# Ecological Indigenous (EIK) and Scientific (ESK) Knowledge Integration as a Tool for Sustainable Development in Indigenous Communities. Experience in Misiones, Argentina

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# Chapter 10
# Ecological Indigenous (EIK) and Scientific (ESK) Knowledge Integration as a Tool for Sustainable Development in Indigenous Communities. Experience in Misiones, Argentina

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## 1 Introduction

Approximately 60 million indigenous people worldwide depend today on forests (CBD Secretariat 2009), and 350 million people living in a forest or nearby have customary rights over these forest areas. Indigenous peoples, communities, local governments, as well as mining, logging and industrial companies, are claiming rights over the same forests, thus creating conflicts of different magnitudes. Many countries lack the mechanisms or tools needed to address these conflicts, to implement reforms in land tenure systems or to allow participation of indigenous peoples and local communities in forest management. These mechanisms are necessary to achieve sustainable forest management.

The inclusion of traditional knowledge in the Convention on Biological Diversity (CBD), more than 20 years ago, has opened the possibility of integration of ecological indigenous knowledge (EIK) and ecological scientific knowledge (ESK) in biodiversity management. The CBD recognizes, particularly in Article 8j, the need to respect the "indigenous and local communities embodying traditional lifestyles rel-

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evant for conservation" as well as the need to "promote equitable sharing of benefits arising from the use of such knowledge innovations and practices."

Ecological indigenous knowledge (EIK) can make a significant contribution to sustainable development. Most indigenous communities inhabit areas where the vast majority of plant genetic resources in the world are located. Many of them have cultivated and used biological diversity in a sustainable way for thousands of years. Their skills and techniques provide valuable information to the global community and a useful model for biodiversity policies (www.biodiv.org/2009). Increasingly, Article 8 (j) and other articles of the Convention on Biological Diversity (CBD) stress the fundamental role of traditional knowledge in the conservation of biological diversity and the need for its implementation at local and international levels. However, Professor Teodora Zamudio, of the Department of Law of Indigenous Peoples of the University of Buenos Aires (UBA), in a recent interview for the magazine Pachamama (www.cbd.int/idb/2009) stated that "researchers have not been trained in the philosophy of the Convention, they are completely unaware of it...or if they have heard rumors on the subject, consider Article 8 (j) as a threat to the development of their task, as a burden...that no one has showed them how to comply. In addition indigenous communities are not prepared -in the majority of cases- to address this relationship with the scientific community". The gap between indigenous and scientific knowledge does not seem to provide possibilities of some kind of unification. The defined parameters of scientific knowledge do not allow the inclusion of any other science that does not conform to its guidelines. The respect for the existence of two different worldviews (EIK and ESK) should promote the search for favorable conditions toward the establishment of a fruitful relationship between these two types of knowledge.

Based on these assumptions, the aim of our study was to conduct an analysis of national and international experiences in implementing projects on natural resource management that include the integration of EIK and ESK. In addition, we conducted a case study in Misiones, Argentina, to analyze the local integration of EIK and ESK.

The present chapter first introduces the concepts of EIK and ESK and the role of ethnosciences in their integration. A section on conservation and environmental services in intercultural settings (IS) follows, then successful cases where indigenous non-timber agroforestry products have been integrated to the local economy are described. Finally, the chapter discusses the national and local legislation regarding natural resource restoration, and presents a local case study on EIK-ESK integration.

## 2 Ecological Indigenous and Scientific Knowledge: Differences and Need for Integration

The indigenous knowledge (IK), also known as traditional knowledge (TK), and as local knowledge (LK), or ecological indigenous knowledge (EIK) is defined as the knowledge that a local indigenous community has accumulated through generations

living in a particular environment (www.unep.org/IK). The EIK also connotes knowledge systems held by traditional communities and based on their experience and adaptation to a local culture and environment (Makinde and Shorunke 2013).

Dei (2000) identifies three aspects of IK: (1) traditional knowledge which is the intergenerational knowledge transmitted from generation to generation; (2) empirical knowledge based on observations of the environment (nature, culture and society); and (3) revealed knowledge that comes through dreams, visions and intuition. EIK is comprehensive and includes both the physical and spiritual aspects of life.

Tella (2007) states that EIK is important for a number of reasons: (1) it provides problem solving strategies for communities; (2) it contributes significantly to global knowledge on development; (3) it is relevant to the development process; and (4) it is an underutilized resource in the development process. However, Ocholla (2007) states that indigenous knowledge continues to be marginalized in development plans, and this has led to its limited use in the development process. One of the reasons why the EIK has been marginalized is because of its tacit nature. EIK resides in memory of the people and is spread primarily by word of mouth. This means that it is, in many ways, endangered when cultural custodians (which are often elderly) die and those who remain do not have full understanding of the history of that EIK.

Dei (2000) notes that the problem arises from the separation of traditional and modern knowledge as if they had no bearing or impact on each other. Many writers tend to invoke the differences between indigenous knowledge and Western knowledge systems in order to explain what IK is. IK is portrayed as holistic, communicated orally, stemming from experience in nature, and closely linked to spiritual and social values. On the other hand, the Western knowledge system is portrayed as narrowly written, theoretical and value-free; while the IK is affected by and affects other forms of knowledge, which seems to point out the need to combine or synthesize the two knowledge systems.

Several authors argue that many of the natural habitats that we know are actually "cultural landscapes" modified by human action (Reyes-García 2009). Manipulations of the environment by indigenous groups range from total or partial domestication of plants and animals to the application of techniques for soil conservation, water collection, handling fire or gathering wild fruits, resulting in natural ecosystems that are the product of human management. For this reason, the abandonment of environmental management practices based on EIK affects the conservation of several ecosystems.

