

AN EVALUATION OF THE PERFORMANCE OF A COMMUNITY RAINFOREST REFORESTATION PROGRAM IN NORTH QUEENSLAND, AUSTRALIA

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ABSTRACT

The Community Rainforest Reforestation Program (CRRP) in North Queensland, Australia, was a multi-faceted experiment in facilitation of farm forestry. It yielded valuable experience in growing native tree species, job training for young unemployed people, and collaboration between federal, state, and local government in forest industry development. It was motivated at least in part by the World Heritage listing of the Wet Tropics of Queensland rainforests, and removal of a large resource from the timber industry. Although not necessarily a success for its stated goals, the program provided a number of achievements, in particular, positive environmental outcomes and lessons for future timber and environmental planting programs on private lands. While the area planted and quantity of timber produced will fall far short of expectations and limited job training activities, it nevertheless provided valuable experience in growing a wide variety of rainforest cabinet timber species in plantations. Survey results indicate that some landholders have applied high quality silvicultural management to their stands, with a view to timber production, while others have been more interested in wildlife habitat and other non-wood benefits.

Keywords: Community forestry; multiple-use forestry; cabinet timbers; rainforest species.

INTRODUCTION

North Queensland has a long history of timber harvesting and marketing of rainforest cabinet timbers, as reflected for example in *Red Gold: The Tree that Built a Nation* (Vader 2002). A large industry operated in the milling of red cedar and other high-value native species, for which there was a well-functioning supply chain, with much of the timber sent to southern markets. The allowable cut, which after WW2 reached 350,000 m³/year, was progressively reduced, and the industry contracted (e.g. Lamb et al. 2003; Harrison et al. 2003). The World Heritage listing of the Wet Tropics of Queensland rainforests in 1988 caused a sudden cessation of timber extraction from most of the tropical rainforest areas. Some timber harvesting continued from approximately 13,000 of government-owned softwood plantations, native forests on private land, and small areas of private plantations. However, forestry in north Queensland has been a case of a *declining industry*, with a loss of infrastructure and skills base. One softwood mill of 25,000 m³ and a few small hardwood mills continue.

Against this background, attempts have been made to revive the north Queensland timber industry, and various reforestation programs have been initiated, including the Community Rainforest Reforestation Program (CRRP), the Plantation Joint Venture Scheme (PJVS) of the Department of Primary Industries, and the

community-driven Trees for the Atherton and Evelyn Tableland (TREAT). These programs, and efforts by Plantation Forests North Queensland (a regional plantation committee or 'forestry cluster') and the North Queensland Timber Co-operative (NQTC) have been aimed at restoring the timber industry.

The CRRP was a particularly interesting effort to restart the timber industry and to achieve other regional goals. This paper examines the performance of the CRRP in terms of its stated goals and other indicators, on the basis of a survey of program participants. In the next section, the nature of the program is outlined. Findings of the survey are then presented. Finally, some policy implications are drawn.

THE COMMUNITY RAINFOREST REFORESTATION PROGRAM

A consultancy was undertaken by Shea (1992) to support a submission to the State and Commonwealth Governments by the Far North Queensland Councils bordering the Wet Tropics of Queensland World Heritage Area (WTWHA). The Shea report indicated that the Wet Tropics region had not been adequately compensated for the loss of the timber industry based on tropical rainforest logging, and recommended that the Commonwealth fund the establishment of a new timber industry under its Structural Adjustment Package. Shea, drawing on earlier work by Kent and Tanzer (1983), argued that there was a strong case for the viability of this new timber industry, with 36,780 ha of land on the Atherton Tableland identified as more suited to forestry or catchment protection than cropping and pastures, but that landholders were unlikely to have sufficient capital to establish plantations and cover the cost of their management until harvest age. The report advocated the Government provide funding over a 30-year period to allow the planting of 1000 ha of high quality cabinet-woods and hardwoods per year (Shea 1992).

The CRRP was designed to facilitate the establishment of mixed-species plantations of mainly native rainforest cabinet timbers on private land. The program was administered by the Department of Primary Industries – Forestry (DPI-Forestry) and more recently the Department of Natural Resources and Mining (NRM). Planting commenced in late 1992, as part of the WTWHA compensation package. Indeed, one of the motivating forces behind the program's inception was the need to overcome the social divisiveness of the World Heritage listing and associated industry contraction and loss of jobs. The program was implemented in 14 local government areas from near Mackay in the south to Cooktown in the north, spanning environments ranging from wet humid tropical lowlands to highland areas up to 800 m–1000 m elevation that occasionally receive frost. Planting was undertaken on high-rainfall areas (averaging from about 1000 mm up to more than 6 m per year) most of which previously supported rainforest and had moderately fertile soils (much being of basaltic origin).

