

**The carbon balance in forest fuels from long rotation forestry: the outcome is in the assumptions.** Egnell, G. (Swedish University of Agricultural Sciences, Sweden; [Gustaf.Egnell@slu.se](mailto:Gustaf.Egnell@slu.se)), Berndes, G. (Chalmers University of Technology, Sweden; [goran.berndes@chalmers.se](mailto:goran.berndes@chalmers.se)).

Many recent studies claim that biomass from long-rotation forestry for energy purposes will not contribute much to mitigating climate change. Typically these studies take a single stand approach and/or use the terminology of carbon debt, focusing on the time lag before the CO<sub>2</sub> immediately released when the harvested biomass is combustion is balanced by carbon captured in the subsequent stand. Other studies take a what if approach with an overexploitation of the forest resource, and few studies include the behavior of the forest owner on altering future markets for forest products or risks associated with carbon stored in forest stands. Here we present results from software developed within the Heureka project in Sweden to estimate total carbon sequestration, including soil and stand carbon, over time following different assumptions for (1) markets for forest fuels, pulpwood, and timber; (2) forest owners behavior based on market expectations; and (3) the age structure of the forest. Results are given for a single stand, a forest estate, and for the whole productive forest in Sweden based on national forest inventory data. Since the outcome is in the assumptions, they are also discussed.

**Evaluation of natural regeneration of woody plants in a mixed plantation of tree species.** Enciso Gomez, M., Leguizamon Aranda, A., Elias Dacosta, L. (National University of Asuncion, Paraguay; [manuelenci@yahoo.com](mailto:manuelenci@yahoo.com); [adanleguiaranda@gmail.com](mailto:adanleguiaranda@gmail.com); [elidaco28@gmail.com](mailto:elidaco28@gmail.com)).

The occurrence of the regeneration of woody plants in a plantation forest is important because it can eventually lead to the formation of a structure and coverage that resembles that of a natural forest. Therefore, the assessment of natural regeneration can produce results that clarify the potential to reconstitute the characteristics of a natural forest through planting. In this study we evaluated the natural regeneration in a 23-year-old mixed plantation with eight native forest species located on the campus of the National University of Asuncion, in the city of San Lorenzo, Paraguay. Sampling areas were systematically established within the plot where individuals were identified and calculations of abundance, frequency, and mixing ratio were completed. We found 20 967 individuals/ha, consisting of 13 families and 25 species. There were no regeneration individuals corresponding to the two planted species. The two species with the highest relative abundance had values of 48.01% and 14.31%, respectively. The two species with higher relative frequency at seedlings stage had values of 15.07% and 12.33%, respectively. While at pole stage, the two species with the highest relative frequency had values of 10.84% and 9.64%, respectively. The mixing ratio of species had a value of 0.04. It was concluded that the mixed planting of native forest species promotes regeneration of a large number of individuals and can be an alternative to restoring vegetation cover having the characteristics of a natural forest.

**Sustainable energy from wood plantations benefits Coopetarrazú coffee.** Esquivel, E., Molina Quesada, S., Arias, D., Briceño-Elizondo, E. (Instituto Tecnológico de Costa Rica, Costa Rica; [eesquivel@itcr.ac.cr](mailto:eesquivel@itcr.ac.cr); [samolina117@gmail.com](mailto:samolina117@gmail.com); [darias@itcr.ac.cr](mailto:darias@itcr.ac.cr); [ebrieno@itcr.ac.cr](mailto:ebrieno@itcr.ac.cr)), Calvo, M. (Coopetarrazú, Costa Rica; [mcalvo@coopetarrazu.com](mailto:mcalvo@coopetarrazu.com)).

For the market value price to reflect coffee with a distinction of being produced sustainably, processing requires heat that traditionally has been obtained from burning wood. However, wood supply comes from different sources with various species, age, and heat capacities, creating differences in boilers at the industrial level, thus justifying the need to obtain a source of biomass of a standard quality for the coffee processing industry. Coopetarrazú coffee industry is located within an area where land use for coffee is inadequate and using farmsteads for forestry would be more appropriate. Using high-density plantations, we established a three-block experimental design with six treatments combining two Eucalyptus species (*Eucalyptus tereticornis* and *E. saligna*) at three stockings (5000, 10 000 and 20 000 trees/ha) in 100 m<sup>2</sup> plots. By periodically evaluating soil nutrients, biomass, stage of development, and carbon sequestered in soil and biomass, we have identified suitable densities and species combinations for energy production. This knowledge is of great importance to Coopetarrazú and other coffee companies.

