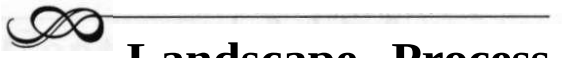

Landscape, Process and Power

Re-evaluating Traditional Environmental Knowledge

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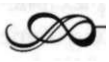
Chapter 2



A Genealogy of Scientific Representations of Indigenous Knowledge

Stanford Zent

Introduction

The anthropological fascination and appreciation for indigenous knowledge has successfully penetrated the popular imagination in recent years. It is now common to find sympathetic references to traditional ecological and cultural wisdom in miscellaneous media, from movies to children's storybooks, from alternative medicine propaganda to New Age religious teachings. Similar to other public trends, the remaking of IK has followed the lead set by advances in scientific research. IK has become incorporated into the research programmes of academic disciplines spanning the social and life sciences, leading some authors to suggest that IK studies deserve to be recognised as a burgeoning interdisciplinary field of research offering many new and exciting theoretical, practical, and ethical insights (Warren et al. 1995; Sillitoe 1998; Grenier 1998). Scientists, politicians, activists and others have stated that this intellectual heritage is valuable and relevant for the modern westernised world and urge that it be documented, preserved, utilised, and integrated with scientific knowledge (Warren et al. 1989; Moock and Rhoades 1992; Williams and Baines 1993; Warren et al. 1995; Posey 1999; Maffi 2001). Despite the mounting accolades, the attitudes of the scientific community towards IK are still marked by considerable ambiguity, scepticism, contention, and debate. The opinions of the 'experts' diverge rather widely in regards to the definition, epistemology, methodology, separation from global science, codification, contextualisation, sustainability, contemporary importance, jurisprudence, and rhetorical repre-

sentation of IK (cf. McCorkle 1989; Berkes 1993; Williams and Baines 1993; Dewalt 1994; Warren et al. 1995; Agrawal 1995; Brush 1996; Cleveland and Murray 1997; Sillitoe 1998; Ellen et al. 2000; Sillitoe et al. 2002). I would argue that such cognitive dissonance is actually a sign of strength, rather than weakness, because it reflects the current lively and dynamic state of IK research and the active attempts of scientists to understand better this complex phenomenon. The present essay contributes to this debate by providing some genealogical perspective of the evolution of scientific representations of IK during approximately the last half century.

Phases of IK Development

The study of IK systems has passed through several discernible developmental phases from the 1950s up to the present day, distinguished on the basis of shifting research foci, methods, theoretical constructs, and objectives. In this chapter I will review seven phases: (a) environmental ethnoscience; (b) theorisation of folk biological classification; (c) modelling the relationship between knowledge and behaviour; (d) the significance of indigenous knowledge for sustainable development and conservation of nature; (e) debates about the valuation, exploitation, and compensation of IK; (f) IK as a critical ecopolitical discourse; and (g) processual perspectives of IK. Discussion of each phase will focus on the problem orientations, research contexts, methodologies, conceptual biases, and seminal bibliographic sources of each of these phases, as well as some of the implicit or explicit contributions to scientific thought that have emerged from this work. Although the order of presentation of the different phases is intended to reflect the chronology of their appearance, there is a certain degree of overlap in time sequence, case studies, and authorship. But more than just a diachronically-ordered typology of distinct academic traditions, the intention here is to convey a sense of the genealogy, or derivation and development, of families of ideas, scholarship, purpose and practice, with each phase recombining selected characteristics of preceding phases, both strengths and criticisms of weaknesses, along with new information and concepts drawn from elsewhere, thereby creating novel forms. As a review article of previous literature, the treatment provided here is decidedly descriptive, motivated by the goal of providing an introductory-level accounting of the growth of the field for the interested reader who may or may not be well versed in the research. For the expert, I remind him or her that the object of our understanding is a fragmented and moving target, even while some aspects come into sharper focus, and, for the novice, I hope to encourage further interest through a basic grasp of some of the key issues surrounding its development and some of the primary works that have been produced.

Before proceeding on to the genealogical exposition, it might be helpful to make a clarification with respect to terminology. Indigenous knowledge (IK) is

presently the most popular term used to refer to the central subject matter treated in this paper and is the term that I use most frequently throughout. An abundance of alternative labels have been used to refer to this topic at different times and places[1], and although each one may evoke slightly different connotations, they have enough focal meaning in common to permit a reasonable level of intersubjective understanding and communication (Ellen and Harris 2000). The (de)merits of the different terms have already been scrutinised and several working definitions have been elaborated to formalise the concept (Kloppenburg 1991a; Hunn 1993; Dewalt 1994; Antweiler 1998; Grenier 1998; Purcell 1998; Semali and Kincheloe 1999; Ellen and Harris 2000; Sillitoe 2002b): I see no need to revisit these issues here (see Heckler, Chapter *One).* However, my main focus will be on indigenous environmental knowledge, which is to say the locally distinctive, situated and learned knowledge by which a particular society or community apprehends the biotic and abiotic components of the environment and their interrelationships and engages them in a practical sense for sustenance, health, shelter, tools and other survival needs and wants. Given the inherent difficulty (and arbitrariness) of demarcating environmental knowledge from other kinds of knowledge, and not wanting to contribute to the further proliferation of terms, I have chosen to stick with the appellation indigenous knowledge.

Environmental Ethnoscience

Environmental ethnoscience refers to the application of the theory and method of the anthropological perspective known as 'ethnoscience' to the study of cultural-ecological relations. Ethnoscience, also referred to as ethnosemantics or folk classification, is an approach to ethnographic description based on the study of terminological systems and other mostly verbal data, an ideational model of culture, and the epistemological privilege of specifying cultural experience and behaviour from an emic (i.e. insider's) perspective. Inspired by the rigorous inductive discovery procedures employed in structural linguistics, ethnoscientific research typically entailed the elicitation of lexical sets in the local language that were analysed in terms of their basic semantic components and relationships (i.e. distinctive features of meaning and their overall structural organisation), with the goal of revealing what the native needs to know in order to act appropriately in specified cultural contexts. This approach began to take definite shape in the 1950s and early 1960s mostly as a result of field studies of kinship, pronominals, colour terminologies, and folk biology (ethnobotany and ethnozoology). As the popularity of the ethnoscientific approach grew, the range of topics studied and the methodological techniques used expanded to include the description of several domains of environmental or ecological interest, such as natural objects or processes (e.g. soils, land use types, ecological communities, topographic surfaces, meteorological features, seasons, diseases), resource types

(e.g. foods, firewood, medicine), and practical activities (e.g. cultivation techniques, food preparation, curing, settlement pattern) (Conklin 1954a, 1954b, 1957, 1961, 1967, 1972; Frake 1961, 1962; 1964; Metzger and Williams 1966; Bulmer 1967; Fowler and Leland 1967; Morrill 1967; Bulmer and Tyler 1968; Basso 1972; Berlin et al. 1974; Johnson 1974; Fowler 1977).

An ethnoscientifically informed approach to the study of human-environmental relationships was pioneered by Harold Conklin in the 1950s with monograph-length field studies of the ethnobotany (1954) and shifting cultivation (1957) of the Hanunoo people (Philippines). Conklin's work highlighted sophisticated treatment of native terminologies, categories, and interpretations of various environmental components (what he labelled 'ethnoecological factors'), but his ethnographic reports were remarkably well balanced and gave ample consideration to other cultural and environmental factors through the participant observation of behaviour and other interdisciplinary field methods. The Hanunoo research was revolutionary in the sense of breaking with previous depictions of non-western mentality as primitive or childlike (i.e. less developed, less intelligent), magical or pre-logical (i.e. irrational, non-empirical), and static (i.e. tradition-bound). Instead, Conklin's work effectively demonstrated that such knowledge systems can be complex, systematically organised and well adapted to prevailing environmental conditions, that economic and social activities are closely integrated and interdependent with environmental categorisations, and that such people are indeed capable of possessing an incredibly robust and encyclopaedic comprehension of their local environment. His ethnobotanical study documented that the number of terminal plant taxa recognised by the Hanunoo exceeds the number of scientific species found in this area, thus suggesting that this non-western folk maintain a more acute taxonomic appreciation of their local floral environment than do western scientists. His agricultural study depicted Hanunoo swidden farming practice as a highly structured, well organised, ecologically balanced activity, thus was instrumental in overturning pejorative notions of shifting cultivation, held by many western scientists at the time, as haphazard, wasteful, destructive, and underproductive forms of tropical land use.

The primary objective of ethnoscientific research was academic in the sense of seeking to improve the ethnographic enterprise of the discipline of anthropology through the employment of more rigorous, replicable and emically accurate methods of data collection and analysis which would produce more detailed and culturally valid ethnographic accounts. The basic objective behind the method is translation from native (i.e. cognised world) to scientific (i.e. operational world) categories, in which a sharp epistemological distinction is maintained between the two knowledge forms. Instead of achieving a new type of ethnography, however, perhaps the most lasting impact of this body of work was to alter scientific attitudes towards non-western, non-literate peoples and their knowledge systems. On one hand, it began to raise questions about the suppos-

edly superior intellect and training of the scientific observer, especially when it came to their grasp of ecologically-complex, poorly-studied local environments (e.g. tropical forests). On the other hand, by demonstrating the sharp detail, empirical accuracy and sheer complexity of ethnoscientific classifications, it became clear that the primitive naturalist' controls a trove of potentially useful information which can be tapped by scientists, for example to catalogue the biodiversity in specific locations (cf. Schultes 1994b; Lewis 1993; Leigh 1993).

