Agroforestry Systems 1: 189–203.
© 1983 Martinus Nijhoff/Dr W. Junk Publishers, The Hague. Printed in The Netherlands.

From research to communication in agroforestry: Some insights from the MAB Programme*

FRANCESCO DI CASTRI, JOHN CELECIA and MALCOLM HADLEY**

Division of Ecological Sciences, Unesco, 7, Place de Fontenoy, 75700 Paris, France

Abstract. Attempts within the Man and Biosphere (MAB) Programme of Unesco to produce research findings and information materials useful for education and training in agroforestry are outlined. Three different field projects – one in the humid tropics of Mexico, another in an urban situation in Papua New Guinea, the third in the arid zones of northern Kenya – provide examples of the types of educational materials and training activities that can be integrated within field research projects. Lessons learned in the preparation of a poster-exhibit 'Ecology in Action', and their possible relevance to the development of programmes in agroforestry education, are described.

1. Introduction

Implicit in efforts to promote agroforestry is the need to seek and test new approaches to professional education and training in this field. This paper aims to contribute to the search for such approaches. The paper is based on three premises.

First, existing scientific information is often not used, or is poorly used, in professional and vocational education related to land use and resource management concerns. And when such information is put to good use, there is often a long delay between information being obtained and applied in education programmes. Agroforestry is no exception to other professional areas. Indeed, given its very nature as an interface, agroforestry might be considered to be more poorly served than say, forestry and agronomy, with their well-established research and training institutes and channels for diffusion of research results.

A second premise, consequent to the first, is that new ways need to be sought for presenting scientific information on agroforestry. And in this respect, the more flexible channels for communication in agroforestry might be an advantage, in facilitating access to modern techniques for diffusion of information and the required cooperation among research scientists, educators and specialists in communications and graphic design.

A third premise is that materials useful for professional education and training in agroforestry, as well as in other related fields, need to based on

*Based on a paper presented to ICRAF International Workshop on Agroforestry Professional Education, Nairobi, Kenya, 6–12 December 1982.

**The opinions expressed in this paper are those of the authors, and do not necessarily reflect the views of Unesco.

the results of concrete research activities, synthesized to highlight those findings thought to be of more general relevance.

The contribution draws on experience gained in recent years within Unesco's Man and Biosphere (MAB) Programme, an international programme of research, training and demonstration designed to develop a better scientific basis for sustained management of resources and for improving man-environment relations. The Programme is based on national contributions to fourteen international research themes, several of which are concerned with land use problems and man-environment interactions in particular bioclimatic and ecological regions, such as arid zones, wetlands, humid tropical systems.

Though the word 'agroforestry' does not figure explicitly in the title of these themes, a number of field research projects contributing to them do include an agroforestry component or focus. Examples include: the development of mixed farming systems in wetland areas in Mexico, based on scientific assessment of the functioning of a traditional agricultural system long practised in the Valley of Mexico; the refinement of small-scale systems of urban agroforestry in the city of Lae, Papua New Guinea, as part of a broader initiative for diversifying energy sources and conserving energy in that city; tree and woodland management within a large-scale project for designing new management strategies for degraded arid land areas in northern Kenya.

Parallel with the promotion of agroforestry-related field studies, there has been an increasing recognition within MAB of the need to provide for the synthesis and presentation of research results in a form useful for different groups, including specialists, planners, teachers and students. Examples relating to agroforestry include state-of-knowledge reports on tropical forest and tropical grazing land ecosystems [14, 15], a slide-tape show and accompanying brochure on man in the humid tropics [16], and coloured posters in an exhibit entitled 'Ecology in Action' [17] – a poster-exhibit prepared jointly by Unesco and Etudes et Planification des Communications (a Paris-based communications firm), produced in multiple copies, initially in three language versions, in a form that can be readily adapted to different uses and other language versions [2]. The body of this article provides further information on attempts within MAB to produce research findings and information materials useful for education and training in agroforestry.

