International forestry research networks - objectives, problems and management

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CTFT TREE SEED BANK, FRANCE large quantities of seed will be needed

The formation of cooperative networks the held of forestry research - particularly those designed to strengthen developing country research programmes - is being discussed and recommended with increasing regularity whenever forest researchers or tropical foresters meet. Such research networks have a long history in agriculture but are relatively recent in forestry. Drawing on information and experience from both areas, this article sets out some guidelines for successful research networks and identities some constraints and possible solutions with particular application to forestry.

• Statisticians, mathematicians, transport experts and economists use the term "network" in a highly specialized sense, and there is an extensive field of network analysis, critical path analysis and similar analytical and prescriptive techniques dealing with networks in such contexts.

For the purposes of forestry and agricultural research in developing countries, however, a network signifies an informal or formal arrangement of cooperation between institutions with similar conditions and problems but without the immediate resources for finding solutions to these problems individually. Networking is a concept most recently accepted by development agencies and developing countries as being a cost-effective mechanism for strengthening institutional capability and causing rapid change in the application of research findings.

Networking is similar to, but extends the concept of twinning, which is the agreement made between two institutions to strengthen one of them by the contributions of staff, training, equipment, materials or finance from the other. Twinning is often established between an institution in a developing country and one in a developed country, but both institutions may be located in countries with similar development status. The United Nations principle of technical cooperation among developing countries (TCDC) also encourages this sharing of information, skills or resources.

Twinning may be extended to multiple twinning, whereby one institution gives support to several or, vice versa, receives support from several. When such an arrangement is made to deal with specific research topics or species it may be considered a network, and usually one of the collaborating institutions is assigned the leadership and coordination of the network. Cooper (1984) reviewed the twinning of institutions as a mechanism for transferring technology, training staff and building management capability; the professional relationships established between the cooperating entities offer complementarily and flexibility over time. In the same paper the author also examined the design issues in establishing twinning, such as the substance of the agreement, the design of services to be rendered, logistical and administrative support, and human behavioural factors.

A network approach generally reduces costs, minimizes duplication, boosts efficiency and leads toward national self-sufficiency in research capability or management. The benefits of a network are therefore most valuable in countries with limited funds and scientific manpower.

Application of and benefits from the network approach will vary according to the technical field involved. For example, networks appear to be particularly well-suited to germ-plasm collection and evaluation, since the network approach is beneficial at all levels procurement of plant material, methodology and exchange of information and results.

In other fields (silviculture, forest products, forest management, for example) where research becomes more site-specific, the benefits of a network approach may be different and in some cases more restricted, limited for example to the methodology aspect.

As experience is gained, a more detailed analysis of the different levels and types of benefits would be worth developing.

MICROPROPAGATION OF EUCALYPTUS, CTFT, CONGO a potential for germ-plasm transfer

In their historical review of agricultural research Plucknett and Smith (1984) recognized seven main principles for success in networking:

- The problem must be clearly defined and a research agenda drawn up
- The problem should be common to many countries
- Strong self-interest must exist in each collaborator
- Participants must be willing to commit resources
- Outside funding should be made available to facilitate the birth and early functioning of a network
- Staff from participating institutions should have sufficient training and expertise to make a contribution
- Networks must be guided by strong and efficient leaders who have the confidence of the participants.

Two other principles should be added for networks to be effective:

- Participants should be prepared and encouraged to share the results of national activities related to the network's research through formal publications, informal reports, newsletters and conference papers.
- Participants should demonstrate, or include preparations to establish, mechanisms for the extension of technological findings to the "user", whether the user be a forest department, an industrial plantation company, a rural community or an individual farmer.

Existing networks

More than 100 international agricultural networks are currently operating (Plucknett and Smith, 1984). Many of these are concerned with the comparative testing of improved crop germ-plasm but others deal with agronomic problems and farming systems, machinery development and socioeconomic constraints on development.

In forestry, cooperative programmes have existed between North American states and companies for many years, including provenance research (e.g. the US cooperative fertilizer study) and tree breeding (e.g. university-industry cooperatives based at the universities of Florida, North Carolina State and Texas A & M).