The conceptual strengths and weaknesses of ethnoscientific research have received a great deal of comment in the years since its inception (D'Andrade 1995) and it is impossible to summarise this complex discussion in the space available. It will suffice to point out that this approach, as understood in its classic and more extreme forms, was based on a concept of culture as knowledge that was (mis)represented as being synchronic (i.e. no concept of change), homogeneous (culturally uniform), holistic (all parts are interrelated and interdependent), homeostatic (internally regulated), closed (bounded from other knowledge systems), relativistic (comprehensible only in its own terms, hence not comparable to other knowledge), formal (analogous to language) and ideal (assumed to be homologous with behaviour). Furthermore, its exclusive reliance on linguistic data effectively excludes non-verbalised forms of knowledge which are embedded in social and ecological behaviours and learned through participant or peripheral observation, individual practice and experimentation (Keesing 1972). Finally, more attention was given to methodological explication rather than theoretical issues. This last criticism was addressed with considerable vigour in the next phase, especially when studies of folk biology began to turn up startling similarities in biological nomenclature and classification, not only among different cultural groups but also between ethnoscientific and scientific biologists.

Theorisation of Folk Biological Classification

Descriptively orientated ethnoscientific studies gave way to more theoretically inclined cognitive research during the 1970s as more investigators became interested in exploring the connections among language, cultural representations, and cognitive processes (Casson 1981; D'Andrade 1995). Paradoxically the study of the relationships between human groups and their organic environments quickly emerged as a cutting edge of this cognitive revolution within anthropology. Whereas earlier studies of ethnobotany or ethnozoology focused on describing the economic or cultural contexts of people's knowledge and use of plants or animals, the primary interest of the field christened as ethnobiology, or folk biology, was in discovering the basic perceptual, cognitive and linguistic underpinnings of the folk (i.e. non-scientific) classification of living things (Bulmer 1970, 1974; Berlin 1973, 1976, 1992; Berlin at al. 1973, 1974; Hunn 1975, 1976, 1977, 1982; Hays 1976, 1982; Dougherty 1978; Randall 1976; Brown 1977, 1979, 1984; Randall and Hunn 1984; Ellen 1979; 1986; Atran

1985, 1990; Boster et al. 1986). Ethnobiology is an interdisciplinary mode of inquiry that incorporates theory, method and data from several different disciplines, including: field biology, biosystematics, cultural anthropology (including ethnoscientific methods), linguistics, cognitive psychology, and logic theory. Study techniques include the collection of voucher specimens (especially plants, birds, reptiles, and insects) in the field, the identification of scientific names by taxonomic specialists, the systematic recording of local names, uses and other cultural significances, the definition of semantic content and structure within and between categories, the exploration of perceptual stimulus recognition, the experimental testing of taxonomic grouping/splitting behaviour as well as category-based reasoning, and the modelling of categorical relationships by means of diagrammatical or quasi-mathematical expressions.

While the growth of this specialised interdisciplinary field has been marked by minute and comprehensive ethnographic descriptions of the knowledge and use of natural organisms by numerous peoples, the main thrust of this work has been comparative and theoretical: to develop a theory of the psychological and biological bases of folk biological classification, their universality and evolution. Much of the credit for establishing this theoretical development should go to Brent Berlin and his collaborators who carried out detailed field studies of Tzeltal (Mexico) ethnobotany and Aguaruna and Huambisa (Peru) ethnobotany and ethnozoology. Comparing their data with other studies, they went on to propose several general principles (i.e. universal tendencies) of classification and nomenclature in folk biology (Berlin et al. 1973; 1974). In the decades following this theoretical breakthrough, many high quality ethnobiological investigations were performed among diverse traditional peoples throughout the world, including many by Berlin's doctoral students, which created a rich empirical database for comparative analysis. This accumulated evidence is reviewed by Berlin in his book *Ethnobiological Classification* (1992), in which he sets out to define and defend a number of structural and substantive typological regularities which are purported to be found in all ethnobiological classification systems. The key tenets can be very briefly summarised as follows: (1) a large but finite subset of the locally present flora and fauna are recognised and named as distinct taxa and this subset is comprised of the most biologically distinctive species as determined by factors such as phylogenetic uniqueness, relative size, prevalence, and ease of observation; (2) the general purpose classification of natural organisms is based on observable morphological and behavioural affinities and is independent of cultural significance; (3) the classification system is organised as a shallow taxonomy consisting of a few (4-6) hierarchically ordered ranks; (4) taxa belonging to the same rank exhibit similar degrees of internal variation/external separation from each other, and thus the concept of rank is conceived as comparably-sized perceptual gaps that really exist in nature; (5) taxa of folk generic rank are by far the most numerous (upper limit of 500-600), the first ones

learned by children, and the most quickly and effortlessly recognisable by virtue of their unitary configurational (i.e. gestalt) pattern, and thus are considered to comprise the core of the classification system; (6) generic and specific taxa exhibit a graded internal structure characterised by a central prototype member and one or more peripheral members; and (7) the lexical structure of names given to groups of living organisms, consisting of primary (simple, productive, unproductive) or secondary (i.e. binomial) lexemes, is closely tied to the rank of the group. Such regularities, it is argued, support the notion that there exists a panhuman cognitive disposition for recognising and organising the complex natural diversity presented by the living world. While Berlin's theory suggests that the universal features of ethnobiological classification are at least partly determined by cognitive capacities that are an innate property of the human mind function, he seems to place more emphasis on the imposition of 'nature's basic plan', by which he refers to real discontinuities (i.e. well-defined clusters of plants and animals) in the natural world that simply cannot be ignored.

The identification of cross-cultural regularities and elaboration of theoretical models of ethnobiological classification, among other developments, was instrumental in overturning the dominant Boasian concept of local culture as relativistic, historic particularistic entity. But in addition to making a notable contribution to the scientific understanding of anthropology, ethnobiological research has advanced the anthropological understanding of science in the sense of revealing the deep affinities between folk biological classification and western systematics, the science of biological classification. Such affinities encompass the sharing of formal-structural properties, such as taxonomic organisation, prototype specimens and binomial nomenclature, as well as substantive correspondences in terms of the delineation of the same groups or clusters of organisms and the recognition of the same pattern of resemblance among organisms (Berlin et al. 1974; Hunn 1975; Berlin et al. 1981; Boster et al. 1986; Boster 1987). The discovery of these correspondences has led to a number of interesting conclusions regarding the biological and psychological origins of the human classification of nature. For biologists, the fairly close mapping of core ethnobiological taxa (usually folk generics) onto Linnaean species is cited as evidence of the objective reality, discreteness, and evolutionary stability of biological species (Gould 1979; cf. Diamond 1966).[2] At the same time, the finding of striking similarities in judgments of biological content and structure across different cultural and ecological systems as well as between ethnoscientific and scientific knowledge traditions has induced the hypothesis that biological classification is rooted in an innate, species-specific, hard-wired, mental modular faculty, much like first language learning (Atran 1990; 1998; Hirschfeld and Gelman 1994; Pinker 1994; Boster 1996; Hunn 2002). This idea began to take shape following Scott Atran's (1990) provocative analysis of the development of natural history and later scientific taxonomic studies in which he argues that scientific

biosystematics share the same cognitive foundations as folk biological classification. Atran points out that scientific taxa such as families, genera and even species are not entirely natural categories. Their genesis derives more from the logic imposed by common-sense, which he defines as the universal, spontaneous, domain-specific cognitive schema employed in the apprehension of living kinds, rather than from modern evolutionary theory.

Theoretical cognitive ethnobiological research has mostly been conducted by anthropologists in collaboration with botanists or zoologists, or, more recently, by cognitive psychologists and anthropologists either working together or informed by each others' research, with a highly specialised academic audience in mind. However, similar to the phase that preceded it, a collateral outcome of this work has been to raise the stock of IK in the broader public opinion in that it has provided scientific credibility to the notion that non-western knowledge of the biological environment is characterised by systematic organisation, remarkable attention to detail, and empirical accuracy. Nevertheless, this phase of research has also been punctuated by sharp criticisms of the dominant theoretical, ethnographic, and methodological tendencies of the field which, critics charge, have led to biased and distorted representations of such knowledge. The overriding concern for demonstrating perceptual and cognitive universals and the tightly controlled format for data elicitation have forced the artificial abstraction and isolation of rigidly formalised taxonomies out of the flow and flux of the dynamic socio-cultural and material contexts, which also provide structure and meaning to classificatory behaviour (Ellen 1986). Such distortion has led to the privileging of shared properties across cultures over variation between and within cultures, individual cognitive processes over collective symbolic representations, referential/mundane over symbolic/ritual meanings, general-purpose over special-purpose classifications, and hierarchical over non-hierarchical (i.e. cross-cutting, graded) types of categorical relationship. By contrast, alternative relativist approaches, such as Eugene Hunn's (1982, 1990) methodological proposal for recording the "activity signatures" of folk biological taxa or Roy Ellen's (1986, 1993) concept of "prehension", put more weight on the thick and textured ethnographic description of the multiple local significances of many taxa, the social and material situations in which they are expressed, the pragmatic or communicative goals which stimulate their usage, and the different social actors that know and convey them — i.e. a more holistic and experientially authentic account. The case for a relativistic, contextualised account of classification is well exemplified by Ralph Bulmer's (1967) classic explanation of why the cassowary is not classified as a bird by the Kalam of New Guinea. Bulmer shows that in order to understand why cassowaries (as well as dogs and pigs) hold a special taxonomic status for this group, it is not enough to look at morphological and behavioural characters. One must also conside? the special relationship of those animals to people in Kalam social and cosmological

thought, such as how, when, and by whom they are hunted, how they are used, and how their hunting and use are ritually regulated.

