2006

Can lessons from the Community Rainforest Reforestation Program in eastern Australia be learned?

Jerome K. Vanclay
Southern Cross University

Publication details

Vanclay, JK 2006, 'Can lessons from the Community Rainforest Reforestation Program in eastern Australia be learned?', *International Forestry Review*, vol. 8, no. 2, pp. 256-264.
The abstract and pdf of the published article reproduced in ePublications@SCU with the permission of International Forestry Review

Can lessons from the Community Rainforest Reforestation Program in eastern Australia be learned?

J.K. VANCLAY

Southern Cross University, PO Box 157, Lismore NSW 2480, Australia

Email: jvanclay@scu.edu.au

SUMMARY

The Community Rainforest Reforestation Program (1993-2000) was an attempt to create healthy vegetated catchments that maximize wood production, environmental protection and employment in eastern Australia. Despite a AUD10 million outlay, these goals were not fulfilled, because of limited resources and continually changing circumstances (goals, staff, institutions) that hampered the efforts of both researchers and coordinators. Both technical and managerial lessons need to be learned: blanket guidelines are rarely helpful because species, nutrition and silviculture need to be matched to each site; vigour, provenance and nutrition of nursery stock is critical to plantation success; health surveillance should not be overlooked; early growth trends may not reflect commercial outcomes; experiments should be planned and adequately funded to examine mission-critical problems thoroughly; and records should be archived, and secured in more than one location. Inability to securely maintain long-term forest research data has been a common failing in many forestry endeavours. Experience suggests that researchers should rely on their professional networks rather than their employing agency to secure data and other records contributing to a professional knowledge base.

Keywords: rainforest, plantation, mixed-species, silviculture, Australia

Les leçons du programme de reboisement de la forêt vierge communautaire d'Australie de l'Est peuvent-elles être apprises?

J.K.VANCLAY

Le programme de reboisement de la forêt vierge communautaire (1993-2000) a essayé de créer des zones végétales saines à même de maximiser la production de bois, la protection environnementale et l'emploi en Australie de l'Est. En dépit d'un investissement de 10 million de dollars australiens, ces buts n'ont pas été atteints à cause d'une limitation des ressources, et du changement continuel des circonstances (buts, employés, institutions) qui ont frustré les efforts, autant des chercheurs, que des co-ordinateurs. Les leçons techniques et de gestion doivent être apprises: les directions généralisées sont rarement utiles, car les espèces, la nutrition et la sylviculture doivent être adaptées à chaque site; la vigueur, la provenance et la nutrition du stock de pépinière est critique pour assurer le succès de la plantation; la surveillance de la santé ne doit pas être négligée; les courants initiaux peuvent ne pas refléter les résultats commerciaux; les expériences doivent être préparées et épaulées financièrement pour pleinement examiner les problèmes critiques de la mission; et des relevés doivent être mis en archive, et ce, dans plus d'une location. L'inabilité de maintenir avec sécurité les données de la recherche forestière à long terme a été un échec fréquent dans nombre d'essais de foresterie. L'expérience suggère que les chercheurs devraient s'appuyer sur leurs réseaux professionnels plutôt qu'employer une agence pour garder les données, ainsi que d'autres notes qui contribuent à une base de connaissance professionnelle en sécurité.

¿Las lecciones del Programa de la Comunidad de Reforestación de Zonas Tropicales en el este de Australia pueden ser aprendidas?

J. K. VANCLAY

El Programa de la Comunidad de Reforestación de Zonas Tropicales (1993-2000) trató de crear áreas de captación de agua que fueran vegetalmente sanas para aumentar la producción de madera, la protección del medio ambiente y la generación de empleo en el este de Australia. A pesar de contar con 10 millones de dólares australianos, dichos objetivos no se cumplieron debido a recursos limitados y al cambio de circunstancias (objetivos, personal, instituciones) que minaron los esfuerzos de investigadores y coordinadores. Las lecciones que quedan por ser aprendidas son de tipo técnico y de manejo: las guías generales no son muy útiles ya que las especies, la nutrición y silvicultura deben ser adjudicadas a cada sitio; la fortaleza, la proveniencia y la alimentación del suministro de los viveros son decisivas para el éxito de la plantación; la supervisión sanitaria no debe ser descuidada; las tendencias de crecimiento no reflejan necesariamente los resultados comerciales; los experimentos deben ser planeados y financiados adecuadamente para examinar cuidadosamente los problemas críticos que presente la misión; y los registros deben ser archivados y guardados en más de un lugar. La incapacidad de mantener la investigación de los datos forestales a largo plazo ha sido un defecto común en muchos proyectos forestales. La experiencia sugiere que los investigadores deberían depender de sus redes profesionales en lugar de su agencia de empleo para asegurar sus datos y otros registros que contribuyen a una base de conocimiento profesional.