International networks of provenance trials have been established for a range of species, often identified with specific International Union of Forestry Research Organizations (IUFRO) working parties. Leading centres have included the Oxford Forestry Institute (OFI), Oxford, United Kingdom (Central American tropical pines and arid zone hardwoods); the Commonwealth Scientific and Industrial Research Organization (CSIRO), Canberra, Australia (Australian species of *Acacia*, *Casuarina* and *Eucalyptus*); the Centre technique forestier tropical (CTFT), Paris, France (African hardwoods and Pacific insular eucalypts); and the Danish Tree Seed Centre (DTSC), Humlebæk, Denmark (Asian tropical pines, *Gmelina* and *Tectona*). FAO has, over the years, supported all of these, in addition to assisting developing countries in establishing networks of both arid and humid zone woody species. Work in this field has also been carried out by the National Academy of Sciences (NAS), Washington, D.C., United States (nitrogen-fixing trees and species for the Sahel zone) and the Nitrogen-Fixing Tree Association (NFTA), Hawaii, United States (nitrogen-fixing trees). Progress reports on these trials appear frequently in FAO's *Forest Genetic Resources Newsletter* and in proceedings of meetings organized by IUFRO working parties S 2.02-08 (Tropical species provenances); S 2.02-09 (Eucalypt provenances); S 2.03-01 (Breeding tropical species excluding eucalypts); and S 2.03-10 (Breeding eucalypts).

An example of network structures and activities is given in the Figure (existing OFI network for tropical pine provenance research).

Problems of networks

Nine main groups of problems have been experienced in the existing forestry research networks.

1. Choosing species or topics It is imperative to maximize the cost-effectiveness of available resources by working on species and subjects that have the widest potential socioeconomic benefit. Traditionally IUFRO has developed a working party to cover a given group of species and/or subjects whenever a group of individual scientists sees a need and is prepared to work together, personally, voluntarily and with no external inputs of resources except perhaps germ-plasm.

EXAMPLE OF A FUNCTIONING NETWORK (Tropical Pine Research Network coordinated by the Oxford Forestry Institute, UK)

Recently, however, attempts have been made to give priority to research topics globally (World Bank and FAO, 1981) or regionally (IUFRO Research Planning Workshop for Asia in Sri Lanka (IUFRO, 1984); IUFRO Research Planning Workshop for Africa in Kenya (IUFRO, 1986) and the East-West Center workshop in Honolulu in March 1986. On a global level, species priorities for conservation, evaluation and improvement have been identified by the FAO Panel of Experts on Forest Gene Resources (1985) and at the ICRAF/OFI/IBPGR Workshop on Multipurpose Tree Germplasm, held in 1983 in Washington, D.C., United States (Burley and von Carlowitz, 1984).

2. Identifying the leading centre As indicated above, successful networks need strong and efficient leaders, organizations and individuals that can provide firm leadership, sympathetic guidance, and relevant information, experimental designs and, where necessary, analyses. In a paper for the 17th IUFRO Congress in Kyoto, Japan, the World Bank and FAO (1981) identified some 90 centres globally that could be considered as having the resources and knowledge to merit recognition as leaders in particular research topics. At the IUFRO workshop in Kandy (IUFRO, 1984) several species networks were agreed upon and leading centres were chosen by negotiation among the participants, recognizing current capabilities and equalizing the work-load as far as possible.

For most of the existing international forestry networks the leading centre is located in a developed country remote from the plantation sites and, with the exception of CSIRO, remote from the natural sites or origin of species and population germ-plasm. This is neither fortuitous nor a hint of incipient neo-colonialism but a reflection of the support given by donor agencies to international development by encouraging their own national institutions to undertake research (e.g. germ-plasm exploration, conservation, evaluation, etc.) for the benefit of many developing countries.

The donor agencies and their national institutions have agreed on species allocations with the help of the FAO Panel of Experts on Forest Gene Resources and they can provide from a wide range of sources seeds whose collection would be impractical for each participating organization in a network. For example, the OFI programme of provenance research in *Pinus caribaea* and *P. oocarpa* has collected and made available up to 50 seedlots for trials on about 500 sites in 50 countries. Assistance is then provided with design, assessment, analysis, interpretation, taxonomic research, chemical analysis, wood quality determination, etc., wherever national institutions cannot undertake such work for themselves. One of the functions of the leading centres for the networks identified at the Kandy workshop will be to determine the capabilities of participants and their needs for external support.