The three levels of government combined to provide technical and physical assistance for farmers to plant woodlots. A mixture of assistance measures was provided, including provision of seedlings, planting and establishment labor and extension support. Work teams undertook planting and also early pruning

In: Baumgartner, David M.; ed. Proceedings of Human Dimensions of Family, Farm, and Community Forestry International Symposium, March 29 – April 1, 2004. Washington State University, Pullman, WA, USA. Washington State University Extension MISC0526. ISBN Number 0-9721994-5-4

and maintenance. These teams included supervisors with training in silviculture, and trainees under the Landcare and Environmental Action Program (LEAP). Some of those trainees were long-term unemployed persons, or were undergoing rehabilitation after incarceration. Training and employment was limited to six months for any individual. CRRP extension officers were available to assist landholders with advice on pruning, thinning, weed and pest control options, replanting, and also native forest management. Initially a major factor in determining species selection was the availability of planting material, which was constrained by the lead time required to establish nursery facilities and seedling production systems (FORTECH 1994).

A wide variety of tree species were planted in the first three years of operation. An initial list of 150 mainly native rainforest species was drawn up, but was progressively narrowed as information was gained about species performance. In the first year alone, 89 different species were planted (FORTECH 1994). At the end of the 1995–1996 planting season, about 1,600 ha of plantations were established with more than 500 landholders participating in the scheme (Creighton and Sexton 1996). Planting continued until 1998, on a total area of about 2000 ha. The program continued to operate in an advisory role until 2000 (Sexton 2000).

The total expenditure on the CRRP was of the order of \$15–20M, although a substantial amount was associated with administrative activities. The total cost during 1992–1995 (the main planting years) for plantation establishment, research, education, and training is reported by Eono and Harrison (2002) at \$5.75 M.

The government did not take any equity in plantations. Throughout the program plantation establishment was heavily subsidized, with landholders initially only required to prepare and fence land prior to planting and to pay a small levy. The financial contribution required from farmers was increased during the program, but remained far less than the full plantation establishment cost. Excluding the LEAP training component, the full plantation establishment cost was of the order of \$2000 to \$3000 per hectare (Newport 2001).

Specific and Implicit Objectives of the CRRP

The CRRP had both commercial and environmental objectives. A multiple-use forestry concept was adopted, with four inter-related objectives, which were asserted to be of equal importance:

1. develop a private plantation timber resource;
2. arrest land degradation following extensive inappropriate clearing;
3. improve water quality in rivers and streams by establishing vegetative buffers; and
4. train a work force to support rainforest plantation establishment (CRRP Management Committee 1993).

As well as the stated timber production and environmental goals, there would appear to have been unstated goals in terms of regional compensation for withdrawal of timber resources from the timber industry, and social healing after the bitter dispute between the Commonwealth and the Queensland Government (Tisdell and Harrison 1999). Given increasing community concerns regarding protection of biodiversity, another implicit objective

Table 1. Research objectives and assessment criteria developed for evaluating the CRRP

Objective	Assessment criteria
Timber production	Total area planted by the CRRP Managed quality (weeding and pruning) Plantation management and harvesting intentions Species likely to be harvested
Arrest degradation	Types of sites planted Proportion of plantings on degraded lands Impacts of plantings on erosion and degradation
Improve water quality	Proportion of plantings along creek lines Impacts of plantings on water quality
Job training and creation	Type and length of training
Biological conservation	Proportion of corridor and buffer plantings Changes in wildlife numbers
Scientific research	Evaluate species performance Species-site information Development of species growth models and stand yield models

was to develop plantations which would assist in biodiversity conservation.

Prior to commencement of the CRRP, there had been little experience with growing native hardwood species in plantations in the region that could be used as a basis for management decisions such as species choice, site selection and silvicultural management. One of the implicit aims of the program was the establishment of a series of trials by which to measure growth of various tree species and mixtures across a range of sites. Information from these plots could then be used to select better performing species, identify appropriate sites for preferred species, develop management prescriptions for spacing, thinning and pruning, and improve understanding of the interactions between species in mixed plantations (Keenan and Annandale 1999).

RESEARCH OBJECTIVES AND METHODS

The overall objective of the research reported here was to evaluate the performance of the CRRP in terms of both stated objectives and other program benefits (or implicit goals). A number of performance criteria were developed to aid in this evaluation (Table 1).

A review was undertaken of published material and unpublished reports relating to farm forestry, soil and water conservation, timber resources and environmental conservation issues, with a particular focus on the Atherton Tableland, which received the most intensive CRRP planting. An initial research proposal developed, based on the review and on discussions with a number of members of the Rainforest Co-operative Research Centre. A familiarization visit was made to North Queensland in July 2000 to inspect reforestation sites, collect further publications and unpublished reports and obtain a list of CRRP landholders. Meetings were held with resource management officers in Cairns and Atherton, including staff of the Department of Natural Resources and Mining (NRM), North Queensland Regional Plantation Committee (NQRPC), North Queensland Timber Co-operative, and Queensland Forestry Research Institute (QFRI). The familiarization trip, together with subsequent discussions, helped in understanding the nature of the CRRP and refining objectives of the research.

As a result of the familiarization trip, it was decided to confine attention to a single stakeholder group (namely landholders) and to limit the survey area to the two adjoining local government areas (Atherton and Eacham Shires) on the central Atherton Tableland. The main method of data collection was an interview survey of

landholders participating in the CRRP in these two shires. Personal interviews were chosen because as a group the CRRP landholders had become 'survey weary' and it was predicted that the level of response to a postal survey would be low. Further, the people who would respond to a postal survey would be unlikely to be a representative sample of the CRRP landholders as a whole. The questionnaire was developed and given an informal trial on a number of experts on farm forestry as well as a number of farm foresters.

