Integrative assessment and planning methods for sustainable agroforestry in humid and semiarid regions

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An introduction to ethnoecology and ethnobotany Theory and Methods

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1. Definitions and goals

1.1 Ethnobotany and Ethnoecology

Since the beginning of civilization, people have used plants. Plants provide people with food, medicines, as well as materials for construction and the manufacture of crafts and tools and many other products like fuel, paints and poisons. Plants often have a ritual character and/ or are used because their hallucinogenic character. Nowadays their chemical and genetic constituents are being increasingly explored for human benefit. Ethnobotany was a term first suggested by John Harshberger in 1896 to delimit a specific field of botany and describe plant uses. It was defined as *"the use of plants by aboriginal peoples"* (cited in Cotton, 1996). Ethnobotanical studies based largely on qualitative methods and had all too often been just academic exercises or have served only external interests, with the results of benefiting neither local people nor conservation (Hamilton et al, 2003). In recent years, researchers have used a much more ecological approach, introducing studies about the interaction between the natural environment and humans.

Ethnoecology is a multidisciplinary field that integrates techniques from biology, anthropology, ethnology, linguistics, economy and other fields. Ethnoecologists do not only work in primary forests, they are also interested in a broad range of vegetation types which have been altered by people, ranging from homegardens to mature secondary forests, where the majority of useful plants are found. Research focuses on the ecological knowledge of the indigenous people and of traditional

agriculturalists. Although most research is conducted in rural areas, some studies – such as descriptions of animals or plant sold in urban marketplaces – are carried out in cities. Ethnoecologists address theoretical questions about the relationship between humans and their environment and the answers contribute to rural development, poverty alleviation, health care and conservation (Martin, 1995). Thus, ethnoecological research is not limited to pure science, it can help to understand the dynamic relations between biodiversity and social and cultural systems.

Ethnobotany:

Definition 1: "*Ethnobotany is the discipline concerned with the interactions between people and plants*" (Jones, 1941, cited in Hamilton et al, 2003).

Definition 2: "Ethnobotany is the part of ethnoecology which concerns plants (Martin, 1995)".

Ethnoecology

Definition 1: *"Ethnoecology encompasses all studies which describe local people's interaction with the natural environment, including subdisciplines such as ethnobiology, ethnobotany, ethnoentomology and ethnozoology"* (Martin, 1995).

Definition 2: "*Ethnoecology is the science of how people understand the relationship between humans, animals, plants and physical elements of a local environment"* (Davison-Hunt, 2000).

In this sense, and according to Hamilton et al (2003) the main tasks of applied ethnobotany are:

- Conservation of plant species - including varieties of crops - and other forms of biological diversity.
- Botanical inventories and assessments of the conservation status of species.
- Sustainability in supplies of wild plant resources, including of non-timber products.
- Enhanced food security, nutrition and healthcare.
- Preservation, recovery and diffusion of local botanical knowledge and wisdom.
- Reinforcement of ethnic and national identity.

- Greater security of land tenure and resource ownership.
- Assertion of the rights of local and indigenous people.
- Agreements on the rights of communities in protected areas.
- Identification and development of new economic products from plants, for instance crafts, foods, herbal medicines and horticultural plants.
- Contributions to new drug development.

1.2 Traditional Ecological Knowledge

According to the Convention on Biological Diversity (CBD), "traditional knowledge refers to the knowledge, innovations and practices of indigenous and local communities around the world. *"The ecological dimension to traditional systems of knowledge is usually taken to refer to a people's medicinal, technical, and ritual uses of plants, animals, and rocks; to place names and occupancy of territory; or to the spiritual, cosmological, and relational aspects to the various presences (animate, inanimate, present or past) in an environment"* (Studley, 1998). Even if there are many definitions for traditional ecological knowledge TEK – which is also known as Traditional Environmental Knowledge (see Johnson, 1992), there is consensus among scientists about the fact that such knowledge is linked to a specific place, culture or society; it is dynamic in nature; it belongs to groups of people who live in close contact with natural systems and it contrasts with "modern" or "Western formal scientific" knowledge" (Warren, 1991).