INTRODUCTION

This article has its origins in a request to review a book, *Reforestation in the Tropics and Subtropics of Australia* (Erskine *et al*. 2005). While perusing this book, I realized that there were several issues better dealt with in more detail than is customary in a book review. Although beautifully produced, the book is unlikely to reach its full potential because of a publication strategy that does not encompass all potential readers, and because it lacks a convenient synthesis. It would have been easy to write a traditional book review complimenting the authors, criticising some minor flaws, and recommending its purchase, but this would overlook the more significant issues of the publication strategy and the utility of a comprehensive synthesis. This is a more comprehensive response precisely because these weaknesses are common, and because such criticism is warranted for many end-of-project publications. This paper offers a brief overview of the Community Rainforest Reforestation Program in eastern Australia, attempts to compile the 'lessons learned' synthesis missing from the book, aims to create a citation for each of the chapters in the book, and canvasses publication strategies that may be effective for this material and other end-of-project reports.

THE COMMUNITY RAINFOREST REFORESTATION PROGRAM

In 1988, the World Heritage Commission inscribed the Wet Tropics of Queensland on the World Heritage List, and the Australian Federal Government stopped the timber harvesting that had been undertaken for more than a century (Vanclay 1996). The Community Rainforest Reforestation Program (CRRP) was initiated in 1993 in response to community calls for compensation to businesses and communities affected by the loss of the timber industry (Vize *et al*. 2005). A Management Committee comprising representatives from Federal, State and Local Governments was set up to manage the CRRP. The Management Committee's vision was to create *"healthy vegetated catchments, maximising wood production, environmental protection and employment"*, and involved four specific goals (Vize *et al*. 2005):

1. create a resource for a sustainable timber industry based on private plantings of native rainforest species;
2. address the problems of land degradation in the region;
3. establish vegetation buffers along rivers and streams;
4. train a workforce to support on-going rainforest plantation establishment.

These goals were short-lived, and evolved through three phases:

a) 1992-94: *'New' forestry*, consistent with the goals above, with attention focused on small plantings (<2 ha) of native species on stream banks and degraded areas;
b) 1995-97: *Production forestry*, with an emphasis on mixed species plantings in blocks of 2-5 ha, supported by modest research and extension through growers cooperatives;
c) 1998-2000: *Commercial forestry*, as funding diminished, leading to a change in emphasis away from rainforest species to commercial plantings on demonstration sites.

Funding for the CRRP ceased in 2000. During its seven years of operation, the CRRP fostered the planting of over 1 million seedlings and 1782 ha in 658 blocks (Vize *et al.* 2005). About 320 ha of degraded land was planted, and 150 ha of stream-bank vegetation was established (Herbohn *et al*. 2000). Over 170 species were trialled during the CRRP, and 20 of these were planted in sufficient numbers and at sufficient sites to allow an analysis of performance (Table 1).

CHALLENGES AND LESSONS FROM THE CRRP

Planting stock

One of the key problems in using rainforest species for afforestation is the sporadic seed production of many rainforest trees, and the difficulty in storing seed of many of these species. This in turn, affects seed quantities available for sowing by nurseries, creates difficulties in providing the desired species at the desired time, and leads to disappointment on the part of the growers and lack of farm forestry coordination within the region (Lott *et al*. 2005).

The CRRP fostered the growth of nurseries, and when the program ceased, the decline in demand for plants caused nurseries to close, downsize, or diversify, creating further difficulties in the supply of seedlings and advice. Lott *et al.* (2005) identified several nursery-related factors critical to the success of a farm forestry program, including:

- experienced or professionally qualified nursery staff;
- continuity of staff and in particular, nursery managers;
- reliable supplies of good quality, viable seed, from local seed sources;

- comprehensive nursery records and labelling of provenances to field planting stage;
- good nursery management including hygiene to minimise pests and diseases
- production of good quality seedlings, supplied on time for planting schedules;
- good information flow between research, extension and nursery staff on propagation techniques and species performance in the field.

Difficulties with seed sources and storage led to research into vegetative production via rooted cuttings (Nikles and Robson 2005). Of the sixteen species evaluated, *Elaeocarpus grandis* and *Cedrela odorata* showed great promise, both in propagation success and field growth. *Araucaria cunninghamii* and *Agathis robusta* also showed promise, with over 70% of cuttings forming roots averaging over 8 roots/cutting, and in the case of *Elaeocarpus grandis*, yielding 17 cuttings per hedge plant during a 3-month study. Nikles and Robson (2005) observed that in one 17 year-old trial, *A. robusta* was second only to *Pinus caribaea* in survival and growth. However, they also reminded readers that near-mature plantations of *A. robusta* in southern Queensland suffered heavy losses due to kauri coccid attack in the 1960s.

Nikles and Robson (2005) identified a number of difficulties associated with their vegetative propagation research, equally applicable to other long-term research endeavours: inadequate and discontinuous funding, staff turnover, changes in priorities of funding bodies and research providers, and difficulties in maintaining the security and good management of field trials that are often distant from the home base of research workers. Inadequate funding, both in terms of amount and continuity, hampered their ability to adequately study hedge management, to test customisation of propagation protocol, to establish and properly maintain good field tests with sufficient species for a long enough period to obtain reliable data, and denied the opportunity to follow-up on preliminary insights. This experience provides a clear lesson with regard to future work of this kind: done properly, such research needs adequate long-term funding, with clear protocols for managing changes of staff, research priorities, and field trials (Nikles and Robson 2005).