A total of 146 landholders participated in the CRRP within the study area. An initial contact letter was sent to each landholder. Interviews were undertaken during December 2000 and January 2001. A total of 72 landholders were interviewed, and at least one CRRP plot was inspected on each farm. A further three listed participants had never planted, and three declined to be interviewed. It was not possible to contact the remaining 68 landholders, mainly because they were away on holidays or had residences away from their land.

The survey data were analyzed using a Microsoft Excel spreadsheet, and various frequency distributions, cross-tabulations and graphs were produced and interpreted. The Statistical Package for the Social Sciences (SPSS) was used to perform chi-squared tests and one-way analysis of variance on the survey data, where appropriate.

LANDHOLDER CHARACTERISTICS, ATTITUDES AND PERCEPTIONS

About one third of the landholders were aged 50 or above. Nearly all had secondary school qualifications or higher and 36% had tertiary qualifications. About one third had a net annual income of over \$60,000. More than half the respondents derived less than 25% of their income from the property, while 41.7% derived more than 75% of their income from the property, with few in the intermediate range. CRRP landholder property sizes averaged about 75 ha, but with nearly half of all properties falling in the 0–50 ha category and with 16% having an area of less than 10 ha.

Thirty-four percent had planted less than 3 ha, and 24% between 3 and 10 ha. The median area was 3.5 ha, the mean 6.05 ha. Seventy per cent had undertaken further tree planting without any financial assistance from the government, while 36% have planted trees under other tree planting programs, though the average area of non-CRRP plantings was less than 2 ha.

Reasons for Tree Planting

As reported by Harrison et al. (2003), about one quarter ranked timber production as the primary motivation behind the decision to participate in the program, and another 20% ranked this as a moderately important factor. Other important motivations were creek bank stabilization (the primary reason for 20% of respondents), land 'rehabilitation and conservation' (10%), aesthetics, provision of shade and shelter, and creation of windbreaks. Landholder reasons for participating in the CRRP differed from the four stated goals of the program, with timber production and creek bank stabilization being the only two announced goals receiving general support.

With regard to non-CRRP plantings, timber production was the most frequently cited motivation, followed by environmental conservation, windbreaks, aesthetics, creek-bank stabilization, weed control, shade and shelter, and scientific research. The notable difference between reasons for CRRP and non-CRRP plantings is the high ranking of windbreaks in the latter, indicating the importance of small fence line and strip plantings.

Table 2. Landholders management intentions for their CRRP plantings, by proportion of area and proportion of respondents

Management intention	Proportion of area (%)	Proportion of landholders (%)
Timber	23.9	13.9
Soil/water management	5	8.3
Conservation	7.9	11.1
All reasons	52	52.8
Ignore	11.2	13.9
Clear the area	0	0

Future Management Intentions of CRRP Plantings

More than half of the CRRP landholders stated an intention to manage their plantings to optimize a number of benefits including timber production, soil and water management and conservation (Table 2). Only about 10% of participants intended to manage their plantings solely for one of the objectives of timber production, soil and water management or conservation. Approximately 15% did not intend to have any active role in managing their plantings. Management intentions can also be expressed in terms of proportion of area planted. By this criteria, the proportion of plantings for timber production as a dominant use is increased from 14% to 24%. The implication is that those planting for timber planted larger areas than those planting for other reasons.

On average, landholders expected to harvest about 70% of their CRRP area; 36% did not intend to harvest any of their CRRP trees, while 47% intended to harvest all of their CRRP trees. The preferred harvest regime is clearly selective logging, followed by replanting. It can be assumed from the small area of CRRP plantation establishment and the preferred harvesting methods, that the contribution of the CRRP to the re-establishment of a timber industry will be limited. Discussions with landholders suggested that attitudes to plantations and perhaps management intentions tend to change over time. Initial plantings are for timber production, but as the trees grow the non-timber benefits tend to become more important to landholders. This may be further reinforced in those planting that receive little maintenance. It was noted in the interviews that landholders would attempt to explain away poor maintenance or low growth rates, by switching priority on planting objectives.

Table 3 reports landholder perceptions of the most positive features of the CRRP. More than 50% stated that the CRRP handling of plantation establishment and maintenance was an important positive feature of the program, with over 30% of respondents claiming that no trees would have been planted without the CRRP. That the majority of establishment and maintenance costs were met by the CRRP was another important positive feature, as was the broad range of goals of the program. Other positives of the program included: saved time; positive and friendly people; range of species available to plant; expertise of those running the program; demonstration and increased public awareness of forestry resulting from the program; and more productive land use by tree farming on degraded sites.

