Vetenskaplig sluttredovisning av projekt inom programmet Swedish Research Links

(Vetenskapsrådet/SIDA/SAREC)

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Projekttitel: **Estimation of gene diversity and drift pattern in natural populations and plantations of four south Indian forest tree species**

Vetenskapsrådets ärendenummer/projektnummer 348-2002-6898
Totalt erhållet belopp senaste bidragsperioden 375 kkr

Projektets syfte kort sammanfattning, enligt ansökan samt eventuella ändringar under projektperioden:

The project aims to investigate the diversity and gene flow in four native Indian forest tree species. Identifying representative natural stands and understanding their reproductive mechanism, quantifying diversity using fertility variation and comparing the variability in plantations and seed orchards, form the work component of the Indian investigator. The Swedish investigator would co-ordinate compilation of data and jointly estimate coancestry, relatedness and resultant inbreeding for different generations in plantations and breeding populations. Standard procedures tested for teak and other broad leaved tree species would be employed. Information generated would help in understanding the probable levels of inbreeding and associated loss of diversity depending on the breeding system of each species. The species considered have great importance in the region from economic and biodiversity point of view. Results would also provide guidelines for domestication of the species. The information on the tropical Indian tree species would be compared with models prepared for temperate species and incorporated in the website managed by the Swedish investigator. Co-authored publications and manuals would be brought out highlighting the findings.

Results

This summery describes results from a collaboration between an Indian Scientist (Mohan Varghese) and a Swedish (Dag Lindgren) and their collaborators. The cooperation is described at http://www.sasnet.lu.se/forestgenetics.html

Planted forests meet most of the wood requirement in tropical countries as natural forests are being conserved for protection of environment and water resources. Plantations of fast growing exotic species like eucalypts meet the fuel and pulpwood requirement and

research has been oriented towards identifying suitable species and genotypes that adapt and perform well in a new location. Domestication of several important native species like teak and sandal is in its infancy. Fertility variation in natural stands and plantations has to be understood to develop strategies for scientific domestication of these species.

There has been a recent trend of increasing use of native forest species in afforestation. Unlike most exotics, the native species are comparatively slow growing. Studies have been made in Teak, Sandal, Neem and Tamarind. Flowers and fruits have been inventoried for different trees and clones in a number of stands and seed orchards. Large variations in ability to produce offspring were generally found in many cases (see the table), often larger than in similar Swedish inventories. If seed collections are done from objects with few trees or clones and these are very variable, it will lead to reduced gene diversity, inbreeding and variations and unpredictability. Higher number of clones and families may have to be used in Indian seed orchards than used for conifers in the west.

Several grafted seed orchards of teak were established in the seventies, with the hope of supplying quality seeds of this important timber species. But seed production from these orchards has been dismally low, hardly any seed is used from them. There has been a renewed interest in teak, stands are used as seed sources, and attempts have been made to understand the genetic variation between populations in the south Indian peninsula.

Many of our efforts have aimed at monitoring variation in fertility among trees and clones for different types of forests situated in southern India. Some results have been compiled in the Table.

Species	Type of object	Ψ	Ψ with action
Teak	Clonal orchard	1.71	1.23
Teak	“	8.33	3.50
Teak	Seed production area	3.7	
Teak	“	2.9	
Teak	“	1.9-3.7	
Teak	“	3.2	
Teak	Natural stand	2.1	
Teak	Seed production area	3.2	2.2
Neem	Plantation	2.7	
Sandal	Plantation	1.8-5.6	
Tamarind	Plantation	3.3-4.3	
Tamarind	Clonal orchard	2.0-2.4	

Ψ stands for sibling coefficient and is a measure on how variable trees are. Ψ=1 means that all trees get the same number of offspring (or have the same number of reproductive structure). If Ψ=2 the chance that two offspring has the same parent is double as high as if the parents were equally fertile. Ψ=1.3-3 are common values in non tropical conditions. If there are a number of trees, the effective number (from a fertility stand point) can be seen as the number divided by Ψ.

When observations were done several years, the observed fertility variations were often (although not always) remarkable similar (the table shows averages of similar values, and notes differences only when they are considerable). Fertility variation was generally higher in a natural stand compared to the SPAs (as indicated by the sibling coefficient value) even though 99% of the trees were fertile in two adjacent years. In the SPAs there was a positive year to year correlation in fertility parameters like proportion of fertile trees (0.935), flowers (0.572) and fruits produced (0.857) per tree. The female fertility variation (-0.35) and the fruit set percentage (-0.742) in two successive years were negatively correlated implying that there is a tendency for alternate bearing in trees in a population.

