3 TAKING LOCAL KNOWLEDGE ABOUT TREES SERIOUSLY

Fergus L. Sinclair and Laxman Joshi

3.1 INTRODUCTION

There has been a sea change in forestry research and development over the last quarter of a century. This has transformed forestry from an ecological discipline, largely about trees and their associated biota, to one which embraces consideration of the people who use forests or want them to be conserved (Westoby, 1987). This change has been forced by practical imperatives. In many developing countries, attempting to keep people out of forests was expensive and largely unsuccessful, so that it became apparent that developing sustainable forest management, either for productive or conservation purposes, required inclusion rather than exclusion of the people in the vicinity of the forest (Oldfield, 1988). As a result, local people who use forests are increasingly seen as legitimate stakeholders in planning forest utilisation and conservation strategies by both public and private forestry initiatives (Bird, 1997). Participatory forest development is in vogue.

There has also been a slow realisation that trees outside forests and modified forests where people farm, may be important for the well-being of forest ecosystems. Trees on farms have critical importance, both because they can renewably supply tree products that might otherwise be unsustainably removed from forests and because tree cover on regional and landscape scales may affect the conservation value of remaining forest fragments. The importance of trees outside forests, the use of natural forest vegetation in agricultural contexts and the deliberate creation of agricultural systems with a forest-like structure are outlined below.

3.1.1 Trees outside forests

There are many examples of the need to domesticate wild trees if they are to be maintained as a renewable resource. The afromontane tree *Prunus africana* from which a cure for benign prostatic hyperplasia is derived, is now on CITES Appendix 2 and threatened with local extinction in Cameroon and Madagascar because of over exploitation (Hall *et al.*, in press). Many other wild trees, such as the shea butter (*Vitellaria paradoxa*) and néré (*Parkia biglobosa*) in West African parklands, the desert date (*Balanites aegyptiaca*) with a main range in the sahel, and marula (*Sclerocarya birrea*) in East and Southern Africa, are similarly important as sources of exported products, local food and wood, or both (Boffa, 1999; Teichman, 1987). Their domestication and utilisation on farm is critical both for preserving rural livelihoods in Africa and the woodlands that remain (Leakey and Simons, 1998). Trees on farms can also provide key habitats, resources and corridors for forest plant and animal species, thereby increasing both local and regional biodiversity (Pimentel *et al.,* 1992). For example, on a national scale, migratory bird species such as the resplendent quetzel (*Pharomacrus mocinno*) and the three wattled bell bird (*Procnias tricarunculata*) that attract visitors to cloud forest reserves in Costa Rica, require sufficient tree cover in the agricultural landscapes that surround them, to make their seasonal migration (Harvey and Haber, 1999). On a continental scale there are moves to protect a Mesoamerican biological corridor, extending from southern Mexico to Colombia. Trees in pastures, windbreaks, live fences and shade trees on coffee farms are important elements in connectivity of tree cover in this region.

3.1.2 Use of forest vegetation in farming

Farming also occurs within modified forest environments which may constitute either effective buffer zones around natural forest or retain much of the ecosystem functions of forest habitat themselves. Natural vegetation may be used from regeneration, or by removal of some trees and enrichment planting with productive species, or trees may be deliberately planted to create forest like environments. The damar *(Shorea javanica*) agroforests around Krui in Sumatra, have recently been recognised as a legitimate land use by the forest authorities because they have been shown to retain forest functions while providing a living for rural people (Tomich *et al.*, 1999). A further 3 million hectares of Sumatra and Borneo are covered in secondary forest enriched with rubber (Gouyon *et al*., 1993). This 'jungle rubber' is managed on a 30 to 60 year rotation by farmers who slash and burn an area, plant rubber and then allow secondary forest regeneration around it. This creates a much more biodiverse environment than intensively managed monocultural rubber plantations, albeit within a modified rather than natural ecosystem (Michon and de Foresta, 1995; Beukema, in press). In contrast, the *miang* tea gardens of northern Thailand involve less disruption of the natural habitat; farmers simply thin the natural forest and enrich with productive plants, in this case principally *Camellia sinensis* (Preechapanya, 1996). In other systems, such as the Kandy forest gardens in the central highlands of Sri Lanka, productive forest-like environments are created by planting useful trees, shrubs and climbing plants around homesteads (Sinclair and Hitinayake, 2000).

So it is common sense that people who use, or who want to use, forests should be a central focus in forestry, and that trees on farms, and farming in forest or forest-like environments, are critical at the forest margin. This puts resource users, and amongst these, farmers and forest dwellers, at the centre of sustainable forest development. A critical issue then arises about how these people participate in forest development and the respective roles for local practitioners and external research and development workers, in the process of developing and implementing tree and forest management strategies. It is argued here that both indigenous and external perspectives and knowledge are valuable, but that rigorous methods are required to acquire and combine them. It is reasonable to assume that this chapter might be read by people working with resource users. It is unlikely to reach the resource users themselves. It is sensible, therefore, to focus upon what we as research and development workers can learn from resource users, and how we can use this knowledge as part of a participatory approach to development.

3.2 WHAT DO RESOURCE USERS KNOW?

Resource users are many and varied. In the chain of use of tree and forest products, there are those directly involved in harvesting, some of whom are also involved in husbandry, while others exploit resources without taking action to ensure their regeneration. There are also people and organisations involved in collection, transportation, processing and retail. This chapter is concerned with direct resource users, and particularly those who live locally and may therefore be expected to have a stake in sustaining the tree resources around them.

3.2.1 Local knowledge

There are many dimensions to the knowledge that tree and forest resource users have and many ways to go about describing it. We are concerned here with local knowledge, that is, the knowledge held by people in particular localities who use trees. In this context the word 'local' can be distinguished from 'indigenous'. Indigenous knowledge implies knowledge that is culturally specific (Sillitoe, 1998), whereas the concern here is with knowledge about trees and the environment that is locally derived through observation and experience. The significance of this distinction, as will be shown below, is that the local knowledge systems from geographically distant and ethnically different locations but with a similar agroecological context show remarkable similarities.