Another key debate has pitted intellectualist against utilitarian explanations of the prolific classification abilities of folk peoples. The former, which amounts to a form of psychological reductionism, holds that people are motivated by an instinctual and unconscious intellectual drive to recognise, categorise and name large numbers of plants and animals, many of them without any apparent use or cultural significance, whereas the latter, which amounts to a functionalist interpretation, contends that no group discriminates all of the biological organisms in their surrounding habitat and a truly exhaustive examination of the (direct or indirect) use- or avoidance-value of this subset would find that the selection process was mostly determined by utilitarian or adaptive criteria. This disagreement has faded from active academic discussions without any clear resolution, since the intellectualists were able to identify taxa with no known significance among the groups they studied while the utilitarians could point to salient species which their informants consistently fail to discriminate. However, this exchange served to cast a spotlight on the issue of the adaptive significance of ethnobiological classifications. If the cognitive faculty for classifying the natural world was selected for and persists under evolutionary pressure throughout the entire human species, then what adaptive function(s) does it perform? Yet most ethnobiological research was focused inwardly on the relationship between classification and the human mind (or thought process) rather than outwardly on the relationship between classification and the environment per se (or ecological interaction). Even though it was sometimes noted in passing that classification constitutes a prior step or necessary precondition for effective interaction, the prevailing theoretical agenda mostly excluded the question of how cognition is related to adaptive behaviour. This gap has stimulated proposals to consider more seriously the operational influence of classification on resource procurement and management behaviours and, by extension, on the flow of energy, matter and information within human-occupied ecosystems (cf. Ellen 1982). The related problem of adaptive change in ethnobiological classification and nomenclature and the cultural or environmental factors which cause or condition it is another neglected topic, with the exception of very general and unilineal evolutionary reconstructions (Berlin 1973; Brown 1977, 1979; Dougherty 1978).

Modelling the Relationship Between Knowledge and Behaviour

While ethnoscientific and ethnobiological research were duly recognised as raising the standards of ethnography and cognitive theory respectively, they also drew criticism from cultural ecologists and others, who argued that structural ethnosemantic treatments of folk classifications failed to address the questions of (1) why some taxa are selected for recognition while other potential categories were not; (2) the material effect of such knowledge on ecological behaviours and

adaptive processes (Vayda and Rappaport 1968; Harris 1974; Keesing 1974; Hunn 1982; Benfer 1989; Nazarea 1999). In contradistinction, the method of cultural ecology was faulted for being inadequate for studying the adaptive patterns of modern day societies whose dependence on the local environment is mediated or complicated by their insertion in larger social, political, economic, and institutional contexts, who are characterised by considerable socio-economic stratification and behavioural variation within populations, and who are experiencing phases of rapid social and technological transformation (Netting 1974; Bennett 1976). In the wake of these countervailing reviews, more attention was given to bridging the gaps between cognitive and behavioural approaches, individual and collective behavioural adjustments, and short versus long-term adaptive processes. Accordingly, some researchers attempted to reconcile cognition with behaviour by developing testable models of the mental operations by which, it may be inferred, local perceptions and understandings get translated into patterned activity. The key theoretical task of this phase has been to chart the causal chain linking abstract cognitive representations with concrete physical movements, cerebral with embodied activity.

The body of literature in which the relationship between IK and adaptive ecological behaviour is explored is somewhat diffuse and heterogeneous, but here I refer mainly to those works that fall under the rubric of decision-making (also known as rational choice) models, especially of peasant farmers. A number of source materials spanning the disciplines of anthropology, rural sociology, economics, mathematics, and game theory can be identified as contributing directly to the development of decision-making models. Limiting this discussion to those provided by anthropologists, the first set concerns efforts to integrate formalist notions of economic behaviour (i.e. individual cost-benefit maximization) with substantivist models of economic processes (institutional provision of goods and services) to make better models of economic production strategies (Cook 1973; Orlove 1977; Gudeman 1978). Second is John Bennett's (1969) comparative study of the adaptive strategies (short-term adjustments) and adaptive processes (long-term changes) of different segments of a rural society in Saskatchewan, Canada. Bennett shows the complex interplay of environmental, economic, and social factors as different actors attempt to resolve problems and manipulate their fortunes, weigh options, and take decisions in their pursuit of multiple objectives. Third, William Geoghegan (1970) and Alan Johnson (1974) carried out separate empirical tests of the correspondence between expressed ethnoscientific categories and rules on one hand and observed behavioural alternatives on the other in regards to residential choices and crop planting practices respectively. Both studies found a fairly high correlation between the expected behaviour predicted from the category or rule and actual practices.

Building on these precedents, a number of researchers sought to investigate how farmers go about processing environmental information and making deci-

sions, especially in the context of agricultural development, as they respond to the challenges of new technology, shifting market forces, governmental policies, political movements, changing environmental conditions, population growth, etcetera (Cancian 1972; Dewalt 1975, 1979; Anderson et al. 1977; Barlett 1977, 1980a, 1980b, 1982; Gladwin 1979a, 1979b; Roumasset et al. 1979). Under these circumstances, farmers must confront, capture and act upon information coming not only from the natural environment but also from the social-political-economic milieus in which their activities take place. The general focus is on how farmers choose between alternative strategies with respect to primary production, for example: selection of crop/livestock types, mixes and rotations; adoption/non-adoption of new varieties; seed handling; cultivation timing and technique; application of fertilizers and pesticides; plot cultivation, fallowing or abandonment; subsistence farming versus cash cropping versus wage labour; sharecropping arrangements; hired versus family labour; purchase and use of machinery; credit versus cash financing; etcetera. The typical research design often encompasses a mix of emic and etic types of data. For example, structured and semi-structured interview formats record farmers' knowledge of folk categories of landscape units and features, practical knowledge of crop/livestock species and their growing habits, soils, pests and diseases, weather patterns and customary cultivation practices; open-ended queries or questionnaires designed to elicit verbal statements and judgments about alternative production strategies and their associated limitations and opportunities; and informal conversations touching on any technical, social, personal, or institutional aspect of farming practice (e.g. crop experimentation, market experiences, family situation, opinion of development programmes or crop insurance). At the same time, etic data is collected through household censuses, socio-economic surveys, land use mapping, soil analysis, crop measurements, labour time sampling, cost analysis, and description of institutional actors and factors. The key variables found to affect decisions, such as land availability and tenure, labour resources and costs, capital, transportation, risk, yield, profits, consumption needs, family size, information uncertainty and others, are then analysed and incorporated into a schematic model, often depicted in the form of decision matrices, flow-charts, or tree diagrams. Finally, the model may be compared and tested against observations of actual performance in order to assess its predictive power. Much emphasis has been placed on developing models that are capable of representing the decision strategies of individuals (i.e. at the household level), rather than simply normative accounts, by identifying the key variables (e.g. altitude of landholdings, social class, number of dependents, etcetera) that correlate statistically with divergent patterns of choice-making. This attention to individual detail has helped to illuminate not only how factual and procedural knowledge is effectively linked to coping behaviour in the short-term, but also what environmental factors cause or condition local diversity of choice, how such diversity can

lead to more marked changes and divergences over time, and therefore why knowledge is directly implicated in adaptive behaviour in an evolutionary (i.e. long-term) sense.

While some approaches have inferred decision processes through the statistical analysis of behavioural outcomes or by using mathematical tools borrowed from microeconomics (e.g. production function, internal rate of return, linear programming), some authors have explicitly attempted to produce more psychologically realistic, or natural, decision models that supposedly follow more closely what environmental information farmers are taking into consideration and the stepwise elimination process that leads to final choices (Gladwin 1979b, 1980; Gladwin and Murtaugh 1980; see also Quinn 1978). Although such emic-based models are intended to represent the rational decision procedures specific to local ethnographic situations, some generalised conclusions have also come out of this work. For example, farmers often make unconscious, non-verbalised distinctions in regards to environmental constraints and framing a sense of their situation before moving on to a more conscious stage involving the deliberate pondering of production choices. Another finding is that farmers tend to make deterministic, rather than probabilistic, logical assessments, through the use of traditionally learned scripts, heuristics, or rules of thumb (i.e. simplifying procedures), to tell them what to do.

The most recent IK decision-making models draw from the insights of artificial intelligence research in using so-called 'expert systems', also referred to as 'knowledge based' systems (Benfer 1989; Guillet 1989a, 1989b; Furbee 1989; Benfer et al. 1991; Schoenhoff 1993). An expert system (ES) is a symbolic-reasoning computer software programme that is designed to mimic human decision-making in a restricted domain of knowledge, such as soil management or health care choices (Guillet 1989b: 57). Rule-based ES consists of a knowledge base of domain-specific facts and procedures, and an inference engine of fixed procedures for manipulating the facts and rules, such as a chained series of 'if...then ...', operations. Proponents of ES tout several advantages of this approach over other decision-making models: (1) it enables more complex and information packed models; (2) the machine-generated model can be presented to local consultants for their evaluation in the field, thus permitting validation, refinement, and translation into an appropriate language and then used to advise local actors on management practices; (3) by requiring the formalisation of usually tacit and implicit procedural knowledge in explicit rule-based form it enhances knowledge capture; (4) through the use of confidence factors (i.e. degree of confidence that a conclusion is valid) it is able to handle incomplete or ambiguous information more adequately; (5) by incorporating variables that may account for individual variation, it is able to provide multiple decision pathways and thus explain how and why different results may be arrived at although starting from the same knowledge base; and (6) used in combination

with computer simulation methods, in which production rules are varied and manipulated, it can be directed towards the creation of more dynamic models in anticipation of future changes in circumstances and strategies (Guillet 1989b; Benfer 1989).

