
5	4	2	5	anito	Senegal14	0.81	2.53	3.08	73.8	3.75	22.8	11.6
5	5	2	7	atora	Burkina19	0.94	1.23	3.53	28.7	1.68	10.0	5.9
5	6	2	6	atora	Burkina02	0.50	1.90	2.38	44.2	1.38	15.1	4.7
5	7	3	5	atora	Sudan18	0.94	1.69	3.13	30.9	1.81	9.3	5.4
5	8	1	6	ato	Rajasthan06	0.56	1.48	2.56	18.0	0.63	5.1	1.8
5	9	3	6	asey	Burkina14	0.94	3.43	1.80	86.6	5.07		
5	10	1	7	asey	Burkina16	1.00	4.74	1.94	163.0	10.19		
5	11	2	8	asey	Burkina15	0.94	2.65	1.33	29.8	1.75		
5	12	1	5	asey	Burkina17	0.63	2.75	1.70	45.0	1.76		
6	1	2	4	aniada	Burkina04	0.75	2.33	1.58	69.6	3.26	21.2	9.9
6	2	1	3	aniada	Burkina05	1.00	4.11	1.94	188.3	11.77	71.8	44.9
6	3	1	4	anito	Burkina06	0.44	1.80	2.43	20.2	0.55	4.5	1.2
6	4	2	3	anito	Senegal14	0.69	2.05	2.64	47.7	2.05	13.3	5.7
6	5	3	1	atora	Burkina19	0.88	2.51	2.54	88.6	4.84	33.8	18.5
6	6	3	3	atora	Burkina02	0.75	1.60	2.33	31.6	1.48	10.1	4.7
6	7	3	4	atora	Sudan18	0.88	1.90	2.79	42.6	2.33	14.2	7.8
6	8	2	1	ato	Rajasthan06	0.69	1.73	2.45	30.0	1.29	10.1	4.3
6	9	3	2	asey	Burkina14	0.81	2.85	1.38	65.3	3.32		
6	10	1	1	asey	Burkina16	0.81	2.72	1.54	51.3	2.61		
6	11	2	2	asey	Burkina15	0.75	2.70	1.25	52.2	2.45		
6	12	1	2	asey	Burkina17	0.88	2.59	1.57	50.9	2.79		

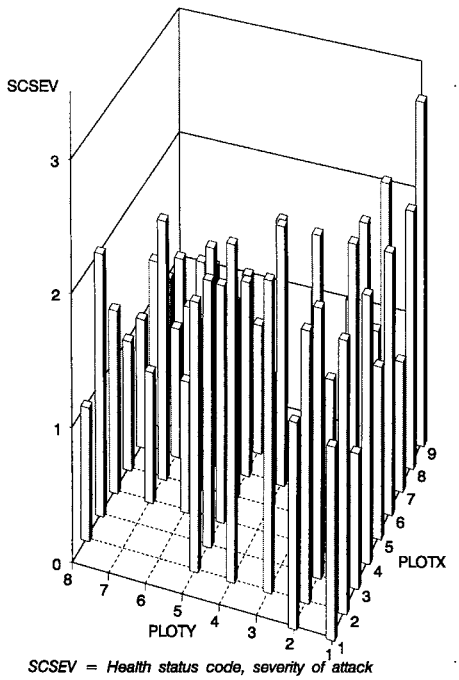
Annex 6. Graphical presentation of the health data

The health status of the trees were evaluated on a scale from 0 to 3, where 0 indicates no damage, and 1, 2 and 3 indicates light, moderate and severe damage, respectively. The health status code is named SCSEV in the diagrams on the following pages.

The diagrams present the mean survival ratios, the damage ratios of the surviving trees and the average damage scores for the damaged trees. They also indicate the distribution of the damage on the trees and the cause of the damage. The damage scores are presented according to plots, blocks and seedlots.

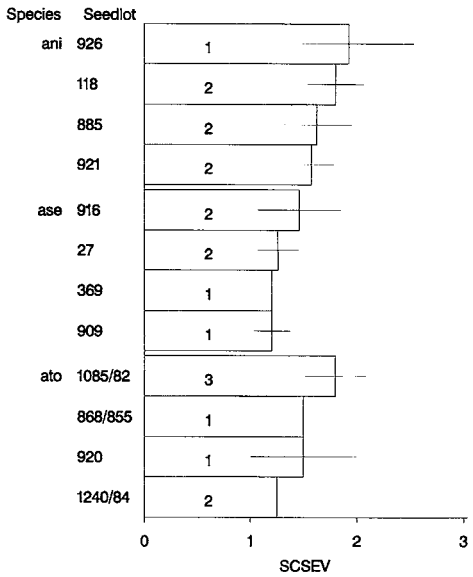
Please note that the seedlot codes correspond to the numbers given in Annex 2.





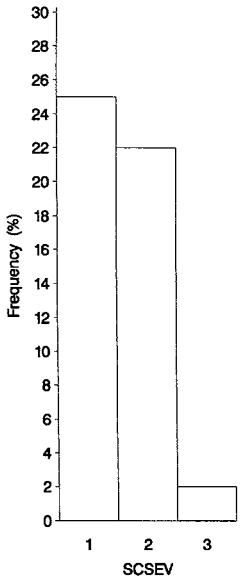
SCSEV = Health status code, severity of attack
Scatter of plot mean values

Trial no. 10



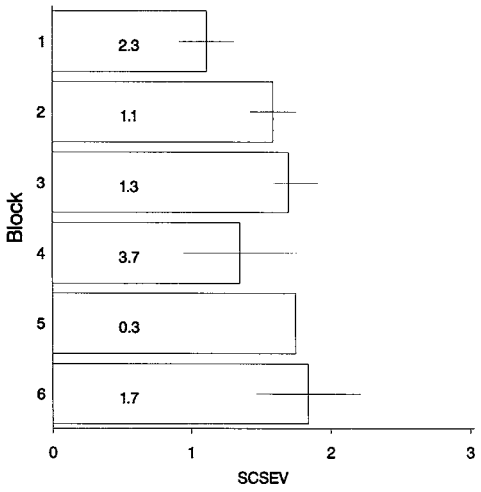
Mean SCSEV of seedlot with error bar line (+/− standard deviation of the mean) and the average number of assessed (living) trees per plot for each seedlot.

Trial no. 10



Frequency distribution of plot mean values

Trial no. 10



Mean SCSEV of block with error bar line (+/− standard deviation of the mean) and the average number of assessed (living) trees per plot in each block.

Trial no. 10