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DIVERSIFIED CROP INDIGENOUS SYSTEM AND LOCAL DEVELOPMENT IN ECUADORIAN AMAZONIA

Sistema indígena diversificado de cultivos y desarrollo local en la Amazonia ecuatoriana

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ABSTRACT. Amazon *Kichwa* agrobiodiverse system is analyzed, focusing on the main promising species capable of added value, which are associated to diversified crops, income and economic quantification of agrobiodiversity profitable forms, as elements to establish sustainable local development strategies for rural communities in the colonized sub Andean central sector. Qualitative methods were used by means of registering in nine research events with communities and its regional organizations as well as quantitative methods through 64 surveys applied to six rural communities down, mid and upstream of *Anzu* river. Up to 482 flora species were recorded but not their uses; a list of cultivated species is established based on its usage, consumer acceptance, relative abundance and possibility of added value; undervaluing of system contribution is analyzed, since its quantification does not exceed 15 % of total family incomes, although communities establish 67 % dependence on forest and agricultural resources for food livelihood. Joint and permanent processes, projects and plans are suggested, known at community meetings, based on a participatory dialogue, a legal agreement and respectful ethics to collective rights, which enable to keep partnerships between universities, communities and other entities, in order to investigate, argue and share benefits, information, technology and knowledge transfer.

Key words: agrobiodiversity, local communities, rural development, sustainability

RESUMEN. Se analiza el sistema agrobiodiverso Kichwa amazónico, con énfasis en las principales especies promisorias susceptibles de agregación de valor y que están asociadas a sus cultivos diversificados, ingresos y cuantificación económica de las formas de aprovechamiento de la agro biodiversidad, como elementos para establecer estrategias de desarrollo local sostenible para comunidades rurales en el sector central sub andino colonizado. Se utilizaron métodos cualitativos mediante registros en nueve eventos de investigación con las comunidades y sus organizaciones regionales y métodos cuantitativos, a través de 64 cuestionarios aplicados en seis comunidades rurales en el curso bajo, medio y alto del río Anzu. Se informaron hasta 482 especies de flora pero no sus usos; se establece un listado de especies cultivadas, en función del uso, aceptación de consumo, abundancia relativa y posibilidad de valor agregado; se analiza la subvaloración del aporte del sistema, pues su cuantificación no supera el 15 % del total de ingresos familiares, pese a que las comunidades establecen un 67 % de dependencia de los recursos de la selva y agropecuarios para la subsistencia alimentaria. Se propone construir procesos, proyectos y planes de acción conjunta y permanentes, conocidos en asamblea por las comunidades, en base a un diálogo participativo, un marco jurídico y una ética de respeto a los derechos colectivos, que permitan mantener nexos entre la universidad, las comunidades y otras entidades, para investigar, replicar y compartir beneficios, información y transferencia de conocimientos y tecnologías.

Palabras clave: agrobiodiversidad, comunidades locales, desarrollo de la comunidad, sostenibilidad

INTRODUCTION

Indigenous peoples of the world rely on the products of nature; they have occupied and used certain territories since national states were about to be structured. Also, they keep their identity, have some experience on rejection and submission;

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however, they have got peculiar features and knowledge that can contribute to sustainable and equitable development (1). Many of them migrate when resources are depleted in the area, until the natural environment is regenerated and can be used again (2). Regarding their world view, Amazonian indigenous peoples carry out subsistence farming systems to preserve biodiversity, as a result of culture and territorial control by local communities, proving autonomy, knowledge, identity and economy (3).

Life systems of indigenous peoples are disturbed by diverse processes such as development, political decision-making, exploitation of natural resources, mining, urbanization, modernization, advanced infrastructure, climate change and global warming (2). Amazon colonization was caused by these developing experiences, which applied knowledge and power derived from a completely different rationality to the one existing in every place (3); besides, it divided possession of the original indigenous territory in the colonized area, but not their biodiverse and subsistence agriculture systems.

Meanwhile between 2012 and 2013, Ecuador raised five points at the Human Development Index (HDI), from 0,708 to 0,711 HDI, to settle in the 95th place, as a mid HDI country of the Ecuadorian Amazon region, in the largest indigenous population provinces, where the worst poverty indicators are still recorded, a discordant concept representing Amazonia as a plenty space (4). Although studies on the Amazon basin emphasize deforestation as the main responsible for forest reduction (5), few studies have been carried out on the borders of colonization, indicating the difficulty in collecting data (6). Amazon *Kichwa* indigenous communities remain on the border of colonization with their wealthy living systems, their agriculture adapted to the environment and use of biodiversity, despite the economic income disadvantages to meet their demands of clothing, education, transportation and health, mainly because of a deficit use of Amazonian biodiversity and scientific knowledge production considering their own community ethnic level, possibilities and territorial resources, in terms of sustainability, as those development models assigned to Amazon region have not provided any benefit to its people. Such considerations place added-value agricultural options and human capital training as new development prospects in indigenous nations.