Plantation management and growth

Most of the soils in the humid tropics of north Queensland available for growing rainforest trees are low in available nutrients (Webb *et al*. 2005). Glasshouse trials using soils from across the region revealed that most macronutrients (nitrogen, phosphorous, potassium, calcium and sulphur) were deficient in at least one soil, and every soil studied was deficient in at least one nutrient. Rainforest tree species responded to nutritional deficiencies in different ways and many suffered depressed growth without showing visual symptoms of nutrient deficiencies. The CRRP response was to prescribe diammonium phosphate (DAP) irrespective of the soil or species. Webb *et al*. (2000) showed that this is not always appropriate: it may be appropriate for *C. odorata* and *A. robusta*, but not for *Castanospermum australe* and *Flindersia brayleyana*. In the CRRP, nutrition of plantings was further compounded by inconsistent weed control. Webb *et al*. (2005) provided a compelling argument for the use of slow-release fertiliser in the nursery, which can have a pronounced effect on growth for more than a year after the plant leaves the nursery, even in the absence of field fertilizer applications (Webb and Reddell 2000).

Growth rates of the plantings were variable. Table 1, a synthesis of data presented by Bristow *et al*. (2005), highlights the importance of matching species and sites. *Corymbia torelliana*, for instance, seems to be sensitive to rainfall, whereas *Eucalyptus cloeziana* and *Araucaria cunninghamii* seem to offer good all-round performance. One should not conclude from Table 1 that *Acacia mangium* is the ideal species, as the table shows only those species planted in more than one rainfall-soil category. *Eucalyptus pellita* was also widely planted, and performed well, particularly when planted in a mixture with acacias (Bristow *et al*. 2006). Glencross and Nichols (2005) presented similar data for plantings in northern New South Wales, and ranked species according to height, diameter and stem straightness. They also provided data concerning survival of plants, and on the current value of sawn timber. Many of these variables are correlated, so the ranking of species remains fairly constant whether they are ranked by height, diameter, or by some composite index reflecting the potential future timber value. In all rankings, *Elaeocarpus grandis* stands out as a promising species for plantations in northern NSW - but Lamb *et al*. (2005) observed that the factors that make it stand out in such rankings may not contribute towards a successful mixed-species plantation.

King and Lawson (2005) observed that the CRRP did not involve entomologists and pathologists until damage and disease were obvious (and in some cases, severe). This is sometimes referred to as the ‘fire fighting’ approach to pest management, whereby control measures are undertaken once visible symptoms are severe, rather than sampling for pests and diseases before they reach critical levels. As a result, many of the plantings failed, or lost all commercial value, because of pest and disease problems (e.g., cedar tip moth, *Hypsipyla robusta*; white cedar moth, *Leptocneria reduct*; and the leaf blight *Cylindrocladium quinqueseptatum*). A health surveillance program would have facilitated early recognition of health problems and significantly increased knowledge of pests and diseases, which could be utilised in planning and managing future plantations. King and Lawson (2005) made several recommendations:

- forest health specialists should be involved in any planting program from its inception to advise on species selection and pest management;
- systematic health surveillance is essential to assess the incidence and severity of pests and diseases over time and to evaluate the impacts on plantation productivity; and
- field staff should be trained to recognise and record health problems, and request assistance as necessary

between scheduled health surveillance visits from specialists.

Pests affect not only the growth of trees, but also the quality of the timber, both during the growth of the tree, and during the post-harvest handling of the wood, so any consideration of pests and diseases should embrace the full value chain. Sadly, not only did the CRRP neglect to include a health surveillance program, but also missed an opportunity to explore whether mixed plantings can be designed to reduce possible pest and disease problems.

Lamb *et al.* (2005) considered the potential advantages of mixed plantings from a production viewpoint. It appears that most of the CRRP plantings are unable to shed much light on this issue, because of the lack of any experimental design. Lamb *et al.* (2005) also cautioned against drawing premature conclusions from the CRRP trials. In the Mt Mee trials near Brisbane, 90% of *Acacia melanoxylon* survived to year 8, but all were dead before year 12, before they had reached a commercial size. Keenan *et al.* (2005) examined stand density management, and observed that many species have a characteristic crown ratio, which must be maintained to achieve good growth. They drew on this crown ratio to develop a guide for thinning frequency and stem spacing, and showed how this formula could be applied to stands with two species.