3.2.2 Knowledge and practice

It is also important to distinguish the present interest in local ecological knowledge from what has been referred to as indigenous technical knowledge (IDS, 1979). Much of what has been written about technical knowledge has actually referred to practice rather than knowledge, but what people *do* and what they *know* are rather different (Sinclair and Walker, 1999). Agricultural practice, for example, has been described by Richards (1989) as a performance, involving the farmer making contingent responses to various events as a season unfolds. Knowledge may be used in making decisions at each point but the resulting field practice, such as a complex intercropping layout, is the result of an interaction between underlying knowledge and a series of events, opportunities and constraints rather than a carefully planned *a priori* design. Knowledge cannot, therefore, be directly inferred only from observation of practice. This is nicely illustrated in Nepal where farmers know that large leaved trees, such as *Ficus roxburghii*, have a propensity to cause splash erosion of soil but nevertheless plant them on crop terrace risers because of their high fodder value (Thapa *et al*., 1995). This represents a trade-off, involving sophisticated knowledge about both tree-crop interactions and the nutritive value of tree fodder on the part of the farmer (Walker *et al.*, 1999). It would be erroneous to assume from their practice of planting the large-leaved trees that farmers did not know they caused erosion. This has immediate consequences for planning research and extension. There is clearly no point promoting an extension message trying to inform farmers about what they already know. There is, however, a researchable constraint relating to how high value fodder can be produced without causing soil erosion. This could be addressed by, for example, breeding smaller leaved trees of the species preferred by farmers or identifying new species with similar fodder value at critical times of the season but with less destructive environmental impact (Sinclair and Walker, 1999).

3.2.3 Levels of explanation

The use of the term ecological knowledge, as described here, also implies that there is some explanatory content to knowledge rather than only heuristic rules of thumb that people may follow but do not know why they work. This has important implications because, whereas explanatory knowledge can be extrapolated to new situations through reasoning, the specificity or generality of unexplained heuristic rules is unknown. Where it has been systematically looked for, explanatory knowledge has often been found amongst rural people. This is consistent with an emerging view of local knowledge as a dynamic resource based upon contemporary observation and experimentation rather than just a legacy from the past (Fairhead and Leach, 1994; Richards, 1994; Thapa *et al.*, 1995; Sinclair and Walker, 1999).

Care is required here, however, because there are often different levels of explanation and their conflation can result in over-emphasis of culturally idiosyncratic explanations involving the supernatural, obscuring pragmatic understanding of natural processes. The supernatural explanations are often at a much higher level than, and distinct from, natural causal mechanisms that are also understood. For example, in Zambia a snake may bite a person who then dies. One level of local explanation of this concerns the mechanism; people know that the snake injects venom and that this is poisonous. Another level of explanation concerns why the snake bit the person, which requires a spiritual explanation which may relate to witchcraft and someone having malicious thoughts towards the victim. Spiritual beliefs more often constrain what people do than what they know ecologically. In Mayan culture it was a belief that people were literally made of maize (Asturias, 1949). This equivalence of flesh and maize meant that indigenous people would not grow maize to sell, but only for subsistence. Commercial cultivation of maize was essentially like trading in people and therefore considered immoral, but did not mean that the Mayans did not know a lot about the ecology of growing maize as a subsistence crop. Conflating spiritual explanations with utilitarian knowledge, as is often done in cultural anthropology (Sillitoe, 1998), may be just as misleading to our understanding of peoples' ecological knowledge, as not recognising a spiritual dimension would be to our understanding of their culture.

3.2.4 Causal understanding

Knowledge of causation is a particularly useful form of knowledge in natural resource management. In some rural communities detailed local understanding of natural causal mechanisms have been found. Figure 3.1 shows a systematic representation of farmers' knowledge about how fodder trees grown on crop terrace risers in Nepal affect splash erosion of soil. It can be seen from this representation that a process locally referred to as *tapkan* describes what hydrological scientists call canopy modification of rainfall. It is clear from this diagram that local people understand how various attributes of trees affect splash erosion. Leaf size, texture and inclination angle, for example, affect water droplet size and hence erosive impact, a causal relationship that was disputed by hydrologists until only a few years ago (Brandt, 1989; Hall and Calder, 1993). *Tapkan* is an important factor abstracted from a much larger causal network understood by farmers about tree-crop interactions, including shading by trees, root competition and fertility contributed from litter decomposition (Sinclair and Walker, 1999).

Furthermore, farmers take these tree attributes into account in deciding where to grow trees on their farms (Thapa, 1994). Bamboo for example, which is considered competitive with crops, is not grown on crop terrace risers. We can be fairly sure that this is relatively new knowledge, based on contemporary observation because growing trees on farm land is a practice that has intensified recently in the mid hills of Nepal in response to declining access to common property forest resources (Carter and Gilmour, 1989).