Besides the rational choice models applied mainly to the study of agricultural decision-making, there have also been some other notable attempts to elaborate conceptual frameworks for understanding the relationship between environmental cognition and behaviour which may be relevant for agricultural and non-agricultural societies. Ellen (1978, 1982) proposes a generative scheme according to which the end states of patterned sets of ecological relationships (e.g. settlement patterns, garden site selection) are traced back through the formative scheduling sequences, thus revealing how cultural rules interact with ecological givens to generate actual behaviour. Hunn (1989) distinguishes between two basic kinds of knowledge: image — 'cultural information organised by similarity' (models of); and plan — 'cultural information organised by contiguity' (models for). He shows how the two can be integrated through an exhaustive elicitation and analysis of the 'activity signatures' of environmental taxa, referring to the total set of predicated statements containing the taxa. Victor Toledo (1992, 2002) advocates ethnoecology as an integrative, interdisciplinary approach to the study of the process of human appropriation of nature, in which the total complex of *kosmos* (the belief system or cosmovision), *corpus* (the whole repertory of knowledge or cognitive systems), and *praxis* (the set of practices as executed by the producer) are carefully observed and recorded. He argues that the articulation of interpretation (kosmos and corpus) and action (*praxis*) can be revealed by a thorough investigation of the structural (ethnotaxonomies), dynamic (patterns and processes), relational (linkages among natural elements or events), and utilitarian (practical uses) dimensions of knowledge about natural resources. While these approaches lack the methodological rigour characteristic of the rational choice school, a less formalistic or structured research design would permit the construction of models which are more flexible, more holistic, less observer-biased, and more valid empirically (Johnson 1980).

It might be said that the focus of this phase of IK research has been equally academic and applied, theoretical and practical. Besides contributing to a more holistic emic-etic approach to the undertaking of ecological anthropological research, it offers advisory and communicative enhancements to applied development work by making explicit what is tacit or unconscious, and often non-verbalised, knowledge, thus facilitating understanding of the vast complexity of the natural decision-making processes employed by local populations. It also serves to point out key differences in farmers' versus agronomists' perceptions and understandings of production issues. Meanwhile the research, design, testing and redesign of expert system computer models in folk contexts has also

begun to have a positive impact on more general applications in the artificial intelligence field, such as contributing towards the development of computerised knowledge acquisition and questioning the universality of western modes of reasoning (Read and Behrens 1989). One of the key conceptual advances achieved during this phase was in recognising and representing IK as a dynamic process instead of a static structure. However, this process is entirely conceived in cognitive psychology terms. That is, IK in most decision-making perspectives is presented as a rather complex formal calculus residing in the head of a hypothetical individual which motivates him or her to react to a particular stimulus with a specific course of action. This approach may be criticised for being overly formal and rational, and for ignoring the social psychology of decision making. Social psychology contends that perception, decisions and actions are structured at supra-individual levels of integration and therefore it is necessary to take into account the social process by which actors observe, communicate, negotiate and acquire different kinds of information through interaction with other community members. Thus information and technology transmission may be explained as much by conformist bias (following what the majority do) and prestige bias (adopting practices associated with successful actors) as much as by performance or payoff information (Henrich 2001; Stone 2004).

The Significance of Indigenous Knowledge for Sustainable Development and Conservation

The agricultural decision-making research described above helped to dispel the myths of peasant farmer irrationality and the impracticality of peasant knowledge in the face of economic and technological modernisation. Moreover, by revealing why individuals choose to adopt or forgo new technologies or managerial strategies and why individuals may respond differently to the same set of global conditions it also implied that IK and IK research have a positive role to play in rural development schemes, for example facilitating communication between outside experts and local practitioners. Yet the focus on farmers as economising, though not necessarily optimising, actors and knowledge as rational logic did not call into question the conventional model of development, built on the core propositions of imported technology transfer and export market expansion, which had dominated the international development scene since the close of the Second World War. However, by the end of the 1970s a radical shift in rural development philosophy was taking hold that highlighted indigenous technical knowledge (ITK) as an essential ingredient for social and economic growth in third world settings. This sea change of policy direction was forced by the growing consensus that the top-down technocratic and economistic approach to development had failed to alleviate the widespread problems of food shortage and poverty, despite supposed success stories like the green rev-

olution, and in some cases might be exacerbating them. This, in turn, led to the loss of confidence in the scientific foundations that supported it. Paul Richards (1985) provides a brilliant analysis of the 'systematic failure' of development policies in colonial Africa, tracing their downfall to the fallacy of scientific universalist thinking that certain principles are true for all times and places and the misplaced pursuit of environmental management problems at an overly abstracted and generalised level. He argues that development strategies in ecologically diverse tropical regions are better guided by the doctrine of ecological particularism — the belief that many environmental problems are localised and specific, thus require local, ecologically particular, responses. This is precisely the guiding principle embodied in many traditional agricultural systems. Furthermore, Richards, along with others (Box 1987; Rhoades 1989), effectively debunks the conventional image of indigenous farmers as being incapable of independent experimentation and innovation.

Western science and technology had by no means been eliminated from development initiatives, but an alternative, and in some ways rival, paradigm began to take shape and win over advocates from within and without the development establishment. This paradigm has been labelled variously as farmer-system, farmer first, farmer-back-to-farmer, populist, participatory or agro-ecological development, and, as the names suggest, it features the local farmer and his or her traditional farming knowledge and practices as the most sensible starting points for intervention (Brokensha et al. 1980; Gliessman 1981; Rhoades and Booth 1982; Chambers 1983; Norgaard 1984; Altieri 1987; Chambers et al. 1989; Farrington and Martin 1987; Warren et al. 1989; Moock and Rhoades 1992; Dewalt 1994; Sillitoe 1998; Warren et al. 1995). Several key principles define this approach: (1) sustainability — achieving long term growth by balancing technological, economic, ecological, and social concerns; (2) appropriate technology — adopting fragmented and locally adapted, usually low input, energy-efficient, diversity-maintaining native technologies which are incrementally modified; (3) bottom-up planning - starting with the knowledge, problems, analysis and priorities of farmers themselves; aware that the diversity of situations and constraints requires diverse, locally specific solutions; (4) local participation — seeking to involve the active participation of local farmers in all phases of the R and D process; and (5) dialogue — fomenting dialogue between development agent and local farmers. With increasing emphasis placed on the intellectual contributions of traditional farmers to new technology generation and implementation, technical IK (or ITK) came to be seen as an undervalued resource that needed to be studied, understood, and incorporated into formal research, development, and extension practice. This led to a surge of IK research conducted mainly by scientists employed by international and national agricultural research centres and development agencies (Brokensha et al. 1980; Biggs 1988; Chambers et al. 1989; Warren et al. 1989;

Moock and Rhoades 1992; Pottier 1993; Warren et al. 1995; see also various issues of Indigenous Knowledge and Development Monitor). An important component of this work has been the creation of specialised IK libraries and databases where the data and results produced in numerous studies are compiled, stored, and disseminated as well as organisational structures dedicated to this task, such as the U.S.-based Center for Indigenous Knowledge for Agricultural and Rural Development (CIKARD), Holland-based Leiden Ethnosystems and Development Programme (LEAD), Canada-based International Development Research Centre (IDRC), among others (Warren 2001). Another measure of success can be found in the extent to which it has penetrated top-down institutions like the World Bank, which in 1998 launched the Indigenous Knowledge for Development Programme in its African department. Based on the idea that IK constitutes the key element of the social capital of the poor and is the main asset they control, the purpose of the programme is 'to leverage global and local knowledge systems to adapt the design of Bank-supported projects and programmes to local conditions' (Gorjestani 2000). A participatory approach has also had a major impact on the field of environmental conservation, where governmental agencies and nongovernmental organisations have embraced the idea of treating indigenous and local peoples as crucial partners in their efforts to preserve natural ecosystems and to promote the sustainable use of natural resources. This can be seen in the proliferation during the past couple of decades of people-inclusive, use-based projects, especially in tropical countries, as an alternative to people-exclusive parks and protected areas (e.g. the Biodiversity Support Program's Integrated Conservation and Development Project initiative, Brown and Wyckoff-Baird 1995). In support of this approach, some analysts have advised that the IK of biodiversity and ecological relationships and indigenous resource management skills constitute valuable tools for conservation planning, implementation, and monitoring, and therefore recommend that these be documented and incorporated into such programmes (Posey et al. 1984; Plotkin and Famolare 1992; Moran 1993; Clay 1988; Posey 1999).

Under the banner of a populist perspective, IK is portrayed as dynamic, experimental, innovative, adaptive, intelligent (but not perfect), locally-specific, and therefore a vital component of development strategy. However, this position is also open to embracing the merits of scientific research and in fact advocates that folk and scientific knowledge be treated as complementary resources which are most effectively used in tandem. In a similar vein, the participatory component sees western scientists and local farmers ideally as mutually dependent collaborators, both sides actively participating in the planning, research, implementation, and monitoring phases. The team approach described here would seem to imply the blurring of the distinction between western scientist and ethnoscientist, between scientific and indigenous knowledge, in the context of

agricultural innovation research. Yet experienced observers have confided that such merger of minds actually entails a 'false closeness' because western science is held up as the standard bearer against which the effectiveness of IK is judged, and because the scientist enjoys greater clout, resources and prestige, hence the partnership is not equal (Fairhead 1993; cf. Scoones and Thompson 1994; Agrawal 1995). Nevertheless, the ideal of balanced and equitable collaboration defines the spirit, if not always the practice, of participatory research (Sillitoe 2002b).

This phase of IK research is marked by an applied orientation, the overall objective being to achieve sustainable development through the design and implementation of technologically appropriate, ecologically harmonious, economically viable, and socially equitable development schemes. The research itself is interdisciplinary and carried out by researchers from diverse academic backgrounds. The ideal setup is to work in teams of specialists composed minimally of a social scientist (e.g. an anthropologist or a rural sociologist), a biologist or agronomist, and an economist. A notable feature is the apparent lack of concern for theory building. Rather the research design addresses the practical objectives of basic ethnographic and ecological description, technology assessment through scientific experimentation (both on- and off-site), communication of technological options to local farmers, ideally through an iterative process, managed implementation of new technologies, and evaluation of the results (with the farmer being the final judge). However, certain theoretical-epistemological assumptions are implicit in much of this research, including a positivist, hard-systems approach focusing on discrete elements and structural integration. Thus IK is viewed as a stock of uniform, systematic, site-specific information, open to incorporating external knowledge elements, potentially fractionable and transferable to non-native contexts, and legitimated by scientific verification (cf. Scoones and Thompson 1994).