**Natural regeneration in Mediterranean pine forests: a conceptual approach under climate change.** Fonseca, T.F. (University of Trás-os-Montes e Alto Douro, Portugal; [tfonseca@utad.pt](mailto:tfonseca@utad.pt)), Lucas-Borja, M. (Universidad de Castilla La Mancha, Spain; [ManuelEsteban.Lucas@uclm.es](mailto:ManuelEsteban.Lucas@uclm.es)), Rodríguez García, E., Bravo Oviedo, F. (Universidad de Valladolid, Spain; [enkaro@hotmail.com](mailto:enkaro@hotmail.com); [fbravo@pvs.uva.es](mailto:fbravo@pvs.uva.es)).

Factors restricting natural regeneration success in Mediterranean pine forests at the earlier stages are especially complex, and some of them are not completely understood. They include year-to-year variability in seed production, post-dispersal seed predation, suitable medium for seed germination and seedling survival, diseases, and variable environmental conditions. In addition, factors can vary annually or within a given year and can vary with local conditions and season. From data obtained in *Pinus nigra* and *Pinus pinaster* stands in Spain during the last decade, results showed that the processes linked at the beginning of recruitment do not predict good expectancies in non-masting years. Moreover, seed germination, seedlings survival, and initial seedling growth are influenced by site perturbation (harvest, fire), stand density, shrub and canopy cover, and soil properties. In conclusion, the relationship between natural regeneration and all the factors involved appears to be site specific and additionally mediated by species plasticity. Further research work is needed to determine whether the relationships described above can be generalized.

**Growth reaction of a multiple use species (*Tectona grandis* L. F.) to pruning in the State of Rondonia, Brazilian Amazon.** Gama, M.B., Vieira, A.H., Rocha, R.B., Locatelli, M. (EMBRAPA, Brazil; [michelliny.bentes-gama@embrapa.br](mailto:michelliny.bentes-gama@embrapa.br); [abadio.vieira@embrapa.br](mailto:abadio.vieira@embrapa.br); [rodrigo.rocha@embrapa.br](mailto:rodrigo.rocha@embrapa.br); [marilia.locatelli@embrapa.br](mailto:marilia.locatelli@embrapa.br)).

Research on tropical silviculture practices is a key point for generating answers for forest managers and policy-makers. Especially in the Brazilian Amazon where complex biodiversity has experienced rapid degradation and the efforts on adjusting management techniques to encourage reforestation are permanent. Production forests may fit viable strategies to mitigate the negative effects of deforestation, but some driving characteristics for enhancing good wood quality are still needed. This study reported on the

pruning trial in a commercial plantation of teak in the State of Rondonia in northwestern Brazil. Treatments consisted of pruning intensities of 25%, 50%, and 75% and the control treatment with no pruning. Differences among treatments in pruning and age were not significant at 25% and 50% intensities in contrast to the control, but were significant at 75% intensity. In addition, the pruning intensities caused no detrimental effect on the commercial height of trees at the age of 44 months. Current findings indicate that moderate pruning regimes are adequate for pursuing improvements to stem form and wood quality without having a strong effect on tree growth and stand yield in this portion of the Amazon.

**Evaluation of the effectiveness of the use of bokashi on seedling quality of *Balfourodendron riedelianum* (Engl.) Engl (Guatambu).** Garcia, M., Zorrilla Benítez, S., Enciso Gomez, M., Vera de Ortiz, M. (*Universidad Nacional de Asunción, Paraguay*; [marialisgarcia@gmail.com](mailto:marialisgarcia@gmail.com); [ser-zorro@hotmail.com](mailto:ser-zorro@hotmail.com); [manuelenci@yahoo.com](mailto:manuelenci@yahoo.com); [dircif@agr.una.py](mailto:dircif@agr.una.py)).

The growing demand for native tree seedlings requires research related to the use of substrates capable of providing seedlings with high initial growth rates and survival after planting. *Balfourodendron riedelianum* (Engl.) Engl (Guatambú) is a native species of Paraguay whose wood is in high demand both nationally and internationally. This study evaluated the effectiveness of bokashi on the quality of seedlings of Guatambú, with and without fertigation. The applied experimental design was a randomized factorial design with 14 treatments, 5 replicates, and a control. Each experimental unit consisted of four plants, totaling 300 seedlings. Morphological parameters including height, collar diameter, shoot dry weight, root dry weight, root shoot dry weight ratio, slenderness index, and Dickson quality index were evaluated. No significant differences in the levels of fertilization were found. The treatment consisting of soil (70%) + bokashi (30%) + fertigation produced the best results in height. In diameter and shoot root dry weight ratio, the best results were obtained with the substrate composed of soil (80%) + bokashi (20%) + fertigation. For slenderness index and Dickson quality index, the substrate composed of soil (50%) + bokashi (25%) + cow manure (25%) with fertigation produced the greatest value.

**Enhancing mine and energy crop soils to promote willow and poplar growth using ash and biosolids: a greenhouse trial.** Gilbert, N. (*International Forestry Students Association, Canada*; [sno\\_reason@inorbit.com](mailto:sno_reason@inorbit.com)).