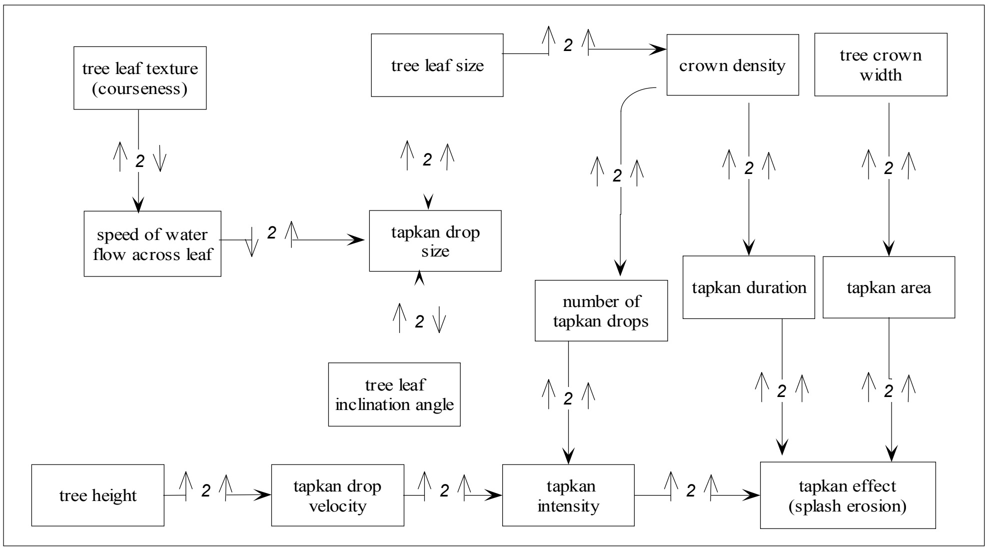

Figure 3.1: A systematic representation of farmer's causal knowledge of how trees affect splash erosion of soil in Solma village in eastern Nepal. Nodes (boxes) represent attributes of components of the agroecosystem. Horizontal arrows represent a causal influence by one node on another node. The small arrows signify the direction of change of values of the causal attribute (left hand side) and the affected attribute (right hand side) (↑ for increase, ↓ for decrease). The numeral '2' signifies symmetry of causation so, for example, if ↑ *x causes* ↓ *y*, then it also follows that ↓ *x causes* ↑ *y*. Not all causal relations are symmetrical, for example it is possible to get older but not younger. Source: adapted from Sinclair and Walker, 1999.

3.2.5 Generality

It may seem a contradiction in terms to seek generality in local knowledge but there is mounting evidence of regularities in the way people understand ecology across cultures. The seminal work of Brent Berlin (1992) has revealed common features in the way plants and animals are named and classified in various non-literate societies, suggesting that recognition of patterns in nature is more important than the culturally specific context from within which they are observed.

When it comes to knowledge about processes involving trees, recent research reveals both locational specificity associated with people's experience of different species and generality in terms of concepts and terminology. Joshi and Sinclair (1997) revealed that the *tapkan* concept, articulated by farmers in one Nepalese village (Solma) and presented in Figure 3.1, was common knowledge across the entire command area of Agricultural Research Station, Pakhribas, comprising the eastern mid-hills of Nepal.

While the term and its conceptualisation were common across the area, knowledge of specific tree attributes affecting *tapkan* varied according to people's experience of different species displaying such attributes (Figure 3.2). So, nearly all respondents (>90%) said that leaf size affected *tapkan*, consistent with some common trees such as *Ficus roxburghii* having very large leaves and hence a destructive *tapkan* effect, but few people (<10%) mentioned leaf inclination angle because only a few uncommon trees have drooping leaves that affect *tapkan*. While people's knowledge was frequently different between sites (people more dependent on resources being more knowledgeable about them), there were few differences between men and women or between wealth groups (Figure 3.2). This pattern was repeated for a series of concepts associated with tree-crop interactions and tree fodder value including: rukhopan (tree competitiveness with crops); *posilopan* (nutritive value of fodder) and *obhanopan* (digestibility of fodder).

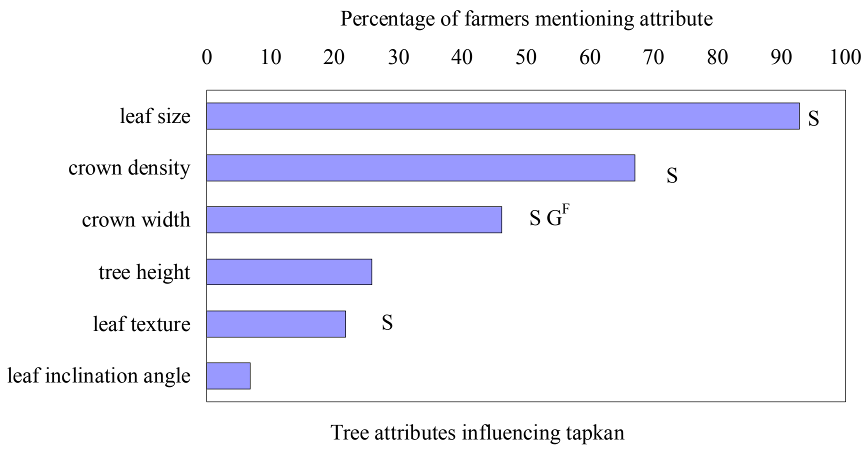

Figure 3.2: Mean percentage of farmers mentioning tree attributes that affect *tapkan*. A random sample of 221 farmers, stratified according to site, gender and wealth, was interviewed in the eastern mid-hills. The four sites, were contrasting in terms of forest access and remoteness. Significant differences in numbers of farmers: at different sites are marked 'S', of different gender 'G' (superscript indicates which gender was higher). Source: adapted from Joshi and Sinclair (1997).

The same terms and concepts surrounding tree fodder have been reported from the central and western hills of Nepal (Rusten and Gold, 1991; Pratap Shreshtra, pers. comm.) and similar criteria for evaluating fodder have been reported from Uttar Pradesh in India, suggesting some commonality in local knowledge about fodder trees across the Hindu Kush (Walker *et al.*, 1999). The persistence of knowledge systems on a regional basis has profound implications. It makes it possible for analysis of local knowledge to drive the agenda of frontline research and extension agencies that work on a regional mandate, as well as making it feasible for local knowledge to directly inform the process of policy formation.

It has been established then, that a sophisticated local system for the evaluation of tree fodder stretches across the Himalayan region. This has also been shown to be largely complementary to what is known biologically (Walker *et al.*, 1999; Thorne *et al.*, 1999). The *posilopan* descriptor was found to relate to protein supply to the duodenum in cattle, once the inhibitory effects of tannins on protein degradability were taken into account while *obhanopan* corresponded to overall dry matter digestibility. Fuzzy system decision evaluation tools, that combined local and biological information, have further revealed the rationality of farmer decisions given their objectives, constraints and what they know about the nutritive value of the tree fodders available (Thorne *et al*., 2000).

