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The Dynamic Interrelationships between Ethnicity and Agrobiodiversity in the Pearl Lagoon Basin, Atlantic Nicaragua

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The Dynamic Interrelationships between Ethnicity and Agrobiodiversity in the Pearl Lagoon Basin, Atlantic Nicaragua

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

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by

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ABSTRACT

The Dynamic Interrelationships between Ethnicity and Agricultural Biodiversity in the Pearl Lagoon Basin, Atlantic Nicaragua

by

Nicholas Enyart Williams

This dissertation characterizes the ways in which increased global connectedness differentially impacts agricultural decisions among the ethnically-diverse farming households in Atlantic Nicaragua's Pearl Lagoon Basin, with specific focus on farmers' maintenance of agrobiodiversity. Research conducted in other parts of the world has shown correlations between a farmer's ethnic identity and the agrobiodiversity they maintain within their farming systems. These trends remain even as small-scale farmers are connected to extra-local political and economic systems, which are cited as the drivers of global agrobiodiversity erosion. Yet, *how* ethnicity influences the maintenance of agrobiodiversity is poorly understood.

Employing a political ecology framework that integrates ethnographic, demographic, survey, and agroecological methods, this research identifies that ethnically-distinct planting strategies exist among the Pearl Lagoon Basin's indigenous (Miskito), Afro-descendant (Creole and Garífuna), and mestizo farmers. Consistent with patterns identified by researchers elsewhere, farmers who identify with the area's indigenous and afro-descendant "minority" groups tend to maintain more diverse farms than nearby farmers who identify as

mestizo, particularly those who are recent migrants to the region. In contrast to the findings of previous studies, however, the *most connected* farmers in the Basin tend to have the *highest* levels of agrobiodiversity within their farming systems.

Qualitative and regression analyses reveal that ethnic patterns in the maintenance of agrobiodiversity are explained in part by the historical farming practices that characterize land use in the Basin and the agroecological knowledge that farmers develop over a lifetime farming in this socio-ecological context. Further, by acknowledging the plastic nature of ethnic identity, this research also highlights the importance of ethnic-based land rights in the Nicaragua's Atlantic Autonomous Region as a critical factor that both directly and indirectly influences the ethnic identities of farmers in the Pearl Lagoon Basin and their abilities to participate in agricultural development projects whose extension activities promote agrobiodiversity conservation.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

I. Introduction

1.1 Problem Statement

Researchers identify biodiversity in agricultural systems (herein agrobiodiversity) as critical to both food security and ecosystem integrity (Thrupp 2000; Jackson, Pascual, and Hodgkin 2007; Harvey et al. 2008; Brussaard et al. 2010). Despite its importance, agrobiodiversity has declined globally since the mid-20th Century (for examples, see Thrupp 2000; Bellon 2004; Brush 2004; Jackson et al. 2007). Scholars attribute this decline to the spread of ideas, values and technologies associated with the 'Green Revolution[1],' including rural development policies that encouraged adaptation of 'modern' agricultural techniques and market-oriented planting strategies (Thrupp 2000; Zimmerer 2010).

Concerned with promoting agrobiodiversity, researchers have sought to identify farm-, household-, and community-level factors that correlate with the maintenance of agrobiodiversity—which combines the cultivation of domesticates and the conservation of wild plant species within an agroecosystem—by farmers in an increasingly connected world (Coomes and Ban 2004; Major, Clement, and DiTommaso 2005; Perrault-Archambault and Coomes 2008). Some of this work reveals strong relationships between a farmer's ethnicity and the types and degrees of agrobiodiversity that they maintain within their agricultural systems (Kirby 2011; Coomes and Burt 1997; Coomes and Ban 2004; Perreault 2005; Brush and Perales 2007; Perrault-Archambault and Coomes 2008; Trinh et al. 2003; Baco, Biaou, and Lescure 2007; Lamont, Eshbaugh, and Greenberg 1999). In particular, studies suggest

[1] The Green Revolution refers to the development of 'modern' agriculture, based on high-yielding seeds and chemical inputs, such as synthetic fertilizers, pesticides, herbicides, and fungicides. The development and implications of this 'Revolution' is discussed further in Chapter 2.

that members of ‘indigenous’ (or ethnic minority) communities are more likely than their non-indigenous neighbors to maintain high levels of agrobiodiversity (Perreault 2005; Perrault-Archambault and Coomes 2008; Brush and Perales 2007). This pattern echoes a tendency in agrobiodiversity research, and land use research more generally, in which ‘indigenous peoples’ are recognized as the global stewards of agrobiodiversity (Orlove and Brush 1996; Ellen, Parkes, and Bicker 2000; Nazarea 2006; Garí 1999; Solari and Cleveland 1993; Kloppenburg 2008; Godoy et al. 2005).

Yet, while some researchers have identified a link between ethnicity and agrobiodiversity, ***how*** ethnicity works to influence farmers’ decisions to maintain agrobiodiversity is not clearly understood (Veteto and Skarbø 2009). This knowledge deficit results from the failure of researchers to acknowledge and account for the complexities of agrobiodiversity, land use decision-making, and ethnicity. First, there is no unified definition of agrobiodiversity or approach to asses it. Broadly, agrobiodiversity is defined as the diversity of domestic and wild organisms living in an agroecosystem (Zimmerer 2010). However, agrobiodiversity has been measured using a variety of methods based on different assumptions about the importance of agrobiodiversity including: quantifying the varietal diversity of a specific crop maintained on a farm (Brush and Perales 2007; Baco, Biaou, and Lescure 2007), measuring plant species diversity in homegardens (Coomes and Ban 2004; Perrault-Archambault and Coomes 2008; Lamont, Eshbaugh, and Greenberg 1999; Aguilar-Støen, Moe, and Camargo-Ricalde 2008), and examining insects or other biota residing in an agroecosystem (Duelli, Obrist, and Schmatz 1999; Burel et al. 1998).

Further, researchers have identified correlations between single or groups of factors and a farmer’s maintenance of agrobiodiversity, but have failed to account for how these myriad factors may be shaped by or related to larger sociopolitical processes. The focus on ethnicity highlights this oversimplification. While *ethnicities* are relatively stable sociocultural categories that may relate to, for example, the shared histories of group members (Geertz 1973; Barth 1969), anthropologists also have demonstrated that ethnic *identity*, or an individual's affiliation with an ethnic category, can be fluid and influenced by sociopolitical context (Vincent 1974; Cohen 1978). Thus, to understand the relationship between ethnicity and agrobiodiversity, research must examine the ways in which a variety of factors and processes operating at various political scales simultaneously work to influence a farmer's land use decisions, and also how these factors and processes also may shape their ethnic identities.

In light of these considerations, my research employs a political ecology framework that integrates agroecological, demographic, and ethnographic data collected in Atlantic Nicaragua's Pearl Lagoon Basin to answer the central research question: *How does ethnicity influence, and how is ethnic identity influenced by, a farmer's maintenance of agrobiodiversity?* As illustrated in Figure 1.1, this framework accounts for the variety of factors and processes that influence land use decisions, as well as the interactions and relationships between these phenomena.

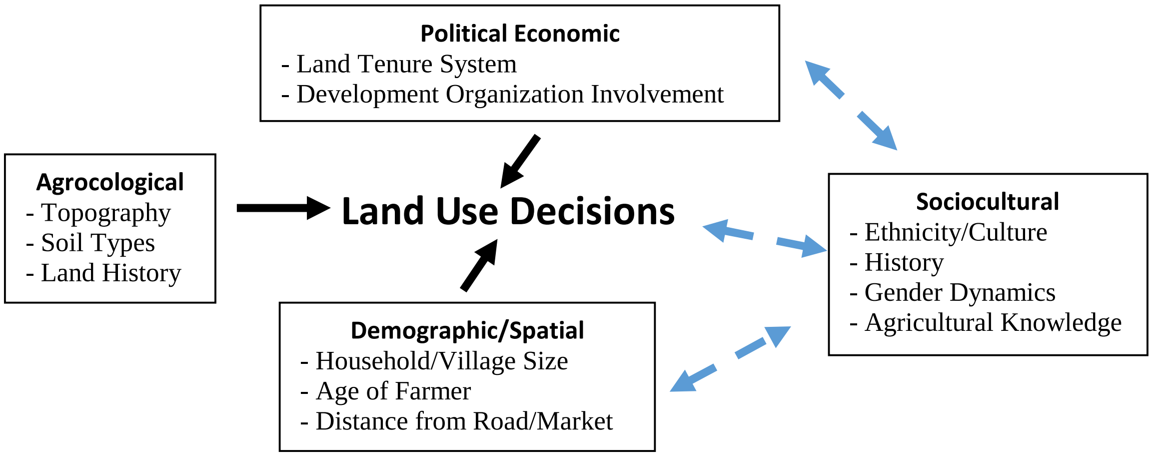


Figure 1.1. This conceptual diagram illustrates the diverse factors that previous agrobiodiversity and land use research identifies to significantly influence land use decision-making, which subsequently shapes a farmer's maintenance of agrobiodiversity. Solid lines and arrows represent previously identified influences, while factors autocorrelating with ethnicity, political factors shaping ethnic identity, and hypothesized feedbacks between the land use decisions and ethnicity are represented by dashed lines and arrows.

To characterize the relationships between ethnicity and agrobiodiversity, I collected and analyzed various agroecological, ethnographic, and demographic data to first determine *if* there is a measurable differences in the levels of agrobiodiversity maintained by famers who identify with the Pearl Lagoon Basin's four main ethnic groups. I hypothesized that farmers who self-identify with the area's indigenous (Miskito) and afro-indigenous (Garífuna) groups have more agrobiodiverse farming systems (measured in terms of species richness, functional diversity, and Shannon Index) than the afro-descendant Creole farmers, while farmers who identify with any of these 'minority' groups have more agrobiodiverse farming systems than farmers who identify with the mestizo majority.

I then assessed the suite of variables that may influence farmers in the Pearl Lagoon Basin to maintain varying degrees of agrobiodiversity within their farming systems. I expected the major factors influencing differences in agrobiodiversity to be: 1) agricultural knowledge 2) (dis)respect for local communal land tenure systems, and 3) participation in agricultural development projects. I also hypothesized that these key factors are related to farmers' ethnic identities. Further, and in contrast to broader patterns regarding ethnicity and agrobiodiversity, I hypothesized that mestizo households that reside in Miskito, Creole, or Garífuna communities have more agrobiodiverse farming systems than mestizos living in more remote parts of the Basin, because they have modified their land use practices in accordance to community land use norms.

1.2 Confronting the concept of ethnicity

While ethnicity as a concept has been unexplored within agrobiodiversity and land use literature, among anthropologists, ethnicities have been characterized sociopolitical groups whose members are believed to share a single or set of characteristics, which might include language, heritage, homeland, religion, or value system (Geertz 1973; Barth 1998; Cohen 1978; Eriksen 2002). Despite relative agreement regarding a basic definition, there is a divergence of opinion regarding how to operationalize ethnicity and approach it as an object of study. "Primordialist" theories of ethnicity suggest that sociocultural characteristics common among farmers that identify with a specific ethnicity, or ethnic category, and share a similar history play a central role in influencing similar land use practices among members of a particular ethnic group (see Hale 2004). Yet, other researchers demonstrate that *ethnic identities*, or affiliations with ethnic categories, often are fluid and context dependent (Vincent 1974; Cohen 1978). Therefore, ethnicity can be measured as a demographic characteristic representative of traits believed to be common among its group members, or it can be recognized as a suite of categories of identification that are activated by an individual within particular social contexts.

My research emphasizes that both of these seemingly contradictory conceptualizations of ethnicity are crucial for understanding the relationship between a farmers' ethnicities and their maintenance of agrobiodiversity. On one hand, ethnic categories can correspond with a mutual history (real or imagined) of a population, which may reflect the shared ethnobotanical and agroecological knowledge, livelihood strategies, and perceptions of their relationship with their natural environment that groups often developed over time in a common socio-ecological milieu. Simultaneously, while ethnic categories in themselves may be relatively stable constructs, individuals actively or passively affiliate with these sociopolitical categories, often in opportune ways. This ethnic plasticity is key to understanding the dynamics of ethnic identity—and how these dynamics relate to land use decision-making—in my study's research site, Atlantic Nicaragua's Pearl Lagoon Basin.

1.3 The political ecology of ethnicity in the Pearl Lagoon Basin

Situated within the Meso-American Biological Corridor[2], the Atlantic Region (or Coast) is also an important site of ethnic diversity within Nicaragua, and within Central America more generally. The Pearl Lagoon Basin (Figure 1.2) is a rural area with particularly pronounced ethnic diversity that includes indigenous, afro-descendant, and mestizo[3] populations who historically maintained ethnically-distinct land use patterns (Helms 1971; Nietschmann 1973; Jamieson 1999). The farming practices of the Basin's

[2] The Meso-American Biological Corridor holds 7% of the world's biodiversity, and the conservation of an intact and healthy ecosystem in this region is critical for maintaining a connection for the flora and fauna of North and South America (Conservation International 2014).

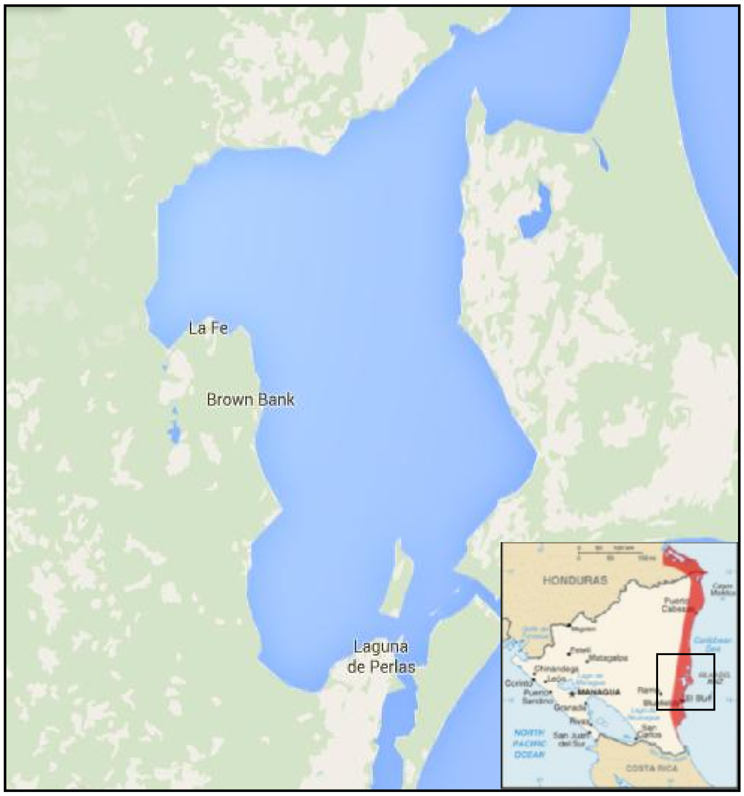
[3] Spanish-speakers of mixed European and Amerindian descent

indigenous and afro-descendant Miskito, Garífuna, and Creole populations have been characterized as biologically-diverse swidden agroforestry systems that include cassava, plantain, coconut, beans, various fruit trees, wild herbs, and a variety of other domesticated and wild species (Coe and Anderson 1996; Coe 1997). In contrast, recently migrated mestizo populations tend to focus on cattle ranching (Jamieson 1999).

While the people of Atlantic Nicaragua have been integrated into global political economic systems throughout the post-Contact period (c. 1620) ((Helms 1969; Helms 1971), the Pearl Lagoon Basin is currently experiencing an era of increased connectedness following the development of the region's first "highway"[4] and the planned construction of a trans-isthmus shipping canal (Anderson 2015). These development have profound impacts upon both regional ecological and social systems. In light of the factors associated with this period of increased connectedness, the Pearl Lagoon Basin serves as an example for understanding the processes and issues regarding how ethnicity relates to the increase, maintenance, or loss of agrobiodiversity in the face of rapid change.

[4] This 80 km 'highway,' which is actually an unpaved dirt track, was completed in 2007 and connects Pearl Lagoon, the largest community in the Pearl Lagoon Basin to the national paved highway system in the town of Rama. While, according to local informants, this road was a point of discussion for decades, it was finally completed under the direction of the Instituto de Desarrollo Rural (IDR) with financial help from the Japanese government (Martínez, León, and Garth 2007). It is important to note, however, that this project was not undertaken until after the establishment of an African Palm oil plantation in Kukra Hill, a community 17 km inland from Pearl Lagoon, and was chiefly intended to help foreign investors expand the agro-industrial African Palm operation (IFC 2010). A dirt spur connects Pearl Lagoon to the Kukra Hill-Rama road.

Figure 1.2 Nicaragua's Pearl Lagoon Basin



Sources: Google Maps and Wiki Commons

1.3.1 Ethnic-based rights

The Pearl Lagoon Basin is located within the Región Autónoma del Atlántico Sur (RAAS), which along with the Northern Autonomous Region (RAAN), was established in 1987 as part of a ceasefire agreement between the US-backed militia—made up mostly of the Atlantic Region's indigenous populations—that was contesting the revolutionary Sandinista government that had come to power in 1979 (Hale 1994; Jamieson 1999). The formal political autonomy granted to the people of the greater Atlantic Region through the Autonomy Statute and related laws grants cultural, political, and material rights—i.e. rights to the region's natural resources—explicitly to the *indigenous* and *afro-descendant* *communities*[5] of Nicaragua's Atlantic Coast (Goett 2006). As such, while many individuals living on the Atlantic Coast may be able to claim affiliation with a number of ethnic categories—including mestizo—exercising an affiliation with one (or more) of the Atlantic Coast's indigenous or afro-descendant groups is requisite to benefit from the rights afforded by the Autonomy Statute and subsequent legal rulings. These benefits include the right to land (Autonomy Statute for the Regions of the Atlantic Coast of Nicaragua, Law no. 28, Art. 9 [1987]).

With the right to land also comes the legitimacy necessary to benefit from many of the governmental and non-governmental agricultural development programs that seek to promote agrobiodiversity in Atlantic Nicaragua. These organizations operate on a breadth of political scales and include 1) NicaCaribe, a federally-directed agricultural extension program that works to distribute already common crops to local farmers in an effort to promote food security throughout the Atlantic Region (Mi Familia 2015); 2) the Nicaraguan Institute of Agricultural Technology (INTA), a federal agricultural extension program that provides information and courses focusing on animal husbandry (INTA 2015); 3) the Black Farmers Cooperative, a government-backed—but locally managed—cooperative that is working to encourage the cultivation of coconuts by farmers around the Pearl Lagoon for export; 4) a regional university that is experimenting with supplying market-oriented crops to select farmers (BICU 2015); 5) and an internationally-funded regional non-governmental

[5] Afro-descendant communities are technically referred to as "comunidades étnicas," or ethnic communities, in Law 445, or the Demarcation Law. This law, passed in 2002, established a communal land titling program throughout the Atlantic Regions, which was believed to be vital to better enable the Region's "pueblos indígenas" and "comunidades étnicas" to manage and protect their land and resource rights (Law 445: Law of the Community Property Regime of the Indigenous Peoples and Ethnic Communities of the Autonomous Regions of the Atlantic Coast of Nicaragua and the Rivers of Bocay, Coco, Indio, and Maiz 2002).

organization (NGO) that operates an experimental nursery and agro-forestry training center in the Pearl Lagoon Basin and has introduced novel plant species to the Basin's farmers (FADCANIC 2014). While influencing the land use practices of local farmers and working to increase regional agrobiodiversity, the organizations currently operating in the Pearl Lagoon Basin, by design, target specific farmers in the region: those who identify as indigenous or afro-descendant.

Individuals who are not members of indigenous or afro-descendant communities are excluded from autonomous land rights. This inability applies predominantly to the 'mestizo' population, most of whom are recent migrants to the Pearl Lagoon Basin. Thus, mestizos also are generally excluded from agricultural extension and development projects that promote autonomy and food and livelihood security among the Atlantic Coast's indigenous and afro-descendant populations through their focus on agrobiodiversity.

Current exclusions are rooted in the discordant history of the divided Nicaraguan nation. Following a colonial relationship with the British (rather than the Spanish who colonized Nicaragua's Pacific and Highland regions), the Atlantic Region was annexed in 1894[6] by a then independent Nicaragua (Helms 1971; Nietschmann 1973; Jamieson 1999). The British government negotiated the Harrison-Altamirano Treaty in 1905, which relinquished sovereignty over the Atlantic Coast (Hale 1994; Jamieson 1999). However, they insisted that in exchange for the British withdrawal, the Nicaraguan State must grant special protections to the Coasts' indigenous and afro-descendant populations (Pineda 2006). As Oertzen et al. (1990) explain, the Harrison-Altamirano Treaty declared that after

[6] The Atlantic Region, formerly "La Mosquitia" or the Miskito Kingdom (also Miskito Reserve), was referred to from the turn of the 20th Century until the establishment of the Autonomous Regions as the Department of Zelaya.

incorporation, the Nicaraguan State should "allow the Indians[7] to live in their villages… following their own customs, in so far as they are not opposed to the laws of the country and to public morality" (quoted in Pineda 2006, p. 66). Decades later, the threat of further incorporation into the Nicaraguan nation, and the potential for intensified subjugation by the mestizo majority, provoked the counter-insurgency against the Sandinistas during the revolutionary period (1979-1987) (Hale 1994).

1.3.2 Ethnic conflict

The distinct, and often contentious, histories of Nicaragua's Atlantic and Pacific regions resulted in a tenuous relationship between the coastal population, or *costeños*, and mestizos from Pacific and Highland regions. These conflicts, however, have localized in recent decades, making ethnic tensions a part of the everyday experience of life on the coast. Mestizos have been migrating to the Atlantic Coast since the region was annexed in 1894. Although this was a very small population until the conclusion of the *Contra* War (1987), individuals who identify as mestizo (and whose family histories tie them to the Pacific Region of Nicaragua) are now not only the majority in Nicaragua, but they are also a strong majority within the Atlantic Regions. Mestizos are estimated to make up somewhere between 63% and 73% of the population of the Atlantic Autonomous Regions (Jamieson 1999; Brunnegger 2007). That said, many of these individuals are rural migrants who came from highland Departments, such as Chontales, Boaco, and Matagalpa in search of 'empty' land, and are currently "squatting" on land was granted through the Autonomy Statute to indigenous and afro-descendant communities. Therefore, because these migrants are not all accounted for in formal censes, the true Atlantic Coast mestizo population is likely much

[7] The document also extends the same right "Creoles."

higher than current estimates (Jamieson 1999).

The recent influx of land colonizers has increased tensions between mestizos and the Atlantic Coast's indigenous and afro-descendant populations. Indigenous and afro-descendant communities in the Pearl Lagoon Basin and elsewhere in the Region are currently seeking to utilize Law 445[8], known as the "Demarcation Law", as a means of strengthening indigenous and afro-descendant communities' land rights through the formal titling of the separate territories (an aggregate of communities within the autonomous political structure (see Table 1.1) of the Atlantic Coast. The hope is that the titling of discreet areas will enable communities and territories to more effectively exercise their legal rights to control these lands. In theory, this formal authority would mitigate resource exploitation conducted by non-community members. However, tensions between these groups, and the land disputes that provoke such tensions, remain unresolved throughout the region.

Table 1.1. Levels of political organization within the Autonomous Regions

Autonomous Structure
National (Nicaragua)
Autonomous Region (RAAN/RASS)
Territory (Pearl Lagoon Basin)
Community

This table depicts the political levels that structure decision-making regarding land and resource control within Nicaragua's Autonomous Regions. According to Law 445, community-level decisions are aggregated to determine territorial and regional resource use policies.

Thus, to understand land use decisions, and the factors influencing those decisions, within the highly politicized ethnic landscape in the Pearl Lagoon Basin, it is critical to approach ethnicity by not only examining the ways in which the shared histories of a

[8] Law of Communal Property Regime of the Indigenous and Ethnic Communities of the Autonomous Regions of the Atlantic Coast of Nicaragua and the Rivers Bocay, Coco, Indio, and Maiz, Law no. 445 [2002]

population may work to influence agricultural strategies and practices, but also by acknowledging that ethnic identification may feed back to influence the relationship between a farmer's rights to participate in communal land tenure systems and benefit from agricultural assistance programs, factors which could greatly structure land use decision-making. As such, I employ a political ecological perspective to examine farmers' land use decisions within the current political-economic landscape. Further, my research was designed to acknowledge the interplay between farmers' decisions and these processes, and the place of ethnicity within these interactions.

1.4 Assessing the relationship between ethnicity and agrobiodiversity: the integration of ethnographic, demographic, and agroecological data

The complex interconnections between ethnic identity, the ability to benefit from agricultural extension programs, and the legal right to land are not the only relationships that are relevant for understanding agricultural decision-making in the Pearl Lagoon Basin and elsewhere. Prior researchers focusing on agrobiodiversity have identified a host of household and community factors that can influence a farmer's maintenance of agrobiodiversity within their farming system. These factors include demographic factors (Perreault 2005; Perrault-Archambault and Coomes 2008; Perz 2003), spatial factors (Major, Clement, and DiTommaso 2005), and household and community characteristics (Coomes and Ban 2004; Perreault 2005). While these factors each may be relevant in understanding a farmer's maintenance of agrobiodiversity, it is important to acknowledge the relationships between these factors and the ways in which complex sociopolitical processes simultaneously work to influence land use decisions.

Therefore, in order to determine, ***how ethnicity influences, and how it is influenced by, a household's maintenance of agrobiodiversity,*** I employed a research design based on the collection and integration of ethnographic, demographic, and agroecological data. The collection and analysis of detailed demographic and agroecological data shows patterns in the relationships between certain various farmer, household, and community factors—including ethnic identity—and a farmer's maintenance of agrobiodiversity. However, the identification of these correlations alone is not sufficient for determining *why* such patterns exist. As such, an understanding of the ethnographic context within which farmers make land use decisions is vital for elucidating the complex relationships between these factors, acknowledging difficult to quantify historical, sociocultural, and sociopolitical processes, and determining how these factors and processes may relate to a farmer's identity. Thus, merging ethnographic data collection methods with demographic and agroecological surveys enables my research to capture the confluence of factors and processes working to shape the relationships between ethnicity and agrobiodiversity in the Pearl Lagoon Basin.

1.4.1 Data Collection and Analysis

This project involved the synthesis of three separate sources of data to characterize the relationships between ethnicity and the maintenance of agrobiodiversity in the Pearl Lagoon Basin. These datasets include 1) the results of surveys conducted with 163 farmers of different ethnic backgrounds throughout the Pearl Lagoon Basin to document the cultivated plants and actively conserved wild species that they maintain within their agroforestry systems along with farm and farmer characteristics, 2) ethnographic data collected in 2013-2014 through participant observation and key informant interviews (N=30) regarding agricultural knowledge, intra-household decision-making, historical and current cultivation practices, household livelihood strategies, involvement with governmental and non-governmental agricultural development organizations, and the dynamics of ethnic identification, and 3) geo-referenced household survey data collected by a collaborating research team based at Michigan State University (MSU) and the University of the Autonomous Regions of the Caribbean Coast of Nicaragua (URACCAN).

While I administered farm surveys, conducted interviews, and collected ethnographic data through fieldwork, additional data were provided though a collaboration with an inter-institutional and interdisciplinary project administrated by researchers at MSU and URACCAN that investigated the impacts of globalization on terrestrial and marine resources in the Pearl Lagoon Basin[9]. This collaboration facilitated access to household demographic and spatial variables that previous agrobiodiversity research shows to positively correlate with the maintenance of agrobiodiversity in other parts of the world. This includes the location of farmers' households, the size of their villages, household wealth indices, household livelihood activity information, and education levels of household members.

Based on a household census developed by MSU-URACCAN, their project selected a random sample of households from around the Pearl Lagoon Basin to survey in 2009, 2010, 2012, and 2014. My investigation included a stratified sub-sample of 163 of the 445 households in the MSU-URACCAN study that identified themselves as participating in farming. With the help of two local field assistants, I administered agrobiodiversity surveys in the wet (or main agricultural) season (August-December) with each of these 163 farmers to gather information about the farmer identified in literature as relevant to the maintenance of agrobiodiversity, but absent from MSU-URACCAN's surveys. These factors include the age of the farmer, the number of years s/he has engaged in agriculture, and the potentially

[9] This project was funded by a National Science Foundation (NSF) Dynamics of Coupled and Natural and Human Systems grant, #0815966.

multiple ethnicities with which the farmer self-identifies. Additionally, my surveys collected specific information about the farms, including both the number and size of fields, size and age of farm, and the specific species and approximate number of each species that a farmer is actively maintaining on his/her farm. These data were used to develop various, complementary agrobiodiversity metrics (accounting for such factors as species richness, abundance, and evenness) for each farmer that serve as the dependent variables in analyses. Employing univariate statistics and step-wise regression analyses (following the protocol of Carr 2008), this information was used to quantitatively determine the strength of the relationships between farmers' land use practices and various household and farm(er) factors, such as ethnicity, distance from the road, involvement with agricultural development organizations, and a multitude of demographic factors.

Throughout the first of two phases of this research, during which agrobiodiversity surveys were administered, I also collected detailed ethnographic information through participant observation and interviews with farmers, community leaders, specialists working for agricultural development projects in the region, and academics with knowledge of the local socio-ecological system. This information, along with data collected during surveys and through participant observation, was used to identify 24 key informants (purposefully selected from each community/ethnic group) whose farms were revisited and who were interviewed during the second research phase in the dry season (January-May). Also, because agricultural development organizations working in the region—including an NGO, government agencies, and a government-funded cooperative—play a pivotal role in influencing the land use strategies of local farmers, two officials from each of the three major agricultural development organizations (N=6) were interviewed to gather detailed accounts of the history of these projects, their funding sources, and their development goals.

Statistical analyses identified correlations between the various farmer and household factors mentioned above and a farmer's agrobiodiversity metrics. Analysis of ethnographic data elucidated the sociocultural, political, and economic factors that encourage or hinder the maintenance of agrobiodiversity by some farmers in the Basin more than others, with a focus on explaining the processes that influence the statistically significant correlations that were identified. Further, ethnographic data was vital for understanding the dynamics of ethnic identification and its relationship to land use strategies. Interviews with agricultural development practitioners explored the history of these projects and their goals, particularly how local ethnic identities are used to garner funding for these projects and thus influence resource allocation.

1.5 Significance of Research

Utilizing the various datasets collected in the multi-ethnic landscape in the Pearl Lagoon Basin, this project explores how the history of these populations, various demographic and household factors, sociopolitical processes currently at work in the region, and the realities of engaging in food production in a coastal, tropical ecosystem shape ethnically-distinct agricultural practices and the subsequent maintenance of agrobiodiversity.

Ultimately, my research identified robust relationships between agricultural development organizations, members of the Basin's indigenous and afro-descendant communities, and agrobiodiversity. These findings highlight the ways in which the ethnic-based land rights characteristic of the communal land tenure system in the Pearl Lagoon Basin, and throughout Atlantic Nicaragua, not only influence the agrobiodiversity maintained among local farmers, but also work to strengthen ethnic identity and ethnic division.

In addition, this analysis revealed that although relationships between individuals that identify with specific ethnic groups and agricultural strategies exist, this relationship is not deterministic. Furthermore, the inconsistencies in these patterns, i.e. individuals whose land use practices diverge from those practices common among others who identify with the same ethnic identity, are where the greatest insights regarding the relationships between ethnicity and the maintenance of agrobiodiversity can be inferred.

The findings from my research are relevant to both theory and policy. First, by elucidating how ethnic identity encourages the sustainment of agrobiodiverse cultivation strategies in the wake of road development, this study makes unique contributions to literature concerning agrobiodiversity and land use. Further, the political ecology framework used in this research, which integrates ethnographic and survey data, has implication for research more generally concerned with understanding the dynamics of socio-ecological systems. In particular, researchers have stressed the central importance of the multi-level sociopolitical processes that shape human-environmental relationships (Young et al. 2006; Ostrom 2009; Brondizio, Ostrom, and Young 2009). Accounting for the complex interactions and feedback between these processes is therefore key to understanding the reciprocal relationships that characterize human-environmental system (Brondizio, Ostrom, and Young 2009; Ostrom 2009; Caldas et al. In press). By employing a methodology grounded in a political ecological framework, my research was able to account for the sociopolitical processes operating at various scales that shape both farmers' land use decisions and their identities. In doing so, my work not only provides insights into the relationships between ethnicity and agrobiodiversity, but also reinforces the importance of these complex, multi-level sociopolitical processes in shaping human-environmental systems.