2. Agroforestry as one form of land use

Agroforestry is a fashionable term for an age-old practice, that of having trees in the agricultural landscape. Its meaning has been refined in recent years, and now connotes the inclusion of trees within a land use system that yields both a food product and a tree product, each meeting the needs of the user of the system [12]. Much interest has been directed in the last few years to the potential of agroforestry, as manifest in such ways as the establishment of

2

the International Council for Research in Agroforestry [7], the promotion by FAO of the role of forestry in integrated rural development [5], the launching in 1982 of a new international journal 'Agroforestry Systems', etc.

But at the same time, as argued by Budowski (1982), agroforestry is suffering from oversale and wishful thinking rather than being based on an objective analysis of what it can and cannot offer. Consequently, there is need for the potential of agroforestry to be weighted with that of other possible land uses in particular geographic locations.

This issue is addressed in one of the coloured posters in the Ecology in Action exhibit (Figure 1, actual size 120 cm by 80 cm), which is concerned with options in tropical land use and which depicts agroforestry as one among several possible forms of land use in these zones. Photographs illustrate some of the major options in land use: modification and clearance of small areas of natural forest (e.g. as in shifting cultivation, extraction of natural products), transformation and clearance of large areas of natural forest, before replacement by tree plantations (e.g. pine, rubber) or permanent agriculture (e.g. for rice, for sugar-cane, for mixed agroforestry systems, for grazing).

The underlying message of this poster — a message that we think is an important one in the professional training of those likely to be concerned with agroforestry and other land uses in the tropics — is that the large biomass and luxuriance of tropical forests are no guarantee of their potential for development. Tropical forests vary greatly in structure and functioning, and the line drawing at the top of the poster (Figure 1) illustrates how the structure of a tropical forest can vary according to site conditions. Not all tropical forested land is suited to the same uses. In choosing among options, account should be taken of the particular features of a given site, such as topography (slope, drainage, altitude), soils (which may vary enormously in nutrient status, from very poor leached soils to very rich usually recent soils), vegetation structure, etc.

This poster has already proved useful within training programmes as a basis for group discussions on land use options in the locality, country and region concerned. Photographs or drawings showing the local land use systems can be struck on the poster, to make it more relevant to the trainees. The poster can also be used as an entry for teaching courses on land capability classifications and other methods for assessing site potential.

3. Mixed farming systems in Mexico

In Mexico, as in most developing countries, a priority problem is to find inexpensive ways of increasing food output using systems that take advantage of the characteristics of the local environment and that can be sustained without the need for large-scale inputs in terms of fertilizers, capital, equipment, etc. One promising approach to this problem has been developed by scientists from the Institute for the Study of Biological Resources

Figure 1. Poster illustrating agroforestry as one of the major options in land use in tropical zones, with the text suggesting scientific approaches to choosing among options in particular localities [17] (Actual size 120 cm by 80 cm)