The framework that Nepali farmers use to evaluate fodders and make feeding decisions differs from that of animal nutritionists, but is remarkably similar to criteria used by hillside farmers in similar agroecological circumstances in Kenya (Thorne *et al.*, 1999). This is explainable by the differences between farmers and scientists in both:

- *what they can observe*: scientists reduce feeds to constituents *in vitro* and it is difficult to predict their integrated effect on cattle because tree fodders have complex chemistry in which phenolic compounds interfere with degradability in the rumen, whereas farmers feed the fodders and then observe effects on productivity and health of whole animals; and
- *what they choose to value:* scientists assume simple objectives of maximising digestible feed intake, farmers have complex suites of objectives and constraints, including requirements to satisfy animal appetite and hence control animal behaviour when feed is scarce causing them to favour less digestible feeds, in such circumstances.

There is good reason then, from the comparability of farmers' local criteria in hillside systems in Nepal and Kenya and their contrast with conventional biological approaches to feed evaluation, to hypothesise generality in the way farmers in similar agroecological circumstances evaluate and decide about feeding tree fodders. This hypothesis merits further testing in a wider range of hill farming circumstances in which tree fodder is fed to ruminants on a cut and carry basis.

Tree fodder is not an isolated case. Similar regularities are discernible in farmers' description and evaluation of tree-crop interactions. Farmers in a range of environments describe interactions between plants as being mediated via effects on soil. In Nepal farmers describe trees as either *malilo* or *rukho* depending upon their competitive effect on crops. *Malilo* trees contribute to soil fertility via rapidly decomposing and nutrient-rich litter and have deeper, less competitive root systems, whereas *rukho* trees have shallow spreading roots and their litter decomposes slowly (Thapa *et al.*, 1995). Farmers managing the multistrata forest gardens in the villages around Kandy in central Sri Lanka describe some plant species as being either *sitelaiy* or *seraiy* (Southern, 1994). In general use, the term *sitelaiy* means cool, cooling or cold and *seraiy*, hot, heating or burning. In relation to ecological interactions, *sitelaiy* species such as banana (*Musa acuminata*) are said to have a positive effect on other species because the soil around bananas remains or becomes moist, thereby providing a favourable micro-climate for other plants. In contrast, *seraiy* species such as clove (*Myristica fragrans*) are perceived to have a negative effect on neighbouring plants and the soil under clove trees is considered unsuitable for cultivation.

Similarly, Khmu and Thai people in northern Thailand, who produce '*miang*' (fermented tea leaves used for chewing) by growing *Camellia sinensis* and *C. oleifera* in thinned hill evergreen forest, use similar terms to distinguish between impacts on the soil of different dominant ground flora species (Preechapanya, 1996). For example, they consider the soil under *Eupatorium adenophorum* to be din yen, which literally means cool but also refers in an agricultural context to moist and fertile soil. By contrast, they describe soil under *Imperata cylindrica* as being *din ron*, which literally means hot, but also refers to dry and hard soil. *Eupatorium adenophorum* is, therefore, viewed as a more desirable ground cover for jungle tea gardens than *Imperata cylindrica*.

The existence of this local knowledge of tree-crop interactions has two major implications.

Firstly, the mechanistic understanding of interactions mediated by the environment makes process-based research on tree-crop interactions directly relevant and interpretable by farmers. This alters prevailing views about what constitutes research relevant to the resource user. Conventionally, adaptive research may be seen as more relevant to rural people than more fundamental research. But, when we know that farmers themselves understand interactions then research on fundamental processes such as root competition can be formulated with farmers and the results communicated to them. This inverts conventional views on how to make research relevant to farmers. We now see that the farmers are often better able to do adaptive research themselves, whereas they can learn from fundamental research, providing that it is targeted at processes they need to understand to improve their systems. There is then a role for researchers in doing research that farmers will find difficult to conduct themselves because the disturbance required is beyond their resources, or the methods of observation required are beyond the tools that they have available. When new knowledge is generated from this research, farmers are best placed to integrate it into their system. This requires common understanding by external researchers and farmers, and effective communication which in turn implies a need for formal acquisition of local knowledge.

Secondly, the generality of local understanding of plant interactions suggests that research with a wide dissemination domain may be derived from analysis of local knowledge. This suggests that analysis of local knowledge can realistically drive on-station and laboratory research as well as more locally situated activity.

3.2.6 Limits to local knowledge

Much of this chapter has stressed the sophistication of local understanding of ecological processes, but it is also clear that there is a lot that local people do not know and that this often constrains their practice. Limits to what resource users can observe often determine limits to their knowledge.

For example, in Honduras, farmers were unaware of the existence of parasitoids (small, solitary wasps and flies whose larval stages are parasitic on insects that damage crops) and entomopathogens (fungal, bacterial and viral diseases that infect and kill insects) because they could not see them, but when taught about them, were able to manipulate natural enemy populations and enhance biological pest control (Bentley, 1994). Similarly, Nepali farmers know more about atmospheric tree-crop interactions (figure 3. 1) than below-ground processes which are difficult for them to observe. Thus, while they classified 40 out of the 90 tree species found on farms as being either *malilo* - enhancing soil fertility and less competitive with crops, or *rukho* - competitive with crops (Thapa, 1994), their causative knowledge about why trees were classified in these ways included only two elements:

- a gross classification of root systems as predominantly shallow or deep, and
- some knowledge of the speed of decomposition of leaf litter (which occurred above-ground and so could be observed).

This contrasts markedly with the six attributes recognised as affecting *tapkan* and their causal influences. Given that trees were regularly lopped for fodder, a number of issues pertinent to practical management arose with respect to species differences in root system characteristics and the effects of different lopping strategies on root development and competitiveness. These represented issues that farmers were unable to address themselves but, as noted above, would be appropriate candidates for a national, regional or local research service. The implication here is that analysis of gaps in local knowledge is useful in planning extension (if the gap can be filled from existing external knowledge) or research (if the gap requires new research to create new understanding to be filled).

