ICFR 3\textsuperscript{rd} Forest Research Symposium

held in the John Bews Complex, University of KwaZulu-Natal, Pietermaritzburg

25\textsuperscript{th} – 26\textsuperscript{th} June 2008
Welcome from the ICFR Director

Welcome to the 3rd Forest Research Symposium hosted by the Institute for Commercial Forestry Research. To date, we have held two very successful Symposia; in 2005 and in 2006. With many of the Industry committed to the IUFRO Working Party 2.08.03 Eucalypt and Tree Improvement Conference held in South Africa last year, it was decided to postpone the next ICFR Forest Research Symposium to 2008.

This symposium aims to bring together the forest research community to create an awareness of the work being carried out by the various forest organisations, providing an outlet for presentations and facilitating interaction and networking.

The Scientific Committee considered all the papers submitted and we have endeavoured to put together a diverse selection of papers covering research from various aspects of the forestry supply chain and addressing both the specific and “big-picture” levels.

I would like to express my thanks to the contributors for their papers. Once again there were many more papers submitted than could be accommodated in the day-and-a-half programme and the scientific team had a tough task selecting the ones presented here.

A special word of thank-you to our two invited speakers; Professor Mark Laing (UKZN) and Dr Bob Scholes (CSIR Fellow) for agreeing to be part of our Symposium this year.

Thank you also to the delegates attending the symposium. Once again it seems as if we’ll exceed a hundred delegates this year. This is your symposium, where you can share ideas and offer comments on work being done. Have fun!

Prof. Colin Dyer
June 2008
### ICFR 3rd FOREST RESEARCH SYMPOSIUM

### PROGRAMME

#### WEDNESDAY 25TH JUNE – DAY 1

**Session 1:** Chairperson Sally Upfold (ICFR)

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| 10h30-11h00 | REGISTRATION & TEA  
Venue: Foyer of the John Bews Building, Life Science Campus |                                    |
| 11h00-11h15 | Welcome                                                                 | Prof. Charles Breen, ICFR         |
| 11h15–12h00 | PLENARY: Combining biocontrol and silicon applications for improved tree health | Prof. Mark Laing, UKZN            |
| 12h00–12h30 | Mycosphaerella leaf disease; a worldwide perspective                  | Guillermo Pérez, FABI             |
| 12h30–13h00 | Some early results from Pinus patula hybrids in southern Africa        | Dr Arnulf Kanzler, Sappi          |

**13h00-13h15 GROUP PHOTOGRAPH ON STEPS OF AGRIC BUILDING**

**13h15–14h00 LUNCH  
Venue: Life Sciences Gardens**

**Session 2:** Chairperson Dr Terry Stanger (Sappi)

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<td>14h00-14h30</td>
<td>Triploid black wattle (Acacia mearnsii) – a means to control the spread of a commercially important forestry species in South Africa</td>
<td>Dr Sascha Beck-Pay, ICFR</td>
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<td>14h30–15h00</td>
<td>Four year genetic analysis of five Acacia mearnsii (black wattle) sub-populations: Genetic parameters and genetic gain predictions</td>
<td>Andrea Louw, ICFR</td>
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<tr>
<td>15h00–15h30</td>
<td>Island colonisation route and contemporary levels of genetic diversity and population structure of Eucalyptus urophylla</td>
<td>Kitt Payn, Mondi SA</td>
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**15h30–16h00 TEA & COFFEE  
Venue: Foyer of the John Bews Building, Life Science Campus**

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<td>Eucalyptus urophylla - an important species to develop as a hybrid partner at low elevation for Sappi in South Africa</td>
<td>Geoff Galloway, Sappi</td>
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<td>16h30–17h00</td>
<td>Genetic variation in growth, basic wood density and pulp yield found in a breeding population of Eucalyptus urophylla S.T. Blake</td>
<td>Francois van Deventer, Mondi SA</td>
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<td>17h00–17h30</td>
<td>Results of Eucalyptus nitens progeny trials – does granny still play a role in the 2nd generation?</td>
<td>Tammy Swain, ICFR</td>
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**17h30–20h00 COCKTAIL PARTY AT THE ICFR**
THURSDAY 26th JUNE – DAY 2

Session 3: Chairperson Prof. Colin Dyer (ICFR)

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<td>PLENARY: Global Climate Change and its relevance to the South African</td>
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<td>Estimating net primary productivity and above ground biomass of</td>
<td>Thamsanqa Mzinyane,</td>
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<td>Eucalyptus grandis through integration of remotely sensed data and a</td>
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<td>process-based model</td>
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<td>09h45–10h15</td>
<td>Further progress in the development of predictive models for growth and</td>
<td>Heyns Kotze, KLF</td>
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<td>wood quality of plantation-grown Pinus patula saw-timber in South Africa</td>
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Session 4: Chairperson Dr Colin Smith (ICFR)

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<td>A preliminary appraisal of nutrient supply and demand in eucalypt</td>
<td>Steven Dovey, ICFR</td>
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<td>The effect of harvesting operations and residue management on the early</td>
<td>Diana Rietz, ICFR</td>
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<td>growth of Eucalyptus grandis at two sites in KwaZulu-Natal</td>
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<td>Effect of spacing on fibre morphology of E. grandis pulpwood</td>
<td>Marius du Plessis,</td>
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<td>Mondi SA</td>
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<td>Drying of burnt timber</td>
<td>Dr Martina Meincken,</td>
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<td>12h45–13h45</td>
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Session 5: Chairperson Dr Bernard Janse (Mondi)

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<td>Laboratory hardwood cooking – batch versus compact cooking and the</td>
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<td>effect of cooking on selection of clones for wood quality</td>
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<td>14h15–14h45</td>
<td>Breeding South African pine wood for improved stiffness using acoustic</td>
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<td>wave velocity: Review and first results</td>
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<td>14h45–15h15</td>
<td>Using sound wave technology to assist in selection in Eucalyptus sawlog</td>
<td>Maurits Perold,</td>
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Session 6: Chairperson Craig Norris (NCT)

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<td>Non-destructive estimation of cellulose content using near infrared</td>
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<td>spectroscopy to rapidly assess kraft pulp yield of Eucalyptus grandis</td>
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<td>16h15–16h45</td>
<td>Bleached or unbleached pulp properties as indicators for breeding?</td>
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<td>16h45–17h00</td>
<td>CLOSURE and THANKS</td>
<td>Prof. Colin Dyer, ICFR</td>
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Session 1
Chairperson: Sally Upfold (ICFR)

Combining biocontrol and silicon applications for improved tree health

Mark has BSc and BScHons (Plant Pathology) degrees, as well as a PhD from the University of Natal. Currently he is Professor and Chair of Plant Pathology as well as Director, African Centre for Crop Improvement (ACCI) at UKZN. Mark is also the Chairperson of PlantBio (a National Biotechnology Innovation Centre), and the Director and Founder of Plant Health Products (Pty) Ltd. In addition to his role in academic, scientific and administrative leadership of Plant Pathology at UKZN, Mark lectures to 3rd and 4th year students and supervises a number of postgraduates. He has been enormously successful in raising funds for his research with funding in excess of R50 million since 1990. Mark manages the ACCI, which has a multimillion rand budget, with 10 staff and 40 PhD students.

