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FORESTRY RESEARCH IN NEW ZEALAND : history, philosophy and practice in brief.

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Introduction

This paper attempts to identify crucial ways in which forestry research has developed and research results transferred to users in New Zealand. Concern has been expressed recently by Sweda (1988), for example, that wood production from forests and plantations in Japan is not as high as it could or should be. He has indicated that Japanese researchers could be interested in the New Zealand experience of transferring forestry research knowledge into practice. Estimates of outturn from New Zealand's present 1 million hectares of plantations will rise to 30 million m^3 per year (see Whyte, 1988), which is the current annual output from Japan's 25 million hectares of forest. This comparison may be a little unfair, but is stated here simply to indicate that there could be an opportunity to boost forest productivity in Japan through analysing the reasons behind New Zealand's performance in this regard.

No analysis of Japan's approach to forestry research is conducted here, however. The intention of this contribution is simply to present a personal view on important reasons why transfer of research knowledge throughout forestry in New Zealand has been reasonably successful. It may be interesting at a later date for scientists like Sweda to analyse the Japan situation in a similar manner. First, however, a brief synopsis of the history of forestry research in New Zealand is needed to provide a perspective on its philosophy and practice.

History of Forestry and Forestry Research

Until about 200 years ago, more than two thirds of New Zealand's land area of 269 000 km^2 was under evergreen forest (kauri, podocarp, podocarp/hardwood and southern beech being the main types). The Polynesians burned off about 4 million hectares in the previous 500 years, but then European settlers cleared a further 8 million hectares between 1840 and 1920. The selection and use of logs, and the clearing of land for farming were both conducted very wastefully, because of the apparent forest abundance. Although much of the forest that was destroyed was of the valuable moist, temperate, lowland variety, the predominance of extensive pastoral agriculture resulted also in unnecessary removal of forest cover from

steep terrain. The earliest forest researchers in New Zealand were, therefore, botanists and true conservationists, concerned with the rapid depletion of rare lowland forest types, the lack of forest replacement and the serious degradation of mountain lands.

In the 1890's and early 1900's, trials were initiated of a large number of introduced conifers such as pines, firs, larches, spruces and cypresses together with eucalypts from across the Tasman. These were largely of a nursery and seedling establishment nature, and could be considered the second phase of forest research in New Zealand. A Royal Commission report published in 1913 reviewed progress in these and earlier trials, and recommended further planting of radiata pine (*Pinus radiata* D. Don.) in particular. The First World War intervened, however, and it was not until 1919 that the Forest Service was established and MacIntosh Ellis became its first Director. He was instrumental in initiating the third research phase, the perpetuation of which has benefitted forestry in New Zealand to a massive extent : his concerns were for (a) economic efficiency, (b) matching end use for forest crops with growing strategies, and (c) the need for a comprehensive systems approach that brought together stand, forest, regional and national planning considerations. His contributions and philosophy are explained briefly below because of their great importance.

The small area of plantation crops that the Forest Service inherited in 1919 had been established and developed through adoption of elaborate and costly regimes. While New Zealand foresters at that time had already concluded that the future wood needs of New Zealand would have to be met from the use of introduced species, MacIntosh Ellis was greatly concerned at the excessively high costs of their establishment. Initially, therefore, he placed little faith, for economic reasons, in the long-term viability of plantation forestry in New Zealand as it was then practised. Indeed, he closed down 12 of the 18 plantations in existence at that time, reduced the new planting to a mere 1600 ha per annum and re-allocated the budget savings to research into more efficient nursery techniques, wider initial spacings and better organisation and management of planting operations. He also directed that an inventory of the remaining forest resources and soils be undertaken, while he himself travelled throughout the country, familiarising himself with what did actually exist, with analysing long-term wood demands and with reviewing the appropriateness of legislation at that time. When the results of national forest inventory clearly revealed by 1923 that New Zealand's wood demands in both quantity and quality could not be met through sustained yield management of the native forests, the comprehensive analyses Ellis had made (in effect,

a classic systems approach to problem-solving) enabled him to present a clear statement of the situation and a recommendation on how to maintain self-sufficiency through planting 120 000 ha of introduced pines and Douglas fir, a plan that was adopted by the then government with remarkable alacrity (see Ellis, 1925).

The target was achieved by 1931, but the plantation boom lasted from 1925 to 1936 during which time 240 000 ha of new planting were carried out. A resource of high quality had been produced because of careful attention to simple but important concepts: the setting of clear objectives; preparing a solid groundwork of practical research; and dedicated, careful implementation of the establishment prescriptions by the workforce and its supervisors.