Landholder criticisms of the CRRP are reported in Table 4. Over 50% of respondents criticized the program for a lack of maintenance and follow-up work on plantations. Frequently criticized aspects of the program included: low job competence (particularly in relation to job trainees killing trees); poor species choices; poor species-site matching; inappropriate planting methods; and lack of communication and information about how the program was progressing and management required. Other criticisms of the program included: criticism of the goals

Table 3. Most positive features of the CRRP from the landholders perspective

Feature	Number of landholders	Fraction of sample (%)
Did the work	54	24.3
Trees wouldn't have been planted	32	14.4
Paid costs	31	14.0
Principles of program	26	11.7
Positive people	19	8.6
Range of species	14	6.3
Expertise	11	5.0
Saved time	10	4.5
Demonstration and public awareness	10	4.5
Nothing	7	3.2
Small area plantings	7	3.2
More productive land use	1	0.5

Table 4. Landholder criticisms of the CRRP

Feature	Number of landholders	Fraction of sample (%)
Maintenance/follow-up	53	19.1
Killed trees/job competency	33	11.9
Species choice	32	11.5
Planting method	29	10.4
Communication and information	26	9.4
Species/site matching	25	9.0
None	17	6.1
More than could handle	17	6.1
Planting stock	17	6.1
Job focus	7	2.5
Environmental focus	7	2.5
Inputs to high	7	2.5
Replacement	4	1.4
Job sacking	3	1.1
Timber focus	1	0.4

Table 5. Species planted in non-CRRP tree plantings

Species group	Proportion of area (%)	Proportion of landholders (%)
Eucalypts	6.5	12.9
Exotic Pines	7	6.45
Native Pines	22.9	12.9
Rainforest Species	63.5	64.52

of the program; landholder inputs being too high; trainee sacking after six months; replacement of stock that had died; and low quality of the planting stock.

TIMBER PRODUCTION PROSPECTS OF THE PROGRAM

Given that a major motivation for the CRRP was the reestablishment of a timber industry in north Queensland, it is relevant to examine the likely impact of the program in developing a future timber resource and encouraging other plantings.

Area Established Under the CRRP, Follow-on Plantings and Harvest Intentions

The total area planted under the CRRP is about 2000 ha, about one quarter of which is in the Atherton and Eacham Shires.

Initial death rates after planting reported by respondents varied considerably between sites, ranging from 1% to 2% at some locations, to as high as 80-90% at others, with an average of 27%. Reasons for mortality included: overly dry or wet weather; species not suited to site; plots overgrown with weeds; and cattle damage. Replacement of trees was common for stands that had mortality rates greater than 20%. However, losses amongst these replantings were also high at around 30%. As a result, stocking densities on some locations had fallen to well below a desired level for timber production.

As noted above, on average landholders expected to harvest about 70% of their CRRP area, and 47% intended to harvest all of their CRRP trees. A substantial proportion of plantings are unlikely to ever be harvested. About 18% of respondents believed that none of their plantings were performing well enough for any timber to be harvested. While 70% of respondents had undertaken further tree planting without any financial assistance from the government (70%), the additional areas were small and could not be expected to provide much commercial timber.

Species from which Timber Production is Most Likely, and Expected Harvest Age

Nearly half of the respondents cited Queensland Maple, Silver Quandong, Queensland Kauri and Eucalypt species as likely to be harvestable. Other commonly mentioned species included Acacias, Hoop Pine, Silver Ash, Silky Oak (northern and southern species) and West Indian Cedar. In non-CRRP plantings, rainforest species were the clear choice, accounting for over 60% of plantings (Table 5). About 20% of non-CRRP plantings are of native Hoop and Kauri Pines, while small areas have been planted to eucalypts and exotic conifers.

Timber from mixed rainforest plantings could begin to be harvested in about 10 to 20 years after planting, as the faster growing species reach early maturity. High value cabinet-woods are not predicted to become available till about 50 years after planting, which led to the prediction (Shea 1992) that timber harvesting of the plantations is unlikely to begin in earnest for 50 years. More recent estimates suggest an earlier harvest age for cabinet timbers, of 30 to 50 years (Russell et al. 1993; Dayananda et al. 2002).

Scale of Timber Production in Relation to Timber Processing Infrastructure

A major determinant of the marketability of the CRRP plantations will be the success of the project in achieving market scale. Shea (1992) envisaged planting levels around 1000 ha per year for the next 30 years, for the resource to be large enough to develop the critical mass needed to support a local processing industry and timber exports. An annual turnover volume of the order of 10,000 m³ would probably be a minimum throughout to warrant processing facilities. At a mean annual increment of 5–10 m³, this would require a planted area of 1000–2000 ha within a mill catchment area. The total area planted under the CRRP on the Atherton Tableland falls short of this threshold, the dominant species are not well known to the trade, the mixture of species creates additional milling difficulties, and some of this area will not be harvested. Hence the CRRP in itself is not of sufficient scale to support a fixed-site mill, though opportunities for portable milling (circular or bandsaw) may arise.