Mark has produced 33 peer-reviewed publications, 41 popular publications; 48 international and 215 local conference presentations. He also received numerous awards for his contribution to research. Mark’s primary research interests are in: Plant breeding, especially Horizontal Resistance: African food crops, cabbage, ornamentals; the Biological control of diseases: Trichoderma and Bacillus; entomopathogens, probiotics for growth stimulation, disease control and accelerated biodegradation of crop debris, commercialisation of probiotics and biocontrol agents; and Epidemiology and control of diseases of vegetables, African cereals, and seedlings.

Mycosphaerella leaf disease; a worldwide perspective

Guillermo is from Uruguay, South America, where he obtained his BSc (2004) and MSc (2006) degrees at the University of Uruguay. In his MSc project he focused on the genetic diversity of Inocutis jamaicensis, a Basidiomycete that causes significant economic losses in Eucalyptus globulus plantations, vineyards and native plants in Uruguay. Guillermo enrolled for a PhD in FABI at the University of Pretoria in January 2007. For this degree, he is working on Teratosphaeria nubilosa, the most important pathogen causing Mycosphaerella leaf disease (MLD) in South Africa, mostly on Eucalyptus nitens. Using microsatellite markers, he is investigating the population structure of T. nubilosa in different provinces of South Africa. He is also comparing these results with populations from Uruguay and will soon visit Western Australia, supported by a grant from Murdoch University, to study the fungus in its native range and so gain a worldwide perspective of MLD.

Some early results from Pinus patula hybrids in southern Africa

After completing his school education at Treverton, Mooi River and Alexander High School in Pietermaritzburg, Arnulf qualified with a BSc degree (Botany and Zoology), an Honours degree in Botany, and a Higher Education Diploma, all from the University of Natal. For four years Arnulf taught Biology and Science at Carter High School in Pietermaritzburg, before joining Sappi Forest Research in 1991, where he has worked as a Research Officer in the Pine Breeding Program, and later with Usutu Pulp Company, in Swaziland as a Tree Breeder. In 1998 he was awarded a CAMCORE stipend and registered for a Masters degree with the Department of Forestry at North Carolina State University in Raleigh, USA. This was later upgraded to a PhD in Forestry, which he completed in 2002. Arnulf is currently the Pine Program Leader for Softwood Breeding in Sappi Forest Research, South Africa.
PLENARY PAPER

Combining biocontrol and silicon applications for improved tree health

Mark Laing
Chair of Plant Pathology and Director of the African Centre, for Crop Improvement, University of KwaZulu-Natal, P Bag X01, Scottsville 3209, Pietermaritzburg
laing@ukzn.ac.za

Tree crops (perennials) suffer from root, trunk, fruit and foliar diseases and pest attacks. Because of their perennial nature, their exposure to pests and diseases cannot be escaped, and these problems may escalate from one season to the next. Furthermore, the breeding of tree crops for resistance to pests and diseases is limited because their breeding cycles are much longer than the reproductive cycles of the pests and diseases, which can therefore adapt faster than the tree crops. Where cultivar traits are important, it becomes even more difficult to manage biotic problems. For example, consumers want Cabernet Sauvignon wine, a Granny Smith apple or a Washington Navel orange, irrespective of the disease and pest susceptibilities of the perennial crop cultivar concerned. As a result, pests and diseases of perennial crops may be extremely serious, often limiting to production, such as the new strains of *Fusarium* wilt of bananas that now threatens world production of bananas.

Typically, tree crops all face root health issues, where both abiotic and biotic factors become increasingly important. Replant problems of tree crops exposes this often hidden issue, and affects most tree crops, including forestry. Where a tree crop is pruned, pathogens inevitably infect the pruning wound and slowly kill the host, such as Eutypa of grapes. And foliar diseases may be extremely serious, diminishing host growth and crop yields to very low levels. For example, Tanzania’s cashew nut trees are now producing less than 5% of the harvest that was grown before cashew’s specific powdery mildew arrived from Brazil.

Use of biocontrol agents and soluble silicon may offer solutions to these problems. Biocontrol agents offer solutions to both biotic and abiotic stresses that may be economically and practically viable, especially if they protect crops during periods of extreme susceptibility, such as during seed germination or seedling transplanting. Unlike agrochemicals, biocontrol agents may persist and even multiply on a compatible host, providing long term protection. Plant-available, soluble silicon is a mineral that is critically short from more than 70% of Africa’s soils. Acid or coastal soils are typically very deficient in soluble silicon which is an essential element for disease and insect resistance, stress tolerance and numerous physiologically activities. Combining biocontrol and soluble silicon often results in additive or synergistic action against both abiotic and biotic stresses. Research underway on perennial crops such as citrus, grapes, avocado, roses, peaches, coffee, bananas, macadamia, and papaya have shown excellent results in the management of a range of pests and diseases, and some abiotic stresses such as lodging, frost damage and drought.
Mycosphaerella leaf disease; a worldwide perspective

Guillermo Pérez
Department of Microbiology and Plant Pathology, Forestry and Agricultural Biotechnology Institute (FABI),
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guillermo.perez@fabi.up.ac.za

Teratosphaeria nubilosa (=Mycosphaerella nubilosa) is one of the most important fungal pathogens that causes leaf spots on Eucalyptus spp. The disease that it causes, known as Mycosphaerella leaf disease (MLD), has lead to significant economic losses in South Africa and other areas of the world. Hierarchical sampling strategies were used to study the spatial distribution of the genetic diversity of T. nubilosa, including the diversity among lesions on a single leaf, diversity among leaves on a tree, diversity at the plantation level and diversity among provinces of South Africa. Different genotypes of the pathogen were recovered from different lesions on a single leaf and from 30 lesions on different leaves of a tree. These results indicate that different lesions correspond to different colonization events and suggest that re-infection does not play a significant role in the structure of the diversity at the levels considered. Random infection by wind borne ascospores is, therefore, the most probable dispersion strategy utilised by this pathogen. As a basis for comparison, severe defoliation associated with symptoms resembling MLD observed on E. globulus in Uruguay since 2007, has been considered as part of this study. Surveys were conducted in December 2007 and the presence of T. nubilosa was confirmed, representing the first report of this pathogen in South America. Using ten microsatellite loci, only one T. nubilosa genotype was distinguished in the Uruguayan population. Interestingly, this genotype is identical to that found in Portugal and Spain, suggesting that the origin of the introduction in Uruguay was from one of these countries. Owing to the fact that T. nubilosa is native in Australia and was introduced into South Africa more than 80 years ago, the high number of genotypes observed, even at small scales, can be explained by multiple introductions over time or by the presence of outcrossing in nature. This will complicate efforts to breed for resistance.
Some early results from *Pinus patula* hybrids in southern Africa

Amulf Kanzler
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amulf.kanzler@sappi.com

It has long been held (Barnes and Styles, 1983) that there could be great potential in crossing *Pinus patula* with the other closed-cone pines to produce hybrids that could be better adapted to the environmental conditions that exist in Southern Africa, than the pure species themselves, all of which have their limitations. *Pinus patula* belongs to the Oocarpae subsection that includes several other Mesoamerican closed-cone pines like *P. oocarpa*, *P. tecunumanii*, *P. jaliscana*, *P. greggii*, and *P. pringlei* (Perry, 1991). Pine breeders have an excellent opportunity to develop hybrids with *P. patula* and incorporate new genes into the breeding population. This presentation will focus on some results from two pollination events performed between 1991 and 1994. *P. patula* was crossed with *P. tecunumanii* using a high elevation source (Las Piedrecitas) in 1991 and a low elevation source (Culmi) during 1993 and 1994.