Regional strategies have been implemented to mobilize the CBD negotiations on issues such as sovereignty of biodiversity, access to natural resources and traditional knowledge, intellectual property rights on innovations based on natural resources, the right of traditional communities and indigenous peoples to develop, and the right of researchers to freely perform their research on biological material for the benefit of humanity. These have been identified as important issues, and have become the object of public policy. In this context, all the different branches of academic science with an interest in natural resources (botany, pharmacology, anthropology, biology, forestry and chemistry), should consider indigenous

knowledge and skills and how to interact with ancestral knowledge on managing biodiversity (Kleiche-Dray 2012).

Globally, the relevance of the 'indigenous' and 'local' forms of knowledge for sustainable development has been amply demonstrated, especially in regard to the management of natural resources (biodiversity, water, soil) and to the prediction of responses to ecosystem disturbances (Rist and Dahdouh-Guebas 2006). The fundamental role played by the Ethnosciences, Ethnoecology and Ethnobiology in the integration of knowledge for sustainable management of natural resources should be stressed.

## 3 EIK and ESK, the Role of Ethnosciences

The ethnoscientific approach developed by the Anthropology of Knowledge or cognitive anthropology can contribute valuable criteria for addressing the relationship between EIK and ESK. Some of its disciplines, such as Ethnobiology and Ethnoecology have been and remain nowadays particularly relevant for addressing EIK. Therefore, it is worthwhile to present the epistemological framework in which they were originated and where they currently operate.

Ethnoscience can be defined as the study of the content and organization of knowledge about nature by traditional societies (Beaucage 2000). In its ontogenetic evolution, it has been the subject of numerous controversies between relativistic and universalistic positions. The first one is sympathetic to the notion that ethnic knowledge about the environment can only be explained in terms of the society where it is developed (Conklin 1955; Murdock and Withe 1969; Hunn 1977); while universalist positions suggest that knowledge concerning living things (plants and animals) is structured similarly in all societies and cultures (Berlin 1972, 1973, 1992). Nevertheless, long before the development of ethnotaxonomy by Berlin, the Universalist position was already adopted as a rule by some early ethnobiologists who worked with indigenous groups in the Southern Cone of South America, including Bertoni (1940) who suggested that "the Guarani race uses a scientific binomial nomenclature, and assigns names to plants and animals in egalitarian and democratic assemblies."

In a way, the Relativistic and Universalistic positions are closely related to the preferential use of the EIK and ESK. In this sense, it has been suggested that each element of a culture can be studied from two points of view, the **emic** and **etic**, related to EIK and ESK, respectively. The most immediate, the **emic**, held by the members of the culture, reflects the linguistic and cultural context (subjective). The second view, **etic**, is the exterior and reflective view, adopting science (Pike 1956). Relativists emphasized these peculiarities of traditional (emic perspective) systems, while Universalists, based on comparative studies, insisted more on the commonalities (etic perspective) (Beaucage 2000).

### *3.1 EIK and ESK in Ethnobiology*

In 1896, Harshberger proposed the word Ethnobotany to describe the study of plants and their uses by different populations of the world. The importance of Ethnobotany and Ethnozoology led scholars of biocultural issues to coin the word "ethnobiology" to include these two fields (Castetter 1944; Clement 1998). Murdock and Withe (1969) used the word Ethnobotany in the context of ethnosciences or cognitive anthropology. Currently ethnobiology is defined as the study of knowledge and concepts on biology, or rather "about life and living things" developed by any culture (Posey 1987). To date, ethnobotany is one of the most important fields of ethnoscience, followed in importance by ethnozoology (Beaucage 2000).

As the most prolific discipline within the ethnociences, ethnobotany has also been subject to a diversity of perspectives and definitions. It has been defined as "the study of direct inter-relationships between humans and plants in dynamic systems" (Alcorn 1995). Currently, the discipline includes the study of the interrelationships of human societies with nature (Alcorn 1995; Alexiades and Sheldon 1996). The latter definition, somewhat ambitious, is inadequate since it detracts prominence and importance from EIK. From our perspective ethnobotany should be defined as a subordinate to ethnobiology which studies the knowledge on organisms and plant life developed by traditional human societies.

Ethnobiology and related disciplines have been branded as romantic and reductionist, figurative attributes that constitute the two strongest criticisms of these approaches. The label of "romantic idealism" has been given by deterministic orientations to circumvent the ethnoscientific approach of the cognitive anthropology (Harris 1979; Durand 2000). Social scientists who mechanically adopt a perspective aligned to these criticisms are at risk of default on the analysis of the socio-political and environmental complexity of the EIK and thus, often unwittingly, contribute to the consolidation of a unilateral approach (Keller 2013).

The most Universalist approaches of ethnobiology driven by Berlin (1973) have been criticized for trying to assess indigenous knowledge with Western science parameters (Descola 2001; Hviding 2001). This criticism suffers from being generalist in its views on a polymorphous discipline, but has increased in popularity dramatically in recent years. According to Reynoso (1986), since its foundation in 1956, cognitive anthropology has continued to enrich and diversify.

Another aspect that has been the subject of uncertainty and suspicion is the scope or the pragmatic value of EIK that has been documented by ethnoscientists. As expressed by Reynoso (2014) in his critique of Perspectivist Anthropology, "far from being exhausted in the classification of plants or ingredients, the ethnosciences are closely oriented practices and knowledge of great strategic importance, not only to anthropologists but to UNESCO, the World Bank and to multinational health food technology companies that have had their eye in it and have already begun to take advantage of it." The documentation of EIK by the ethnosciences has confused ethnobiology with bioprospecting. The bioprospective resemblance awarded to ethnobotany has also been extended to a historical level, linking this

discipline to the practice of inventorying resources from the colonies to provide the colonialists with alternative benefits (Ruiz 1805). This research has been documented in such works as the "Days Náuticas" by Fray Jacinto de Carvajal (1648), and works by Ortega (1996), the "Ethnobotanical News" by Augusto Guinnard (Martínez Crovetto 1963), containing an analysis on useful plants made in the nineteenth century (Guinnard 1864).

