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The Potential of Biodiversity in the Andean Region: Use, Conservation and Regulations

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1. Introduction

Biodiversity has paramount importance for the social, cultural and economic development of humankind, making part of the national heritage of each country and representing enormous environmental, cultural and economic values. As population grows, the demand for freshwater, food and energy resources risks environmental sustainability. Biological resources represent a huge potential, insufficiently exploited, that requires strengthening and applying scientific and technological progress aimed to understand, characterize and use these resources for the benefit of local communities. Technologies and the way in which we should use them are a growing challenge, and problems related to governability, social organization and human rights are of increasing importance in achieving sustainable results (Hodson, 2009). Some ecosystem services that benefit society are air quality, climate (both global and local CO_2 sequestration), water purification, disease control, biological pest control, pollination, recycling nutrients, providing fertile soils and prevention of erosion. There are a multitude of anthropocentric benefits of biodiversity in the areas of agriculture, science and medicine, industrial materials, ecological services, in leisure, and in cultural, aesthetic and intellectual value.

The Latin American and Caribbean region is a biodiversity superpower. It has one of the greatest endowments of natural capital in the world, which is a source of economic growth and has the potential of becoming the world leader in offering the services its ecosystems and biodiversity provide, and in return receive new benefits from this conservation and sustainable management. The region includes six of the world's most biodiverse countries—Brazil, Colombia, Ecuador, Mexico, Venezuela and Peru—as well as the single most biologically diverse area in the world, the Amazon. South America alone has more than 40% of the Earth's biodiversity, and more than one-quarter of its forests (Bovarnick et al., 2010; UNDP, 2010b). The Tropical Andes (Bolivia, Colombia, Ecuador, Perú and Venezuela) is the richest and most diverse region on Earth in terms of biodiversity -one of the major centres of world domestication, according to Vavilov-. It contains about a sixth of all plant life in less than one percent (0.8%) of the world's land area, in an extension of 1,542,644 km², from western Venezuela to northern Chile and Argentina, including large portions of Colombia,

Ecuador, Peru, and Bolivia. Roughly bounded by the Tropic of Capricorn in the south and the end of the Andes range in Colombia and Venezuela in the north, the region follows the tropical portion of the Andes Mountains and several adjoining cordilleras (mountain ranges). The Member Countries of the Andean Community hold the first place in the world in diversity and endemism of vascular plants, birds, amphibians, and total vertebrates (excluding fish); and the sub-region is also the center of origin of important Andean-Amazon phytogenetic resources which supply approximately 35 percent of the world's agricultural food production and industrial production.

The Tropical Andes hotspot extends downward to an elevation of 1,000 meters in the west, down to 500 meters in the east, a cutoff between the forests of the Andean slopes and the Amazonian lowlands. Different types of vegetation correspond to gradients in altitude. Tropical wet and moist forests occur between 500 and 1,500 meters above sea level; cloud forests extend from 800 to 3,500 meters above sea level, including the montane cloud forests that cover more than 500,000 km² in Peru and Bolivia and are among the richest and most diverse forests on Earth. At higher altitudes (3,000-4,800 meters), grassland and scrubland systems reach up to the snow line. These ecosystems include the páramo (moorland), a dense alpine vegetation growing on a thick mat of sponge-like, highly absorbent mosses and grasses in the cold, humid reaches of the northern Andes, and the drier puna, characterized by alpine bunchgrass species surrounded by herbs, grasses, sedges, lichens, mosses and ferns in the cold but dry southern Tropical Andes. In addition to these main ecosystems, there are also patches of dry forests, woodlands, cactus stands, thornscrub, and matorral (brush) found in this hotspot.

The Tropical Andes is home to an estimated 30,000-35,000 species of vascular plants, accounting for about 10 percent of the entire world's species and far exceeding the diversity of any other hotspot. It is also the world leader in plant endemism, with an estimated 50 percent (and perhaps 60 percent or more) of species found nowhere else on Earth. This means that nearly seven percent of the world's vascular plants are endemic to the 0.8 percent of the earth's land area represented by this hotspot. One of the more unique plant species is an Andean bromelilad that require 100 years to mature. This region also includes the largest variety of amphibians in the world, with 664 distinct species, of which near 450 species are listed as threatened on the 2004 IUCN Red List (www.biodiversityhotspots.org). Many rural and indigenous populations depend on biodiversity for their livelihoods, including fishing, non-timber forest products, and agriculture. The region's immense array of natural resources makes for a unique laboratory for products and processes that could incubate medical solutions for current and future generations (Bovarnick et al., 2010; UNDP, 2010a, 2010b).

2. Use and conservation of biodiversity

The use and exploitation of natural resources and specific biological diversity is one of the cornerstones for development for many countries with high biodiversity. This should be associated with the implementation of diversified markets that favor the quality and added values of the products obtained directly, as well as the services arising from their use. Plants and microorganisms are the most representative groups of biodiversity being used as source of industrial developments. The most important sector where plants are used for producing medicaments and drugs is the pharmaceutical industry. Plant species provide a great variety of products like food, medicines and raw materials. Some plant extracts are used in the manufacture of glue, soaps, cosmetics, dyes, lubricants and polishes among

many other products. Plants also provide an important source of renewable energy and a new opportunity to take advance of the biotechnology potential (CBD, 2000).
The most direct and important use of biodiversity is as a source of food. Plant biodiversity is the basis of development and sustainability of agricultural production systems. A reduction in the genetic diversity of crops represents an increase in vulnerability to new pests and diseases. The economic value of the reservoir of genetic traits present in wild varieties and traditionally grown landraces is extremely important in improving crop performance (The Academies of Sciences, 2007). Although a large number of plant species are edible, only a small percentage is used intensively in the production of food with significant nutritional value. After 10,000 years of sedentary agriculture and the discovery of 50,000 varieties of edible plants, today only 15 crop species provide more than 80% of the food of the world. Rice, wheat and maize are the basic food for two thirds of the world population. Likewise only a few of the numerous animal species are used for food (FAO, 2004, 2011a). This situation has increased the vulnerability of agriculture and impoverished the human diet. As a result, many regional and local crops that have traditionally been important for feeding the poorest sectors of society are nowadays underutilized or neglected.

2.1 Andean agricultural biodiversity

The Andean region is one of the most important centers of crop origin in the world, containing a high diversity of domesticated crops and their wild relatives. The main nine Andean root and tuber crops (ARTC) are spread throughout South America from southeastern Venezuela to northwest Argentina, with the greatest diversity concentrated in Peru, Bolivia, and Ecuador.
The discovery of America brought about the biggest exchange of germplasm in history. Previously, only three species - one cultivated (sweet potato) and two spontaneous (bottle gourd and coconut) - were common to the agricultures of both the Old and the New World. After 1492, the exchange of cultivated species not only radically changed the diet of the majority of humankind but also led to commercial crops being developed in the tropics and a new world economic order being created. The relationship between human beings and cultivated plants affected everything from basic food and clothing requirements to the use of plants for ornamental purposes and leisure (FAO, 1994).
Ancestral Andean populations used natural resources for food and medicinal purposes. Among the most known are the root and tuber crops (ARTC), which are still of great economic and nutritional importance for Andean subsistence farmers. They can grow at high altitudes under extremely difficult conditions of drought, freezing temperatures, and UV exposure. Additionally they included fruits from the Yunga and Quechua zones in their diet. Some had very special flavours, such as the sachatomate, capulin, Peruvian pepino, various species of Cactaceae. passionfruit and mountain papayas as well as condiment, aromatic and medicinal species. The considerable plant genetic variability is explained by the profuse ecological diversity that characterizes the Andes. The presence of numerous progenitor and wild species related to the domesticated crop species represent an incalculable plant genetic resource, because they carry the genes for adaptation to a wide diversity of high Andean climatic conditions thus, their preservation is an urgent need.
Part of this huge agro-biodiversity includes:

- Andean tubers and roots: Potato (*Solanum* spp.), Oca (*Oxalis tuberosa*), Mashwa (*Tropaeolum tuberosum*), Bitter potatoes (*Solanum x jazepczukii), (Solanum x curtilobum*), Ullucu (*Ullucus tuberosus*), Maca (*Lepidium meyenii*), Arracacha (*Arracacia xanthorrhiza*),

Mauka, chago (*Mirabilis expanse*), Leafcup (*Polymnia sonchifolia*), Yacon (*Smallanthus sonchifolius*)

- Andean grains and legumes: Canihua (C*henopodium pallidicaule*), Quinoa (*Chenopodium quince*), Love-lies-bleeding (*Amaranthus caudatus*)
- Andean fruits: Pepino (*Solanum muricatum*), Tree tomato (*Cyphomandra betacea*), Mountain papaw (*Carica pubescens*)

2.2 How traditional knowledge can be used to obtain new products

The use of plants in healing processes in Colombia has an old history, where many learning, experiences and practices have been accumulated and inherited. During the XVI and XVII centuries when the Europeans learned of the healing procedures used by indigenous communities, a confrontation took place among the ways of healthcare, and how to understand the concepts of being healthy and the sickness. The use of plant therapies was the main base of the Greek and Arab medicine. During the middle ages these therapies were addressed into a scientific character expanding the pharmacopeia with plant species from Eastern and Western India and the discovery of America. The botanical development from XVI century where the plants were planted in botanical gardens to be studied and classified to learn of the potential from each species, allowed physicians to incorporate important knowledge of the medicinal use of plants.

Medicinal plants have the potential of being an important source of income for growers and transformers. Colombia as a mega-diverse country includes a vast ecosystem variety represented by tropical moist forests, savannah plain and alluvial forest. Many studies in Colombia undertaken by the Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (Alexander von Humboldt Research Institute on Biological Resources), give evidence that the Country comprises nearly 50000 flora species of which at least 6000 have some kind of therapeutic use (Bernal et al., 2011). However, it is interesting that with this enormous potential of plants, the Vademecum prepared by INVIMA -Instituto Nacional de Vigilancia de Alimentos y Medicamentos -, registers only 95 species approved for medicinal use of which, only 11 are native plants.

In the Americas, only three Research Centers are working on alternative therapies in collaboration with the WHO Traditional Medicine activities in particular the Program for Collaborative Research in the Pharmaceutical Sciences at the University of Illinois at Chicago. They provide through their database of medicinal plants, NAPRALERT, free information to all nonprofit institutions in the Third World. One particular case is the experience of Peru where their studies have been focused on the phytochemistry of medicinal plants used by different ethnic communities. Some studies have evaluated the presence of alkaloids in plants commonly used, and the possible implications of their use. Additional studies have been conducted on pharmaceutical technology in order to contribute to solve health problems, and to expand intermediate pharmaceutical technology and pharmaceutical development.

An interesting experience in Peru is located in the highlands of Puno, where medicinal plants are among the most diverse and valuable in the region, have not only therapeutic but also nutritional benefits and are used in daily life (Jahuira & Viviana, 2005). Many plants in this region are used for therapeutic purposes covered by traditional knowledge, habits, customs and ways of life of the Aymara-Quechua, and constitute the main response to the health problems of impoverished communities: respiratory disease, diseases of the oral cavity, dysentery and gastroenteritis, injuries and poisoning, diseases of the genito-urinary tract, skin diseases and subcutaneous tissue disease.

The needs of private business, has stimulated increased use of medicinal plants seeking to find alternatives to some medical problems to prevent morbidity and mortality of highland populations, as well as a source of income for farmers. Indeed, several studies have demonstrated an important experience of the Andean communities in productive chains with ongoing efforts to establish integrated production processes, processing, use and consumption of medicinal plants to generate greater profits for the farmer in a sustainable way (Jahuira & Viviana, 2005).

Also in Peru the Health Ministry has implemented health programs with the use of medicinal plants, whose services and holistic approach now consider the biological, mental and spiritual human being, besides the involvement of the family, experience performed by the former-INMETRO, now called the National Center for Intercultural Health (CENSI) whose objective requires the practice of traditional medicine power through scientific research programs. This led to joint actions with conventional medicine, based on the use of products from the region (Bernal et al 2011). The use of medicinal plants depends on the type of disease and treatment desired. Thus we find plants that can be taken alone or combined with other plants. The plants most used are: Amaccari (*Boconia frutescens*), Sano sano (*Cyathea spp.*), Vino vino (*Tradescantia zanonia*), Cascarilla (*Cinchona calisaya*), Lacre rojo (*Vismia macrophylla*), Nogal (*Junglans neotropica*), Ayapira (*Picramnia sellowii* subsp. spruceana), Suli suli (*Cestrum sp.*), Pajuaito (*Erechtites hieraciifolius*), Ortiga negra (*Urera laciniata*), Sangre de grado (*Croton lechleri*), among others (Corporazione Italiana; De Vida, 2008; Damiano et al., 2011)).

In Colombia, the development of knowledge on medicinal plants has been slow and the documented experiences are limited to certain regions and ethnic groups. However, some cases deserve to be highlighted, as will be shown. In recent years, studies evaluating the uses of plants (both timber and non timber) in the Amazon Piedmont have been conducted by the SINCHI scientific research institute, for different communities comparing similar uses according to ethnicity. Results show that in most cases, treatments remain within their communities (Bernal et al., 2011). Previous studies have found that many of the species to which some communities give more importance, are related to the construction and sawmilling activities rather than to medicine or food, which suggests that, depending on the interests of the community these should be evaluated.

A number of functional properties, suggested by ethnomedicine against a wide range of dysfunctions and pathologies (e.g. gastric ulcers, diarrhea, microbial and viral infectious wounds, insect bites neurogenic inflammations, arthritis), have also been also corroborated and have led to a number of commercial products (Gupta, 2008).

One of the initiatives in medicinal plants promoted by the Colombian Government conducted a national survey of medicinal and aromatic plants as a useful tool to understand the situation in an exploratory way. The survey permitted reaching the main actors who participate in this chain of production and learn about their business and legal issues, as well as the market expectations of the use of medicinal plants in Colombia. It also permitted identifying other medicinal and aromatic plants sold in Colombia. One of the major problems was the refusal by several laboratories to be part of the survey. A high percentage did not respond to it, probably due to their position on commercial and regulatory conditions -under which the sector develops-.

Examples of medicinal plants used in phytotherapies in different Andean countries

- Bolivia: *Cedrela fissilis* belongs to the Meliaceae family. It is a plant grown in tropical America from Mexico to Argentina and it is representative of Bolivia. The ethanol

extract of the dried plant has been evaluated for its cytotoxicity and antitumoral activity against various cell lines presenting a weak antitumoral activity against P338 leukemia. Toxic effects have been identified at doses of 1800 mg / kg in mice (Suffness et al, 1988).