Traditional Ecological Knowledge TEK

Definition 1: "TEK is a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. Further, TEK is an attribute of societies with historical continuity in resource use practices; by and large, these are non-industrial or less technologically advanced societies, many of them indigenous or tribal" (Berkes, 1993).

Definition 2: *"TEK is a body of knowledge built by a group of people through generations living in close contact with nature. It includes a system of classification, a set of empirical observations about the local environment, and a system of self-management that governs resource use* (Studley, 1998)

As the Convention on Biological Diversity points out, traditional knowledge is of great importance not only to those who depend on it in their daily lives, but to the Western society, as well. Many plant-based medicines and cosmetics are derived from traditional knowledge and other articles include agricultural and non-timber forest products. Traditional ecological knowledge can also help to achieve a sustainable development: Most indigenous and local communities are situated in areas where the vast majority of the world's plant genetic resources are found and many species have been cultivated and used in a sustainable way for thousands of years. The skills and techniques of these indigenous and local communities provide valuable information to the global community and can be a useful model for biodiversity policies. The international community has recognized this close and traditional dependence of the indigenous and local communities on biological resources in the preamble, and more concretely, in the Article 8(j) of the **Convention on Biological Diversity**, which has been ratified by 178 countries. (Convention on Biological Diversity).

***Article 8(j)* of the Convention on Biological Diversity** *states:*
Each contracting Party shall, as far as possible and as appropriate : Subject to national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge innovations and practices.

2. Research methodology

2.1 Research design

It is essential to define first the goals of the project before selecting the approach which best suits the interests, budget and schedule. Most methods used in ethnobotanical and ethnoecological studies are time-consuming and can be expensive. Several trips to the field may be costly, but usually the most successful projects are those which span several seasons and continue for a number of years. Long-term projects allow to work with local people to record ecological knowledge in

a variety of contexts, including ritual occasions and seasonal farming activities. But sometimes it is not possible to conduct a long-term project. In these cases Rapid Ethnobotanical Appraisal can be used.

Rapid Ethnobotanical Appraisal

This appraisal derives from the Rapid Rural Appraisal (RRA), originally developed to guide and evaluate development initiatives. The techniques are conducted in a short time without requiring expensive tools because participants seek a sketch of local conditions rather than an in-depth-study. A small group of local people is selected and interviewed qualitatively about a wide range of topics in a semi-structured way, allowing a comprehensive view of how the community acts as a whole. The techniques are highly visual and are carried out by community members, often in collaboration with the researcher (Martin, 1995).

Ethnobotanical fieldwork requires researchers to collaborate with government officials, scientists, and local people. In most countries, researchers must obtain official permits before conducting any research, especially when conducting research in indigenous communities. Fieldworkers should also obtain permission from community members before initiating research activities. Researchers need to clearly and honestly discuss their goals, methodology and consequences of the research to local communities. Another important point is the selection of local informants. A common mistake is assuming that one is dealing with culturally homogeneous groups. There is often a considerable degree of intracultural variation and specialization. This must be taken into account when selecting informants. Researchers are also expected to compensate informants and communities with a fair amount of money and/ or through gifts and services. Last, but not least, the intellectual property rights regarding the ecological knowledge of the indigenous people must be taken into consideration. When designing an ethnobotanical project, researchers must take into consideration and respect the national legal frames about biodiversity prospecting. Furthermore, they should handle according to the Code of Ethics of the Society of Ethnobiology (Society of Ethnobiology, 1998).

2.3 Data collection in ethnobotany

2.3.1 Collecting and identifying plants

Among the most basic skills in ethnobotany is plant collecting. Collections are valuable because they serve as voucher specimens, which are permanent records of the plants recorded in a certain place or community. They allow taxonomists to identify the family, genus and species of a collection (Martin, 1995). The selection of samples should be based on the representativeness of the plant species. Plants should include flowers, fruit or both in order to make their identification easier. Specimens should be pressed in the field whenever possible. A good herbarium specimen consists of a dried, pressed section of a plant containing well preserved vegetative and reproductive structures (Alexiades, 1996). The determination follows at the affiliated Herbarium. Determinations can only be as good as the specimens on which they are based. The herbarium label should include the name of the institution and of the collector, the project title, family, genus and species of the specimen, specialist and date of determination, locality, vegetation and habitat, latitude and longitude, altitude, plant description and collecting date.