Biodiversity

Biodiversity outcomes from CRRP plantings were also examined. Wardell-Johnson *et al.* (2005) noted that the composition of the plantation influences seed dispersers in a number of ways. Some plantation tree species are more attractive to seed dispersers, and the number of fleshy-fruited, bird-dispersed plants used in plantations is correlated with the richness of frugivorous birds inhabiting or visiting those plantations (Kanowski *et al.* 2005). Increasing the number of species in a planting also tends to increase structural complexity and attracts seed dispersers (Wardell-Johnson *et al.* 2005). Rainforest timber plantings can help to promote colonisation by rainforest taxa, provided that management favours processes associated with the development of a rainforest environment and minimizes environmental weeds. Early canopy closure is the most effective way to minimize weed incursion.

Kanowski *et al.* (2005) found that richness of rainforest birds (and other organisms) in CRRP plantings was correlated with age, with plant and structural complexity, and with distance to intact forest. These results suggest that plantations are likely to have limited value for rainforest taxa when established on cleared land, at some distance from intact forest and when managed intensively for timber production. Management of plantations for faunal biodiversity requires careful attention to plantation design, silviculture and harvesting, but there is little evidence to guide such efforts. Catterall *et al.* (2005) called for research to guide such plantation design, including (1) projects that aim to provide differing combinations of biodiversity and production, set within different landscape contexts; (2) simultaneous quantitative assessments of both biodiversity and timber at a range of plantation styles, at an appropriate stage of their development; and (3) a built-in biodiversity research component at the initial stages of large-scale tree-planting schemes.

Socio-economics

Herbohn *et al.* (2005) reported a landholder survey that revealed different attitudes towards farm forestry, and indicated some possible avenues to support plantation endeavours (Table 2). Harrison *et al.* (2005) presented an economic analysis of the costs and benefits of the CRRP, summarized in Table 3. It appears that the CRRP did not deliver net benefits at the target discount rate of 7%, but can be valued at AUD 5 million if the more modest discount rate of 5% is applied. These findings are sensitive to the assumptions made; for instance, a small increase in timber or carbon prices also leads to a positive NPV at 7%.

Erskine *et al.* (2005b) posed, but did not answer the question "How large is the newly established rainforest timber resource?", one of the original CRRP objectives. They reported 4200 ha of mixed species plantations, and 1.2 million seedlings planted by the CRRP, but acknowledged a survival rate of around 60%. Sadly, there is no estimate of the standing volume, or a projection of when commercial thinnings may be available – because institutional changes mean that many of the records required to prepare such an estimate are unavailable, possibly lost (Bristow, pers. comm.). Erskine *et al.* (2005b) offered some useful guidance about the choice of species for plantations:

- Landholders interested in production should plant monocultures of *Araucaria, Elaeocarpus grandis, Flindersia brayleyana* or eucalypts such as *Eucalyptus pellita, E. resinifera, E. cloeziana* and hybrids.
- Landholders interested both in production and rainforest habitat should plant monocultures or mixtures of *Araucaria, Acacia* spp., *Elaeocarpus grandis, Flindersia brayleyana, F. schottiana* or *Grevillea robusta*, and include some fruit-bearing trees such as *Ficus*.
- Landholders interested primarily in rainforest habitat should plant closely (for rapid canopy closure) with many species sourced from local provenances , or plant a cover crop of a fast-growing pioneer species such as *Acacia* spp and underplant with fruit-bearing successional species.

Erskine *et al.* (2005b) close on a rather sober note: "... *most of the key scientific organisations that initiated, managed or researched reforestation with high value tree species in northern Australia have ceased to exist or have been so transformed that they are unable to maintain the databases and scientific knowledge accumulated over the last decade.* ...". They catalogued a series of disasters in which data, genetic material and long-running experiments have been lost or compromised as a result of staff and institutional changes. Documenting the experiments, findings and lessons learned (Erskine *et al*. 2005a) is good insurance against institutional shortcomings.

PUBLICATION STRATEGIES FOR RESEARCH DISSEMINATION

The material presented above illustrates that the book (Erskine *et al*. 2005a) warrants attention, not by research scientists, but also by many others involved in rainforest ecology, management and policy. The question is, will the book reach this audience and gain their attention? The first chapter is available free on-line (http://www.rirdc.gov.au/reports/AFT/05-087.pdf), and the book is available for purchase from the Rural Industries Research and Development Corporation (RIRDC) bookshop (http://extranet.rirdc.gov.au/eshop/), but the danger of it passing unnoticed seems high. Is the RIRDC website accessible to the intended audience? RIRDC publications are seen by the search engine google.com, but not by the specialist search engines scholar.google.com, and are not carried by the internet giant amazon.com. In due course, the book will be abstracted by CABI, and some chapters may be noticed in the *Science Citation Index*, but the book is not seen by ISI, so will not appear in *Current Contents*.

There is a more fundamental question: is a hardback book the right avenue of publication for the intended audience? The book is beautifully presented, with glossy paper and colour pictures, as if a coffee-table book. But much of the material is quite technical or philosophical in nature, would probably achieve a greater impact in traditional scientific journals, and may have limited appeal as coffee-table browsing. Other material in the book may be quite helpful to landholders, but it is not evident that they will outlay AUD75 for the limited amount of "how to do it" advice the book presents. The book also contains some strong messages for research managers, government bureaucrats and politicians, but these messages are likely to get lost in an illustrated book of 275 pages.