In addition to intellectual contributions, the results of this study will also be useful to NGOs and governmental organizations working in the Atlantic Nicaragua, and in other parts of the world. In particular, the results of this work are being shared with the Foundation for the Autonomy and Development of the Atlantic Coast of Nicaragua (FADCANIC), an NGO that aims to promote the improvement of natural resource management among local populations through their Agroforestry Center. One of the primary goals of this organization is to promote the conservation of plant resources and habitats in the Atlantic Region. Thus, by gaining a more explicit understanding of the motivations that affect the land use decisions of local residents, this research provides information that will help enhance their capacity for promoting good practice agroforestry and local resources conservation in Atlantic Nicaragua, allowing FADCANIC to better account for and adapt to these attitudes and desires.

What is perhaps the most relevant finding from this study in regards to development organizations is the acknowledgement that those individuals who are more likely to engage in land use practices that go against region development goals (i.e. newly migrated mestizos) are the *least* likely to benefit from development projects that seek to improve agrobiodiversity and forest conservation at the regional level. The beneficiaries of many development projects working in the region are those who traditionally maintained high levels of agrobiodiversity. However, the populations who could arguably benefit the most from outreach and extension projects are the very individuals who lack legal right to the land that they are altering. While this is an inconvenient reality, the results of the research are being shared with local, regional, and national-level policy-makers in Nicaragua in order to help them design and implement policies that take into account the importance of working with these unwanted, but fully-settled and invested groups, to secure the long-term viability of the local natural resources that are vital to local livelihoods.

1.6 Chapter Summary

In the remaining chapters of this dissertation, I describe the background for my research and describe in detail the data and analysis techniques that I used to investigate the relationship between a farmer's ethnicity and their maintenance of agrobiodiversity.

In Chapter 2, I establish the theoretical foundations for this research, expanding upon the ideas presented in the introductory chapter regarding agrobiodiversity, ethnic identity, and the increased connectedness of farmers to global political and economic systems. This includes discussion of: 1) the importance of agrobiodiversity (in its various forms) as previously described by researchers and practitioners; 2) the well-documented global erosion of agrobiodiversity as farmers become more integrated into global economic systems (particularly in the later-half of the 20th Century); 3) ethnicity as a factor linked to farmers' resilience and resistance to reduce the agrobiodiversity of their farming systems; 4) anthropological concepts of ethnicity--specifically ethnic identity's potential for plurality and its flexible nature; 5) the role that a political ecological perspective can play in elucidating the linkages between ethnic identities and land use practice.

Building upon Chapter 2's review of theoretical literature, I introduce the study area, the Pearl Lagoon Basin, Nicaragua in Chapter 3. This chapter includes a history of the region and its populations (Miskito, Creole, Garifuna, and mestizos). This include a discussion of the historical and current livelihood activities in the region, which are highly diverse and characterized (historically and currently) by a reliance on fishing, farming, hunting, gathering, and periodic access to wage labor. In Chapter 3, I also highlight the close relationships of these populations throughout the colonial and post-colonial eras (16th Century-present), and the resulting ethnic landscape in the lagoon.

Additionally, Chapter 3 describes recent changes to the region, which are emphasized by the development of the highway, including: 1) the rapid increase in seafood export following road development, the resulting impacts on fishery health, which is increasing the Region's residents' reliance on terrestrial resources 2) the increased presence of NGO's to help with the regional autonomy process (who are also focusing on agricultural extension as part of the autonomy process); 3) the increased presence of governmental and government-sponsored programs focused on the agricultural sector (who see farming as a way to promote economic development in the region); 4) and, finally, the land grabs that occurred (and are still occurring) north and west of the lagoon following the civil war (1979-1990), where migrants and profiteers have developed cattle ranches and are extracting lumber.

In Chapter 4, I present my project's hypotheses, research design, and field methods. Particular emphasis is given to how the collection and integration of ethnographic, demographic, and agroecological data are both appropriate and necessary for addressing my research questions and hypotheses. I describe 1) the general fieldwork approach and timeline of data collection; 2) the design and implementation of agrobiodiversity surveys (including training field assistants); 3) the selection of primary informants and interview techniques used; and 4) how farm-level data was collected, organized, and processed. I also describe the approach to conceptualizing and quantifying agrobiodiversity in this chapter. Agrobiodiversity can defined and measured in a variety of ways. This project utilizes species richness, function diversity, and the Simpson's Diversity Index as metrics for agrobiodiversity for each of the farmers in this study in order to account for the various relevant dimensions of agricultural biodiversity.

In Chapter 5, I present the ethnographic data collected for this study. Here, I provide the ethnographic context in which farmers around the lagoon make agricultural decisions. I detail how people approach farming, the varying ways that people perceive the agricultural and 'wild' landscapes, and the current and historical relationships between farmers and agricultural development projects. The relationship between ethnicity and community membership, and the ways in which this relationship structures land rights in the region, is also a focal point of this chapter.

Next, Chapter 6 discusses the trends, patterns, and general findings that result from analyses of the demographic and agroecological survey data collected as part of this study and the data collected through MSU-URACCAN's household survey. This includes how well spatial data, a farmer's ethnicity, a household's livelihood diversity, a farmer's gender, their household wealth, and other variables predict various agrobiodiversity metrics for each farmer. In Chapter 6, I also test the relationships between key predictors of a farmers' agrobiodiversity metric to identify covariates.

In Chapter 7, I address the hypotheses that guide this study through the synthesis of the ethnographic, demographic, and agroecological data used in this research. I discuss how the quantifiable factors identified as strongly correlating with a farmer's level of agrobiodiversity relate to the factors, characteristics, and perspectives derived from ethnographic data. Chapter 7 focuses on key findings, such as the role of ethnic-based rights and the ways and which these rights relate to ethnic identification and a farmer's ability to benefit from agricultural assistance programs. Additionally, I discuss the ways in which the historically and currently diverse livelihood strategies of many local people, particularly those that identify as indigenous or afro-descendant, work to discourage farmers from market-orientated agricultural production. The strong relationships between ethnicity and community of residence as well as the ways in which age relates to agrobiodiversity also are highlighted.

My thesis is concluded in Chapter 8 by revisiting and summarizing the major findings of this research. This work suggests that while research conducted in the 1980s and 1990s in other parts of the world (particularly in Central America) demonstrates that foreign and domestic agricultural development projects historically worked to erode agricultural biodiversity, similar projects are working today to implement activities that work to conserve agrobiodiversity, as it is now viewed as an important component of 'sustainable' rural development. This can in part be attributed to the ways in which political, academic, and philanthropic communities have shifted, impacting the missions (and funding requirements) of these projects.

This research further suggests that relationships between ethnicity and agrobiodiversity in the Pearl Lagoon Basin can at least in part be explained by similar policy shifts. Ethnic identities, do not define, but often relate to the histories of farmers and their families. Afro-indigenous farmers around the lagoon generally have deeper local agroecological knowledge—developed through a longer history in the lagoon—than mestizos who recently migrated to the area (although mestizos raised in the region or living in afro-indigenous communities are familiar with the local ecosystem, and maintain levels of agrobiodiversity on par with afro-indigenous farmers). Despite this, development organizations working in the region today aim to promote the autonomy and well-being of specifically the afro-descendant and indigenous populations, often leaving mestizos out of projects. While this is politically tenable, the result is a situation in which those having the greatest negative impact on local ecological health appear to be largely ignored by ecologically-minded agricultural development organizations.

II. Central Concepts: Agrobiodiversity and Ethnicity

2.1 Introduction

This chapter establishes the theoretical foundations for this study. I describe agrobiodiversity as a variable concept within multidisciplinary research concerning sustainable agriculture, food security, and biodiversity conservation. In light of associations observed globally between the agrobiodiversity that rural, small-scale farmers maintain and the ethnic identities of these farmers, I also discuss anthropological insights into the complex, multidimensional nature of ethnic identity. Ultimately, I argue that these complexities complicate apparent relationships between ethnicity and agrobiodiversity and draw attention to the role of historical and contemporary agricultural development programs in shaping these relationships.

Agrobiodiversity is widely recognized as a critical component of farming systems that promote beneficial relationships between humans and the biophysical environment (Altieri and Rosset 1996; Garí 1999; Thrupp 2000; McNeely and Scherr 2003; Foley et al. 2005; Jackson, Pascual, and Hodgkin 2007; Harvey et al. 2008). Agrobiodiversity positively correlates with the resistance and resilience of agro-ecosystems[10] to pest infestations, disease, and climate variability (McNeely and Scherr 2003; Brush 2004; Jackson, Pascual, and Hodgkin 2007). Additionally, genetic resources that are often conserved within diverse agro-ecosystems increase the ability of farmers and plant breeders to adapt to changing environmental stressors (McNeely and Scherr 2003; Jackson, Pascual, and Hodgkin 2007). Therefore, scholars argue that agrobiodiversity is an issue of paramount concern for both local and global food security (Thrupp 2000). Further, it can also play an important role in biodiversity conservation by maintaining critical habits (McNeely and Scherr 2003; Harvey et al. 2008; Brussaard et al. 2010).

Market-oriented farmers often tend to sacrifice farm-level agrobiodiversity for crop specialization (Brown 1999; Bellon 2004; Major, Clement, and DiTommaso 2005). Thus, as Thrupp (2000) argues, small-scale farmers' increased integration into global political economic systems could jeopardize: 1) the long-term health and viability of local agro-ecological systems around the world and 2) the conservation of the genetic resources that could be a safety net for global food systems. Further, the continued erosion of agrobiodiversity globally could undermine more general biodiversity conservation efforts (Harvey et al. 2008).

In contrast to this broad trend, research with small-scale farmers has also shown that the ethnic (or "cultural") identity of a farmer can be a mediating factor in the decline of agrobiodiversity maintenance with increased connection to extra-local political economic systems—either working in some way to discourage market-orientation or encourage the maintenance of biodiverse planting strategies in spite of market involvement (Kirby 2011; Coomes and Burt 1997; Coomes and Ban 2004; Perreault 2005; Brush and Perales 2007; Perrault-Archambault and Coomes 2008; Trinh et al. 2003). In particular, studies of agrobiodiversity, especially those focusing on Latin America, suggest that members of 'indigenous' (or ethnic minority) communities are more likely to maintain high levels of agrobiodiversity than their non-indigenous neighbors (Perreault 2005; Perrault-Archambault and Coomes 2008). My research aims to explain *how* and *why* a farmer's ethnicity relates to

[10] Agroecosystems are ecosystems that are managed by humans, at least in part, to obtain food.

the types and degrees of agrobiodiversity that they maintain, which until now has remained poorly understood (Veteto and Skarbø 2009).

To address the complex and dynamics nature of human-environmental relationships, I explicitly consider political ecology as a conceptual and methodological framework for agrobiodiversity research. Paired with theories and insights put forth by social scientists regarding race, ethnicity, indigeneity, and peasant livelihoods in Latin America, a political ecological perspective reveals that the observed relationships between ethnicity and agrobiodiversity likely are rooted in certain groups' historical involvement in global economic systems and the forms of social and economic organization (including food production strategies) that this involvement (or lack thereof) engendered. This is highlighted by the fact that researchers and policy-makers often identify politically and economically marginalized 'indigenous' peoples as stewards of agrobiodiversity and ideal target of development projects seeking to promote the conservation of agrobiodiverse farming practices (Nazarea 2006; Garí 1999; Solari and Cleveland 1993).

Yet, relationships between ethnicity and cultivation practices cannot be assumed to be direct or constant. People alter their livelihood strategies in light of new opportunities or constraints (Stonich 1989; Stonich 1991; Stonich 1993; Chambers and Conway 1992; Scoones 2001; Ellis 1998; Ellis 2000). Further, while previous agrobiodiversity research has treated ethnicity only as a unidimensional, fixed factor, anthropologist have shown peoples' ethnic identities can be fluid and context specific (Jamieson 2003; Wade 1997; Vincent 1974; Cohen 1978). This plasticity may complicate and confound the correlations that have been identified previously between farmers' ethnic identities and their tendencies to conserve agrobiodiversity.

Therefore, the responses of farmers in Nicaragua's Pearl Lagoon Basin to a changing political, economic, and socio-cultural landscape, while perhaps influenced, cannot be assumed to be dictated by their ethnic identities. Further, farmers' ethnic identities may also be influenced by the changing socio-political landscape in which they live. Thus, in order to determine *how ethnicity influences, and how ethnic identity is influenced by, a farmer's maintenance of agrobiodiversity*, my research utilizes a political ecology framework to directly account for the confluence of historical and contemporary factors and processes operating at various political levels that are working to influence both the ethnic identities of rural farmers and their decisions to maintain (or not to maintain) agrobiodiverse farming systems.

2.2 Human-Environmental Systems and Political Ecology

In the past several decades, the scientific community has acknowledged the need to increase research on the relationships between humans and the biophysical environment (Lubchenco 1998). Further, scholars stress that multidisciplinary research and interdisciplinary thinking are necessary to understand the intimate links and continuous interactions between these systems (Moran 2010). This encouragement, along with an increased acknowledgement of 'environmental' issues in mainstream politics, has fostered a growth in research regarding "coupled human and natural systems" (Liu et al. 2007) or "coupled socio-ecological systems" (Young et al. 2006). These loose, yet evolving, theoretical frameworks center on the notion that human activities and ecological systems are intricately linked through their dynamic, reciprocal relationships. Thus, champions of these frameworks stress that because of incontrovertible feedbacks these spheres cannot be studied in isolation (Young et al. 2006; Liu et al. 2007). Further, a variety of research approaches are necessary to understand the complex and dynamic relationships between human and environmental systems (An and López-Carr 2012).

In particular, Ostrom (2009) and others (Young et al. 2006; Brondizio, Ostrom, and Young 2009) highlight the ‘multilevel nature’ of the factors and processes shaping human-environmental relationships (Brondizio, Ostrom, and Young 2009). As Brondizio and others (2009) posit, human-environmental relationships are not bounded by time and space, but rather are shaped by the intersection of local and extra-local phenomena. Therefore, a critical concern within human-environmental systems research is how to account for the complex interactions and feedbacks that result from this overlap, with particular focus on the multi-level political processes shaping human-environmental relationships (Young et al. 2006; Ostrom 2009; Brondizio, Ostrom, and Young 2009).

Notably, preceding the recent emergence of coupled human-natural systems (CHANS) and socio-ecological systems (SES) research, anthropologists and geographers utilized a broad suite of theoretical and methodological frameworks to understand how political-economic and ecological forces interact to affect social agents’ use and management of natural resources (Blaikie 1985; Stonich 1993; Bryant 1998; Walker 2005; Walker 2006; Forsyth 2008; Neumann 2009; Robbins 2004; Biersack and Greenberg 2006; Paulson, Gezon, and Watts 2003). These ‘political-ecological’ perspectives, known collectively as political ecology, have been employed to capture the multitude of socio-political and economic factors operating at various political scales that influence human-environmental relationships.

As Walker (2005) explains, political ecology is more deeply rooted in the political economy realm than fields more directly focused on ecology. Political ecology is a way to link local ecological contexts into the broader levels of political economy (Stonich 1998).

These frameworks are generally rooted in Marxist, Marxian, or neo-Marxian political economy, i.e. centering analysis on the idea that modes of production shape human relationships to ‘nature’ (Walker 2006). However, this perspective acknowledges a broad range of factors that influence human-environmental relationships in addition to global economic forces, including, the state, class, ethnicity, and ideology (Stonich 1998). In doing so, Stonich (1998) argues that a political ecological framework is positioned to recognize the heterogeneity of responses that individual actors may have to the same or similar political or economic drivers.

While influencing current CHANS and SES research, the explicit use of political ecology within these research domains remains rare. This deficit may partly reflect the criticisms that political ecology has faced in regard to the ability of research that uses this perspective to make effective policy interventions. Walker (2006) argues that political ecologists historically have had little involvement with major international environmental policy-making institutions. Specifically, the explicit employment of Marxist language within a political ecology framework appears to have undermined its use in western policy development (Walker 2006). This made political ecological analysis a difficult fit for major international environmental policy-makers.

Despite this critique, political ecology provides a conceptual and methodological framework for evaluating human-environmental relationships that specifically accounts for the multi-level, socio-political and economic processes influencing the decisions of resources users and managers (Paulson and Gezon 2005). These factors and their interactions are critical to understanding human relationships with the biophysical environment. Therefore, a political ecological perspective can provide important insight into the interacting processes that shape farmers’ maintenance of agrobiodiversity, in spite of the erosion of agrobiodiversity globally. Further, a political ecology framework can expose how trends in agrobiodiversity conservation relate to farmers' ethnicities by acknowledging the role of socio-political processes in both ethnic identity and land use decision-making.

2.3 Agrobiodiversity

The terms, 'planned', 'on-farm' 'agricultural' or simply 'agro' biodiversity, broadly encompass all organisms living in agricultural landscapes (Jackson, Pascual, and Hodgkin 2007). This includes edible plants, livestock, freshwater fish, soil organisms, and 'wild' resources (Thrupp 2000). Because of the social and ecological benefits of agrobiodiversity, it is a central concept within research regarding 'sustainable' agriculture (Altieri and Rosset 1996; Gliessman 2006; McNeely and Scherr 2003; Jackson, Pascual, and Hodgkin 2007).

Three overlapping research domains focus on agrobiodiversity. Each of which highlights a different beneficial aspect of biodiverse agroecosystems and, therefore, conceptualizes agrobiodiversity in somewhat distinct ways:

2.3.1 Agroecology

First are those who relate most closely to proponents of "agroecology," an alternative agricultural strategy to 'modern,' capital- and technologically-intensive agricultural. They include Altieri (2002), Rosset (1996), Gliessman (2006), and Buttel (2003a). These researchers and practitioners aim to conserve or develop agricultural systems that enhance overall ecosystem function while maintaining productivity and highlight the importance of agrobiodiversity in such systems. Thus, agroecologists include all biota in their conceptualizations of agrobiodiversity, as their goal is to promote relationships and feedbacks within agroecosystems that closely resemble the complex interactions 'naturally' occurring in ecological systems (Gliessman 2006). Agrobiodiversity can therefore be measured by variation in crops (Koocheki et al. 2008) or even through measures of various biota as proxies for overall ecosystem diversity (Duelli, Obrist, and Schmatz 1999).

Primarily, this group emphasizes that biodiverse agricultural landscapes enhance the resistance and resilience of agroecosystems to perturbations that can be disastrous for farmers, like pest infestations, disease, and climate variability (McNeely and Scherr 2003; Jackson, Pascual, and Hodgkin 2007). Thus, agrobiodiversity is important for the maintenance of a healthy ecosystem and is also vital to household- and community-level food security for small-scale farmers (Thrupp 2000). Additionally, biodiverse agroecosystems can help to buffer farmers from economic instabilities that can be associated with monoculture farming, like the reliance on commercial-inputs (Conroy, Murray, and Rosset 1996) or the potential failure of a farmers single crop (Baumgärtner and Quaas 2010).

2.3.2 Biodiversity conservation

The second group takes a more ecologically-centric perspective regarding the benefits of biodiverse agroecosystems. They include McNeely and Scherr (2003), Foley and others (2005), Harvey and others (2008), and Brussaard and others (2010). These advocates of agrobiodiversity emphasize its potential role in the conservation and maintenance of biodiversity within and beyond agricultural systems, although the feedbacks between human and environmental systems are generally stated, as well. Land use directed at food production has serious implications for global biodiversity conservation (Pimm and Raven 2000; McNeely and Scherr 2003; Foley et al. 2005; Jackson, Pascual, and Hodgkin 2007; Harvey et al. 2008; Brussaard et al. 2010). In particularly, industrial agriculture, and the monocropping that is often characteristic of this type of food production, results in the destruction and fragmentation of habitats, while the use of chemical inputs can seriously degrade soil systems (Altieri 2002; Foley et al. 2005; Brussaard et al. 2010).

Biodiverse agroecosystems, however, can contribute to biodiversity conservation, creating or maintaining habit for various types of flora and fauna (Pimentel et al. 1992; McNeely and Scherr 2003; Donald 2004; Harvey et al. 2008; Brussaard et al. 2010). Further, agroecosystems that utilize the complementary functions of various trees, crops, non-food plants, and fauna may not require the use of large amounts of synthetic inputs that is characteristic of monoculture farming (Altieri 2002; Jackson, Pascual, and Hodgkin 2007). These systems in themselves work to conserve certain plant and animal species, but can also be more beneficial to neighboring ecosystems than input-intensive farming, as potential harmful chemicals do not leave these agroecosystems in run-off. Thus, agrobiodiversity conservation is seen, in many instances, to be complementary to other conservation efforts that target non-food plants and animals (Harvey et al. 2008; Brussaard et al. 2010).

2.3.3 Crop genetic diversity

The third realm of research is concerned with the role of agrobiodiversity for both local and global food security. This includes Bellon (2004), Brush (2004), Jackson and other (2007), Thrupp (2000), and Coomes and Ban (2004). In particular, this group, which is also rooted in conservation biology (Brush 2004), highlights the importance of crop genetic diversity, a specific aspect of agrobiodiversity (Bellon 2004; Lamont, Eshbaugh, and Greenberg 1999; Coomes and Ban 2004; Major, Clement, and DiTommaso 2005; Brush and Perales 2007; Perrault-Archambault and Coomes 2008; Aguilar-Støen, Moe, and Camargo-Ricalde 2008; Kirby 2011). This element of agrobiodiversity is arguably the primary focus of most previous agrobiodiversity research.

Plants have been cultivated around the world in various locations and by diverse groups of people for millennia. Thus, a great variety of individual genes or combinations of genes that code for certain traits in a plant can exist within a single plant species. ‘Landrace’ is a term used to describe “geographically or ecologically distinctive populations [of plants and animals] which are conspicuously diverse in their genetic composition,” (Cleveland, Soleri, and Smith 1994). These varieties of a given crop species are critical to the local and global food systems. In addition to being bred to thrive in specific (and often novel) agroecosystems, they provide farmers and plant breeders with resources to adapt to pest outbreaks, diseases, or changes in climate or weather that may impact said species (McNeely and Scherr 2003).

The expansion of monocultures of high-yielding, ‘modern’ plant varieties associated with the Green Revolution[11] is seen as a threat to crop genetic diversity (Bellon 2004; Brush 2004; Jackson, Pascual, and Hodgkin 2007). Thus, researchers and policy-makers encourage active efforts to conserve these resources, so that they are available in the case of some future crisis (Thrupp 2000; Bellon 2004; Brush 2004; Jackson, Pascual, and Hodgkin 2007).

Seed banks, a form of gene bank, are the *ex situ* method of conserving crop genetic diversity. This approach involves the use of centralized repositories, which can operate at various levels, such as a community seed or national bank (Bellon 2004), or an international gene bank like the Svalbard Global Seed Vault in Norway or the Millennium Seed Bank Project in London, the latter of which is currently storing over 2 billion seeds (MSB 2012). Scientists and plant breeders can utilize the genetic resources stored in these repositories if there is a need to develop a new variety, for example, to respond to a pest infestation. However, although this may be the function of community—even national—seed banks,

[11] The Green Revolution refers to the development of ‘modern’ agriculture, based on high-yielding seeds and chemical inputs, such as synthetic fertilizers, pesticides, herbicides, and fungicides. Originally developed by U.S. researchers and implemented in Mexico, this type of agricultural production spread to farmers throughout the world with the aid of philanthropic institutions like the Rockefeller Foundation (Gupta 1998).

international seed banks are generally promoted for their potential role as some sort of Noah's Ark of seeds if a globally catastrophic event were to occur (BBC 2006).

2.3.3.1 Focus on gene conservation at the household-level

An entire branch of agrobiodiversity research focuses specifically on identifying the characteristics of certain communities or households around the world that maintain high degrees of crop genetic diversity (Coomes and Ban 2004; Major, Clement, and DiTommaso 2005; Perrault-Archambault and Coomes 2008). Though rarely explicitly stated, this research aids plant gene banks and plant breeding centers in the more efficient and effective location and procurement of landrace seeds. Researchers have identified that certain farmer or household characteristics like 'remoteness' (generally the distance from an urban or market center), household size, the age or gender of the primary farmer, or the farmer's ethnicity significantly correlates with types and degrees of crop genetic diversity that a farmer or farming household conserves (Coomes and Ban 2004; Major, Clement, and DiTommaso 2005; Perrault-Archambault and Coomes 2008; Wezel and Ohl 2005). Therefore, these characteristics serve as guides for locating farmers, households, and communities that are likely to conserve important crop genetic resources (Maxted, Ford-Lloyd, and Hawkes 1997).

'House', 'home' or 'kitchen' gardens, are also generally highlighted in this type of research, as farmers tend to grow plants with dietary or cultural importance in their gardens even when engaging in monoculture in their other sites of food production (Coomes and Ban 2004). Thus, in some cases, home gardens—which, admittedly, are difficult to delineate from other horticultural plots (Aguilar-Støen, Moe, and Camargo-Ricalde 2008)—often represent the highest amount of diversity in a farmer's field portfolio (Coomes and Ban 2004; Nair 1993). As a result, a number of researchers focus considerable efforts on identifying household characteristics that correlate with high amounts of crop genetic diversity being maintained specifically in home gardens (Lamont, Eshbaugh, and Greenberg 1999; Trinh et al. 2003; Coomes and Ban 2004; Major, Clement, and DiTommaso 2005; Perrault-Archambault and Coomes 2008; Aguilar-Støen, Moe, and Camargo-Ricalde 2008).

Finally, although *ex situ* seed banks have been employed as the primary genetic conservation strategy for maintaining this key element of agrobiodiversity, a growing number of researchers argue that farms have a greater capacity for gene conservation (Altieri and Merrick 1987; Brown 1999; Bellon 2004; Brush 2004). There is a multitude of reasons cited by proponents of *in situ* (in this case on-farm) over or even in place of *ex situ* crop genetic conservation. These range from issues related to the long-term, cold storage of dormant seeds (Altieri and Merrick 1987) to the lack of control of and access to resources housed in many of these banks for many farmers (Kloppenburg 2008). Further, there is limited capacity and procurement capabilities in even the largest of the banks in existence today, which is currently only 10% of known wild plant species in the world (MSB 2012). Consequently, researchers and policy-makers advocate policies that encourage on-farm genetic conservation in addition to effectively locate landraces. These policies are particularly important in light of the impacts of globalization and market development on agrobiodiversity conservation and maintenance.

2.4 The impacts of political economic 'development' on agrobiodiversity

Agrobiodiversity is thought to be eroding globally (Thrupp 2000; Bellon 2004; Altieri and Merrick 1987). This narrative assumes that agricultural systems throughout the world 'traditionally' relied on biodiversity. As Thrupp (2000) explains, farmers utilized crop genetic diversity for plant selection, crop diversity to avoid risk, and maintained a habitat for other plants and animals that were integral parts of these agroecosystems. However, the Green Revolution changed the global agricultural landscape. Following World War II, farming, particularly in the industrialized world, became increasingly characterized by mechanization, chemical inputs, and—most importantly—monocropping. Further, as Green Revolution technologies reached (or were pushed upon) farmers in what was then called the "Third World," they too began to plant and rely on a reduced number of 'modern' high-yielding crop varieties (Thrupp 2000; Bellon 2004).

This process occurred in part because of government policies that encouraged the utilization of these new technologies as a means of rural economic development and to improve food security (Stonich 1993; Conroy, Murray, and Rosset 1996; Altieri 2002; Thrupp 2000; Gupta 1998). However, the narrative of biodiversity erosion is also built on the idea of market rationalization, i.e. that economically rational farmers seek to benefit from economies of scale and thus plant monocultures of high-yielding crop varieties if they are or become integrated into market systems (Bellon 2004; Dusen and Taylor 2003). The overall result of these policies and social processes has been a reduction of agrobiodiversity in farming systems around the world (Altieri and Merrick 1987; Thrupp 2000; Bellon 2004).

2.4.1 Heterogeneous impacts

Anthropologist Stephen Brush was among the first to question this grand narrative, revealing that this 'development' process is more nuanced than this homogenizing narrative would lead one to believe. As Brush demonstrates, the dichotomy between 'traditional' and 'modern' is not so clear. In the high Andes, for example, where Brush undertook his dissertation fieldwork in the early 1970s, he witnessed the *integration* of a high-yielding seed variety into the local farming systems. Instead of abandoning their traditionally biodiverse farming system, Andean farmers absorbed 'modern' seeds into their cultivation practices, growing these tubers in addition to the tubers, tuberous roots, and other plants that they had cultivated historically. Thus, these farmers developed a hybrid system (Brush 1976).

Brush's study was pivotal to agrobiodiversity research because it illustrated that there is variation and heterogeneity in farmers' responses to the availability of Green Revolution technologies. Further, it highlights the agency of farmers; specifically that their 'rationality' was not solely aimed at market optimization. Brush suggests that farmers throughout the world may continue to maintain agrobiodiversity despite the availability of Green Revolution technologies for a variety of reasons: 1) it helps them avoid risks of crop failure associated with only producing one crop; 2) they are farming in diverse environments in which their landrace varieties out-perform 'modern' varieties; and/or 3) farmers continue to cultivate certain landraces that have cultural value, based on taste or use in ceremony (Brush 2004; Bellon 2004).

Brush's findings regarding the potential for varied responses of individual or groups of farmers to their ever-changing landscapes (even despite a larger trend of global agrobiodiversity erosion) provoked a suite of theoretical and applied research questions regarding the maintenance of agrobiodiversity. With the goal of the promotion of global *in-situ* agrobiodiversity conservation in mind (as well as trying to encourage the increased utilization of biodiversity by farmers currently employing input-intensive monocultures), many researchers have sought to identify the specific factors characteristics that may promote the maintenance of agrobiodiversity by farmers faced with new opportunities or constraints.

2.5 Ethnicity, indigeneity, and the moderation of agrobiodiversity erosion

Following Brush's findings regarding farmers' heterogeneous responses to development initiatives and market access (Brush 2004), researchers relying on quantitative analyses of farm, farmer, and household data collected through field studies—mostly conducted in Latin America—have identified that certain farmer or household characteristics correlate with the maintenance of high levels of crop genetic diversity despite access to 'modern' seeds or markets. These include the size of the household or village (Coomes and Ban 2004) and the age (Perreault 2005), education level (Perz 2003), and gender of the farmer (Perrault-Archambault and Coomes 2008). This realm of research also has highlighted that people with certain ethnic identities tend to maintain more agrobiodiversity than neighbors who belong to other ethnic groups, even when opportunities for market access exists or farmers are market-oriented (Brush and Perales 2007; Perrault-Archambault and Coomes 2008; Kirby 2011).

Agrobiodiversity researchers, as well as others concerned more generally with land use change, often specifically recognize "indigenous peoples" as the global stewards of agrobiodiversity (Orlove and Brush 1996; Ellen, Parkes, and Bicker 2000; Coomes and Burt 1997; Nazarea 2006; Garí 1999; Solari and Cleveland 1993; Kloppenburg 2008; Godoy et al. 2005). Coomes and Burt (1997), for example, showed that indigenous peoples of the Peruvian Amazon had high levels of agrobiodiversity despite market orientation (Coomes and Burt 1997). Further, research in Chiapas, Mexico (Brush and Perales 2007), Amazonia (Perrault-Archambault and Coomes 2008), and Vietnam (Trinh et al. 2003) showed that indigenous farmers tended to maintain greater agrobiodiversity even in comparison to non-indigenous people living in close proximity and farming in similar environments. Yet, how indigeneity (or ethnicity) influences farmers to maintain high levels of agrobiodiversity relative to members of other groups remains a question within agrobiodiversity literature (Veteto and Skarbø 2009). Answering this question could provide key insights into the rational for the conservation of agrobiodiverse farming practices and help the promotion of agrobiodiversity conservation around the world.