Figure 1: An herbarium specimen of *Cordia alliodora* collected in Shaime, Province of Zamora Chinchipe, Ecuador, and hosted at the Herbarium "Reinaldo Espinosa" of the Universidad Nacional de Loja, Ecuador. The label includes ethnobotanical information

The field notebook is the main tool to record information. Notes must be taken on the field while making plant collections and not at the end of a day or trip in order to avoid the loss of data. A standardized numbering system should always be used to label all collections and cross reference them with the field notes (Alexiades, 1996).

Indigenous plant names contain interesting information about the use and perception of plants by a particular culture. Fieldworkers should acquire basic linguistic skills of the local language and work with or seek the advice and cooperation of a linguist familiar with that particular language (Alexiades, 1996; Martin, 1995). The names should be recorded - using audio cassettes or MD recorders - for subsequent transcription. Beyond this, it is recommended to document the collected specimens using a photo camera. Pictures of a plant in its natural state can be very useful for its identification - as they include information about its morphological, architectural and ecological characters - and can be used to support plant and checklist interviews.

2.3.2 Interviewing

The main way of gathering ethnobotanical information is to talk with people, to watch what they do and to participate in their activities. Native language should be used, and in general questions should not be complicated or ambiguous. Various field interview techniques exist:

2.3.2.1 Techniques of Inquiry

(adapted from Alexiades, 1996; Cunningham, 2001 and Martin, 1995):

Participant observation

This technique is based on observing human-plant interactions, such as wild plant gathering or homegarden management. The ethnobotanist accompanies the local people and participates in the gathering of fruits or other forest products, in hunting activities, in farming or in the use of medicinal or hallucinogen us plants.

Ethnobotanical inventory or field interview

It consists of walking in the field or in the forest with an informant, listen to him and asking him about plants and collecting and taking notes on them and their uses. This technique is very time-consuming, but allows informants to see the

plants in their natural state, which minimizes the risk of misidentification and offers an excellent context for the interview.

Plant interview

The plant interview consists of collecting plants in the field, bringing back to the village and present them to informants. Pressed plant specimens can also be used in this way. If no fresh or press plant specimens are available pictures of the plant species can be very useful. This technique is very helpful during preliminary or short studies or in order to reconfirm collected data.

Artefact interview

In the artefact interview the researcher asks the Informants – for example while visiting them at home - about the plants which are employed in the manufacture or preparation of particular items, like parts of the house, tools, baskets, etc. The technique is a good way of beginning an ethnobotanical study, as it is simple and will familiarize the local community with the researcher.

Checklist interview

The researcher compiles a list of plant names and present it to the informants. This option is interesting for well-known plants, but errors can occur as the names can vary from one local group to another. Photographs, drawings and herbarium sheets may be used as complementary aids during the interview. This approach is useful as part of a structured interview (see 2.3.2.2).

Group interview

As the name indicates, the ethnobotanist conducts interviews with a group of informants. Group discussions can produce a wealth of data and lead to discovery new topics and questions. Some people will be more willing to share their knowledge in a group environment, while others will be reluctant to disclose certain types of knowledge in front of other community members.

2.3.2.2 Types of interviews (adapted from Alexiades, 1996 and Martin, 1995)

The techniques described above (2.3.2.1) employ one or more of the interview types listed in this section. The setting of the interview and the degree to which questions are predetermined, as well as the questions asked determine the degree of control of the interviews.

Informal interview

The informal interview has no structure, the researcher simply makes notes during or after casual conversations.

Unstructured interview

This type of interview has the appearance of a casual conversation, but the actors involved know that it is an interview. It develops within the framework established by the researcher.