Actions to reduce fertility variation were tested in teak by either putting limits on the harvest of seeds per tree or by thinning. It is possible to reduce variations in the contribution to the progeny, but this severely reduces seed production. Another way to reduce fertility variation is thinning considering fertility. Selection for tree DBH was observed to reduce the fertility variation as DBH was positively correlated to reproductive output in teak.

Sandal flowers twice a year, much higher fertility variation was observed for flowering in August than in February. Fertility variation was found to be low in ten year old sandal plantations compared to those of neem and tamarind**.**

Gemensamma publikationer
Published:

Kamalakannan R, Varghese M and Lindgren D 2007.Fertility variation and its implications on relatedness in seed crops in seedling seed orchards of *Eucalyptus camaldulensis* and *E. tereticornis.* Silvae Genetica in press (0611).

Prescher F, Lindgren D & Varghese M. 2004. Genetic Thinning of Clonal Seed Orchards using Linear Deployment. In Li B & McKeand S Eds Forest Genetics and Tree Breeding in the Age of Genomics: Progress and Future. Conference Proceedings, pp 232-240.

Varghese, M., Ravi, N., Son, S.-G. & Lindgren, D. 2003 Variation in fertility and its impact on gene diversity in a seedling seed orchard of Eucalyptus tereticornis. In: Eucalyptus Plantations – Research, Management and Development, R.-P. Wei and D. Xu (eds), World Scientific, Singapore, 111-127.

Varghese M, Lindgren D and Nicodemus A. 2004. Fertility and effective population size in seedling seed orchards of Casuarina equisetifolia and C. junghuhniana Silvae genetica 53:164-168.

Varghese M, Nicodemus A, Nagarajan B & Lindgren D. 2006. Impact of fertility variation on gene diversity and drift in two clonal seed orchards of teak (*Tectona grandis* Linn f). New Forests 31: 497-512

Varghese M, Lindgren D & Ravi N 2006. Linear thinning in a clonal test of Eucalyptus camaldulensis for conversion to a clonal seed orchard. Journal of Tropical Forest Science 18(2): 102-108.

Submitted:
Varghese, M., Lindgren, D. & Son, S.-G. 2006 Seedling seed orchard thinning considering breeding value, fertility variation and gene diversity

Varghese M., Ravi N., Son S-G & Lindgren D. 2005 Strategies for optimising gain and diversity in a seedling seed orchard of *Eucalyptus tereticornis*

Varghese M, Kamalakannan R, Nicodemus A, and Lindgren D 2006. Fertility variation and its impact on seed crop in seed production areas and a natural stand of teak in southern India. Can. J. For. Res. Submitted.

Varghese M, Lindgren D & Kamalakannan R 2006. Gene diversity consideration while creating south Indian forests. Poster presented at workshop on Policies in Tropical Rural Development – Swedish contributions, influences and research needs at Umeå 061120-21, will be posted at http://uctree.slu.se

Kamalakannan R, Varghese M, Bilir N and Lindgren D 2006..Conversion Of a Progeny Trial Of *Eucalyptus tereticornis* To A Seedling Seed Orchard Considering Gain And Fertility. Isik F (ed) Low input breeding. Proceedings of conference in Turkey 2006

Seminarier, föreläsningar etc
Utöver de internationella möten som framgår av litteraturförteckningen har Dag Lindgren hållit haft ett seminarium i Indien och Mohan Varghese ett i Sverige vid våra respektive heminstitutioner.

Kortfattad beskrivning av samarbetet
Dag Lindgren har gjort två veckolånga resor till Indien och Mohan Varghese har varit två månader i Sverige. Dag Lindgren har medverkat vid analysen av ett ganska stort antal data insamlade i sydindiska skogliga objekt (klonplantager, fröplantsplantager, frötäktsbestånd och naturskogar). Syftet med projektet enligt ansökan har nåtts , även om den slutliga syntesen och jämförelsen med tempererade arter ej helt fullföljts. Jag har inte haft någon annan finansiering för samarbetet än detta projekt, men samarbetet har vidgats och lett till fler studier än vad som ursprungligen avsågs.