Table 6. Condition of CRRP plantations by area and proportion of respondents

Condition of plantation	Proportion of area (%)	Proportion of landholders (%)
Very well maintained	24.8	19.4
Good condition	30.9	20.8
Require maintenance	33.7	43.1
Unmaintained	10.8	16.7

Plantation Management Issues and Timber Quality

The quality of plantation management, and the impacts this has on timber quality, can be expected to affect the development of any new timber industry. It is the belief of some researchers that only the well-managed (well pruned) plantings will be attractive for harvesting (FORTEC 1994). As market demand for high quality sawn or veneer products from plantations is likely to increase, ready markets should be available for CRRP timber, provided an adequate volume and suitable quality is achieved. Markets for commodity and lower quality timber products are far less certain, hence it is important to adopt silvicultural regimes that maximize the production of high quality logs (FORTEC 1994). Table 6 reports the condition of CRRP plantings as assessed by respondents and verified by the interviewer. There is an even spread of plantings in the categories of 'very well maintained', 'well maintained' and 'weeding/pruning required', with only a small proportion of the area in the 'overgrown/unmaintained' category. However, it can be expected that many of the 'weeding/pruning required' plantations will move into the lower condition category if appropriate management techniques are not applied soon. The differences between the proportion of area and proportion of landholders indicates that landholders with larger plantations manage them to a higher standard.

Contribution of the CRRP to Knowledge about Growing Non-traditional Species and Successful Plantation Systems

While much is known about traditional monoculture plantations based on exotic pines, silviculture knowledge for new forms of rainforest plantations is in its early days. Could the higher market value of these timbers compensate for their slower growth, now that timber from native forests is no longer available? If so, which species should be planted? What are the best sites? What plantation design should be used? What are the most successful plantation management practices for these non-traditional species? When the CRRP commenced in 1993, it was against a backdrop of skepticism from many foresters formerly involved in rainforest logging operations. Few attempts had been made to grow native tropical species under plantation conditions, and those attempts had produced far from spectacular results. Many foresters had expressed concerns about both the length of time it was expected to take trees to reach a merchantable size, and the likely inferior quality of plantation-grown timber relative to that growing in native forests. Little or no information existed about the likely growth rates of rainforest and many eucalypt species under plantation conditions. Likewise, there was little information about successful species mixtures, and effective planting and establishment methods for rainforest species (Herbohn et al. 2000a).

Practical research to address these questions requires long-term plantation trials. A number of plantations were established in north Queensland in the past by DPI-Forestry, some of which are now over 60 years old. These provide baseline data on growth rates of commercially attractive trees but it is clear that better growth rates might be possible if more up-to-date establishment and management methods are used.

During the early development phase of the CRRP, over 150 highly regarded timber species from North Queensland forests, and a limited number of highly valued exotics, were screened to determine their suitability to site and their adaptability to plantation conditions. About a third of these species were selected for further consideration across the region (Creighton and Sexton 1996). Based on outcomes of CRRP rainforest species plantings, some research has been conducted on a small number of the more promising species.

Estimates of growth rates and likely harvest ages, along with information about species mixtures, is of interest to a number of groups. These groups include farmers who are interested in planting rainforest trees, forest service staff who advise on tree planting and farm forestry activities, and financial modelers and economists who wish to predict likely returns to individual farmers and regional economic benefits (Herbohn et al. 2000a). Given the lack of historical data on almost all the rainforest species, the estimates produced are a convenient mechanism through which to collate and summarize current expectations. Also, these estimates will allow a reassessment of expectations about likely performance of rainforest cabinet timbers under plantation conditions.

The capacity of forest policy-makers and managers to predict plantation growth and yield is critical for many strategic and operational purposes. At a strategic level, yield models coupled with financial models permit assessment of whether an investment in forestry should be made at a particular site and which species should be grown. At an operational level, yield models can guide decision-makers toward optimal planting densities, and be used to refine the timing and intensity of silviculture and harvesting operations (Vanclay 1994).

STATISTICAL ANALYSIS OF SURVEY FINDINGS (CHI-SQUARED TESTS AND ANOVA)

Cross-tabulations were obtained for a number of survey variables, in terms of frequencies of responses, and the relationship between various pairs of variables was examined using chi-square tests of independence. In essence these tests compare the null hypothesis of independence in population proportions against the alternative hypothesis that the variables are related. Where the probability is less than 0.05, the null hypothesis of independence is rejected, and it is concluded that these variables are related.

Table 7 reports probabilities—under the hypothesis of independence—obtained in chi-squared tests, using the Statistical Package for the Social Sciences (SPSS). Most tests reveal no relationship between variables. Chi-squared probabilities indicate relationships between plantation condition, and education and income. However, more than 25% of cells had expected frequencies of less than five for these tests, shedding doubt on their reliability. A valid result for the chi-squared test of independence was found for the area of CRRP plantations versus the proportion of area the landholder expects to harvest; landholders that have established larger plantations also expect to harvest a greater proportion of these plantings.

One-way analysis of variance (ANOVA) was also conducted on a number of survey variables. Tests where results are statistically significant are reported in Table 8. These tests compare plantation condition with both time spent on plantation management (hours/ha) and proportion of area for which harvest is expected. CRRP plantings that are in very good condition have significantly greater labor input than those which needed weeding and pruning or are overgrown. The expected proportion of area to be harvested differs significantly between all four plantation condition states.