This mode of representation has of course drawn its fair share of criticism, especially from post-structuralist quarters (e.g. Hobart 1993). For example, the general systems framework depicts knowledge as an abstract, formally constituted, internally coherent entity that can be logically separated from its particular social, economic, political, and ecological contexts. This, in turn, leads to several dubious, and seemingly contradictory, assumptions regarding knowledge documentation, evaluation, and use. On one hand, it has compelled an overemphasis on discovering or falsely attributing the one-to-one knowledge counterpart (or 'hidden reason') behind each observed practice, which of course implies a questionable conflation of knowledge and practice (Fairhead 1993). Richards (1993) challenges the notion that cultivation practices reflect the simple application of a predetermined, fixed, and abstractly conceived stock of knowledge, rather they are improvised and adjusted to fit momentary circumstances which may be dictated by ongoing observations of weather patterns, crop performance, and so on (see also Sillitoe 1996). On the other hand, the imaginary dissection

of IK into so-called 'technical' and 'non-technical' sectors serves as a sleight of hand by which knowledge itself can be severed from culturally situated practice and belief. This severance makes it accessible for documentation, codification, and *ex situ* preservation in scientific databases with an eye towards isolating specific 'technical' elements of it and transporting them to other settings. Critics charge that if the broader social, political, religious, aesthetic, moral and other dimensions are ignored or eliminated, the resulting extracted knowledge base is so transformed and distorted as to have little value or meaning (Fairhead 1993; Agrawal 1995, 2002; Ellen and Harris 2000; cf. Warren et al. 1995). The results of much IK research, especially those involving rapid appraisal techniques, have been questioned by members of the anthropological establishment on the grounds that adequate understanding of the practices and the motives behind them, much less the ability to communicate effectively between scientists and locals, cannot be achieved over the short term. The conclusion is that anthropologists with long-term commitments to their study communities need to take on a greater role in applied research and development projects (Hobart 1993; Sillitoe 1998, 2002a; Ellen 2002).

Debates about the Valuation, Exploitation, and Compensation of IK

During the 1980s, growing concerns over environmental degradation along with the advancement of biotechnology would add even greater value to IK and usher in a new phase of rhetorical representation and debate. The rise in value was fuelled by the combination of diminishing supply of biological resources, due to the advancing pace of tropical deforestation, agricultural modernisation and attendant loss of biodiversity, and increased demand as a result of the greater capacity to identify, manipulate and utilise genetic material (Brush 1993). A number of prominent ethnobotanists and pharmacologists began to extol the virtues of ethnobiological and agro-ecological knowledge for natural product development in the sense of providing leads for the elaboration of new foods, condiments, medicines, cosmetics, pesticides, fibres, crop germplasm, etcetera (Elisabetsky 1986; Schultes 1988, 1992, 1994a, 1994b; Plotkin 1988; Soejarto and Farnsworth 1989; Schultes and Raffauf 1990; Balick 1990; Cox and Balick 1994; Balick et al. 1996). Richard Evans Schultes, for example, proclaimed that the Amazon forest constitutes 'an untapped emporium of germplasm for new economic plants (1980: 259)' and proposed that indigenous people be regarded as 'a kind of rapid-assessment team already on the ground, which could help to locate the most promising plants for chemical and pharmacological evaluation' (1994: 24). Schultes's former student, Mark Plotkin, asserted that there is an urgent need to document disappearing ethnobotanical knowledge of tropical forest peoples in order to avert a 'serious economic and scientific loss for mankind' (1988: 87). An explicit motivation behind these arguments was to capture and harness the enormous power of international capital and industry

for the service of achieving conservation objectives. Both the species-rich forests and the biocultural integrity of indigenous forest peoples are increasingly eroded and endangered by predatory forms of development. By contrast, biotech-based development depends on the survival and use of living organisms and information about them, which means that safeguarding the forests and salvaging the traditional knowledge and practices of its native inhabitants will (at least potentially) produce more material benefit than by destroying them (cf. Peters et al. 1989). A research agenda aimed at the expanded collection and documentation of biological resources and economic ethnobiological knowledge was thus defined, which theoretically would produce a win-win outcome of environmental conservation, protection of cultural diversity, and economic growth.

This agenda was embraced by the agricultural seed and pharmaceutical industries which found IK to be a valuable tool for bioprospecting, the search for commercially valuable genes and chemical compounds in biological organisms. Folk crop varieties developed and maintained over long time periods by local farmers were already an important component of global crop genetic resources. Large numbers of accessions were stored in the extensive network of international and national gene banks and these were made freely available to both local farmers and industrial plant breeders (Brush 1996; Cleveland and Murray 1997). By the 1980s, more emphasis was placed on the *in situ* conservation of folk varieties through the study and encouragement of farmers' perception, selection, propagation and utilisation of biodiversity within traditional agroecosystems (Altieri and Merrick 1987; Oldfield and Alcorn 1987; Brush 1991; Moock and Rhoades 1992; Cleveland et al. 1994). Justifications for this approach included the need to maintain supplies of crop genetic diversity in the face of environmental change and to provide specific information about folk varieties as well as their wild and weedy relatives that can be used as raw material for breeding modern commercial varieties (MVs). With the continued expansion of industrially produced MVs (hybrids, transgenics) around the world, the traditional cultivars therefore constitute a vital resource for food supply as well as agricultural commerce (Cleveland and Murray 1997).

Pharmaceutical applications of IK deal mainly with the ethnomedical uses of wild plant species. The significance of culturally-specific ethnopharmacopoeias for commercial drug discovery was hinted at by the large number of prescription drugs sold worldwide containing active compounds derived from plants and the fact that there is a high correlation between the therapeutic uses of such plants in traditional medicine and medical science (Farnsworth 1988). Accordingly, some researchers argued that ethnographic-directed investigations could be used to improve the time and cost efficiency of screening plants for bioactivity (Balick 1990; Cox 1990; Daly 1992; King 1992). Putting this logic into practice, IK-based bioprospecting research mushroomed during the late 1980s and 1990s, financed by private corporations or public institutions having direct ties (i.e. sell-

ing patent rights) to industry, and carried out by scientists affiliated with botanical gardens, universities, or research institutes located in the donor or recipient countries.[3] The research chain involved here is complex and costly and requires a disciplinary division of labour, whereby anthropologists or ethnobotanists consult with native healers to document the medicinal plant taxa, preparations and treatments; botanists collect the plant specimens and identify the species; chemists/pharmacologists perform the bioassays and extract or synthesise the active compounds; and medical doctors oversee the clinical trials. Another screening strategy has been to comb the published literature on ethnopharmacology for information about promising medicinal species. However, the lofty expectations initially attached to ethnodirected bioprospecting would not last very long, due partly to the lack of big commercial 'hits' after a decade of intensive search and improvements in random screening techniques *(The Economist* 1999), but more importantly because of the controversy generated over the economic, ethical and legal implications of exploiting biodiversity and IK for commercial purposes.

The purpose and practice of bioprospecting was severely criticized for committing economic injustice against the nations that contain a large portion of the biodiversity and the communities that possess information about it. Darrell Posey (1990a, 1999) wrote that the biotechnology industry has 'mined' biogenetic resources via IK for many years and returned only a miniscule proportion (less than 0.001%) of profits to indigenous peoples. The recent frenzy of collection replicates this exploitative habit by considering the knowledge and resources of indigenous peoples to be 'intellectual *terra nulliu's,* which is to say ascribed no value and assumed to be free for the taking. Vandana Shiva (1996) branded industrial bioprospecting as biopiracy, signifying the misappropriation or unauthorised use of biological resources and information, and frames the discussion in geopolitical terms. For this author, bioprospecting is the modern 'high tech' equivalent of the old colonial habit of the northern nations, which are capital-rich but biodiversity-poor, plundering the natural and human resources of the southern nations, which are capital-poor but biodiversity-rich.[4] It also amounts to biological and intellectual piracy in the sense that both the genetic material and the traditional knowledge are treated as 'global commons' (i.e. open-access, free goods) and therefore not duly compensated while, at the same time, scientific and corporate claims of invention are rewarded with patents under western-dominated national and international property laws. If local communities and tropical nations receive no substantial benefits from biotechnology, they would have no incentive to preserve biodiversity or knowledge. These criticisms and others like them effectively shifted the locus of debate from academic and business circles to policy, legal, and advocacy forums where the focus has been on the issues of intellectual property rights (IPR), equitable benefit sharing, customary property rights, social versus economic benefit, rights of refusal, prior informed consent, ethical behaviour by researchers, the meaning of the term 'indigenous', and the broader

plights affecting indigenous peoples such as self-determination and defence of cultural and human rights (Cunningham 1991, 1993; Brush 1992, 1993; Kloppenburg 1991b; Swanson 1995; Brush and Stabinsky 1996; Posey and Dutfield 1996; Cleveland and Murray 1997; Moran 1999). A large part of this debate has dealt with the quandary of reconciling existing concepts and uses of IPR, built on the precepts of identifiable invention, exclusive rights over profit by private parties, direct compensation for investment and exchange, and market-determined value, with IK which is characterised by uncertain inheritance, shared use rights by collectivities, creativity through free exchange of information, and socially-determined value (Brush 1996; Posey and Dutfield 1996).