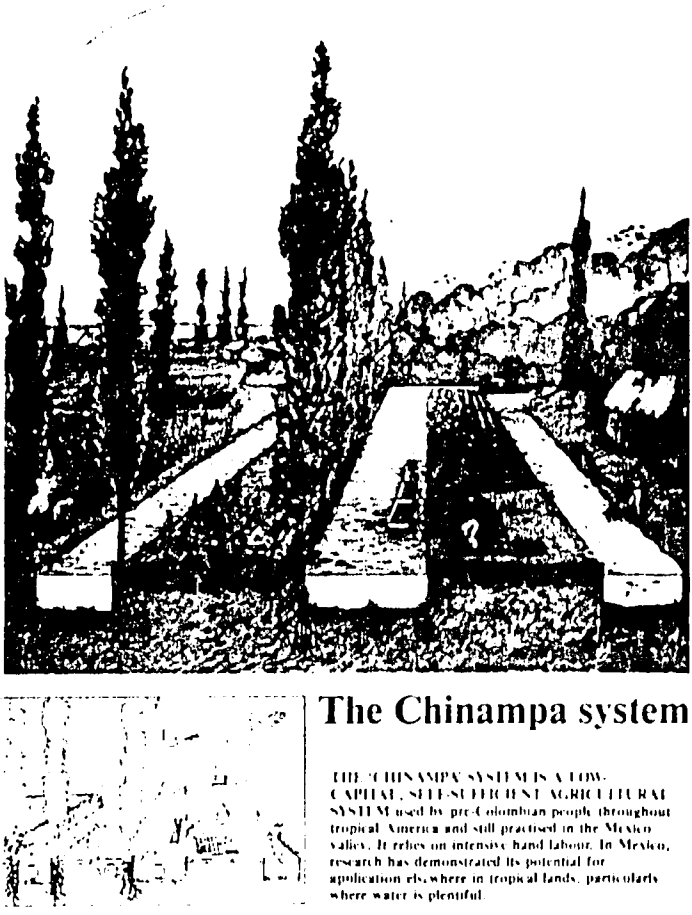

Figure 2. Part of a poster showing how the *chinampa* system works [17].

(INIREB) in Jalapa, who recognized the special nature and success of a traditional agricultural system, the *chinampa*, and decided to experiment with it in order to create a new method for meeting food needs [6, 9].

The *chinampa* consists of creating small plots of land on which crops can be grown from plant materials and mud dredged from the bottom of swamps and lakes, the plots being separated from each other by water channels in

which fish can be raised (Figure 2). Analysis of the *chinampa* has showed it to be a low-capital, labour-intensive, sustainable system of farming, with the potential of being combined with small-scale forest industries to produce multiple products from farm and forest. The system has been tried out in four rainforest areas in Mexico. One of these areas, in Tabasco state, consisted of a combination of semi-evergreen rainforest and swamps. Another very different site was chosen in tropical rainforest at Chiapas traditionally farmed by shifting, slash-and-burn methods. Here, *chinampas* were built near a river which provided the irrigation water, with the organic mulch for the *chinampa* plots being obtained from the litter of the adjacent rainforest.

Satisfactory results have been obtained from the mixed agropiscicultural systems that have developed on a pilot basis. Tree crops such as papaya and banana have been successfully combined with vegetable crops and poultry, pig and fish production. Systems of recycling plant residues and animal wastes have been refined and high sustained yields of tree and vegetable crops have been recorded, for example over 54 t ha^{-1} of celery within a 150-day growing period. Progress has also been achieved in promoting the use of native tree species such as *Brosimum alicastrum* in reafforestation and agroforestry programmes, following studies that had demonstrated the adaptability of the species to a variety of soils and climates, its rapid growth, the utility of its leaves for forage, the nutrition value of its fruits (particularly the seeds) for human and animal food, the commercial potential of its wood (Pardo and Sanchez, 1977, quoted from Gomez-Pompa [6]).

The research of the INIREB team has been closely linked with training and demonstration at various levels, and these activities lie at the heart of the success that has been achieved. Formal graduate and undergraduate courses are regularly offered by the researchers themselves, in which theoretical knowledge is combined with field practice. Seminars and workshops are organized on specific subjects for scientists and technicians. Students come from a number of disciplines, both in the natural and social sciences, training for careers ranging from bio-ecological field research to social work, marketing, management, planning, etc.

The most successful innovation in the training and information activities of the *chinampas* and integrated farming projects has been the organization of field training seminars for and by the *campesinos*,[1] based on their own knowledge and experience and reinforced by their active participation in field work. Information is thus transmitted informally, in everyday language, reflecting local perceptions and values. The seminars have enabled *campesinos* to visit, often for the first time in their lives, other distant areas and compare similarities and differences in production systems and community experience.