- Colombia: *Ilex guayusa* belongs to the Aquifoliaceae family. It is a plant that grows in southern Colombia and along the border with Ecuador at altitudes between 200 and 2000 m in tropical rainforests and secondary vegetation (Correa and Bernal 1990). The Indian communities have used the leaves as stimulant for nerve and muscle. Compounds act as digestive, emetic and expectorant, and in some cases have shown effects against diabetes.
- Another important plant species in Colombia is *Croton lechleri* Müll. Arg. (sin. *Croton draconoide*s Müll. Arg., Euphorbiaceae). It is a small-sized Amazonian tree growing on the eastern Andean slopes of Peru, Colombia, Bolivia and Ecuador, commonly known as sangre de drago, sangregado, palo de grado, pocure, racurana, sangre de dragòn, sangre de grado or named with the Quechua terms of arleiia and lan huiqui (Gupta, 2008). A recent study on *Croton lechleri* (Damiano, et al 2011), examined for the first time the essential oil obtained by steam distillation of fresh stem bark from Amazonian Ecuador *Croton lechleri* adult plants. The results showed sesquiterpene prevalence and clarified the structure of the major compounds. Antioxidant and antibacterial assays were also performed employing (HP) TLC-bioautography strategy to detect the fraction(s) that would best determine the biological activities. Some fractions showed having antioxidant and antibacterial activity, while one of the fractions (RF=0.7) almost exclusively characterized by sesquicineole, displayed only antibacterial properties. The efficacy of the essential oil was weak in relation to positive controls of commercial thyme essential oil and BHA, but similar to that expressed by other *Croton* spp. essential oil as reported in related literature.
- Perú: Tara is a plant produced in several areas of Peru between 1000 and 2900 masl.. The sheath is separated from the seed and is an excellent export product as feedstock for the production of tannic acid used in the fur industry, pharmaceutical paints and other chemical products. From Tara seeds, using thermal-mechanical process a food grade gum from the endosperm can be obtained, constituting an alternative to traditional rubber global food industry, paints and varnishes, among others. This gum was approved by Resolution on September 26, 1996 (No. ECC: E-417) by the European Community, to be used as a thickener and stabilizer in food for human consumption. (de la Cruz Lapa, 2004).
- Venezuela: *Averroe bilimbi*, species belonging to the Oxalidaceae family is a small tree native to India and cultivated in Venezuela. This plant is used to cure abscesses and inflammation. Extracts of this plant are used against diarrheal diseases. In preclinical studies it has been shown that the extract of the fruits of *Averroe bilimbi* has mutagenic activity when injected into mice intraperitoneally at a dose of 50 ml/kg. Studies have shown its effect on amenorrhea in women with menstrual delay between 10 and 111 days 80% of the patients recovered function. (Gupta, 2008).
- Ecuador: *Myroxilom balsamum* is a Leguminosae-Papilionoidae plant family called the balsam tree, widely grown in Ecuador. Ethnobotanical knowledge reports that the balsam tree produces a yellow balm that solidifies to crystal pieces. The drug has expectorant and antiseptic functions. (Gupta, 2008). In medicine, the black salve is used to treat ulcers. Pharmacopoeia in Mexico recommends the tincture of the fruits as

antispasmodic and stimulant especially in cases of eclampsia. It was found that the ethanol extract at a concentration of 2000 ppm has antibacterial activity against several species of Staphylococcus and antifungal activity against certain species of Trichophytum. The active ingredients of the balsam are benzoic acid and cinnamic acid, benzyl benzoate, nerodiol and resins (Walberg & Enzel, 1971).

- Cuba: Studies conducted in *Manilkara zapota* plants, belonging to the Sapotaceae family have shown that their seeds are compounds that are used in digestive disorders, colitis, diarrhea and parasitism. Likewise, these compounds are effective for treating colds, kidney pains and hair loss. There are also reports of use of the leaves in treatments for skin conditions (Roig, 1988).
- Additional plants of interest include:
  - Leaves from the plant species belonging to the genus *Ligustrum* are used as herbal medicine in Europe, China, and Japan. The antioxidant properties of five *Ligustrum* species from Taiwan were compared by using *in vitro* antioxidant methods such as DPPH radical scavenging, TEAC, and FRAP assays. Cell-based antioxidant methods were used, including Fe2+/ascorbate-induced lipid peroxidation on brain homogenate and AAPH-induced erythrocyte haemolysis. The amounts of major phenolic compounds from the *Ligustrum* species, including phenylpropanoids, flavonoids, and iridoids, were determined by spectrophotometric methods. The results showed that all *Ligustrum* species exhibited antioxidant, radical-scavenging, anti-haemolytic, and lipid peroxidation-inhibiting activities at different magnitudes of potency. Among all *Ligustrum* species from Taiwan, *Ligustrum morrisonense* is presented as a potential source of natural antioxidants (Chi-Rei et al., 2011).
  - *Centella asiatica* is a perennial herb with high utility in traditional medicines, herbal drugs and cosmeceutics. (Munduvelil, T., 2010). Medicinal properties of C. asiatica have been ascribed to its bioactive pentacyclic triterpenoid derivatives such as asiaticoside, madecassoside, asiatic acid and madecassic acid (Inamdar et al., 1996). Asiaticoside has been identified as an active compound in *C. asiatica* associated with its wound healing properties (Shukla et al., 1999). Wound healing activity of asiaticoside is a result of stimulation of collagen and glycosaminoglycan synthesis (Cheng et al., 2004). It is also found to have activity against herpes simplex viruses 1 and 2, mycobacterium tuberculosis and as a neuroprotectant (Lu et al., 2004).

2.3 Conservation of biodiversity and genetic resources

Meeting the food needs of the world's growing population while reducing poverty and protecting the environment is a major global challenge. It is essential to take environmental concerns into account in order to develop technological solutions that are sustainable in the long run. According to the UN Millennium Project (2005), meeting these demands will require agricultural productivity increases and product diversification to improve the livelihoods of the poor, protect the environment, and ensure broad-based economic growth. Plant genome sciences, and plant biology as a whole, are vital enterprises that can contribute significantly to human health, agriculture, energy security, and environmental stewardship (The Academies of Sciences, 2007). Biodiversity and agriculture are strongly interrelated because while biodiversity is critical for agriculture, agriculture can also contribute to conservation and sustainable use of biodiversity. Indeed, sustainable agriculture both promotes and is enhanced by biodiversity. Maintenance of this biodiversity is essential for

the sustainable production of food and other agricultural products and the benefits these provide to humanity, including food security, nutrition and livelihood (Hodson, 2009). Biodiversity and ecosystem services conservation, and sustainable management are essential to the future of the Andean region and its long-term competitiveness. Bioprospecting, the emerging field of biomimicry and biotrade depend heavily on diverse, sustainable and healthy ecosystems. Investment in knowledge, research and technology development is necessary to be at the forefront of natural resource-based technologies, products and markets (UNDP, 2010a, 2010b).

Biodiversity is crucial as a strategic resource, with an essential function in the cycles of the bioelements, in climate regulation, in maintaining the viability of agriculture, fishing, and other activities associated with food security. Thus, the conservation of the enormous diversity in the Andean Region is imperative for preserving life multiplicity and maintaining a natural balance among species. The Andean natural resources continue to be exploited in an unsustainable way and the availability of these resources for use in the development of the region is threatened by processes of environmental degradation, such as deforestation, erosion, sedimentation, contamination, and rapid urbanization, among others.