Results thus far suggest that the *P. patula* x *P. tecunumanii* hybrid has performed well over the full range of sites currently planted to softwoods within Sappi. All data currently reported was for tests that were eight years or younger. Overall, the growth of the *P. patula* x *P. tecunumanii* hybrid has generally been better or comparable to *P. patula* and either slightly poorer or comparable to the *P. elliottii* x *P. caribaea* var. *hondurensis* hybrid (PECH).

The origin of the *P. tecunumanii* parent appears to have an important impact on the adaptability of the hybrid to Sappi sites. *P. patula* x *P. tecunumanii* (High elevation) hybrids as represented by Las Piedrecitas, performed relatively better on high elevation sites and were more comparable in growth to *P. patula*. The *P. patula* x *P. tecunumanii* (Low elevation) hybrids as represented by Culmi were growing well on the warmer sites, where they may be expected to compete with PECH. It should be noted however, that the latter sources were only represented by pollen from one tree; nevertheless, indications are that the type of sites to be planted to the hybrid will have an important bearing on the selection of the *P. tecunumanii* population to be selected as the parent in the hybrid.

Furthermore, it is clear that specific testing of families will be required before any hybrid material is made available for operational use. The indications from this limited data set indicate that the variation amongst families was larger than the variation at the species / hybrid level.

One of the major advantages of the hybrid may be increased tolerance to the Pitch Canker Fungus (PCF), *Fusarium subglutinans* f. *sp. pini*. A series of three tests in South Africa, utilising three-year old field trials and with a range of Pine hybrids, including the *P. patula* x *P. tecunumanii* (Culmi) hybrid was subjected to branch inoculations with the PCF strain currently found in South African nurseries ((Roux and Wingfield, 2002)). The rankings of the various species and hybrids were consistent with expectations derived from previous seedling screening trials with the *P. patula* x *P. tecunumanii* (Culmi) hybrid ranked higher than the pure *P. patula* entries.
Session 2
Chairperson: Dr Terry Stanger, Sappi

Triploid back wattle (Acacia mearnsii) – a means to control the spread of a commercially important forestry species in South Africa

Sascha has a PhD (Botany), from the University of Natal. She is currently Project Leader for the Acacia Tree Improvement programme at the ICFR with expertise in Acacia breeding, testing of alternative Acacia species, and in the development of a sterile variety of black wattle. Sascha’s research interests lie in ensuring a constant supply of improved germplasm, in the form of seed, to the industry. She co-ordinates all seed sales for black wattle, both commercial and select/improved seed to the Industry. Much of her recent research efforts have concentrated on developing a sterile black wattle to help restrict the spread of wattle outside of plantation boundaries, through gamma irradiation techniques and through the production of a triploid variety.

Four year genetic analysis of five Acacia mearnsii (black wattle) sub-populations: Genetic parameters and genetic gain predictions

Andrea studied at the University of KwaZulu-Natal, Pietermaritzburg where she obtained an MSc in Genetics. She is employed by the ICFR as a Research Scientist in the Tree Improvement programme working with both Acacia and Eucalyptus. Her current work is focused mainly on the breeding of Acacia for genetic improvement. Her research interests lie in quantitative genetics and genetic testing as well as advanced-generation breeding strategies and principles.

Island colonisation route and contemporary levels of genetic diversity and population structure of Eucalyptus urophylla

Kitt Payn is currently a PhD student enrolled at North Carolina State University. A component of his research is presently being carried out in the Myburg laboratory at the University of Pretoria. This research broadly entails a population genetics study of Eucalyptus urophylla that is of value to conservation and breeding programmes. Financial support for this work was provided by Mondi Business Paper through the Wood and Fibre Molecular Genetics Programme and by Camcore, Raleigh, NC, USA. Kitt’s interests outside of tree improvement include fly-fishing, hiking and overseas travel.

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Kitt Payn
Mondi SA
Kitt.payn@up.ac.za
Session 2 continued
Chairperson: Dr Terry Stanger, Sappi

Eucalyptus urophylla – an important species to develop as a hybrid partner at low elevation for Sappi in South Africa

Geoff has a diploma in forestry from Saasveld (1982). After qualifying he worked for the then SAFRI tree breeding programme at DR de Wet in Sabie for four years and for the final two years was stationed at Jessievale working with the Cold Tolerant eucalypts.

Geoff joined Sappi in 1989 and since then he has been working with the subtropical hardwoods in Kwambonambi. At present, his title is Senior Research Officer, Eucalyptus Clonal Development.

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Genetic variation in growth, basic wood density and pulp yield found in a breeding population of Eucalyptus urophylla S.T. Blake

After matriculating, Francois was forced to hang around in the army for two years, which he sort of enjoyed. Hanging up his boots, he packed his cork-screw and logbook (which was out of date by then), and headed for Stellenbosch to study forestry. Here he quickly learned the railway schedule to Newlands, as well as numerous back-roads to some lovely wine farms. He also managed to successfully complete his studies. He was now a forester, or so he thought.

Francois started his career with H.L. & H. as a silviculture forester. After a few years he was demoted to harvesting forester, and certainly did not enjoy it! Piet Schön, who was then Tree Improvement Manager at H.L. & H., was kind enough to offer Francois a job as tree breeding forester. During this period, H.L. & H. became part of Mondi and Francois joined the Mondi tree breeding team in Sabie. During 1998 Francois was transferred to Pietermaritzburg and took up the post of Eucalyptus tree breeder. Here he managed to survive numerous restructurings and to this day fully enjoys the wonderful and stimulating world of tree breeding. Francois is currently busy with an MSc in tree breeding which he hopes to complete by September this year.

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Results of Eucalyptus nitens progeny trials – does granny still play a role in the 2nd generation?