RIRDC clearly favour this publication format, as they publish well over a hundred books each year, but it is questionable whether Australia's rural industries (and others interested in the research) are best served by this format. The Forest Research Program (FRP) of the British Department for International Development has a different strategy, encouraging project managers to publish in journals (e.g., Prabhu *et al*. 2003), to make electronic reprints available on-line (http://www.frp.uk.com/documentArchive.cfm), and to prepare brief summaries for policy makers and busy executives (e.g., Hayward 2004). Other institutions have a similar strategy. By coincidence, another book, "*Environmental Services and Land Use Change: Bridging the gap between policy and research in southeast Asia*" (Tomich *et al*. 2004) arrived on my desk the same day as "*Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*". Both books arise from a workshop, and both are elegant hardbound volumes with 16 chapters and over 200 pages, but the Tomich *et al*. (2004) book is simultaneously a special issue of the journal *Agriculture Ecosystems and Environment*, and each author gains the benefit and convenience of a journal publication, while the institution gets the prestige of a book. My own experience is that many journals are happy to offer special issues with guest editors, provided that the quality and content is consistent with journal standards (e.g., Skovsgaard and Vanclay 1997, Vanclay *et al*. 2003). Publication in this way seems to draw much wider attention than institutional books.

Finally, it seems appropriate to point out three weaknesses present in Erskine *et al*. (2005a), and rather common in many scientific publications:

1. Half of the abstracts in Erskine *et al*. (2005a) are vague introductory statements with phrases like "*This chapter reviews ... and concludes with some recommendations ...*". These verbs should be avoided, and authors should make an effort to compile abstracts that convey more information. For instance, instead of "The response to fertilizing is discussed", an abstract could report "The optimal fertilizer application is ... kg/ha and produces a ...% increase in yield" (Vanclay 1993).
2. Several figures could be improved by following some of the guidance offered in "*The visual display of quantitative information*" (Tufte 1983) to focus on the uncluttered communication of information.
3. Growth data are usually summarized in one-way tables, overlooking the well-established fact that growth depends on a range of site and stand conditions. Beetson *et al*. (1992) and Vanclay *et al*. (1995) illustrated some ways to make growth summaries more informative.

Despite these few weaknesses, and my scepticism about the publication strategy, the book should prove useful to anyone working in the fields of farm forestry, ecological restoration, and related areas.

CONCLUSIONS AND KEY LESSONS

Although not unique, the findings by the CRRP researchers are too valuable to hide in a limited-circulation book, and it is worth highlighting some of their key findings:

- Blanket guidelines are rarely helpful; species, nutrition and silviculture need to be matched to the site and to project objectives;
- Quality (vigour, provenance and nutrition) of nursery stock is critical to plantation success;
- Health surveillance should not be overlooked (prevention is better than cure);
- Early growth trends should be interpreted cautiously, as they may not reflect commercial outcomes;

TABLE 1 *Performance (asterisks) and numbers of trees for major species planted in CRRP, grouped parent material and rainfall†.*

Species	Basalt			Alluvial			Metamorphic		Granite	Total trees	Average growth, all stands			
	Dry	Med	Wet	Dry	Med	Wet	Dry	Med	Med		dbh	ht	form	index
Acacia mangium					***** 70**			***** 12**		93	26	16	3	10
Eucalyptus pellita		***** 123**	***** 186**	** 59	***** 91**	** 16	***** 49**	***** 41**		565	18	15	4	9
E. cloeziana	** 99	***** 85**	***** 35**	***** 63**	***** 86**	***** 17**	***** 16**			409	17	15	3.9	8
Elaeocarpus grandis		***** 77**	***** 21**		***** 51**	***** 29**	** 44	***** 10**	** 13	248	18	13	4.2	8
E. resinifera	** 15				***** 46**					71	19	14	3.5	7
Grevillea robusta				***** 25**	***** 18**					46	18	12	3.8	7
E. camaldulensis				***** 91**	** 44					135	16	14	3.5	6
Flindersia brayleyana		** 63	** 77	** 43	** 87	** 22	** 50	***** 44**		393	15	12	4	6
Nauclea orientalis					** 26	***** 11**				38	17	9.8	4.1	6
E. drepanophylla	** 45				** 10					58	13	13	3.7	5
E. tereticornis					***** 88**		** 41	** 65		194	14	12	3.5	5
A. cunninghamii		** 141	** 52	** 30		** 17			** 60	307	13	8.3	4.2	4
Cedrela odorata		** 21	** 11					** 12		57	14	9.2	3.2	3
Khaya nyasica							** 19	* 10		48	11	9.2	4.1	3
Terminalia sericocarpa		**12			** 31					53	12	8.8	3.6	3
Corymbia torelliana					***** 30**		* 36	***** 10**		78	12	8.3	3.3	3
Flindersia schottiana		* 32						** 12	** 14	74	9.2	7.4	3.7	2
Agathis robusta		** 197	** 38	** 12	** 19		* 14			291	9.2	6.6	4.1	2
C. australe		* 25	** 38	* 14	* 45					134	7.6	7.4	3.5	2
Paraserianthes toona					** 27			* 16	** 28	80	8.1	5.9	2.7	1

† Dry <1500mm, Med 1500-2500mm, Wet >2500mm/yr; Asterisks indicate average dbh increment, *** >2 cm/yr, ** 1-2 cm/yr, * <1 cm/yr; index = dbh * ht * form, scaled into the range 1-10; dbh in cm, ht in m, form 1=poor (branchy, bent or twisted), 5=clean straight bole. Based on data in Bristow *et al*. (2005).