Wood ash from bioenergy production contains a high concentration of nutrients essential for plant growth and can neutralize acidity in soil. The objective of this study was to assess the growth of willow and poplar in soils amended with different amounts of bioenergy ash (0%, 0.5%, 1%, 2%). In two trials divided by soil type (sand and loam), clonal cuttings were grown in a greenhouse for 4 months. Three bioenergy ash differing in chemical properties, such as pH and CEC, and bioenergy system, boiler system versus gasifier, were used for this study. To supplement the nitrogen deficiency common of wood ash, biosolids were mixed into half the treatment samples. The acidic, well-draining, sandy soil produced the greatest yield of new growth in the mixed ash and biosolids combinations. In the neutral loam trial, the plants also responded best to the ash treatments mixed with biosolids. These results suggest a method of fertilization that not only promotes plant growth, but also provides a use for materials otherwise considered to be waste.

**Advanced oak seedling development as influenced by shelterwood treatments, competition control, deer fencing, and prescribed fire.** Gottschalk, K., Miller, G., Brose, P. (*U.S. Forest Service, USA*; [kgottschalk@fs.fed.us](mailto:kgottschalk@fs.fed.us); [gwmiller@fs.fed.us](mailto:gwmiller@fs.fed.us); [pbrose@fs.fed.us](mailto:pbrose@fs.fed.us)).

Advanced northern red oak (*Quercus rubra* L.) seedlings in an 85-year-old forest located in north-central Pennsylvania were observed for 10 years after manipulation of overstory density, herbicide control of interfering plants, exclusion of deer by fencing, and application of a single prescribed fire. A total of 24 treatment combinations including untreated controls were studied on 72 permanent plots. Seedling survival and seedling growth were enhanced by both exclusion of deer by fencing combined with a moderate (12% of basal area) to high (27% of basal area) removal of the overstory. Published dominance probabilities for site index 70 were applied to the average size and number of tagged advanced seedlings in each plot to determine which treatments produced the greatest predicted number of codominant oaks in the next stand after final harvest. Treatments that included exclusion of deer by fencing combined with a moderate (12% of basal area) to high (27% of basal area) removal of the overstory projected new stands with more than 50 percent oak composition. Fencing and no overstory removal, while producing much less growth, also predicted more than 50 percent oak composition. Oak seedling development and suggestions for writing silvicultural prescriptions to prepare for successful oak regeneration are discussed.

**Mixed-species plantations of *Eucalyptus* and *Acacia mangium* as an alternative for bioenergy production in tropical regions.** Hakamada, R. (*University of São Paulo, Brazil*; [rodrigo\\_hakamada@yahoo.com.br](mailto:rodrigo_hakamada@yahoo.com.br)), Bouillet, J. (*CIRAD, France*; [jean-pierre.bouillet@cirad.fr](mailto:jean-pierre.bouillet@cirad.fr)), Gonçalves, J. (*University of São Paulo-ESALQ, Brazil*; [jlmgonca@usp.br](mailto:jlmgonca@usp.br)), Voigtlaender, M. (*Institute of Forest Research, Brazil*; [mvoigtlaender@gmail.com](mailto:mvoigtlaender@gmail.com)), Gava, J. (*Suzano, Brazil*; [jgava@suzano.com.br](mailto:jgava@suzano.com.br)), Leite, F., Mareschal, L., Nouvellon, Y., Mazoumbou, J., Koutika, L., Epron, D., Laclau, J. (*CIRAD, France*; [jean-paul.laclau@cirad.fr](mailto:jean-paul.laclau@cirad.fr)).

Silvicultural practices that increase wood production in forest plantations are required to achieve society's demand for renewable energy sources. Mixed-species plantations of *Eucalyptus* and *Acacia mangium*, a N-fixing species, have been studied as a pathway of ecological intensification, enhancing nitrogen availability and carbon accumulation within the system. Our objective was to compare the potential of bioenergy production in pure and mixed-species plantations. We used calorific values from the literature along with data of wood production measured at five sites in Brazil and Congo with various levels of productivity to calculate the energy produced at the end of stand rotation (on average 6.2 years after planting). We compared pure *Eucalyptus* stands (100E) to mixed-species stands with the same density of *Eucalyptus* trees with 25% *Acacia* trees (100E:25A). At all sites, the mixtures generated energy gains ranging from 0.2 to 36.3% compared to *Eucalyptus* monocultures. These gains were highly correlated ( $R^2 > 0.99$ ) with total stemwood production, due to comparable calorific values for both species. This study opens the possibility for using mixed-species plantations of *Eucalyptus* with N-fixing tree species as a renewable source of bioenergy for both domestic and commercial uses.