Local knowledge throws new light on agroforestry research in Asia

By Fergus L. Sinclair

1. Introduction

This article describes some highlights of collaborative agroforestry research in Asia, over the last decade, involving the School of Agricultural and Forest Sciences (SAFS) at the University of Wales, Bangor (UWB). This began with a focus on local knowledge that revealed sophisticated understanding of ecological processes by farmers. This has changed perceptions of what research is relevant to farmers and led to a blend of participatory process-based and systems level research.

2. New ways of knowing

In the early nineties a novel project on indigenous agroforestry knowledge heralded a new era of collaborative research in Asia involving SAFS, UWB. Initially there were collaborators in Nepal (Pakhribas Agricultural Centre), Sri Lanka (the Universities of Peradeniya and Sri Jayawardanapura) and Thailand (the Royal Forest Department and the Chiang Mai University). Six research fellows studied farmers' knowledge across a broad range of agroecological circumstances, focussing on fodder trees in Nepal, Kandy forest gardens in Sri Lanka and miang tea gardens in hill evergreen forest in Thailand. But, before the local knowledge could be understood and used in planning research and extension, appropriate methods of knowledge acquisition had to be created. This led to the development of a knowledge-based systems toolkit and methodology (AKT), in conjunction with the Department of Artificial Intelligence at Edinburgh University. Formal methods of knowledge representation enabled rapid and repeatable knowledge acquisition, increasing both the depth of knowledge obtained from farmers, and the flexibility with which the recorded knowledge could be used to inform research and extension.

3. Farmers' knowledge

Treating farmers' knowledge seriously in this way revealed that they often had a sophisticated understanding of ecological processes. For example, Balaram Thapa, working in Solma village in the eastern mid-hills of Nepal, found that farmers operated a complex trade-off between the fodder value of trees at key times in the season and their competitive effects on crops. Farmers' knowledge of both tree-crop interactions and nutritive value of tree fodders for livestock was detailed and explanatory. His colleague Laxman Joshi (now based at ICRAF in Bogor, Indonesia) went on to generalise this result across Nepal, finding that the conceptual basis of the knowledge system was widespread amongst mid-

> **Project example 1: Integrating indigenous and biological knowledge to implement improved dry season feeding strategies in the hills of Nepal**
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> In Nepal, over 50% of the population live in the hills and more than 60% of these people live below the poverty line. In the eastern hills, within the command area of the NARC (Nepal Agricultural Research Council) agricultural research station, Pakhribas, almost 70% of farm households are in food deficit for some of the year. Livestock play a pivotal role in hill farming systems, in terms of maintaining soil fertility, providing draught power and producing milk-based products for home consumption and sale. Dry season feed shortages are an enduring problem in smallholder, mixed farming systems. High levels of crop-livestock integration in these systems, means that such shortages constrain not only livestock, but also the productivity of the cropping systems that depend on them. Tree fodder is an important resource, particularly for poorer farmers with small land holdings and only limited access to forest or grazing resources, as it may be produced on crop boundaries or steep hillsides, both unsuitable for arable cropping. On the steeper hillsides occupied by such farmers these may account for half the total land area. The specific objective of this project will be to improve the year-round stability of fodder supplies and thus food security of resource-poor farm families. This will be achieved through integration of farmers' and biological knowledge, through the provision of tools necessary to improve the effectiveness of extension services in supporting the management of existing uses of tree fodder, and through identifying new tree fodder resources and planning dry season feeding strategies in general.

hill farmers, although details varied according to the extent to which farmers were dependent on particular resources.

4. Scientific complementarity

Another colleague, Desh Subba, compared farmers' evaluation of the nutritive value of tree fodder with laboratory methods used in animal science. This revealed close correspondence of two independent descriptors of value used by farmers (posilopan and obanopan) with protein supply and overall dry matter digestibility. But there was both complementarity and discrepancy. A major discrepancy was that animal scientists favoured tree fodders with higher digestibility, whereas in times of the season when feed was scarce, farmers valued fodders that satisfied animal appetite

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and hence had a lower digestibility. Complementarity was more common, particularly in terms of farmers being better able to describe seasonal variation in nutritive value for a diversity of tree species while scientists understood more about how particular dietary components affected livestock performance. Thus, combining local and scientific knowledge produced a more powerful knowledge base than could have been derived from either source alone. Desh Subba is presently exploring the comparability of local and scientific knowledge in more depth in his PhD research, using participatory on-farm feeding trials.