3.2.7 Complementarity

It has already been pointed out above that some local knowledge is comparable with scientific understanding, but where it is also complementary to science there are particularly large gains to be made from integrating local and scientific knowledge. For example, the existence of formally documented records of farmers' and researchers' knowledge about the nutritive value of tree fodder, referred to above, made it possible to compare the equivalence of terms used by farmers and scientists. This was done using automated reasoning procedures on computer (Kendon *et al.*, 1995) and revealed that fodder that scientists described as having a high tannin content tended to be described by farmers as bitter. While scientists had some detailed knowledge about the role of tannins in protein digestion by ruminants and decomposition of leaf litter, they knew very little about the actual tannin contents of the 90 native species used by Solma farmers and how this varied seasonally. In contrast, farmers did not possess detailed knowledge about the mechanism of action of tannins in ruminant digestion, although they did associate leaf bitterness with lower palatability and nutritive value and had extensive knowledge about how leaf bitterness varied in a large number of tree species throughout the season. This demonstrates complementarity between farmers' knowledge of their local vegetation and scientists' knowledge of process that could be exploited in designing appropriate research; indeed, farmers' understanding of intraspecies variability has led researchers to revise strategies for sampling tree material for analysis of its nutritive value (Walker *et al.*, 1999). Clearly, because of this complementarity, the combination of what farmers and scientists know represents a more powerful resource than either knowledge system alone.

Equivalence of terms is not always as straightforward as this, particularly where farmers aggregate knowledge differently from scientists, usually because of contrasts in their methods of observation. The earlier example of local description of the nutritive value of tree fodder serves as a good example of this. Farmers' knowledge is aggregated in terms of knowing about the effect of supplementation of particular tree fodders on animal productivity whereas scientists disaggregate fodders into their nutritive and antinutritive components. So, whereas farmers incorporate effects of both protein and tannin content in a single index of protein supply to the animal (*posilopan*), scientists measure protein and tannin separately. Thus, while there is no direct correspondence between *posilopan* and routine feed analysis it is possible, with a bit of ingenuity, to interpret one measure in terms of the other (Thorne *et al.*, 1999) This then allows us to take advantage of the complementarity of farmers' knowledge about how *posilopan* varies in local vegetation and scientists' understanding of how protein supply affects animal function.

3.2.8 Biodiversity

Complementarity between local and scientific knowledge frequently stems from local knowledge of biodiversity. As was noted in the introduction, rural people often use a much more diverse germplasm in their cultivation or collection activities than the relatively few domesticated species that have dominated in agricultural and forest science, and also know about inter- and intra- species variation in the vegetation around them.

Much, but not all, of this knowledge may be utilitarian, in that it is associated with the use of plants. Nepali farmers for example understand seasonal variation in fodder quality of different tree species either grown on farms or collected from forest, with close to a hundred tree species being utilised at village level (Thapa *et al*., 1997). Furthermore, they consistently recognise subspecies variation in seven tree species, six of which have not yet been botanically differentiated. These subspecies variants are not only recognised by differences in morphological characteristics, such as leaf size, but are also ranked differently by farmers in terms of fodder quality (Walker *et al.*, 1999). For example *Ficus nerifolia*, locally called *dudhilo* in Nepal, is classified as either *thulo pate* (large leaved) or *sano pate* (small leaved), each with different fodder value. Differences in their fodder quality have been confirmed through laboratory analysis of leaf chemistry that show significantly lower tannin content and higher cellulase digestibility in the smaller leaved variety (Walker *et al.*, 1999). In addition to specific knowledge about components, resource users may appreciate overall levels of biodiversity. For example, typically 30% of plant species found in Kandy Forest Gardens have no apparent use (Perera and Rajapakse, 1991), but attempts to intensify garden productivity by replacing these with productive plants have not been adopted (Hitinayake and Sinclair, 1998). This is perhaps because local people value the diversity itself within their system without necessarily assigning particular value to specific components.

There are also non-utilitarian aspects to local knowledge of biodiversity. Trees often possess spiritual and ritual significance and may be known in this context rather than, or as well as, in a utilitarian role. In Nepal, for example, farmers retain *Ficus roxburghii* on their crop terrace risers, not only because it is a good fodder tree but also because the large leaves have important ceremonial uses. Rural people in many societies have named and have knowledge about organisms in their immediate environment regardless of their utility (Berlin, 1992). This makes resource users a valuable source of information about local biodiversity, even though local categorisation and naming may not correspond directly with botanical and zoological conventions.

There is an apparent dichotomy between people who assert that local knowledge is entirely based upon what people think it is necessary to know (Niamir, 1990), and those who suggest that, rather like scientific knowledge, local knowledge is essentially an intellectual process, that attempts to explain the complex reality that people encounter (Howes and Chambers, 1980). However, as has been described above, while people's specific ecological knowledge tends to be related to their experience and dependence on particular resources, conceptual understanding is often more universally held. Local knowledge, therefore, displays both a fundamental human need to explain, and pragmatic expediency in relation to what knowledge has been acquired.

3.3 WHEN AND HOW SHOULD WE LEARN FROM RESOURCE USERS?

3.3.1 Knowledge and the knower

The preceding discussion has shown that resource users have sophisticated ecological knowledge that is often comparable with scientific understanding and may complement it. It may seem self-evident then that we, as research and development professionals, should seek to understand local knowledge as a prerequisite to forest research and development activity that may have a local impact. It can be argued, however, that it is the local people themselves rather than their knowledge that needs to be involved in the process. This assertion is based on the premise that in a participatory process that involves resource users, their knowledge will also be involved through the actions and decisions of participants, even if it remains implicit. In such a situation, it can be posited that there is no need for understanding on the part of external researchers of the local knowledge nor any utility in making local knowledge explicit. In the extreme, acquiring local knowledge in these circumstances can be seen as extractive.