TABLE 2 *Influences on planting behaviour and recommended support strategy (based on Herbohn et al 2005).*

Group	Influences on planting behaviour	Recommended support
1 High intensity	Some personal interest in trees coupled with a commercial focus and limited capital (land size) leads to risk aversion.	Provide information about multiple purpose plantings. Provide tax breaks/ incentives and rate reductions
2 Retired professionals & hobby farmers	Strong personal interest in tree growing and lower reliance on landholding for income leads to high participation in farm forestry.	Continued CRRP scheme (provide labour, information and organisation for planting activities)and foster networks.
3 Progressive second generation	Strong interest in tree growing but rely on landholding for income and have limited ability to cope with demands of tree planting and management.	Provide advice about plantings; Provide tax breaks/incentives and rate reductions
4 Traditional	Low personal interest in tree growing. High reliance on land for income. Enjoy agricultural production.	Develop options for short rotation plantations and annuity schemes
5 Experienced/ comfortable	Moderate personal interest in tree growing and reliance on land for income.	Develop options for short rotation plantations and annuity schemes

- Experiments should be planned and adequately funded to examine mission-critical problems thoroughly; and
- Records (research data, etc) should be archived, and secured in more than one location.

It is inevitable that endeavours such as the CRRP require "best bets" to be taken. Perhaps the greatest failing of the CRRP is that it did not adopt an adaptive management approach, in which well-designed and resourced experiments evaluate and guide such 'best bets' (Walters and Holling 1990).

The goals articulated for the CRRP were ambitious and challenging, and (despite the outlay of AUD10 million) the limited resources and changing circumstances (goals, staff, institutions) clearly hampered the efforts of researchers and coordinators alike. Perhaps the most useful conclusion is to echo the frustration articulated by Nikles and Robson (2005) and Erskine *et al*. (2005b) that the CRRP lacked sufficient resources and stability to create new insights into rainforest systems, that are by their very nature, complex, dynamic and multi-faceted. One of the CRRP researchers put it quite bluntly: *"It didn't meet the goals, the records have been lost, and important lessons have not been learnt"*. Sadly, these experiences are not unique (e.g., Dawkins 1997; Dawkins and Philip 1998). Rainforest research, by its very nature is long-term, whether it is directed at timber production or other aspects of ecology, and long-term research requires stable long-term commitments in funding, institutions and staffing (Nikles and Robson 2005).

Sadly, such long-term stability in no longer the norm in agencies managing natural resources. Many forest managers with experience in Commonwealth countries have the expectation that governments should be stable, the civil service should be impartial, and that forest services should foster the development of a cadre of skilled professionals and create a durable knowledge base for efficient resource management. Sadly, this is the exception rather than the rule: governments change, civil service departments are reorganised, and research and management is outsourced. Professionalism in natural resource management depends on experienced practitioners (managers and researchers), supported by an adequate and evolving knowledge base. In many cases, these experienced practitioners and knowledge bases are not fostered and supported by governments, but by networks such as the Commonwealth Forestry Association and the International Union of Forest Research Organizations (IUFRO). If these networks are to provide a pivotal role in developing the skills and experience of foresters, perhaps they can, and should also play a role in preserving and maintaining the knowledge base. At present many government agencies do not favour this option, and discourage sharing of data. I myself have been in the situation, where at the completion of my service with an agency, was (1) warned by my then boss that all of the materials with which I had worked were agency property, and must remain with the agency; (2) was presented with a computer tape by one of the computer support staff, who advised me that the best thing I could do for the agency was to take a copy of all the data with which I had ever been involved; and (3) some years later, was contacted by a colleague in that agency, asking if by any chance I had a copy of certain data, because there had been a problem with the computer system, and a large amount of data had been lost and could not be restored because of inadequate back-up procedures. People are understandably coy about admitting to similar incidents, but it is my understanding that such situations are not uncommon. History suggests that at some stage in their evolution, most agencies will suffer political interference, staff turnover (restructuring, downsizing, outsourcing, etc) or computer difficulties (upgrades, failures, viruses, etc) that will compromise databases. The logical response to this situation is to recognise the fallibility of agencies, and the strength and opportunities offered by professional networks (Colchester *et al*. 2003), and to share data with co-workers and professionals with shared interests. I do not advocate that data are given to anyone without restriction, but experience suggests that the scientific community, and society as a whole, are best served when data are shared amongst scientific peers, in the spirit of scientific collaboration to help advance the knowledge base. Institutional efforts (e.g. Vanclay 1998) to pave the way for data-sharing appear to lack momentum, and it seems that the 'best bet' lies with informal networks. Such data-sharing may be hampered by institutional barriers and affiliations (e.g., many IUFRO officers participate in bilateral or multilateral projects in which some partners may not encourage data-sharing), but experience suggests that in the long term, the scientific and wider communities will be grateful for such efforts to help extend the useful life of scientific databases. Obviously, we cannot, and should not, attempt to save all data arising from all experiments, as some data have limited utility. However, long-term field studies are of particular interest, especially when based on geo-referenced plots. For such studies, there are well-established protocols (e.g. Vanclay 1991) that indicate material of long-term interest.