5. Change in perception

It was immediately apparent that the creation of formal knowledge bases led to profound changes in the perceptions and behaviour of research and extension staff and hence their interactions with farmers. Similar results were obtained in other countries and contexts. After finding that the complexity of Kandy forest gardens rendered their classification into recommendation domains impossible, Gamini Hitinayake in Sri Lanka, found that interventions involving knowledge about components and processes could be effective. For example, whereas attempts by researchers to design more productive garden systems failed, farmers lacked knowledge on specific aspects of garden management such as pruning of timber trees, which if they were taught, allowed them to simultaneously improve timber value and understorey productivity. The key point was to address specific areas of farmers' knowledge, leaving them to integrate this into their complex and heterogeneous systems, depending upon their individual circumstances and priorities. In Thailand, Pornchai Preechapanya found that farmers' understanding of processes of soil erosion in the traditional and sustainable miang tea gardens could be applied to control erosion in new systems where tea was replaced by coffee and erosion was a problem.

6. Change in research methods

Today, a formal evaluation of local knowledge is becoming accepted as a prerequisite for planning appropriate agroforestry research. In Nepal, for example, Thakur Tiwari has begun a crop improvement programme for maize on mid-hill terraces by evaluating farmers' knowledge about local and introduced varieties and how they interact with other components of the farming system. Since farmers intercrop the maize with millet, on terraces where fodder trees ameliorate the atmospheric and soil conditions and feed maize stova to cattle, their criteria for varietal selection are complex. Taking local perceptions into account in selecting germplasm has led to participatory crop improvement that combines yield increases with acceptability to farmers for the first time and prospects for higher yielding varieties being adopted by farmers are good. Furthermore, farmers themselves are co-operating to continue local improvement programmes under their own control. Similarly in Chitwan in the Terai, Dil Serchan, working for a local NGO called LIBIRD (Local Initiatives for Biodiversity Research and Development) began

research on the use of green manures in high potential rice cropping systems by evaluating local knowledge. These developments build on pioneering research on participatory approaches to crop improvement in India and Nepal spearheaded by the DFID Plant Science Research Programme based at the Centre of Arid Zone Studies in Bangor.

Project example 2: Participatory crop improvement for maize-millet intercropping in the mid-hills of the Himalayan region

Food deficit and low income are common amongst the hill farmers in the Himalayan region where maize is the most important rain-fed crop. In Nepal, maize is grown on about 0.8 million ha (almost 40% of the total cultivated area of the country) and 80% of this occurs on terraced hill land, producing over 1.3 million tonnes of maize per year. Maize yields currently average just over 1.5 tonnes per hectare in hill regions, less than half of what is regularly achieved with improved varieties on outreach research sites, and they are steadily declining over time. The purpose of this project is to sustainably increase yields from systems on sloping lands by minimising production losses. This will ultimately be achieved by incorporating attributes for higher yield and pest and disease resistance from introduced germplasm into locally acceptable maize varieties that are system compatible. Local knowledge of farmers and their criteria for varietal selection developed in the first year of the project will be harnessed to incorporate system compatible traits from local germplasm with the higher yield potential, and pest and disease resistance, of introduced germplasm in a participatory crop improvement programme. This will produce new varieties of maize and possibly millet which will be both higher yielding under farmer circumstances and adoptable by farmers because they are compatible with the complex farming system and farmer's priorities. New germplasm for farm evaluation will be produced by the end of the project together with an ongoing participatory crop improvement programme that will continue to refine and deliver improved germplasm. Adoption of these new varieties will improve nutrition and increase farm income. There is a demonstrable potential to double maize yield on upper rain-fed (bari) terraced land in Nepal alone in the coming decade, this could increase maize yield in the country by around 750 thousand tonnes.

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7. Combining research results with local knowledge

It is important, however, not to romanticise local knowledge. It is clear that there is much that farmers still need to know to improve their livelihoods and there are significant contributions that science can make. For example, several years of research at Agricultural Research Station, Lumle in western Nepal in conjunction with Rita Gardner at the Royal Geographical Society, has revealed much greater nutrient loss through leaching than had been previously thought. Pratap Shreshtra at LIBIRD, in evaluating farmers' knowledge, found that farmers knew a lot about surface

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processes (run-off) but had little or no understanding of leaching. Morag McDonald at Bangor obtained funding for a joint programme involving scientists from both Lumle and LIBIRD to conduct participatory technology development for soil and water conservation in western Nepal that combines scientific experiments with on-farm participatory trials and evaluation of local knowledge. Similarly, at the Rubber Research Institute in Sri Lanka (RRI), Lakshman Rodrigo's ecophysiological PhD research, supervised by Clare Stirling at Bangor, revealed that not only could banana be intercropped with rubber to provide early returns before the rubber trees were tapped, but that rubber yields were also higher under intercropping. Now, further research, involving both evaluation of local knowledge and continued agronomic trials on-station and on-farm, is looking at a wider range of intercropping options and the requirements for effective extension of rubber intercropping technology to improve livelihoods of poor farmers. Rubber is also the subject of research led by ICRAF in Indonesia, where the traditional jungle rubber system that covers over 3 million ha of Sumatra