Several anthropological factors are known as directly and indirectly affecting the state of conservation of ecosystems and biodiversity. Among them are the high levels of poverty, insufficient environmental education, increased population and urban development, extension of the agricultural/livestock frontier, forest extraction, opening of new roads, the slash and burn system, overgrazing, burning of pasturelands, over-exploitation of biological resources, oil extraction, gold mining, trade, tourism, introduction of alien species, and pollution. One frequently mentioned natural cause of the alteration of ecosystems is that of extreme climatic phenomena. Additionally, invasive alien species are one of the principal threats to worldwide biological diversity, and could result in serious deterioration of the megadiversity of the Andean sub-region (CAN, 2002, FAO, 2011a, 2011b). In the cloud forests, agriculture, deforestation, dams, and road building are the most significant threats. At higher altitudes, seasonal burning, grazing, agriculture, mining, and fuelwood collection have degraded the grasslands and scrublands of the puna and páramos. One of the most important and directly measurable land degradation impacts are associated with extensive cultivation of opium poppy, which has led to the clearing of thousands of hectares of montane forests and the spread of chemical herbicides through rivers and streams that pose additional threats to plant and animal species, especially amphibians. Activities associated with this trade often make it difficult to safely sustain conservation activities in the area (Hodson, 2009). Coca, once grown for local consumption in the Andes, is now produced for external markets, often in areas with armed groups -that generate instability and often serve to secure land for unscrupulous investors-. Internationally financed eradication campaigns force traffickers and growers to constantly relocate, making drug-related activities a principal cause of forest loss. The range of environmental impacts from illicit crops, trafficking, and violence is broad, and must be studied (Fjeldsa et al, 2005).

The growing concern on genetic erosion has led to the establishment of germplasm conservation programs worldwide. Approaches for biodiversity –germplasm- conservation include: Collection, identification and documentation of genetic resources, consideration of the impacts of traditional farming, cropping and agroforestry systems and the use conventional landraces and cultivars of domesticated plants and wild related species. The

two major strategies for conservation of genetic resources are: a.- *"in situ"* conservation, which allows continued evolution and adaptation of a species in response to the environment; -though more dynamic, it is exposed to habitat destruction by natural calamities and/or human interference-, and b.- "*ex situ*" conservation, which can be used to ensure easy and ready accessibility of reproductive material. Effective conservation strategies often incorporate elements of both. For example, *ex situ* collections can be used for *in situ* population enhancement, or even to reintroduce rare/extinct species in the wild (Hodson, 2009).

To comply with the compromises on the Convention on Biological Diversity (CBD), the five Member States of the Andean Community (Bolivia, Colombia, Ecuador, Peru, and Venezuela) approved by Decision 523 the Regional Biodiversity Strategy for the Tropical Andean States. The Strategy (signed in July, 2002) is the result of a participative process of the Andean Committee of Environmental Authorities (CAAAM), in cooperation with representatives from different sectors related to the conservation and sustainable use of biodiversity, including public sector, native, Afro-American and local communities, along with the industrial and academic sectors, civil society, consumers and international organizations. It establishes approaches for the cooperative conservation and sustainable use of biodiversity around six main general objectives: 1) Conservation and sustainable use of ecosystems, species and genetic resources *in situ* and complementary actions *ex situ*; 2) Equitable sharing of benefits, based on a correct economic valuation of the biodiversity components; 3) Protection and enhancement of knowledge, innovations, and practices of the indigenous, Afro-American, and local communities based on recognizing their individual, community, and group rights; 4) Development of scientific knowledge, innovations and technologies for the conservation and the sustainable use of biodiversity, while preventing and minimizing risks to the environment and human health; 5) Inclusion of the conservation and sustainable use of biodiversity in sectoral policies and development projects with sub-regional impact; and, 6) Development of the capability for international negotiation regarding the conservation and sustainable use of biodiversity in the Andean Community (CAN, 2002).

One of the main objectives of the Global Treaty on Plant Genetic Resources for Food and Agriculture is to save and share crop diversity. As of March 2011, the gene pool created under it had reached 1.5 million samples of the world's 64 most important food crops, where one-sixth of the signatories have made their crop collections available under the Treaty. Between 600 and 800 samples are exchanged each day through the Treaty's Standard Materials Transfer Agreement (SMTA), which has been helpful in overcoming legal obstacles that in the past have prevented breeders and researchers from gaining access to critically needed crop-breeding materials. The global fund of the International Treaty is currently supporting projects all around the world to help farmers in 11 developing countries to conserve crop diversity and to adapt to weather extremes and other threats to food security. For example, in Peru, the fund is helping to maintain biodiversity in the 15,000-hectare "Potato Park", where local and indigenous farmers are reintroducing thousands of heirloom potato varieties to adapt them to rising temperatures. Scientists predict that diseases and other threats aggravated by climate change could decrease potato yields by one third in coming decades.

Information supplied by the countries of the Andean sub-region reveals a significant number of germplasm banks that contain genetic resources of great importance for agriculture, socioeconomic aspects, and food security. The Andean Community registers 88

active banks (preserving tuber and root crops, cereals, vegetables, fruit trees, forest trees, leguminous crops, forage species, industrial plants and ornamental plants), of which 50% are managed by public institutions. Additionally and in relation to germplasm banks, the two international CGIAR centers of the Andean subregion (International Potato Center, and International Center for Tropical Agriculture) operate within the multilateral framework established by the FAO International Commitment.

Despite the high level of threat in the Tropical Andes, a network of protected areas today conserves some of the most important remaining intact ecosystems in the hotspot. Protected areas cover some 16 percent of the original extent of vegetation in the region, although only about eight percent of the hotspot is protected in reserves or parks under IUCN categories I to IV. However, even these parks are not inviolate, and without adequate enforcement and monitoring, they can be damaged by settlement, poaching, and illegal logging. Because research has shown that small parks may not adequately protect biodiversity in the long term, conservation efforts in the Tropical Andes have focused on the need to add to and connect this network of protected areas. By connecting existing parks through corridors of protected areas and biodiversity-friendly, sustainable development projects, ecological processes like migration, dispersal, and gene flow among populations are enhanced. For example, Conservation International has begun the implementation of the Cóndor-Kutukú Conservation Corridor,including the following areas in Ecuador: Podocarpus National Park, Sangay National Park, Condor National Park, Cordillera de Kutukú and Cordillera del Cóndor. In Peru, the Corridor includes the Santiago-Comaina Reserved Zone, Tabaconas-Namballe National Sanctuary and Cordillera Azul National Park (Fjeldsa et al, 2005).

Colombia has a National Environmental System coordinated by the Ministry of Environment that involves 33 Regional Autonomous Corporations, the National Park Service and five research institutes promoting terrestrial and marine biodiversity conservation research. The National System of Protected Areas (SINAP); indigenous reserves and Afro-Colombian collective territories extend over 37% of Colombia's terrestrial land and include representative samples of 70% of the country's natural ecosystems providing important safeguard to the country's natural heritage. If forest reserves and other conservation categories are added, an approximate 43% of Colombian territory is under some sort of conservation scheme (UNDP, 2010a).