The information materials stemming from these MAB projects range from technical reports and articles in scientific journals to extension bulletins written in everyday language with line drawings to accompany the text (Figure 3). Other education and information efforts include the preparation

Figure 3. Examples of pamphlets produced by the Institute for Study of Biological Resources (INIREB) of Jalapa, Mexico, as part of the Institute's education and demonstration programmes.

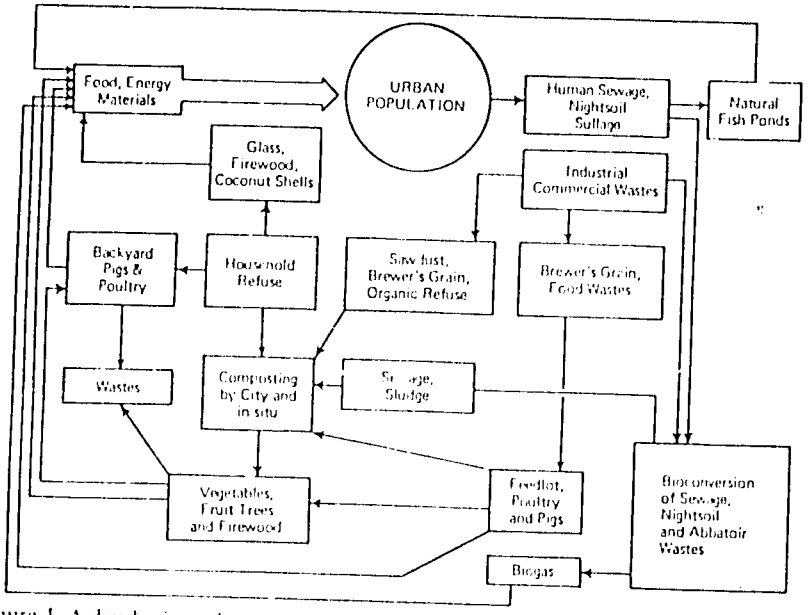

Figure 4. A developing urban agro-ecosystem Lae, Papua New Guinea [10].

of slide sound series, documentary films for television, taped radio programmes and coloured posters.

As a result of the initial achievements of INIREB on *chinampa* agriculture and integrated mixed farms, the programme of agroforestry and piscicultural experimentation is being expanded by the establishment of 25 demonstration farms in up to ten Mexican States, with funding provided by the Inter-American Foundation. Staff from three regional experimentation centres in Veracruz and Tabasco will train agronomists and peasant technicians to work and manage these farms. Each farm will combine vegetable gardening, fruit tree nurseries, forage and pasture, chicken, pig, and fish production, and anaerobic digesters and composting systems, on plots ranging from about 2–4 ha. Twenty agronomists and 150 peasant technicians will be trained to manage the farms, record production levels, solve technical problems, and promote other community activities, such as cooperatives. INIREB will also develop an outreach programme for peasants in the regions surrounding each farm to demonstrate the advantages of 'integrated farming' and to draw from them their own experiences and skills in adapting to diverse ecological settings. A production fund will be established as an incentive to community groups such as cooperatives, *ejidal*[2] councils, or other private service organizations interested in establishing experimental farms and adapting new technologies. Local groups will contribute land and labour to set up the farms, and low interest loans will be made for initial productive investments such as fish, seedlings, breeding stock, and equipment for digesters, or for commercial and infrastructural activities related to the farms.

4. Diversifying energy sources at Lae, Papua New Guinea

Lae in Papua New Guinea provides another example of agroforestry as one component of an overall land use plan — but in this case, land use within an urban context. Like many other cities in the tropical world, Lae has grown rapidly in the last ten years or so, with considerable migration from rural areas and increasingly acute problems linked with the use of energy. At Lae, an ecological analysis of the sources, flows and end uses of energy has led to a plan to meet future energy needs substantially from renewable sources [10, 11]. Practical measures include the development of urban agroforestry as an integral part of an overall policy for conserving energy and improving patterns of nutrient cycling (Figure 4).