Ethnobiologists have responded in a precautionary manner, suggesting the omission of publications on taxonomic identity of medicinal species (Prance 1991). However, to defend the intellectual property rights of communities, it is better that EIK is documented and attributed correctly in scientific publications, which may become publicly available documents before any leases by pharmaceutical companies. As expressed by Hersch-Martínez (2002), the protection of traditional knowledge, the struggle for self-determination and other rights that local communities and indigenous peoples claim for themselves should not be ignored.

## *3.2 EIK and ESK in Ethnoecology*

Following Toledo (1990), Ethnoecology is defined as the discipline which studies the conceptions, representations and knowledge on nature that allow indigenous societies to produce and reproduce the material and spiritual conditions of their social existence through proper management of natural resources and ecosystems. Toledo and Barrera-Bassols (2008) propose a conceptual framework for the study of traditional knowledge, based on the Cosmos-Corpus-Praxis complex where Cosmos represents the belief system or world view, the Corpus is the full repertoire of skills or cognitive systems, and the Praxis symbolizes the set of productive practices including different uses and management of natural resources.

Ethnoecology is currently defined as the study of local ecological knowledge understood as a complex form of adaptation and habitat modification, the result of the process of co-evolution between culture and nature. It is a discipline which contributes value to local ecological knowledge systems, underlining their potential to improve the well-being of today's society (Reyes-García and Martí Sanz 2007). Indigenous ecological knowledge, as a key component for the management of natural resources, also has the potential to contribute to human welfare and rural economic development (Reyes-García and Martí Sanz 2007).

Based on his personal experiences in accompanying participatory research and development processes, Ardón Mejía (2001) proposes a multidisciplinary approach from an ethnoecological perspective. He points out that participatory methods applied to ethnoecological research start with the recognition of the integrity of the individual and human groups, from a perspective that does not set rigid boundaries between material, social and spiritual aspects that, through a historical process, have shaped the environmental, social and economic reality in the daily life of individuals and human groups to the present day.

## 4 EIK and ESK in Education

In a time characterized by uncertainty and complexity it is important not to forget that the sophisticated knowledge of the natural world is not limited to what is recognized as a science or ecological scientific knowledge (ESK). Human societies have also developed ecological knowledge and explanations from rich experiences in their surrounding environments. The terminology adopted here to refer to these knowledge systems of indigenous groups is ecological indigenous knowledge (EIK).

The EIK is relevant because it has stimulated scientific thought over time, contributing to science in general, and to the conservation of biodiversity and management of natural resources in particular. Moreover, it has promoted innovation based on such knowledge. As examples, one can point to the commercialization of agricultural technologies such as permaculture, water and soil conservation, or marketing of many products such as handicrafts, pesticides, beauty products, seeds and medicines based on EIK.

EIK should be considered as valuable knowledge in educational programs. One wonders then, how EIK is integrated into educational programs that focus on ESK that has long been established and valued as formal educational knowledge.

As pointed out in previous sections, EIK is the result of a cumulative and dynamic process of practical experiences. Unlike ESK, EIK is local, holistic and carries a worldview that integrates physical and spiritual aspects (Toledo 1990). Therefore, some sectors related to scientific communities consider learning this knowledge as unimportant because they argue that it is anecdotal and imprecise. This attitude is a key obstacle to incorporating EIK into formal education.

Added to the epistemological differences in perspectives, the loss of indigenous languages and values that accompanies acculturation is a major cause of EIK loss. As generally EIK is not taught in schools, the time and resources invested in formal education are not invested in the acquisition of EIK (Sternberg et al. 2001).

EIK loss is the result of a long process of erosion of social, political and institutional structures sustained by local systems of natural resource management. The factors behind this erosion range from specific factors such as changes in land use, loss of local dialects, acculturation and schooling, to more widespread changes such as industrialization, rural migrations, market integration and cultural homogenization processes linked to globalization (Turner and Turner 2008). Educational institutions often do not promote EIK recovery and its integration with ESK, but rather limit any expression of diversity, heterogeneity and variety, particularly multiculturalism.

Multiculturalism involves cultural identity. Various authors hypothesize that the loss of cultural identity should be a major cause of loss of EIK (Marín 2002; Diez 2004). A pedagogical approach based on an intercultural education perspective, mainly with indigenous communities, can be an alternative to recover EIK and integrate it into formal education. In this sense, Marín (2002) believes that intercultural

education is one of the key considerations in the development of programs that can give value to indigenous languages and cultures, combining them with elements of Western culture.

Regarding the application of the intercultural approach in Peru, Argentina and the rest of Latin America the fragmentation of intercultural education programs has unfortunately weakened its original founding principles. Intercultural bilingual education has failed to be broadly implemented because it remains isolated from the mainstream educational system (it is considered education for Indigenous peoples), and is not articulated with proposals and actions in other sectors. It has also failed to facilitate the participation of underrepresented sectors in planning or decision-making. In many cases, it is implemented as a focused and vertical proposal, which does not usually encourage alternative ways to manage diversity and difference (Diez 2004).

Moreover, the pedagogical work with this approach is complex because it requires training of teaching staff that is not only limited to the technical-pedagogical aspect, but also demands an awareness and sensibilization work of the process of teaching and learning, a culture of interdisciplinary work, and the recognition of the cultural rights of indigenous peoples.

Another element to consider in this analysis is that EIK is passed down from generation to generation and the elderly play an essential role in the adaptive learning process. The incorporation of new generations of indigenous groups and rural communities into the globalized market economy changes the implementation of activities linked to the production stage, alienating them from nature. This interferes with the dynamics of the transmission of EIK and the possibility of programming the integration of EIK and ESK in formal education.

To summarize, it is clear that indigenous peoples have extensive knowledge of how to live sustainably. However, formal educational systems have disrupted the practical aspects of everyday life of indigenous knowledge and ways of learning, replacing them by abstract knowledge and academic ways of learning. Today, there is a serious risk of indigenous knowledge being lost and, along with it, valuable knowledge about sustainable livelihoods.