These views of attempts to treat local knowledge as seriously as scientific understanding are caricatures that set up a false dichotomy between involvement of people and knowledge. This anxiety stems in large part from the great difficulty that anthropologists have in separating knowledge from the person or people who know it. Such a view causes immediate problems in natural science, since we are clearly willing to see scientific knowledge as separate from scientists and to transmit and use it accordingly. It is useful then to define knowledge for our present purposes as understanding that can be articulated (Sinclair and Walker, 1999). In this scheme information is used as a collective term. The simplest form of information is data, which when interpreted by the human mind creates understanding, some of which can be articulated as knowledge (Figure 3.3). Then it becomes clear that both local people and local knowledge can and should be involved in participatory approaches. But to do this we require formal methods for acquiring local knowledge that make it explicit so that researchers can learn about what resource users already know and use this knowledge in the research and development process.

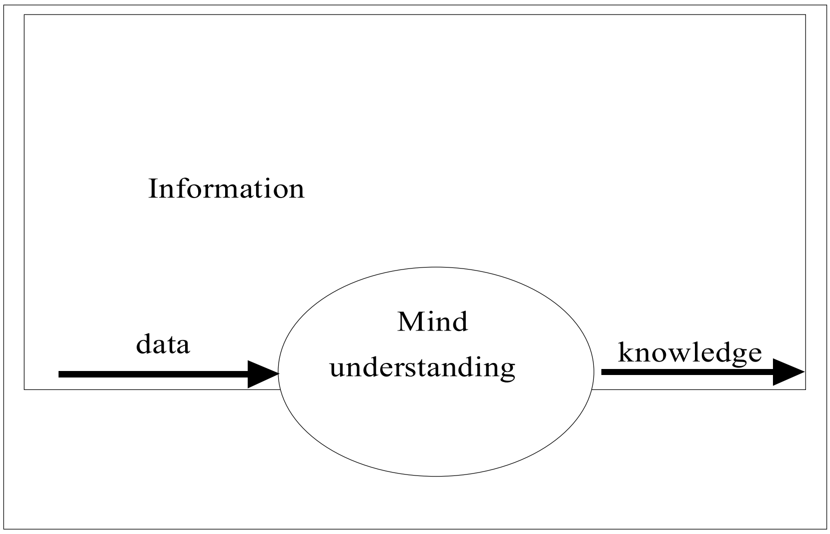

Figure 3.3: A view of knowledge as human interpretation that can be articulated.

3.3.2 Why implicit local knowledge is not enough

Explicit records of local knowledge can empower local communities by improving the dialogue between the community and those with resources and powers that affect them and, where there are similar requirements amongst communities, by identifying research, extension and policy at larger scale institutional levels that are locally relevant. It has been established above that there are often limits to local knowledge determined by limits to observation. While there is ample evidence that resource users experiment, they are often constrained in the extent to which they can afford to perturb the environment and measure the consequences. This means that external research services can offer something which complements what resource users can do themselves but this can only be achieved if there is mutual understanding. Professional research can serve local needs if the researchers understand what local people already know, the priority areas where new knowledge is required and are then able to communicate advances. We should not expect resource users to learn our vocabulary and concepts any more than we learn theirs.

Furthermore, the existence of general patterns in local understanding in similar agroecological conditions makes it feasible and cost effective to drive regional research on the basis of local requirements (Walker *et al.*, 1997). As illustrated above, analysis of local knowledge across a region may identify fundamental research requirements common to many resource users. This requires aggregation of local knowledge from different localities, which in turn requires explicit records that can be aggregated.

3.3.3 Partial views of knowledge

In order to develop explicit records of local knowledge systems, not only do we have to distinguish knowledge from the person who knows it, but we also have to focus on particular areas of knowledge.

This is necessary to create manageable and coherent representations of knowledge that are of practical relevance, can be assembled rapidly and cost-effectively and can then be readily used. This again creates problems in anthropological traditions that demand study of whole cultural systems and see any predetermined focus of study as unduly biasing the research (Sillitoe, 1998).

Ellen's (1998) suggestion that we must elucidate *in toto* the 'encompassing cultural matrix' in which knowledge is embedded if we are to understand practices and knowledge well enough to use them effectively to meet development or conservation goals is not borne out by the material presented here. On the contrary, by focusing on ecological knowledge we have shown great utility in being able to improve dialogue between researchers and resource users and identify problems faced by farmers, that external research services can help to address.

It is important to get beyond an apparent conflict between having a focus for knowledge acquisition and the possibility of introducing bias because there are certain aspects of a system that we want to know about. Vayda (1996) proposes doing this by starting from an action of interest and working outwards to seek explanations for it. This implies only considering as much of the cultural system as is necessary for the purpose in hand. This has parallels with focusing on knowledge of particular processes, such as agroecology, and then only including what is directly relevant to this, as in the formal methods of knowledge acquisition that we have advocated (Walker and Sinclair, 1998). Advocating the construction of partial views of local knowledge systems does not diminish the importance of the cultural context in which they occur but does assert that there is utility in separating out some knowledge and working with it for particular purposes. Indeed, we have shown that such abstraction allows identification of useful generalities amongst knowledge systems that would otherwise be obscured.

3.3.4 Knowledge and power

Knowledge and power are intertwined and, therefore, ownership and control of the transmission of knowledge are of fundamental importance in development. However, this neither precludes there being areas of knowledge that people are willing to share nor the development of systems to protect intellectual property. Knowledge-based systems methods can be used to ensure that the source of information remains attached to knowledge that is acquired (Sinclair and Walker, 1998). Computerised systems have been designed in which the source of a statement, and information about the source, are essential contextual information that are held about any item of knowledge so that it is always possible to see who contributed knowledge and credit them with any value that accrues to it (Walker *et al.*, 1995).

Discussion of intellectual property with respect to local knowledge has understandably been dominated by the possibility of very valuable pharmaceutical products being derived from it. While it is important to ensure that rights to the value accrued from such local knowledge and germplasm are protected, much of the functional knowledge that farmers and forest dwellers have, is of a much more mundane nature, and may be shared to mutual benefit amongst communities of resource users and with external researchers.