Within the city itself [10], 400 allotment gardens, ranging in area from 100–400 m^2, have been drained from unused land, fertilized and allocated to low-income families. These gardens form part of a major programme to take the pressure off the surrounding hills. An urban composting system has been introduced. Household refuse, sawdust, market residues, sewage sludge and other sources of waste nutrients have been used for producing compost, which is then applied in allotment, backyard and council gardens for increasing yields of vegetables and fruit trees. Initially, manual methods have been used for producing 2000 t yr^{-1} of compost, but the aim is ultimately to produce 11 000 t yr^{-1} by mechanized means. At the same time, the City Council has introduced experimental plots for testing new combinations of vegetables and trees, and for demonstrating results to allotment holders and other interested individuals. The Council has funded and established a herbarium of all useful tropical fruit and nut trees and has multiplied their stocks, which are planted regularly in parks and along streets, in and around the city. The aim is to augment food supplies for low-income groups, as well as serving as landscaping and shade trees.

In the hills around the city, subsistence agroforestry forms part of a scheme for restoring degraded land areas as a permanent gardening and fuel-wood production zone, with buffer zones of native forest for maintaining wildlife, floristic diversity and water catchment control. About 70 ha of fuel-wood crops, 100 ha of conservation enrichment planting, and 5 ha of short-rotation garden systems including *Leucaena*, have been established. The latter is particularly interesting and successful, and has attracted overseas funding for parallel research into such aspects as nitrogen fixation, mineral nutrient cycling and biomass production in terms of food and fuel under controlled conditions.

Lae provides a good example of how a well-conceived research project can have a rapid impact on policy-making, and how agroforestry can contribute to the improved planning and management of urban areas, as well as in the more usually considered rural zones. As such, the project might prove useful as a source of information for agroforestry training in other countries. A key

ingredient in the success of the Lae project has been the involvement of scientists, government officials and community leaders from the beginning of the project. This has served to focus research on priority problems and to provide for the communication of results to planners and resource managers.

5. Tree management in the arid zones of northern Kenya

In northern Kenya, as in many other parts of the Sudano-Sahelian zone, there is a trend towards sedentarization of pastoralists — increasing populations of people and livestock, overuse of the rangeland plants and soils, 'the drought becomes permanent', a lack of alternative markets, starvation and a reliance on external aid. In northern Kenya, the Integrated Project in Arid Lands (IPAL) aims at developing management plans and systems of land use that will reverse the present trends of degradation and establish sustained production within the livestock economy of the district, at a level adequate to provide for the needs of a growing (and probably) partially sedentarized population.

Trees have three important roles in the arid zone in northern Kenya, seen from the standpoint of the pastoralist populations [8]. They provide firewood, materials for the construction of houses and livestock enclosures, and they provide browse for the livestock upon which the pastoralists are almost wholly dependent for their subsistence. In addition to these three essential contributions to pastoral economy, trees are valued for their shade (an important factor in the survival of cattle and smallstock in the arid zone) and some for their fruit and other useful products, such as fibre for rope and gum for the gum arabic industry. They also have a crucial role in the maintenance of soil fertility and in the reduction of soil erosion and dessication.

The wood requirements of pastoralists are known to vary greatly from one arid zone region to another, but it is apparent that in northern Kenya the Rendille and Gabra pastoralists, with their traditional diets of uncooked milk, sometimes with fresh blood (in the case of the Rendille), have a low annual requirement for firewood, possibly amounting to 0.1 m^3 of solid wood equivalent per person per year. This may be compared with the normally assumed annual fuel wood consumption in agricultural areas in Africa of 1 m^3 per person. On the other hand, the use of wood by the Rendille and Gabra people for the construction of night enclosures appears to be very high [13].