Table 8. Cross tabulations and chi-square tests of independence on some survey variables

Variable 1	Variable 2	Chi-square probability
Plantation condition	Age	0.5527
	Education	0.0105*
	Income	0.0280*
	Income from property	0.3061
Proportion expecting to harvest	Income	0.8914
	Education	0.1165
	Age	0.8975
	Income from property	0.9147
Hours spent on plantings	Income from property	0.4439
	Income	0.5593
	Education	0.2630
	Age	0.8835
Other tree plantings	CRRP plantation condition	0.3637
	Proportion expecting to harvest	0.4933
Area planted	Proportion expecting to harvest	0.0319*
	CRRP plantation condition	0.4082

Table 9. One-way ANOVA of survey variables

Factor	Condition of planting	Mean	95% Confidence Interval for Mean	
			Lower Bound	Upper Bound
Labour input (hrs/ha)	Very good	82.14	44.32	119.96
	Good	52.60	9.55	95.64
	Needs work	14.58	2.31	26.84
	Overgrown	18.58	-5.35	42.52
Proportion expected to be harvested	Very good	90.00	74.47	105.52
	Good	74.20	50.84	97.55
	Needs work	42.74	25.56	59.91
	Overgrown	24.16	-0.62	48.95

Table 9. Land use prior to CRRP plantation establishment

Previous land use	Proportion of area (%)	Proportion of landholders (%)
Grazing/dairying	67	45
Cropping	2	7
Degraded/weed infested land	18	23
Creekbanks	13	25

Overall, the statistical analysis reveals a close association between harvesting intentions, and plantation size and management effort, with larger plantations more typically managed for timber production. A reservation about the statistical findings is that some bias may have arisen because a group of CRRP participants was not available for interview at the time of visits to the Atherton Tableland (some of whom live off-farm). It may be that a smaller proportion of these intend to harvest their trees, although the relationship between plantation size, intensity of management and harvest intentions probably still holds for these landholders.

CONSERVATION AND TRAINING BENEFITS

The CRRP has played a role in arresting land degradation, improving water quality, protecting conservation values, and providing training and employment, each of which are now considered.

The Role of the CRRP in Arresting Land Degradation

Information to assess the contribution of CRRP plantings in arresting land degradation and erosion is limited. Impacts can

be inferred from a number of landholder responses. An evaluation of the land use prior to the establishment of CRRP plantings aids in identifying land quality and management issues. About 20% of CRRP landholders indicated that prior to planting trees the land was degraded or weed-infested and had little production (Table 9). The proportion in terms of area planted is also around 20%. Few landholders reported that their plantation had been established on high quality cropping land. About 25% of CRRP plantations were established on unused creek banks (though only about 12% by area). Nearly half of the CRRP plantings (and 70% by area) were established on land, which had previously been used for grazing or dairying.

The majority of plantings are on high quality soils (54% of landholders), compared with moderate (28%) and low quality soils (20%). When assessed in terms of area planted, there is approximately a uniform area distribution across the three soil quality categories. Although a small proportion of plantings (19% by frequency and 27% by area) occurred on slight slopes, most plantings occurred on moderate to steep slopes. The distribution of slope types (slight, moderate, steep) was less uniform when assessed in terms of area planted, indicating larger plots were typically on steeper land. Overall, it can be concluded that plantings tended to be on soils of reasonable quality, but on sloping grazing land subject to degradation, hence the plantings may have had a positive impact on land protection.

The Role of the CRRP in Improving Water Quality

The environmental dimension of CRRP plantings on water quality includes impacts on protection of water quality, reduced sedimentation of watercourses, protection against streambank erosion, increased opportunities for recreation (i.e. fishing), and improved aesthetics of waterways. Herbohn et al. (2000b) report that water quality appears to have improved in regions with CRRP plantings, with supporting evidence from scientists and local port authorities. Also, improvements in water quality appear to have had a positive impact on the value of waterway aesthetics and perceived recreation opportunities along waterways (Herbohn et al. 2000b). Qureshi (1999) noted the major benefits of riparian revegetation in the coastal wet tropics, concluding that trees aid in creek bank stabilization, but that tree cover can leave the soil surface exposed and vulnerable to run-off, and is not favored by farmers using cropping machinery near creeks. Eono and Harrison (2001) noted positive benefits in terms of water yield and quality due to CRRP plantings.

About 65% of CRRP plantings had a riparian component. The total area of creek bank revegetation by the landholders surveyed was 159 ha or 37% of the total CRRP planted area. The majority of landholders (80%) reported no effect from tree plantings on the riparian environment. Both a decrease and an increase in weeds were reported, and a small proportion of respondents noted improved water quality. The distributions by proportion of landholders and area represented are almost identical. It is possible that given the early stage of CRRP plantings, the effects on the riparian zone are yet to be realized.

Biodiversity Conservation Values of CRRP Plantings

Keenan and Kent (1997) reported that mixed-species plantations can have high biodiversity values, recording between 22 and 181 species in plantations on the Atherton Tableland. Many CRRP tree plantings are now well-established and beginning to attract birds and other wildlife. Wildlife records collected by CRRP participants contributed to research being conducted by NatureSearch¹. In terms of wildlife numbers, about 70% of landholders noticed an increase associated with their CRRP plantings, and nearly 30% reported a large increase. Species level identification was poor, but generally there was an increase in avifauna and some small mammals.