Collecting rubber in the forest   from SAFS's Web Site

Project example 3: Combining ecological knowledge and socio-economic perspectives in the participatory improvement of multistrata agroforestry systems at the forest margin

Multistrata agroforestry systems are abundant in Asia, Africa and Latin America, often as small intensive land use units managed by women to produce household goods and income but in some areas they are more extensively used for income generation. There is an urgent pressure from resource-poor smallholder farmers in the forest margin to produce more from complex multistrata agroforestry systems to improve their food security and income generation. This is a widespread problem in the tropics affecting a range of plant associations with broadly similar ecological structure (e.g. forest gardens across the tropics, jungle rubber and damar in Indonesia, jungle cacao in Cameroon and Ghana, spice gardens in Sri Lanka and jungle tea in Thailand). Conventional solutions presently available involve conversion of complex agroforests to simple, intensively-managed, 'orchard'-type plantation systems, involving loss of biodiversity and consequent stability and sustainability problems. As an alternative the productivity of these complex agroforests could be sustainably improved by incremental change to current practice, intensifying the multistrata system. To enable this, there is a need to understand farmer decision making, particularly the extent to which their biological understanding is robust and how it is integrated with socioeconomic factors. Through collaborative research on the jungle rubber system in Indonesia, this project will: i) develop efficient generic means to systematically acquire information on decision-making criteria, resources and markets from farmers, and then combine these with ecological knowledge in order to ii) improve the productivity and environmental impact of complex multistrata agroforestry systems and prevent their conversion to monoculture.

and northern Borneo is important both for the maintenance of rural livelihoods and biodiversity. Bangor's involvement here

has been through Laxman Joshi who has taken his experience in developing and applying knowledge-based systems methods from his work in Nepal and applied it, together with socio-economic survey work led by Gede Wibawa at the Indonesian Rubber Research Institute at Sembawa, to understanding farmer decision making. This forms part of a large smallholder rubber improvement programme that also involves agronomic trials and ecological modelling. As with other research, understanding local knowledge and practice has been a central plank of the development strategy. Progress is being made both with introducing higher yielding rubber clones to the system and encouraging gap rejuvenation (locally known and practised by farmers under the name of 'sisipan') as opposed to environmentally destructive slash and burn.

8. Policy

As experience with using local knowledge as a basis for planning agroforestry research and extension accumulates in Asia, the techniques for formal knowledge acquisition are becoming institutionalised. Recently, the Executive Director of the Nepal Agricultural Research Council called for institutional use of local knowledge in research planning while pointing to the need to secure intellectual property rights. New initiatives involving ICRAF, Bangor and a host of local and national collaborating institutions seek to combine local knowledge, experimental research and modelling to empower local communities to manage natural resources more productively and sustainably, and to inform appropriate policy formation that will enable it.

9. Selected publications

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Agroforestry courses at the University of Wales, Bangor

Prifysgol Cymru - University of Wales
BANGOR

As the leading centre for education and research in agroforestry in the UK with a number of specialist agroforestry academic staff, the University of Wales Bangor (UWB) offers both undergraduate and postgraduate taught courses in agroforestry.

Both B.Sc. and M.Sc. courses are designed to provide an interdisciplinary education in the principles and practice of using land to meet human needs for food, fuel and timber with consideration of ecological, economic and social dimensions and their integration. This involves the consideration of trees, crops, animals and people.

The B.Sc. course runs for three or four years (the four-year course includes a one year placement for work experience). The degree is based on a firm grounding in agricultural, forest and social science and is designed to produce a new generation of graduates who are able to consider the ecological, economic and social complexity necessary to evaluate and improve the land use practices found in the real world, rather than to be hidebound by artificial subject boundaries.

The M.Sc. course is a one-year course designed for holders of B.Sc. level qualifications or their equivalent in the natural sciences, forestry or agriculture. Apart from the aims described above, the course will enable students to develop skills in integrating knowledge across disciplines necessary to evaluate and improve both traditional and novel agroforestry practices. In addition, the course develops skills in critical analysis, creative thinking and individual research initiative required by professional agroforesters. The course has two parts: a formally taught element which runs from September to April, and subsequently a period of approximately five months during which students research a specific area of interest to them and produce a dissertation.

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