Tammy is the Programme Manager for the Tree Improvement Programme (Acacia and Eucalypts) at the ICFR. She has an MSc in Agriculture (Genetics) from the University of Natal, Pietermaritzburg and is currently working towards her PhD looking at developing an advanced generation breeding population for Eucalyptus nitens. Her expertise and research interests lie in tree improvement in cold tolerant eucalypt species and the testing and improvement of alternative eucalypt species.
Triploid black wattle (*Acacia mearnsii*) – a means to control the spread of a commercially important forestry species in South Africa

**Sascha L Beck-Pay**

*Institute for Commercial Forestry Research, P O Box 100281, Scottsville, 3209, Pietermaritzburg*
sascha.pay@icfr.ukzn.ac.za

Black wattle (*Acacia mearnsii de Wild*) is a leading commercially grown forestry species in South Africa, however, it is also a classified invader indigenous vegetation. One of the research aims at the Institute for Commercial Forestry Research (ICFR) is to restrict the spread of Black Wattle outside of plantation boundaries. This could be done through the development of a seedless or sterile wattle variety, which would be beneficial to both the black wattle industry and the environment. One approach being investigated is the production of a triploid variety. The long-term objective is to ultimately guarantee that all the seed sold or distributed to the growers will produce sterile or seedless trees, hence reducing the possible spread of black wattle from commercial plantations.

Triploid induction entails crossing diploids with chemically-induced tetraploids, in an attempt to produce triploid seed, which can be grown commercially. Due to the uneven number of chromosomes present in the triploid, the trees will potentially be unable to undergo successful sexual reproduction, resulting in a reduced seed set and/or sterile trees. To date, tetraploids have successfully been induced by treating chipped seed with 0.01% colchicines for a period of six hours. A number of both direct and indirect techniques have been established to confirm the ploidy level, namely flow cytometry, stomatal guard cell length and frequency, chloroplast numbers within stomatal guard cells and chlorophyll content. The induced tetraploids were established in a field trial and on flowering, controlled pollinations between tetraploids and diploids were conducted. Eighteen months later triploid seed was collected from the crosses. Tissue culture and nursery techniques were then used to establish the triploid seed.

This talk will present the results to date and the future of this project.
Four year genetic analysis of five *Acacia mearnsii* (black wattle) sub-populations: Genetic parameters and genetic gain predictions

**Andrea K Louw and Sascha L Beck-Pay**

*Institute for Commercial Forestry Research, P O Box 100281, Scottsville, 3209, Pietermaritzburg*

andrea.louw@icfr.ukzn.ac.za

A Multiple Population Breeding Strategy was implemented in the *Acacia* Tree Improvement Programme at the Institute for Commercial Forestry Research, to improve timber yield and quality while still maintaining an acceptable bark quality. Determined by origin of seed, subpopulations were established in 2002 across different sites in KwaZulu-Natal. Each subpopulation was established as a progeny trial with a breeding seed orchard adjacent to it. The management of the seed orchards will be determined according to the performance of the families within the progeny trials. This paper is a summary of the estimated genetic parameters of the four-year growth measurements of the first five subpopulations. Genetic gain predictions were estimated and these are discussed in the paper. The establishment of two different trial designs at each site allowed for testing the effect of each design for selection efficiency. Genetic correlations between the trial designs were calculated to compare differences in family ranking at each site.
Island colonisation route and contemporary levels of genetic diversity and population structure of *Eucalyptus urophylla*

**Kitt G Payn**, William S Dvorak, Bernard JH Janse and Alexander A Myburg

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*Eucalyptus urophylla* (Timor mountain gum) is an economically important plantation species endemic to the volcanic slopes of seven islands in eastern Indonesia. In this range-wide study of genetic diversity in *E. urophylla*, we first investigated the geographical distribution of chloroplast haplotype diversity to gain insight into the species island colonisation route. DNA sequence data were obtained from 198 plants representing 51 provenances. Chloroplast haplotype diversity exhibited a decreasing trend from east to west in the species’ native range, consistent with an east-to-west colonisation route across the islands. Environmental factors that may have contributed to the contemporary spatial distribution of chloroplast DNA haplotypes, such as ocean currents and fluctuations in sea levels were identified. Microsatellite markers were then used to infer the levels of genetic diversity and population structure present in the nuclear genome. Samples comprised 357 plants representing 45 provenances, which were then grouped to form 19 geographically defined populations. High levels of microsatellite diversity were observed throughout the geographic range and there was limited genetic differentiation among populations. Gene flow among the populations is likely responsible for the apparent weak influence of geographic insularity on the nuclear genetic diversity and population structure. The results of the above studies will contribute towards a greater understanding of the nature and distribution of the genetic variation of *E. urophylla* and will provide direction for conservation and breeding strategies for this species.
Eucalyptus urophylla – an important species to develop as a hybrid partner at low elevation for Sappi in South Africa

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Eucalyptus urophylla S.T. Blake is one of two Eucalyptus species that does not occur in Australia. It is found on seven islands in the eastern Lesser Sunda Archipelago of Indonesia: (from west to east) Flores, Adonara, Lomblen (Lembata), Pantar, Alor, Timor, and Wetar. The species range limits are approximately 7° 30′ S to 10° S, and from 122° E to 127° E. Populations of E. urophylla are most common on Timor, Alor and Wetar, with a scattered distribution elsewhere.

Eucalyptus urophylla is adapted to low altitudes (10 to 60 masl) in the subtropical climate (MAT = 22.6°C) of the KwaZulu Natal North Coast, South Africa (range is 28°18′ S to 28°43′ S and 32°03′ E to 32°16′ E). Hybrid clones with Eucalyptus grandis as one parent and E. urophylla as the other are deployed commercially as mono-clonal blocks by Sappi at these low altitudes, where gains of up to 40% over benchmark material have been obtained. Sappi has invested considerable resources to obtain the provenance range of E. urophylla in Indonesia, starting in 1984 with a collection of seed from Flores. Conventional breeding using subpopulations based on the island of origin is used and population turnover is with full sib seedlots to maintain species purity. Tested and improved E. urophylla is then used as a hybrid partner with E. grandis to improve the productivity of Sappi Forests.

This paper outlines the progress that Sappi has made with E. urophylla over the last twelve years since it first started importing seed for breeding purposes. To date a total of 21 P₀ and three F₁ trials have been established. Selections have been made in all P₀ trials and established in a clonal archive for breeding purposes. Solid wood density was determined for a series of P₀ trials from Alor and Timor provenances. At the individual tree level there was a substantial range of 50% in basic wood density (0.353 to 0.533 g/cm³).
Genetic variation in growth, basic wood density and pulp yield found in a breeding population of *Eucalyptus urophylla* S.T. Blake

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The first objective of the work presented here was to evaluate *Eucalyptus urophylla* provenances in terms of growth, basic wood density and pulp yield performance. The second objective was to determine genetic parameters of the same three traits for a breeding population grown on the KwaZulu-Natal coastal plains. Data from a single trial, containing 17 provenances, was used to evaluate growth. From the same trial, data from 30 selected families representing 11 provenances was used to evaluate basic wood density and pulp yield.