As mentioned previously, genetic resources are the raw material for agricultural development and continued survival of natural populations. Therefore their sustainable use is crucial for global food security and economic well-being. An additional and valuable tool for the conservation and sustainable utilization of biodiversity is biotechnology. Biotechnologies are increasingly being applied to enhance genetic resources for food and agriculture GRFA (FAO, 2011a). Biotechnology applications can provide comparative advantages over, or can increase the effectiveness of, traditional technologies for the characterization, conservation and utilization of GRFA. Biotechnology applications for characterization include molecular markers and the so-called "omic" technologies. The two FAO reports related to the state of food and agriculture (2003-2004 and 2010-2011) deliver an overview of the current status of biotechnology applications applied to the characterization, conservation and utilization of GRFA, as well as the comparative advantages that biotechnologies can provide over conventional technologies (FAO, 2011a, 2011b, 2004). Correspondingly, the Commission on Genetic Resources for Food and Agriculture observing the increased use of biotechnology in the conservation and sustainable use of

GRFA over the past 15 years, has been considering the application and integration of biotechnologies in biodiversity issues "*maximizing the positive effects and minimizing the negative effects of biotechnology*".
In fact, both the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture and the Global Plan of Action for Animal Genetic Resources identify a direct or indirect role for agricultural biotechnologies in some of their priority areas. Characterization is a prerequisite for identifying and prioritizing the genetic resources to be conserved and is fundamental for optimizing appropriate allocation when resources are limited. Characterization also links conservation and utilization as it allows identifying unique and valuable traits of conserved genetic resources, both *in situ* and *ex situ*, for incorporation into breeding programmes (FAO, 2011a).

3. Regulatory frame

During the last three decades there has been worldwide increased interest regarding environmental and natural resources issues. While in the 20th century concerns were raised in relation to the impacts of human activities, dangers of environmental degradation and possible effects on climate change, desertification and pollution, the 21st century is bringing more awareness of the real value of biodiversity and the ecosystems in which they live to provide us food, water, human health, and climatic stability (UNDP, 2010b). There are several International and Regional treaties and agreements related to biodiversity, and each country has its individual regulations. The main regulatory broad frame is the Convention on Biological Diversity (CBD), adopted at the 1992 Earth Summit in Rio de Janeiro, where world leaders agreed on a comprehensive strategy for sustainable development – "*meeting our needs while ensuring that we leave a healthy and viable world for future generations*"-. The Convention has 193 Parties and three main goals: conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits from the use of genetic resources (www.cbd.int/).
The CBD enhanced the world's commitment in relation to environmental management and biodiversity conservation –sustainability-, and is one of the most relevant subjects of international relations and policies, as well as National sovereignties towards control over biological resources. The potential value of genetic resources (especially in developing countries with high biodiversity) has generated the development of mechanisms to regulate and control the collection, trade and research related with biological resources, while developed countries are trying to extend patent laws, intellectual property rights, and biotechnology on the use of components of biological resources (Grajal, 1999). The Latin American and Caribbean nations represent the most biologically diverse region on Earth. South America alone is home to almost half of the planetary biodiversity, and more than a quarter of its forests. The Americas as a whole possess nearly 122 million hectares of fertile land, 93 million hectares of grassland, more than 132 million hectares of forest, and 27% of the world's available fresh water (UNDP, 2010b).
The fair and equitable sharing of benefits arising from the use of genetic resources (ABS) is the third objective of the Convention and several articles of the Convention set out terms and conditions for access to genetic resources and benefit-sharing. Since 2004, Parties to the Convention have been negotiating an instrument to effectively implement the ABS provisions of the Convention. At its tenth meeting, in Nagoya, Japan, the Conference of the Parties adopted the Nagoya Protocol on Access to Genetic Resources and the Fair and

Equitable Sharing of Benefits Arising from their utilization. In Decision X/1, Parties requested that the Secretariat provide technical assistance to developing country Parties seeking to support the early entry into force and implementation of the Nagoya Protocol. In light of this request, a number of capacity building and awareness-raising activities on the Nagoya Protocol are planned for the next two years.

An important consideration regarding regulations and agreements related with biodiversity, natural resources, sovereignty and local communities is that this normative frame is intended for the protection of the rights and to improve welfare, food security health and safety of the society, especially the most needed in developing countries, which depending on the interpretation given to the regulation, might result exactly in the opposite.

3.1 International agreements

The principal international agreements and treaties related to biodiversity and trade are briefly described:

Convention on Biological Diversity (CBD) (www.cbd.int/)

Entered into force in 1993 - Legally binding for countries that have ratified (193 as of April 2011)

Covers all biodiversity; provides general principles for the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits from the use of genetic resources.

International Treaty on Plant Genetic Resources for Food and Agriculture ITPGRFA (http://www.planttreaty.org/)

Entered into force on 29 June 2004 - Legally binding for countries that have ratified (127 as of April 2011)

Covers all PGRFA and addresses diverse topics, including conservation, use, international cooperation, technical assistance and farmers' rights. No country is self-sufficient in plant genetic resources; all depend on genetic diversity in crops from other countries and regions thus, international cooperation and open exchange of genetic resources are essential for food security. The objectives of the Treaty are the conservation and sustainable use of Plant Genetic Resources for Food and Agriculture and the fair and equitable sharing of the benefits arising from their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security; establishes a multilateral system for select crops (approx. 35 crops/crop complexes plus certain forages); sets rules for access and benefit sharing for these materials, both *ex situ* and *in situ*. The ITPGRFA creates the Multilateral System of Access and Benefit-sharing, which provides for facilitated access to plant genetic resources for food and agriculture (ITPGRFA Article 12.3.a), which includes 35 crops and 29 forage genera (Annex 1 of the ITPGRFA). At its First Session, in June 2006, the Governing Body of the ITPGRFA adopted a Standard Material Transfer Agreement (SMTA), which sets out the legal conditions that apply to both providers and recipients of plant genetic resources for food and agriculture (PGRFA) in the Multilateral System.

International Plant Protection Convention IPPC (https://www.ippc.int/)

Established in 1952. Revised text entered into force in 2005 - Legally binding for countries that have ratified (177 as of April 2011)

International treaty seeking to secure coordinated, effective action to prevent and to control the introduction and spread of pests of plants and plant products protecting cultivated and wild plants. Addresses phytosanitary issues with the transfer of plants and animals.

WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) (http://www.wto.org/)
Entered into force in 1 January 1995
The WTO-SPS Agreement recognizes the IPPC as the relevant international standard setting organization for the elaboration of international standards to help ensure that phytosanitary measures are not used as unjustified barriers to trade. The health aspect of the SPS Agreement basically means that WTO members can protect human, animal or plant life or health by applying measures to manage the risks associated with imports. The measures usually take the form of quarantine or food safety requirements.
Agreement on Trade-Related Aspects of Intellectual Property Rights - WTO-TRIPS (www.wto.org/)
Entered into force in January 1995 - Legally binding for members that have ratified it (153 as of April 2010)
Member States
The Multilateral Trade Agreement embodies provisions on Trade Related Intellectual Property (TRIPS). As a result, many countries are now developing and enacting intellectual property rights legislation, including plant variety protection (SGRP, 2010). It introduced intellectual property legislation into the multilateral trading system. Member states must comply with minimum standards of protection of intellectual property and ensure protection of micro-organisms, non-biological and microbiological processes and plant varieties that meet protection criteria. The TRIPS Agreement has an important principle: intellectual property protection should contribute to technical innovation and the transfer of technology. Both producers and users should benefit, and economic and social welfare should be enhanced, the agreement says.
UPOV 1961, 1972, 1978, 1991 - Plant Breeders' Rights (http://www.upov.int/)
Legally binding for ratifying countries (68 as of April 2010)
Through a succession of international laws, UPOV aims to harmonize national laws for protecting plant varieties. The objective is to provide and promote an effective system of plant variety protection, with the aim of encouraging the development of new varieties of plants, for the benefit of society. The UPOV Convention provides a *sui generis* form of intellectual property protection which has been specifically adapted for the process of plant breeding and has been developed with the aim of encouraging breeders to develop new varieties of plants.
Agreements entered into by the governing body of the Treaty on Plant Genetic Resources for Food and Agriculture ITPGRFA and the CGIAR centres and other international institutions under Article 15 of the Treaty
The eleven CGIAR Centres hosting international crop and forage collections have signed agreements with the Governing Body of the ITPGRFA (in 2006), placing those collections under the overarching international framework of the ITPGRFA.
11 CGIAR centres (those having *ex situ* collections) have signed binding agreements with the Governing Body, (place the *ex situ* collections held in trust by the Centres and other international institutions within the purview of the Treaty)
The System-wide Genetic Resources Programme SGRP (SGRP, 2010) (http://www.sgrp.cgiar.org/) of the Consultative Group on International Agricultural Research (CGIAR) unites the CGIAR's independent agricultural research Centres in a common effort to sustain biodiversity for current and future generations. The diversity embodied in plant, animal, forest and aquatic genetic resources supplies the building blocks