About 61% of CRRP plantings were reported by landholders as forming part of a continuous or stepping-stone vegetation corridor network. More than half of the plantings (55%) adjoin a forested area (hence taking the form of buffer plantings), and another about 20% are within one kilometer of a forest area.

Of existing native remnant or regrowth forest areas on CRRP landholders properties, nearly half (45%) were smaller than 5ha, though close to a quarter were larger than 35 ha. A total of 63% of respondents reported having existing forest on their property, the aggregate area being 1145 ha. Of this, about 82% was classed rainforest, 15% as eucalypt forest and 3% as mixed rainforest and eucalypts. Twenty seven percent intended to manage their native forest for conservation purposes, 9% planned selective logging and 64% had no management intentions.

Training and Job Creation

Training was provided through the Landcare and Environmental Action (LEAP) program during the early stages of the CRRP. Shepherd (1993) noted that the formal training component comprised over 25% of the total time of recruits, and that the training provided participants with useful, recognized skills that will be attractive to employers involved with land-based natural resource management. He further commented that participants were constantly developing new vocational skills in the field while working alongside their supervisor. The training attempted to develop in the young recruits a work ethic and an understanding of contributing today to a goal many years off.

It was not possible to investigate job creation and spillover effects of the post-establishment phase in any detail. The prospects of job creation from reforestation is limited as experienced labor is not really necessary, as with adequate advice most workers can readily learn the techniques used in forest establishment and maintenance. In most instances of private forestry establishment and management in north Queensland, the landholders carry out the work themselves.

The number of hours spent on the CRRP plantations by landholders and family members varied considerably, with 47% spending no time over the past year on plantation maintenance, and the average time being 36 hours per year. Labor had been

hired for plantation work by 31% of respondents. A total of 39 people had been hired for a total of 1051 hours or an average of 50 hours work per hiring landholder, to undertake weeding, slashing, spraying and pruning.

DISCUSSION

The CRRP has been a bold experiment in growing rainforest and eucalypt trees on farm land. Due to the relatively small area planted, the four stated objectives could not be said to have been achieved to any substantial level. Also, it could be argued that a large amount of taxpayer funds was spent for a relatively small plantation area. However, the program has provided a great deal of experience in growing very-high-value non-traditional native rainforest species in small woodlots, and has generated a great deal of interest among landholders in growing these species. Within the limits of the scale of plantings, it had positive land protection and wildlife habitat benefits, and provided a platform for skills training and rehabilitation of a disadvantaged community group.

What policy lessons can be drawn from the CRRP? It seems clear that the benefits if replicating the program would be marginal, but that the findings about growing rainforest cabinet timbers could be put to practical use. These species are strongly favored by landholders, and can perform well in plantations provided the stand management is sound. While there is still much to be learnt about desirable species mixtures and field layout arrangements, some species and simple mixtures have been identified as of high promise. The small scale of plantings to date is not sufficient to attract new technology into hardwood processing. Lack of silvicultural advice is a clear limitation on further plantings.

It may be that policy measure could be implemented at relatively low cost, which would have a strong stimulatory effect on tree planting and associated resource production and environmental benefits. Somewhat larger plantings than under the CRRP would be desirable to gain economies of scale. Areas of government support could include ensuring access to high quality seedlings of the most financially viable native species, provision of extension service with regard to site-species matching and silvicultural management, and perhaps in the future some assistance with timber marketing. Clearly, a substantial financial input from landholders would be required, and would probably lead to greater commitment to stand management.

A number of general conclusions for forest industry development can be drawn from CRRP experiences. These include:

1. Where timber production is a priority, the focus should be on growing a limited number of recognized brand-name species, which have proven ability to be grown in plantation situations.
2. A major reason for planting failure is the tendency to underestimate the level of inputs required. Program co-ordinators and participants need to develop mechanisms for focusing of follow up maintenance and not maximizing areas planted.
3. Investigation is needed into the future evolution of the forestry industry. In particular, a focus is needed on economically sustainable ways of harvesting small quantities of high value timbers.
4. Regional natural resource management (NRM) planning needs to plan for sufficient planting to provide for a sustainable industry as well as acknowledge and take advantage of the benefits provided by reforestation to the NRM objectives.

¹ NatureSearch is a Queensland Environmental Protection Agency system which is enlisting members of the community to gather information on Queensland's flora and fauna. Wildlife records are loaded onto the WildNet system where they can be utilized by managers, planners, biologists, and naturalists for a range of conservation purposes. Information about the wildlife using CRRP plots, for instance, will help demonstrate how valuable these plantings can be as wildlife habitat and help in developing guidelines for future farm forestry plantations if attracting wildlife is an important motivation for the landholder.

5. There is a need for policy makers to provide opportunities for landholders to derive benefits from the non-timber aspects of their plantings. This could include provision of free trees under a Land for Wildlife arrangement, rate rebates for areas planted, and discounts on herbicides or fencing equipment.
6. Bundling up of a number of objectives can result in conflicting objectives.
7. There is an overriding need for forestry development projects to have a long-term view, particularly with regard to funding. As such a priority in project development should be to set in place mechanisms for cost retrieval.