Comparison of consumption rates with calculated wood production of *Acacia reficiens* shrublands [8, p. 105] has shown that the 30 000 pastoral people in the IPAL study area should be able to obtain their wood requirements for fencing from the annual production from approximately 1080 km^2 of shrubland (less than a quarter of the total area of this single tree community), without reducing its standing crop biomass. On the face of it, taking the tree populations of the region as a whole, it would appear that there is no threat to the woodlands from over-exploitation. Unfortunately, this is not the case. Through the extreme concentration of the wood consumption in the

vicinity of the settlements, tree populations are being almost totally destroyed by progressive felling outwards from each centre at rates which not only exceed the annual production but steadily reduce the standing crop biomass as well.

In this perspective, scientists within IPAL have addressed the question of how woodlands can best be managed to ensure the maximal sustained production of the tree populations for the benefit of the pastoralist people and the country as a whole. Detailed information is therefore being collected on woodland dynamics and productivity on the one hand, and potential human utilization on the other. Specific activities include correlations of biomass-dimension relations for different tree and shrub species, livestock impact trials, establishment of exclosures, experimental reafforestation, exploitation of gum arabic as a possible means of diversifying the economy of the region. The overall guiding principle of these studies is that management of tree populations must be integrated with the regulation of land use in general, with water resource management, with settlement policy, with the provision of substitute building and fencing materials and with tree planting, to help accelerate rangeland rehabilitation and the provision of fuel and building materials.

The role of trees and their products in the ecology and economy of arid lands is therefore an important one for education programmes on improving land use in these zones. In northern Kenya, the topic forms part of training and orientation courses that have been organized within IPAL for different groups, including land use planners, extension workers, local pastoralists and visiting scientists. The topic has also been addressed in various communications exercises that have been undertaken, including radio programmes, slide-tape shows, and trial use of video films as an education tool in remote areas.

More generally, the experience gained within the IPAL operation in northern Kenya has been drawn upon in the preparation of the poster reproduced as Figure 5. The top row of photographs in this poster illustrates some of the uses of trees and shrubs in meeting essential needs in arid, developing countries. The silhouette of the acacia tree shows how slowly woody plants grow in arid lands and yet how quickly they can be cut down, and accelerate the processes of desertification. The bottom row of photographs includes examples of alternative sources of energy, or improved use of tree products, e.g. energy-efficient ovens, alternative building materials and forage plants, reafforestation. As for the 'Ecology in Action' exhibit as a whole, it is hoped that this poster might prove useful in education programmes, serving as a starting point in stimulating scientists to produce information materials based on local examples and designed for specific target audiences (e.g. trainees in agroforestry).

The many faces of wood in arid lands

Trees and shrubs are used to meet many essential needs in arid developing countries. They are vital in protecting against desertification. But woody plants are getting scarcer. Not only do they grow more slowly in arid lands than anywhere else, but overexploitation and savanna fires prevent natural regeneration.

PRESSURE ON WOODY PLANTS DUE TO:

- Increase in human population
- Increase in number of grazing animals
- Increase in croplands and human settlements reducing areas where woody plants can grow