Clearly, trust amongst people has to be maintained for knowledge exchange to occur - and this puts an onus on researchers to manage knowledge they acquire responsibly. There should be reciprocity between local communities and external researchers, that involves exchange of knowledge, since it is very difficult to see how researchers can be effective without an appreciation of local knowledge, and if they are effective then resource users will want to know about their results.

3.4 CONCLUSIONS

The main conclusion of this chapter is that forestry research and extension workers need to be able to deal systematically with partial representations of local knowledge systems appropriate to particular purposes rather than attempt to understand entire cultures. This involves creating explicit representations of local ecological knowledge that are dynamic and readily accessible in a cost-effective manner. Knowledge based systems methods and tools have been developed to facilitate this. Where they have been used, generalities in what resource users currently know and what they need to know to improve their management of tree resources have emerged and been found to be both comparable and complementary to scientific understanding. This makes it possible to invest in acquisition of local ecological knowledge at the level at which research and extension activity are planned and policy is formulated.

ACKNOWLEDGEMENTS

This publication describes work from a series of research projects funded by the United Kingdom Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID. R4731, R6322, R7264 Forestry Research Programme, R7637 Livestock Production Programme. These projects have involved collaboration with many people and institutions as detailed in the literature that is referred to. We thank Dr. Michelle Jones who very ably assisted in tracking down references and presentation of figures.

REFERENCES

Asturias, M.A. (1949). *Men of maize*. Editorial Losada, SA, Buenos Aires, Argentina.

Bentley, J.W. (1994). Stimulating peasant farmer experiments in non-chemical pest control in Central America. In: *Beyond farmer first* (eds. I Scoones and J Thompson). Intermediate Technology Publications, London, pp. 147-150.

Berlin, B. (1992). *Ethnobiological classification: principles of categorisation of plants and animals in traditional societies.* Princeton University Press, Princeton, NJ.

Beukema, H. (in press). Terrestrial pteridophytes as indicators of a forest-like environment in rubber production systems in the lowlands of Jambi. Sumatra. In: *Agriculture, Ecosystems and Environment* (in press).

Bird, P. (1997). Funder or founder: the role of development agencies in shared forest management. *Commonwealth Forestry Review* 76: 179-181.

Boffa, J.-M. (1999). *Agroforestry parklands in sub-Saharan Africa*. FAO Conservation Guide 34. FAO, Rome.

Brandt, C.J. (1989). The size distribution of throughfall drops under vegetation canopies. *Catena* 16: 507-524.

Carter, A.S. and Gilmour, D. (1989). Increase in tree cover on private farmland in central Nepal. *Mountain Research and Development* 9: 381-391.

Ellen, R .(1998) Comment [on Sillitoe (1998)]. *Current Anthropology* 39:238-239.

Fairhead, J. and Leach, M. (1994). Declarations of difference. In: *Beyond farmer first* (eds. I Scoones and J Thompson). Intermediate Technology Publications, London, pp. 75-79.

Gouyon, A., de Foresta, H. and Levang, .P (1993). Does 'jungle rubber' deserve its name? An analysis of rubber agroforestry systems in southeast Sumatra. *Agroforestry Systems* 22: 181-206.

Hall, J.B., O'Brien, E.M. and Sinclair F.L. (eds.) (in press). Prunus africana*: a monograph. School of Agricultural and Forest Sciences*, University of Wales, Bangor (in press).

Hall, R.L. and Calder, I.R. (1993). Drop size modification by forest canopies: Measurements using a disdrometer. *Journal of Geophysical Research* 98: 18,465-18,470.

Harvey, C.A. and Haber, W.A. (1999). Remnant trees and the conservation of biodiversity in Costa Rican pastures. *Agroforestry Systems* 44: 37-68.

Hitinayake, H.M.G.S.B. and Sinclair, F.L. (1998). Categorising complex agroforestry practices for farming systems research and extension (FSR/E): the case of forest gardens in Kandy district, Sri Lanka. In: *Changing agricultural opportunities: the role of farming systems approaches* (eds. Ranaweera, N.F.C., Gunasena, H.P.M. and Senanayake, Y.D.A.). Asian Farming Systems Association, Perideniya, Sri Lanka, pp. 173-188.

Howes, M. and Chambers, R. (1980). Indigenous technical knowledge: analysis, implications and issues. In: *Indigenous knowledge systems and development* (eds. Brokensha, D. , Warren, D.M. and Werner, O.). University Press of America, Lanham, Maryland, pp. 329-340.

IDS (1979). *Rural development: whose knowledge counts?* IDS Bulletin 10(2). Institute of Development Studies, University of Sussex, UK.

Joshi, L. and Sinclair, F.L. (1997). *Knowledge acquisition from multiple communities.* Report, School of Agricultural and Forest Sciences, University of Wales, Bangor, UK.

Joshi, L., van Noordwijk, M., Wibawa, G., Vincent, G., Hardiwinoto, S. and Sukandi, T. (2000). Gap replanting – an emerging trend in rejuvenation of jungle rubber agroforests in Jambi, Indonesia. Paper presented at workshop "Evolution and sustainability of intermediate systems of forest management", 28 June-1 July 2000, Lofoten, Norway.

Kendon, G., Walker, D.H., Robertson, D., Haggith, M., Sinclair, F.L. and Muetzelfeldt, R.I. (1995). Supporting customised reasoning in the agroforestry domain. *The New Review of Applied Expert Systems* 1: 179-193.

Leakey, R.R.B. and Simons, A.J. (1998). The domestication and commercialization of indigenous trees in agroforestry for the alleviation of poverty. *Agroforestry Systems* 38: 165-176.

Michon, G. and de Foresta, H. (1995). The Indonesian agro-forest model: forest resource management and biodiversity conservation. In: *Conserving biodiversity outside protected areas: the role of traditional agroecosystem*s (eds. Halladay, P. and Gilmour, D.A.). IUCN Forest Conservation Programme, Andalucia.