for sustainable agriculture to fight poverty, bring health and food security, and protect the environment. The SGRP is the culmination of a long-standing collaborative partnership among CGIAR Centre scientists and technicians involving sharing of know-how and joint action to address common research problems. The focus of the collaboration has always been the CGIAR Centre genebanks' plant genetic resources collections and the challenges surrounding their management. The Booklet of CGIAR Centre Policy Instruments, Guidelines and Statements on Genetic Resources, Biotechnology and Intellectual Property Rights (Version III, August 2010), was updated to include policy instruments and guidelines related to the management of PGRFA under the framework of the Treaty.

FAO/IPGRI Genebank Standards (ftp://ftp.fao.org/docrep/fao/meeting/015/aj680e.pdf)
Recommended by FAO and IPGRI –currently Bioversity International- to be used as the reference in national, regional and international genebanks. Endorsed in 1993 by FAO Commission on Plant Genetic Resources -not legally binding-, sets out recommended gene bank storage standards for seeds of orthodox species only

FAO Code of Conduct for Plant Germplasm Collecting and Transfer
(www.planttreaty.org/smta_en.htm)
Adopted by FAO Conference in 1993, not legally binding
Deals with the etiquette of collecting and transfer of PGRFA. Both the Treaty and the CBD have provisions that add to, or modify the guidance provided by the Code and have provisions on collectors' permits, responsibilities of collectors, sponsors, curators and users, as well as on reporting, monitoring and evaluating observance of the Code

CGIAR policies/ instruments (http://www.sgrp.cgiar.org/?q=node/1053)
Apply only to the CGIAR. Some of the policies and instruments are related to the Governing Body-CGIAR agreements and specify actions that must be taken by centres to meet these contractual obligations.
Centres' Guide to the Implementation of the Standard Material Transfer Agreement (SMTA) and includes: Guidelines for germplasm acquisition; Model MTA for use with non-food/feed crops; Guidelines for acquisition and transfer of germplasm: micro-organism, animal and aquatic and marine; Ethical principles related to genetic resources; Guiding principles on Centres' Intellectual Assets; Principles involving centre interaction with the private sector; Position statements on biotechnology, the FAO-CGIAR agreements, 'genetic use restriction technologies' and the need to resolve certain issues concerning IPRs and genetic resources.

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (http://www.cbd.int/abs/**)**
Adopted by the Conference of the Parties to the Convention on Biological Diversity at its tenth meeting in October 2010 in Nagoya, Japan. It will be open for signature by Parties to the CBD from 2 February 2011 until 1 February 2012 at the United Nations Headquarters in New York.
It is an international agreement which aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding, thereby contributing to the conservation of biological diversity and the sustainable use of its components. It deals with "access and benefit sharing" with countries or local communities when inventors use genetic materials and any associated traditional knowledge. It builds on the long-established principles of the CBD itself.

3.2 Subregional Agreements (Community of Andean Nations CAN) (http://www.comunidadandina.org/ingles/treaties.htm)

Because Andean countries as a group probably hold the largest portion of biological diversity in the world in absolute numbers, endemic and restricted range species, these countries have been among the first in the world to define a legal regulatory framework to control the access to genetic resources, and agreements to comply with the Convention on Biological Diversity. International trade in the products of biological diversity is subject to a series of regulations and trade agreements, where attention has focused on how to deal with the problem of tariff and non-tariff barriers that affect trade. The effect that the opening-up of the economies of the CAN member countries has on the patterns of use of biodiversity needs to be studied in depth for specific biological resources. The Andean Environmental Agenda for 2006-2010 provides for the formulation and organization of the Andean Strategy on Climate Change - EACC and its corresponding Action Plan. This Agenda contains both short- and medium-term subregional actions that add value to national efforts and help strengthen the capacities of the Member Countries with regard to environmental and sustainable development issues.

To date, the most relevant agreements in Andean Community related to biodiversity and trade are:

Common Regime on Access to Genetic Resources - Decision 391: Aims to regulate access to the genetic resources of the Member Countries and their by-products, taking into account that the Member Countries have sovereignty over the use and development of their resources and possess a sizeable biological and genetic heritage that should be preserved and developed on a sustainable basis. Decision 391 defines the basis for a common regime for access to genetic resources by the Andean Pact countries. This resolution imposes new cumbersome controls upon access of genetic resources. If implemented in letter and spirit, Decision 391 will impose disincentives on biodiversity research, and therefore will impair growth in the knowledge base of Andean biodiversity at a time when these countries need more information to better manage their biological resources (Grajal, 1999).

Regional Biodiversity Strategy for the Tropical Andean Countries - Decision 523: It is one of the first strategies of a regional nature adopted by a group of countries signatories of the Convention on Biological Diversity, and it is a specific contribution to meeting the goals of the Convention. At the same time, it is a valuable instrument for enhancing the Andean peoples' own perception of the importance of their rich natural heritage, and a fundamental one for ensuring the sustainability of the Amazon Basin as a whole. It is also a tool of great significance for constructing new kinds of relationships among countries, regions, and continents. It aims to set bases for a community policy with other countries on the subject of biodiversity, in view of the challenges the subregion confronts in the process of negotiating the Free Trade Area of the Americas (FTAA), in the World Trade Organization (WTO), and in other bilateral and multilateral negotiation processes, including international environmental conventions, in particular the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture.

Common Provisions on the Protection of the Rights of Breeders of New Plant Varieties - Decision 345: Its purpose is: (a) to recognize and ensure the protection of the rights of breeders of new plant varieties by the grant of breeders' certificates; (b) to promote research activities in the Andean area; (c) to promote technology transfer activities within and outside the subregion. The scope of this Decision encompasses all botanical genera and

species insofar as the growth, possession or use thereof are not prohibited for reasons of human, animal or plant health.

Common Intellectual Property Regime - Decision 486: Replaces Decision 344. The objective is the protection of intellectual property considering the agreements of the World Trade Organization -including the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)-, and the Paris Convention for the Protection of Industrial Property.

Consultative Council of the Andean Community Indigenous Peoples - Decision 674: The Council acts as a consultative body within the framework of the Andean Integration System to promote the active participation of indigenous peoples in economic, social, cultural and political matters concerning subregional integration.

Integral and Sustainable Alternative Development Andean Strategy - Decision 614: With the objective of contribute to the reduction of poverty and to achieve social cohesion in the Member Countries, in the target areas defined, and to establish policy guidelines, conceptual focusing and goals and indicators, for alternative development actions and projects, with a comprehensive and sustainable approach.

Andean Committee of Environmental Authorities (CAAAM) Decision 435: Establishes the "Comité Andino de Autoridades Ambientales" integrated by environmental authorities of the Member Countries as an advisor body in environmental issues.