Results showed that significant differences exist between the various provenances for all three traits. Provenances of Mainang, Watakika and Apui produced the best growth, with Lelobatan and Kilawer producing the highest pulp yields. Lere-Baukenget and Mainang produced wood with the highest densities. Heritabilities for volume growth and pulp yield appeared moderate to weak with estimated values of 0.17 and 0.11, respectively. The heritability for basic wood density was found to be much stronger at an estimated value of 0.51. Although genetic correlations ($r_A$) between the traits were all negative, $r_A$ between volume growth and basic wood density, as well as pulp yield and basic wood density were weak ($r_A = -0.05$ and $-0.16$, respectively). A stronger genetic correlation was found to exist between volume growth and pulp yield ($r_A = -0.65$).

These results will be implemented in an advanced generation breeding strategy as well as a hybrid clonal deployment plan.
Results of *Eucalyptus nitens* progeny trials –
does granny still play a role in the 2\textsuperscript{nd} generation?

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*Eucalyptus nitens* remains one of the most important commercial cold tolerant eucalypt (CTE) species currently grown in the summer rainfall regions of South Africa. In many ways, this species is ideal for improvement, as significant provenance variation exists for snow, frost and cold tolerance, as well as flowering, seed production and pulping properties. These characteristics can be utilised, together with breeding for growth, to supply the requirements of the diverse forestry sites in South Africa, as well as the range of end products required by the Forestry Industry.

At present, the ICFR breeding programme for *E. nitens* consists of a base population of trials comprising the material originating from various provenances in Australia, Breeding Seed Orchards (BSOs) and Clonal Seed Orchards (CSOs), as well as progeny trials and BSOs of a small number of 2nd generation families (90). The latter trials comprise only those families which had flowered and produced seed at time of establishment. Ninety month measurements were completed in the 2\textsuperscript{nd} generation trials, and analyses have shown an increase of over 20% in growth for the top 15 families over the commercial controls. Although there were significant differences between the 2\textsuperscript{nd} generation families, neither South African seed orchard of origin nor 1\textsuperscript{st} generation mother family seems to be playing a role in the performances of the 2\textsuperscript{nd} generation. The maternal grandmother no longer seems to be playing a role, as no significant provenance differences, based on the origin of the maternal grandmother, exist in the 2\textsuperscript{nd} generation.
**Session 3**

*Chairperson: Prof. Colin Dyer (ICFR)*

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**Global Climate Change and its relevance to the South African Forestry Industry**

Dr Bob Scholes is a systems ecologist, employed by the Council for Scientific and Industrial Research, South Africa. He has been active in the field of Global Change research since 1990 and has been a member of several steering committees of international research programmes, such as the International Geosphere-Biosphere Programme and the Global Climate Observing System. He has been a lead author for the Intergovernmental Panel on Climate Change on several occasions and was a co-chair of the Conditions Working Group of the Millennium Ecosystem Assessment.

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**Estimating net primary productivity and above ground biomass of Eucalyptus grandis through integration of remotely sensed data and a process-based model**

Thamsanqa Mzinyane obtained an MSc from the University of KwaZulu-Natal in Pietermaritzburg, and he is now studying towards a PhD on *Quantitative Assessment of Water Status and Chemical Bioassays as Impacts to Growth of Eucalyptus clones Using Hyperspectral Remote Sensing*. He is supervised by Dr Fethi Ahmed, Professor Norman Pammenter and Dr Jan van Aardt. His hobbies are watching soccer, rugby and cricket.

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**Further progress in the development of predictive models for growth and wood quality of plantation-grown Pinus patula saw-timber in South Africa**

Heyns started his forestry career as a practising forester with a forestry diploma from the Saasveld Forestry College. He then completed both a BSc forestry degree and an Honours BSc degree in forestry at the University of Stellenbosch. During this time he studied under Prof. Leon Pienaar, who was on sabbatical at Stellenbosch. Prof Pienaar is renowned for his growth and yield research at the University of Georgia, USA, and he laid the foundations for Heyns’s interest in growth and yield modelling. After University, Heyns joined the CSIR as a junior researcher during which time he completed an MSc degree at the University of Stellenbosch and developed volume and taper models for *Pinus patula*. Heyns later moved to SAFCOL, and is currently Programme Manager of the Growth and Yield Research programme. His research programme is closely linked with the forest planning department to aid with analysis regarding forest inventory, forest economics and the growth and yield simulator used in the forest planning system.
Global Climate Change and its relevance to the South African Forestry Industry

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The centre of gravity of international efforts in the global change arena has shifted decisively from asking whether climate change is occurring and what causes it, to debating the best way to address the changes. There is near-consensus that a global mean temperature increase substantially above 2 °C (which translates into an atmospheric CO₂ concentration of about 500 ppm) would be ‘dangerous’, and incur impact costs higher that the expenditure needed to avoid such a target. Given that the world has already witnessed a 0.8°C rise, and is already committed by the inertia of the global climate system to a 1.5 °C rise, clearly urgent and strenuous action would be needed to stay below the 2 °C level. In order to reach a meaningful ‘Post-Kyoto’ global agreement to limit and sharply reduce emissions of greenhouse gases, it will be necessary for high-emission developing countries such as South Africa to accept mitigation responsibilities as well. Therefore the research and policy focus in South Africa is moving from being exclusively centred on impact and adaptation, to one having a mitigation element as well.

As a natural products industry with a long planning horizon, forestry clearly has an interest in future climate scenarios. The emerging view is that the main eastern seaboard tree-growing regions will be significantly warmer by mid-century, but not necessarily drier. The increased evaporative demand will be offset by rising CO₂ and increased rainfall. But the pressure on national water resources will continue to intensify, so issues of the water use by plantations will continue to be under the spotlight, as will the water demand of processing plants. It is entirely consistent with the projections that the frequency and intensity of both droughts and floods will increase. The southern and western Cape is projected to become net drier, and see a greater fraction of its rain in summer. The consequences for changing fire regimes are important for plantation managers.

The forest sector also has some options to benefit from the mitigation area, over and above the sale of carbon credits from afforestation. Cogeneration, especially if based on biomass fuels, is an attractive way to bring down South Africa’s dependence on fossil fuels. The use of forest byproducts as direct fuels is also efficient. The use of low-embodied energy materials in construction – particularly particle boards and other wood-based products – has several climate change mitigation advantages.
Estimating net primary productivity and above ground biomass of *Eucalyptus grandis* through integration of remotely sensed data and a process-based model

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This study describes the integration of remotely sensed data and a process-based model i.e., Physiological Principles Predicting Growth-Spatial version (3PG-S), for the estimation of net primary productivity (NPP) and above ground biomass (AGB) of *Eucalyptus grandis*. 3PG-S is a production model driven by remote sensing data reducing the tedious and time-consuming field data collection. The process-based model allows for prediction of growth in relation to fluctuating weather patterns and can be driven by remotely sensed data. The model was tested and validated on *Eucalyptus grandis* stands in Zululand, South Africa. Absorbed photosynthetically active radiation (APAR) was estimated from global solar radiation based on empirical relationship of average maximum and minimum temperatures, and from a linear relation with the satellite-derived normalized difference vegetation index (NDVI) which represents photosynthetic capacity of all vegetation.