The aim of this research study is to analyze Amazon *Kichwa* agrobiodiverse system, the main promising species –those associated to its diversified crops- that can add value and incomes from using Amazonian agrobiodiversity in six rural communities pertaining to the territory from the native Ecuadorian Amazon *Kichwa* nation, affected by colonization in *Anzu* valley and its perception argued with Amazonian indigenous representatives, so as to establish a sustainable local rural development strategy.

MATERIALS AND METHODS

Location and geographic features. *Kichwa* indigenous communities of the studied area come from Napo province and have been permanently settled since late 20th century, except *Union de Llandia*, with more farm immigrants from Inter-Andean region or Sierra, as a result of colonization process. They are located from 508 m up to 1 200 m over sea level on the eastern slopes of central Andes, to the south of sub-Andean zone, known as *Napo Elevation*, on hydromorphic alluvial soils of forest vocation, volcanic origin and conservation purposes; soils which are made up by debris cones in the Amazon mountain bottom, as a consequence of melting plio-quaternary icecaps and volcanic or seismic activity (7). These communities are situated in the tropical rainforest, where rainfall exceeds 6 000 mm per year, with an average temperature between 20 and 24^{o}C, a tropical wet climate and a topography with hills, from relatively flat lands on lower areas up to slopes of 70^{o} or more at higher altitudes.

Measured indicators. Amazonian *Kichwa* agrobiodiverse system cycle; main promising species capable of adding value, which are associated to its diversified crops; income and use of Amazon agrobiodiversity; perception of sustainable local rural development strategies.

Methodology

Selected communities. Six communities from the non-served rural areas along the main Amazon trunk road were selected down, mid and upstream of *Anzu* river, considering their vulnerability, besides belonging to a colonization sector which extracts resources and destroys its material base of existence. Community approach was designed through contacts with its leaders and members; permission to develop this research was given by consensus at a community meeting and field investigation took place between July, 2012 and July, 2014 through using qualitative and quantitative methods.

Qualitative methods: a case study and participating observation in nine public events at *Kichwa* national communities, where they discuss their changing reality and state their own judgment about the way that best meets their aspirations (8). They also inquired about Amazon *Kichwa* agrobiodiverse system, the main promising species capable of adding value, which are associated to its diversified crops, the use of technologies adding value to raw materials, the link with universities and quality of education.

Quantitative methods: a statistical method was applied to measure impact (9, 10) by surveying the 64 families from six communities as well as their leaders. They appeal to probable income maximization and diversification risks (6) through questions about the use, destination and economic quantification of Amazonian agrobiodiversity profitable forms assuming "how much", "how much you can buy", "how much you can sell" for the reference year 2012.

RESULTS AND DISCUSSION

Amazonian *Kichwa* agrobiodiverse system is made up by *chacra-ushun-purun* cycle and the use of renewable forest resources in seasonal runs.

Chacra has a variety of species that meets annual food needs of the family; firstly, corn or banana are planted; afterwards, cassava, bean, orange, tangerine, cacao, bitter orange, "chonta", pepper, squash, papaya, pineapple and other species. They are settled down primary or secondary forests to take advantage of organic fertility and are allowed to grow for several years.

After the first year or early harvests, it is named *ushun*, cassava and other root crops are planted again; bananas, useful palms and fruit trees increase whereas cassava and bananas are harvested, *ushun* continues as such.

However, when harvest ends, it is transformed into *purun*, a natural regeneration process during which trees and palms are grown to form secondary forests with great diversity of useful tree species probably reaching a wooded shape, plenty of edible and useful species to obtain biological preparations for medical, medicinal and food purposes.

The use of renewable forest products is complemented by running towards the ancient *purun*, hunting and fishing reserves, called *purines*. Communities report food, medicinal, craft and mythological uses of flora and fauna species from *chracras*, *ushun*, *purun* and *purines*. Meanwhile in the low forest, other communities record up to 366 flora species, 28 mammal species, 51 bird species and 141 fish species (11), in the study area, *Kichwa* communities have up to 38 mammal species, 62 bird species and 482 flora species (12); thus, there are more species, but not all the possible uses of known species are reported, as the communities from the low forest do. This fact suggests that the knowledge of existing species in *Kichwa* indigenous territorial system, including its uses, are at the risk of decreasing, as colonization border advances; however, it is notable that indigenous territories keep their rich biodiversity, even in colonized areas and resources are only used as raw materials without applying science and technique to add value; this could be obtained by linking research projects with universities from the local territory.