REFERENCES

Creighton, C. and Sexton, G. (1996), Community Rainforest Reforestation Program—a farm forestry demonstration, in A. Grodecki, J. Aitchison and P. Grimbeek, *Managing and Growing Trees Training Conference*, 8-10 October, held in Bundaberg, Department of Natural Resources, Brisbane, Brisbane, Vol. 1 pp. 100 - 109.

CRRP Management Committee (1993), *Community Rainforest Reforestation Program: Sowing the Seeds for a Future Wet Tropics Timber Industry*, Queensland Department of Primary Industries Forest Service, Brisbane.

Dayananda, D., Irons, R., Harrison, S., Herbohn, J. and Rowland, P. (2002), *Capital Budgeting: Financial Appraisal of Investment Projects*, Cambridge University Press, Cambridge.

Eono, J-C. and Harrison, S.R. (2001), 'Economic evaluation of tree planting on water quality improvements', in A. Grodecki (ed), *Managing and Growing Trees: Farm Forestry and Vegetation Management*, Kooralbyn, 19-21 October 1998, Department of Natural Resources and Greening Australia, Brisbane, pp. 276-285.

Eono, J-C. and Harrison, S.R. (2002), 'Estimation of costs and benefits of the Community Rainforest Reforestation Program in north Queensland', *Economic Analysis and Policy*, 32(2): 69-89.

FORTECH (1994), *Commercial Potential for Plantations of High Value Rainforest Timbers in North Queensland - Assessment of Market Opportunities for Plantation Grown Wood Products*. Report prepared by Forestry Technical Services Pty Ltd. for the North Queensland Afforestation Project Joint Board, Canberra.

Harrison, R. (2002), *An Evaluation of the Community Rainforest Reforestation Program*, B.Sc.Hons. thesis, School of Geographical Sciences and Planning, The University of Queensland, Brisbane.

Harrison, R., Wardell-Johnson, G. and McAlpine, C. (2003), *Rainforest Reforestation and Biodiversity Benefits: A Case Study from the Australian Wet Tropics*, *Annals of Tropical Research*, 25(2): 67-77.

Herbohn, K.F., Harrison, S.R. and Herbohn, J.L. (2000a), 'Lessons from small-scale forestry initiatives in Australia: the effective integration of environmental and commercial values', *Forest Ecology and Management*, Vol. 128, pp. 227-240.

Herbohn, K.F., Harrison, S.R. and Herbohn, J.L. (2000b), 'The inclusion of non-wood benefits in reporting systems of forest enterprises', in S.R. Harrison and J.L. Herbohn (eds), *Tropical Small-scale Forestry: Social and Economic Analysis and Policy*, Edward Elgar, Cheltenham, pp. 161-176.

Keenan, R. and Annadale, M. (1999), *Growth of Tree Species on Private Land in North Queensland (Experiment 799)*, Department of Primary Industries, Atherton.

Keenan, R. and Kent, G. (1997), 'Forest Management in North Queensland: Field Tour Notes for UNESCO/IUCN International Workshop', *From Reforestation to Rehabilitation: Increasing Biological Diversity in Reforestation Programs*, Atherton Queensland.

Kent, D.J. and Tanzer, J.M. (1983), *Evaluation of Agricultural Land*, Atherton Shire, North Queensland, Brisbane: Queensland Department of Primary Industries.

Lamb, D., Keenan, R.J. and Gould, K. (2003), 'Historical background to plantation development in the tropics: A north Queensland case study', in S.R. Harrison and J.L. Herbohn (eds), *Sustainable Farm Forestry in the Tropics: Social and Economic Analysis and Policy*, Edward Elgar, Cheltenham, pp. 9-20.

Newport, M. (2001), Department of Natural Resources and Mining, Atherton, personal communication.

Qureshi, M.E. (1999), *Development and Implementation of a Decision Support Process for Sustainable Catchment Management*, PhD thesis (unpublished), The University of Queensland, Brisbane.

Russell, J.S., Cameron, D.M., Whan, I.F., Beech, D.F., Prestwidge, D.B. and Rance, S.J. (1993), 'Rainforest trees as a new crop for Australia', *Forest Ecology and Management*, Vol. 60, No. 1, pp. 41-58.

Sexton, G. (2000), Department of Natural Resources, Atherton, personal communication.

Shea, G.M. (1992), *New Timber Industry Based on Valuable Cabinetwoods and Hardwoods: Consultancy Report for Councils of the Wet Tropics Region*, Queensland Forest Service, Brisbane.

Shepherd, P. (1993), 'The Benefits of Education and Training: An Educator's Lament', Paper presented to the Inaugural Conference, Community Rainforest Reforestation Program, Innisfail, 5-7 November.

Tisdell, C. and Harrison, S.R. (1999), 'Compensation for the taking of natural resource interests: Principles and practices in recent Queensland cases', *Australian Journal of Environmental Management*, Vol. 6, No. 2, pp. 99-108.

Vader, J. (2002), *Red Gold: The Tree that Built a Nation*, North Holland, Sydney.

Vanclay, J.K. (1994), *Modeling Forest Growth and Yield Applications to Mixed Tropical Forests*, CAB International, Wallingford.

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