Semistructured interview

In this type of interview the fieldworker has a list of questions and topics that need to be covered, but this list is only a guide, it allows the researcher to be flexible. As the discussion gets under way, new lines of inquiry arise naturally while some of the prepared questions will fall to the wayside.

Structured interview

This interview bases on fixed questions and are mainly used for the evaluation of local knowledge (see 2.3.5). The structured interviews should be reserved for later stages of the ethnobotanical study, when a high degree of confidence between researchers and locals exist.

2.3.3 Mapping (adapted from Townsley, 1996)

The topographic distribution of the plant specimens, homegardens, households and local infrastructure is covered in a map. Existing maps, GPS records taken during the survey and aerial photographs represent the basic topographic information. The latitude, longitude and altitude of the collected plant specimens should be recorded using GPS. As a starting point for discussion with some individuals and groups of local people, rough maps of the area can be drawn up. Nearby highs can be used as

a means of obtaining a “bird's-eye view” from which informants can directly indicate particular features of the landscape and territory which are of importance to them. These maps provide a physical focus for discussions, giving something concrete for people to refer to when talking about local circumstances, changes in conditions or particular matters and allow them to illustrate their view of their environment and what is of relevance in it for them. At the same time, mapping helps to complete limited information provided by existing maps, which are often incomplete, and to get a better understanding of key local particularities. Finally, they provide a basic sketch map for use for filling in thematic information, as historical changes in settlement and land use, social and economic particularities among the local inhabitants or land cover.

2.3.4 Market survey (Adapted from Alexiades, 1996 and Cunningham, 2001)

Most cities in a region have markets with sections were plant products like fruits, vegetables and medicinal plants are sold. Moreover, such products are sold in informal markets, mainly in rural areas and/ or along roads. These places are important sources of information for conservation, rural development and resource management programmes. Direct observations, interviews and surveys of traders, vendors and consumers can be used to obtain qualitative and quantitative data concerning socio-economic, ecological and cultural aspects of wild plant products and horticulture products. For instance, market survey allows the identification of overexploited wild plant species or of plant products with a high potential for horticultural or industrial development as new crops or products.

2.3.5 Analytical tools for the evaluation of local ecological knowledge

(adapted from Alexiades, 1996; Hamilton et al, 2003 and Martin, 1995)

Through the use of analytical tools, participants show their cultural preferences and empirical ecological knowledge by ranking objects or sorting them basing on criteria such as similarity or relative quality:

2.3.5.1 Free-listing

Informants are asked to list items in a given period of time. They could be asked, for example, to name as many medicinal plants as they can in five minutes.

2.3.5.2 Ranking

Ranking helps to highlight local preferences for different concerns. People are encouraged to divide sets of items or activities into categories and rank them according to different criteria. For example, informants who provide a list of plant used as construction materials could be asked which one is the best or used more often and why.

2.3.5.3 Other tools for the evaluation of local ecological knowledge

Other important tools for the evaluation of local ecological knowledge are: **triad tests** (the researcher gives the informants three plant specimens, plant pictures or other items and they have to choose one that "*does not fit*" or choose the two "*that seem to fit the best*"), **pile sorting** (participants divide objects into a number of groups according to the overall similarity of items) or the **24 hour recall** (participants have to list, for instance, the name of the plant products they have consumed during the last 24 hours).

2.3.6 Quantitative methods for analyzing ethnobotanical knowledge

(Adapted from Phillips, 1993)

Quantitative ethnobotanical techniques are complementary to the more traditional qualitative techniques of inquiry (see 2.3.2.1). Quantitative techniques cannot replace the need for qualitative description of indigenous knowledge, but allow the analysis of patterns of plant use knowledge. But there are important advantages in their use. Numerical data can be analyzed statistically and allow the researcher to check the credibleness of the data collected, increasing the methodological scientific rigor of the research.

2.3.6.1 Informant consensus

This method is used to establish the relative importance of each use, directly from the degree of consensus in informants responses. It requires highly structured questionnaires. The relative importance of each species is evaluated by the proportion of respondents who cited it.