Agrobiodiversity researchers have proposed specific cultural characteristics of various communities around the world that work to promote the maintenance of agrobiodiversity among members of these (and other) indigenous or “ethnic minority” groups. These factors include taste preferences (Bellon 2004; Brush 2004; Kirby 2011), use of diverse plants for ritual purposes (Gupta and Chandak 2010; Kirby 2011), a community’s expansive social networks (Coomes and Ban 2004), their historical agro-ecological environment (Bellon 2004; Perrault-Archambault and Coomes 2008), culturally-bound seed trading networks (Kirby 2011), or simply that farmers see certain crop varietals to be important to cultural identity (Perreault 2005) or cultural continuity (Del Angel-Pérez and Mendoza Briseno 2004).

However, most previous research in this realm fails to account for the multi-level political and economic factors that are central to human-environmental systems and are critical to understanding both the land use decisions of farmers and their ethnic identities. Thus, while previous research identify relationships between members of particular ethnic groups and agrobiodiversity conservation, this research does not *explain* these patterned relationships. To understand why people categorized as “indigenous” or “ethnic minorities” occupy a central position in agrobiodiversity research and conservation efforts, it is vital to acknowledge what separates “indigenous” and “non-indigenous groups.” Exploration of these categories provide important insights about the role of political economy for agrobiodiversity conservation and help to explain broader relationships between ethnic identity and agrobiodiversity.

2.6 Ethnicity, Indigeneity and Political Economy

A universal definition for indigeneity is difficult to determine. However, the usage of this term, in both academic and non-academic contexts, is heavily tied to ethnicity, i.e. certain ethnic groups are labeled as ‘indigenous’ groups.

2.6.1 Theories of ethnicity

Anthropologists have studied the concept of ethnicity since the term arose in the 1950s (Eriksen 2002), resulting in a host of conceptual and operation definitions of this construct. These can be simplified into two major categories: ‘primordialism’ and ‘constructivism’ (Hale 2004).

Primordialists, like Clifford Geertz (1973), take the position that the demarcation of groups of people is a deeply historical convention that bounds people based on shared characteristics. According to primordialists, although the formation of an ethnic group occurred at some point in history, ethnic categories in themselves, and individuals’ affiliations with these categories, are believed to be stable. This stability is based on the often-observed connections between ‘biological’ heredity and ethnic identity (Geertz 1973; see also Hale 2004 for review). In contrast, *constructivists*, like Fredrick Barth (1969), highlight the flexibility of these characteristics over time and argue that ethnic labels in themselves structure social life, engendering certain shared characteristics among group members (Barth 1969). Additionally, research regarding the fluidity of individuals’ identities support the constructivist stance, revealing that although an ethnic category may in many ways be stable, individuals' affiliations with a particular category, or set of categories, can be flexible (Vincent 1974; Cohen 1978).

While these theoretical perspectives can be seen as deeply antithetical, the insights into ethnicity contributed by work in each of these paradigms can also be viewed as complementary, providing a complex, nuanced, and realistic understanding of the nature of ethnicity (Hale 2004). Both perspectives seem to agree that ethnicities, whether externally- or internally-imposed, are sociocultural-political categories that describe certain commonalities of a group. These commonalities can shape ethnic categories or be shaped by them. Further, commonalities can be real or imagined. Examples of such characteristics might include, but are not limited to, language, biological heritage, homeland, religion, or value system (Geertz 1973; Barth 1969; Cohen 1978; Eriksen 2002). Further, while primordialists assert that an *ethnic category* may be relatively stable, the work of constructivists reveals that not only can the characteristics linked to a given ethnic category change over time, but individuals can affiliate, or be affiliated with, more than one group in their lifetime, or even at a single point in time.

This more nuanced theoretical orientation regarding ethnicity is fundamentally important to understanding 'everyday forms' of ethnic identification and expression. While ethnic categories in themselves are social constructions tied to narratives of history, affiliation with these categories (be it through self-identification or the external assignment of an ethnic label) is a complex social process. An individual can self-identify with various ethnic categories at particular moments in time and in particular social spaces (Hale 2004; Okamura 1981), making multiple ethnicities possible for a single individual. Further, external interpretation of a subject's ethnic identity is also significant for ethnic identification, which can be in conflict with or work to shape an individual's self-identification (Nagel 1994). Finally, self-identification or the ascription of an ethnic label to an individual may not necessarily be rooted in a uniform and explicit set of characteristics, as individuals can have disagreements about what specifically constitutes membership or affiliation with a particular ethnic category (Nagel 1994). Thus, consideration of the potential dynamics, contradictions, and inconsistencies of ethnicity-in-practice set up a number of methodological hurdles for researchers concerned with ethnicity and identity.

2.6.2 Ethnicity and Political Economy

Recently, research in anthropology and related social sciences has become less concerned with abstract theorizations regarding the roots of ethnicity than they have been with the dynamics, political use, and implications of ethnic categories (Hale 2006; Postero 2006; Speed 2007; Saldivar 2011; Gould 1998). This research also provides crucial insights into theories of ethnic formation and lived realities of ethnic identities by emphasizing the importance of ethnicity within national and global political economies.

As Robison explained (1983), ethnic distinctions played a critical role in the development of the modern global political economic system. As socio-political categories, ethnicities—in this case, often externally imposed identities—served as the foundation of exploitation, legitimizing the oppression of members of specific groups that possessed certain ‘inferior’ characteristics, thus rationalizing their subordination within the political economic system (Robinson 1983). Additionally, the top-down development of homogenous ethnic identities among heterogeneous populations has also played a prominent role in marginalizing—even erasing—certain subaltern populations that were exploited during colonial eras. This phenomenon has been discussed in relation to nation-building throughout Latin America, with focus on the ways in which it complicates the abilities of marginalized populations to seek formal recognition of their historical oppression (Hale 2005; Hale 2006; Gould 1998; Gudmundson and Scarano 1998; Saldivar 2011).

Thus, ethnicity cannot be discussed without acknowledging the role that power played and plays in the formation, characterization, and maintenance of these categories, i.e. what many researchers have come to refer to as the 'racialization' of ethnicity (Robinson 1983; see also Baker 2010). The importance of power in formation and consequences of ethnic categories complicates primordialist-constructivist theories of ethnicity, and is crucial both for understanding indigeneity, and also how indigeneity relates to land use decision-making.

2.6.3. Indigeneity

Like ethnicity, debate exists regarding the concept of 'indigeneity.' Some anthropologists claim that 'indigenous' should not be considered a valid category (Kuper 2003). However, at its core, indigeneity requires that two populations occupying a similar space for one of them to gain the designation of the 'indigenous,' 'native,' 'aboriginal,' or 'first' population (Béteille 1998). Thus, similarly to ethnicity, indigeneity is defined by difference between one group of people in relation to another.

According to the UN Working Group on Indigenous Populations:

> [There are] four principles to be considered in any definition of indigenous peoples: (1) priority in time, with respect to the occupation and use of a specific territory; (2) the voluntary perpetuation of cultural distinctiveness; (3) self-identification, as well as recognition by other groups and by state authorities, as a distinct collectivity; and (4) an experience of subjugation, marginalization, dispossession, exclusion or discrimination, whether or not these conditions persist (Kenrick and Lewis 2004:5).

Thus, indigenousness describes a recognized ethnic group that historically inhabited a particular place, or at least longer than the other contemporary inhabitants, and occupied a position on the fringe of the dominant socio-political order.

As displayed by the U.N.'s acceptance of indigeneity, in recent decades, nation-states (rather than solely activists and theorists) throughout the world have acknowledged the historical marginalization, oppression, and subjugation that these groups suffered under the reign of colonial powers and subsequent modern nation-state system. However, as Hale (2005, 2006) posits, the acknowledgement of the history and continued presence of indigenous peoples has not dissolved the well-established radicalized ethnic hierarchies that structure sociopolitical organization within contemporary nation-states, and particularly throughout Latin America (Hale 2005; Hale 2006). Rather, legitimation often assuages political struggles by forcing politicized ethnic groups to use language and navigate institutions created by the 'racist' state (Hale 2005; Hale 2006; Goldberg 2002), perpetuating the inequality of these populations.

Despite the various consequences and arguments that have been cited and posed about the effects of the label, researchers generally agree that indigeneity is a political category that is intended for use as a political tool (Kuper 2003; Kenrick and Lewis 2004; Dove 2006). In his oft-cited criticism of the indigenous category, Adam Kuper (2003) points that the indigenous label can invoke ideas of an ethnic group being anachronistic. Further, he argues that it insinuates that a group of people maintains a way of life more akin to the original inhabitants of the world, or at the very least the carriers of ancient culture. Yet, regardless of these critiques, the underlying theme on both sides of this debate is that some people, those rightfully or inappropriately termed indigenous, share a history of political and/or economic marginalization.

Thus, understanding what about ethnicity—particularly indigenous ethnicity—makes individuals more likely to conserve agrobiodiversity than members of other groups necessitates the acknowledgement of what these groups share: a similar historical position within the global political economy.

2.7 The Development Industry and the Political Ecology of Agrobiodiversity Conservation

Despite recognizing the importance of political and economic factors in influencing farmers' land use decisions (Thrupp 2000; Coomes and Burt 1997; Coomes and Ban 2004; Perrault-Archambault and Coomes 2008; Altieri 2002; Bellon 2004), few agrobiodiversity researchers have designed studies that focus specifically on the complex political-economic factors shaping agrobiodiversity conservation. Yet, as heretofore argued, human-environmental relationships are characterized by the interaction of multilevel socio-political, economic, and ecological factors. Thus, a political ecological framework can help to expose how and why the historical marginality of indigenous groups places then in a central position within agrobiodiversity conservation literature.

Abbott (2008) is one of the few researchers to explicitly apply a political ecological analysis to understand agrobiodiversity erosion. He employs this framework in an examination of the ways in which government policies in Ecuador impact the conservation of landrace bean varieties by mestizo smallholders[12]. His analysis is in many ways a retelling of the well-worn narrative of agrobiodiversity erosion (Thrupp 2000; Bellon 2004). Abbott shows that mestizo farmers conserved some socially valuable landrace varieties in spite of

[12] Smallholder is another term for small-scale farmer

land reform policies, an agricultural cooperative initiated by the International Center for Tropical Agriculture, and government credit programs (Abbott 2008). These institutional changes and initiatives resulted in the reduction of overall agrobiodiversity maintained by the farmers. However, despite this archetypal agrobiodiversity erosion story, Abbott's use of a political ecological analysis provided unique insights into the position of indigenous people in agrobiodiversity research.

By documenting the various institutions and actors involved in this period and process of agrarian change, Abbott demonstrated that the mestizo farmers in his study that work most closely with agricultural extension agents tended to maintain the lowest levels of agrobiodiversity, which he attributed to the extension program's emphasis on the assumed marketability of modern bean varieties. In doing so, Abbott provided insight into a specific factor that can differentially influence agrobiodiversity erosion/conservation among small-scale farmers—close involvement with a government sponsored agricultural extension program.

Thus, while Abbott is researching non-indigenous farmers, the results of his political economic analysis shed light on the central position of indigeneity in agrobiodiversity literature: Those who have been historically marginalized within the global political economy, and particularly by the nation-state system (Anderson 1991; Wade 1997; Goldberg 2002)—indigenous peoples or minority populations, more generally—have also been historically excluded from agricultural development and extension programs that would encourage them to alter their agricultural practices to focus on monocultural production (Bebbington and Thiele 2005).

2.8 Does indigeneity or ethnicity ensure resistance to change?

By acknowledging the role of agricultural development institutions in influencing farmers' land use practices, Abbott's study shows that historical political and economic marginalization is the central component of the link between indigenous (or ethnic minority) groups and contemporary land use practices that promote agrobiodiversity conservation. These groups have maintained 'traditional' agrobiodiverse farming systems while on the fringes of a changing world.

However, when indigenous communities are the targets of agricultural development or extension programs, should it be expected that they maintain their biodiverse agricultural practices? Does the history of these groups make their members resistant or unlikely to alter their cultivation practices in ways that erode agrobiodiversity? Does the act of identifying with an indigenous or a minority group signal a refusal to engage with development projects? Finally, are agricultural development strategies stable and homogenous?

The chapters that follow address the relationships between agrobiodiversity and ethnic identity in Nicaragua's Pearl Lagoon Basin. Utilizing a political ecological perspective, this work examines the ways in which sociopolitical forces working at a various political levels influence the land use decisions of local farmers. Further, my research draws on anthropological understandings of ethnicity recognizing that an ethnic identity may relate to a set of characteristics shared by group members, but that individuals' affiliations with these sociopolitical categories also can be plastic. Therefore, while a shared history may result in the development of characteristics common among members of an ethnic group that work to promote agrobiodiversity, the act of identifying with a particular ethnic category locates an individual within a broader sociopolitical context. This position, in turn, affects the structures and factors influencing their land use decisions. Previous agrobiodiversity research has overlooked these complexities regarding ethnic identity, and thus failed to acknowledge the sociopolitical processes that shape relationships between ethnicity and agrobiodiversity.

Finally, acknowledging the potential for flexible relationships between identities and land use decisions, this work looks to individual farmer's responses to a changing political, economic, and sociocultural landscape to better understand the configurations of factors influencing land use decision-making that impact agrobiodiversity. In doing so, this research develops a more nuanced and useful understanding of the relationships between ethnicity and agrobiodiversity.

III. Livelihoods and Ethnic Identity in Nicaragua's Pearl Lagoon Basin

3.1 Introduction

I conducted my investigation of the complex and dynamic relationships between ethnic identity and agrobiodiversity maintenance in Nicaragua's Pearl Lagoon Basin. A confluence of factors and processes make this socio-ecological landscape a unique, yet appropriate, research site to explore these relationships and determine *how* ethnicity works to influence agrobiodiversity maintenance in an increasingly connected world. This includes: 1) the Basin's pronounced ethnic diversity (Jamieson 1999); 2) the historically agrobiodiverse subsistence-based land use practices characteristic of the indigenous and afro-descendant populations farming in the Basin (Coe and Anderson 1996); 3) the continually increasing political, economic, and social connectedness of the Basin to the greater region (and world) highlighted by the 2007 construction of the area's first highway.

Atlantic Nicaragua's post-Contact history is characterized by relative political autonomy paired with boom-and-bust interactions with the global economy. The region served a colonial outpost for the British, within which foreign-owned companies facilitated the extraction of resources for global markets. This provided wage labor for local people, but foreign enterprises abandoned the Atlantic Region during periods when political, economic, or ecological problems reduced profit margins (Helms 1971). This cycle drove local populations to develop sociocultural, political, and economic systems that were not solely reliant on foreign assistance or trade (Helms 1969; Helms 1971). Thus, local livelihood strategies depended heavily on local natural resources, particularly for subsistence (Nietschmann 1973), along with the use of foreign goods when available.

This reliance fostered the development and maintenance of close, complex relationships between the local populations and their biophysical environment. Local people hunted, fished, foraged, and cultivated crops through a system of complex swidden agroforestry throughout the pre- and post-Contact Periods (Nietschmann 1973). Since the 1970s, residents of the Atlantic Nicaragua have engaged in fishing for export, but have continued to exploit many other local resources almost solely for subsistence purposes (Garland and Carthy 2010). This diverse subsistence strategy and lack of capitalization encouraged the conservation of many local natural resources, particularly within the Region's expansive lowland tropical forests (Nietschmann 1973). This socio-ecological relationship, at least in part, helped historically to maintain the biological integrity of this global "biodiversity hotspot"[13] (Conservation International 2014).

Today, the sociopolitical (and socio-ecological) landscape continues to evolve as the Pearl Lagoon Basin and the larger Atlantic Autonomous Region as its residents becoming increasingly connected to extra-local political, economic, and social processes. Following the construction of the first highway to connect the Basin to the rest of Nicaragua by land, a rapid increase in seafood exportation has had dramatic, negative impacts on the health of the fisheries that serve as a subsistence base for most of the local indigenous and afro-descendant populations (Stevens 2014). Concurrently, a host of government and non-

[13] The sparse population and abundance of natural resources make the Atlantic Region of Nicaragua a key component of the Meso-America Biological Corridor. Conservation of this Biodiversity Hotspot, a term used to describe the richest and most threatened biological regions on the planet, is argued to be valuable in its own right, since the Biological Corridor holds 7% of the world's biodiversity. Moreover, the conservation of an intact and healthy ecosystem in this region is also critical for maintaining a migratory highway for the flora and fauna of North and South America (Conservation International 2014). Thus, degradation of the natural environment due to land use activities in Atlantic Nicaragua has the potential to impact biodiversity conservation efforts throughout the Western Hemisphere.

governmental agricultural development programs are working to influence the land use decisions of local populations in an effort to promote both economic development and food security.

Further, while the Basin has long been home to individuals who identify as Miskito, Creole, and/or Garífuna, the socio-ecological system has been greatly altered a continually growing migrant mestizo population from Nicaragua's Highland Regions coming in search of 'empty land' north and west of the Pearl Lagoon in which to develop cattle ranches. In addition to impacting local ecosystem integrity, the land use of activities of migrant ranchers have provoked tension between migrant populations and the Basin's more established indigenous and afro-descendant populations

Yet, while associations can be identified between farmers belonging to certain ethnic groups and their (historical) land use strategies, it is critical to acknowledge the complex and plastic nature of ethnic identity in the Pearl Lagoon Basin's multiethnic landscape (Jamieson 1999; Jamieson 2003; Gordon 2003; Pineda 2006) and the ways in which ethnic identities are interrelated with larger sociopolitical processes. Furthermore, local farmers' land use practices are not necessarily *predetermined* by their ethnic identities. Rather, there is potential for flexibility and adaptation of livelihood strategies in light of new opportunities and constraints, both economic and non-economic. Therefore, the political ecological framework employed in my research draws attention to the sociopolitical processes that are influencing both ethnic identity and land use strategies in the Pearl Lagoon Basin to more fully understand the relationships between ethnicity and agrobiodiversity.

3.2 The formation of Atlantic Nicaragua

The Atlantic (or Caribbean) Region of Nicaragua occupies roughly half of the land area of Nicaragua. It is divided into two politically autonomous regions, the *Región Autónoma del Atlántico Sur* (RAAS), or the Southern Atlantic Autonomous Region, and the *Región Autónoma del Atlántico Norte* (RAAN), or the Northern Atlantic Autonomous Region (see Figure 3.1). The Pearl Lagoon Basin is located in the RAAS, which despite covering 27,407 km^2 has an estimated population ranging between 350,000 and 400,000 people. The RAAN is slightly larger, covering 32,159 km^2, but with a smaller population of approximately 250,000 inhabitants. Together these regions only account for between 700,000 and 750,000 of Nicaragua's 5.8 million citizens (Central Intellegence Agency 2014).

Figure 3.1: Nicaragua's RAAN and RAAS (highlighted in dark blue)

Source: Wikimedia Commons

The residents of this large, sparsely populated, rainforest-covered coastal plain have long been politically, economically, and culturally disconnected from the country's highland and Pacific regions. A long history of negotiations and treaties, however, formed Atlantic Nicaragua as a distinct region within the modern nation-state.

Atlantic Nicaragua was historically part of a greater region, often referred to (namely by Europeans) as the Mosquito (or Miskito) Coast. Named for the Miskito (or Miskitu) Indians in the region, this area comprises the Caribbean coast of much of modern-day Nicaragua, as well as part of Honduras's eastern coast (see Figure 3.2). The Mosquito Coast has a distinct history from the Pacific and highland regions of Central America. The people of this region have been separated from the rest of Central America since the pre-conquest era (pre-1530), in part because a mountain range divides the area that the modern nation-states of Nicaragua and Honduras now occupy (Nietschmann 1973). Archaeologists categorize the pre-conquest residents of the Pacific and highland Central America as part of the Mesoamerican Culture Area, while they view the historical residents of the Miskito Coast to be more closely related to the people that inhabited the Caribbean Coast of South America (Helms 1971).

Further, the Spanish began settling and colonizing the Pacific lowlands of Nicaragua beginning around 1520, while the people of the Miskito Coast had a colonial relationship with the British (Jamieson 1999). The British, interested in the region's natural resources—chiefly mahogany—maintained 'rights' to the region until the mid-nineteenth century. However, after a series of confrontations with United States naval forces operating under the Monroe Doctrine, the British delegated a portion of its Miskito protectorate to Honduras (1859), dividing the Miskito Coast. The remaining coastal region was granted to Nicaragua in 1860, but maintained autonomy under the Treaty of Managua (Helms 1971). This autonomy was put on hiatus in 1894 when, as Charles Hale (1994) argues, the Nicaraguan and U.S. governments saw potential for banana plantations on the Atlantic Coast.

Formal autonomy was renegotiated in 1987 following the end of the *Contra* War, in which a mostly Miskito army waged a counter-insurgency against the Sandinistas throughout the Atlantic Region. Today, the current autonomy agreement grants decision-making power and collective land rights for the local indigenous and afro-descendant populations (Jamieson 1999).

Figure 3.2: The Miskito Coast

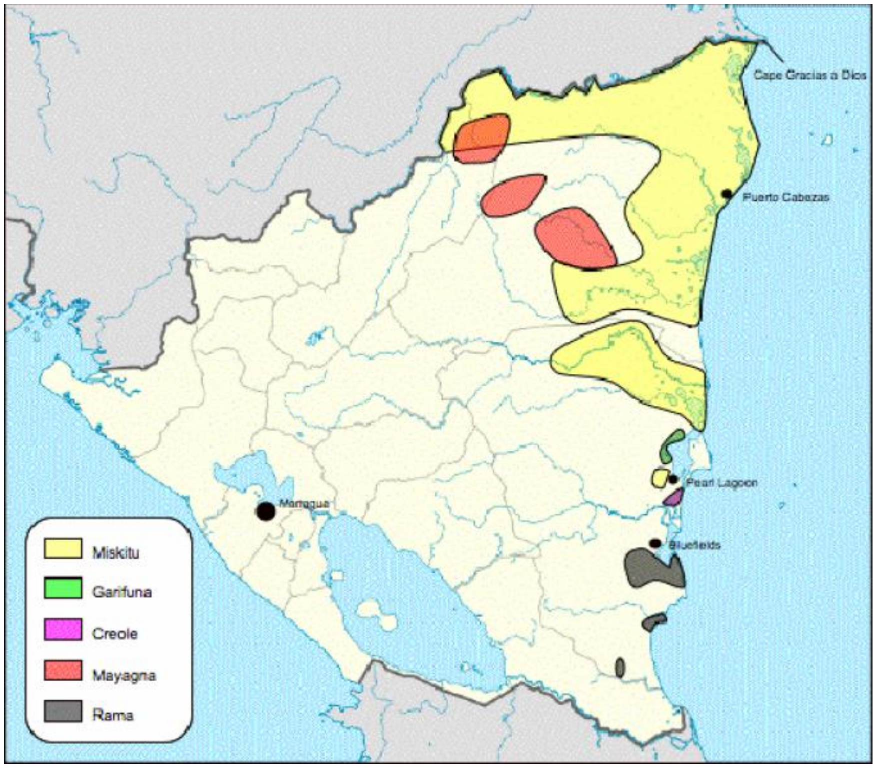
Source: Wikimedia Commons

3.3 The people of the Atlantic Nicaragua's Pearl Lagoon Basin

Unlike Pacific Nicaragua—where Spanish colonial policies nearly eradicated the indigenous inhabitants of the region creating a more or less uniformly Spanish-speaking mestizo population—Atlantic Nicaragua is home to almost the entirety of Nicaragua's indigenous, afro-descendant, and non-Spanish speaking people (Jamieson 1999). Today, along with a growing mestizo population, the groups living in Atlantic Nicaragua include indigenous peoples (Miskito, Rama, and Mayagna) and afro-descendants (Garífuna and Creole) (Figure 3.3).

As the historical majority, at present the Miskito make up only 17.75% of Atlantic Nicaragua's total population. The Region's other indigenous and afro-descendant groups each account for only a small additional fraction: Creoles (2.95%), Mayangna (1.1%), Garífuna (0.19%), Rama (0.23%). Although the complex nature of mestizo settlements in the region make it difficult to determine, mestizos are believed to account for as much as 73% of the population and are thus by far the largest ethnic group in the region (Jamieson 1999; Brunnegger 2007). This shift in population structure, driven by governmental policies that left many mestizos peasants from the Pacific and highland regions landless (Jamieson 1999), has profound implications for this human-environmental system.

Figure 3.3 Ethnic Groups of Atlantic Nicaragua



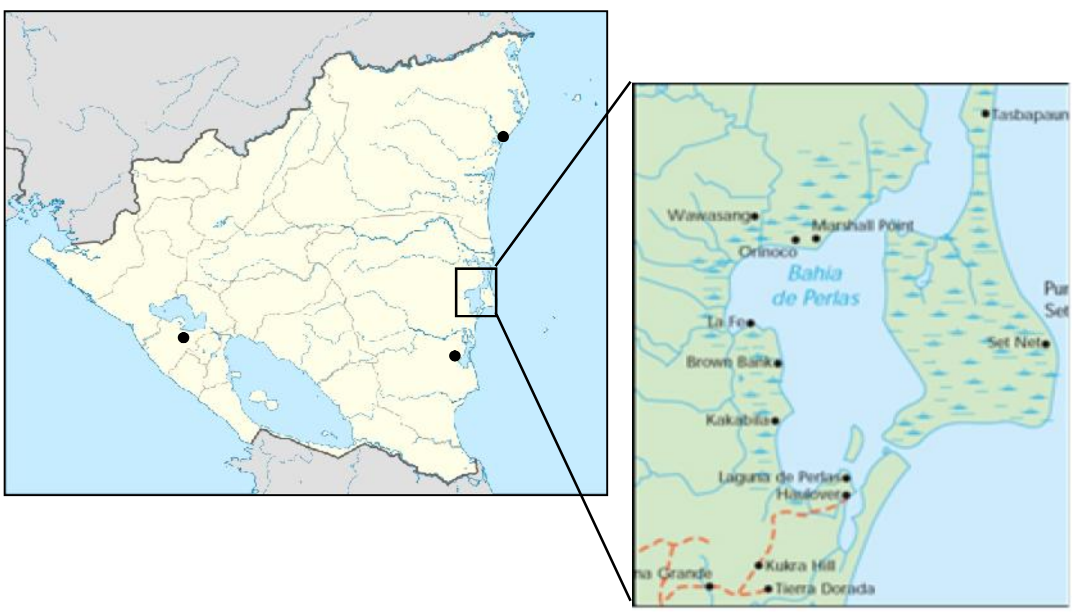
Source: Author’s drawing and Wikimedia Commons

Figure 3.3 shows what are known to be the approximate settlement areas of indigenous and afro-descendant populations of Atlantic Nicaragua (adopted from Coe 1997; Davidson 1980). Mapping the settlements of the region’s ethnic groups is problematic, however, for a variety of reasons:

1) Because little has been formally documented about the settlement patterns of the Region’s rural mestizo populations, their settlements are not included in this map. Although, it is believed that most rural mestizos live in the southern and western regions of the Atlantic Region (Jamieson 1999).
2) This map does not depict the ethnic compositions of the major population centers of the Atlantic Coast, such as Bluefields, Puerto Cabezas, and Pearl Lagoon. It should be noted, however, that these large, ethnically-diverse communities are the primary settlement sites for Creoles and are also home to mestizo, Miskito, Garífuna, Rama, and Mayagna populations (Jamieson 1999; Christie 2004).
3) There is a certain level of flexibility to ethnic identities in Atlantic Nicaragua. This plasticity is particularly evident in the Pearl Lagoon Basin, a small area that is home to members of four of the Region’s ethnic groups: Miskito, Garífuna, Creole and mestizo. Although there are distinctions between these groups, individuals and families can categorize themselves and be categorized in more than one ethnic group. This complexity is obviously difficult to display in a map format.

The Pearl Lagoon Basin (shown in Figure 3.4), the terminus of the first highway connecting the southern Caribbean Coast to Pacific and Highland Nicaragua, is one of the most diverse areas in Atlantic Nicaragua in terms of ethnic identities, especially outside of the Region’s two main urbanized areas, Bluefields and Puerto Cabezas (Jamieson 1999; Christie 2004). Along with being a primary center of both Garífuna and Creole culture in Atlantic Nicaragua, the Basin is also home to Miskito people and a growing mestizo population. People who identify as Miskito are the largest group in the Basin (~40% of the population), followed by the Garífuna (~26%), the Creole (~26%) (Christie 2004). Most of these individuals live in or near to the 12 established communities situated on or near the shores of the 534 square kilometer Pearl Lagoon (Table 3.1). The Basin is also home to an unknown, but steadily growing number of mestizo migrants. Pueblo Nuevo (Wawashang on the map and starred in Table 3.1), serves as the only recognized mestizo settlement.

Figure 3.4: The Pearl Lagoon Basin



Sources: www.wikicommons.org and Dr. Gerald R. Urquhart

Table 3.1. Characteristics of communities in the Pearl Lagoon Basin

Community	Population in 2006	Dominant Ethnic Make-up	Chief Economic Sectors (of equal importance)
Pearl Lagoon	2,540	Creole, Miskito, Garífuna, mestizo	Fisheries, Agriculture, Tourism
Haulover	1,897	Creole, Miskito	Fisheries, Agriculture
Raitipura	250	Miskito	Fisheries, Agriculture
Awas	93	Miskito	Fisheries, Agriculture
Kakabila	497	Miskito	Fisheries, Agriculture
Brown Bank	202	Garífuna, Creole	Fisheries, Agriculture
La Fe	110	Garífuna, mestizo	Fisheries, Agriculture
San Vicente	81	Garífuna	Fisheries, Agriculture
Orinoco	1,010	Garífuna, mestizo	Fisheries, Agriculture
Marshall Point	261	Garífuna, Creole	Fisheries, Agriculture
Tasbapauni	1,445	Creole, Miskito	Fisheries, Agriculture
Set Net	416	Miskito, Creole	Fisheries, Agriculture
Pueblo Nuevo[14]	unknown	Mestizo	Agriculture

Source: (Beer and Vanegas 2007)

3.3.1 Ethnic fluidity on the Caribbean Coast

Although distinct ethnic categories appear to exist in the Pearl Lagoon Basin, research conducted in the region in recent decades highlights that like in many other parts of the world, ethnic identity in the Basin is fluid, flexible, and context dependent (Jamieson 2003; Gordon 2003; Vincent 1974; Cohen 1978). This fluidity specifically pertains to the indigenous and afro-descendant populations that have resided alongside (and with) one another for more than a century and developed very similar livelihood strategies and ethnobotanical knowledge (Jamieson 1999; Jamieson 2003; Gordon 2003; Pineda 2006; Coe and Anderson 1996). As such, while general, separate histories can be described for local populations, many of the Basin's inhabitants identify with a suite of ethnic categories, including indigenous, afro-descendant, mestizo, and even European ancestry. *Costeño*, or

[14] Pueblo Nuevo is an informal settlement without formal land rights; its exact population is unknown.

coastal person, is a unifying term with which most of these individuals tend to identify. Further, while the migrant mestizo population mostly stands apart, there are numerous examples of mestizos from the Highlands assimilating into the Basin's indigenous and afro-descendant communities.

3.3.2 The Miskito

The establishment of a Miskito, or Miskitu, identity occurred in the post-Contact Period. Beginning in the early seventeenth century, French buccaneers (and later the British) developed a "friendly relationship" with the people inhabiting the area round Cape Gracias a Dios, near the Nicaraguan-Honduran border, in a region of Central America mostly ignored by the Spanish (Nietschmann 1973; Pineda 2006).

The populations living in this region at the time of European contact were not Mesoamerican groups, a category used by archaeologists and historians to describe the indigenous people that lived in Nicaragua's western region and throughout much of Central America (MacLeod 2008). As Murdo MacLeod (2008) states, Mesoamericans, though undoubtedly varying over space and time, were farmers that were organized around small cities-states; many of these groups residing in Nicaragua became part of the Spanish colonial system after conquest of the Pacific Lowlands in 1520 (Faber 1993).

In contrast, inhabitants of the Atlantic Coast lived in small groups composed of several families and spoke languages in the Macro-Chibchan language family, relating them to the native people living on the northern coast of South America (Helms 1971). These semi-nomadic groups used open-sided thatch huts for shelter and traveled along the coast and rivers systems fishing, hunting and gathering wild plants. Additionally, early European accounts document subsistence patterns that also include swidden agriculture and horticulture; cultivating bananas, plantains, maize, sugar cane, root vegetable, and tuberyielding plants (Helms 1971; Nietschmann 1973). Karl Offen (2002) argues that geographic separation, i.e. living in the Region's various river valleys, was the primary factor distinguishing these groups before the Contact Period. This isolation resulted in as many as ten or more different dialects in the region (Helms 1971; Offen 2002).