Some species from *Kichwa* agrobiodiverse system are also destined for sale. Table I shows forest product destination to domestic use and sale.

On average, more than half the families extract forest products to use them for subsistence rather than for sale. The amount of money that families receive from forest products constitutes one part of their annual income declared.

Table I. Quantification and destination of forest resources (2012), in percent and cost (USD)

Use of forest products	Tzawata	Wayuri	Flor de bosque	Boayaku	Unión de Llandia	Veinticuatro de mayo	Average
Families extracting forest products (%)	34	67	78	85	40	50	59
Domestic use of forest products (%)	70	100	70	7	21	42	52
For sale (%)	30	-	30	93	79	58	48
Annual average per family extracting (USD)	520,00	215,00	533,00	960,00	813,00	160,00	534,00

Prepared by the authors based on household surveys

Regarding diversified crop species, *chacras* from *Kichwa* communities are also ecological, symbolic, economic and social areas of mutual work among family members (13); as long as they have more useful diversified crop species, they give more prestige to families and communities, better conditions of survival, knowledge, profits and work.

Chacras do not use any chemicals and reach up to 107 associated species, such as food, ritual, medicinal, flavoring, cosmetic and even a toxic one called "barbasco" (*Lonchocarpus utilis*) used for fishing (11); this empirical knowledge should be strengthened by studying collections, crop associations and *in situ* germplasm bank facilities that allow to search on a wide biodiversity, to develop added-value products and agro-industrial processes through scientific projects with universities from the territory, considering the performing way, work rhythm and community needs, not by a linear way, without considering the length of holistic time at the community (14).

Table II shows food, medicinal, flavoring, cosmetic, ritual and toxic plants used at the communities studied. Many of them have the possibility of increasing its plantation and added value, because of their high organoleptic, digestive and nutritional qualities (15), except ritual and toxic ones, which have a specific crop use.

Those species present in the table may have more than one type of use known by communities, also all or some of them may have properties for biological preparations, probiotics, prebiotics, omega essential oils and other profitable qualities needed for the research work. Associated to crop diversified farming system structures of local communities, there is an increasing plantation in these ecosystems and network relationships between families; however, it is neither desirable nor appropriate to establish monocultures.

Table II. Food, medicinal, flavoring, cosmetic, ritual and toxic plants at the communities studied

Common name	Scientific name	Use
Food plants		
Achiote	*Bixa Orellana*	Food colouring. Used for burns
Celery	*Pouteria caimito*	Fruit, canned goods
Uvillas	*Puorouma tomentosa*	Fruit, canned goods
Chontaduro	*Bactris gasipaes*	Fruit for human consumption; qualities for oils, animal food, soaps
Guabas	*Inga* sp.	Fruit, canned goods
Killa	*Theobroma bicolor*	Fruit; for chocolate and drinks
Groundnut plant	*Caryodendron orinocense*	Fruit; for oils
Morete	*Mauritia flexuosa*	Fruit, canned goods, crafts
Bitter orange	*Solanum quitoensis*	Fruit, canned goods and essences
Paparagua	*Artocarpus altilis*	Fruito, qualities to control cholesterol
Puka kambi	*Theobroma subincanum*	Fruit, canned goods
Medicinal plants		
Chuchuhuazo	*Maytenus macrocarpa*	Rheumatism
Curarina	*Potalia amara*	Snake bites
Guayusa	*Ilex guayusa*	Invigorating, refreshing
Leche de ojé	*Ficus insípida*	Stomach upsets
Dragon tree blood	*Croton lechleri*	Hurts
Cat claw	*Uncaria tormentosa*	Antioxidant
Flavouring plants		
Pepper	*Capsicum sp*	Hot spice. Antimicrobial
Garlic	*Mansoa alliacea*	Spice. Antimicrobial
Ishpingu	*Ocotea quijos*	Flavouring spice
María panga	*Piper peltatum*	Flavouring spice: Used for pains
Cosmetic plants		
Shiwa	*Oenocarpus bataua*	Hair care oil
Wituk	*Genipa americana*	Natural colouring
Ritual plants		
Ayahuasca	*Banisteriopsis caapi*	Contact with spiritual world by shamans
Resin	*Protium fimbriatum*	Candle wax
Incense	*Clusia cf. Multiflora*	Flavouring, environmental purification
Waira panga	*Siparuna thecaphora*	Cleaning spiritual world by shamans
Wantuk	*Brugmancia suaveolens*	Contact with spiritual world by shamans, protection against serious bruises
Toxic plants		
Barbasco	*Lonchocarpus utilis*	Fish toxic