2.3.6.2 Subjective allocation

In the subjective allocation the researcher assigns subjectively the relative importance of each plant use. The method has been mainly used to evaluate the cultural significance and usefulness of plant species and families or to asset the importance of subjectively assigned use categories.

2.3.6.3 Uses totalled

When using this method no attempt is made to quantify the relative importance of each plant use. The number of plant uses are simply totalled, by category of plant use, plant taxon or vegetation type. This method does not differentiate the relative importance of uses or species.

2.3.7 Ecological methods for ethnobotanists

(adapted from Hall & Bawa, 1993; Martin, 1995 and Peters, 1996)

The ecological methods allow ethnobotanists to analyse the ecological context within people interact with plants. These methods go beyond the traditional ethnobotanical plant collection, plant identification and use documentation and take into account the fact that things happen when people use plants.

2.3.7.1 Quantitative assessment of species density

This method measures the number of individuals per unit area, informing the researcher about how much of a given plant resource is available for exploitation and where the greatest abundance of this resource is located. It offers the possibility of estimating the long term sustainability of plant resource exploitation too. The study requires systematic or random plots or transects, which will vary in size in dependence of the selected plant species.

2.3.7.2 Growth yield studies

The basic objective of a yield study is to provide an estimate of the quantity of resource (fruits, seeds, latexes, resins, gums, stems, leaves, roots, barks, etc) produced by a given species growing in a particular area. As it is very difficult to monitor all the individuals of a selected species, a sub sample of plants must be selected. The selection should be stratified by two main variables: diameter and condition. Using the results from a plot survey as a guide, the

fieldworker should randomly select individuals from different size classes and habitats. Ideally, the number of sample trees selected from each size class should be the same in each site condition or forest type.

2.4. Processing and analysis of ethnobotanical data

(adapted from Martin, 1995)

2.4.3 Processing

Ethnobotanical data should be organize in a way that facilitates statistical analysis. A matrix with different fields should be defined. Potential fields are: Collection number, local plant name, scientific plant name, habit, plant parts used, uses, preparation, habitat, locality, name of the informant, commentaries, etc. The data collected on each separate item (a plant species, for instance) constitute a record. The values are the specific data that correspond to each field and record.

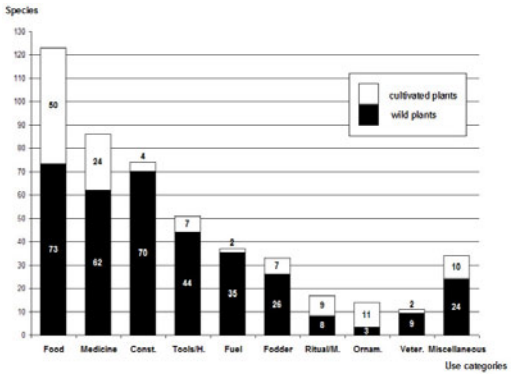
2.4.2 Analysis

By analysing the matrix several quantitative interpretations can be done, for instance *the total of used wild and cultivated plants subject to different ethnic groups*, *the number of used wild and cultivated plants according to the different use categories*, etc. In addition, descriptive and inferential statistics represent a very important tool to understand the use or classification of plant resources across a set of plant specimens collected or categories elicited.

2.4.3 Presentation

The results can be presented as tables and graphs. Tables present data in rows and columns, permitting the contrast of values or related categories. Graphs typically relate two dimensions, such as quantity or membership in a category. Bar graphs compare the quantity of a single dimension of various related categories or objects. The height or length of each bar indicates the quantity on a numerical scale which is shown in the bottom of the graph. Pie charts are divided into slices, indicating the

relative proportion or percentage of one category as compared with the others.