In characterising the system of plantation forestry in New Zealand, Ellis paid great heed to developing strategies for growing crops to satisfy the country's long-term needs for a wide range of forest products. Indeed he made a remarkably accurate forecast of what New Zealand's wood demands would be and how they would be met 30 years later. He recruited an engineer to oversee the accumulation of a vast quantity of technical knowledge on wood properties of, and manufacturing possibilities for a large number of native and introduced species. This knowledge was crucial in setting up sawmills to saw plantation grown species and in getting radiata pine readily accepted in such a short time. This concern for end-use capabilities is documented in an article entitled, '*Quality vs. Quantity*' by Entrican, 1950.

Concern for wood quality as well as quantity is a philosophy which has remained to this day, as can be clearly seen from examining the content of the silvicultural research programme of the Forest Research Institute over the past 25 years or so.

Also, many of today's forest researchers spent their early days working in sawmills and evaluating mill outturn.

Consequently, sawmill studies have continued to feature prominently in silvicultural research programmes and the experience so gained has had a major impact on shaping radiata pine cropping regimes. A review of this topic is set out in Whyte (1988).

The Forest Research Institute in Rotorua began as a base station for the National Forest Survey which commenced in 1947. Although a very small unit initially, it has remained largely in one piece, dedicated to integrating wood quality and utilisation with growing tree crops. The centralised approach to research (representing the fourth phase of research) has provided a focal point not only for Forest Srevice research but also for researchers from

other government departments, the universities and companies. This had produced an environment in which research results could be readily obtained at little or no cost to the user, in which a healthy, free exchange of ideas could be transacted, and in which a good balance of short-and long-term research coul be easily maintained. The advent of a "*user-pays*" : philosophy and the dissolution of the Forest Service in April, 1987 has markedly changed the future outlook for forest research in New Zealand, as it enters its fifth phase.

Recent and Present Structure of Forest Research in New Zealand

Prior to April, 1987, the Forest Research Institute was an arm of the Forest Service and had about 180 scientists, of which 140 were based in Rotorua and the remaining 40 in Christchurch. They accounted for about two thirds of the national forest research effort : the remaining contributions came from other government departments (12 per cent), industrial companies (14 per cent) and universities (6 per cent). Programmes for all this research were reviewed regularly by three Research Advisory Committees (Production, Products and Protection), whose reports went first to the Director-General of Forests, who then subsequently forwarded the information to the Minister of Forests. There was some overlap and duplication of effort, but it was recognised and could be controlled to quite an extent. The Research Advisory Committees consisted of people specially selected for their abilities from various parts of the forest sector : in addition to their advisory role, members of these committees relayed their acquired knowledge on forest research programmes to colleagues and superiors. Rotation of membership ensured that this two-way filtering process resulted in useful communication on research coverage and progress throughout the sector.

The Forest Service was dissolved in 1987 and three new government forestry agencies were formed : the Ministry of Forestry ; the New Zealand Forestry Corporation Ltd ; and the Department of Conservaion. The Forest Research Institute became part of the Ministry of Forestry which neither owns nor manages any forests, but which provides services to the forestry sector and to the government. The services include research, training, policy advice, advisory support, timber certification, health inspection and fire control. About thirty fewer research scientists are now employed at the Forest Research Institute, the three research advisory committees have been replaced by one Research Policy Advisory Group, while five research cooperatives funded jointly by industry and the government have been established. The government has reduced its funding of forest research by about 40 per cent, some of which drop will be replaced by revenue earnings from services to the sector and overseas

organisations. Indications are that research emphasis will be directed more and more to aspects of harvesting, transporting and processing logs, into creating new products and into finding near markets.

Strengths and Weaknesses

One of the main strenghts of New Zealand's forest research over the years has been the adoption of an integrative systems approach directed to producing raw material that would likely be in demand. Kirkland (1985) identified four stages of plantation forestry research :

(1) identifying and trying possibly suitable species for afforestation ;

(2) collecting, analysing and interpreting information on separate components of the plantation system ;

(3) adopting a systems approach and integrating knowledge and experimentation in a coordinated fashion from selecting seed, to growing and then down as far as primary processing ;

(4) extending the integration of growing, harvesting, processing, utilising and marketing to the incorporation of financial management control.

To a degree, New Zealand has followed this path and adopted the principal concepts relatively quickly. MacIntosh Ellis in the 1920's had very clear objectives as to why plantations were being established. After a national Forestry Development Conference in 1969, those objectives were altered in recognition of the need for additional afforestation being grown with export markets solely in mind. Having such clear objectives has greatly simplified the tasks of researchers and allowed them to progress swiftly through the four stages above.