The model outputs (i.e. NPP and AGB) were tested against data made available by the Institute of Commercial Forestry Research (ICFR) in order to provide independent estimates of forest growth capacity. The results showed significant correlations ($r > 0.8, p < 0.001$ and $r > 0.85, p < 0.01$) between predicted and observed values for NPP and AGB for all plots, respectively. Also on combining all the plots, significant exponential regressions ($r = 0.95, p < 0.01$, $R^2 = 0.94$, $n=144$, $SE = 0.032$ and $r = 0.93, p < 0.01$, $R^2 = 0.91$, $n=115$, $SE = 0.116$) were obtained for both NPP and AGB, respectively. Furthermore, model outputs show variation within compartments. Results presented show that the 3PG-S model is robust and reliable and can be used with confidence to predict NPP and AGB of *Eucalyptus grandis* in the Zululand region of South Africa.
Further progress in the development of predictive models for growth and wood quality of plantation-grown *Pinus patula* saw-timber in South Africa

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The objective of this paper is to further discuss and demonstrate the progress made (after an initial report by Kotze and Malan 2005), with the understanding, modelling and simulation of tree growth and wood quality of South African-grown *Pinus patula* saw-timber in response to the effects of site quality, planting density, thinning and pruning. Research to date focused on the development of stand-level growth and yield models. Model components for dominant height, survival and basal area are used to estimate growth of unthinned stands in relation to planting density. A basal area/thinning ratio model estimates the ratio of basal area removed in a thinning in relation to the ratio of stems removed. Thinnings are done selectively from below. A basal area thinning response model estimates basal area growth after a thinning. At any point in time the diameter distribution can be recovered by using a Weibull distribution and a method of moments approach. Height-by-diameter and live crown height models estimate tree height and live crown height for each dbh class in the distribution. Taper models were developed for the estimation of product volumes. Data for the growth and yield models were gleaned from long-term spacing trials, thinning response trials, permanent sample plots, thinning control inventories and destructive sampling. Current research focuses on the development of models to estimate within-tree basic wood density and branch characteristics determining the knottiness of lumber, such as number of branch clusters per annual shoot, maximum branch diameter, distribution of branch diameters within a branch cluster, branch angle and branch development over time. Data for the wood quality models were gleaned from trees destructively sampled over the site quality range. The inclusion of prediction models for tracheid length, spiral grain and microfibril angle is envisaged at a later stage. To demonstrate our progress, the growth and wood quality models were combined in a simulation program, the Forestry Scenario Analysis Tool. This program quantifies the effect of site quality and silviculture (planting density, thinning, pruning and rotation) on stand growth, tree dimensions, log product yields and economics. It also includes a bucking algorithm capable of bucking each tree in the stand table to provide an estimate of the total log harvest and their qualities in terms of position in the tree, log length and thin-end diameter. Algorithms determine the effect of pruning on the defect core size as well as quantify the effect of the live crown height on the live knot stem section. A sawmill conversion simulator predicts lumber yield and size distribution, using a preset sawing pattern for each log type and diameter class. Currently, the output also contains information on the expected wood density and absence or presence of knots (clear, semi-clear or knotty). This enables the system to provide an estimate of the value of each individual lumber piece produced in terms of current lumber prices. Finally, the cash-flow for the whole stand is generated, economics criteria are applied and the influence of forest practices on wood quality evaluated in forest economic terms on a stand-level basis.
Session 4
Chairperson: Dr Colin Smith (ICFR)

A preliminary appraisal of nutrient supply and demand in eucalypts

Steven joined the ICFR in 1996, first as a student, then on contract for a full year. He was appointed to the ICFR permanent staff in early 1999 as an assistant field technician for the Karkloof study. Through a determined interest in forest ecology and generous opportunities afforded by the ICFR, he has progressed to fill a research post. Steven completed his undergraduate studies and MSc at the University of KwaZulu-Natal, and is currently registered for a PhD in Forestry at the University of Stellenbosch, looking at using biogeochemical nutrient cycling processes to understand the impact of plantation management on sustainable productivity. He intends developing simplified indicators applicable to sustainable plantation forestry management decision making. Steven enjoys achieving his goals in ecological plantation forestry sustainability through exploration of new and innovative ideas to solve complex problems using simple models.

The effect of harvesting operations and residue management on the early growth of Eucalyptus grandis at two sites in KwaZulu-Natal

Diana has an MSc in Soil Science from the University of Natal. She is currently employed at the ICFR as a Research Scientist in the Sustainable Forest Productivity Programme. Her research is focused on the effect of forestry operations, particularly harvesting and residue management, on soil mechanisms that affect plantation productivity. Diana is currently completing her PhD on this subject in Eucalyptus plantations.

Effect of spacing on growth and fibre morphology of Eucalyptus grandis pulpwood

Marius du Plessis has a Saasveld Diploma, a BSc Forestry and an MSc Agriculture (Forestry). Research interests include the chemical Kraft pulp processes, genetic improvement of species used in the pulping processes, the contribution and influence of individual species and site to process and pulp quality, laboratory and pilot scale standards setting, testing methods and having some fun making paper. Marius is married to Eureka, and has three sons. When he is not making paper, he enjoys caravanning, camping, DVD-ing and Googling.

Drying of burnt timber

Martina studied physics in Konstanz / Germany and obtained an MSc degree in 1998. After completion she came to South Africa for a six month internship at the National Accelerator Centre / Faure that eventually turned into a 10 year stay, in which she did, however change her specialisation entirely. Martina began her PhD in Polymer Science and graduated in 2002 with a dissertation dealing with the film formation and thermal transitions of polymers analysed with Atomic Force Microscopy (AFM). After two years as a postdoc and three years as a Researcher at Polymer Science, she became Senior Lecturer in the Department of Forest & Wood Science in 2006. Here she is in charge of wood physics & drying and composite materials and is still working on surface analysis of various materials with AFM.
A preliminary appraisal of nutrient supply and demand in eucalypts

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Sustainable timber production needs to be increase on or at least maintain to ensure present and future market demands are met. The productivity of a forest plantation is dependant on relationship between nutrient supply from pools in the soil, forest floor, and trees and age related growth demand. Two separate studies were used to appraise nutrient supply and demand. The first compared static nutrient pool sizes with final tree uptake, while the second tracked nutrient accumulation with age. A 45 site nutrient pool study, undertaken in 2003, was used to determine nutrient pool size across a range of summer rainfall plantations. Nutrients in trees, forest floor biomass and the first meter of soil were quantified for each site using various analytical methods. Analyses of soil nitrogen were not available at the time of analysis. The second study determined above ground nutrient accumulation of *Eucalyptus grandis* under levels of residue management.

The first study suggests that site characteristics determined the weight of contribution to nutrient pools by the various plantation components. Soils with low nutrient holding capacity, having with low clay and organic carbon content and shallow depth had smaller nutrient pools. High temperature and rainfall sites, typically high productivity sites, also tended to have small litter nutrient pools. Cooler sites tended to accumulate larger forest floor nutrient pools. The relationship between the forest floor and soil nutrient pools may also play a role in determining nutrient supply. Nutrient accumulation was the greatest around the time of canopy closure in the second study. A reduced nutrient availability, created through residue removal was reflected in a decreased growth and nutrient uptake. Further nutrient accumulation fluctuations were related to climatic factors.