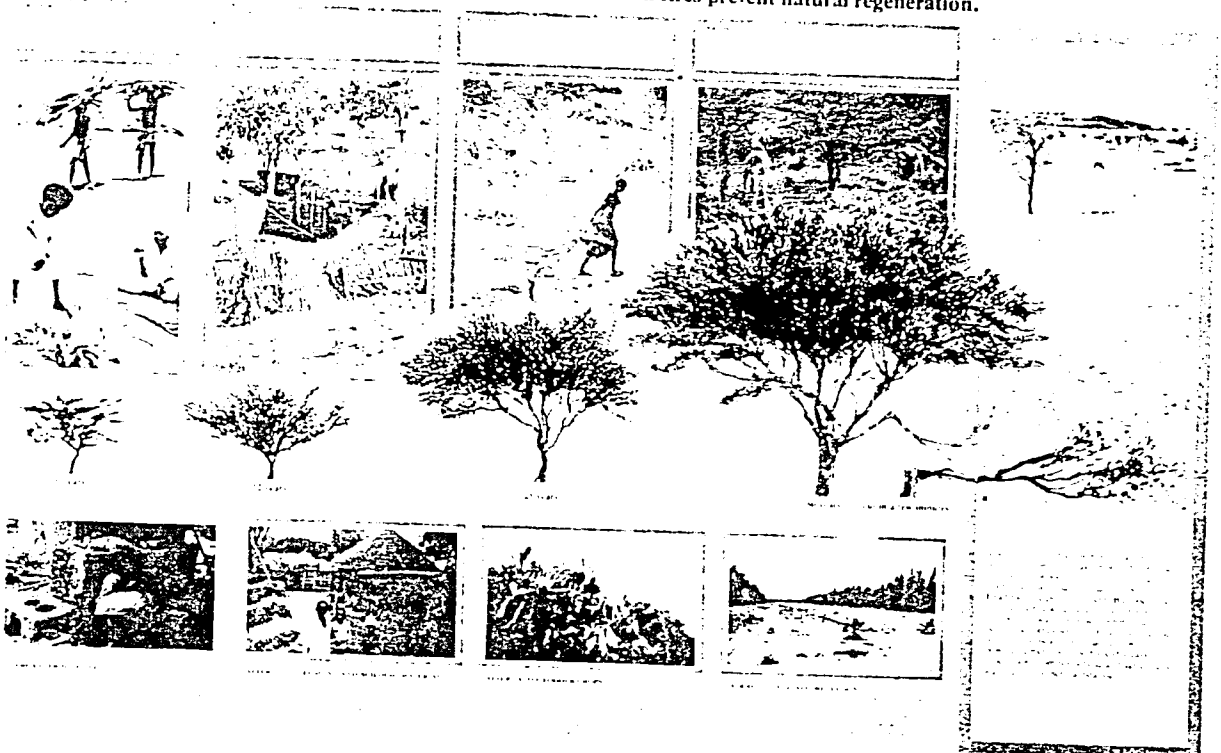

Figure 5. Poster showing some of the roles played by woody plants in arid zones, and some alternatives to more efficient use [17].

6. Concluding remarks

Agroforestry *per se* has not been a primary focus for research, training and information activities within the MAB Programme. But field research activities, such as the three projects described in this contribution, have included an agroforestry component and have provided insights useful in programmes of professional education and training in agroforestry. Among such insights are:

(1) The possibilities offered by understanding of traditional, mixed agricultural systems in the tropics for developing new production systems adapted to present-day needs and socio-economic constraints.

(2) The need to develop training programmes tailored to the needs of different groups, including research workers, land use planners, local resource 'practitioners' (farmers, fishermen, etc.), extension workers, etc.

(3) The urgence of convincing scientists to take an active role in programmes for popularizing scientific information for educational purposes at the local and national levels.

(4) The importance of integrating the efforts and experience of scientists, planners and local people from the outset of a project, in order to help shape research and prepare the ground for the use of research findings in training and planning activities.

(5) The opportunities presented to educational programmes and information activities by the range of tools and techniques now available, including pamphlets, slide-tape presentations, television and radio programmes, posters, video films, simulation games, etc.

Experience gained in the preparation and testing of the Unesco poster exhibit 'Ecology in Action' might also be relevant in considering the needs of professional education and training in agroforestry. Among the design features and aims of the exhibit [3, 4], mention might be made of the importance of:

(1) Presenting scientific information at different levels of technical detail, in a form useful for environmental education.

(2) Seeking the middle ground for information transfer, between information materials which serve only to heighten environmental awareness, and technical publications of research findings which can be understood only by specialists.

(3) Enjoining the efforts of scientists and communications specialists.

(4) Looking for ways to multiply the impact of synthesized information (e.g. through multiple copies, appeal to different audiences, adaptability to various uses and situations).

(5) Shrinking the time delay between generation and application of research information.