The British developed a close political and economic relationship with the coastal population, which lasted for two centuries (Hale 1994). The crowing of the first Miskito king in 1631 aided their indirect rule of the region and later became a critical factor in the establishment of the British superintendency of the Miskito Shore (1749-1786) (Hale 1994). Importantly, weapons supplied by the British enabled the inhabitants around Cape Gracias a Dios to expand and secure territory. This includes their conquest of the Pearl Lagoon Basin in the seventeenth century (Beer and Vanegas 2007), which was previously inhabited by other indigenous groups. Therefore, the Miskito are believed to be culturally and linguistically related to one of the indigenous groups inhabiting the coastal area around Cape Gracias a Dios during the early Contact Period, as well as marooned African slaves and others that had escaped from plantations in Honduras (Conzemius 1932).

Mary Helms (1971) asserts that the traditional "peasant" category, with its emphasis on agriculture as the primary source of subsistence, the surpluses of which provide a foundation for state-level society (Wolf 1966), is a poor fit for the Miskito. Rather, unlike many of Central America's historic inhabitants, she categorizes them as a "purchase society." This categorization is reflective of the fact that along with agriculture, "hunting and fishing, gathering of natural resources for barter and sale, and wage labor have all been equally important to the Miskito economy since its origins in the seventeenth century" (Helms 1971:4).

In particular, horticulture and small-scale agriculture gained increased importance historically for Miskito households during eras of “company times” (Hale 1994), or the periods during which foreign owned companies—namely from the US, established rubber (1860’s and 1870’s), mahogany (1880’s) and mineral (1890’s) extraction sites and to an even greater degree during the banana plantation era (1890’s-1950’s) (Nietschmann 1973). During these boom periods, wage labor was widely available to men living in the region, but often involved contract employment that could keep an individual away from their home village for up to a year. As a result, purchased goods and horticulture (customarily a women’s activity) supplanted the hunting and fishing activities central to Miskito subsistence strategies (traditionally male responsibilities) as the primary subsistence strategies for many households (Nietschmann 1973). Today, most Miskito people living in the region are still small-scale agriculturalists and fishermen living in small villages along the Atlantic Coast (Dennis 2004). These mixed livelihood strategies also characterize the Miskito communities that surround the Pearl Lagoon.

3.3.3 The Garífuna

Garífuna is an ethnic category that describes descendants of a group referred to by the British colonists of the Caribbean as “Black Caribs,” who mostly lived on what is now St. Vincent. This group emerged from “relations” between marooned or escaped slaves from West Africa and native populations from the Caribbean, who the British called “Caribs” (Davidson 1980; Anderson 2009). Although French colonists settled on St. Vincent, the Black Caribs maintained political autonomy and evaded colonial control for much of the sixteenth and seventeenth centuries. However, the British sought to develop sugar plantations on the island and gained treaty rights to St. Vincent from the French in 1773 (Anderson 2009). The Garífuna joined with French settlers to successfully regain control of the island between 1779 and 1783, but were formally expelled to the island of Roátan, Honduras (held by the Spanish) in 1797 after the British finally defeated the French-Garífuna alliance (Davidson 1980; Anderson 2009).

From Roátan, where the Black Carib/Garífuna exiles had further "relations" with the local Arawak Amerindian population (Hale and Gordon 1987; Anderson 2009), they spread north and south along the Caribbean coastline of Central America. The southernmost sites of Garífuna culture in Central America were established in the Pearl Lagoon Basin before the turn of the twentieth century, where Garífuna people came to participate in a mahogany-logging boom (Davidson 1980; Beer and Vanegas 2007).

The Garífuna have divergent histories from the Miskito (and Creole) people living in and around the Pearl Lagoon Basin and maintain distinct cultural identities. An ethnic revival that has been occurring throughout the greater Garífuna community since the 1980's has strengthened the Nicaraguan Garífuna identity. According to local anthropologist Kensey Sambola, a Sandinista literacy campaign brought Belizean Garífuna to Atlantic Nicaragua, which reconnected the Nicaraguan population with the larger Garífuna diasporic community (Personal Communication 2011). Despite cultural distinctions, however, centuries of contact and intermarriage between these communities and life in a similar biophysical environment have resulted in most people from these groups sharing very similar overall livelihood strategies and ethnobotanical lore today (Coe 2008). Thus, like the Miskito, the Garífuna (and Creole people) cultivate a wide variety of plants for their households on communal lands to supplement fishing for food and sale, hunting, gathering, and periodic wage labor.

3.3.4 Creoles

Creole is a broad cultural category that refers to Caribbean people of African and European descent who settled on the Atlantic Coast between the mid-seventeenth century and the first half of the twentieth-century (Jamieson 1999). People categorized in this way came to the region, like the Garífuna, for labor opportunities, but particularly to work as merchants (Helms 1971). Many of these afro-descendants, however, developed livelihood strategies based on the mixed agriculture, horticulture and fishing characteristic of the Miskito and Garífuna populations living on the lagoon.

The heterogeneity of this group makes a singular ethno-historical narrative difficult to piece together. Rather, literature regarding Nicaraguan Creoles has tended to emphasize the complexities and dynamics of Creole identity politics (Jamieson 2003; Gordon 1998; Gordon 2003; Goett 2006). As Edmund T. Gordon (1999, 2003) and Jennifer Goett (2006) document, the liminal ethno-racial position that that the Creole occupy—in terms of Blackness/Whiteness, Blackness/Indigenousness, autochthonous/diasporic—allows them the ability to express their identities flexibly, often to gain politically advantageous ways. For example, before the reinstatement of regional autonomy following the *Contra* War, Creole people had a tendency to highlight the Anglo-ness of their family histories along with their Black lineages, often to a greater degree than their Blackness or African-ness (Gordon 2003). This was likely to claim a stronger connection to the foreign business interests (from Britain and the U.S.) that historically dominated the Region's political economy. More recently, following autonomy, Creole identity politics shifted, as members of this group were pushed to accentuate their 'indigenousness' in order to put themselves in position to make regional land claims (Goett 2006).

Additionally, information regarding local characterizations of Creoles can be extracted from research regarding more "everyday" ethnic flexibility among Atlantic residents, particularly those living in the Pearl Lagoon Basin. Here, Creole identity has been described to be associated with the ways in which an individual generally engages in economic exchange: a Creole (as opposed to Miskito) being one whose economic transactions are perceived by the community to be driven by individualistic, as opposed to communal concerns (Jamieson 2003). Notably, this economically-derived ethnic demarcation is in contrast with ethnicity based on origin or religious beliefs that are often the crux of ethnic divides elsewhere, particularly in Latin America (Wade 1997; Fuchs 2005). Further, this stereotyping also points to the historical position (or simply locally perceived position) of Creole group members in the regional political economy. As described above, members of this group were closely aligned with foreign business undertakings, awarding them a prominent place within the regional political economy. However, this also resulted other regional residents associating Creoles with these foreign interests, rather than local interests.

3.3.5 Mestizos

A century ago mestizos were ostensibly absent from the Atlantic Region, especially near to the coast (Jamieson 1999). Today, however, people who identify as mestizo are now the largest population in Nicaragua's Atlantic Region. They are estimated to make-up somewhere between 63% and 73% of the total regional population (Jamieson 1999; Brunnegger 2007; Beer and Vanegas 2007). Many of these individuals are living in unincorporated rural areas, making exact numbers difficult to determine (Jamieson 1999).

The first, albeit small, group of mestizos came to Atlantic Nicaragua during Nicaragua's attempt to incorporate the Atlantic Region into the nation-state in the late nineteenth century (Jamieson 1999). The next waves of mestizos settled in the Atlantic Region were landless peasants from the Pacific Region that migrated in the 1950's after a rapid decline in cotton production that resulted in reduced labor demand. Many sought to develop cattle ranching operations on the 'empty' frontier lands that existed in the Caribbean

Plain (Jamieson 1999). This trend has increased since the end of the Nicaraguan *Contra*-War (Brunnegger 2007; Beer and Vanegas 2007).

Although some mestizo migrants originally settled in a few of the region's already established communities, some formerly rural frontiers-people have urbanized, and some new migrants are also settling in these communities, there are still a large, but unknown number, of Atlantic mestizos living on deforested agricultural lands in the interior of the region where they farm and raise cattle (Jamieson 1999). Little, however, has been documented about these individuals, at least in part because of the illicit status of many rural mestizos in the region.

3.4 Ethnicity and Conflict in Atlantic Nicaragua

Paired with the decline of the artisanal lagoon and marine fisheries[15] that serve as the main protein and a major revenue source for local indigenous and afro-descendant populations (Nietschmann 1973; Stevens 2014), the expansion of the agricultural frontier and the encroachment of mestizo ranching continually nearer to the Basin's established communities has sparked conflicts between these settlers and the region's *Costeño* populations.

These conflicts can, at least in part, be attributed to implications and consequences of the passage of the National Assembly of Nicaragua's Law 28, the Autonomy Statute for the Atlantic Coast of Nicaragua, in 1987. This formal declaration of regional autonomy, enacted following the end of the *Contra* War, recognizes the "multi-ethnic" nature of the region, gives official status to local languages, and declares rights to regional self-determination and

[15] This decline was provoked, for the most part, by the ability to export local fish to the Pacific and Highland regions of Nicaragua via the newly built road (Stevens 2014).

control over natural resources (Brunnegger 2007). An autonomous political structure currently works in parallel with the national political system (Table 3.2), which theoretically both insures continued assistance regarding socio-economic development from the central government and enables autonomous decision-making (Constitution of Nicaragua, Articles 175-188 [2005]). However, throughout the decades following the passing of Law 28, the national government has maintained substantial political power that has been used to direct the Region's economy. Further, inter-ethnic/community conflicts can also be traced to the vagueness of the Autonomy Statute regarding how the rights that it grants should be achieved.

Table 3.2. Political structure of Nicaragua and the Autonomous Regions

National Structure	Autonomous Structure
National Government	
Departmental Government	Regional Autonomous Councils (RAAN/RASS)
Municipal Government	Territorial Councils
	Communal Councils

For example, article 9 of the Autonomy Statute states that "the right to own communal lands shall be recognized in the rational use of the mineral, forest, fishing, and other natural resources of the Autonomous Regions, and said use should benefit the inhabitants equitably, by means of the agreements between the Regional Government and the Central government" (Autonomy Statute for the Regions of the Atlantic Coast of Nicaragua, Law no. 28, Art. 9 [1987]). Yet, which communities have the right to which specific pieces of land (and how to protect that right) was never clearly defined. Following a legal suit brought to the Inter-American Court of Human Rights by the Awas Tingni Miskito community in the RAAN against the Nicaraguan government in 2001, the federal government was forced to initiate the demarcation of communal lands to specific communities throughout Atlantic Nicaragua (Finley-brook and Offen 2009). However, surveying and titling the land is a difficult and costly process (Offen 2003; Hale 2005; Finley-Brook and Offen 2009). Thus, formal demarcation of communal lands is an ongoing process.

While demarcation may remedy the nebulousness of community boundaries (or simply territorial boundaries in the case of the Pearl Lagoon Basin[16]), the process poses the potential for a number of unintended consequences (Finley-brook and Offen 2009). For example, the demarcation process includes a loosely described "cleaning up" of communal lands, in which those without communal right to "indigenous lands" are required to vacate their illicit land claim (Law of Communal Property Regime of the Indigenous and Ethnic Communities of the Autonomous Regions of the Atlantic Coast of Nicaragua and the Rivers Bocay, Coco, Indio, and Maiz, Law no. 445, Art. 35-38 [2002]). How this de-occupation would take place, particularly in examples in which individuals invested labor and/or money into the property but will not receive compensation, remains undefined. Further, who qualifies as indigenous or "ethnic" (and *how* they qualify) in a multicultural landscape adds additional complications. And in this way, ethnic-based land rights have the potential to shape the self-identification of local people.

[16] The "12 Indigenous and Afro-Descendant Communities of the Pearl Lagoon Basin" are seeking demarcation on the territorial level. The hope, according to local community leaders, is that this will 1) help to avoid inter-community land conflicts and 2) create unity among these communities as they attempt to challenge the illegitimate land claims of migrant ranchers.

3.5 Agricultural development in the Pearl Lagoon Basin

Concurrent with the land rights politics and conflicts occurring in the Pearl Lagoon Basin and elsewhere in the region, a number of governmental agencies and non-governmental development organizations (NGO) are working to promote regional autonomy on a variety of fronts. For example, the internationally-funded[17] regional NGO, the *Fundación para la Autonomía y el Desarrollo de la Costa Atlántica de Nicaragua* (FADCANIC), or the Foundation for the Autonomy and Development of Nicaragua's Atlantic Coast, is working with communities around the Basin on issues relating to the demarcation process. Additionally, this organization and others are also focusing on a variety of other development campaigns as a means of promoting regional autonomy. This includes agricultural development. As a result, in addition to the influence of the historical cultivation strategies characteristic of farmers in the region, the activities of these organizations are working to shape the land use decisions of local residents.

Projects (see Table 3.3) are directed from a range of political levels, all of which seek to promote regional economic autonomy and food security through agricultural development. The Black Farmers Cooperative, for example, is a local initiative to the Pearl Lagoon Basin with backing from the federal government to expand local, small-scale coconut production for export. NicaCaribe is an extension project facilitated by the *Ministerio de la Familia* (Ministry of Family). This program supplies farmers throughout the Atlantic Region with a variety of 'traditional' subsistence crops to boost food security. Bluefields Indian and Caribbean University (BICU) also has begun a project supplying select

[17] FADCANIC receives most funding from the Norwegian development organization, but has also been funded in part by the Unites States Agency for International Development (USAID) and the Austrian Organization for Development Co-operation.

farmers in the Basin with “non-traditional” crops through a grant from the Danish government that aids work on increasing local resilience to climate change.

Agrobiodiversity conservation and promotion are key components of FADCANIC’s, NicaCaribe’s, and BICU’s project the goals. Further, because these organization and Black Farmers explicitly focus on promoting regional autonomy, all of these agricultural development projects specifically focus on individuals who identify as indigenous and afro-descendant—the legal grantees of autonomy. These individuals are eligible to participate in workshops and receive free seeds and plants. Individuals without legal right to land, i.e. migrant ranchers, generally do not received aid from these projects. Thus, as with land rights, there is a benefit to highlighting one’s indigenous or afro-descendant identities in order to be in position to receive needed and wanted aid.

Table 3.3. Agriculture-focused development organizations

Project Name	**Level at which Administrated**	**Primary Focus**	**Communities in which they work**
Fundación para la Autonomía y el Desarrollo de la Costa Atlántica de Nicaragua (FADCANIC)	Internationally funded NGO, regionally managed	Agrobiodiversity promotion through novel plants and workshops; Agriculture-focused	With indigenous and afro-descendant farmers throughout the Basin
Black Farmers Cooperative	Funded by national government, locally managed	Distribution of coconut and rice for eventual export	In historically afro-descendant communities: Pearl Lagoon, Brown Bank, La Fe, San Vicente, Orinoco
NicaCaribe	Funded by national government, regionally managed	Distribution of staple crops to local farmers (i.e cassava, plantain, rice)	With indigenous and afro-descendant farmers throughout the Basin
Bluefields Indian and Caribbean University (BICU)	Internationally funded program, managed by regional university	Crop experimentation to identify agroecologically suitable non-traditional crops for export	Currently testing crops in La Fe and Orinoco

3.6 Conclusion

The histories of the indigenous, afro-descendent, and mestizo communities living in Nicaragua's Pearl Lagoon Basin resulted in ethnically-distinct land use patterns. While the indigenous and afro-descendant populations developed similar agro-forestry systems characterized by high on-farm biodiversity, these practices are a contrast to the extensive ranching operations that are generally associated with mestizo migrants. The land rights and agricultural development initiatives that aim to strengthen political and economic autonomy for the indigenous and afro-descendant communities within the Pearl Lagoon Basin (and throughout Atlantic Nicaragua) appear to be positioned to strengthen the distinctions in land use strategies between members of these groups. All of these organizations aim to improve food security in the region, while FADCANIC, NicaCaribe, and BICU's agricultural extension programs specifically stress the importance of agrobiodiversity within their development strategies. These extension activities, which include supplying farmers with free seeds and plants, are not extended to residents of the Basin's informal mestizo communities.

However, while generally corresponding with the ethnic identities of farmers, land use—and the maintenance of agrobiodiversity—is not necessarily *predetermined* by a farmer's ethnic identity. Further, land use decisions are not dictated solely by the activities of development project. Instead, there is potential for the adaptation of land use strategies in light (or in spite) of new opportunities and constraints in this ever-changing socio-ecological landscape. Therefore, identifying heterogeneity among the land use practices of farmers that identify with particular ethnic groups can help to reveal the prominent factors and process that influence agricultural decision-making. Further, while these drivers may tend to be associated with members of particular ethnic groups, they also may influence farmers' maintenance of agrobiodiversity regardless of the farmer's ethnic identity.

Additionally, the highly politicized ethnic landscape engendered by the Region's ethnic-based land rights (and the organization aiming to bolster those rights through development initiatives) also has the possibility of influencing the ethnic identification of local people in this multiethnic landscape. Therefore, in order to understand the relationship between ethnicity and agrobiodiversity in the Pearl Lagoon Basin it is critical to acknowledge the history of local populations, the potential for flexibility regarding land use practices, *and* the dynamics and politics of ethnic identity. As such, it was vital to develop a novel research design, which I describe in the following chapter, to account for the various and potentially confounding factors influencing these relationships. The result is a more complete understanding of how ethnicity relates to agrobiodiversity conservation, as well as information regarding local land use strategies that could be useful for assuaging the current and forthcoming land rights conflicts.

IV. Research Design

4.1 Introduction

This chapter details the research design and methods I employed in my investigation of the relationships between ethnicity and agrobiodiversity in Nicaragua's Pearl Lagoon Basin. The political ecological approach that I used required the collection and integration of ethnographic, demographic, and agroecological data 1) to account for the complex nature of ethnic identity and 2) to gain detailed information regarding agrobiodiversity that is comparable between farms and farmers. As described in Chapters 1 and 2, agrobiodiversity has been conceptualized in a variety of ways. Thus, in this chapter I also describe the specific conceptual and methodological approach that I took to assess agricultural biodiversity for this study. Ultimately, the integration of the farm, farmer, household, and community data collected through this research enables me to address and answer the research questions and hypotheses that guide this project.

The data used in my study come from three different sources. The first is a dataset that contains information garnered from agrobiodiversity surveys that I administered with the help of two local field assistants to 163 farmers throughout the Pearl Lagoon Basin during the rainy (or main agricultural) season in 2013. This includes detailed information about farmers and their farms, including plant species and abundance counts used to develop agrobiodiversity metrics. I collected ethnographic data through participant observation and key informant interviews over 10 months in 2013 and 2014. This includes information regarding farmers' agricultural knowledge, historical and contemporary cultivation practices, household livelihood strategies, and involvement with governmental and non-governmental agricultural development organizations. I also employed ethnographic methods to collect information regarding formal and informal rules regarding land tenure, the design and implementation of local development projects, and the dynamics of ethnic identification. The third—and final—dataset was compiled by a collaborating research team, primarily based at Michigan State University (MSU), and contains geo-referenced household survey data.

The household and agrobiodiversity survey data provided a host of information about farms, farmers, and their households that I analyzed using R (R Core Team 2013). These data—selected based on significant factors identified in prior agrobiodiversity research—are used to determine the extent to which various farm-, farmer-, community-, and household-level factors correlate with the agrobiodiversity measured on a specific farm. The ethnographic data was analyzed using RQDA (Huang 2014). This data is vital for contextualizing the agricultural and household survey data and *explaining* the relationships between these factors and the degrees of agrobiodiversity that a farmer maintains. Further, ethnographic data is necessary for understanding how difficult-to-quantify factors, such as the valuation of certain qualities of agricultural landscapes, influence the relationships between ethnicity and agrobiodiversity.

4.2 Research Questions and Hypotheses

In order to answer my central research question, *how does ethnicity influence, and how is ethnic identity influenced by, a farmer's maintenance of agrobiodiversity in the Nicaragua's Pearl Lagoon Basin*, it is necessary to determine if the contemporary land use practices of local farmers result in ethnically-distinct patterns regarding the agrobiodiversity within their farming systems. Further, I also need to identify the primary factors driving farmer's land use decisions that impact agrobiodiversity, and how these factor relate to ethnicity. As such, this research was directed by the following sub-questions, which were addressed by testing the related hypotheses:

SQ1) *Do members of different ethnic groups in the Pearl Lagoon Basin maintain different levels of agrobiodiversity within their farming systems?*

H1: Households that self-identify with Nicaragua's ethnic minority groups (Miskito, Garífuna, or Creole) have more agrobiodiverse farming systems than farmers who identify with the mestizo majority.

H2: Farmers that self-identify as indigenous (Miskito) and/or afro-indigenous (Garifuna) farmers have more agrobiodiverse farming systems than farmer that identify as non-indigenous Creole.

SQ2) *What are the major factors influencing farmers in the Pearl Lagoon Basin to maintain varying degrees of agrobiodiversity within their farming systems?*

H3: The major factors influencing the land use decisions that govern agrobiodiversity maintenance or erosion throughout the Basin are 1) agricultural knowledge 2) (dis)respect for local communal land tenure systems, and 3) participation in agricultural development projects.

SQ3) *Do the major factors influencing farmers' decisions to maintain highly agrobiodiverse farming systems relate with farmers' ethnic identities?*

H4: These factors are highly related to farmers' ethnic identities.

H5: In contrast to broader patterns regarding ethnicity and agrobiodiversity, mestizo households that reside in historically Miskito, Creole, or Garífuna communities have more agrobiodiverse farming systems than mestizos living in more remote parts of the Basin, as they have modified their land use practices in accordance to community land use norms.

4.3 Measuring and Qualifying Ethnicity

Previous research concerning agrobiodiversity conservation primarily relied upon quantitative data to explore the relationships between various household or farmer characteristics, such as singular ethnic identities, and the biological diversity maintained in a garden, plot, or farm (for example, Perrault-Archambault and Coomes 2008; Major, Clement, and DiTommaso 2005; Kirby 2011). This one-dimensional understanding of ethnicity fails to account for the dynamics and plurality of ethnic identities and does not fully account for how processes of identification relate to land use decision-making. In light of these considerations, this research, rooted in a political ecological framework, was designed with the explicit aim of collecting and *synthesizing* ethnographic, demographic, and agroecological data to address the relationship between ethnicity and agrobiodiversity and to test each of these complex hypotheses.

Ethnic categories may be rooted in the shared histories or characteristics of a particular population (Geertz 1973; Barth 1998; Cohen 1978; Eriksen 2002). Thus, the shared history of a group may result in common land use practices among farmers who identify with that category. Similarly, the land use practices (or other characteristics) common among a group of farmers may inform a shared ethnicity. Further, previous research also points to the plasticity of ethnic identity (Vincent 1974; Cohen 1978; Jamieson 2003)—i.e., that individuals may hold multiple ethnicities that they activate in a particular socio-political milieu. Therefore, to account for the ethnicity of the farmers in my study—which is necessary for testing hypotheses 1, 2, 4 and 5—my research design considers ethnicity in two ways.

First, it is treated as an *inclusive* set of categories for the individual farmers who participated in this study. Individuals necessarily do not maintain a singular ethnicity. Rather, they hold a suite of ethnic categories within their identities that are expressed in particular contexts (Vincent 1974; Cohen 1978; Jamieson 2003). In the Pearl Lagoon Basin a farmer's ethnicity can include indigenous, afro-descendant, and mestizo ethnicities within their identity portfolio, each of which may inform or be informed by a farmer sharing characteristics (or a history) with those populations (Geertz 1973; Barth 1969; Eriksen 2002). Further, identifying with one of these categories does not negate one's ability to identify with another ethnicity in a different context. Additionally, these ethnicities may be activated in particular sociopolitical contexts within which one's identity may influence their position within sociopolitical structures. Therefore, ethnographic data is vital for understanding how social and political processes currently at work in the Pearl Lagoon Basin may 1) work to influence individuals' identities and 2) the ways in which specific identities may influence one's opportunities or constraints, particularly with regard to processes that influence land use.

4.4 Quantifying Agrobiodiversity

Paralleling characterization of ethnicity, this study approaches agrobiodiversity in multiple ways to account for the complexities of this concept. As described in Chapters 1 and 2, agrobiodiversity is argued to confer or be correlated with multiple ecological and social benefits. These include food security (Thrupp 2000), ecosystems services (Altieri 2002; Foley et al. 2005), and habitat conservation (McNeely and Scherr 2003; Harvey et al. 2008; Brussaard et al. 2010). However, there are numerous ways to quantify biodiversity, none of which are on their own serve as a standard method to assess all of the potential benefits of agrobiodiversity. Approaches taken to measure agrobiodiversity include quantifying 1) varietal diversity of a specific crop (Brush and Perales 2007; Baco, Biaou, and Lescure 2007), 2) plant species diversity, often only in homegardens (Coomes and Ban 2004; Perrault-Archambault and Coomes 2008; Lamont, Eshbaugh, and Greenberg 1999; Aguilar-Støen, Moe, and Camargo-Ricalde 2008), or 3) insects or other biota residing in an agroecosystem (Duelli, Obrist, and Schmatz 1999; Burel et al. 1998).

My study includes multiple, complementary measures of agrobiodiversity in order to account for the various potential benefits of biodiversity in agricultural landscapes. This includes collecting the plant data necessary for calculating 1) species richness, 2) functional diversity, and 3) the Shannon Index[18]:

4.4.1 Species Richness

Species richness is a common method of measuring biodiversity in agricultural and other ecological systems. It is simply a count of the number of species present in a landscape (Gotelli and Colwell 2001). Within this context, quantifying species richness determines how many different plant species a farmer has within their farm. However, they may have only one plant of a particular species. Thus, while an inappropriate metric in discussions of general 'land use' and habitat conservation (i.e. a farmer could maintain 100 hectare of unplanted soil accompanying a rich garden), species richness is useful for discussing the crop (and non-crop) diversity a farmer is maintaining. Therefore, species richness measurements theoretically provide information regarding the ways in which the farming practices of a particular farmer work to promote local (and global) food security.

Assessments of species richness are useful particularly when considering local farmers' relationships with agricultural development organizations. Such organizations often only give a farmer a single plant to propagate, particularly novel fruit tree species. Thus, such projects can have considerable impacts on local farmers' species richness in a very short period of time, while other metrics of diversity may not be changed significantly.

4.4.2 Functional Diversity

Functional diversity is predicated upon the notion that all plants are not created equal (Mouchet et al. 2010). Plants play different roles within an ecosystem, such as fixing nitrogen or making up an important part of a food web. Further, within the context of

[18] Also referred to as the Shannon-Weiner Index or Shannon-Weaver Index

agrobiodiversity, plants have different sociocultural values or functions. Some plants are food plants, some lumber, some medicine, or a combination of all of these functions. An ecosystem made up of diverse grass and shrub species with no known human application is not diverse in the same ways as a system with an equal number of species represented by fruit trees and other staple foods. These two systems do not provide the same types of benefits to their farmers. Measures of functional diversity aim to account for such differences.

Therefore, functional diversity is employed by this study as a metric of ecosystems services housed within an agricultural landscape—a benefit of agrobiodiversity (Altieri 2002; Foley et al. 2005)—allowing comparison of the various use values of plants within and between agroecosystems. Specifically, this study utilizes measure of average functional diversity, or the average number of uses of the given plants maintained within farming system (Semichon-Linard 2001). This metric was selected because unlike other measures of functional diversity, such as functional richness, average functional diversity is not skewed by species richness, which is already accounted for in this research design.

4.4.3 The Shannon Index

The Shannon Diversity Index is a standard measurement of plant diversity used by ecologists that takes into account species richness (number of species present) and evenness (relative abundance of species) within an ecological community (Beals, Gross, and Harrell 2000). Researchers have used this index previously to measure biodiversity within agroecological landscapes (Koocheki et al. 2008). However, generally the Shannon Index is used to measure fauna, not flora, residing within the soil (Kennedy and Smith 1995) or with an entire agroecosystem (Burel et al. 1998; Weibull, Bengtsson, and Nohlgren 2000).

This measure is used in this study specifically because of its ability to assess the evenness of a system. For example, a Shannon Index distinguishes between an agroecosystem comprised of one mango tree and 10 corn stalks as compared to a farm with 10 of each species. This species richness is equal between these two theoretical farms, but how evenly they are distributed is not. Thus, the Shannon Index can provide a measure of habitat potential, a noted benefit of agrobiodiversity (McNeely and Scherr 2003; Harvey et al. 2008; Brussaard et al. 2010). Because abundance measures of grasses are difficult for local farmers to estimate, these plants are excluded when calculating Shannon Indices.

4.5 Research Design and Timeline

The data used to determine the relationships between ethnicity and agrobiodiversity in the Pearl Lagoon Basin come from three separate, but complementary datasets. These data contain 1) agrobiodiversity and farmer data collected through agrobiodiversity surveys, 2) ethnographic data, and 3) household survey data collected by a collaborating inter-institutional and interdisciplinary project administrated Michigan State University (MSU) and the University of the Autonomous Regions of the Caribbean Coast of Nicaragua (URACCAN) that is investigating the impacts of globalization on terrestrial and marine resources in the Pearl Lagoon Basin.

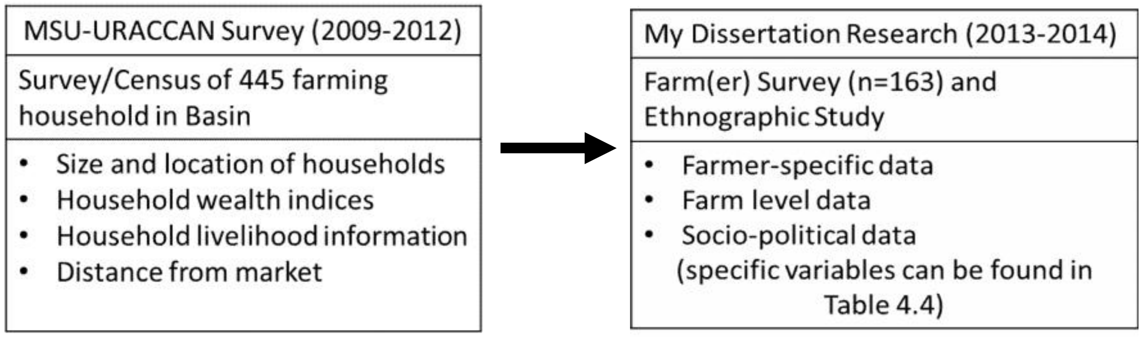
4.5.1 Research Collaboration

My research was formulated through a collaboration with the MSU-URACCAN project. A subsample of households was selected from the MSU-URRACAN sample in order to include a diverse array of quantitative household data collected by the MSU-URACCAN team. This includes household demographic and spatial data that previous agrobiodiversity research has shown to strongly positively correlate with agrobiodiversity.

The survey data also includes the location of households and villages (Coomes and Ban 2004), household wealth indices (Coomes and Ban 2004), household livelihood activity information (Aguilar-Støen, Moe, and Camargo-Ricalde 2008; Lamont, Eshbaugh, and Greenberg 1999; Perreault 2005), and distance from market (Major, Clement, and DiTommaso 2005). This dataset, however, does not include a range of farmer-specific characteristics (including key factors like ethnic identity), agrobiodiversity data, or sociopolitical information that is key to understanding the relationships between ethnicity and agrobiodiversity. Therefore, information from the MSU-URACCAN study provided only a limited, but useful, amount of data for this investigation (Figure 4.1).