## 5 Conservation and Environmental Services in Intercultural Settings (IS)

Biodiversity sustains the functioning of the ecosystems, which provide a broad set of services to human societies. Therefore its constant loss brings serious consequences for the present and future well-being of human populations. The provision of food, fiber, medicines and fresh water, crop pollination, filtering of contaminants and protection from natural disasters are some of the ecosystem services that can be threatened by the decrease and changes of biodiversity. Cultural services such as spiritual and religious values, opportunities for education and learning, as well as aesthetic and recreational values are also threatened by losses of biodiversity (CBD

2010). In this section we discuss the importance of maintaining ecosystem biodiversity for the provision of environmental services to human populations and present strategies for conservation.

## *5.1 Importance of Biodiversity for Human Populations*

Biodiversity is the variation that exists not only among species of plants, animals, microorganisms and other life forms of the planet, but also within a single species (genetic diversity), and at the ecosystem level, where all species interact with each other and the physical environment. This diversity is of vital importance for people because it sustains a great variety of ecosystem services on which human societies have always depended on, although its importance is frequently underestimated or completely unknown. When some element of biodiversity is lost, ecosystems lose their ability to recover and the services they provide are threatened. Ecosystem services can be classified into four categories:

**Provision services,** providing goods that benefit people directly and generally have a direct monetary value, such as fuelwood, medicinal plants, fish;

**Regulation services**, including the whole spectrum of vital functions sustained by the ecosystems which are generally not assigned monetary value in conventional markets: climate moderation, carbon storage, elimination of contaminants, protection from natural disasters such as landslides and coastal storms;

**Cultural services**, which do not offer direct benefits but contribute to satisfy certain society needs and thus influence the desire to cover the costs of their conservation, for example, the spiritual value of certain ecosystems such as sacred forests, or the aesthetic beauty of landscapes and coastal areas that attract tourists;

**Support services**, which do not benefit people directly but are essential for the functioning of ecosystems and are thus indirectly responsible for the other services, such as soil formation and the processes that support plant growth.

It is important to note that generally the regions of greater concentration of diversity are home to indigenous populations. Some biological endemisms can be linked to specific linguistic expressions, which can be considered "linguistic endemisms". Likewise, "endemic traditional knowledge" is a highly valuable resource among indigenous populations that needs to be preserved (Boege 2004; Nabhan 2003). Species extinction and destruction of native habitat are associated with the disappearance of indigenous languages and with the erosion of cultural biodiversity (Maffi 2001). Indigenous peoples can be considered "ecosystem people"; their territories are regions of origin of biodiversity as well as "cultural" phytogenetic reserves, which are unique in the world, such as corn in the Mesoamerican cultures of Mexico (Boege 2004), among many other examples.

The concept of Biocultural Diversity expresses the complexity of the scientific endeavor, since it goes beyond the reductionist view that tends to set apart the natural and social sciences knowledge. Bioculture involves a new philosophical vision

of life and Earth. This complex concept has to consider the profound processes of cultural hybridization that indigenous peoples are subject to in their modern dynamics. These are the central aspects that must be considered if we want to advance towards an ethical legitimacy (Agraz and Matsumoto 2010).

The field of "sociology of conservation", with contributions from both rural and environmental sociology, tries to understand how natural resources and the environment create the conditions for social organization, and how social welfare is linked to patterns of use of the natural resources, while at the same time considering people's values and attitudes about environmental problems. It focuses on conservation work associated with communities that practice sustainable use and livelihoods (Torrealba and Carbonell 2008). Sociology of conservation studies may start with a specific focus on locations or resources to arrive at a "macro" understanding of the processes of political and economic organization and examine them within a global perspective.

## *5.2 Ecosystem and Biodiversity Degradation*

When a natural habitat is destroyed it is unable to keep most of the native species. Plants and animals linked to it will be destroyed or forced to emigrate, and as a result biodiversity is reduced. Habitat destruction by humans through agriculture expansion, mining, forest logging and urban sprawl are currently the most important causes of species extinction. Other causes of habitat destruction or degradation include habitat fragmentation, geological events, effects of climatic change and the presence of invasive species (Pimm and Raven 2000). Conversion of forests to agriculture is the main cause of deforestation in the tropics (Sanderson et al. 2002; Geist and Lambin 2002).

Degradation, fragmentation and pollution are aspects of habitat destruction resulting in the collapse of ecosystems. Desertification and deforestation are specific types of habitat destruction. Actions to minimize the destruction of ecosystems should consider those irreplaceable services provided by natural habitats, and they should be aimed at protecting remaining intact areas, educating communities about the importance of biodiversity and natural habitat, developing ways to increase agricultural production without increasing the cultivated area and preserving corridors to reduce damage of fragmented habitat (Geist and Lambin 2002).

The majority of future scenarios predict that during the present century the levels of extinction and habitat loss will increasse, with consequent decreases in the provision of environmental services that are important for human well-being (Vitousek et al. 1997; CBD 2010). If ecosystem degradation reaches certain thresholds or points of no return, there is great risk of drastic losses of biodiversity, with the consequent deterioration of a wide range of ecosystem services. These changes will likely affect the most vulnerable communities first and with higher intensity, but in the long run all societies and communities will suffer the consequences.

## *5.3 Strategies to Conserve Biodiversity*

Most forests, especially primary forests, when in their natural state, are relatively resilient and resistant to diverse types of changes. Therefore it is important to try to keep the specific and genetic composition of the biodiversity of these ecosystems in order to preserve the natural mechanisms that provide their capacity for recovery or resilience (Thompson 2012).

Future human activities need to focus on the conservation of endangered species that are of commercial and cultural importance and functional ecological groups that play specific and fundamental ecosystem roles such as pollination, control of numbers of herbivores by predators of higher trophic levels, nutrient cycling and soil formation and protection. It will be increasingly necessary to restore terrestrial, marine and continental shelf ecosystems to reestablish ecosystem function and the provision of valuable services.