The storm generated over the protection and compensation issues and its impact on law and policy matters has shaken up the field of IK studies and altered the roles and conduct of different participants more deeply than anything else in recent years. Although the international legal framework is still evolving and no broad consensus has yet been achieved, it is precisely the dynamic and often contentious nature of this process that has opened up the field of research, policy and action to new players, including intergovernmental bodies, national governments, NGOs, indigenous organisations and local communities. The Convention on Biodiversity (CBD) has had a huge impact on policymaking at national levels, by: (1) enjoining the contracting governments to preserve traditional knowledge, of innovations and practices that are relevant to the conservation and sustainable use biodiversity; (2) recognising the sovereignty of nation-states over genetic resources and their right to regulate access to them; (3) promoting the wider application (i.e. biotechnological development) of such resources and knowledge in support of conservation goals; and (4) encouraging the equitable sharing of benefits arising from such utilisation. Guided by this precedent, many national governments in biodiversity-rich regions have enacted strict access regulations, for example, requiring researchers and bioprospectors to comply with prior informed consent and full disclosure rules and to sign benefit-sharing and technology transfer agreements with government agencies and/or local groups. This has not eliminated bioprospecting however. Instead, in some countries it has fomented partnerships among public institutions, researchers and business groups (e.g. Brazil's autochthonic medicine programme, cf. Lapa 2002), which raises questions about the fair representation of local communities' interests by distant national governments. Presently there are far more nominally 'non-profit' NGO's than profit-seeking companies working with local communities on IK-related projects, funded by private as well as public donors. One important trend in their work has been to seek to build local-level capacities for documenting, managing, using, and transmitting their own knowledge, such as through the creation of community registers and exchanges among different local experts (cf. Gupta 1997). Indigenous organisations and local communities in many places have become increasingly sensitive to the political and economic implications of scientific research and

thus have asserted a much more active role in deciding and controlling who and what kind of study or applied programme is done on their lands and knowledge systems, requiring researchers/managers to sign formal agreements and accept greater local input into the study. Moreover, it is increasingly common to find communities refusing to cooperate with outside researchers and some indigenous organisations have gone so far as to declare moratoriums on all research until IPR and other outstanding matters (e.g. land claims) are resolved to their satisfaction. Important effects of the increased militancy are that preconceived research agendas are becoming less and less viable, the topics and questions of investigation are becoming more closely aligned with locally-defined problems and the data and information produced are being more controlled by the study groups.

This phase of research has emphasised the economic, and by extension the ecological and ethical, significance of IK from a world systems perspective. By placing a market value on IK, recognising property rights, and ensuring that fair compensation is paid, it is believed that environmental governance and social justice will be served. However, the act of reducing IK to a mere commodity, as a resource to be exploited, patented, or bought and sold in the global marketplace, also signifies its decontextualisation and deculturation. A divisible, particularistic, objectivistic conception of knowledge is implicit in this perspective, focusing on those discrete bits of information that stand up to external verification and so provide leads to novel and valuable genes or molecules. The scientific validity of IK is acknowledged but only to the extent that it has become an input for biotechnological scientific research. However, the finding of intercultural consistency in the therapeutic applications of particular taxonomic groups (cf. Trotter and Logan 1986) as well as the high degree of correspondence between traditional medicinal plants and commercial drugs derived from plants provides evidence that at least certain portions IK are developed through an empirical trial and error process, much like the scientific method. This debate has also exposed the close economic and political links between science and industry, undermining the pretension that ethnobiological research is a politically neutral activity, tarnishing the image of scientists as so-called disinterested truth-seekers and confusing the distinction between public and private information.

IK as a Critical Ecopolitical Discourse

Although the value of IK for the contemporary western world had become firmly established by converting it into a commodity for the agricultural development and biotechnology industries, critics of these perspectives contended that it still suffered inferior treatment as compared to scientific knowledge from a world political-economic system that did not offer sufficient compensation nor adequate legal protection for its use. Thus in the 1990s a new critique emerged that blamed the previous perspectives with failing to address the root causes of this fundamental inequality, which were thought to stem from the

lesser epistemological authority accorded to unscientific types of knowledge as well as the subordinate position of the non-scientific knowledge holders in power relationships with outsiders (Agrawal 1995; Shiva 1996; Dei et al. 2000). Added to this were disenchanted assessments of the rational planning establishment's attempts to systematise and scientise — abstract, extract, evaluate, recodify and disseminate — IK to promote rural development without considering the social and political effects of this act of intellectual conquest (Thrupp 1989a, 1989b; Hobart 1993; Agrawal 1995; 2002; Escobar 1995). Meanwhile many of the marginalised and oppressed peoples of the Third and Fourth Worlds were also re-evaluating their own positions and attitudes towards native versus foreign knowledges in reaction to the social tensions and contradictions stirred up by cultural modernisation, market penetration and habitat degradation, a situation described by George Dei (Dei et al. 2000) as the 'crisis of knowledge' in an age of globalisation. In response to perceived threats coming from the outside, some local groups have questioned the authority of science-based education and development and instead expressed renewed faith in traditional beliefs, values and institutions as a means for defending their cultural identity, political independence, economic security, spiritual wellbeing, ecological integrity, and other basic rights (Dei at el. 2000; Posey 2004). Arising from these critiques, IK was recast as an eco-political discourse in the sense of constituting a totality of language, meaning and agency (i.e. intentional actions) which structures and (re)produces peoples' relationships to each other and to nature. A recurrent theme of the discursive orientation is the revalidation of IK vis-a-vis global science especially in regards to the projects of environmental conservation and sustainable development. This phase is heavily influenced by the postmodernist and poststructuralist intellectual paradigms and is largely concerned with the themes of: knowledge pluralism (there are many systems of knowledge, science being one of them), the cultural construction of knowledge (knowledge of the world is the product of specific cultural and historical contexts), the power relations of knowledge (e.g. hegemonic, subordinate, resistant), textual representations (e.g. valid/non-valid, rational/irrational), polyvocality (expression of different points of view), and cultural critique (by exposing hidden assumptions and forcing self-reflection).

Two general tendencies in the treatment of IK from a discursive point of view can be identified, constructive and deconstructive. Constructive treatments involve the articulation of images of IK as rhetorical devices and conceptual propositions in environmental discourses that are intended to promote social and political change. Such representations have been routinely employed, in literature and speech, by different factions of the radical environmentalist movement (Shiva 1988; Callicott 1989; Mander 1991; Durning 1992; Merchant 1992; Drengson 1995), and by indigenous rights advocates (cf. Posey 1999: 555-601). The master narrative appearing in these accounts is the 'ecologically

noble savage', according to which indigenous people are stereotyped as wise and gentle stewards of nature who live(d) in ecological and spiritual balance with their environment prior to the disrupting impact of western industrialism. Critics point out that this stereotype depends on oversimplification and distortion of a diverse and complex indigenous cultural panorama, and more closely resembles western ideas and fantasies (Brosius 1997; Grande 1999; Whelan 1999). Nevertheless, this idea was popularised during the 1970s and 1980s, asserting that supporting the land rights of indigenous peoples is fully compatible with environmental justice, thereby seemingly uniting the goals of the environmentalist and indigenous rights movements (Bunyard 1989; Perrett 1998). However, this alliance appears to be unravelling in recent years due to a clash of priorities (ecocentric versus socio-centric respectively). On one hand, the contemporary as well as historical accuracy of the notion that indigenous peoples are always and essentially conservationists came under severe questioning by ecologists (Diamond 1987; Redford 1991; Krech 1999; Whelan 1999). Consequently, many environmentalists have become sceptical about leaving conservation policy in the hands of indigenous groups, especially now that they are experiencing population growth, using machine technology and adopting consumerist habits (Redford and Stearman 1993; Soule 1995; Perrett 1998). On the other hand, indigenous activists and their defenders continue to appropriate the ecosavage narrative but the meanings they attach to key concepts such as biodiversity, conservation and sustainable management diverge from those given by scientists: the conservation objective is often subordinated to a larger political agenda in which social justice goals (e.g. self-determination, resource rights, human rights) are the first priorities (Redford and Stearman 1993; COICA 1999; Benton and Short 1999).

Deconstructive treatments entail the analysis of the social and historical constructions of IK in particular ethnographic settings, especially in the context of conservation and development projects and experiences. Such studies examine the linkages among competing categorisations and representations of knowledge, the agencies of distinctively positioned social actors, and the prevailing contests over power, resources, identity, cultural patrimony and other goals. This approach has been increasingly employed to evaluate the (manipulative) communication, (discriminatory) assumptions and (poor) performance characteristic of many conventional technoscientific and participatory oriented development histories, and to suggest alternative engagement strategies (Kloppenburg 1991a; Hobart 1993; Escobar 1995; 1997; Apffel-Marglin and Marglin 1996; Haen 1999; Ellen et al. 2000; Sillitoe et al. 2002; Bicker et al. 2004). The perspective labelled Beyond Farmer First (BFF), which views agricultural development as an ideological and political process, provides a pertinent example (Scoones and Thompson 1994). As an applied research strategy, BFF supersedes the populist strategy by focusing attention on lour main areas:

(1) analysis of difference in knowledge, according to gender, ethnicity, class, age, religion, etcetera; (2) examination of the power relationships between different social actors who have divergent, often conflicting, interests with regard to access to and control of resources; (3) exploration of new participatory approaches that would give local people more control over the research and development process; and (4) transformation of institutions and policies in the direction of greater democracy, decentralisation, and diversification. The general objective here is to achieve a socio-politically and gender differentiated type of development based on the tenets of active participation, empowerment, and poverty alleviation.