Identifying sites according to nutrient supply and demand potential may be an importation step in formulating management regimes for maximum productivity. Sites need to be managed such that small nutrient pool sites are managed conservatively while large sites accumulating nutrients managed to avail more nutrients during crucial growth periods. The aim is to manage sites for optimal nutrient supply to ensure maximal productivity during high nutrient demand periods, while minimising nutrient loss.
The effect of harvesting operations and residue management on the early growth of *Eucalyptus grandis* at two sites in KwaZulu-Natal

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In contrast to forestry, the agricultural sector has considerable, well-established evidence that certain practices have a negative impact on the long-term productivity of agricultural land, despite the improvement of genotypes. Harvesting and residue management are two forestry practices most likely to reduce long-term site productivity. The aim of this study was to evaluate the effect of different intensities of harvesting and residue management on soil processes and the growth of *Eucalyptus grandis* at two contrasting sites in KwaZulu-Natal (Rattray in Zululand and Shafton in the Midlands). In particular relationships between the productivity of young, fast-growing *Eucalyptus* stands to changes in soil properties and processes as a result of the treatments were sought.

In the most recent rotation, these sites were harvesting impact trials discussed by Smith and du Toit (2005) and Smith (2006). For this study, a gradient in harvesting intensity and residue load was established in a factorial design.

Increasing harvesting intensity significantly increased penetrometer soil strength (PSS). However the presence of residues reduced this effect of the machinery on PSS in the top 0.3 m of soil. Increasing bulk density increased the amount of plant available water at Rattray, but decreased it at Shafton. Tree growth was significantly negatively affected by increasing harvesting intensity. At Rattray, this effect decreased with time, becoming non-significant after two years. However at Shafton the effect increased with time, as initially there was no effect until the trees were 1 year old, and subsequently became more significant. Until six months of age, increasing residue retention negatively affected tree growth at both sites. Thereafter no significant growth responses to residue were measured at Rattray, while at Shafton increasing levels of residue retention improved tree growth.

These results indicate that PSS is a good indicator of early tree growth. The persistence of similar levels of PSS from the previous trials to prior to implementation of these trials indicates little natural amelioration. Residue removal may initially improve tree growth, but this effect does not persist and may negatively impact growth in the long-term. In addition, residue removal prior to mechanised harvesting will increase the impact on the soil. Different growth responses (in time) to treatments indicate different key processes operating at each site.
Effect of spacing on growth and fibre morphology of *Eucalyptus grandis* pulpwood

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Results from a Nelder 1a trial that was established in 1998 on a good site, on Peak plantation in Swaziland, were used for the analysis of this study. The Nelder spacing trial is a systematic experimental design, named after its originator and provides an effective means of studying growing space and yield in forest plantations over a time period. The design is versatile, offers economics of area, plants and time, and can be used over a range of soil types and species.

Sampling was at first restricted to one quarter of the trial area and later done across the entire Nelder trial. Unfortunately in the 2007 catastrophic fires, the trial was damaged beyond recovery and a final measurement was done. Results presented in this study are from the pre-fire sampling period.

A breakdown of growth responses influenced by the wide range of stocking levels; ranging from 123 to 8898 stems per ha, for a total of 16 treatments, is given. A growth model was fitted to the data that revealed significant models for all components of a growth model; e.g. Coefficient of Determination ($R^2$), MSE and $n$ values for Dominant Height prediction form are respectively, 0.9693; 1.5517; 476. Other values are shown in the presentation. Severe suppression was evident in the high stocking levels causing stagnation of diameter growth at two years and top die-back of the crowns. The wider stocking levels of between 5200 and 8800 showed growing trends of relative free growth; wide diameters and heavy crowns.

The variation in wood quality for various treatments was also studied. Fibre morphological characteristics like wood density, vessel characteristics, cell wall diameter, thickness and lumen size, were studied in the radial plane from pith to bark, on 10 discs taken at increasing heights from each tree. Furthermore, NIR spectroscopy predictions were done to predict the potential changes in cellulose and lignin fractions within a tree and over treatments. From results presented here it is evident that there is an interaction between cellulose (as a precursor for pulp yield) content and stocking density at different levels. It is also evident that the rate of change in some wood and fibre characteristics changes with the intensity of stocking density.

An economic model applied indicates optimum levels where forest yield, timber size and wood characteristics are most profitable.
Drying of burnt timber

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The fires raging across South Africa in 2007 caused severe financial damage to the wood industry. In this study we determined if wood that has been exposed to different degrees of fire can be dried in the same way as green wood or if it results in a different wood quality.

We compared the MC distribution of the green wood and after drying, colour changes due to degradation, mechanical and structural properties, as well as the chemical composition of green and burnt wood and found significant differences between green and burnt wood.
Session 5  
Chairperson: Dr Bernard Janse (Mondi SA)

Laboratory hardwood cooking - batch versus compact cooking and the effect of cooking on selection of clones for wood quality

Athol joined Mondi in 1989 to establish the Eucalyptus clonal testing facility at the Richards Bay Mill. Together with the late Peter Leah, he was responsible for implementing clonal selection criteria that included pulping characteristics. In 2005 Athol joined CC Innovation, when Mondi restructured. With the upgrading of the pulp mill in Richards Bay, 10 of the 14 batch digesters were replaced by a single continuous digester. Most of his time over the last few years has been spent together with the team from CCI on trying to understand the implications of lower cooking temperature, longer cooking times and the inclusion of a pre-impregnation stage on the quality of the final pulp and the impact that these changes will have on how the next generation of clones need to be selected.

Breeding South African pine wood for improved stiffness using acoustic wave velocity: Review and first results

Francois studied at the University of Stellenbosch where he obtained a BSc in Forestry, BSc Hon, MSc and a PhD in Wood Science. He started his career at the Forest Research Institute of the Department of Water Affairs and Forestry in Pretoria in 1971. After that he served for different periods of time at the National Timber Research Institute of CSIR, Department of Wood Science of the University of Stellenbosch as lecturer and the Division of Environment, Water and Forestry Technology (Forestek) of the CSIR in Pretoria. In 1997 he joined the South African Forestry Company Ltd (SAFCOL). Currently he is employed by Komatiland Forests (Pty) Ltd, a subsidiary of SAFCOL, as Programme Manager: Wood Quality and Processing at the company’s research centre near Sabie. He is mainly responsible for the development, implementation and monitoring of strategies aimed at understanding and improving the wood quality of the company’s timber resource. He has a special interest and experience in the factors controlling within- and between-tree variability in wood properties, including silvicultural and genetic factors.