Considering the large number of endangered species, funding aimed at safeguarding biodiversity is insufficient and therefore it is essential to define conservation priorities of "biodiversity hotspots" (Myers et al. 2000). Globally, 34 sites have been identified for these categories, which are characterized by the greatest biodiversity, and have large concentrations of endemic species, many of them currently endangered. These hotspots are experiencing large losses of habitat, in some cases up to 70% of their habitat (Cincotta and Engelman 2000).

Most of the biodiversity hotspots are located in tropical and subtropical regions. Latin America contains several biodiversity hotspots (Giraudo and Povedano 2004), including the Atlantic Forest comprising Brazil, Paraguay and Argentina, which has been reduced to 8% of its original forest cover. In the Province of Misiones, Argentina, the Interior Atlantic Forest (Atlantic Forest of Alto Parana) retains 40% of its original forest cover. Approximately 800,000 ha are forests of varied density and structure and 600,000 ha are rural degraded secondary forests in agricultural land areas (Ministerio de Ecología 2010).

The true benefits of biodiversity and the costs of losing it should be reflected in the economic and market systems of the human populations that they sustain. Perverse subsidies and lack of economic valuation of the enormous benefits that ecosystems provide have contributed in great part to biodiversity loss. However, through regulations and other measures, markets can and must create incentives that protect and strengthen natural infrastructure instead of overusing it. The restructuring of economies and financial systems after the global recession is a good opportunity to conserve the biodiversity of species and ecosystems that are vulnerable, have cultural value, or protect key ecosystem services (CBD 2010).

Ecosystem restoration can bring financial benefits to the involved communities (Montagnini and Finney 2011). However, the levels of restored biodiversity and services rarely reach pre-disturbance levels. This confirms the assertion that if possible, it is convenient and even more economically sound to avoid degradation and to conserve rather than restore the damaged ecosystem.

Mechanisms of PES (Payments for Environmental Services) can be used to favor the sustainable management, use and marketing of NTFP (non-timber forest products). This can favor the diversification of income sources, so that farmers do not depend solely on conventional crops. In addition, promoting a variety of products can also serve to prevent the environmental degradation associated with monoculture systems (Logan-Hines et al. 2015, Jarrett et al. 2017, Chap. 12, this volume). The support through subsidies, PES programs, certification of NTFP, as well as the creation of a value chain for these products can support the maintenance of local livelihoods and the conservation of natural resources (Montagnini and Jordan 2005; Montagnini and Finney 2011; Logan-Hines et al. 2015; Montagnini and Metzel 2017, Chap. 2, this volume).

## 6 Integration of EIK and ESK in Marketing of Indigenous Non-Timber Forest Products from Agroforestry Systems

In this section we show examples of how through collaboration between scientists, international organizations and communities mechanisms are devised to add value to non-timber forest products and facilitate their entry and access into larger markets, benefitting the indigenous communities through an integration of EIK and ESK. Technical and scientific knowledge can be instrumental in ascertaining the medicinal, nutritional, or other use value of specific products. Likewise, personnel from research institutions, private companies, foundations or non-government organizations can inform local communities about the different steps in the value chain to reach key markets for their products. This can involve mechanisms to add value to the products before they reach markets so that the producers obtain better financial returns. Collaborators from other sectors can also inform communities about new or best practices for processing, packaging, branding and advertising their products.

Indigenous agroforestry systems can be brought into alignment with integrative landscape management strategies. Increasingly these strategies seek to incorporate supply chains based on the sustainable management of forests and agroforestry systems that generate income from a variety of native species (Jarrett et al. 2017, Chap. 12, this volume). There are several examples where indigenous communities have been able to reach local and/or international markets for their agroforestry products.

In this section we describe successful cases where indigenous non-timber agroforestry products have been incorporated to the local economy, with the assistance of technical and scientific personnel, thus integrating indigenous and scientific knowledge in a purposeful and useful fashion. This section provides examples of how businesses and communities have worked together to maintain traditional agroforestry practices and organic cultivation techniques while increasing the product quality and market growth of indigenous non-timber forest products.

### *6.1 Guayusa (*Ilex guayusa *Loes.) from Napo, Ecuador*

Napo, Ecuador, is a region in the Upper Amazon that has been characterized in recent decades by immigration, urbanization and the consolidation of indigenous land holdings through communal land tenure. These processes have been both accompanied and facilitated by increased state involvement in natural resource governance, infrastructure development and the expansion of government services to rural communities. Rapid expansion of road networks has increased the ability of smallholders in the region to continue expanding the agricultural frontier, resulting in a "post-frontier" moment where landscape management has become increasingly important in order to avoid extensive resource degradation and loss of ecosystem services. At the same time, urbanization and greater market integration has led local communities to become more reliant on the cash economy, generating a pressing need for market-oriented livelihood opportunities that are compatible with existing agroforestry systems. In Napo, Runa, a social enterprise, has been able to create new value chains for agroforestry products and to work with state agencies and indigenous communities to support biodiversity conservation in buffer zones between settled areas and natural reserves (Jarrett et al. 2017, Chap. 12, this volume).

One of Runa's most successful agroforestry products, the guayusa, *Ilex guayusa* Loes., is native to the Northwestern Amazon. Traditionally, this small tree has been used and cultivated by indigenous communities to prepare a stimulating drink which is consumed very early in the morning. Due to its high levels of caffeine and antioxidants, the guayusa leaves are used as a natural stimulant. Today, the guayusa is present in the kichwa amazonian culture of Northeastern Ecuador and in Northern Peru. The Runa Company currently sells guayusa products in over 7000 stores in the United States, Canada and Ecuador. Through their research program, Runa focuses on the domestication process of the guayusa for its growth in agroforestry based on the traditional "chakra" system. In addition, the creation of a guayusa value chain supports the sustenance of the local livelihoods and the conservation of natural resources (Logan-Hines et al. 2015).