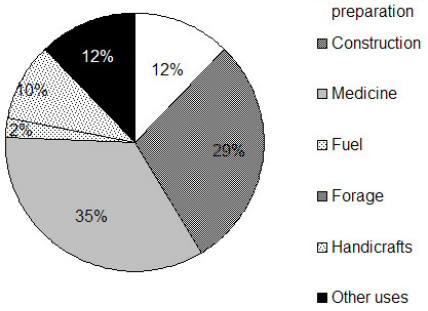


Figure 2: Bar graph (left) and pie chart (right) showing the results of an ethno-botanical study

3. Case-study: Ethnoecological research in southern Ecuador

(Adapted from Gerique & Pohle, submitted and Pohle & Gerique, submitted)

3.1 The study

The tropical mountain rainforests of southern Ecuador are one of the most biodiverse ecosystems worldwide. Unfortunately, increased human activity is resulting in the disappearance of the existing mountain rainforests. It is of utmost importance to understand the plant-use patterns of the inhabitants of this region in order to develop conservation strategies. The aim of the study is to document and analyse current plant knowledge and plant use by the ethnic groups who live along the altitudinal gradient: the Shuar in the humid premontane forest of the upper Nangaritza valley and the Saraguros and Mestizo settlers in the lower tropical mountain rainforests in the north of the Podocarpus National Park.

The ethnospecific botanical knowledge is being documented and inventories of traditionally used plants (wild and cultivated), including their botanical and local names, are being compiled. At the same time, the ethnospecific land-use techniques are being analysed.

Different ethnoecological techniques have been used in order to gather information. The "ethnobotanical-inventory-technique" has been the main procedure used to collect ethnobotanical information. "Artefact-interviews" and "participant observation techniques" have been used if the chance is given. "Plant interviews" using colour photographs and "checklist interviews" have been conducted in order to complete field information. "Group interviews" have sometimes developed spontaneously with

community members. All interviews have been conducted in Spanish. Pictures of plant species have been taken and specimens have been collected if possible. The pictures were of great aid due to the reluctance of some Shuar communities at the beginning of the study to share information and to allow the researchers to take plant specimens. The collected plant specimens are being processed by local botanists and deposited in Loja at the Herbarium Reinaldo Espinosa of the Universidad Nacional.

3.2 Provisional results

The Shuar are typical rainforest dwellers and therefore their culture and traditions are strongly linked to this environment. They have shown an impressive knowledge of plants, using almost 300 plant species, from which around 210 are wild. All households make extensive use of forest products. Most of the plants are used to supplement the diet or as medicinal plants. Many plants, too, are used as construction material. The Shuar use forest products exclusively for their own needs, there is virtually no commercialisation.

The Saraguros from El Tibio have a far less comprehensive knowledge on wild plant species and their utilization. As agro-pasturalists they have transformed most of the primary forest into pastures, homegardens and fields, leaving some forest remains along mountain ridges or in river ravines. Their plant knowledge reflects this way of life. They have a comprehensive knowledge of pasture, ruderal and cultivated plant species but they are less familiar with forest plant species. The latter knowledge is mainly reduced to woody varieties which they extract and sell before clearing the forest. The actual ethnobotanical inventory includes about 70 wild plant species, most of them used as medicine or for their wood and 90 cultivated plant species. The majority of the cultivated plants are species that supply nutritional value, followed by medicinal and ornamental plants.

The mestizo settlers base their economy on cattle ranching aswell and have transformed large areas of forests into pastures too. The actual ethnobotanical inventory includes about 60 wild plant species. Timber is the main forest product, while some ruderal plants and the fruit of a few tolerated tree species are used as food or as medicine. Furthermore some of them cultivate more than 100 species for food, medicinal and ornamental purposes. But the cultivation of plants in homegardens by the mestizo settlers is much more heterogeneous as in the case of

the Shuar and the Saraguro. It strongly depends on the household. Some households have no homegardens, while others cultivate colorful gardens and produce a large assortment of fruit, corn and vegetables.

The ethnobotanical survey carried have shown that the degree of plant use and plant knowledge does not depend on plant species diversity in the specific habitats. Instead other factors, such as ethnospecific traditions, or a high demand for forest products or pasture land to fulfil the basic needs of life support, are more decisive factors.

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