4. Indigenous communities, traditional knowledge and biodiversity

It is common to find a linear view of biodiversity as an input for research and foresight that eventually enters into the value chain of the economic system. The mindset of anthropological positions is far from being instrumental, understanding that biodiversity is an integral part of indigenous peoples and this is indispensable from their cultural environment, dignity and survival (Brush, 1993; Dove, 2006).

Knowledge of how to interact with tropical ecosystems is not merely confined to crops, but includes environmental issues such as recovery from floods, forest regeneration, along with management of species migration, soil dynamics and water management among others (Naveh, 1998). Biodiversity in ancient knowledge has value beyond the use of plants, animals and other natural resources for medicine, food and industry. Biodiversity also determines and is determined by certain traditional practices of cultivation and management of soil, seeds and animals, forms of natural resource management, rituals and ceremonies as well as a set of rules and metaphors about the use and conservation of biodiversity.

Over the years Indigenous peoples have been advocated to sustain a struggle for the conservation and use of biodiversity, especially on issues such as food sovereignty. Also the Indians have had to negotiate their rights over traditional knowledge and genetic resources. Finally, the Indian communities have made progress in advocacy through the creation of organizations that have expanded the possibilities to govern over their environment, resources and knowledge.

4.1 Biodiversity and food sovereignty

Policies to combat poverty have often prioritized food security, which consist in ensuring food obtained via the mass production of few and low cost crops. Instead, food sovereignty is designed to guarantee the people the means to grow their own traditional food (Montagut & Dogliotti, 2006).

The biological diversity of crops has been focused on a struggle between the imposition of varieties and seeds, and the right of people to feed themselves with their own crops. For example, during the period of expansion of the Inca empires' (1400-1500), the leaders stepped up the production of maize and potato because of their ease of extensive cultivation and storage. Throughout the area known as Puacartambo (between Ecuador and Peru), the Incas imposed on the families the widespread cultivation of maize and potato. With the Spanish conquest new crops such as barley and wheat were added, and introduced additional pressures that threatened the food sovereignty of the indigenous American people. Indigenous communities created new organizational forms, which divided the land and labor for the production of traditional varieties (Zimmerer, 1999; Zimmerer, 1993). Crops are culturally rooted (in fact the word culture is derived from crop), and certain plants have some fundamental properties for ceremonies and rituals.

With the birth of the republics in Latin America, indigenous Andean communities increased their chances of influencing the public sphere, interacting with the new state to guarantee their rights, but things did not change much. The Indians began to organize protest, as shown in the case of Cochabamba, Bolivia in 1881, where the natives of the country gathered to defend the right to sow their own food and require support to extend their traditional crops. Currently, the planting of local and traditional varieties in the Andean region is socially divided. On the one hand, the rich classes have grown varieties of exclusive consumption and poor farmers grow varieties for subsistence (Zimmerer, 1993).

Contrary to what is commonly believed, Zimmerer's work shows that Inca crops did not use and extend biodiversity in agriculture. Households and ancient indigenous organizations of families were the social units that preserved over the years the biodiversity and ancestral knowledge. The resistance of indigenous peoples to lose their traditions and lifestyles, along with their identity and their right to food sovereignty, had allowed the preservation of traditional knowledge (Zimmerer, 1999). Likewise, the establishment and extension of traditional crops is a form of defense against the domination in the Andean countries and a way of sustaining its food security (Dove, 2006). However, in recent decades the problem of food security has been neglected by the negotiation of ownership of traditional knowledge and biodiversity.

4.2 The negotiation of traditional knowledge and biodiversity

Through the years, indigenous people have been at a disadvantage when negotiating with different researchers and corporations that have been seeking to access their knowledge and biodiversity. Bioprospecting, dating in modern science from the nineteenth century botanical expeditions, has been a topic of concern for indigenous people in recent times. Latin America has many cases in which indigenous communities receive little or nothing in return for their knowledge and genetic resources, due to the institutional gap on issues such as the property of biodiversity, among corporations, research organizations and indigenous people (Palacio et al., 2005; Zerda & Forero, 2002). As anthropologist Brush (1993, p. 658) states: "*Since the biological resources of indigenous people are increasing in value to industrial countries, why should indigenous people continue to operate under the common heritage principle by providing their knowledge and resources as free goods*?".

Simpson (1997), consistent with Brush (1993), sets out three possible ways to compensate indigenous knowledge in negotiations with modern organizations. The first is direct compensation agreed upon between indigenous communities and organizations, which generally seeks a market transaction and when indigenous people are in disadvantage.

The second came to the Third World Network proposal in the 90s (Zerda & Forero, 2002) and the Food and Agricultural Organization – FAO. This proposal steers governments to define a type of trusteeship between indigenous peoples and relevant State agencies to invest in development projects. The third is a bottom up approach where indigenous customary law based on their ability and organization, as well as support from public and private organizations on legal issues, negotiates and makes their arrangements in keeping with their own will.

One of the key points in the discussion on the negotiation of traditional knowledge and biodiversity is to understand the vision on this issue with the indigenous leaders. In 2005 the Misak Guambiano community living in the department of Cauca in Colombia, as stated by de la Cruz (2006), issued the following statement on its website:

"We live with biodiversity, we live by it, and we keep it without destroying it in a sustainable way ... because these are our sacred and ceremonial sites. … Because the Earth is our mother and mother is not exploited, is not traded, not sold, because we would be destroying its spirit and our essence, so we cannot allow you to extract and use its resources to patent and privatize living by destroying biodiversity. For this reason we fully protect what is our Mayor Right. And for the same reason we organize ourselves better every day, with more strength, to defend with honor and dignity these resources, which are not the product of men but of our gods. They left them to serve us, and for us to care for and manage them and not to exhaust them, sell them or allow others to expropriate. The world has been witness to our struggle to improve our lives.."[1]

de la Cruz (2006) argues that many similar statements have been made by indigenous peoples of the Andes, Amazon and in general from other regions in the world. Organizational skills, as they themselves acknowledge, are essential to ensure respect for their rights. Certainly statements such as the International Indigenous Forum on Biodiversity (IIFB) [2], organization discussed below, are clear in stating that:

"...our collective knowledge is not a commodity to be traded like any object in the market. Our knowledge of biodiversity is indivisible from our identities, laws, institutions, value systems and worldviews as Indigenous Peoples. For generations, our peoples have been and remain the guardians of nature from which we all depend. We are therefore totally committed to the first two objectives of the Convention which are the conservation and sustainable use of biodiversity. But any discussion of the third objective on access and benefit sharing must recognize the fundamental rights of indigenous control of our own knowledge, the right of free prior informed consent as peoples and our collective territorial rights"[3].

Traditional knowledge is understood then, as invaluable in the field of goods, given that it is indivisible and not individually appropriated. This knowledge is part of the same traditions of the people and their ways of interacting with their environment. In itself this knowledge governs a lifestyle, an identity that can not be alienated or lost because it is the mechanism for continued community dignity.

The intellectual property system that enshrines the individual's monopoly of knowledge clashed with the ways in which indigenous peoples understand their resources and their environment. Although there are success stories like the Shaman Pharmaceutical Company in Ecuador and Colombia, as well as Merck and INBio in Costa Rica (Landon, 2007), most

[1] http://colombia.indymedia.org/news/2005/11/33423.php Retrieved February 25, 2011
[2] http://iifb.indigenousportal.com/about/ Retrieved February 25, 2011
[3] http://www.prodiversitas.bioetica.org/doc59.htm Retrieved February 25, 2011

cases result in biopiracy and patent litigation (Restrepo, 2006) or in simple exchanges that do not suitably compensate the value of genetic resources (Zerda & Forero, 2002). Negotiations among indigenous communities and other organizations are difficult because the former are not used to thinking in terms of profits or revenue sharing. It is also unclear how specific communities are the exclusive possessors of the resources, and what benefits are to be received in case of finding commercial uses of biodiversity. Finally, there is no clear institutional framework for negotiations and deals which have impeded the sustainable use of biodiversity (Palacio et al, 2005).