Since 2010, Runa has bought, processed and marketed leaves from approximately 2500 indigenous farmers in the Ecuadorian Amazon. Starting in 2010, Runa Foundation and their partner, the Runatarpuna Exportadora, S.A. enterprise, started to produce *Ilex guayusa* in community nurseries. Between 2010 and 2012, about 150,000 guayusa plants were produced by approximately 750 farmer families in Napo Province. From the start of the marketing process the economic benefits have been an important factor to maintain interest among farmers in participating in Runa initiatives. Before they started working with Runa, the average income of farmers was about USD $50/month. With Runa, some farmers have earned up to USD $300 in one day through selling the leaves of mature trees (Logan-Hines et al. 2015).

It has been estimated that sales of guayusa leaves have increased annual producer incomes by 5–10% (Jarrett et al. 2017, Chap. 12, this volume). Runa calculates that farmers could harvest 0.5–1 kg per guayusa plant in the first year. The model developed by Runa attempts to avoid farmer dependence on guayusa as a

monoculture crop, and instead promote its growth in agroforestry systems planned and managed based on the traditional growing systems for guayusa in the farmers' chakras. These multistrata agroforestry systems include native fruit and timber trees, food crops and guayusa to diversify production and provide subsistence products in addition to commercial crops. Runa's participatory research program has developed a guayusa domestication handbook that includes tree planting, agroforestry design and management, harvest operations and marketing procedures (Logan-Hines et al. 2015).

## *6.2 Organic Yerba Mate from Argentina, Paraguay and Brazil*

Yerba mate (*Ilex paraguariensis* Saint Hilaire, Aquifoliaceae) is native to a relatively large region encompassing eastern Paraguay, northeastern Argentina, and southern Brazil. When the Spanish colonists arrived in the fifteenth century, they observed the Guarani indigenous people consuming yerba mate as an infusion made with dry and ground leaves. The Spanish adopted its use relatively quickly. The Jesuit priests who established their religious missions in Misiones, Argentina observed that the Guarani people who drank mate stayed awake longer and could work harder than those who did not. Domestication of the species started during the eighteenth century, and the first successful plantations were established in the early 1900s in San Ignacio, Misiones (Montagnini et al. 2011).

Trade in yerba mate (YM) is currently a lucrative business in Argentina, Paraguay, and Brazil. YM leaves are locally consumed as a tea with a market expanding to the USA, Europe and Asia, as it contains nearly twice the antioxidant levels of green tea and is energizing, making it an alternative to coffee (Montagnini et al. 2011; Eibl et al. 2015; Eibl et al. 2017, Chap. 11, this volume). Organic YM producers can get up to 20% price surplus and most YM cooperatives have organic YM as one of their products. Typically grown in monocultures, its management can cause erosion and soil exhaustion. However, YM grows naturally in subtropical forest and is shade tolerant, making it appropriate for agroforestry systems (AFS). Many farmers have their own nurseries to produce seedlings to use with YM and to sell for additional income. The extra work involved in using the organic practices while planting and tending to native species is compensated by higher YM prices.

Guayakí, one of the most successful organic YM producers and exporters, buys YM leaves from indigenous producers in Paraguay, as well as from farmers in Brazil and Argentina. The company manufactures a variety of YM products including YM tea bags, loose YM and YM drinks. Their organic YM is certified by O.I.A. (Organización Internacional Agropecuaria, International Agriculture Organization), accredited by the USDA. The participating farmers conduct an annual census of native species in their parcels. Guayakí has a nursery to produce native species to plant with YM, and some farmers have their own nurseries. To compensate for the extra work involved in using organic practices, Guayakí pays its farmers ~2–3 times the "normal" price for their leaves (Montagini et al. 2011).

## 6.3 Wild and Cultivated Cacao from Bolivia

Wild cocoa is a product that cannot be sold directly, but requires some processing at the collector level, either through fermenting and drying the seed or through processing the dried seed into cocoa paste. In their report on marketing chains for non-timber forest products, Rushton et al. (2004) describe the value chain for wild and cultivated cacao in two communities, San Silvestre and Carmen Emero, in the Amazon of Northern Bolivia. At the community level there are two possible products derived from cocoa collection: dried seed and cocoa paste. Three supply chains were identified in the two communities: (1) Dried seed sold to formal chocolate processors who sell chocolate on the national market and export organic chocolate; (2) Dried seed sold to an informal market in La Paz; and (3) Cocoa paste that is consumed locally, sent to nearby relatives or sold to traders in towns.

In the communities studied, 38% of the families interviewed (14 out of 37) reported growing cocoa as well as collecting it from wild sources. The proportion of family income derived from cocoa was 7–14%. Product prices relate to the supply of cocoa, the distance from a main trading center, and the availability of transportation by boat or road. Cocoa is both an important income-generating product and part of the local diet, and therefore families have local and external markets for their product. Just over half of the families interviewed reported that they sold their cocoa products to traders and the rest of the families reported that they sold to local consumers.

In France, a panel of international experts recently evaluated cocoa products and selected the top 50 to be transformed into chocolate; including three from native Bolivian cocoa. One of the grains classified in this select group comes from the Carmen Emero community, which has been strengthening their production processes and improving their cocoa quality (aroma, flavor and texture) since 2002. Through this program, the Helvetas Swiss Intercooperation Institution and the Wildlife Conservation Society have provided technical assistance and support to strengthen the value chain for quality cocoa in the tropical landscapes north of La Paz (Página Siete 2015).

## 6.4 Successful Commercialization of AFS Products

The successful commercialization of an agroforestry product depends critically on the existence of an accessible market; potential demand; the absence of substitutes; access by producers, processors and traders to market information; technical management capacity; organization; high value/unit weight; and trader characteristics (age, experience, education, etc.). Market information is important in terms of breaking into new markets and maintaining market share. Technical capacity and organization are particularly important for products that require processing (Montagnini and Metzel 2017, Chap. 2, this volume).