3. Identifying network participants The Kandy workshop recognized, from among those attending, some potential participants in the identified multipurpose tree species networks. However, such networks should not be considered as clubs with a restricted membership. One of the great advantages of networking is that a greater number of field sites provides increased information on the effects of interactions between site and genotype or management. Leaders and members of networks should constantly be seeking new participants able to meet the principles introduced earlier.

4. Encouraging active participation and providing resources Even when potential participants can be identified, they may not see the importance of joining a network, or they may not have sufficient resources to follow the agreed research agenda. The leader should clarify the benefits, quantifying them where possible on the basis of production gains in similar conditions or species, and seek sources of financial or personnel support.

Additional financial support may be obtained from donor agencies once a network's objectives, research agenda, leading centre and actively participating centres are identified and prepared in a suitable form. The form may differ between donors and advice should be sought from the forestry adviser in each agency. Some agencies prefer to finance national projects individually, some can consider an entire network, while others prefer subjects that are part of a network's overall operation, e.g. training courses, postgraduate education or workshops.

Personnel support comes from such courses and workshops eventually, but in the immediate future additional staff may be provided through twinning with better-endowed institutions.

> **Networks need strong and efficient leaders: organizations and individuals that can provide firm leadership, sympathetic guidance, and relevant**

information, experimental designs and, where necessary, analyses.

5. Communications and feedback To be effective, the results of all the participants' research should be combined (at a workshop or by the leader), circulated to all collaborators, and published for the benefit of others. Feedback from the field to the leader is often sporadic (because of shortages of staff and skills) or hesitant (because of fears of loss of national or personal data). In addition to the support described in Section 4 above, these constraints may sometimes be met by allocating national staff temporarily to the leading centre to assist with the combined analysis and publication. This is particularly effective when the leading centre is associated with a university that can accept postgraduate students to work on network data or problems.

6. Plant malarial Most of the existing forestry research networks and all of the multipurpose tree networks identified at the Kandy workshop require exchange of plant material between countries. This is usually in the form of seed, and large quantities will be required before the end of the present century for network activities, national research programmes and extensive rural use and plantation development. Such seed should be accompanied by certificates of origin and quality (Jones and Burley' 1973) and of plant health (Ivory, 1984). It is commendable that many countries now adhere to international agreements on plant quarantine, but this sometimes has the effect of delaying seed imports with consequent loss of viability. Leaders and participants in networks should ensure that seeds are "met" at airports, cleared through customs and plant-health formalities efficiently, and dispatched to field sites or stores immediately. Since for many species seed supplies are difficult and costly to obtain, the greatest efficiency should be sought in their use.

Tissue culture and micropropagation may be developed in the foreseeable future to an extent that permits rapid and healthful international transfer of improved germ-plasm. If so, there will undoubtedly be delays before customs and quarantine officials become familiar with such material, and rules become adjusted for its handling. Micropropagation has already been used to transfer oil-palm germ-plasm from Nigeria through the United Kingdom to Malaysia, and leaders of multipurpose tree germ-plasm networks could well seek advice from Malaysian participants on means of expediting such transfers.

7. Amount of material for comparative testing When a network is concerned with evaluating germplasm (e.g. species, provenance, family or clonal tests) it has several aspects that are in mutual conflict. As the number of field sites for tests increases, with consequent increase in environmental variation, the precision of estimating genotype-site interaction effects may improve but the amount of seed required also increases. At the same time, if all network participants are in a position to supply seed of some local native origins or exotic populations of the species concerned, the number of seedlots increases and not all are likely to have future application in all sites.

It is often counterproductive to ask participants to test too many seedlots. The network leader therefore has to strike a balance between recommending that all participants test everything and trying to identify specific seedlots for individual test sites. The latter option may not be feasible in the early stages of evaluating a new species when little is known about the response of the species to specific environmental or managerial conditions.