Using sound wave technology to assist in selection in Eucalyptus sawlog breeding programmes

After matriculating at Drostdy Technical High School in 1998, Maurits started studying at Stellenbosch University in 1999 and finished his BSc Wood Science in 2002. He then enrolled for an MSc investigating the occurrence and control of yellow and brown stain during kiln drying, which he completed in 2005. Maurits began working for HM Timber in January 2006, primarily to initiate and manage research and development projects for HM Timber sawmills, focussing on primary processing and drying. Part of his responsibilities are to identify and test new or old technology used to measure wood quality either in standing trees, logs or boards and investigate their potential for use in our breeding programs and sawmilling applications.
Previous selections of clonal material for pulping properties relied on batch simulated cooking (BSC). However, recent advances in cooking technologies have resulted in increased pulp yield from the same woody biomass. We were thus interested in seeing whether a change in cooking conditions would result in a change in the ranking of selected material. In this study we compared the ranking of different species of eucalypts and Acacia, also grown on different sites, that were pulped under two different conditions – one representing the old batch cooking process and the second more closely reflecting the new continuous digestion process. Results obtained from this study clearly showed that the cooking process influences the ranking of individual clones and we recommend that certain changes be introduced when looking at selection of clones.
Breeding South African pine wood for improved stiffness using acoustic wave velocity: Review and first results

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Due to the results of intensive forestry and tree breeding forest managers are increasingly inclined to reap the financial benefits of faster growth by harvesting earlier, as new generations of genetically improved forest trees reach merchantable sizes much quicker. However, the impacts on the industry for solid wood products might be negative, as they will face increasing proportions of juvenile wood in their raw material intake, which is intrinsically less stable, and lower in strength and stiffness. The changing characteristics of our timber supply therefore necessitate that breeding programmes intensify their efforts on improving the characteristics of juvenile wood. Reliable methods must also be found for assessing and tracking juvenile wood quality characteristics, and selecting the most appropriate rotation ages to fully exploit the qualities offered by the resource. Since almost all the important wood properties of juvenile wood, even the radial gradients of some of them, are moderately to strongly heritable, there is good opportunity to improve characteristics genetically, with the main emphases being on reduced core size, increased stiffness, an average spiral grain angle of less than 6° and increased radial uniformity. As juvenile wood is characterised by marked differences in microfibril angle, the use of wood density as a single characteristic to increase stiffness and strength has been found to be less effective compared to mature wood, as microfibril angle is known to be inextricably linked to stiffness, longitudinal shrinkage, warp and stability. To counteract the adverse effects of increasing amounts of juvenile wood on the distribution of strength and stability characteristics of the future timber supply, selection for improved juvenile wood stiffness on standing trees in current tree breeding programmes, using a technique that accommodates both the influences of wood density and microfibril angle, has become of utmost importance. The use of acoustic speed to assess standing timber quality has been found to meet this requirement.
Using sound wave technology to assist in selection in *Eucalyptus* sawlog breeding programmes

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The cumulative pressure on local sawn timber growers after the devastating fires last year and continuous climate change, force tree breeders to try to take “quantum leaps” in breeding high quality, high volume trees in a shorter time. Many destructive tools and methods exist to assist the tree breeder in measuring the traits important for their applications.

Over the last decade or two, tools and methods have been investigated to assist tree breeders in sampling and measuring trials non-destructively and, thereby, allowing one to evaluate the trials over an extended time. This would not only allow one to investigate effect of external variables on the wood quality, but could allow the tree breeder to make selections at a very young age.

One of these tools, a Fakopp Tree Sonic was used to evaluate eucalyptus trees intended for sawtimber production. Measurements were taken on the standing trees as well as the wet and air dried boards. The data was analysed and some conclusions drawn from the results. The main aim was to understand the data one captures and how one could use the data to assist us during tree selection.
Session 6
Chairperson: Craig Norris (NCT Forestry Co-operative)

Non-destructive estimation of cellulose content using near infrared spectroscopy to rapidly assess kraft pulp yield of *Eucalyptus grandis*

Anton has MSc and PhD degrees in Wood science, specialising in wood quality from Technical University in Slovakia. During his PhD study he spent 4 months in ETH institute in Zurich – Wood Physics department. He joined CSIR in 2001 as a post-doc, focusing on development of rapid screening tools – densitometry, image analysis and microscopy to assess fibre characteristics of pine and eucalypts. Currently he is a senior scientist within CSIR Forestry and Forest Products in Durban. His main research focuses on development of near infrared spectroscopy calibration models for rapid assessment of chemical wood composition, pulping properties and solid wood properties using non destructive sampling systems. My other research interests include research on the evaluation of the impact of age, environment, stand growth and genetic on wood, pulp and paper properties to maximise product quality, and improving non-destructive estimates of whole-tree wood properties in plantation eucalypts.

Bleached or unbleached pulp properties as indicators for breeding?

Theo received his PhD in 2001 from the University of Stellenbosch. The topic for the dissertation was characterisation of whiterot fungi from South Africa as biopulping agents. He then spent three years at the Forest Products Laboratory in Madison, Wisconsin. In their wood preservation department, he worked on basic research in the field of fungal degradation of wood. The key hydrogen peroxide pathway, of the whiterot fungus *Phanerocheate chrysosporium*, was studied and new unknown compounds as products from this pathway identified. Theo then joined the Innovation competency centre at Mondi as fibre chemist, where his main task is management of projects with Mondi’s knowledge partners.
Non-destructive estimation of cellulose content using near infrared spectroscopy to rapidly assess kraft pulp yield of *Eucalyptus grandis*

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Kraft pulp yield is important for plantation profitability, but traditional assessment is time consuming and costly. Cellulose content is one of the properties which strongly influences the kraft pulp yield. However the determination of cellulose still involves wet chemistry measurement which limits the number of samples that can be processed within a tree breeding program. In this paper, the utility of near infrared (NIR) spectroscopy for predicting cellulose content in *E. grandis* was examined. *E. grandis* is one of the major species in South Africa grown for pulp and paper production. Wood samples were collected from 16 sites in different regions of SA to capture the widest possible variation in the investigated property. NIR spectra, collected from both sawdust and solid wood samples, were combined with their corresponding cellulose concentrations to develop NIR predictive models. The results of the NIR models including the different sampling strategies used are discussed. The developed models were used to predict the cellulose profiles on pith-to-bark strips sampled at breast-height from 28 trees. The weighted mean values for cellulose representing the whole disc were then related to the kraft pulp yield of the corresponding 2m long billet samples. It was observed that cellulose was strongly correlated with screened pulp yield, highlighting that NIR spectroscopy can be a valuable tool in a tree breeding program for the rapid and non-destructive assessment of kraft pulp yield.
In a highly commoditized market, product quality often gives a competitive advantage. Pulp buyers of many large corporations are realizing that whilst paper can be made from most pulp ("pulp is pulp"), the cost of quality and reliability of the paper making process can be dramatically influenced by pulp quality. Historically tree breeding programs have relied exclusively on the use of pulping properties such as pulp yield and final Kappa number. Therefore, this study was aimed at ranking clones according to pulp qualities such as burst index, tensile and apparent sheet density. However, it has been shown that bleaching significantly influences the final pulp quality. Our results indicate that the laboratory bleaching process and cooking temperature influences the ranking of clones based on pulp quality properties.