Prepared by the authors based on field research

Concerning income and economic composition on the use of Amazonian agrobiodiversity, besides the species listed in Table II and the extraction of soft wood for containers of goods and fine wood for furniture and house construction, families grow banana, cassava, Chinese potato, bitter orange, sugar cane and citrus crops for consumption and marketing, among the main species that help family economy, besides raising domestic animals. On the other hand, money incomes are also provided from businesses and jobs, bonuses and human development subsidies to families living under material poverty conditions (Table III).

Renewable forest resources, both for domestic use and for sale, are not considered a direct cash income but a quantity of money collected of all goods and services of the community system in the study area (6).

Cash incomes, in US dollars, coming from a private business and an outer home job are higher than other incomes in all communities, except in *Union Llandia*, where the amount of crop and animal properties reaches 53 % and in *Boayaku*, where there is a similar percentage to that of crops and animals, both of 41 %.

These cash incomes are not available for every family within each community, but it happens in all communities. It is the most differentiating economic factor, which confirms that one or more members expect to receive remittances to alleviate the pressure on scarce resources, such as land and house space, as a risk minimizing strategy and income diversification (6); besides, forest products do not strongly appear in the accumulation strategies of rural rich people[A] and Amazon farm incomes are, on average, lower than at the national level, which encourages Amazonian rural population to seek for alternative sources of income; when people have neither capital nor education, they look for agricultural wage-earning job, but if they have financial and human capital, they are able to face the barriers to get into their own businesses (16).

The amount of crops and animals is higher in *Union Llandia*, *Boayaku* and *Veinticuatro de Mayo*, with 53, 41 and 40 % respectively, closer to the border of colonization, transport roads and whose *Kichwa* population is 20, 85 and 50 % out of the total. The three communities with 100 % *Kichwa* population, *Flor de Bosque*, *Tzawata* and *Wayuri* have 22, 15 and 9 % in this record; however, it was observed that subsistence *chacra* size and cash crops increased, which indicates marketing orientation and not only subsistence as it traditionally was. Sale destination is declared in every community, but not all families have marketing production. The growth of a fine aroma cocoa (*Theobroma* sp.) begins to be encouraged in the area, which also needs added value on behalf of community development. This scene enables project development linked with higher academic institutions.

Forest resources reach 15 % money contribution in *Boayaku* families, located on the border between colonization and forest, 12 % in *Tzawata*, 10 % in *Flor de Bosque* and 5 % in *Wayuri,* at *Kichwa* communities, proving the profitable use of woods, crafts, animals, medicine, housing fibers, utensils and foods, among others; meanwhile *Union de Llandia* indicates 8 % and only 1 % in *Veinticuatro de Mayo*. However, on average, communities reported 67 % dependence on local resources for food subsistence.

[A] Cavendish, W. *How do forests support, insure and improve the livelihoods of rural poor? A research note* [en línea]. Center for International Forestry Research, Bogor, Indonesia, 2003, 23 p. [Consultado: 30 de marzo de 2013], Disponible en: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.205.9472&rep=rep1&type=pdf>.

Table III. Monetary income differentiated between income sources and communities

Incomes and renewable resources (for domestic use and sale) quantified in a year	Tzawata (12 surveys)		Wayuri (6 surveys)		Flor de bosque (9 surveys)		Boayaku (13 surveys)		Unión de Llandia (20 surveys)		Veinticuatro de mayo (4 surveys)	
	USD	%	USD	%	USD	%	USD	%	USD	%	USD	%
Businesses and jobs	20 760	61	17 650	80	37 080	64	41 370	41	25 760	32	24 780	56
Bonuses and ubsidies	4 200	12	1 260	6	2 520	4	2 940	3	5 880	7	1 260	3
Crops and animals	5 030	15	2 090	9	12 485	22	40 745	41	43 345	53	17 855	40
Forest resources	3 975	12	1 020	5	5 540	10	14 670	15	6 800	8	480	1
Total amount year 2012	33 965	100	22 020	100	57 625	100	99 725	100	81 785	100	44 375	100

Prepared by the authors based on household surveys

This finding shows that although money incomes are important, rural resources, their agrobiodiverse systems, forests, crops and animals, in general, are still very important for self-subsistence; it seems evident that forest resource evaluation is poor and inconsistent with its significance, since it is considered that western Amazon –where Ecuador and the study area are located- is one of the most biodiverse areas of the planet, the home for several indigenous peoples, which keeps intact the wet tropical forest portions besides a high probability for stabilizing weather conditions facing global warming problems (17, 18).