A prime example of the integrative approach is demonstrated in the task force solution to major problems. In the 1950's a team of entomologists, silviculturists and managers was formed to tackle the mortality in radiata pine caused by the wood-wasp, *Sirex noctilio* ; in the 1960's a team of pathologists, tree breeders, mensurationists, aerial sprayers, tree nutritionists and managers put their heads together over the pine needle blight outbreak caused by the needlecast fungus, *Dothistromapini*, and another, consisting of mensurationists, silviculturists, soil scientists, fertiliser manufacturers, site preparation scientists and operators, and managers all contributed to overcoming the apparent decline in second crop productivity that was postulated for the Nelson region ; then in the 1970's, harvesting

planners, mensurationists and managers formed a Mensuration Project Team to devise and promulgate mensurational and forecasting capabilities needed to assist in the planning for and managing of the burgeoning plantation resource ; a direct successor to that was the Radiata Pine Task Force which produced SILMOD, a series of sub-models aggregated to provide a stand economic framework for tracing the interactions of silvicultural operations from time of planting through to delivery of harvested wood supplies at utilisation plants so that the quality and value of the wood could be predicted ; in turn the successor to the Task Force was the Conversion Planning Project team, the work of which was aimed at developing a stand modelling capability to link tree crop production aspects with processing options and market outlets, so that decision-makers might be able to choose silvicultural operations which would be better directed at meeting market demands for various forest products ; as mentioned previously, the latest team approach involves research cooperatives, currently into radiata pine breeding, stand growth modelling, forest fertilisation, eucalypt management and evaluation of pruning on a stand basis.

In all these team efforts, the emphasis has been on bringing together the expertise of several research disciplines, forest mansgers and operators. Their collective wisdom from wide ranges of backgrounds has usually produced a kind of hybrid vigour or synergistic effect in terms of research output and has improved the dissemination of research findings because of the higher than usual unmbers of people involved in one single major research effort. For example, there were over 100 contributors to the Conversion Planning Project team, which number of people together represented 20 per cet of the forest research capability and about 5 per cent of senior forest managers in the whole country.

During the last 20 years, the Forest Research Institute has made great efforts to communicate research findings to potential users : they have travelled the country to explain findings at local meetings, staged Open Days, organised symposia (usually at least once a year at which there are 200 to 300 participants), placed demonstration trials all over the country, made films, published cartoons, written for trade journals and produced a series of 6 to 10 pamphlets a year entitled, "What's New in Forest Research". It has long been known that simply publishing research in journals and books with a scientific emphasis is almost a guarantee in New Zealand, and some other countries, that little or none of it will be put into practice : managers want firmer commitments to success than scientific articles and find the style of communication (particularly the predominance of scientific jargon) unsuitable for

their comprehension. For this reason, one of the Research Advisory Committees strongly supported a 1970's policy of the Forest Research Institute to require scientists to spend 20 per cent of their research time communicating the results of their research in ways other than scientific publication. The alternatives listed earlier represented various ways in which these efforts were directed so as to effect that policy.

In the 1950's and 1960's, the Forest Research Institute was small enough that individual researchers could interact among themselves. There was a considerable amount of joint research that was initiated and carried through voluntarily at a personal level. There was, moreover, a large proportion of the scientists from overseas (Europe and North America particularly). This diversity of background often produced healthy differences in scientific opinion and approach and led to much useful professional argument. Most had degrees in forestry in addition to basic science while overall a very high proportion (>50 per cent) were primarily biologists so that research that was biologically impractical was readily identified and rejected. The expansion of staff numbers in the 1970's resulted in recruitment of staff from scientific disciplines other than forestry. These larger numbers and the even greater diversity of background, however, decreased the level of personal interaction and made the formation of special teams and task forces essential if productive cooperation were to continue. To meet the need for more personal interaction between researchers and managers, a few recent forestry graduates were seconded to the Forest Research Institute for up to three years while some newly recruited overseas scientists would be sent to a large forest station for several months so that they could develop working relationships with field foresters and managers, help them identify the major problems they were facing and gain some appreciation of their research priorities.

Placing recent forestry graduates in temporary research positions is not as wasteful as it may appear at first glance. Each Bachelor of Forestry Science graduate from the only university School of Forestry at a New Zealand university undertakes a research study in the final year of the degree and completes a dissertation. Some who show some aptitude for research can then work under guidance and direction of researchers at the Forest Research Institute. If that early promise is sustained and if the graduates so wish, they may elect to remain in research or return to field forestry. If the former, then it is likely that they will be sent overseas to complete a Ph. D. degree: if the latter, or if insufficient research aptitude is displayed, they will move to a forest station where their experience in research can still be

put to good practical use.