Using a household census developed as part of their research, the MSU-URACCAN project surveyed a random sample of households from around and outside of the Pearl Lagoon Basin to survey in 2009, 2010, 2012, and 2014. The project sought to survey 500 households per year. Yet, because of attrition rates, their five year project surveyed nearly 1400 households. These household are located in communities near to the Pearl Lagoon, as well as in remote areas south and north of the Basin. For example, Monkey Point, a majority Creole community 83 km south of the Pearl Lagoon, is included in the MSU-URACCAN study. Although unknown at the time of selection, Monkey Point is near to the mouth of a proposed trans-isthmus canal (Anderson 2015), and is now of interest to the MSU-URACCAN project as it may experience rapid changes to the socio-ecological system in the coming decade. Originally, however, communities like Monkey Point and those north of the lagoon, such as the Miskito community of Prinzapolka (120 km north of Pearl Lagoon), were selected essentially as ‘controls’ for analyses examining the socio-ecological impacts of connectedness in Atlantic Nicaragua as defined by distance from the area’s newly built road.

Figure 4.1. Research Collaboration Design



4.5.2 Sampling Strategy

Agrobiodiversity surveys were limited to a sub-sample of households (within a sub-sample of communities) surveyed by the larger MSU-URACCAN team. The eight communities included in this study are listed in Table 4.1, which is comprised of all of the communities within the Pearl Lagoon Basin there were part of the MSU-URACCAN project. While MSU-URACCAN surveyed household in nearby territories (i.e. those communities north and south of the Pearl Lagoon Basin described in section 4.5.1), my choice of these survey communities reflect that the region's ethnic diversity is most pronounced in the communities near to the Pearl Lagoon (the area north of the lagoon, for example, is almost exclusively Miskito-speaking communities) and that these communities share interrelated sociopolitical and agroecological contexts.

Table 4.1. Communities Included in Study

Community	Population in 2006	Dominant Ethnic Make-up	Chief Economic Sectors (of equal importance)
Pearl Lagoon	2,540	Creole, Miskito, Garífuna, mestizo	Fisheries, Agriculture, Tourism
Raitipura	250	Miskito	Fisheries, Agriculture
Awas	93	Miskito	Fisheries, Agriculture
Kakabila	497	Miskito	Fisheries, Agriculture
Brown Bank	202	Garífuna, Creole	Fisheries, Agriculture
La Fe	110	Garífuna, mestizo	Fisheries, Agriculture
Orinoco	1,010	Garífuna, mestizo	Fisheries, Agriculture
Pueblo Nuevo	Unknown	Mestizo	Agriculture

Source: (Beer and Vanegas 2007)

Within these eight communities, 445 households surveyed by MSU-URACCAN included farming as part of their household livelihood portfolios. I identified a sub-sample of 163 of those 445 farming households to include in my study. This includes households from each of the eight communities listed above to account for a diversity of ethnic identities and community-linked factors. I did not intentionally weight the number of farmers by the size of the community (or "mother tongue," MSU-URACCAN's proxy for ethnicity), but there is an unequal number of farmers in my sample from each of the eight communities. This inequality is a result of my selecting a sub-sample from the larger MSU-URACCAN sample. While MSU-URACCAN surveyed a proportional number of households in each community in relation to the community population, an unequal number of households in each community that identified themselves as engaging in farming.

Initially, considering the difficulty of traveling around the lagoon and the short window of the agricultural season, I aimed to survey 200 households. I planned to include all of the household that has been surveyed by MSU-URACCAN in 2012 (the most recent survey preceding the start of my fieldwork in 2013). Using a list of names and household GPS coordinates provided by the MSU-URACCAN project, I was only able to find 131 of the over 200 farming households surveyed in 2012 that were 1) locatable (some names and

GPS coordinates were improperly input, other had migrated), 2) currently engaging in farming, and 3) and/or were willing to participate in my survey. As a result, the locatable and willing farmers surveyed in 2010, but missing in the 2012 survey (n=32), were also included in my project. As a result, one limitation of analyses regarding my sample population relates to the different years in which some households were surveyed by MSU-URACCAN. Therefore, I included very few variables from their study in my analyses.

I visited households in August and September of 2013 to identify the household member or members that were primarily responsible for making decisions regarding the households' farms. These "primary farmers" were almost always also the primary caretakers of the farms, although a select number of household in the Basin employed watchman to stay on their farms (in exchange for a place to stay) while they stayed elsewhere (e.g., Pearl Lagoon or Bluefields). Primary farmers were revisited during the remainder of the wet (or primary agricultural) season. During this visit, agrobiodiversity surveys were administered. Participant observation—which was used throughout the 10 month project—and information from the agrobiodiversity surveys aided the identification of 30 key informants who were revisited and interviewed during the dry season (described in section 4.6.2).

Table 4.2. Fieldwork Timeline

Activity	**Aug. '13**	**Sept. '13**	**Oct. '13**	**Nov. '13**	**Dec. '13**	**Jan. '14**	**Feb. '14**	**Mar. '14**	**Apr. '14**	**May '14**
Identify Farmers										
Agro-biodiversity Surveys										
Participant Observation										
Key Informant Interview										

4.6 Data Collection

4.6.1 Agrobiodiversity Surveys

Agrobiodiversity surveys (Appendix A) were administered with the help of two local field assistants (both with formal training in agro-forestry) to 163 farmers to gather information about the farmer identified in literature as potentially relevant to agrobiodiversity maintenance, but absent from MSU-URACCAN's survey. These factors are summarized in Table 4.3 and were collected (along with ethnographic data) to test the five hypotheses that guide this research. These quantifiable factors include: 1) the age and gender of the primary farmer(s), 2) the number of years they have been engaged in agriculture, 3) the potentially *multiple ethnicities* with which the farmer self-identifies, 4) the agricultural development organizations with which they currently work or historically worked, 5) and the types of plants or assistance they received from these projects. Additionally, these surveys collected specific information about the farms, including 6) both the number and size of fields, 7) size and age of farm, 8) who previously worked the land the farmer is using, 9) if they maintain a garden, 10) the distance from their house to their various fields, and 11) the specific species and approximate number of each species that a farmer is actively maintaining on their farm. Additional factors, such as the distance of a farmer's household from the "highway," household livelihood diversity, and household wealth index were derived from or provided by the collaborating MSU-URACCAN project. Community population information was acquired from the census data conducted for the demarcation of the Pearl Lagoon Basin Territory detailed in Beer in Vanegas (2007). A description of how each of the quantifiable variables included in this project (listed in Table 4.3) was measured can be found in Chapter 5.

Table 4.3 Quantifiable Factors Included in this Research

Factor	Source	Hypotheses Addressed
Farm Factors		
Age of Farm	Agrobiodiversity Survey	H2, H3
Size of Farm[19]	Agrobiodiversity Survey	H2, H3
Homegarden (presence/absence)	Agrobiodiversity Survey	H2, H3
Pasture (presence/absence)	Agrobiodiversity Survey	H2, H3
Distance to farm (minutes)	Agrobiodiversity Survey	H2, H3
Farmer Factors		
Farmer Age	Agrobiodiversity Survey	H2, H3
Years Farming	Agrobiodiversity Survey	H2, H3
Gender	Agrobiodiversity Survey	H2, H3
Indigenous or Afro-descendant Identity	Agrobiodiversity Survey	H1, H3
Mestizo Identity	Agrobiodiversity Survey	H1, H3
Mestizo Identity (Afro-Indigenous Communities)	Agrobiodiversity Survey	H4
Household Factors		
Distance from Road (km)	MSU-URACCAN	H2, H3
Household Livelihood Diversity[20]	MSU-URACCAN	H2, H3
Household Wealth Index[21]	MSU-URACCAN	H2, H3
Political Factors		
Community of Residence	Agrobiodiversity Survey	H2, H3
Size of Community of Residence	(Beer and Vanegas 2007)	H2, H3
Access to Credit	MSU-URACCAN	H2, H3
Affiliation with Agricultural Development Organizations	Agrobiodiversity Survey	H2, H3

To gather the information necessary to develop the agrobiodiversity metrics that serve as the dependent variables in my analyses, my research assistants and I administered plant surveys using the primary language of the farmers, which includes Creole, Spanish,

[19] Farm size was measured in *manzanas*, the local measure for land area. While technically smaller than a hectare, today in the region these two measures are used interchangeably.

[20] This is a count of livelihood strategies within a household's portfolio, surveyed by MSU-URACCAN.

[21] This is a measure of assets surveys by the MSU-URACCAN project.

and Miskito. Plant names were verified with community leaders in each language to ensure reliability of the survey instrument in each language. When possible, surveys were administered with the primary farmer on their farm. If their schedule did not permit—some farms are as much as a day paddle away and many farmers have diverse livelihood activity portfolios and do not visit their farms daily—surveys took place in the farmers' communities. Surveys lasted approximately 1-2 hours depending on the time spent walking the farm.

Following documentation of the general farm and farmer information listed above, farmers were presented with a list of all plant species previously identified to be part of local ethnobotanical lore (Coe and Anderson 1996; Coe 1997; Coe 2008), as well as recently introduced plants identified through pilot surveys. Farmers were asked to state whether or not this species was present within the area that they considered to be their farm. Farmers were also asked to estimate the number of each species present. Plant surveys generally involved a tour of the farm.

While these recalls and estimations do not accurately account for *all* of the species diversity that may be present within a farm, this method was useful to gather information regarding the *planned*-diversity present on a farm. These farms are complex agro-forestry systems, which often include a plethora of wild plant species. Many of these species, however, are considered to be "bush" (or wild) species that a particular farmer may not believe to have an application, use value, or desire to have it taking up space on their farm. Therefore, recalls and estimations relayed the agroecological knowledge of a farmer and provided agrobiodiversity information linking to the direct agricultural decisions of a farmer.

4.6.2 Participant Observation and Interviews

Concurrent with the administration of agrobiodiversity surveys, detailed ethnographic information was collected through participant observation (DeWalt and DeWalt 2002; Bernard 2006) and interviews (Yow 2005; Riley and Harvey 2007) with farmers, community leaders, local agricultural development specialists (namely working for agricultural development agencies), and academics with knowledge of the local system. Information gathered through participant observation, interviews, and data collected through agrobiodiversity surveys was used to identify 24 farmers to serve as key informants.

Three farmers were selected from each of the 8 communities and expressed a range of ethnic identities, ages, and genders. These individuals where not randomly selected. I selected these farmers in part based on rapport; some farmers around the lagoon were unwilling to allow me to accompany them for a day on their farm without financial compensation (particularly after participating in my agricultural survey during the wet season and the MSU-URCCAN survey in previous years). Additionally, like with the agrobiodiversity surveys, traveling around the lagoon, tracking down farmers, and accompanying them to their farms in the dry season (during which farmers visit their lands less frequently) limited the number of people that I could interview. Ultimately, while not securing an even distribution of ages and genders within each community, I interviewed (at least) one woman in each of the eight communities and spoke with men with a range of ages living around the lagoon, collecting a diversity of perspectives.

Farmers and their farms were revisited and interviewed during the dry season (January-May). These interviews lasted between 1 and 4 hours. While not exclusively, interviews tended to accompany farm visits. I utilized travel time (which included bus, boat, and/or on foot) to begin conversations about central topics and themes. I continued to probe (Bernard 2006) these topics and inquire into specifics of agricultural strategies once on the farm. Topic covered in interviews included: 1) the general history of agriculture in the region, 2) the long-term goals of the farmer in terms of their farm and their perspective of an 'ideal' agricultural landscape, 3) a farmer's approach to plant selection, 4) the factors that farmers perceive to influence their agricultural decisions, 5) their perceptions of the relationship between ethnicity and agricultural strategies, 6) perspectives, critiques, and nature of the interactions that local famers have of the development projects working in the region, and 7) ethnic identity politics.

A sample list of interview questions can be found Appendix B. However, I used an open-ended interview style (Yow 2005). While posing similar central question to my key informants to gain comparable data, I allowed informants to direct the conversation so that they could voice their opinions about the topics I covered with them that they felt were most pertinent. Therefore, equal amounts of time were not allocated to each theme during interviews.

Because agricultural development organizations working in the region play a pivotal role in influencing the land use strategies of local farmers, six officials from each of the four major agricultural development organizations focusing on planting strategies[22] were interviewed to gather detailed accounts of the history of these projects, their funding sources, and their development goals. These informants include the director of FADCANIC's agricultural programs as well as the regional extension director, the regional extension

[22] This is includes FADCANIC, NicaCaribe, Black Farmers, and BICU. Officials from INTA, which focuses on animal husbandry, were not directly interviewed, but their projects were described by farmers with whom they work.

officer from NicaCaribe, the director and presidents of the Black Farmer's Cooperative, and BICU's extension agent. As with farmer interviews, central themes served as foundations of the questions that initiated the semi-interviews (Bernard 2006), and agents and officials were given the opportunity to elaborate and expound upon points and ideas that most provoked them.

The quantifiable data collected through agroecological and household surveys enabled me to determine the relationship between measured factors, such as age, ethnicity, gender, or distance from the regional road, and the agrobiodiversity metrics for each farmer included in my study. These data were therefore collected and analyzed to test (at least in part) all five of the hypotheses posed and assessed by my study. Yet, the descriptive, ethnographic data collected through participant observation and interviews was vital for more fully understanding the dynamics of ethnicity in the Pearl Lagoon Basin and identifying difficult to quantify factors and processes that influence land use decision-making. Thus, the information I collected using ethnographic methods helped me when paired with survey data to address hypotheses 3-5.

4.7 Data Analysis

4.7.1 Analyses of Survey Data

Data collected through agrobiodiversity surveys and drawn from the MSU-URRACAN household survey dataset were recorded and organized in a .csv file. Statistical analyses were conducted using R (R Core Team 2013), to identify correlations between these various farmer and household factors mentioned above and a farmer's agrobiodiversity metrics. Three separate agrobiodiversity metrics serve as the dependent variables in regression and other statistical analyses. These metrics, described above, were calculated using the R package, "vegan" (Oksanen et al. 2013). Vegan was created to help ecologists to calculate various measure of biodiversity within biological communities. In this case of my research, each farm was framed as a distinct ecological community and vegan calculated 1) species richness, 2) functional diversity, and 3) the Shannon Diversity index[23] for each farm.

Relationships between these dependent variables and the various famer, household, and community factors described in Table 4.3 were assessed using appropriate univariate analyses depending on the nature of the independent variable (see Leeper 2000; McDonald 2009). Statistically significant relationships ($\alpha < .05$) were documented, and significant factors served as codes for analyses of ethnographic data (described in Section 4.7.2).

Multiple regression analyses were also performed to identify the (multiple) factors that best predict the degrees of agrobiodiversity that a farmer maintains in their agricultural system. Standard multiple regression models were constructed following a protocol similar to that used by Carr (2008). In this protocol, multiple regressions are performed on groups of potentially related factors to identify significant predictor variables of the dependent variable (in this case species richness, functional diversity, and the Shannon Index) (Carr 2008). Factors were grouped into four categories: 1) farm factors, 2) farmer factors, 3) household factors, and 4) political-economic factors. Analyses were performed "step-wise," retaining statistically significant factors from the first group of equations in the second, *et cetra*. The end results are considered the best-fit models, which identify the most significant factors correlating with each agrobiodiversity metric. By analyzing groups of variables in stages, step-wise regressions also identify secondary factors that may be relevant to land use

[23] These metrics were log-transformed to normalize this data for linear regression analyses, ANOVAs, t-tests, and multiple regressions assume normality (Leeper 2000).

decision-making. The relationships between factors identified through these models and univariate analyses were further addressed by ethnographic data.

4.7.2 Analyses of Qualitative Data

Significant relationships identified through statistical analyses and common themes derived inductively from fieldnotes (Bernard 2006) were used as a guide for coding the ethnographic data collected over the course of fieldwork. Field notes, derived from daily jottings (Bernard 2000), were recorded in Evernote (Pachikov 2015). These files were translated into .txt documents and loaded into RQDA (Huang 2014). This graphical user interface works within R, is similar to other qualitative data management and analysis software, such as ATLAS.ti or NVivo, enabling the user to load, store, and organize qualitative data. This program was selected because it is open source (i.e., freely available). I employed RQDA to code the ethnographic data that I collected throughout the course of my fieldwork. I derived codes from the variables measured in the farm and household surveys as well as through common theme inductively gleaned from the fieldnotes. Sections of text linked to specific codes could then be called into single document windows to better identify patterns in the qualitative data.

This data helped to expose the sociocultural, political, and economic factors that encourage or hinder agrobiodiversity maintenance for some farmers in the Basin more than others. Further, ethnographic data was vital for understanding the dynamics of ethnic identification and its relationship to land use strategies. Interviews with agricultural development practitioners explored the history of these projects and their goals. This work highlighted that identification with local ethnic identities are used to garner funding for these projects and thus influence resource allocation.

4.8 Conclusion: the integration of ethnographic and survey data

The methodology employed in this research produced complementary ethnographic and survey datasets. Analysis of the household data collected by the MSU-URACCAN project and the farm and farmer data collected through agrobiodiversity surveys can reveal patterns among farmers and farming strategies in the Pearl Lagoon Basin. Alone, however, quantitative analyses of these diverse data have the same shortcomings of previous agrobiodiversity research. While correlations can be identified between certain measureable farm, farmer, household, or community characteristics (or groups of these characteristics) and agrobiodiversity, qualitative data is necessary to explain these relationships.

Ethnographic data reveals sociopolitical processes operating at various scales that influence the land use decisions of farmers in the Pearl Lagoon Basin. These processes both shape and are shaped by identity politics in the region. These complex factors, however, are unidentifiable through quantitative (or qualitative) survey data alone. Therefore, the integrated design of this project enables this research to not only identify relationships between ethnicity and agrobiodiversity, but more fully contextualize and explain these relationships. In doing so, my work is able to answer fundamental questions regarding land use decision-making that previous research on agrobiodiversity has overlooked.

V. Analysis of Ethnographic Data

5.1 Introduction

In this chapter, I present analyses of the ethnographic that I collected in Nicaragua's Pearl Lagoon Basin over the period of August 2013 – May 2014. Analyses of these data distinguish the political, sociocultural, and economic processes operating at various scales that influence farmer's land use decisions. Additionally, data collected through participant observation and key informant interviews expose that local and extra-local political processes influence and relate to ethnicity. The results of these analyses provide an ethnographic context for the results of the quantitative analyses of agricultural and household survey data presented in Chapter 6. When synthesized with quantitative results (Chapter 7), ethnographic data helps me to explain how a farmers' ethnic identities both works to influence and are influenced by the degrees of agrobiodiversity maintained within their farming systems.

5.2 Collection and Analysis of Ethnographic Data

I collected ethnographic data through participant observation, unstructured interviews during and following the administration of agrobiodiversity surveys, and semi-structured interviews with key informants. Key informants include 1) farmers (N = 24) selected from each of the 8 communities sampled in the Peal Lagoon Basin (Figure 5.1) and 2) administrators, directors, and staff members (N = 6) who work for the governmental and non-governmental agriculture-focused development organizations operating in the region.

Ethnographic data were analyzed using RQDA (Huang 2014). Factors included in quantitative analyses[24] and common themes derived inductively from fieldnotes served as guides for coding (Bernard 2006). Using RQDA, blocks of text that share codes were aggregated into single documents. I then reviewed each document to identify patterns in the sections of my fieldnotes and interview transcripts that I had determined to directly or peripherally relate to a particular theme. This enabled me to use ethnographic data relating to a specific code, such as ‘age,’ ‘markets,’ or ‘ethnic politics,’ to investigate and clarify how these factors relate to farmers’ agricultural decision-making. Further, analysis of coded text helped me to elucidate the dynamics of ethnic identification in the Pearl Lagoon Basin and the relationships between identity and sociopolitical processes at work in the region.

The findings that resulted from this ethnographic analysis then were synthesized into four overarching topics. I developed these topics based on thematic associations between codes. For example, I combined the key information gleaned from text coded as ‘fishing’ and ‘labor migration’ into a broader theme, off-farm—or alternative and additional—livelihood activities. I then reviewed this further-aggregated data to understand how this (group of) factor(s) or process(es) influence or relate to agricultural decision-making in the Pearl Lagoon Basin. These four themes are presented below, following a brief explanation of general trends in the regarding the agricultural practices in the Pearl Lagoon Basin, and reveal the significant factors and process influencing the relationships between ethnicity and agrobiodiversity in the Basin.

[24] Ethnographic and quantitative analyses were done in tandem. Therefore, I was able to use factors identified through quantitative analyses as statistically significant predictors of the agrobiodiversity metrics to develop codes for ethnographic analyses. This enabled me to more clearly explain these statistically significant relationships through my ethnographic findings.

Figure 5.1. The Pearl Lagoon Basin (12.3500° N, 83.6667° W).

Dashed lines represent main residential areas of the Basin's formally recognized communities.
Sources: Google Maps, Wiki Commons, and Beer and Vanegas 2007

5.3 Agriculture in the Pearl Lagoon Basin

While the variation in agricultural practices among the residents of the Pearl Lagoon Basin is a focus of my study, there are trends that can be used to describe the general agricultural (and culinary) landscape of the region. Throughout the Basin, farming ranges from complex agroforestry systems to open, de-forested pastures for cattle ranching. Agroforestry systems generally include a diversity of annual crops, like corn (*Zea mays*);

perennial fruit trees including various citrus varietals, coconuts (*Cocos nucifera*), supa (*Bactris gasipaes*), cacao (*Theobroma cacao*), kinep (*Melicoccus bijugatus*), Ethiopian apple (*Syzygium malaccensis*), guava (*Psidium guajava*), mango (*Mangifera indica*), and avocado (*Persea americana*); fruit-bearing herbaceous plants, primarily varieties of plantain and banana (*Musa sp*.); pineapples (*Ananas comosus*); and starchy roots, which along with plantains are locally referred to as "breadkind," including cassava (*Manihot esculenta*) and dasheen (*Colocasia esculenta*). Because (along with seafood) these agroecosystems are the basis of local diets, as well as medicinal systems, local farmers also tend to maintain a wide variety of ethnobotanically-important wild species, such as fitsy bush (*Petiveria alliacea*), barsley (*Ocimum micranthum*), cinnamon (*Cinnamomum zeylanicum*), and jackass bittas (*Neurolaena lobate*).

Clearing land for planting generally takes places in the dry season (January-May), tending during the wet season (June-December), while harvesting occurs throughout the year. Most farmers work alone (or with their spouse/partner), but depend upon family members of all ages for labor intensive planting (like cassava) or harvest (like corn). Farms can be located as far as 6 hours (via boat, horse, or walking) from a farmer's community of residence. This is generally the result of a shortage of available land near to their community or because their historical familial land is located in another area of the Basin. Therefore, farmers who tend distant farms commonly build a "camp," or a small wooden, thatch-roofed, stilted house in which to sleep and work for consecutive days on their farm, particularly during the wet season. Additionally, farmers and their households utilize homegardens, which consist of fruit trees and culinary and medicinal herbs, to help avoid daily trips to their farms.

Many farmers throughout the lagoon maintain pasture land and raise cattle in addition to tending plants. Yet, local residents tend to associate ranching cattle most with the farmers living on the north end the lagoon in and around Pueblo Nuevo. These predominantly mestizo farmers and households generally, as one Pueblo Nuevo local described, to "spend all of their time raising cows" and subsisting almost solely on "rice, beans, cheese, and sometimes a little meat" (interview 10/1/13). Despite these stereotypes, as I describe in the conclusion of Section 5.3.4 some residents of Pueblo Nuevo have some of the most agrobiodiverse farms in the region, planting a wide variety of fruits, annuals, and maintaining wild plants. These deviations from land use norms that take place on the individual level are driven by a host of factors and processes. The primary factors influencing land use decision and the variation in agrobiodiversity among farmers in the Basin are described in the following sections.

5.3.1 Age and Experience Farming

Ethnographic data highlights the ways in which age, experience, and the position of agriculture in the life history of farmers around the lagoon influence their land use strategies, and in turn, the varying degrees of agrobiodiversity that they maintain in their agricultural systems. Residents of the Basin, particularly those in the historically afro-indigenous communities on the shores of the lagoon, describe a history of diversified household livelihood strategies. These strategies include fishing, various forms of local and extra-local wage labor, and farming. Interviews with farmers also reveal the ways which livelihood activities shift over the course of an individual's lifetime. As a farmer from Pearl Lagoon explained, "young people are supposed to go out and fish or look for work. Older folks are the ones that take responsibility for growing food" (interview 8/6/2013).

This pattern applies to both men and women. Throughout the Basin, more men than women take responsibility for the family farm (95 men in my sample identified as the primary farms for a given household versus 40 women). However, within many households (28 in my sample) men and women describe sharing an equal amount of decision-making power into the farm. Further, I did not identify significant differences in approach to farming or agricultural knowledge between genders. They grow similar plants in similar configurations, have engaged in farming throughout their lives, and both men and women serve as reservoirs of local ethnobotanical knowledge. Men and women do, however, take on different labor roles on the farm. As a female farmer in Orinoco commented, “not to make difference between man and woman, but we is not the same in some ways. We is not as strong physically” (interview 4/8/14). Therefore, women who are the primary farmers in their families, especially elder women farmers, often periodically rely upon the assistance of younger generations (particularly young men) to assist with physically demanding farm labor (although older men often do also rely on the labor of younger generations for arduous tasks).

Some young people do maintain their own farms, but the vast majority of the Basin’s youth only engage in farming when they go out to help the older generations of their family on the family farm periodically—an activity though which agroecological knowledge is passed down through the generations. However, the family farm is generally the domain of the oldest living generation. This is particularly true for farmers from the town of Pearl Lagoon, most of whom farm in an area along the region’s new road, referred to as Rocky Point. Here, the *average* age of the primary farmer is 58 (+/-7.3). The oldest farmers still working in Rocky Point are in their late 70’s. For the Pearl Lagoon farmers and other older farmers living in the Basin, farming can be thought of as a retirement strategy. As a 60 year old farmer in Orinoco stated with strong creole accent, “You must plant a little of each thing and have things for eat… My father and grandfather stated, ’you must prepare when you’re young. You can't prepare when you are old. You no want beg when you is old--you may not get’” (interview 4/10/14). Younger men and women may participate in farming, but it is also a time to focus on fishing or migrate to for labor. Older farmers focus solely on their farms and utilize agrobiodiverse planting strategies that rely heavily on perennial plants and lessen the burden of day-to-day work (see Image 5.1). One farmer stated that, "If you no plant, you no have… If you only plant plantain, you only have plantain… Every year you must add to [your farm], planting more and more fruit trees, making it dense” (interview 2/5/14). An elder from Pearl Lagoon pointed out, farmers like her have a lot of mixed fruit trees, so that they “have time for relax” and still meet their subsistence needs (interview 8/8/13).

Image 5.1. The Agroforestry System of a farmer from Pearl Lagoon.

As mentioned in Section 5.3, homegardens also serve as an important part of farmers' planting strategies across farmers' ages. Gardens serve as sites of subsistence resources that require relatively little effort to obtain. This is particularly important for older farmers who do not have the energy to travel regularly to their farm. A farmer of in his mid-60s living in Pueblo Nuevo told me that he had abandoned his farm altogether, only growing foods in his half-hectare garden. As he put it, he is simply "too old to work" the farm (interview 10/23/13). Further, a farmer from La Fe in his late-60's stated that his overall goal was "to relax, man" and that in order to do so, "you gotta plant in town the fruits, man. Or else you have to live on the farm, because if you ain't there, the animals will eat them all up" (interview 10/10/13). Thus, in addition to ease of access for harvesting, important plants are tended in gardens so they can be more easily defended against pests.

Older farmers also have developed and acquired agroecological knowledge over the course of their lives in the region's particular agroecological milieu. This knowledge is most obvious when considering wild plant identification and application, inter-cropping configurations, and the use of in-situ decomposition to increase soil nutrients and productivity. While fire is utilized for initial clearing of areas by almost all farmers, key informants throughout the Basin reported re-planting fields for years or even decades in lieu of burning to clear additional land. One farmer in Orinoco explained, "For cassava I chop it, let it rot and turn to manure. Then I use the area again" (interview 4/8/14). While burning provides a pulse of nutrients to the soil and is common in tropical agricultural systems in Central America (Atran 1993), it is also associated with unintended consequences. As summarized by a La Fe farmer, "[Burning] kill out everything. It burn the swamps and kill out all of the frogs and snakes and small animals" (interview 4/10/14). Fauna are perceived by many informants to be important components of the agroecological system, and farms often are configured in ways that maintain a heterogeneous landscape for the benefit of non-human animals. A Pearl Lagoon farmer reported maintaining a "little [forest], so no peal the whole farm." He believes that the small patch of forest "gives food to the monkeys, them" and "bring the birds," all of which are seen by this farmer as important attributes of a healthy agroecological system (interview 1/20/14). A farmer in Orinoco reinforced this sentiment, pointing to the aesthetic qualities of a healthy farm: “You no have area in reserve, you no have animals. I no want no big [pasture]; it will destroy the beauty that I can have on the farm. I will lose the birds and the animals” (4/8/14).

As farmers age, they aim to develop low maintenance farming systems that produce a variety of subsistence resources, like food and medicine. To achieve this goal, farmers employ the agroecological knowledge developed over their lifetime, such as specific intercropping patterns that work in the various topologically distinct parts of their farm. A Kakabila farmer explained, “We plant dasheen down there,” he pointed to a depression in his field, “but no corn, no pine[apple] neither, ” as too much water will cause these crops to rot (interview 2/5/14).

In contrast, young farmers are still developing their knowledge and often are just beginning to develop their farms in anticipation for the future, while they divide their time between farming and more fiscally lucrative livelihood activities. As a 20 year old Kakabila farmer stated, “I’m trying to build my little plantation” for the future, but right now he "catches every type of fish [he] can" to make money that he puts towards building his house in town (interview 10/6/13).

5.3.2 Alternative and Additional Livelihood Activities

The livelihood activities that draw (primarily young) farmers away from full-time (or even part-time) devotion to their or their family's farm include fishing, turtling, local wage labor, and labor migration. Fishing for lobster, shrimp, and turtle for export has been a livelihood activity for residents of the lagoon since the 1960s. Lobster and turtle fishing involve temporary migration into the Caribbean to an island camp, generally one of the nearby Pearl Cays. Shrimping takes place both in and outside of the lagoon, but young men and women can be found on the docks of each of the communities around the lagoon throughout the dry season throwing cast nets. For the past half century, local fisherman have been harvesting these marine resources and selling them to middle-men who shuttle these high value products throughout the Caribbean and North America (Nietschmann 1973).

Despite the collapse of the lobster fishery and the extremely low turtle and shrimp stocks that resulted from this history of exploitation and export, the export of fishery products has increased markedly since the construction of the regional highway (Stevens 2014). Although the road, which was completed in 2007, has had no detectable impact on agricultural exports, fish buyers who transport products to the Pacific Region spurred an increase in fishing effort (Stevens 2014). In light of the scarcity of lobster, turtle, and shrimp, globalization driven by the completion of the road has resulted in traditionally subsistence fish becoming the targets of the most recent export boom (Stevens 2014). As one La Fe elder described pulling "dori loads of shrimp" from the lagoon in recent decades, but abandoning shrimping all together in recent years as a result of paltry catch rates; therefore, he now targets lagoon finfish to sell to the middlemen (interview 10/10/13).

The overfishing of these stocks and the resulting decline in the subsistence fishery has implication for the livelihood strategies of local individuals and households. First, fish for local consumption is both scarce and increasingly expensive. As a young man in Orinoco stated, “even if you got the money, there ain’t no fish for buy. [The fisherman] only bring for them family” (interview 8/21/13). As a result, in addition to “fishing harder” in order to meet household economic and subsistence needs, key informant interviews revealed that households shift emphasis to other livelihood activities to meet their needs. A woman from Awas put it simply: "Fishin' hard. That’s why we farm" (interview 10/4/13).

Further, in light of the low fish stocks, households may shift their efforts onto other more lucrative livelihood activities, of which farming is only one possibility. Although turtling is still profitable, the London-based Wildlife Conservation Society spearheaded a community development initiative in Kakabila to train local turtlemen as wildlife tour guides in lieu of catching turtles for meat. Other tourism-focused wage labor activities are also increasingly common. This follows a history of local afro-indigenous regional residents working on international cruise ships. Referred to as “shipping out,” English-speaking locals have sought work on transnational cruise ships since at least the 1970’s (although, according to a local record-keeper, this was very rare at the time). Similarly, some local residents migrate for years or even decades to seek paid work elsewhere in Nicaragua or in Panama, Costa Rica, the Cayman Islands, and the United States. During their time abroad, they both send back remittance and aim to save money to improve their living conditions once they return home.