The three case studies presented in this section – Guayusa in Ecuador; Organic Yerba Mate in Argentina, Paraguay and Brazil; and Cacao in Bolivia – show examples of how through collaboration between scientists, international organizations and communities mechanisms are devised to add value to non-timber forest products and facilitate their entry and access into larger markets. Influential individuals can have a high impact on product value, marketing and transportation costs, and processing decisions. For example, the local traders and processors of cocoa seeds play a key role in adding value to the product and reducing the transaction costs of regional traders.

Successful value chains require capable entrepreneurs to search, create and maintain markets. Technical and scientific knowledge are instrumental in assessing and improving product design, in researching key steps in the value chain and in providing assistance on community organizational aspects. Community collaboration with scientists and microenterprises can contribute to the growth of the non-timber forest products sector, but this growth also brings challenges in maintaining the ecological integrity and sustainability of these cultivation systems as production is scaled up.

## 7 Legislation Related to Ecosystem Restoration in Argentina

Ecological restoration is "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (SER 2004). Some of the current strategies for the restoration of degraded areas are linked to conceptions of indigenous communities about nature and human beings, focused on functionality of interactions between organisms in the processes of natural succession (Reis et al. 2010). In Argentina, current national and state legislation links indigenous communities with conservation and restoration strategies, recognizing their ancestral rights to the land they inhabit. The Constitutional Reform of 1994 established the human rights to the environment which should be "healthy and balanced", for "the satisfaction of the needs of future generations". This statement highlights the incorporation of the sustainable development concept. Similarly, the Constitution also incorporated a mandate to repair environmental damage, including restoration and rehabilitation (Law No. 25,675).

In addition, National Law No. 26,331, "Law on Minimum Standards for Environmental Protection of Native Forests", states the following objectives: (a) To promote conservation through the Management of Native Forests and regulation of the expansion of the agricultural frontier and any other changes in land use; (b) To implement the necessary measures to regulate and control the decrease in area of existing native forests, tending to achieve a lasting area in time; (c) To improve and maintain ecological and cultural processes in native forests that benefit society; (d) To use precautionary and preventive principles, maintaining native forests whose environmental benefits, or environmental damage that their absence would generate,

cannot be demonstrated with the techniques available today; (e) To promote enrichment, conservation, restoration, improvement and sustainable management of native forests.

It is urgent to take actions geared towards conservation of natural resources and restoration of the productive functions of degraded areas. Likewise, it is imperative that indigenous communities and their indigenous knowledge are respected. Based on local experiences and scientific publications on the subject the scientific community should make a historic contribution to natural resources restoration by integrating EIK and ESK in the process.

## 8 Case Study of EIK and ESK Integration in the Multiple Use Guaraní Reserve (MUGR)

### *8.1 The Guarani People in Misiones, Argentina*

The Mbya people who in the nineteenth century literature appeared as Caingua or Kaygua (those belonging to the jungle), belong to the Guarani ethnic group. They inhabit lands which were inaccessible to settlers after the expulsion of the Jesuits from Misiones province in 1767. The Mbya people are characterized by their wide mobility, although currently their territories are more restricted. Their settlements are located in regions of Paraguay, Argentina, and Brazil. For them, the concept of territory goes beyond the physical boundaries of villages and trails, and is associated with a notion of the world. Their territory includes shared sectors, however in their villages they preserve their natural resources and keep the privacy of their community. For them the land is not only a production resource, but it is also the scene of religious life and social relationships that give meaning to their existence. Agriculture is the structural activity of community life; it involves joint projects, reciprocal exchange, rituals and renewal cycles (Http: /pueblosoriginarios.com/sur/chaco/mbya.html) (Accessed 05/30/2015).

The Tupi-Guarani people originated by the Madeira river, a southern tributary of the Amazon River, about 5000 years ago (Migliazza 1982). Apparently, the ancient migrations of the Tupi-Guarani looking for the "land without evil" and its consequent diversification and dispersion of families and linguistic subfamilies, could coincide with a period of reduction and fragmentation of their original habitat, the tropical jungle, caused by a drought (Schmitz 1991).

The earliest records of the Guarani presence in Misiones, Argentina date back some 1200 years B.P. (Poujade 1995), but their arrival, in what is now known as the Upper Parana Atlantic Forest, stretches back more than 2000 years, as farmers practicing shifting cultivation (Schmitz 1991; Noelli 2004). Today the southern Guarani people make up a population of more than 98,000 individuals (Azevedo et al. 2009), one of the largest indigenous populations in the lowlands of South America (Assis and Garlet 2004). In Argentina, the Guarani population is just over 6500 individu-

als, of which about 1000 belong to the Ava Chiripa and the remaining to the Mbya group (Azevedo et al. 2009). Both groups are widely distributed in the province of Misiones.

Among the Guarani, the gathering of natural resources consists of hunting wild animals, agriculture and harvesting of different plant products (Noelli 1993; Felipim 2001). The Guarani indigenous peoples are the custodians of Ecological Indigenous Knowledge -EIK- transmitted by word of mouth.

## *8.2 Methodology: Selection of the Study Population (Scientific and Indigenous Community) and Data Collection and Analysis*

Two types of communities were interviewed: the scientific community (34 respondents) and the local indigenous community (6 respondents). The indigenous community consisted of local people settled in the Yabotí Biosphere Reserve. Two Guaraní Mbya villages located on the Multiple Use Guaraní Reserve (MUGR) in the province of Misiones, which is part of the Yaboti Biosphere Reserve were selected. The chosen villages were the *Ita Piru* (dry stone) community and the *y'akaporã* or caramelito community (Fig. 10.1).

Semi-structured interviews and open interviews were used for the local community, and online interviews were used for the scientific community. The data were recorded using Microsoft Excel spreadsheets (2013), and processed using STATA 12.1 software.