8. Experimental design The leader of a research network is generally expected to produce experimental designs for field trials, especially where participating centres and scientists are not familiar with the basic principles of design and analysis (despite the staff principle for success described earlier). Depending on the material and sites to be tested (see Section 7 above) designs may be simple (e.g. randomized complete blocks) or more complex (e.g. incomplete block designs, lattices, etc.); they may be fixed for all sites or vary between sites in terms of type of design, degree of replication and size of plot; each field site may have a different set of entities for test (e.g. different provenances; see Burley and Wright, 1984). Management may be uniform and imposed by the leader, agreed to be uniform by negotiation, or varied between sites.

Whatever is agreed, the leader should suggest flexible designs, provide management manuals and offer sources of assistance with assessment and analysis, remembering throughout that although combined analysis in the network concept offers more information than the sum of the participants' individual results, the prime reason for most networks is to provide material for individual participants to make their own decisions and to develop future programmes.

9. Comparability of assessment To be meaningful in combined analysis, data from different collaborators should be strictly comparable in terms of method of assessment, precision and bias (or rather, freedom from bias). Standard characters and methods can be prescribed in the protocol of collaborative research, and in some networks different participating centres are responsible for assessment of different characters (e.g. the NAS nitrogen-fixing tree network). For multipurpose trees the number of traits of interest is not yet fully known, and simple but precise methods of assessment have not been developed for many. Some guidance is available in the ICRAF manual for the evaluation of multipurpose trees (Huxley, 1984) and there is a strong case for providing for one common assessment of all field trials by one person or team from the leading centre at an agreed meaningful point in the trial's life (Gibson, 1982, reports on a single assessment of a sample of 12 sites in the CFI [now the Oxford Forestry Institute] international tropical pine provenance trials).

Conclusions

Networking, twinning and multiple twinning offer means of enhancing staff development, speeding technology transfer, providing research material and guidelines not easily available to all potential beneficiaries, and yielding research results that are greater in extent and value than the sum of the individual activities that are components of the network. Various principles govern the success of networks; they encounter several types of problem, but these can be overcome, and the indication from extensive international agricultural networking, now supported by evidence from several forestry germ-plasm and management networks, is that networking is a cost-effective, politically acceptable, scientifically enlightening and stimulating approach to problems in the management and improvement of natural resources.

References

BURLEY, J. & VON CARLOWITZ, P. (eds) 1984 *Multipurpose tree germplasm*. Proc. ICRAF/CFI/IBPGR Planning Workshop, 1983, Washington, D.C., USA. Nairobi, Kenya, ICRAF. 295 pp.

BURLEY, J. & WRIGHT, H.L. 1984 *Experimental design in multipurpose tree research*. Invited paper. IUFRO Research Planning Workshop for Asia, Kandy, Sri Lanka. 20 pp.

COOPER, L. 1984 *The twinning of institutions; its use as a technical assistance delivery system*. World Bank Tech. Paper 23. 46 pp.

FAO. 1985 *Report of the Sixth Session of the FAO Panel of Experts on Forest Gene Resources*.

GIBSON, G.L. 1982 *Descriptions of seed sources and collections for provenances of* Pinus caribaea. Tropical Forestry Paper No. 12, Comm. For. Inst., Oxford, UK. 98 pp.

HUXLEY, P.A. 1984 *Manual for the evaluation of multipurpose trees*. (6 sections paginated individually.) Nairobi, Kenya, ICRAF.

IUFRO. 1984 Proc. IUFRO Research Planning Workshop for Asia at Kandy, Sri Lanka.

IUFRO. 1986 Proc. IUFRO Research Planning Workshop for Africa (Sahelian and North Sudanian Zones) at Nairobi, Kenya.

IVORY, M.H. 1984 In J. Burley & P. von Carlowitz, eds. *Multipurpose tree germplasm*, p. 241-8. Nairobi, Kenya, ICRAF.

JONES, N. & BURLEY, J. 1973 Seed certification, provenance nomenclature and genetic history. *Silvae Genetica*, 22(3): 53-58.

PLUCKNETT, D.L. & SMITH, N.J.H. 1984 Networking in international agricultural research. *Sci*., 225: 1989-93.

WORLD BANK & FAO. 1981 *Forestry research needs in developing countries - time for a reappraisal?* Special paper. 17th IUFRO Congr., Kyoto, Japan. 56 pp.