As a forest manager or researcher, you should ask yourself about the long-term security of information you have gathered, and who you could entrust to help ensure its longevity. Until a few years ago, technical obstacles make it difficult to share data in this way, but recent developments in scanners, data transfer technology and mass storage devices make the task easy, so easy that it seems negligent not to do so.

TABLE 3 *Net Present Value estimates for CRRP (Harrison et al. 2005).*

Parameter	Change	NPV (AU$M, 2001 prices)
Baseline (r = 7%)		-1
Discount rate (r)	+5%	+5
	+9%	-3
Timber price	+3%	+6
	-3%	-3
All costs	+10%	-2
	-10%	0
Carbon price	$3/t	-3
	$50/t	+3
Mean Annual Increment	10%	0
	-10%	-4

REFERENCES

BEETSON, T., M. NESTER and J.K. VANCLAY, 1992. Enhancing a permanent sample plot system in natural forests. *The Statistician* **41**:525-538.

BRISTOW, M., ERSKINE, P.D., MCNAMARA, S. and ANNANDALE, M., 2005. Species performance and site relationships for rainforest timber species in plantations in the humid tropics of Queensland. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 84-100.

BRISTOW, M., VANCLAY, J.K., BROOKS, L. and HUNT, M., 2006. Growth and species interactions of Eucalyptus pellita in a mixed and monoculture plantation in the humid tropics of north Queensland. *Forest Ecology and Management*, in press.

CATTERALL, C.P., KANOWSKI, J., LAMB, D., KILLIN, D., ERSKINE, P.D. and WARDELL-JOHNSON, G.W., 2005. Trade-offs between timber production and biodiversity in rainforest plantations: Emerging issues and an ecological perspective. In: Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 206-221.

COLCHESTER, M., T. APTE, M. LAFORGE, A. MANDONDO and N. PATHAK, 2003. Learning Lessons from International Community Forestry Networks: Synthesis Report. CIFOR, Bogor, 90 pp. http://www.cifor.cgiar.org/publications/pdf_files/CF/Synthesis.pdf

DAWKINS, H.C., 1997. Silviculture in the Tropical Rain Forest: An historical analysis of success and failure. Oxford Forestry Institute, ISBN 0850741483, 272 pp.

DAWKINS, H.C. and PHILIP, M.S., 1998. *Tropical Moist Forest Silviculture and Management: A history of success and failure*. CAB International, 359 pp.

ERSKINE, P.D., LAMB, D. and BRISTOW, M. (Eds.) 2005a. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, 275 pp.

ERSKINE, P.D., LAMB, D. and BRISTOW, M., 2005b. Reforestation with rainforest trees: Challenges ahead. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 264-272.

GLENCROSS, K. and NICHOLS, J.D., 2005. Growth performance and review of wood quality concerns for rainforest timber species in subtropical eastern Australia. In: Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 101-113.

HARRISON, S., HERBOHN, J., SMORFITT, D., EMTAGE, N. and SUH, J., 2005a. Economic issues and lessons arising from the Community Rainforest Reforestation Program. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 245-261.

HAYWARD, B., 2004. Virtual solutions for real problems. Forest Research Program, Research Summary 008, 4 pp. http://www.frp.uk.com/document_archive/FRP_Summary_008.pdf (27 Oct 2005)

HERBOHN, K.F., HARRISON, S.R. and HERBOHN J.L., 2000. The inclusin of non-wood benefits in reporting sysems of non-wood enterprises. *In:* S.R. Harrison and J.L. Herbohn (eds) *Sustainable Farm Forestry in the Tropics: Social and economic analysis and policy.* Pp 161-176.

HERBOHN, J., EMTAGE, N., HARRISON, S., SMORFITT, D. and SLAUGHTER, G., 2005b. The importance of considering social issues in reforestation schemes. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 224-244.

KANOWSKI, J., CATTERALL, C.P., PROCTOR, H., REIS, T., TUCKER, N.I.J. and WARDELL-JOHNSON, G.W., 2005. Biodiversity values of timber plantations and restoration plantings for rainforest fauna in tropical and subtropical Australia. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 183-205.

KEENAN, R.J., DOLEY, D. and LAMB, D., 2005. Stand density management in rainforest plantations. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 141-160.