Niamir, M. (1990). *Community forestry: decision making in natural resource management in arid and semi-arid Africa.* Community Forestry Note 4, FAO, Rome.

Oldfield, S. (1988). *Buffer zone management in tropical moist forests*. IUCN, Cambridge.

Perera, A.H. and Rajapakse, R.M.N. (1991). A baseline study of Kandyan forest gardens of Sri Lanka: structure, composition and utilization. *Forest Ecology and Management* 45: 269-280.

Pimentel, D.U., Stachow, D.A., Tackacs, H.W., Brubaker, A.R., Dumas, J.J., Meany, J.A., O'Neil, S.D., Onsi, E. and Corzilius, D.B. (1992). Conserving biological diversity in agricultural/forestry systems. *BioScience* 42(5): 354-362.

Preechapanya, P. (1996). *Indigenous ecological knowledge about the sustainability of tea gardens in the hill evergreen forest of northern Thailand.* PhD thesis, University of Wales, Bangor, UK.

Richards, P. (1989). Agriculture as a performance. In: *Farmer first* (eds. Chambers, R., Pacey, A. and Thrupp, L.A.). Intermediate Technology Publications, London, pp. 39-51.

Richards, P. (1994). Local knowledge formation and validation: the case of rice in Sierra Leone. In: *Beyond farmer first* (eds. Scoones, I. and Thompson, J.). Intermediate Technology Publications, London, pp. 165-170.

Rusten, E.P. and Gold, M.A. (1991). Understanding an indigenous knowledge system for tree fodder via a multi-method on-farm research approach. *Agroforestry Systems* 15: 139-165.

Sillitoe, P. (1998). The development of indigenous knowledge: a new applied anthropology. In: *Current Anthropology* 39: 223-252.

Sinclair, F.L. and Hitinayake, G. (2000). Ecosystem services of forest gardens in Sri Lanka. In: *Forests in sustainable mountain development: a state of knowledge report for 2000* (eds. Price, M.F. and Butt, N.). CAB International, Wallingford, pp. 153-155.

Sinclair, F.L. and Walker, D.H. (1998). Qualitative knowledge about complex agroecosystems. Part 1: a natural language approach to representation. *Agricultural Systems* 56: 341-363.

Sinclair, F.L. and Walker, D.H. (1999). A utilitarian approach to the incorporation of local knowledge in agroforestry research and extension. In: *Agroforestry in sustainable agricultural systems* (eds. Buck, L.E., Lassoie, J.P. and Fernandes, E.C.M.). Lewis Publishers, New York, pp. 245-275.

Southern, A.J. (1994). *Acquisition of indigenous ecological knowledge about forest gardens in Kandy District, Sri Lanka.* MPhil thesis, University of Wales, Bangor, UK.

Teichman, I. von (1987). Notes on the distribution, morphology, importance and uses of the indigenous Anacardiaceae. 2. The importance and uses of Sclerocarya birrea (the marula). *Trees in South Africa* 35: 2-7.

Thapa, B. (1994). *Farmers' ecological knowledge about the management and use of farmland tree fodder resources in the mid-hills of eastern Nepal.* PhD thesis, University of Wales, Bangor, UK.

Thapa, B., Sinclair, F.L. and Walker, D.H. (1995). Incorporation of indigenous knowledge and perspectives in agroforestry development. Part Two: Case-study on the impact of explicit representation of farmers' knowledge. *Agroforestry Systems* 30: 249 - 261.

Thapa, B., Walker, D.H. and Sinclair, F.L. (1997). Indigenous knowledge of the feeding value of tree fodder. *Animal Feed Science and Technology* 67: 97-114.

Thorne, P.J., Subba, D.B., Walker, D.H., Thapa, B., Wood, C.D. and Sinclair, F.L. (1999). The basis of indigenous knowledge of tree fodder quality and its implications for improving the use of tree fodder in developing countries. *Animal Feed Science and Technology* 81: 119-131.

Thorne, P.J., Sinclair, F.L. and Walker, D.H. (2000). The interactive role of fodder trees in hillside landscapes: using fuzzy sets to combine farmers' knowledge with science. In: *Forests and society: the role of research. Proceedings of the XXI IUFRO World Congress, 7-12 August 2000, Kuala Lumpur* Volume 1 (eds. Krishnapillay, B., Soepadmo, E., Arshad, N.L., A.Wong, H.H., Appanah, S., Chik, S.W., Manokaran, N., Tong , H.L. and Choon, K.K.). IUFRO, pp. 743-751.

Tomich, T.P., Thomas, D.E. and van Noordwijk, M. (eds.) (1999). *Research abstracts and key policy questions – methodology workshop on env.ironmental services and land use change: bridging the gap between policy and research in South East Asia.* Workshop held on 31st May-2nd June, 1999, Chiang Mai, Thailand. ASB-Indonesia Report No. 10, ICRAF, Bogor.

Vayda, A.P. (1996.). *Methods and explanations in the study of human actions and their environmental effects*. CIFOR/WWF Special Publication, CIFOR, Bogor.

Walker, D.H. and Sinclair, F.L. (1998). Qualitative knowledge about complex agroecosystems. Part 2: formal representation. *Agricultural Systems* 56: 365-386.

Walker, D.H., Sinclair, F.L. and Kendon, G. (1995). A knowledge based systems approach to agroforestry research and extension. *AI Applications* 9 (3): 61-72.Walker, D.H., Sinclair, F.L., Joshi, L. and Ambrose, B. (1997). Prospects for the use of corporate knowledge bases in the generation, management and communication of knowledge at a frontline agricultural research centre. *Agricultural Systems* 54: 291-312.

Walker, D.H., Thorne, P.J., Sinclair, F.L., Thapa, B., Wood, C.D. and Subba, D.B. (1999). A systems approach to comparing indigenous and scientific knowledge: consistency and discriminatory power of indigenous and laboratory assessment of the nutritive value of tree fodder. *Agricultural Systems* 62: 87-103.

Westoby, J.C. (1987). *The purpose of forests: follies of development.* Blackwell, Oxford.