The discursive phase of IK research and writing evinces an intellectual programme that is geared overtly or covertly towards ideological criticism and socio-political activism (or advocacy). It is critical in the sense of exposing and challenging the hidden premises and truth assumptions that sustain environmental idioms, ideologies and practices. It is action oriented to the extent that it seeks to effect revolutionary change in the social, political and ecological status quo (e.g. empower the poor and underprivileged; decentralise legitimacy; break dependency, foster self-determination, restore healthy ecological relationships) (Alexiades, Chapter Three). These principles are evident in discussions of the problematic relationship between scientific and indigenous knowledge. Lori Ann Thrupp (1989a; 1989b), for example, argues that western scientific knowledge is a powerful ideological force that provides the rationality of exploitative capitalist and modernist institutions, delegitimises and displaces IK through domination of education and development policies, and appropriates and scientises particular bits of IK to further its hegemonic spread around the world (see also Agrawal 2002). She urges development agents and institutions to abandon their faith in scientific superiority and instead to recognise and appreciate the intrinsic value of IK, as seen from local people's own points of view. This type of legitimisation can be a potential source of empowerment for marginalised people, enhance their self-esteem and confidence, and lead to more effective and sustainable local-level actions.

Critical expositions of eco-political policies and discourses have advanced the study, theory and applications of IK in several ways, of which only a few can be mentioned here. Some writers (Cashman 1991; Rocheleau 1991; Fernandez 1994; Mishra 1994; Simpson 1994) have called for greater attention to the gendered nature of rural people's knowledge because this division, and especially the crucial contribution made by women to the survival of their families and communities, is too often ignored by outside researchers and development agents. Such blindness and deafness towards women elicits the recommendation that special efforts be made to study and incorporate female expertise, skills and opinions in development interventions to the benefit of women as well as their communities. Arun Agrawal (1995) rejects the polar separation of IK and global

science on substantive, methodological and contextual grounds, and points out that the two 'classes' of knowledge have been in intimate interaction since at least the fifteenth century. The demystification and demolition of this binary construct is considered a first step towards levelling the value judgments that denigrate IK and reforming political relationships that discriminate against indigenous peoples. The dissolution of essentialist conceptual dichotomies also paves the way for the concept of hybrid knowledges (natures/cultures), which refers to the creative synthesis of local and global, insider and outsider, traditional and modern, forms of knowledge. It is proposed that most, if not all, societies perpetually incorporate and fuse selected elements of spatially and temporally heterogeneous knowledges peculiar to their location and history, transforming the knowledges and recreating themselves in the process (Escobar 1999; Gupta 1998). The hybrid nature(s) of IK is thought to constitute a potential source of agency and empowerment for marginalised peoples in the sense of constituting a strategy for resistance to external hegemonic discourses and for alliance with alternative discourses and their corresponding social actors.

Epistemologically, this phase is broadly defined as poststructuralist, anti-positivist, anti-essentialist, relativist, constructivist and subjectivist. However, this characterization needs to be qualified by noting that strict versus constrained forms of constructivism can be distinguished (Hayles 1995; cf. Escobar 1999). According to the strict version, all descriptions or representations of the real world 'out there' are so distorted by cultural and perceptual filters that we cannot attain certain or objective knowledge about it. Therefore the study of peoples' comprehension and engagement of nature reveals more about human society and history than it does about the biophysical environment. An environmentalist critique of this position warns that if nature is nothing more than a figment of the human imagination, then it can also be argued that environmental problems are not real and no concrete actions need be taken to address them (Soule and Lease 1995). By contrast, the constrained version recognises that everybody's understanding of the world is shaped by language, history, and social position but that the real (i.e. pre-social) world imposes certain objective limits on the accuracy and consistency of these representations and therefore some viewpoints are more/less truthful than others. This position suffers from ambiguity in drawing the line between what is subjectively constructed versus objectively real (Soule 1995). What constraints does a politicised, constructivist approach impose on the specific understanding of IK? First and foremost, we are reminded that knowledge is power, which focuses our attention on the larger political and economic contexts, but at the expense of technical or ecological comprehension (Vayda and Walters 1999). Second, the view of nature as social construction obliges us to look at the historically-framed webs of meaning and action that constitute and transform it. At the same time, if nature has no essential, objective or pre-social status, then the knowledge of it cannot be described

or assessed in terms of the criteria of empirical reliability, specificity, comparability or adaptive utility. Finally, the rejected paradigm of revamping IK systems through technological engineering, implied by the critique of science-based development, is replaced by the even more dubious faith in social engineering by political reform or revolution (Sillitoe 2002b).

Processual Perspectives of IK

The social constructivist critique of the supposed ontological and epistemological divide between global science and IK implies as corollary that neither one should be conceived as static, bounded and indifferent systems. The emphasis on interactive engagement, whether oppositional or mutualistic, shifts the investigative gaze to the dynamic (re)constitutive processes and properties of it in fragmented socio-historical contexts marked by encroaching global interconnections of people, material goods and information. However, most deconstructive studies are relatively unconcerned about the particular facts and details of particular knowledge systems and more interested in knowledge *per se* (Ellen 2002). By the mid-1990s, another group of interlocutors was voicing alarm that biological, cultural and linguistic diversities around the world were all rapidly declining, giving rise to the hypothesis that the different types of diversity are interdependent and the degenerative trends are interlocking processes (Nietschmann 1992; Harmon 1996; 2002; Nettle and Romaine 2000; Maffi 2001; 2005). At the local scale, the extinction or erosion of traditional environmental language, knowledge and practices may explain a significant degree of this linkage. Confronted with these disturbing revelations, several researchers were morivated to begin exploring the dynamic or processual aspects — creation, transmission, transformation, conservation, and loss - of IK, but this time on a more empirical footing. The core questions addressed by this work include: how it is created, what the learning process entails, who passes it on to whom, in what situations and contexts transmission occurs, why it is lost or changed, what is the social organisation of knowledge, how social relationships regulate the flow of information, how use patterns and contexts affect knowledge, and what social and ecological factors promote its conservation or extinction. This phase is quite recent, little more than a decade old, still incipient, eclectic, and has not yet coalesced into an easily recognisable body of work. Nevertheless, a process-oriented approach to IK is plainly evident in the growing number of case studies that focus on the ebb and flow, agreement and diversity, transmission and acquisition, retention and transformation of knowledge in specific groups, places and time frames. Much of this research can be conveniently grouped into the following four problem issues or themes: the social organisation of knowledge, knowledge as socially situated performance, the transmission and acquisition of knowledge, and cultural modernisation and the intergenerational retention/loss of knowledge.

(1) Social organisation of knowledge: cognitive variation was long considered a problem for representations of cultural knowledge in general (D'Andrade 1987) and ethnobiological classification in particular (Gardner 1976, Ellen 1979), but several researchers working with traditional ecological knowledge during the last twenty years have highlighted such variation and used it as a guide map for reconstructing historical processes of knowledge change (Boster 1980, 1984, 1986; Nazarea 1995, 1997; Kempton et al. 1995; Atran 1999; Zent 1999a, 2001; Osseweijer 2000; Zent and Zent 2004). This work has advanced a processual perspective of IK by establishing that social organisation consrrains and patterns knowledge distribution synchronically (according to social variables of age, gender, occupation, education, class, ethnicity, etcetera) and diachronically (by regulating the exchange and flow of information over time). To the extent that knowledge is distributed among social segments and transferred through social relationships, any changes in the surrounding physical or cultural environment that impact on social organisation will exert a collateral effect on knowledge. The distribution of IK has also been modelled in terms of social information networks, which broadens our perspective of the flow of information from a micro scale (individual or dyadic levels) to a more macro scale (community or intergroup levels) (Ford 1976; Box 1990; Hanyani-Mlambo and Hebinck 1996; Atran and Medin 1997; Atran 1999; Ross 2002). A focus on networking is useful for identifying the following: (a) the community's propensity to encounter, spread and assimilate new information; (b) the community's capacity for adapting cognitively to changing technological and environmental conditions; (c) the extent and shape of information sharing; and (d) the degree to which expert ecological information is bound to other patterns of social life.

(2) Knowledge as socially situated performance: a common criticism of scientific (etic) and ethnoscientific (emic) approaches to the description and analysis of IK has been the tendency to decontextualise it, thus not taking into consideration its context-indexed meanings, uses, purposes and variations (Ellen 1986; Ellen and Harris 2000). Addressing this problem, some researchers have focused precisely on the situational, performance-embedded aspects of IK (Borofsky 1987, 1994; Murphy 1992; Ellen 1993; Richards 1993). Richards' (1993) demonstration that the knowledge displayed by African farmers is better understood as concrete practice rather than abstract competence points to the sequential and contingent effect over time of many small and momentary fluctuations in growing conditions, labour supply and market factors as leading the way to knowledge/practice change. Robert Borofsky's (1987) ethnography of Pukapukan (Micronesia) knowledge shows how situational variables (e.g. social relationships between participants) structure, modify, and ultimately transform expressions and referential contents in the course of practice events.

(3) Transmission and acquisition of knowledge: studies of enculturation or informal education in traditional societies have dealt mainly with the socialisation of values, attitudes and personality traits (Scribner and Cole 1973), but a building trend in IK studies is to focus on the transmission and acquisition of practical ecological knowledge and skills (Stross 1973; Ruddle and Chesterfield 1977; Dougherty 1979; Hewlett and Cavalli-Sforza 1986; Lave and Wenger 1991; Ohmagari and Berkes 1997; Hunn 2002; Zarger 2002; Casagrande 2002; Wilbert 2002; Zent n.d.). These studies have provided descriptive and statistical accounts of the IK learning/teaching process in different cultural settings. Key topics covered include: the types and rates of knowledge accretion by age; the effects of education, occupation, community, and other dynamic variables on individual acquisition; the interpersonal relationships that are more or less responsible for knowledge transmission; and the particular methods and contexts in which learning occurs. Results so far indicate that much learning occurs informally (outside school) and unconsciously, begins at a very early age and is nearly complete by adolescence, takes place in customary activity contexts (work, play and rest), involves observation and experience (e.g. peripheral participation, trial and error), depends somewhat on local language fluency, is obtained from primary care-givers and is usually initiated by the novice and not the expert (i.e. learner-directed). Socio-cultural and economic changes that affect these variables, such as time spent in traditional versus non-traditional activities, with peers versus adults and higher valuation of extra-local knowledge, can disrupt the transmission continuity over time and are manifested locally as a knowledge generation gap (Ross 2002a; Zent n.d.). The question of intergenerational IK transmission is presently a hot issue in environmental policy circles because little is known about it and long-term maintenance depends on it (Nakashima 2005).