(6) Rooting educational and information materials in the results of field experience.

13

(7) Seeking a balance in synthesis between the knowns, the doubts and the unknowns of science.
(8) Taking account of diversity of geographical scales, time frames and perceptions in presenting information on land use problems.
(9) Combining information from social and biological sciences.
(10) Preparing information and education materials which provide a global perspective within which local problems can be placed.

Though these features relate to the poster exhibit as a whole, and in particular its relation to the broad field of environmental education, it is hoped that they might also be of interest in examining instructional needs and tools in the field of professional agroforestry education.

Notes

1. *Campesino* – peasant farmer.
2. In the *ejido* system of land ownership, the State grants land to a group of peasants who can exploit it individually or as a group.

References

1. Budowski G (1982) Applicability of agro-forestry systems. In: LH MacDonald (ed) Agro-forestry in the African humid tropics. Proceedings of a Conference held in Ibadan, Nigeria, 27 April–1 May 1981. United Nations University, Tokyo. pp 13–16.
2. di Castri F, Hadley M and Damlamian J (1982a) Ecology in Action – an exhibit: an experiment in communicating scientific information. Nature and Resources 18(2):10–17.
3. di Castri F, Hadley M and Damlamian J (1982b) Communicating information on the environment: between emotions and hard data. Ambio 11 (6):347–354.
4. di Castri F, Hadley M and Damlamian J (1982c) Ecological information for environmental education: seeking the middle ground, multiplying the impact. Paper presented to IUBS Symposium on Environmental Education through Biology. Ottawa, 26 August 1982
5. FAO (1978) Forestry for rural communities. FAO Forestry Department, Rome.
6. Gomez-Pompa A, Morales HL, Avilla EJ and Arilla JJ (1982) Experiences in traditional hydraulic agriculture. In: KV Flannery (ed) Maya subsistence: studies in memory of Dennis E. Puleston. Academic Press, New York. pp 327–342.
7. King KFS and Chandler MT (1978) The wasted lands. The programme of work of the International Council for Research in Agroforestry. ICRAF, Nairobi.
8. Lusigi W (1981) Combatting desertification and rehabilitating degraded production systems in northern Kenya. IPAL Technical Report A-4. Unesco, Nairobi.
9. Morales HL (1983) Chinampas and integrated farms: learning from the rural traditional experience. In: F di Castri, FWG Baker and M Hadley (eds), Ecology in practice: establishing a scientific basis for land management. Tycooly, Dublin (in press).
10. Newcombe K (1983) Energy conservation and diversification of energy sources in and around the city of Lae, Papua New Guinea. In: F di Castri, FWG Baker and M Hadley (eds), Ecology in practice: establishing a scientific basis for land management. Tycooly, Dublin (in press).
11. Newcombe K and Pohai T (1981) The Lae project: an ecological approach to Third World urbanization. Ambio 10(2–3):73–78.
12. Steppler HA (1982) An identity and strategy for agro-forestry. In: LH MacDonald

(ed), Agro-forestry in the African humid tropics. Proceedings of a Conference held in Ibadan, Nigeria, 27 April-1 May 1981. United Nations University, Tokyo. pp 1–5.

13. Synnott TJ (1979) A report of prospects, problems and proposals for tree planting. IPAL Technical Report D-2b. Unesco, Nairobi.
14. Unesco (1978) Tropical forest ecosystems. A state-of-knowledge report prepared by Unesco, UNEP and FAO. Natural Resources Research 14. Unesco, Paris.
15. Unesco (1979a) Tropical grazing land ecosystems. A state-of-knowledge report prepared by Unesco, UNEP and FAO. Natural Resources Research 16. Unesco, Paris.
16. Unesco (1979b) Man and the humid tropics. MAB Audio-Visual Series 1. Unesco, Paris.
17. Unesco (1981) Ecology in action: an exhibit. Thumbnail sketches of 36 posters. Unesco, Paris.

15