Finally, in parallel to the increased connectedness to the Caribbean and beyond, life in the Pearl Lagoon Basin is increasingly impacted by illicit and semi-illicit export and trafficking operations. This includes rosewood export, namely to China. Although policies and restrictions are in place that aim to regulate the legal harvesting and export of rosewood, some Basin residents work as contractors for financiers based in Bluefields to locate these valuable trees around the lagoon and describe numerous examples of “back road deals” (interview 08/21/2013). In addition to rosewood, life on the Atlantic Coast is increasingly impacted by the transcontinental drug trade. Cocaine from South America moves north through the Caribbean, often just outside the mouth of the lagoon. Fisherman occasionally happen upon bushels discarded while evading interactions with law enforcement, known as “white lobsters.” These bushels are sold back to cartels, providing economic stimulus to ‘lucky’ households around the lagoon. Local people also receive money for aiding narco-trafficking operations in various capacities, such as setting up fuel depots on off-shore islands. Thus, involvement in the drug trade is an important, although problematic to quantify, aspect of the local economy and an influence upon livelihood decisions.

The range of livelihood activities available to local people partly explains the paucity of export-focused agriculture, particularly among farmers in the Basin’s indigenous and afro-descendant communities. Key informants described a history of exporting local agricultural products, including rice and bananas through the 1970’s, to regional, national, and international markets via marine shipping. Today, however, in an increasingly connected political economic landscape, non-farm livelihood activities occupy the time and energy of the younger generations, particularly activities that appear to have more financial return for less physical strain or time commitment (often described as “fast money"). This can characterize fishing, involvement in the drug trade, day labor (for example in aiding rosewood extraction campaigns), or opportunities associated with migration. As one farmer explained:

> “The young people always have a different aspiration than us. ‘I don’t want to go to the farm, I want try to get ship out. I going to Cayman. I going to US.’ They think on that. They no think of the farm. In my case, I no want. I tell my children that what would inspire me if for all my children to come out of high school, out of university. We never have the chance to go to university because of our

situation. It was only in Leon and Managua that had university, and we was poor people. They have a chance, so for that case I only have girl children here. I tell her. 'I no want you to work. I no want you to help me.' When they come to visit I just want them to sit here and chat with me. Not to carry cassava for planting. 'I want to see you in the school, in the church'" (interview 1/24/14).

5.3.3 'Connectedness': the road and agricultural development organizations

In addition to the introduction of new and alternative livelihood activities to residents of the Basin, the increased connectedness of the Basin and its residents to extra-local political, economic, and social processes engendered myriad effects upon contemporary life in the Basin. Major factors that influence agricultural decision-making include an increase in food imports and the increased presence and number of the governmental and non-governmental agricultural development projects.

While the 2007 construction of the first road into the region provided a new route for the export of local products and resources, the current landscape is consistent with the findings of the agriculture and fishery surveys conducted by Schmitt and Kramer (2010) that encompassed the period of road completion. Schmitt and Kramer found what while the road provided a host of new opportunities of the export of lagoon and marine products, the road had little impact on the export of agricultural goods. Today, the export of agricultural commodities remains extremely uncommon. Many farmers sell excess agricultural products locally, either to small shops or value added products house-to-house. A handful of farmers also sell coconut oil to "that white man, Coconut Jim," (interview 11/7/13) an entrepreneurial American ex-pat who travels from the Pacific Region to source local handmade coconut oil which he packages and sells in tourist shops on the Pacific side of the country. Generally, however, excess farm products are distributed freely to friends and family members who visit a farm. As a Kakabila farmer said, "a good farm is a farm with many things to eat, not many things for sell" (interview 2/6/14).

While the road has not increased agricultural exports, key informants report that it has influenced agricultural decision-making. These impacts are most notable for farmers who work directly adjacent or near to the road. In particular, daily bus traffic that passes through Rocky Point, the agricultural area for Pearl Lagoon, has increased access to farms for Pearl Lagoon farmers. When asked about the impact of the road, a Pearl Lagoon/Rocky Point farmer explained,

> "The road is much easier. We have much more people coming. Very easy to come with 10 cordoba and return with 20. And can take things to town much easier. When we were young we would sell, but had to take it out on horse. We had to walk in the mud, so we took much less" (interview 1/22/14).

Buses carry farmers and their goods to and from Pearl Lagoon, which allows farmers to avoid a 2+ hour walk through a treeless (and thus sun-baked) savanna to reach their farms. Therefore, as this farmer explained, many of the older farmers who work land in Rocky Point have easier access to their farms than they did before the road. Another elderly Rocky Point farmer mentioned to me that she is “able to come to [her] farm every day [she wants]” as a result of the bus, and would be unable to make the trip otherwise (interview 1/22/14).

In addition to access for to Rocky Point from Pearl lagoon, the road also provides a means through which to import goods. Before the road, all cargo came to the lagoon via a canal system that connect the lagoon to Bluefields, the largest city on Nicaragua’s Caribbean Coast. A community leader in Pearl Lagoon who has recorded the details of historical events, and who other community members consider the local record keeper, explained these imports were moved on a locally-owned barge (“called the mail boat, because it carry the mail” (interview 3/11/14). Today, enterprising salesman from the Pacific and Highland

Regions of Nicaragua drive trucks filled with a wide variety of goods to sell in Pearl Lagoon. This includes foodstuffs, both packages and fresh. Multiple times a week, trucks filled with fruits and vegetables from markets in the Pacific and Highland Regions roll into Pearl Lagoon. Many of the products available (e.g. onions, tomatoes, dragon fruit, carrots, and cruciferous vegetables) are difficult to grow, and thus uncommon, in the Basin. Because of the long history of international travel through labor abroad, local people are familiar with and enjoy these foods. Other products imported via trucks, however, are also grown locally. This foods includes watermelon, avocados, citrus, pineapple, and eggs. Refrigerated trucks coming to source fishery products also occasionally bring frozen chicken.

While the availability of these goods is a welcome change for local residents, a director of FADCANIC (a regional, foreign-funded development program) described the impact that these relatively cheap products have on the local agricultural economy through an anecdote recounting the Program's work to organize a local farmers market. At the first market, she asked one of the farmers for how much she was selling a pineapple. The farmer responded, '50 cordoba.'[25] The NGO director responded, 'but the truck sells one for 20.' The farmer replied that it was a 'good, local pineapple' and that, "it wasn't worth her time and energy to sell her products for nothing." Farmers became disenchanted by low sales, and the market project quickly dissolved (interview 9/3/13).

In addition to a failed farmers market, the governmental and non-governmental organizations currently working in the Basin today have initiated a range of agriculture-focused projects that work to impact the land use decisions of local farmers. Some of these activities are market-focused. The Black Farmer's Cooperative, a local cooperative with financial assistance from the central government, offers coconut seedlings to participating farmers in an effort to produce an exportable volume of coconuts or value added products in the coming years. Despite what he sees as a reluctance of local farmers to employ 'recommended' techniques for tending young coconut trees, the director of the Black Farmer's Cooperative believes that this project has the potential to help participants accrue up to "$1500 per month and bring them into the middle class" (interview 8/13/13).

FADCANIC, a regional NGO that is working to promote autonomy in part through projects that target food security and food sovereignty, supports an agroforestry training center north of the lagoon, called the Wawashang Agroforestry Centre. Here, high school students can receive an academic education in addition to training in agroforestry techniques. The campus is connected to a farm and nursery. FADCANIC distributes saplings and seeds to select farmers through the lagoon. Resources are distributed by FADCANIC, generally accompanying workshops and information sessions in the communities around the lagoon, or sold to single farmers or other organizations like the Black Farmer's Cooperative, which contracts FADCANIC to produce coconut saplings. A government food security project, NicaCaribe, also contracts orange, coconuts, cacao, and breadfruit from FADCANIC's Wawashang Centre. Finally, Bluefields Indian and Caribbean University (BICU) is also working with a select group of local farmers to test the viability of crops that could be exported to Nicaragua's Highland and Pacific Regions, such as onions. To date, however, none of the products promoted by these organizations have reached the marketplace.

5.3.4 Ethnic Identity, Ethnic-based Rights, and Community

Like the construction of the road, the number of agricultural development organizations working in the Pearl Lagoon Basin highlight the increased political, economic,

[25] This is approximately $2.00.

and social connectedness of the Basin to extra-local processes. These organizations (described in Chapter 3) aim to impact the land use practices of local farmers in ways that increase or bolster existing agrobiodiversity. Each of these programs focuses on ‘sustainable’ agriculture as a means of strengthening the political and economic autonomy of local populations. As a local director of FADCANIC explained, “There needed to be an NGO that had resources to help the autonomy process. You can't have autonomy without development, and FADCANIC was going to direct development responsibly" (interview 12/17/13). FADCANIC focuses on agroforestry as a fundamental part of that mission. As their website states, their effort to encourage “sustainable agroforestry systems” will “improve local livelihoods and conserve natural resources” (FADCANIC 2014).

The resources supplied by these organizations, however, are not distributed to everyone in the Basin, which often results in intra-community tension. Each of these organizations employs a slightly different process and/or criteria to select farmers and communities to include in their projects. NicaCaribe, for example, requested that community leaders identify the ‘farmers’ in their community, so that they could receive plants. Clearly, therein lies the potential for community politicking when selecting these farmers. As one community leader and farmer explained when asked about the selection process, “I may know a man no farm, but I feel pressure to say him is” (interview 12/18/13). FADCANIC, BICU, and Black Farmers select farmers based on their community-level knowledge, seeking out individuals who they believe will follow through with the implementation of their projects (interviews 10/11/13 and 12/10/13). FADCANIC, for example, uses the results of projects from previous years to select beneficiaries for future projects, thereby creating select lineages receiving these agricultural resources (interview 9/1/13).

Communities also are not regarded equally by these organizations. Farmers from Pearl Lagoon, for example, are the primary beneficiaries of FADCANIC's outreach and extension activities. In addition to ease of access (it is the community closest to the road), FADCANIC administrators highlight the importance of the historically agrobiodiverse farming practices characteristic of the older farmers in Rocky Point. As a local official clarified, "in Kakabila, for example, their way of being is to plant and eat cassava. The rest of their food comes from community fruit trees and the lagoon. Rocky Point has a different farming tradition. It is the fruit basket of the Atlantic Coast... nowhere else do Afro-descendants plant in this way--with agroforestry" (interview 12/17/13). Since the goals of FADCANIC involve increasing and conserving regional agrobiodiversity, these farmers are positioned to be the most amenable to FADCANICs project activities (and perhaps the easiest community in which to see 'successful' outcomes). Therefore, although FADCANIC works around the lagoon, Pearl Lagoon farmers (who work in Rocky Point) receive a disproportionate amount of attention for the organization.

In parallel, because FADCANIC and Black Farmers specifically aim to strengthen regional political-economic autonomy through their agricultural extension projects, ethnicity becomes an important attribute in the selection process. While individuals' ethnic identities are not overtly important, these projects explicitly target communities that are considered to be indigenous and/or afro-descendant, as these communities have legal right to local land within the Pearl Lagoon Territory as part of the Regional Autonomy Law, Law 28. For example, despite the heterogeneity of identities within communities around the lagoon, The Black Famers Cooperative exclusively works in communities that are described locally based on community settlement history as Creole or Garifuna: Pearl Lagoon, Brown Bank, La Fe, and Orinoco. Their project is not active in Miskito and Mestizo communities, such as

Raitipura, Awas, Kakabila, and Pueblo Nuevo. Within the included afro-descendant communities, individuals are not barred from participation based on their identities. However, there is a relationship between the ethnicity assigned to a community and the correlating proportions of individuals within these communities that identify with that identity. The history of settlement patterns around the lagoon result in people with shared histories (and shared identities) tending to reside in specific communities. While most individuals, particularly in indigenous and afro-descendant communities, express multiple ethnicities within their identities, maintaining at least part of one's identity to correspond with that of the community identity (linking one to the history of the community) is an important part of the socio-politics of group membership and can help in the process of securing access to community land (a decision of the community leaders). Therefore, most members of the Black Farmer Cooperative identify with Creole and Garifuna ethnicities.

A farmer who is one of the principle members of the Black Farmers Cooperative in Orinoco (a Garífuna community) provides an apt example of the importance of ethnicity and the plasticity of identity in regards to community membership and resource access. During the agricultural survey, we spoke about his family history; he described his "mestiza mother" who was "from the Pacific" but lived in Pueblo Nuevo and his "Creole father" who was from Pearl Lagoon. The informant was raised along the river between Pueblo Nuevo (a mestizo community) and Orinoco. When asked about his ethnicity, I provided him a list of options with which he could say "yes" or "no" as to whether or not he identifies with this group. Miskito—"no;" Creole—"no;" Garífuna—"I am a lone Garífuna man;" Mestizo—"I told you, I am a lone Garífuna man" (interview 8/23/13). Without "being" Garífuna (of which he does not claim any "hereditary" link), this farmer would not have legitimate access to Orinoco community land. Further, if he was unable to work community land (and was, for example, working land in the area around Pueblo Nuevo), it would be difficult (if not impossible) for him to gain membership in the Black Farmers Cooperative. Therefore, despite not being part of a Garífuna *lineage*, this farmer maintain a steadfast affiliation with this important sociopolitical category.

While FADCANIC offers credit to farmers in Pueblo Nuevo, none of these projects distribute plants or seeds to farmers who reside there. Although there is heterogeneity within the community, the majority of Pueblo Nuevo's residents are recent migrants to the region and identify exclusively as mestizo (see Figure 6.1 below). These individuals and their families came to the Basin from neighboring highland departments, including Boaco, Matagalpa, and Chontales. The areas from which these individuals migrated can largely be described as ranching communities.

Interviews with these farmers revealed that some migrants residing in the area were landless in the Highlands. Many of those individuals remain landless in the Basin and work as laborers and tenants. In contrast, other recently migrated farmers with residences in Pueblo Nuevo sold their parcels in the Highlands to expanding neighboring ranches and used the profits to purchase land in the Basin. A native of Pueblo Nuevo said of the newcomers to his community, "the people come here because the land is cheap. They can sell their land in Chontales and buy twice as much here… In Chontales, there is only pasture, and they can't see the land in any other way. The land is for cows and horses. Nothing more" (interview 4/22/14) Parcels in the Basin were purchased either from other mestizo migrants or from individuals or families from Tasbapauni, a coastal community on the north of the Pearl Lagoon that historically used the area that Pueblo Nuevo now occupies for farming. These farms and ranches, by and large, are the primary focus of household economies for families in Pueblo Nuevo[26].

Pueblo Nuevo's mestizo households are not included within the ethnic-based land rights that characterize autonomy in the Pearl Lagoon Territory. Therefore, they are not sought out as beneficiaries of FADCANIC's, NicaCribe's, The Black Farmers Cooperative, or BICU's agricultural extension projects. Despite being exempted from resource distribution projects, however, relationships exist between some farmers in Pueblo Nuevo and agricultural development organizations, particularly FADCANIC. The Wawashang Agroforestry Centre is located on the bank of the Wawashang River, opposite Pueblo Nuevo. The close proximity provides easy access for local farmers to purchase seedlings and seeds from the Centre to plant on their farms. Additionally, the Agroforestry Centre is almost exclusively staffed by Pueblo Nuevo residents. This includes long-term residents of the area, migrants seeking in need of wage labor, and agroforestry specialists who FADCANIC hired and brought to the region. Therefore, while not targeting these populations in outreach projects, FADCANIC's activities near Pueblo Nuevo both draw farmers with advanced knowledge of agroforestry techniques to live and work in the area and spread this knowledge to local people that are hired to carry out these practices in the experimental farm and nursery.

[26] Interestingly, because of the complex logistics that would be involved in transporting cattle from Pueblo Nuevo, down the Wawashang River, across the Pearl Lagoon, and then west on the regional road, market-oriented ranchers drive their animals for three to four days through a jungle track to a town near to the nation's paved highway system. Therefore, while many agricultural products come to the lagoon via the road, the Basin's chief agricultural export does not utilize this infrastructure.

5.4 Conclusion

The data presented in this chapter details the ethnographic context in which to I am exploring the relationships between ethnicity and agrobiodiversity. Analysis of the ethnographic data that I collected over the course of my fieldwork points to four key factors and processes that influence the variation in land use strategies (and the associated maintenance of agrobiodiversity) that is characteristic of farming in the Pearl Lagoon Basin. These are: 1) a farmer's age and concomitant development of agroecological knowledge, 2) the diverse livelihoods characteristic of local residents, 3) the increasing connectedness of the Basin to extra-local political, social, and economic processes, 4) and ethnic-based rights characteristic of this autonomous region. When integrated with analyses of the survey data presented in Chapter 6, these factors and processes both contextualize the statistical relationships that result from these analyses and help to explain the relationship between ethnicity and agrobiodiversity in the Pearl Lagoon.

VI. Analyses of Demographic and Agroecological Data

6.1 Introduction

Ethnographic data collected during the study period illustrates that the life histories and agroecological knowledge generally relate farmers' ethnicities. However, inconsistencies in these trends (i.e. mestizo farmers who maintain highly agrobiodiverse agroforestry systems) reveal that an individual's personal history and experience farming in the region's agroecological context is a prominent set of factors shaping the land use decisions of farmers. Additionally, ethnographic data highlights the complex interrelationships between identity politics, land tenure, and the ability to benefit from agricultural extension programs in the Pearl Lagoon Basin. Importantly, while indigenous and afro-descendant farmers tend to maintain highly agrobiodiverse farming systems, their identities also secure their access to land and increase their ability to benefit from agricultural development and extension projects that seek to increase regional agrobiodiversity.

Quantitative analyses produce additional information that draws attention to specific factors and processed influencing the degrees of agrobiodiversity that local farmer maintain within their agricultural systems. Paired and compared with the results of ethnographic data analyses, the results of this study provide insight into these complex inter-relationships between ethnicity and agrobiodiversity in the Pearl Lagoon Basin.

6.2 Descriptive Information

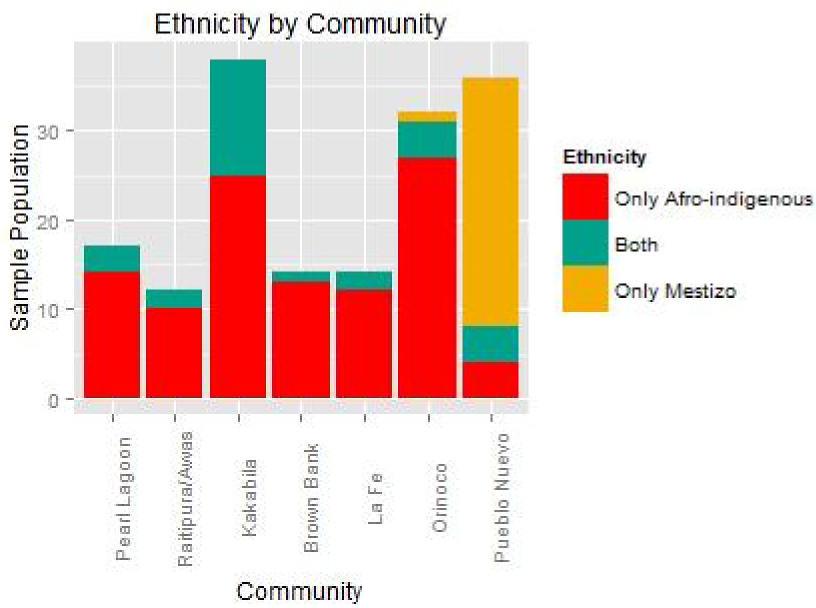
With the help of two local field assistants, I administered agrobiodiversity surveys (Appendix A) to 163 farmers within 8 communities in Nicaragua's Pearl Lagoon Basin, a subset of the MSU-URACCAN sample. Demographic statistics regarding the 163 farmers in my sample population can be found in Table 6.1; the ethnic make-up of the sample population (by community) is depicted in Figure 6.1.

Table 6.1. Demographic and geographic characteristics of the sample population to which agrobiodiversity surveys were administered.

Community	Distance to road terminus	Population	Sample #	Ethnic Make-up of Sample C = Creole, G = Garifuna, M = Miskito Mz = Mestizo ME = Multiple Ethnicities	Mean farmer age (± standard error)
Pearl Lagoon	~ 0 km	2,540	17	C = 7, G = 1, M = 1, Mz = 1, ME = 7	57.8 (± 1.9)
Raitipura/Awas	~ 1.6 km	343	12	C = 1, M = 6, ME = 5	48 (± 4.1)
Kakabila	~ 8.8 km	497	38	M = 19, ME = 19	43.9 (± 2.1)
Brown Bank	~ 13.3 km	202	14	C = 5, ME = 9	48.2 (± 3.6)
La Fe	~ 19.6 km	110	14	G = 5, ME = 9	42.4 (± 3.8)
Orinoco	~ 25 km	1,010	32	G = 24, Mz = 1, ME = 7	47.7 (± 2.4)
Pueblo Nuevo	~ 40.7 km	unknown	36	G = 2, Mz = 30, ME = 4	43.6 (± 1.9)
Total		> 4,702	163	C = 13, G = 32, M = 26, Mz=32, ME = 60	46.2 (± 1.0)

Sources: Beer and Vanegas 2007 and my own work

Figure 6.1. Ethnicities of Sample Population by Community (n=163).



This includes 1) farmers who include only indigenous or afro-descendant identities in their identity portfolios, 2) those who include only mestizo, and 3) those who include both afro-indigenous identities *and* mestizo. Communities are arranged in terms of distance from the terminus of the regional road (distance increases from left to right).

6.3 Description of Variables and Univariate Statistical Analyses

As described in Chapter 4, surveys were used to collect information regarding the factors identified in prior agrobiodiversity and land use research to influence land use decision-making of a farmer's maintenance of agrobiodiversity. These factors were grouped into four main categories, which serve as groupings for the 'step-wise' multiple regression detailed in Section 6.3. These include farm-, farmer-, household-level and political economic factors.

Prior to regression analyzes which identify the most significant predictors of a farmer's maintenance of agrobiodiversity, I employed univariate statistical tests to investigate relationships between single variables and the three agrobiodiversity metrics considered in this study to explore the significance of each individual factor on these land use outcomes. These metrics include: 1) species richness, a measure of plant diversity a farmer maintains, 2) average functional diversity, which measures the diversity of benefits provided by the specific configuration of plants a farmer maintains in their agricultural system, and 3) the Shannon Index, which accounts for both abundance of plants and the evenness of their distribution with a farmer's agricultural system. Analyses were performed using R (R Core Team 2013), and the results are summarized in Tables 6.2-6.5.

6.3.1 Farm-level factors

Farm-level factors include characteristics that specifically pertain to the age, location, size, and organization of a farmer's agricultural system. As part of agrobiodiversity surveys, farmers were asked to approximate the age of their farm (a discrete numerical variable measured in years) and its distance from their primary residence (a continuous variable measured in minutes, but is dependent on the mode of travel that the farmer employs, i.e., boat, bus, or walking). While the age of a farm has a significant effect on all three metrics of agrobiodiversity, linear regression analysis does not identify distance as a significant predictor of any of the metrics.

During surveys, interviewers also toured farms and/or discussed the different areas of a farmer's agricultural system. The interviewer worked with the farmer to estimate the sizes (a numerical variable measured in hectares) of the various areas of managed land. Farmers also classified these areas as 1) fields, 2) pasture, or 3) home gardens. These are locally defined land use types and can be generally described as follows: 1) Production fields ($\bar{x}$ 5.5 hectares ± 10.7) are on-farm cultivation areas where farmers actively maintain both food and non-food plants; 2) Pasture (or *potrero*) is cleared area that is used for animal grazing. Pastures ($\bar{x}$ 22.1 hectares ± 26.2) generally are dominated by grasses, but also contain important tree species, which may provide shade, fruit, or firewood; 3) Home gardens ($\bar{x}$

0.16 hectares ± 0.25), which in terms of content may closely resemble production fields, are cultivation areas near to the household.

Although farmers may have additional fallow or forested land to which they have rights or access, only the land(s) currently in use was(were) aggregated to determine the size of their farm. Further, because of the potential ambiguities in regard to the different land use types (such as where a “field” ended and a “pasture” or “garden” began), agrobiodiversity was not calculated per land use type, but on the farm-level. The size of the farm is identified through by linear regression analysis to predict a farmer’s functional diversity, while the presence of a pasture and homegarden with a farmer’s agricultural system are both significant predictors of both functional diversity and species richness.

Table 6.2 Summary of Agrobiodiversity Analyses of Farm Data.

Factor Category	Factor	Descriptive Information	Data Source	Species Richness	Functional Diversity	Shannon Index
Farm	Age of Farm[27]	x̄ = 40.4 (± 36.6)	Agrobiodiversity Survey	*b* = 0.01, $R^2 = 0.09$ $p < 0.001$	*b* < 0.001 $R^2 = 0.01$ $p < 0.08$	*b* = 0.01 $R^2 = 0.05$ $p < 0.002$
	Size of Farm	x̄ = 19.7 hectares (± 27.2)	Agrobiodiversity Survey	NS	*b* = 0.05 $R^2 = 0.02$ $p = 0.04$	NS
	Homegarden (presence/ absence)	Presence = 98	Agrobiodiversity Survey	*t*(117.85) = 2.94 (+), $p = 0.004$	*t*(129.31) = 2.95(+), $p = 0.004$	NS
	Pasture (presence/ absence)	Presence = 66	Agrobiodiversity Survey	*t*(160.27) = 2.33 (-), $p = 0.02$	*t*(158.30) = 3.38 (-), $p < 0.001$	NS
	Distance to farm	x̄ = 63.3 minutes (± 11.6)	Agrobiodiversity Survey	NS	NS	NS

163 farms were included in the analyses. Agrobiodiversity is referred to be ABD. Slope, R^2, and p-values of the relationships between the factors listed and three metrics of agrobiodiversity (species richness, functional diversity, and the Shannon Index) are reported for linear regression analyses. Equations and significance are provided for t-tests. Non-significant effects are indicated by NS. Positive and negative directionality of significant regressions are indicated by (+) and (-), respectively.

6.3.2 Farmer-level factors

Farmer factors specifically pertain to attributes or characteristics of the primary farmer in a given household, who was identified by the household head on my preliminary visit to the household and whose positions were confirmed by other community members. All of these variables were collected during agrobiodiversity surveys and include estimations of a farmer's age (a discrete numerical variable self-reported in years), the number of years they have been farming (also a self-reported discrete variable), and their self-identified gender (a categorical variable with three levels, which include man, woman, or couples who

[27] Shapiro-Wilk tests revealed that both age and size of farm are not normally distributed. Therefore, to meet the assumptions of linear regressions (Leeper 2000), both factors were normalized.

farm together—in the latter case couples ages and number of years farming are averaged for analyses). Dummy variables were created for categorical variables with more than 2 levels, which in this study includes both gender and community of residence (described in Section 6.3.4), for each level of the factor when it is used in a linear or multiple regression to prevent spurious results.

The (multiple) ethnicities with which a farmer self-identifies (Miskito, Creole, Garífuna, and/or Mestizo) was also documented during surveys. Reponses were grouped into three dichotomous categories: 1) farmer includes indigenous and/or afro-descendant with their identity portfolio, 2) farmer includes mestizo within their identify portfolio, and 3) farmer living in one of the Basin's established indigenous and/or afro-descendant communities and includes mestizo in their identity portfolio (the latter of which is necessary to test Hypotheses 5).

While the inclusion of Creole, Garifuna, and Miskito identities are all correlated with high levels of agrobiodiversity, multiple regression analysis identifies the aggregate category, "Indigenous and/or Afro-descendant," as a more significant predictor. Therefore, because of the similar land use practices and overlapping histories of these populations this larger category is used in analyses to ease data manipulation and comparisons. However, it is important to note that farmers that identify with Garifuna (average species richness = 36) and Creole (richness = 35) have higher average levels of agrobiodiversity than do farmers who include Miskito in their identity portfolios (richness = 30). For mestizo, richness = 25.

Table 6.3 Summary of Agrobiodiversity Analyses of Farmer Data.

Factor Category	Factor	Descriptive Information	Data Source	Species Richness	Functional Diversity	Shannon Index
Farmer	Farmer Age	$\bar{x} = 46.2$ (± 13.1)	Agro-biodiversity Survey	$b = 0.01$ $R^2 = 0.09$ $p < 0.001$	NS	$b = 0.01$ $R^2 = 0.05$ $p = 0.003$
	Years Farming	$\bar{x} = 25.4$ (± 14.9)	Agro-biodiversity Survey	$b = 0.0008$ $R^2 = 0.05$ $p = 0.002$	NS	NS
	Gender	95 Men 39 Women 27 Couples	Agro-biodiversity Survey	NS	NS	NS
	Indigenous or Afro-descendant Identity	N = 131	Agro-biodiversity Survey	$t(49.79) = 5.14$ (+), $p < 0.001$	NS	$t(39.85) = 3.28$ (+), $p = 0.002$
	Mestizo Identity	N = 60	Agro-biodiversity Survey	$t(100.69) = 4.02$ (-), $p < 0.001$	NS	$t(94.43) = 3.90$ (-), $p < 0.001$
	Mestizo Identity (within Afro-Indigenous Communities)[28]	N = 26	Agro-biodiversity Survey	$t(36.84) = 2.77$ (+), $p < 0.001$	NS	$t(49.32) = 2.08$ (+), $p < 0.001$

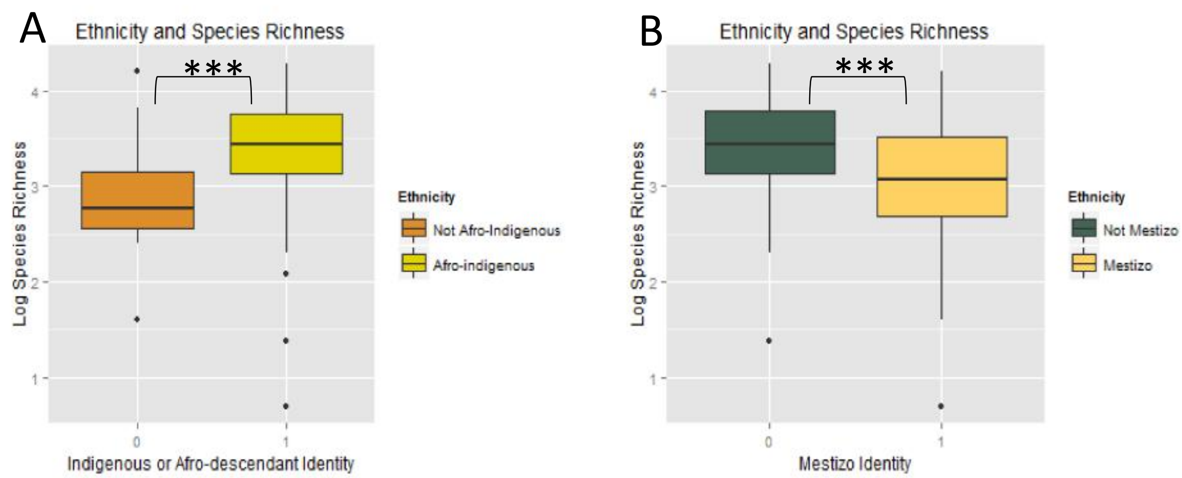
163 farms were included in the analyses. Agrobiodiversity is referred to be ABD. Slope, R^2, and p-values of the relationships between the factors listed and three metrics of agrobiodiversity (species richness, functional diversity, and the Shannon Index) are reported for linear regression analyses. Equations and significance are provided for t-tests. Non-significant effects are indicated by NS. Positive and negative directionality of significant regressions are indicated by (+) and (-), respectively.

Age of farmer is identified through linear regression analyses as significant predictors of both species richness and Shannon Indices, and the number of years that a farmer has been engaging in agriculture is also a statistically significant predictor of species richness. These factors can serve (in certain ways) as proxies for a farmers' agricultural experience. However, neither of which has a statistically significant impact on the average functional diversity of the plants that a farmer maintains.

[28] These analyses compare individuals residing within afro-indigenous communities who include mestizo within their identities with mestizos residing in Pueblo Nuevo.

The ethnic categories with which a farmer identities are also significant predictors of the farmer's species richness and Shannon Index, but not their average functional diversity. A comparison of farmers' species richness measures based on the ethnicities (or group of ethnicities) that they include within their identify portfolios can be seen in Figure 6.2.