(4) Cultural modernisation and intergenerational retention/loss of knowledge: for years, observers of indigenous groups have reported and lamented the rapid decay or total loss of slowly accumulated ecological knowledge, but such observations were largely anecdotal or impressionistic and not backed up by hard data or precise understanding of the kinds, rates and causes of knowledge erosion (Linden 1991; Schultes 1994a). A recent wave of research is specifically geared to addressing this information gap through the systematic investigation of the impact of modernisation and acculturation on diachronic processes of knowledge retention/loss (Nabhan and St. Antoine 1993; Chipeniuk 1995; Nabhan 1997, 1998; Ohmagari and Berkes 1997; Godoy et al. 1998; Rosenberg 1998; Zent 1999a, 2001; Lee et al. 2001; Heckler 2002; Ross 2002a, 2002b; Byg, A. and H. Balslev 2004; Zent and Zent 2004; Reyes-Garcia 2005). This body of work is noteworthy for empirically confirming and documenting that IK is indeed undergoing drastic changes in many groups where cultural modernisa-

tion is taking place, thus appearing to confirm the hypothesis of generalised erosion. Some of the change indicator variables observed to correlate with variations of IK level include: age, gender roles, personal and parental schooling, bilingualism, market involvement, habitat degradation, distance to forest or town, contact with other groups, availability of western medicines, occupational focus, wealth, religious belief and public economic assistance. However, the direction and strength of these effects on knowledge vary considerably across the different study sites. Moreover, a recent study of the Tzeltal Maya by Rebecca Zarger and John Stepp (2005) found remarkable persistence of knowledge after three decades of progressive socio-economic change (see also Hunn 2002; Sowerine 2004). These results suggest that the erosion process is culture- and site-specific and that complex (and still poorly understood) interactions among cultural and environmental variables determine whether knowledge is discarded or retained. But they may also reflect methodological variance and only the Zarger and Stepp study used time-series data. More such diachronic studies and a better idea of the normal or background rates of knowledge variation, along spatial and temporal dimensions, are needed before general tendencies can be clearly discerned.

Processual IK studies have typically employed integrative methodologies, combining cognitive experimental techniques (structured interviews, cognitive games, sorting and ranking tasks, projective tests), standard anthropological field methods (elicitation of folk classifications, ethnosemantic analysis, participant observation, kinship and social network analysis, socio-economic surveys, life and community histories), bio-ecological data collection (plant trails or plots, plant or animal collections), and different types of statistical analysis (consensus analysis, correspondence analysis, cluster analysis, regression, analysis of variance). However, one of the chief criticisms of the processual perspective has been the lack of standardised methodologies which in turn inhibits comparisons across case studies and generalisation of broader trends. One can envision that further development of this approach hinges upon achieving greater methodological sophistication and clarity.

Theoretical integration of processual studies of IK is presently underdeveloped, due in part to the methodological limitations mentioned above. Some authors have developed potentially useful theoretical frameworks centred around the concepts of process, interactivity and contextuality, notably Tim Ingold's (2000) notion of 'dwelling' and Paul Sillitoe's (2002b) four-dimensional 'global domains model', but it is presently unclear how these may be applied to organise and interpret the expanding empirical database on IK change and variation. To begin this task of conceptualisation, it will be useful to extract the most obvious theoretical-epistemological principles that are reflected in this body of work. Generally speaking, the processual approach implies a shift of descriptive and explanatory focus from structure, classification, function, and content to process, genesis, variation, and context. Knowledge is conceived not

simply as an abstract, self-contained, inert body of useful technical and symbolic information but rather as the active, open, somewhat fluid cognitive fabric of observable social and ecological interactions. Other key tenets of this approach are: (1) an explicit sense of history, which considers the production and reproduction of IK in specific cultural and ecological contexts as problematic (rather than automatic) and therefore a central focus of the investigation (cf. Zent 1999b); (2) anti-essentialism, which makes variations, context-embeddedness, and historical contingency the main objects of description and explanation (cf. Vayda 1994); and (3) a pro-positivist bias, which holds that positive statements alleging knowledge change or conservation must be sustained by empirical evidence, which should be obtained through systematic, operationally explicit, replicable, and often quantitative methods of data collection (cf. Martin 1995; Alexiades 1996).

The problem orientation of the processual phase of IK studies is applied as well as academic. Clearly a primary stimulus of the paradigmatic turn towards studying knowledge dynamics, distributions, and contexts has been the concern for the progressive and pervasive trend of local knowledge erosion or change and the desire to develop more effective *in situ* and *in vivo* conservation measures. Whether implicit or openly stated, a common theme throughout much of this work is that a more sophisticated general-theoretical and local-empirical understanding of IK dynamics can enhance the design and success of intervention efforts aimed at local knowledge preservation, such as ethnoenvironmental education or revitalisation programmes. Thus one of the main contributions of this phase is the potential support it provides to scientists and planners working in knowledge-based conservation and development projects.

Conclusion

My main motivation for undertaking this review has been to celebrate the dynamic variety and fertility of scientific views and approaches to local ecological knowledge during the past half century. The diversity of methodological and theoretical orientations has enriched our appreciation and understanding of IK, but also made it increasingly difficult for the scientific community to reach consensus concerning the proper role and significance of the many locally-situated, tradition-rooted, culturally-embedded knowledges in relation to the so-called universal, transcultural scientific disciplines. This is to be expected and even healthy but also disconcerting to policymakers and the public at large who are demanding greater clarity and definition (i.e. simplification) regarding the epistemological, social, ethical and utilitarian status of local knowledge as judged from a 'scientific perspective' (see *Nature* magazine, 1999, Vol. 401: 623, 631). The stakes of this call for unity out of diversity are not merely academic. For example, some educators are striving to open spaces for IK-related studies and

modes of learning in the academy (Semali and Kincheloe 1999), a goal that has great significance for the increasingly multicultural urban society as well as the increasingly globalised rural societies. Yet if no scientific agreement exists about how IK is to be understood, then how would it be possible to draw the line for any non-scientific knowledge form, for example the Christian theory of divine creation, prejudicial racist or sexist doctrines or beliefs in little green men from Mars. A major challenge therefore is to integrate the useful insights provided by the different phases while at the same time overcoming or correcting the narrow conceptual biases that each one inevitably entails. What principles provided by the previous approaches might be incorporated into a broadly acceptable, synthetic perspective of IK? The ethnoscientific phase has taught us of the culturally organised and rationalised nature of local environmental classifications, and ethnoscientific methods of data collection and analysis have been widely adopted as standard investigative procedure in most empirical IK studies. The discovery of close affinities of folk and scientific biological classification through research in theoretical cognitive ethnobiology has ratified the claim that folk biologists possess very extensive and accurate knowledge of a large portion of the biodiversity of their surrounding habitats and therefore are valuable sources of scienrific information about local biodiversity. Research on formal models of the relationship between cognition and behaviour has established that the path from apprehension of environmental information to concrete action is operationalised through a complex logical process that we may characterise as fundamentally rational yet extremely intricate and conditioned by a vast array of surrounding environmental factors. The research phase dealing with IK as input for sustainable development and environmental conservation has highlighted the ecological wisdom of many traditional resource practices and the practical utility of counting on local peoples as active, intellectually astute participants in and conttibutors to agricultural research and development initiatives. The literature devoted to debates about the valuation, exploitation, and compensation of IK has raised our consciousness of the contradictory, unequal and seemingly unethical treatment accorded to non-scientific forms of knowledge within the dominant world political-economic system: on one hand, it is recognised to have scientific validity and economic value; on the other hand, it is devalued and discriminated against from a juridical-political point of view. The discursive phase counsels us to be aware of the political dimensions of IK, especially the power plays behind supporting or refuting it, and the sometimes antagonistic relationship between scientific and local knowledge. Finally, the processual phase has revealed that the normal state of local knowledge is change, that it is variably distributed, that it is eminently adaptable and responsive to changing environmental conditions, and therefore it may be fragile and can only be Sustained through active effort.

Notes

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1. These include: folk science, people's science, citizen science, ethnoecology, traditional knowledge, traditional ecological (or environmental) knowledge (TEK), indigenous environmental knowledge, rural people's knowledge (RPK), and local knowledge.
2. Boster's (1987) test showing that novices, or untrained biologists, exhibit a high level of agreement with scientists and folk biologists in sorting bird specimens provides further confirmation of the objective reality of phylogenetic relationships.
3. The close ties between private and public institutions in the recent wave of bioprospecting research are demonstrated by a few well-known examples. In 1986, the U.S. National Cancer Institute hired several botanical gardens to collect plants and screen extracts from the neotropics for anti-HIV and anti-cancer activity. In 1990, the multinational corporation Merck Co. signed a contract with the Costa Rican government and the National Biodiversity Institute (INBio), a non-profit organisation set up by the government, for the right to screen samples of that country's biodiversity. The International Cooperative Biodiversity Groups (ICBG) grant programme is coordinated by the U.S. National Institutes of Health (NIH). Created in 1993, the programme was designed to foster bioprospecting partnerships among local communities, academic researchers, and biotechnology businesses.
4. Brush (1993) points out that this criticism is somewhat unfair in the sense of choosing to ignore that plenty of plant material has been exchanged within and between tropical countries and regions. Local populations in the American tropics have also benefited from medicinal and other utilitarian plants introduced from the Old World (Bennett and Prance 2000).

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