It also states that biodiversity preservation and sustainable management of ecosystems are key elements in the policies and strategies of poverty reduction from global, national and local levels for 70 % of the world's poor people living in rural areas depending directly on biodiversity for their survival and well-being (19, 20, 21, 22). It is necessary to repopulate and revalue native renewable resources used by communities, to add value and make up human capital for its care.

As for the perception of sustainable rural local development strategies for the communities under study, it was observed that such communities are in the rural area and have not migrated to the city that grows and multiplies its pollution problems, lacks supply and has increasing demand of resources for consumption. Through the indicators measured, the identity, its Amazon agrobiodiversity system structure, as well as the knowledge of susceptible species to added value and money vulnerability were evident to solve material needs. Table IV summarizes the analysis carried out among indigenous organizations and the Amazon State University of *Puyo*, Ecuador.

To meet investigation needs, research, linking and teaching networks are proposed to form, incorporating ancient cultures, wise men and their rites; to enable some specialization on ancestral knowledge and institutionalize a linking policy with community on academic evaluation. Also, Ecuadorian state prevents an urgent discussion about strategies that help sustain the national competitive advantage, based on natural and biological wealth, supported by the development of productive and local generation technology networks, to encourage Prometheus scholarship program and the facilities of an Amazonian regional university (23).

In this opening context of collaboration for community support, it is necessary to make more specific plans of action with respect and common benefit for all communities.

Table IV. Agenda to promote ecological sustainability

Problems	¿What to research for?	Proposals
-Higher education is not always accessible; it does not always recognize indigenous supply, nor search for knowledge discussion on behalf of community benefits; it is a social differentiating factor that can functionally serve extractive sectors or bio-pirating. -The university has a linking job that is not quite recognized; it has some pressure of marketing logics before generating science, culture, local art. A higher interdisciplinary job and ancestral knowledge incorporated to public policies are required. - Educational quality in communities is low, dislocated; it lacks information and long-term job conscience. Indigenous communities expect short-term results.	- Alternative income sources with emphasis on local biodiversity, ecology, charging capacity, reforestation, animal and Amazon fish rising, agroecology and native plants processed with marketing potential. - Philosophy, performance to interrelate among community needs, income possibilities and supporting institutional mediation. - Dynamics of use and ancestral systems of territorial management, etnobotany, intellectual property, knowledge papers, biogeochemical cycles, renewable energy. Release and adaptation to climatic change. - Socioeconomic and demographic studies. Women's role on environmental preservation and sustainable management of resources. Emigration, immigration and cultural changes.	-Construir procesos, proyectos y planes de -To make up processes, projects and joint or permanent plans of action; known in community assembly; based on a participatory discussion, a legal context and a respectful ethic to collective rights; allowing to keep links between universities, communities and other entities, so as to investigate, replicate and share benefits, information and transfer knowledge or technologies. -To include ancestral knowledge in the curricular net; to involve nationalities into academic processes and investigations related to biodiversity.

Source: Prepared by the authors based on the workshop of Amazon State University (UEA) with rural and indigenous communities as well as state institutions from Zone 3 (Pastaza, Tungurahua, Chimborazo and Cotopaxi), to encourage ecological sustainability within the adaptive framework to climate change at the Amazonian Biodiversity Preservation, Post grade and Research Center, UEA, Puyo, June 10-11, 2014.

CONCLUSIONS

- Amazonian *Kichwa* agrobiodiverse system cycle of six of their communities is presented with the main promising species -associated to their diversified crops-, which can add value, incomes and economic composition of Amazonian agrobiodiversity use in these rural communities located in the territory of Ecuadorian Amazon *Kichwa* indigenous nation.
- It is notable that *Kichwa* indigenous territory studied maintains agrobiodiverse systems, but there is a risk of losing resources, structures and ancestral knowledge, as a result of market influence and colonization processes.
- It is necessary to make up strategic solutions between communities and territorial universities for developing their power and own knowledge, improving population permanence in the rural sector and strengthening not only their identity, but also their social, mutual and popular economy, natural heritage stability and biological knowledge through Amazonian fruit processing, enrichment and support of agro-ecological systems.

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