Figure 6.2 Ethnicity and Agrobiodiversity.



Box and whisker plots of the relationship between ethnic identity and agrobiodiversity maintenance, as assessed by species richness. Ethnic identity is binned in two ways: individuals who include indigenous or afro-descendant identities (including Miskito, Creole, or Garifuna) within their identity portfolios (A) and individuals who include mestizo (B). Center lines represent the median log-transformed species richness for a given ethnic binning, the top and bottom of each box represents the upper and lower quartiles (respectively) and dots represent outliers 1.5 times greater than or less than the upper and lower quartiles, respectively. Asterisks represent level of statistical significance, where * < 0.05, ** < 0.01, *** < 0.001.

6.3.3 Household-level factors

Data at the household-level were provided through my collaboration with the MSU-URACCAN project. These factors include the geographic location of a household, household wealth, and their livelihood diversity that characterizes a particular household. The location of a household (which was collected using a GPS by MSU-URACCAN surveyors—and which I later ground-truthed) was used to calculate the distance of a household to the road's terminus in Pearl Lagoon (a continuous variable). Complex measures of distance could have been calculated, for example ones that include travel time (Kwan 2010) or attempting to determine distance in terms of the availability of transportation. However, fieldwork in the region revealed that generally people and goods move slowly via boat or barge via the lagoon. Further, few farmers own boats with motors, so they rely other community members (often fisherman) and travel when transportation is available. Transportation availability also varies greatly throughout the year, as inclement weather during the wet season makes travel difficult. Thus, distance was measured simply in terms of kilometers of distance between a farmer's community of residence and Pearl Lagoon via the lagoon. This distance is a significant predictor of a farmer's species richness and Shannon Index, but not the average functional diversity of the plants they maintain.

Wealth indices, which are numerical variables, were developed through principal component analysis conducted on a list of household assets documented during MSU-URACCAN surveys (Jirapramukpitak et al. 2014; Vyas and Kumaranayake 2006). Assets range from housing related assets (i.e., roofing-type, wall material, floor material, type of bathroom, cook set-up, refrigerator/freezer, lighting, or if the household has a gas-powered generator) to common goods (radio or mobile phone) to uncommon goods (satellite dish, air conditioner, personal computer, camera, iron, vacuum, washing machine, bicycle, motorcycle, chainsaw, or a fan). Principal component analyses group related (i.e. common) assets, giving them less weight in calculating a household's wealth index. Therefore, possessing assets that are rare among lagoon residents identify wealthy households. The wealth indices produced through this method can be used to compare the relative wealth of household around the lagoon. Linear regression analyses do not identify wealth indices as significant predictors of any of the agrobiodiversity metrics.

Finally, household livelihood diversity indices also were derived from the MSU-URACCAN survey data. This discrete variable is a sum of the various livelihood activities included within a household's livelihood activity portfolio. For example, if a surveyed household has members that participate in farming, fishing, and wage labor, the household received a 3. If members of the household only engage in farming, they receive a 1. Admittedly, this is a reductionistic method of measuring livelihood diversity, as it does not weight the importance of the various activities included in a household's livelihood portfolio, nor does it assess time commitments or potential time or labor allocation trade-offs that would prevent a household from engaging in certain configuration of activities. Despite these shortcoming, this index is useful for testing if households that are completely devoted to farming have more or less agriodiverse farming systems than household with more diversified livelihood activity portfolio; regression analyses do not identify a significant difference.

Table 6.4 Summary of Agrobiodiversity Analyses of Household Data.

Factor Category	Factor	Descriptive Information	Data Source	Species Richness	Functional Diversity	Shannon Index
Household	Distance from Road	Based on residential community	MSU-URACCAN	*b* = -0.01 R^2= 0.08 p < 0.001	NS	*b* = -0.01 R^2= 0.11 p < 0.001
	Household Livelihood Diversity	x̄ = 1.7 activities (± 1.2)	MSU-URACCAN	NS	NS	NS
	Household Wealth Index	Asset-based	MSU-URACCAN	NS	NS	NS

163 farms were included in the analyses. Agrobiodiversity is referred to be ABD. Slope, R^2, and p-values of the relationships between the factors listed and three metrics of agrobiodiversity are reported for linear regression analyses. Non-significant effects are indicated by NS. Positive and negative directionality of significant regressions are indicated by (+) and (-), respectively.

6.3.4 Political Economic factors

Political economic factors (Table 6.5) include community of residence (a categorical variable reported by the farmer during agrobiodiversity surveys) and the population of the community in which a farmer resides (as reported in Beer and Vanegas 2007). These related factors both are significant predictors of all three agrobiodiversity metrics. The pair-wise comparisons of species richness in relation to community of residence can be seen in Figure 6.3, which are identical to those identified by a Tukey HSD post hoc comparison for a farmer's Shannon Index by their community of residence. A Tukey HSD comparison also indicated that Kakabila's average functional diversity is significantly greater than is Orinoco's, but that there is no other significant differences between residents of the Basin's other communities.

Other political economic factors include a farmer's access to credit (a dichotomous variable measured as yes or no), which is contained in MSU-URACCAN survey data, and whether a farmer works with one of the agricultural-focused development projects that currently has activities in the Basin (also a dichotomous variable measured as yes or no). Information relating to involvement with development organizations was collected through agrobiodiversity surveys. Both of these variables are determined to significantly predict the species richness and Shannon Index of a farmer's agricultural system, but not the average functional diversity maintained within their farm.

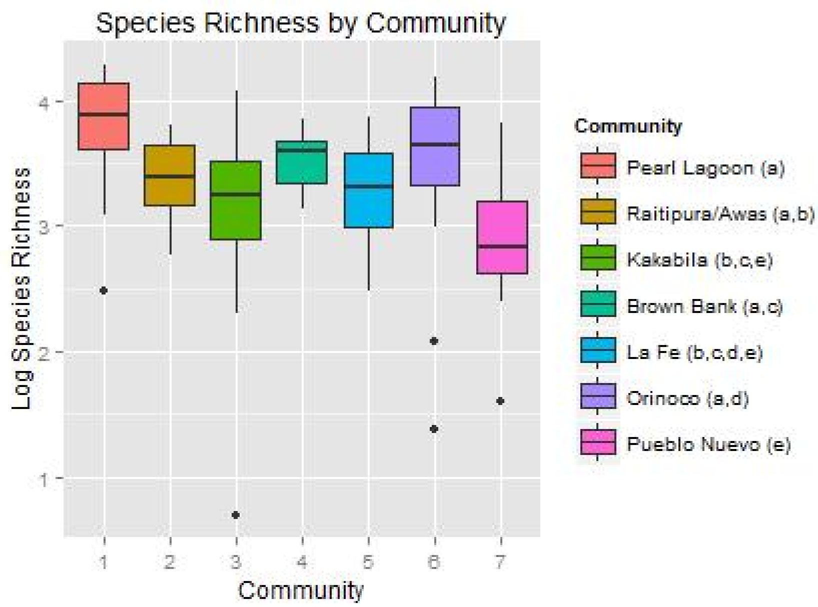
Table 6.5 Summary of Agrobiodiversity Analyses of Political-Economic Data.

Factor Category	Factor	Descriptive Information	Data Source	Species Richness	Functional Diversity	Shannon Index
Political-Economic	Community	N = 7[29]	Agro-biodiversity Survey (Beer and Vanegas 2007)	$F(6, 156) = 8.84$, $p < 0.001$	$F(6, 156) = 2.77$, $p < 0.01$	$F(6, 156) = 10.98$, $p < 0.001$
	Size of Community	$\bar{x} = 810$		$b < 0.001$ $R^2 = 0.08$ $p < 0.001$	$b = 0.03$ $R^2 = 0.03$ $p = 0.03$	$b < 0.001$ $R^2 = 0.18$ $p < 0.001$
	Access to Credit	Yes = 27	MSU-URACCAN	$t(34.51) = 2.59$ (+), $p = .01$	NS	$t(33.55) = 3.27$ (+), $p = .003$
	Agricultural Development Affiliation	N = 102	Agro-biodiversity Survey	$t(93.11) = 5.20$ (+), $p < .001$	NS	$t(104.61) = 3.83$ (+), $p < .001$

163 farms were included in the analyses. Agrobiodiversity is referred to be ABD. Slope, R^2, and p-values of the relationships between the factors listed and three metrics of agrobiodiversity are reported for linear regression analyses. Equations and significance are provided for t-tests and ANOVAs. Non-significant effects are indicated by NS. Positive and negative directionality of significant regressions are indicated by (+) and (-), respectively.

[29] The neighboring (and historically linked) Miskito communities of Raitipura and Awas are treated as a single community.

Figure 6.3 Community and Species Richness.



This is a box and whisker plot of the relationship between community membership and agrobiodiversity maintenance, as assessed by species richness. The relationship between community membership and agrobiodiversity was assessed by ANOVA ($p < .001$), followed by a Tukey's HSD post-hoc test. Communities that do not share a letter in the legend significantly differ in their species richness. Communities are arranged in terms of distance from road (distance increases from left to right). Center lines represent the median log-transformed species richness for a given ethnic binning, the top and bottom of each box represents the upper and lower quartiles (respectively) and dots represent outliers 1.5 times greater than or less than the upper and lower quartiles, respectively.

6.3.5 Univariate Analyses of Potential Co-factors

I also conducted univariate analyses on the various farm-, farmer-, household-, and political economic factors identified to correlate with the agrobiodiversity metrics considered in this study to identify co-factors. Table 6.6 displays the results of the chi-squared tests, t-tests, and Fisher's Exact Tests analyses that explore the relationships between key predictor variables and the ethnicities that a farmer includes within their identity portfolio.

These analyses reveal significant relationships between the ethnicities with which a farmer identifies and their community of residence and the age and size of their farm.

Notably, analyses also reveal that farmers who include an indigenous and/or afro-descendant ethnicity within their identity portfolio are more likely to work with the agricultural development organizations working in the Basin than are farmers who identify with mestizo. Ethnic identity does not, however, have a statistically significant relationship with farm age, a farmer's access to credit, or the presence or absence of a homegarden or pasture within a farmer's agricultural system.

Table 6.6 Summary of Significant Relationships between Ethnicity and Other Factors.

Factor	Data Description	Indigenous/Afro-descendant identity	Mestizo Identity
Community	7 Categories	$\chi^2(6, N = 163) = 119.20$, $p < 0.001$	$\chi^2(6, N = 163) = 70.82$, $p < 0.001$
Farmer Age	Years	NS	NS
Farm Age	Years	$t(102.05) = -4.41$, $p < 0.001$	$t(158.64) = 4.39$, $p < 0.001$
Farm Size	Ha	$t(39.65) = 3.43$, $p < 0.001$	$t(108.61) = 2.60$, $p = .01$
Agricultural Development Organization Affiliation	Presence/Absence	$p = 0.002$ (+), Fisher's Exact Test	$p = 0.03$ (-), Fisher's Exact Test
Access to Credit	Presence/Absence	NS	NS
Homegarden	Presence/Absence	NS	NS

163 farms were included in the analyses. P-values of the relationships between the various farm, farmer, household, and political-economic factors listed and identities that include indigenous or afro-descendant ethnicities and those that include mestizo are reported. Non-significant effects are indicated by NS. Positive and negative directionality of significant regressions are indicated by (+) and (-), respectively.

Because a farmer's involvement with an agricultural development organization is a significant predictor of the species richness and Shannon Index of a farmer's agricultural system and also strongly correlates with the ethnicities a farmer includes within their identity portfolios, I examined additional potential co-factors of a farmer's affiliation with an agricultural development organization in Table 6.7. Chi-squared tests and t-tests show that while a farmer's relationship with an agricultural development organization does not correlate with whether or not a farmer has access to credit, it does correlate with a farmer's age and the community in which they live.

Table 6.7 Factors Correlating with a Farmer's Relationships with Agricultural Development Projects.

Factor	Data Description	Agricultural Development Organization Affiliation
Community	7 Categories	$\chi^2(6, N = 7) = 15.82$, $p = 0.02$
Age	Years	$t(129.89) = 2.50$ (+), $p = 0.01$
Access to Credit	Presence/Absence	NS

This table shows co-variation between a farmer's affiliation with agricultural development organizations and other significant predictors variables of the agrobiodiversity metrics displayed in Table 2. Non-significant effects are indicated by NS.

6.4 Multivariate Analyses

This analysis follows the methodology employed by Carr (2008), in which multiple regressions are performed on groups of potentially correlated factors to identify significant predictor variables of species richness, functional diversity, and the Shannon Index. As described in Section 6.2, factors are grouped into four categories: 1) farm factors, 2) farmer factors, 3) household factors, and 4) political-economic factors. Analyses are performed "step-wise," carrying statistically significant factors from the first analyses into the second and the statistically significant variables from the second group of equations to the third, *et cetra*. The end results are considered to be best-fit models that identify the most significant factors predicting each agrobiodiversity metric[30]. By exploring groups of variables in stages, step-wise regressions, which complement the univariate analyses, identify secondary factors

[30] The order in which groups of factors are included in regression analyses developed "step-wise" can impact the outcome of regression models. Therefore, alternative analyses were explored, which incorporated the groups of factors (i.e. farm, farmer, household, and political economic) in different orders. Ultimately, while significant factors slightly vary in the intermediate steps of these alternative analyses, the most predictive models remain the same.

that may also be relevant to land use decision-making, which can be explored in the synthesis and comparison of these results with the results of the analysis of my ethnographic data.

6.4.1 Farm-level Factors

Table 6.8 summarizes the first set of models (Step 1), which describe the potential relationships between farm-level factors and the three agrobiodiversity metrics focused on in this study. In Tables 6.8 - 6.11, '*' represents significance at the 0.05 level, '**' represents significance at the 0.01 level, and '***' represents significance < 0.001.

In models predicting species richness and the Shannon Index, the age of the farm is a significant predictor of agrobiodiversity. Additionally, farmers with homegardens maintain more species richness and average functional diversity than do farmers without gardens. This is consistent with previous research concerning agrobiodiversity, which shows that homegardens play a prominent role in species and variety conservation among small-scale farmers (Coomes and Ban 2004). Pasture also is negatively correlated with average functional diversity.

Table 6.8 Multiple Regressions of Farm-Level Factors.

Factor Category	Factor	Data Description	Species Richness	Functional Diversity	Shannon Index
Farm	Farm Age	Years	***	NS	***
	Farm Size	Ha	NS	NS	NS
	Distance from Household	Minutes	NS	NS	NS
	Homegarden	Presence/Absence	***	**	NS
	Pasture	Presence/Absence	NS	**	NS

163 farms were included in the analyses. P-values of the relationships between the farm factors listed and three metrics of agrobiodiversity are reported using significance stars. Non-significant effects are indicated by NS. Positive and negative directionality of significant regressions are indicated by (+) and (-), respectively.

6.4.2 Farmer Factors

The second set of models include significant farm-level factors (from Step 1) and farmer-level factors. In addition to the marginal significance of farmer age in relation to species richness and the Shannon Index, farmer's ethnic identities are the only variables that were identified as significant predictors of agrobiodiversity in these regression analyses (Table 6.9). A farmer's inclusion of an indigenous or afro-descendant ethnicity in their identity portfolio is a significant predictor of the agricultural species richness they maintain, while inclusion of mestizo is inversely correlated with species richness and the Shannon Index. Ethnicity does not have a significant relationship with functional diversity. The age of the farm remains significant in species richness and Shannon Index models. The maintenance of a homegarden also remains a significant predictor of a species richness and functional diversity, while the inverse relationship between pasture and average functional diversity remains significant.

Table 6.9 Multiple Regressions of Farmer Factors.

Factor Category	Factor	Data Description	Species Richness	Functional Diversity	Shannon Index
Farmer	Farmer Age	Years	* (+)	NS	* (+)
	Years Farming	Years	NS	NS	NS
	Gender(s)	Man, Woman, Both	NS	NS	NS
	Indigenous or Afro-descendant Identity	Presence/Absence	* (+)	NS	NS
	Mestizo Identity	Presence/Absence	** (-)	NS	** (-)
Farm	Farm age	Years	** (+)		*** (+)
	Homegarden	Presence/Absence	** (+)	*** (+)	
	Pasture	Presence/Absence		*** (+)	

163 farms were include in the analyses. P-values of the relationships between the farmer and farm factors listed and three metrics of agrobiodiversity are reported using significance stars. Non-significant effects are indicated by NS. Positive and negative directionality of significant regressions are indicated by (+) and (-), respectively.

6.4.3 Household Factors

Step 3 of the regression analyses incorporate household-level factors in addition to the significant farm- and farmer-level factors identified in Step 2. In contrast to previous research that identified household wealth (Coomes and Ban 2004) or distance from market (Major, Clement, and DiTommaso 2005) to correlate with a farmer's maintenance of agrobiodiversity, these factors are not significant predictors of agrobiodiversity maintenance in multiple regression models of household factors (Table 6.10). Household livelihood diversity (Lamont, Eshbaugh, and Greenberg 1999; Perreault 2005; Aguilar-Støen, Moe, and Camargo-Ricalde 2008) is a significant predictor of only average functional diversity. The addition of these variables does not alter the outcomes of the farm factor + farmer factor model predicting the Shannon Index. However, the inclusion of these variables nullifies the effect of mestizo identity upon species richness. Therefore, while mestizo identity is a predictor of the species richness within a farmer's agricultural system, variation in species richness is better explained by other farm and farmer factors. These factors include: a farmer's age, the age of their farm, whether they maintain a homegarden, and if they include an indigenous or afro-descendant ethnicity within their identity portfolio.

Table 6.10 Multiple Regression of Household Factors.

Factor Category	Factor	Data Description	Species Richness	Functional Diversity	Shannon Index
Household	Distance from Road	Km	NS	NS	NS
	Household Livelihood Diversity	Count of Activities	NS	* (+)	NS
	Household Wealth Index	Asset-based	NS	NS	NS
Farm	Farm Age	Years	* (+)		** (+)
	Homegarden	Presence/ Absence	** (+)	** (+)	
	Pasture	Presence/ Absence		** (-)	
Farmer	Farmer Age	Years	** (+)		* (+)
	Indigenous or Afro-descendant Identity	Presence/ Absence	** (+)		
	Mestizo Identity	Presence/ Absence	NS		* (-)

163 farms were include in the analyses. P-values of the relationships between the household, farmer, and farm factors listed and three metrics of agrobiodiversity are reported using significance stars. Non-significant effects are indicated by NS. Positive and negative directionality of significant regressions are indicated by (+) and (-), respectively.

6.4.4 Political Economic Factors

Finally, Step 4 includes political-economic factors in addition to the significant predictor variables identified in Step 3. Because community is a categorical variable with 7 levels, it was defined as a factor in R (which creates dummy variables), and the overall effect of community on the agrobiodiversity metrics (reported in Table 6.11) was determined by an analysis of deviance. While R sets community 1 as the reference variable by default, the community set as the reference level is arbitrary (Hornik 2015). Therefore, the effect of community does not change if another community is set at the reference level.

Intriguingly, while none of these political economic factors predict functional diversity, each of these factors has a statistically significant relationship with species richness and the Shannon Index. Further, the inclusion of the political economic factors nullifies the effect of ethnicity in the species richness and Shannon Index models.

The only remaining relationships from previous models are 1) age of a farmer and species richness, 2) presence of a homegarden and both species richness and functional diversity, and 3) a negative correlation between presence of pasture and average functional diversity. Thus, in addition to these relationships, political economic variables—which include community of residence, access to credit, and working with an agricultural development project—best explain the quantitatively measured differences in agrobiodiversity among farmers in the Pearl Lagoon Basin, particularly in terms species richness and the Shannon Index.

The variables in these models (which include the remaining farm, farmer, and household factors) explain 37% of the variation in species richness among farmers (R^2=0.37), 34% of the variation for Shannon Indices (R^2=0.34), but only 13% of variation in functional diversity among farmers (R^2=0.13). Re-running a final regression without including the non-significant factors did not improve the model fit.

Table 6.11 Multiple Regression of Political-Economic Factors.

Factor Category	Factor	Data Description	Species Richness	Functional Diversity	Shannon Index
Political Economic	Community	7 Categories	*	NS	**
	Access to Credit	Presence/ Absence	* (+)	NS	* (+)
	Ag. Dev. Affiliation	Presence/ Absence	*** (+)	NS	* (+)
Farm	Farm Age	Years	NS		NS
	Homegarden	Presence/ Absence	** (+)	* (+)	
	Pasture	Presence/ Absence		* (-)	
Farmer	Farmer Age	Years	* (+)		NS
	Indigenous or Afro-descendant Identity	Presence/ Absence	NS		
	Mestizo Identity	Presence/ Absence			NS
Household	Household Livelihood Diversity	Count of activities		NS	

163 farms were include in the analyses. P-values of the relationships between the political-economic, household, farmer, and farm factors listed and three metrics of agrobiodiversity are reported using significance stars. Non-significant effects are indicated by NS. Positive and negative directionality of significant regressions are indicated by (+) and (-), respectively.

6.5 Conclusion

While a farmer's ethnic identity strongly correlated with the species richness and Shannon index of their farm, the most robust predictors of a farmer's maintenance of agrobiodiversity (across the three separate agrobiodiversity metrics considered in this study) were: (1) a farmer's age, (2) a farmer's maintenance of a garden or pasture, (3) a farmer's affiliation with an agricultural development organization, and 4) a farmer's access to credit.

Together with the results of the analyses of ethnographic data presented in Chapter 5, these results draw attention to the complex relationships that exist between history, identity, community, and involvement and interactions with the agricultural development initiatives being implemented in the Basin. Thus, the interaction of these factors appears to strongly influence the maintenance of agrobiodiversity by local farmers. Chapter 7 will explore these relationships through the syntheses of the data presented and explain how the interactions of these processes work to shape agricultural decisions and the maintenance of agrobiodiversity in the Pearl Lagoon Basin. In doing so, this work further clarifies the ways in which ethnicity works to influence, and how it is influenced by, and a farmer's maintenance of agrobiodiversity in an increasingly connected socio-political landscape.

VII. Research Findings: the synthesis of quantitative and qualitative data

7.1 Introduction

To more clearly elucidate the complex relationship between ethnicity and agrobiodiversity, I collected and analyzes complementary ethnographic, demographic, and agroecological data in the agriculturally and ethnically-diverse area of Nicaragua's Pearl Lagoon Basin. This research employed a political-ecological framework to answer the central research question, *how ethnicity influences, and how is ethnic identity influenced by, a farmer's maintenance of agrobiodiversity in the Nicaragua's Pearl Lagoon Basin?* and the following sub-questions:

SQ1) *Do members of different ethnic groups in the Pearl Lagoon Basin maintain different levels of agrobiodiversity within their farming systems?*

SQ2) *What are the major factors influencing farmers in the Pearl Lagoon Basin to maintain highly agrobiodiverse farming systems?*

SQ3) *Do the major factors influencing farmers' decisions to maintain highly agrobiodiverse farming systems relate with farmers' ethnic identities?*

Analyses revealed that a confluence of elements works to shape the ethnically-distinct patterns of land use characteristic of the Pearl Lagoon Basin—findings which affirm, augment, and challenge the findings of previous agrobiodiversity research. For example, the agrobiodiversity and household surveys lend support to previous findings of ethnically-distinct patterns in agrobiodiversity maintenance. Specifically, this research reinforces previous research indicating that 'indigenous people' or ethnic minorities tend to have higher levels of diversity than their non-indigenous or non-minority neighbors (Coomes and Ban 2004; Perreault 2005; Brush and Perales 2007; Perrault-Archambault and Coomes 2008). Additionally, this work confirms the importance of homegardens in species conservation

(Lamont, Eshbaugh, and Greenberg 1999; Trinh et al. 2003; Coomes and Ban 2004; Major, Clement, and DiTommaso 2005; Perrault-Archambault and Coomes 2008; Aguilar-Støen, Moe, and Camargo-Ricalde 2008).

Yet, in contrast to previous work regarding the impacts of road development and increased connectivity on land use decision-making and agrobiodiversity conservation (Major, Clement, and DiTommaso 2005; Abbott 2008; Dusen and Taylor 2003), the political ecological approach employed in this study revealed that the *most connected* farmers in the Pearl Lagoon Basin —those who live closest to the road and participate in agricultural development projects—have the *highest* levels of agrobiodiversity. This phenomenon can be attributed in part to shifts in the underlying philosophies that drive agricultural development projects.

While researchers previously documented that agricultural development initiatives across Latin America negatively affect agrobiodiversity conservation and to disrupt sustainable land use practices (Stonich 1993; Conroy, Murray, and Rosset 1996; Thrupp 2000; Keleman, Hellin, and Bellon 2009; Abbott 2008), ongoing development initiatives promoted in the Pearl Lagoon Basin are working, both directly and indirectly, to promote agrobiodiversity maintenance among local farmers. These initiatives are particularly focused upon farmers who are residents of the region's indigenous and afro-descendant communities. The extension activities of these development organizations incorporate contemporary concepts of ecosystem resilience and food security (Thrupp 2000; Jackson, Pascual, and Hodgkin 2007; Harvey et al. 2008; Brussaard et al. 2010), thus stressing the importance of agrobiodiversity in building sustainable food systems in Atlantic Nicaragua. Therefore, these organizations and their extension activities do not only provide evidence for the evolution in the policies that guide Latin American agricultural development projects, but also are key to understanding the relationship between ethnicity and agrobiodiversity in Nicaragua's Pearl Lagoon Basin and, potentially, in other rapidly developing regions of the world.

7.2 Synthesis of Results

Results of quantitative and qualitative data analyses provide the information necessary to answer the central research questions and test the hypotheses that frames this research. These results elucidate the interrelated factors that shape land use decision-making and the corresponding maintenance of agrobiodiversity by local farmers. The acknowledgement and recognition of the nuances of these interdependent relationships enables this research to more robustly explain how ethnicity influences, and how it is influenced by, the agrobiodiversity a farmer maintains within their agricultural system.

7.2.1 Hypothesis 1

H1: Households that self-identify with Nicaragua's ethnic minority groups (Miskito, Garífuna, or Creole) have more agrobiodiverse farming systems than farmers who identify with the mestizo majority.

Relationships between farmers' ethnic identities and their maintenance of agrobiodiversity are well-documented globally (Kirby 2011; Coomes and Burt 1997; Coomes and Ban 2004; Perreault 2005; Brush and Perales 2007; Perrault-Archambault and Coomes 2008; Trinh et al. 2003; Baco, Biaou, and Lescure 2007; Lamont, Eshbaugh, and Greenberg 1999). In particular, the work of Perrault (2005), Perrault-Archambault and Coomes (2008), and Brush and Perales (2007) provide examples in which "indigenous" people (or ethnic minorities) maintain higher degrees of agrobiodiversity than their non-indigenous neighbors elsewhere in Latin America. These correlations exist even in spite of (increased) market access, which is a factor cited as a primary driver of agrobiodiversity erosion (Brown 1999; Bellon 2004; Major, Clement, and DiTommaso 2005). Researchers have hypothesized that farmers maintain agrobiodiversity because of inherent factors associated with farmers' ethnicities, such as: taste preferences (Bellon 2004; Brush 2004), the use of diverse plants for ritual purposes (Gupta and Chandak 2010), social networks (Coomes and Ban 2004), their historical agro-ecological environment (Bellon 2004; Perrault-Archambault and Coomes 2008), and/or that farmers see certain crop varietals to be important to cultural identity (Perreault 2005) or cultural continuity (Del Angel-Pérez and Mendoza Briseno 2004).

In light of these findings and theories, it was hypothesized that trends similar to those observed elsewhere regarding ethnicity and agrobiodiversity would also exist in the Pearl Lagoon Basin. This hypothesis was also informed by the contrasting histories of the Region's dominant populations: mestizos, most of whom are recent migrants from ranching communities in Nicaragua's Highland Region (Jamieson 1999; Beer and Vanegas 2007), and the indigenous and afro-descendant populations whose diversified household livelihood strategies have included agroforestry and wild plant collection for decades, if not centuries (Helms 1971; Nietschmann 1973; Jamieson 1999; Coe and Anderson 1996).

Supporting this hypothesis, significant correlations were observed between the Pearl Lagoon Basin farmers' ethnic identities and the degrees of agrobiodiversity they maintain in their farming systems. Farmers who express indigenous or afro-descendent identities (Creole, Miskito, or Garifuna) within their identity portfolios have significantly higher species richness and Shannon Indices than do farmers who include mestizo as part of their identities (Figure 6.2). These findings reveal that indigenous and afro-descendent farmers in the Pearl Lagoon Basin tend to both maintain more agriculturally-relevant species on their land and have a more equitable distribution of farm species than their mestizo counterparts.

On average, the indigenous and afro-descendant farmers of the Basin maintain a greater number of plant species, higher species abundance, and a more even distribution of those species than do mestizo farmers. Further, they do so on smaller sized land parcels ($\bar{x}$ = 15.6 hectares versus 27.0 hectares). Because more diverse farms are thought to contribute to both food security and ecosystem integrity more strongly than less diverse farms (Thrupp 2000; Jackson, Pascual, and Hodgkin 2007; Harvey et al. 2008; Brussaard et al. 2010), farmers who identify as indigenous and afro-descendant are likely to maintain more agroecologically robust farms than do farmers who identify as mestizo.

In contrast to the relationships observed between ethnic identity and agricultural species richness and evenness, no significant relationship was observed between a farmer's ethnicity and their farm's functional diversity. The functional diversity metric was included to assess the ecosystem services in terms of social provisions provided by the specific plants maintained by farmers. Therefore, this research indicates that ethnicity is *not* a factor that differentiates farmers in the Basin whom maintain plants with a variety of human uses and applications. However, this finding must be considered within the context of the specific method of measuring functional diversity used in this study. Functional diversity was calculated based on the average number of uses for each plant; therefore, farms with higher species richness, but with plants that only serve a single anthropocentric-purpose, may have lower average diversity than a farm with only one type of crop with many applications. Alternate functional diversity metrics bias more species-rich farms, by summing the functional diversity of all species present in a landscape (Semichon-Linard 2001).

Thus, while broadly reinforcing previously identified trends regarding the relationships between ethnicity and agrobiodiversity, this research also reveals that even farmers in the region who on average have relatively low species richness and evenness nonetheless maintain comparable levels of functional diversity (particularly within their homegardens) to their more agriculturally-diverse neighbors. If the functionality of a managed landscape is maintained with fewer species, it may be less resource intensive for a farmer to plant and maintain a reduced number of species and satisfy their basic needs. This pattern therefore contributes to our understanding of why the land-use decision making of farmers—in particular those individuals who do not have a historical context of highly agrobiodiverse farms—may not necessarily favor maintaining farms characterized by high species richness and evenness.

7.2.2 Hypothesis 2

H2: Farmers who identify as indigenous (Miskito) and afro-indigenous (Garifuna) have more agrobiodiverse farming systems than non-indigenous Creole farmers.

As described in Chapter 3, Jamison (2003) explored the ways in which the flexibility of ethnic identity is utilized in the Pearl Lagoon Basin to differentiate between individuals' engagement in activities and behaviors driven by individual concerns versus those perceived to be in accordance with communal norms. Notably, individuals who engage in capitalist, market-driven activities are perceived to be more 'creole.' These generalizations and stereotypes are associated with the historical role of this population as administrators in colonial and post-colonial government and merchants (Jamieson 1999; Jamieson 2003). Additionally, agrobiodiversity research points to market-access and market-orientation as a major driver of agrobiodiversity erosion (Major, Clement, and DiTommaso 2005; Dusen and Taylor 2003). Based on this information, I hypothesized that famers who identify as Creole would have lower agrobiodiversity than farmers who include an indigenous (Miskito) or afro-indigenous (Garifuna) ethnicities in their identity portfolios.

In contrast to my hypothesis, no significant differences were identified in the agrobiodiversity of farmers whose identity portfolios include Creole, Miskito, or Garifuna (Table 6.2). Further, while there are observable (although not statistically significant) differences in the mean agrobiodiversity of farmers who identify with each of these groups, they do not follow predicted patterns. For example, farmers who include Garifuna within their identities have the highest average species richness ($\bar{x}$ = 36 maintained species) followed by Creole ($\bar{x}$ = 35 maintained species). In contrast, farmers who include an 'indigenous' Miskito identity in their portfolios have lower average species richness ($\bar{x}$ = 30 maintained species).