Some of the major weaknesses in New Zealand, however, are the low level of funding for research in general, the small numbers of researchers and the limited perspective they are able to focus their research efforts on. New Zealand spends less than 0.5 per cent of its GDP on research while a country like Japan invests between 2 and 3 per cent of its GDP, or even more. The small numbers of researchers involved in forestry means that a higher proportion must make significant breakthroughs to remain viable. To this end, research efforts have been much more constrained and less able to depart from a strict programme directed largely by centralised agencies that can be easily targetted by the sector as a whole. With only one University School of Forestry, the links with other disciplines at the remaining universities cannot be easily made. There are, moreover, only eight academic staff at the University of Canterbury School of Forestry and so their teaching and research is usually much less specialised and more general than elsewhere. Thus, there is very little capacity for University researchers to compensate for the tightly controlled state-funded programme.

New Zealand forestry and wood-processing companies have not established their own research groups as such: instead, they have mostly relied on government research paid largely by the taxpayer. The present government policy to fund less research than previously has produced two noticeable trends in addition to the changes in direction previously mentioned: (1) there are even fewer researchers now than before; and (2) companies are identifying and funding research priorities with mostly short-term spin-offs while largely neglecting projects that are more uncertain and more long-term. There is also an indication that research efforts are more dispersed, less closely coordinated and subject to competitive duplication. A small country of few researchers like New Zealand may lose its international research standing if these trends continue too far and for too long.

Contrasts with Japan

The following table of national statistics lists some major differences in the scale and form of forestry between Japan and New Zealand: the forest covers are approximately two thirds and a quarter of the respective land areas, while the corresponding proportions of forest areas in plantations are 54 and 17 per cent; log production in Japan represents about one third of national wood needs, while in New Zealand only about 5 per cent of the wood needs are imported; Japan has between 30 and 40 times more people than New Zealand, but uses

less than half as much wood per head of population than in New Zealand ; spending on forest research in Japan is far ahead of New Zealands, in absolute amount, per head of population, per hectare, per m^3 of annual cut, per m^3 of plantation growing stock, or, in fact, in any way the amount can be expressed. The concentration in New Zealand on one species, radiata pine, has been a conscious decision that has lowered costs of research, but it is not without its detractors with regard to scientific merit. Japan with its greater species and forest diversity and with the strong influence of long-standing traditional culture, customs and building practice preferences has a much more complex research environment to address.

Table : Statistical Comparisons of Japan with New Zealand

		Japan	New Zealand
Total Land Area (000 km^2)		378	270
Indigenous forest	(%)	30.0	22.0
Plantations	(%)	36.5	4.4
Agricultural land	(%)	15.5	53.1
Other non-forested land	(%)	14.0	18.5
Waterways	(%)	3.0	1.1
Growing Stock			
-Indigenous forest	(Mm^3)	1500	Not known
-Plantations	(Mm^3)	1361	209
	(m^3/ha)	133	174
(Average age in years)		23	13
Annual cut	(Mm^3)	42	10
Annual Log Production-domestic	(Mm^3)	35	10
Annual Log Imports	(Mm^3)	60	0.6
Annual Domestic Consumption	(Mm^3)	95	6
Research Demography			
Population (millions)		120	3.3
Annual per capita Timber Consumption (m^3/person)		0.8	1.9
National Expenditure on Forest Research (millions yen)		107571*	2800
-(millions yen/ha)		4302	389
-(millions yen/m^3 of cut)		2561	280
-(millions yen/m^3 of plantation growing stock)		79	13

* estimated as 10 per cent of the national forest budget

New Zealand has considerable advantage over other countries in transferring technical knowledge because of the small size of its population. This extends to forestry as is shown in the pattern of ownership: over 80 per cent of the plantation area is in the hands of four organisations (Forestry Corporation, Elders NZFP Forests, Fletcher Challenge and Carter Holt Harvey). In contrast, Japan has over 2.8 million forest owners (Sweda, 1988). The average size of the 2 million farm forest holdings is 2.6 ha (Nagumo, 1988). The whole forest sector in New Zealand has met regularly in National Conferences at which research programmes and needs have been thoroughly discussed, whereas such meetings are not altogether feasible in Japan for its nearly 3 million owners. Thus, the situation in Japan is greatly different from New Zealand.

It is not for an outsider, therefore, to suggest whether or not even a small part of New Zealand's forest research philosophy and practice has any relevance to Japan. Only someone with a very intimate knowledge of forestry research in Japan could make a valid judgement on that score. The recent visit of JAFS to New Zealand in October, 1988 to stimulate increased communication and awareness of research in forestry management planning tools was most successful in promoting better mutual understanding. But even with this advantage and also the benefit of short visits to Japan, it would be unwise for an overseas researcher to make suggestions except through a formal committee containing also Japanese scientists. That solution, however, may have some attraction for future investigations.

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