The Andean region has formed the Indigenous Working Group on Biodiversity of the Andean Community (CAN), which proposed that *"...given the characteristics of traditional collective and comprehensive knowledge of indigenous people, it is recommended for their protection the use of their ancient systems, that is, on the basis of customary law and cultural practices of their own, allowing communities to strengthen their traditional strustures ."* (cited by de la Cruz, 2006, p. 7).

Customary law is a foundation of collective rights formed by the habits of a population. Unlike positive law, which focuses on the writing of laws, customary law rests on the cultural background and knowledge to establish traditional standards of behavior. Developing a form of intellectual property rights, collective and fair with traditional knowledge and genetic resources used by the natives, and entering into dialogue with the positive law, is a very important issue today. The negotiations of indigenous communities are very varied making it necessary to not only consolidate indigenous organizations, but also to support regulation and enforcement of indigenous rights (Palacio et al, 2005; Zerda & Forero, 2002) The only country with progress in this area is Peru (de la Cruz, 2006), which in 2004 created the National Commission for the Protection of Access to Peruvian Biological Diversity and the Collective Knowledge of Indigenous Peoples working with other indigenous organizations in Peru in the negotiations and demands for rights.

Zerda & Forero (2002) understood that the 'Alternative Proposals' to the Third World Network will not help the development of the deals and negotiations between indigenous people and other actors. The authors call for institutional and organizational strengthening of indigenous communities, and predicted the creation of international organizations that represent indigenous matters as the CBD. Progress in indigenous law is accompanied by the organizational capacity of communities to represent and defend their interests and rights. Organizations are the means to steer governance in their own affairs.

4.3 The organization of indigenous peoples

Indigenous peoples since the nineteenth century in the nascent American republics have been defending their rights to preserve their lands, livelihoods, culture and resources. Undoubtedly, new organizational forms will enter to define the way in which indigenous peoples can increase the power of governance over their own destiny. As noted, the negotiations between indigenous communities and organizations for research and production have a profound inequality, and eventually run relationships where the indigenous community will never receive benefits, unless it is properly organized.

The mechanism by which communities have preserved their traditions, cultures and forms of social reproduction have been through regional organizations of indigenous peoples. These organizations in the Andes began to appear since the 1980's to differentiate themselves from the farming peasants and have an entity, legally capable of representing

their rights at national and international level (Yashar, 1998). For example, Colombia's indigenous regions of Cauca, Chocó, Sierra Nevada, Córdoba, Llanos Orientales and Tolima gathered in 1982 to create the National Indigenous Organization of Colombia – ONIC (http://www.onic.org.co/nuevo/sobrenos_n.shtml), which currently represents all the country's indigenous communities. Similar cases occurred with the Confederation of Indigenous Nationalities of Ecuador (http://conaie.nativeweb.org/) and the National Indian Council of Venezuela – CONIVE (http://www.conive.org/). Also, organizations have been established in eco-geographic order like COICA (Coordinating Body of Indigenous Organizations of the Amazon Basin), which rises in response to the Amazon Cooperation Treaty signed in 1978 by the Amazon basin countries. The treaty did not consider the indigenous peoples, who finally organized themselves in the creation of COICA in 1984.

Organizations have enabled indigenous peoples to have a capacity of voice and collective defense of their rights. Support of States, various NGOs and various grants and contributions has allowed indigenous organizations to have communication channels and means of negotiating with modern society. One of the most relevant businesses for indigenous communities is to govern their natural resources and traditional knowledge, additional development of indigenous law, and legal organizations represented are the mechanisms to accomplish this.

For example in Peru, the National Institute for the Defense of Competition and Intellectual Property Protection INDECOPI established the program "Towards the effective protection of the collective knowledge of indigenous peoples", which provides training in indigenous law and forms of negotiation, as well as ways to protect the property of their resources. In early 2000, the company PureWorld Inc U.S. patented applications and uses of *maca*, a plant native of Peru. Thanks to the management of INDECOPI and the National Commission for the Protection of Access to Peruvian Biological Diversity and the Collective Knowledge of Indigenous Peoples, the patent was promptly canceled because it was recognized that there is no change or novelty from the holder different from that of the Peruvian indigenous peoples who have cultivated this species since ancient times (Landon, 2007).

Also, is worth to remember the famous case of Yage or Ayahuasca, which is a root of an Amazonian tree whose medical effects are sacred in the ceremonies of the Amazon tribes. In the early 1990's a California man named Loren Miller obtained the patent for yage to be exploited by his company, the International Plant Medicine Corporation. By the end of the 1990s, pronouncements by indigenous peoples and their organizations on the subject were strong and repeated (Muelas, 1997). In 1999 the Center for International Environmental Law – CIEL, an American organization, represented COICA and the Coalition for Amazonian People and Their Environment (Amazon Coalition) in applying to revoke the patent.

There are at least 30 large organizations with international prominence, serving different indigenous issues. One of the most important is the International Indigenous Forum on Biodiversity [IIFB] (http://iifb.indigenousportal.com/about/) created in 1996 for negotiations on the Convention on Biological Diversity. This organization works for states to enable them to respect, preserve and maintain traditional knowledge and biodiversity management. As mentioned before, the Andean countries created the Indigenous Working Group on Biodiversity of the Andean Community (CAN). This body is responsible for matters related to the Andean Decision 391 on traditional knowledge and genetic resources of biodiversity in indigenous communities.

In October 2010 the IIFB ended the Nagoya Protocol to be signed in 2011 and 2012 to regulate the issues of fair and equitable compensation of benefits arising from the use of genetic resources and biodiversity. In this regard the IIFB declared on October 29, 2010 that:

"*With the adoption of the Nagoya Protocol on Access to Genetic Resources and Fair and Equitable Sharing of Benefits, governments have enacted international legislation in relation to genetic resources and the associated traditional knowledge. Indigenous people and local communities have spiritual values, ethical standards, and rights under customary laws that guide us in the use of our lands, territories, resources and traditional knowledge, which must be respected. The parties have agreed to take action under national law to uphold the law, human rights and Indigenous People to protect traditional knowledge. But there is more to do to stop biopiracy. Look forward to working with governments for fair and meaningful implementation*"[4].

The continuity of worthy life in communities depends on their ability to organize, to exercise their form of customary law, and has to impact on the level of legally binding negotiations. Also, it is important for indigenous peoples to enhance their capacity to have voice and communicate. In this aspect, the World Summit on the Information Society declared explicitly the importance of "exploring the viability of establishing multi-stakeholder portals for indigenous people". Furthermore, launch education and training programs for indigenous people to provide them participation in the Information Society. The initiative also stated the development and implementation of policies "to preserve, affirm, respect and promote the diversity of cultural expression and indigenous knowledge and traditions through the creation of varied information content and the use of different methods, including the digitization of the educational, scientific and cultural heritage", enhancing "the capacity of indigenous peoples to develop content in their own languages", and finally "cooperate with indigenous peoples and traditional communities to enable them to more effectively use and benefit from the use of their traditional knowledge in the Information Society" (WSIS, 2003).

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