For the scientific community, a mixed survey was designed (via email and in person), while indigenous community interviews were based on semi-structured questions and adjusted as the project progressed. Focused interviews were conducted with members of the communities under study, open surveys were carried out with "Opygua" religious leaders, traditional leaders, the "Cacique", and local experts on specific topics, identifying the different niches of ecological indigenous knowledge.

## *8.3 Results*

### 8.3.1 Indigenous Community

There were 19 members of both communities who participated in the interview process (Ita Piru: 3 men, 3 women and 5 children; Caramelito: 3 men, 1 woman and 4 children). However, only the men of both communities answered verbally the questions.


**Fig. 10.1** A Guarani indigenous community inhabiting the Multiple Use Guarani Reserve
(**a**) Development of community surveys in ita piru (Photo: L. López)
(**b**) Elder using pipe (Photo: J. Araujo)
(**c**) religious temple or Opy (Photo: L. López)
(**d**) Children playing (Photo: J. Araujo)
(**e**) Settlement village y'aka porã (Photo: L. López)

- The Caciques of both communities (two respondents) mentioned that there are difficulties in maintaining traditional knowledge, attributed to the lack of interest by young people in receiving the knowledge from older members of their communities, and the lack of spiritual leaders.
- All the respondents stated that the lack of continuity of human relationships and regular contact with the scientific community undermines confidence in the continuity of long-term projects.
- There are serious difficulties in accepting the close coexistence with communities of Western culture. This is attributed to the harmful effects that Western cultures produce to the environment (social, natural and spiritual), including contamination of biotic and abiotic resources and a supply of consumer goods that decreases the interest of young people in learning traditional knowledge.

### 8.3.2 Scientific Community

- 64% (22 people) of the survey participants reported that they have worked with indigenous communities and/or members of indigenous communities directly or indirectly, while the remaining (12 people) participants reported never having worked with indigenous communities. Most of the surveyed were located in the province of Misiones (19), with the remaining participants in the provinces of Salta and Jujuy, and some have reported work experience in Brazil.
- Among work and/or projects carried out in conjunction with the indigenous community, they mentioned three experiences related to working with orchids: assistance in designing interpretative forest trails, a native orchid exhibit; provision of orchid seedlings that had been multiplied using in-vitro propagation techniques; and workshops on orchid propagation (nursery). In addition, they mentioned environmental education; training and support in the development of community tourism; and work in a rural high school.
- The main difficulties highlighted in work directly and/or indirectly with indigenous communities were related to communication: lack of understanding of the community language, the discontinuity of activities and funding of the projects, lack of institutional networking and the lack of relevant knowledge about the communities involved.
- As for achievements in conjunction with indigenous communities and their members, scientists considered that they had good relationships, cooperation and acceptance. Eleven survey participants out of the 29 surveyed consider ESK very important, 17 consider ESK important, and one partially important. One out of 20 surveyed believe that EIK is essential, one of main importance, 8 very important and 10 important. These results indicate that there is a high stated consideration of the importance of EIK on behalf of the scientific community, but do not indicate the extent to which EIK is currently incorporated into formal learning or scientific activities in conjunction with indigenous communities.

- The vast majority, represented by 82% (28 respondents) believe that it is possible to see ESK integrated with EIK in the implementation of a program for natural resource management. As tools to favor integration for natural resource management, they mentioned participatory workshops, implemented with openness and humility to understand indigenous culture; negotiation; appropriate participatory methodologies; exchanging experiences and continuous dialogue; and grassroots collaboration.

## 9 Conclusions

Strategies for sustainable development in the Management of Natural Resources (MNR) have to resort to a wide range of knowledge, covering "ecological scientific knowledge" (ESK), as well as the "ecological indigenous knowledge" (EIK). Unlike scientific knowledge, indigenous knowledge is comprehensive, functional and adaptive to changes in the social and natural environment, and has been passed over thousands of generations. This is a challenge to the management of natural resources which is currently based on disaggregated and partial expertise. An important challenge for the integration of EIK and ESK in the MNR, therefore, is to find ways to encourage dialogue and cooperation among diverse groups of stakeholders with different forms of knowledge, rather than to impose a single vision through a hegemonic discourse that mutes all other forms of expression.

The analysis of the results of the present case study highlights the challenges, as evidenced by both communities, in the integration of EIK and ESK projects. The analysis of results from the scientific community reveals: (a) an acknowledgment of errors and/or difficulties in the process of approaching indigenous communities, (b) an interest in integrating both knowledges and (c) proposals for mechanisms to consider in implementing EIK and ESK integrated projects in the management of natural resources. It is recommended, for example, that in the process of conducting scientific research there should be a consultation stage and capture of experiences and lessons learned by indigenous knowledge. Scientific knowledge should not serve to validate and supplement cultural errors or deviations that the EIK may have suffered.

Central aspects in the analysis of integration strategies between EIK and ESK emerge from the results of surveys conducted with indigenous communities. On one hand, it appears that EIK must regenerate through the natural context where it has been gestated through millennia. On the other hand, survey participants expressed the need to implement measures to prevent and remediate the erosive processes that undermine the integrity of the cultural scene where EIK could be applied, and to preserve the integrity of the natural environment which produces this type of cultural setting. Preventive measures included ensuring the legal possession of large forest areas by indigenous peoples in order to stop or slow the advance of the agri-

cultural frontier in natural spaces where EIK is recreated. Remedial suggestions included adopting autochthonous **strategies**, such as the use of oxen to till the land.

The dialogue with stakeholders who are bearers of traditional knowledge, at least at the local level, is very complex. Projects integrating EIK-ESK have limited institutional base and disjointed science and technology. On the other hand, the technologies applied are foreign to the indigenous communities and do not include local cognitive perceptions regarding the management of natural resources. To address rapid environmental change, we not only need to use all the sources of information and knowledge available, but also embrace a variety of ways to think, learn, adapt and transform. Integrating EIK and ESK to successfully implement environmental projects is one way to expand the variety of tools and information sources available for conservation.

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