KING, J. and LAWSON, S., 2005. Insect pests and diseases of rainforest timber species grown in plantations. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 114-128.

LAMB, D., ERSKINE, P.D. and BRISTOW, M., 2005. Reforestation with rainforest timber trees in the tropics and subtropics of Australia: A brief overview. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No

05/087, Rural Industries Research and Development Corporation, Canberra, pp. 2-6. http://www.rirdc.gov.au/reports/AFT/05-087.pdf (27 Oct 2005)

LAMB, D., HUYNH DUC NHAN and ERSKINE, P.D., 2005. Designing mixed-species plantations: Progress to date. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 129-140.

LOTT, R., SEXTON, G. and NOVAK, M., 2005. Seed and seedling supply for farm forestry projects in the tropics and subtropics of eastern Australia. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 24-48.

NIKLES, D.G. and ROBSON, K.J., 2005. Vegetative propagation and preliminary field performance of sixteen rainforest tree species in north Queensland. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 49-68.

PRABHU, R., M. HAGGITH, H. MUDAVANHU, R. MUETZELFELDT, W. STANDA-GUNDA and J.K. VANCLAY, 2003. ZimFlores: A model to advise co-management of the Mafungautsi Forest in Zimbabwe. *Small-scale Forest Management, Economics and Policy*, **2**(2):185-210.

SKOVSGAARD, J.P. and J.K. VANCLAY (Eds.), 1997. *Regeneration success and early growth of forest stands*. Selected papers from an IUFRO Conference held in Copenhagen in June 1996. Special issue *of Forest Ecology and Management* **97**(2).

TOMICH, T.P, VAN NOORDWIJK, M. and THOMAS, D.E., 2004. *Environmental Services and Land Use Change: Bridging the gap between policy and research in southeast Asia*. Special issue of *Agriculture Ecosystems and Environment* **104**(1), 244 pp.

TUFTE, E.R., 1983. *The Visual Display of Quantitative Information*. Graphics Press, Cheshire CT, 197 pp.

VANCLAY, J.K., 1989. Site productivity assessment in rainforests: an objective approach using indicator species. *In:* Wan Razali Mohd, H.T. Chan and S. Appanah (eds) Proceedings of the Seminar on Growth and Yield in Tropical Mixed/Moist Forests, 20-24 June 1988, Kuala Lumpur. Forest Research Institute Malaysia, p. 225-241.

VANCLAY, J.K., 1991. Data requirements for developing growth models for tropical moist forests. *Commonwealth Forestry Review* **70**:248-271.

VANCLAY, J.K., 1993. Writing a scientific paper for publication. *Annals of Forestry* **1**:199-202.

VANCLAY, J.K., 1996. Lessons from the Queensland rainforests: Steps towards sustainability. *Journal of Sustainable Forestry* **3**:1-17.

VANCLAY, J.K., 1998. TROPIS: Tree Growth and Permanent Plot Information System. *Journal of Forest Planning* **4**:1-5.

VANCLAY, J.K., J.P. SKOVSGAARD and C. PILEGAARD HANSEN, 1995. Assessing the quality of permanent sample plot databases for growth modelling in forest plantations. *Forest Ecology and Management* **71**:177-186.

VANCLAY, J.K, R. PRABHU and F. SINCLAIR (Eds.), 2003. Participatory Modelling of Community Forest Landscapes. *Small-scale Forest Economics, Management and Policy* 2(2):117-326.

VIZE, S., KILLIN, D. and SEXTON, G., 2005. The Community Rainforest Reforestation Program and other farm forestry programs based around the utilisation of rainforest and tropical species. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 7-22.

WALTERS, C.J., and HOLLING, C.S. 1990. Large scale management experiments and learning by doing. *Ecology* 71:2060-2068.

WARDELL-JOHNSON, G.W., KANOWSKI, J., CATTERALL, C.P., MCKENNA, S., PIPER, S. and LAMB, D., 2005. Rainforest timber plantations and the restoration of plant biodiversity in tropical and subtropical Australia. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 162-182.

WEBB, M.J. and REDDELL. P., 2000. Demonstration of the potential effects of nursery nutrients – Tropical cabinet timbers. RIRDC Publication No. 00/119. Rural Industries Research and Development Corporation, Canberra.

WEBB, M.J., REDDELL, P., HAMBLETON, A. and ROBSON, K., 2000. Growth response of four tropical plantation timber species to increasing phosphorus supply and assessment of phosphorus requirements using foliar diagnosis. New Forests 20:193-211.

WEBB, M.J., BRISTOW, M., REDDELL, P. and SAM, N., 2005. Nutritional limitations to the early growth of rainforest timber trees in north Queensland. *In:* Erskine, P.D., Lamb, D. and Bristow, M. (eds) 2005. *Reforestation in the Tropics and Subtropics of Australia Using Rainforest Tree Species*. RIRDC Publication No 05/087, Rural Industries Research and Development Corporation, Canberra, pp. 69-82.