Paralleling this finding, despite relationships between residence patterns and ethnicity in the Pearl Lagoon Basin that result in individuals who identify as Creole tending to live in communities closer to the new road (Figure 6.1), these farmers (nor most others around the lagoon) are heavily engaged in market-oriented farming. As ethnographic data revealed, farming is predominantly a subsistence activity—particularly among indigenous and afro-descendant farmers. Excess crops are sold locally, but few farmers make planting decisions based on markets, especially export markets that demand volume productions of key crops.

The increased connectedness of the Basin with the more-developed Highland and Pacific Regions of Nicaragua introduces new opportunities for marketization, providing both infrastructure that could be used for exporting agricultural commodities and attracting a host of agricultural development organizations that are specifically aiming to marketize local crops. For example, the Black Farmers Cooperative and FADCANIC are encouraging farmers to become more market-orientated, providing them with coconut and other cash-crop seedlings, while simultaneously organizing opportunities for farmers to sell their agricultural products. Community leaders also report being approached by foreign corporations that sought to lease agricultural lands in the Basin for coconut production and export. However, despite these opportunities, farmers—especially those who live closest to the road—maintain their subsistence focus and valuation of agrobiodiverse farming systems. This behavior is at least partly explained by the age of these farmers, who use farming as a subsistence-based retirement strategy, and alternative livelihood activities that appear to be more financially lucrative in the short-term, thus drawing potentially entrepreneurial individuals away from farming. It is within this context that save a few gallons of coconut oil, the only local exports currently traveling via the new road are fishery products.

7.2.3 Hypotheses 3 and 4

H3: The major factors influencing the land use decisions that govern agrobiodiversity maintenance or erosion throughout the Basin are 1) agricultural knowledge 2) (dis)respect for local communal land tenure systems, and 3) participation in agricultural development projects.

H4: These factors are highly related with farmers' ethnic identities.

Research previously conducted in the Pearl Lagoon Basin supplied information regarding: 1) the unique agroecological and ethnobotanical knowledge employed in local agroforestry systems, 2) the ethnic-based rights that define the formal land tenure system of the Pearl Lagoon Basin, and 3) the activities of agricultural development projects working in the region to enhance regional autonomy in part through the promotion of agrobiodiverse land use practices. Each of these phenomenon was predicted to shape the land use practices of local farmers. My research identified a myriad of underlying factors that robustly correlate with the agricultural species richness, average functional diversity, and Shannon Index of farms within the Pearl Lagoon Basin. Therefore, while my findings confirm hypotheses 3 and 4, they also provide insight into additional factors that influence a farmer's maintenance of agrobiodiversity.

Variation was observed among which factors most strongly correlate with each of these agrobiodiversity metrics. For example, a farmer's maintenance of a homegarden is a key predictor of high species richness and average functional diversity, but did not correlate with a farmer's Shannon Index. This pattern likely reflects that the relatively small homegardens of Basin farmers will disproportionately increase a farm's species richness (i.e. the total number of species maintained) over its species evenness (i.e. the relative abundance of each species). However, across the agrobiodiversity metrics considered, the most significant predictors of a farm's agrobiodiversity were: 1) the age of a farmer, 2) if a farmer maintains a garden (positive) or pasture (negative), 3) a farmer's affiliation with agricultural development organizations working in the region, 4) a farmer's access to credit, and 5) a farmer's community of residence.

Farmer ethnicity in the Pearl Lagoon Basin strongly correlates with farm species richness and the Shannon Index (although not a farm's average functional diversity). However, regression models reveal that these other factors supersede the importance of ethnicity in predicting farm-level agrobiodiversity. Notably, the step-wise multiple regression analyses indicate that political factors nullify relationships between a farmer's identity and their agrobiodiversity. These political factors include: a farmer's community of residence, access to credit, and affiliation with agricultural development organizations. It is important to note that potential predictor factors in step-wise multiple regressions which are themselves highly correlated can reduce the significance of a given factor (Kumar 1975; Farrar and Glauber 1967). Therefore, the loss of farmer ethnic identity as a significant predictor of agrobiodiversity in the step-wise regression models is driven by highly significant correlations between ethnic identities, community of residence, and involvement with local agricultural development projects (Tables 6.6 and 6.7).

Older farmers, regardless of these other predictive factors, tend to have more agrobiodiverse farms than do younger farmers. Ethnographic data explains how this pattern is underlain by the approach that older farmers take to farming. For older farmers (particularly those in afro-indigenous communities), farming is a subsistence activity that functions as a form of ‘retirement strategy’ and does not depend upon the ebbs and flows of potential market interests. Research conducted by Helms (1971) and Nietschmann (1973) in previous decades (detailed in Chapter 3) describes women as the primary cultivators and caretakers of agricultural systems in Atlantic Nicaragua. This division of labor was attributed women’s’ abilities to maintain these low-maintenance sources of subsistence while men periodically migrated for labor. Today, rather than an overt gendered division of labor, elders now tend to take on the role of primary caretakers of family farms, as both men and women migrate for labor. These older farmers employ knowledge acquired over a lifetime of farming in the Basin’s particular agroecological context and draw on a wealth of local ethnobotanical knowledge (Coe and Anderson 1996; Coe 1997) to maintain a diversity of food and non-food resources. Coupled to this preference for a diversity of agricultural products, older farmers generally have worked to develop systems that require as little maintenance effort as possible. Therefore, a confluence of age, experience, and agricultural knowledge play prominent roles in structuring the land use decisions of farmers in the Basin in ways that work to promote agrobiodiversity.

The results of ethnographic data analyses reveal additional processes that influence farmers’ land use decisions and maintenance of agrobiodiversity. Specifically, ethnographic data highlights ethnic-based land rights in the Atlantic Autonomous Region as a factor that both links a farmer's ethnic identity and their community of residence and also influences the ethnic identity(ies) with which farmers' most strongly associate. Farmers' identities are an important component of claiming community membership. Ethnic-based land rights in the Atlantic Autonomous Region also shape the opportunities that a farmer has to participate in the agricultural development projects that are working to increase agrobiodiversity (and potentially increase commercialization) among farmers in the Pearl Lagoon Basin.

Ethnicity is a fundamental factor that establishes a farmer's ability to legally access land and to benefit from agricultural extension projects. While not governed by a farmer's community of residence, farmers draw upon their 'mixed' histories and the flexible nature of ethnicity in the Pearl Lagoon Basin to highlight indigenous and afro-descendant ethnic identities that can secure access to communal lands and, therefore, access to assistance programs, which include access to credit. Critically, mestizo farmers living in Pueblo Nuevo are largely excluded from these ethnic-based land rights and agricultural extension projects. Further, many of these farmers engage in expansive cattle ranching as their primary income source and livelihood strategy, thus cultivating only a limited number of subsistence crops.

In contrast to this dominant pattern, select farmers who live in Pueblo Nuevo and identify as mestizo are among farmers with the highest agrobiodiversity in the Basin. These particular farmers work for the agroforestry training center and nursery established by FADCANIC, a regional NGO. While not the targeted beneficiaries of extension projects, these farmers are responsible for carrying out the agroforestry techniques that are central to the mission of the Agroforestry Centre, which stress the importance of agrobiodiversity. As such, 'NGO-integrated' mestizo farmers utilize similar strategies on their own farms, thereby promoting current paradigms of agro-ecological resilience within their land-use decision-making. Therefore, while there are ethnically-distinct patterns of land use and agrobiodiversity maintenance among farmers in the Pearl Lagoon Basin, these relationships are not deterministic. Further, the heterogeneity with regards to agrobiodiversity within the ethnic and residential communities in the Pearl Lagoon Basin exposes that a set of interacting socio-political factors greatly influence the agricultural decisions of local farmers.

7.2.4 Hypothesis 5

H5: In contrast to broader patterns regarding ethnicity and agrobiodiversity, mestizo households that reside in Miskito, Creole, or Garífuna communities have more agrobiodiverse farming systems than mestizos living in more remote parts of the Basin, as they have modified their land use practices in accordance to community land use norms.

Because of the inclusive nature of identities in the Pearl Lagoon Basin, some individuals living in communities characterized as indigenous or afro-descendant include mestizo within their identity portfolio (Figure 6.1). This can in part be attributed to historical (albeit small) migrations of people from Pacific and Highland Nicaragua to the Atlantic Region. Despite the relative isolation of the Atlantic Coast and its populations from Pacific and Highland Nicaragua—and the rest of Latin America—individuals from these areas began migrating to the Atlantic Region at least as early as the late 19th Century, when the Region was first incorporated into the Nicaraguan nation-state (Jamieson 1999). As a result, many individuals in the Pearl Lagoon Basin trace a portion of their ancestry to these early migrants. Additionally, a small portion of more recent migrants to the region have moved from rural settlements into established communities around the lagoon to access resources, such as primary schools for their children.

It was hypothesized that the assimilation of these mestizo populations into predominantly indigenous and afro-descendant communities would force their adoption of land use strategies that are regulated by community norms. These indigenous and afro-descendant communities include: Pearl Lagoon, Raitipura, Awas, Kakabila, Brown Bank, La Fe, and Orinoco. The land use norms of these communities promote significantly smaller farms than those developed in Pueblo Nuevo (14.3 ± 23.1 versus 38.6 ± 31.4), with significantly higher species richness and Shannon Indices (Figure 6.3). The land tenure system in the Pearl Lagoon Basin allows access to land for all members of these indigenous and afro-descendant communities. Ethnographic research in the region revealed that community membership is distinguished informally on the community-level. Community leaders ultimately decide if an individual can access community resources—such as land—based on interpersonal relationships, micro-politicking, and their belief that this individual's actions will not be damaging to community resources or norms. In light of this plasticity in community membership and land-rights, farmers who reside within indigenous and afro-descendant communities and identify (at least in part) as mestizo were predicted to have higher agrobiodiversity than mestizos living in Pueblo Nuevo, the majority mestizo settlement north of the lagoon.

This hypothesis was supported by the survey and ethnographic data collected in the Basin. Farmers who include mestizo in their identities and live in communities along the shore of the lagoon have higher species richness and Shannon Indices[31] than mestizo farmers in Pueblo Nuevo. However, synthesis of survey and ethnographic data exposes the nuances of this relationship and of ethnic identity in the Basin. While 26 of 127 farmers residing in indigenous and afro-descendant communities included in this study include mestizo within their identities, only one farmer residing in an indigenous and afro-descendant community

[31] Similar to comparisons between farmers that identify with indigenous and afro-descendant groups and all farmers who identify as mestizo, average functional diversity is not significantly different between mestizo farmers in Pueblo Nuevo and those residing in other communities.

considers themselves to be exclusively mestizo. This farmer and his family moved recently into Orinoco so that his children could attend school and was granted access to land by the community. Moreover, this farmer maintains a more agrobiodiverse farm than the average mestizo farmer in Pueblo Nuevo. Notably, all other farmers residing in indigenous and afro-descendant communities that include mestizo within their identity portfolio also express the *dominant community identity* within their portfolios.

These identities become vital parts of a socio-political process of community membership and help individuals to secure the rights granted to community members, such as the right to land. Further, many individuals, particularly in Orinoco, describe a father, mother, or grandparent who was "from the Pacific" (or "Spaniard," as mestizos are referred locally), but do not include mestizo within their identities. The key informant from Orinoco depicted in Section 5.3.4 who, despite having a mestizo mother and Creole father, identifies only as Garifuna. This resistance to self-identifying with a mestizo lineage with the indigenous and afro-descendant communities can be attributed in part to the tenuous relationship between residents of this community in particular and the ever-encroaching land colonization radiating from Pueblo Nuevo toward Orinoco and the lagoon. Therefore, these dynamics of ethnic identification reveal that while family "heritage" influence ethnic identity in the Pearl Lagoon Basin, individuals' ethnicities are also shaped by contemporary socio-political process, which link identity, community, and rights.

7.3 Conclusion

Through the collection and integration of ethnographic, demographic, and agroecological data, this research contributes additional information and novel insights into the relationship between ethnicity and agrobiodiversity. This project largely supports the findings of previous research regarding correlations between a farmer's ethnic identity and their maintenance of agrobiodiversity. This work also reinforces preceding findings regarding the importance of homegardens in the conservation of important plant species. Yet, by including more complex and complementary approaches to the study of both ethnicity and agrobiodiversity, this research provides new perspectives into *how ethnicity influences and how it is influenced by a farmer's maintenance of agrobiodiversity*.

Ultimately, farmer land use decision-making in Nicaragua's Pearl Lagoon Basin is shaped by the histories of populations, the agroecological knowledge accrued over their lives and passed through generations, and the role of agriculture within their livelihood strategies. However, examining ethnicity not simply as a "fixed-factor," but as an active socio-political process, reveals the confluence of factors and processes that shape the ethnically-distant patterns of land use and agrobiodiversity maintenance observed in the Basin.

In particular, complex interrelationships between ethnicity, community membership, ethnic-based land rights, and agricultural development organizations became evident over the course of this research. Within the highly plastic ethnic landscape of the Pearl Lagoon Basin, individuals exercise specific configurations of identities to both acknowledge their familial heritage, but also to secure their community membership. This membership enables them to benefit from ethnic-based community land rights and places them in position potentially to benefit from the agricultural development projects that aim to bolster regional autonomy through their promotion of agrobiodiverse farming practices. Further, these organizations aim to aid the very populations who historically maintained highly diverse agroforestry systems. Therefore, it is by affecting access to ethnic-based land rights and assistance programs that work to conserve and increase local agrobiodiversity that ethnicity shapes and is shaped by a farmer's maintenance of agrobiodiversity.

Yet, there is also heterogeneity of land use practices among individuals who identify with a particular ethnic group. For example, there are a number of farmers who identify as mestizo who are among the farmers maintaining the highest levels of agrobiodiversity in the Basin. These heterogeneities reveal that the relationship between ethnicity and agrobiodiversity in this region is not deterministic. Further, they expose additional phenomena that are critical for understanding the processes that shape agrobiodiversity maintenance in this complex and changing socio-ecological system. Specifically, the identified relationships between mestizo farmers in Pueblo Nuevo and the Agroforestry Centre that functions as a hub for FADCANIC's extension activities underscores the importance of agricultural organizations in promoting agrobiodiverse farming in the Pearl Lagoon Basin.

VIII. Conclusions: Implications and Future Directions

8.1 Introduction

While scholars previously identified links between a farmer's ethnicity and their conservation of agrobiodiversity in an increasingly connected world (Kirby 2011; Coomes and Burt 1997; Coomes and Ban 2004; Perreault 2005; Brush and Perales 2007; Perrault-Archambault and Coomes 2008; Trinh et al. 2003; Baco, Biaou, and Lescure 2007; Lamont, Eshbaugh, and Greenberg 1999), understanding processes and mechanisms that structure and drive these relationships has remained inadequate. Researchers hypothesized that specific sociocultural factors shared by farmers that belong to the same ethnic group encouraged the resilience of these individuals to the agrobiodiversity erosion observed globally throughout the latter half of the twentieth century (Bellon 2004; Brush 2004; Gupta and Chandak 2010; Coomes and Ban 2004; Perrault-Archambault and Coomes 2008; Perreault 2005; Del Angel-Pérez and Mendoza Briseno 2004). However, by failing to account of the flexible nature of identity, previous agrobiodiversity research overlooked the ways in which a confluence of factors and processes may work to shape both a farmer's land use decisions and their ethnic identities.

Rooted in a political ecological approach, my research integrated ethnographic, demographic and agroecological data collected in the Pearl Lagoon Basin to 1) determine if ethnically-distinct patterns of agrobiodiversity conservation exist in the Basin, 2) identify the primary factors and processes that influence these patterns, and 3) examine the interactions between these factors and processes. This research approach was designed to develop a more holistic and comprehensive understanding of the reciprocal relationships between ethnicity and agrobiodiversity and answer the central research question that guided this study: *how* *does ethnicity influence, and how is ethnic identity influenced by, a farmer's maintenance of agrobiodiversity in the Nicaragua's Pearl Lagoon Basin*.

Significant relationships observed between a farmer's ethnic identity and the agrobiodiversity they maintain within their farming system indicate that farmers who identify themselves in surveys (at least in part) as indigenous and afro-descendant tend to maintain more diverse farms than nearby farmers who identify as mestizo. In order to more deeply understand the mechanisms underlying these relationships, I identified the key farm, farmer, household, and political economic factors and processes that are associated with the agrobiodiversity maintained by farmers in the Basin. These factors and processes included: 1) a farmer's age and concomitant agroecological knowledge, 2) the role of agriculture within the diverse livelihood strategies characteristic of many Basin residents, and 3) a farmer's involvement (or lack thereof) with agricultural development organizations working in the region to promote agrobiodiversity conservation.

Further, the plastic nature of ethnic identity was explicitly recognized in my research approach. Within this paradigm, ethnicity was considered not solely as a unidimensional factor or attribute of a farmer or household, but also as a as a fluid, socio-political identity that shapes and is shaped by opportunities and constraints. This research framework highlighted the importance of ethnic-based land rights in the Nicaragua's Atlantic Autonomous Region as a critical factor that both directly and indirectly influences the ethnic identities of farmers in the Pearl Lagoon Basin and their abilities to participate in agricultural development projects whose extension activities promote agrobiodiversity conservation.

By employing a political economic framework that integrates ethnographic, demographic, and agroecological data for elucidating the feedbacks that characterize complex socio-ecological systems, my study has implications for agrobiodiversity research as well as scholarship more broadly concerned with understanding the dynamics of these systems. In particular, my research highlights the importance of the integration of ethnographic and quantifiable data to understand the dynamic interrelationships that can exist between factors shaping human-environmental interactions. The results of this work also raise a series of questions concerning feedbacks between biodiversity loss and livelihood shifts in linked aquatic-terrestrial socio-ecological systems. Intriguingly, my ethnographic data signals that Basin residents' valuation of land resources is increasing as Pearl Lagoon fish populations decline. Therefore, characterizing the reciprocal impacts of aquatic biodiversity loss, livelihood strategies shifts, and growing reliance on terrestrial biodiversity in this turbulent socio-ecological landscape could produce critical insights into the mechanisms that enhance and degrade socio-ecological resilience in systems subject to accelerated globalization pressures.

Finally, my research provides information that has practical policy applications, which can enhance the ability of the agricultural development organizations working in the Pearl Lagoon Basin and elsewhere to improve local natural resource management. Particularly, my work highlights that local residents who have the greatest negative impact on the region's socio-ecological system (i.e., recent migrants who identify as mestizo) are the least likely to benefit from extension programs that are working to improve natural resource conservation.

Additionally, complementing its direct applications to agricultural policy initiatives, the insights gained through this investigation of land use decision-making within the Basin highlight unintended consequences of the vagaries that characterize resource control and land access within Nicaragua's Autonomous Atlantic Regions. Specifically, it calls attention to the lack of clear policies regarding how to deal with the land colonization associated with migrant populations from the Highland Regions. Local and region policy-makers must consider the serious dilemma that has arisen from the ambiguities of this Autonomy Law and consider a path to integrate, rather than futilely struggle to contest, the migrant populations into the regional socio-ecological system. The national government could play a pivotal role in moderating land use conflicts in the Atlantic Region. However, they have recently shown a complete disregard for the rights to land control granted to the people of the Autonomous Regions throughout the development of the Nicaraguan trans-isthmus canal (Meyer and Huete-Pérez 2014; Anderson 2015). Following these actions, the national government's active support of autonomy seems unlikely.

8.2 Scholarly Contributions

8.2.1 Agrobiodiversity

The findings from this research both support and augment previous research on agrobiodiversity. First, this work adds to a suite of case studies that report an observable relationship between a farmer's ethnic identity and the level of agrobiodiversity they maintain (Kirby 2011; Coomes and Burt 1997; Coomes and Ban 2004; Perreault 2005; Brush and Perales 2007; Perrault-Archambault and Coomes 2008; Trinh et al. 2003; Baco, Biaou, and Lescure 2007; Lamont, Eshbaugh, and Greenberg 1999). Additionally, this research emphasizes the significance of homegardens in the conservation of socioculturally important plant species and supporting farm-level agrobiodiversity (Lamont, Eshbaugh, and Greenberg 1999; Trinh et al. 2003; Coomes and Ban 2004; Major, Clement, and DiTommaso 2005; Perrault-Archambault and Coomes 2008; Aguilar-Støen, Moe, and Camargo-Ricalde 2008).

Agricultural development organizations and road development were also found to play a prominent role in the land use decisions of small-scale farmers, results which complement previous agrobiodiversity research (Major, Clement, and DiTommaso 2005; Abbott 2008; Dusen and Taylor 2003). However, unlike earlier studies and commentaries that stressed the role of development and development organizations in farmer's decisions to reduce agrobiodiversity in favor of fewer, more easily commodified cash crops, my research indicates that agriculturally-oriented development organizations operating in Atlantic Nicaragua are playing a significant role in encouraging farmers to conserve and increase the agrobiodiversity on their farms.

In contrast to the policies characteristic of agricultural development observed in previous decades that focused on crop specialization to improve marketization (Stonich 1993; Conroy, Murray, and Rosset 1996; Thrupp 2000; Keleman, Hellin, and Bellon 2009; Abbott 2008), contemporary concepts of ecosystem resilience and food security that highlight the fundamental and positive role of plant diversity (Thrupp 2000) direct the policies of the organizations working in the Pearl Lagoon Basin today (FADCANIC 2014). Yet, a farmer's ability to benefit from agricultural outreach projects in the Basin is determined by the community in which they reside, and a farmer's membership in these communities (and access to community land) is shaped by their ethnic identities. Therefore, the results of this research stress the importance of the reciprocal relationship between ethnicity and current development policies, which target ethnic minority populations in the Pearl Lagoon Basin in an effort to promote autonomy for the 'historical populations' of the Atlantic Coast.

This project also contributes to more clearly defining agrobiodiversity within the context of research and policy. Agrobiodiversity is argued to confer a variety of social and ecological benefits, including food security (Thrupp 2000), ecosystems services—such as reducing soil erosion (Altieri 2002; Foley et al. 2005)—and habitat conservation (McNeely and Scherr 2003; Harvey et al. 2008; Brussaard et al. 2010). Yet, there is no standard measurement of agrobiodiversity. Generally, studies choose one method of assessing agrobiodiversity that align with specific research goals. The various approaches taken to assess agrobiodiversity include measuring: 1) varietal diversity of a specific crop (Brush and Perales 2007; Baco, Biaou, and Lescure 2007), 2) plant species diversity, often only in homegardens (Coomes and Ban 2004; Perrault-Archambault and Coomes 2008; Lamont, Eshbaugh, and Greenberg 1999; Aguilar-Støen, Moe, and Camargo-Ricalde 2008), or 3) insects or other biota residing in an agroecosystem (Duelli, Obrist, and Schmatz 1999; Burel et al. 1998). However, by including complementary agrobiodiversity metrics in my research, my work shows how specific metrics inform somewhat distinct interpretations of the factors underlying the maintenance of agrobiodiversity.

Specifically, my research highlighted the importance of comparing several agrobiodiversity metrics (species richness, average functional diversity, and the Shannon Index) to understand the relationships between land use decision-making and agrobiodiversity maintenance. While a farmer's age and ethnicity strongly correlated with the species richness and Shannon Index of their farms, these factors do not predict the average functional diversity of the plants that a farmer maintains. These findings indicate that while members of certain ethnic groups may value species diversity and farmers who are older build agrobiodiverse farms over time, all farmers seek to satisfy their basic needs through key, multi-use plants. Therefore, by comparing these multiple measures of agrobiodiversity, this work help to provide a more complete understanding of the factors and processes that shape agrobiodiversity in its various forms. Further, it encourages future research to account for the complexities of agrobiodiversity to mitigate inaccurate generalities regarding the links between specific farm-, farmer-, or community-level factors and agrobiodiversity.

8.2.2 Socio-ecological Systems and Political Ecology

This research has implications for theory that are applicable beyond research specifically concerning agrobiodiversity. This work contributes to research in political ecology (Robbins 2004; Biersack and Greenberg 2006; Walker 2006; Paulson and Gezon 2005; Bryant 1998; Stonich 1993) as well as a growing body of scholarship concerned with improving understandings of socio-ecological systems (Young et al. 2006; Liu et al. 2007; An and López-Carr 2012; Lambin and Meyfroidt 2010; Brondizio, Ostrom, and Young 2009). In particular, the research design utilized in this project provides a framework for applying a political ecological approach that integrates a diversity of data types to understand the linkages and feedbacks that previously have been identified to characterize socio-ecological systems (Young et al. 2006; Liu et al. 2007).

The integration of detailed ethnographic, demographic, and agroecological data revealed key insights regarding the dynamic and reciprocal processes that shape human-environmental relationships. These observations could not be fully understood through quantitative models alone. In particular, my research showed that when treated as a demographic characteristic, ethnicity was strongly correlated with a farmer's agrobiodiversity maintenance. However, I also observed ethnicity to be reflective of a sociopolitical process rather than simply a fixed factor. Ethnicity and other complex socio-cultural and socio-political process are central to structuring the social landscape within which people make decisions that affect socio-ecological systems. The inclusion of such phenomena in this study helped to reveal that the inverse relationship between distance from a road or market and a farmer's maintenance of agrobiodiversity in comparison to previous agrobiodiversity research is largely explained by the intersection of ethnicity and connectedness.

A major challenge to the integration of factors traditionally considered in agrobiodiversity research (e.g. distance from road) (Major, Clement, and DiTommaso 2005; Perrault-Archambault and Coomes 2008) with relatively fluid socio-cultural processes like ethnic identity is that the latter are often both difficult to quantify and impossible to understand without in-depth *in situ* studies. Similarly, although researchers aim to identify the best configuration of factors that correlate with decision-making outcomes, these factors are routinely treated simply as static attributes or characteristics within decision-making models concerning socio-ecological systems (Lambin and Meyfroidt 2011; Irwin and Geoghegan 2001; Nelson and Hellerstein 1997). As the quantitative analyses presented in my study show, while a predictive model can be developed with these factors, they rarely account for all—or even most in the case of my study—of the variation in complex human behavior.

To address these challenges, my research design measured and accounted for ethnicity in two complementary ways: as a category that relates to shared characteristics or histories of a population, but also acknowledging that individuals' affiliations with these categories (or qualities) are often are plastic and shaped by socio-political processes operating at various scales. In doing so, I was able to show statistical relationships between ethnicity and agrobiodiversity *and also* identify the mechanisms underlying the relationships between a farmer's maintenance of agrobiodiversity and their ethnic identity. As such, my research strongly supports recent calls to develop more robust frameworks for understanding socio-ecological systems that integrate complex cultural phenomena (Ostrom 2009; Young et al. 2006; Caldas et al. In press). Further, this work highlights the growing need to develop methodologies to collect and aggregate "mixed" datasets from *in situ* studies conducted globally. Such a framework is necessary in order to move beyond theoretically-driven ideas about how stakeholders make decisions that shape socio-ecological relationships to models that include more accurate conceptualizations regarding how people make decisions within their realized contexts of opportunities and constraints.

The multifaceted approach that I took to measuring and assessing the role of ethnicity in socio-ecological systems also makes contributions to political ecology research that focuses on increasing our understanding power relationships shape access and use of natural resources (Paulson and Gezon 2005; Bryant 1998; Paulson, Gezon, and Watts 2003). In line with many studies employing a political ecology framework (Biersack and Greenberg 2006), my exploration of the relationship between ethnicity and agrobiodiversity highlights the importance of "everyday interactions" with political processes. Importantly, my research highlights how politics operating at various scales—from intra-community dynamics to changes in international development philosophies—shape ethnicity-agrobiodiversity relationships on the local-level.

By accounting for the ways in which ethnicity (and history) shapes land use patterns, my research demonstrated how contemporary development politics focus on historically marginalized indigenous and 'ethnic minority' populations as the stewards of global agrobiodiversity and aim to enhance the abilities of these populations to remain resilient to agrobiodiversity erosion in the face of global change. Additionally, my research exposed how ethnically-explicit policies regarding land and resources access that are based on these patterns in turn shape individuals' identities. Therefore, my novel research framework enabled me to track power relationships from the global to the local and to identify how these relationships shape human-environmental relationships (Biersack and Greenberg 2006), and elucidate how people navigate multi-scaled power structures to gain access to the resources they need to survive.

8.3 Applied Significance

8.3.1 Agricultural Development Policies

This research contributes useful insights for agricultural development organizations working in the Pearl Lagoon Basin and beyond. Specifically, the findings from this study are being shared with the Foundation for the Autonomy and Development of the Atlantic Coast of Nicaragua (FADCANIC). FADCANIC is a prominent regional NGO and one of the key players working locally to improve natural resource management and promote food security through the conservation of agrobiodiversity. By providing an explicit understanding of the factors and processes motivating the land use decisions of local residents, this research provides information that will help enhance the capacity of FADCANIC to promote socio-ecologically effective agroforestry and local resources conservation in Atlantic Nicaragua.

In particular, this work draws attention to a complicated, yet critical issue concerning the extension projects of local agricultural outreach organizations, including FADCANIC. My research reveals that the recently migrated farmers—who are most likely to engage in land use practices that are detrimental to the regional socio-ecological system—are the least likely to benefit from the development projects that are working to improve local natural resource management and agroecological sustainability. Instead, in an effort to promote regional autonomy, organizations like FADCANIC specifically target the indigenous and afro-descendant populations that are the legal grantees of autonomy. These indigenous and afro-descendant populations have historically maintained biodiverse agroforestry systems (Nietschmann 1973; Helms 1971; Coe 1997). In contrast, the migrant mestizo populations who focus on expansive cattle ranching are doing so on land to which they have no legal claim (Jamieson 1999; Beer and Vanegas 2007).

The problematic reality is that focusing extension activities on these recently migrated populations—who are not the intended beneficiaries of regional autonomy—may be the most effective strategy for preventing further degradation of the local ecology and promoting food security among some of the region's poorest populations (Jamieson 1999) while also assuaging regional tensions between indigenous and afro-descendant communities and the illegal land colonizers that are moving continually closer to the Basin's formal communities. My research indicated that farmers who identified as indigenous and/or afro-descendant tended to maintain more diverse farms than neighboring mestizo farmers. However, ethnic identity does not *determine* a farmer's land use practices. Notably, mestizo farmers who have relationships with FADCANIC and other development organizations are among farmers with the highest on-farm diversity in the region. Therefore, the inclusion of mestizo populations into projects aiming to promote more sustainable land use within the Basin is not a hopeless endeavor. While these migrant populations are not the intended beneficiaries of regional autonomy, they are fully invested in their lives in region, and better dealing with the populations is necessary to secure regional socio-ecological sustainability.

8.3.2 Demarcation and 'Cleaning Up' of Communal Lands

While the political tenability of policy shifts regarding who is targeted by assistance programs might be difficult, my research suggests that these crucial issues must be addressed. In this vein, local and region policy-makers also must confront the issues concerning land colonization brewing in the Pearl Lagoon Basin and regionally. Throughout the Atlantic Coast, tensions between the regions' more historical indigenous and afro-descendant populations and recently migrated mestizos (now the regional majority) are constantly growing. These tensions are a direct consequence of the land colonization that is associated with these migrant populations. However, while they may be illegally occupying land formally granted through the Autonomy Law (Law 28) to indigenous and afro-descendant communities, there is no clearly defined method of assimilating, managing, or extricating these 'illicit' populations.

The demarcation of lands throughout the Atlantic Region was initiated to remedy the nebulousness of community boundaries (or simply territorial boundaries in the case of the Pearl Lagoon Basin) so that local indigenous and afro-descendant[32] communities could more effectively control the land and its resources. Included within Law 445, which outline the communal property regime of the Atlantic Regions, is a loosely described "cleaning up" of communal lands. Following the titling of communities and territories throughout the region, those without communal right to "indigenous lands" or those belonging to another "ethnic community" are required to vacate their illicit land claim without any compensation (Law of Communal Property Regime of the Indigenous and Ethnic Communities of the Autonomous Regions of the Atlantic Coast of Nicaragua and the Rivers Bocay, Coco, Indio, and Maiz, Law no. 445, Art. 35-38 [2002]). However, there is no description within the Law 445 regarding *how* de-occupation would take place.

The migrant populations into the Atlantic region have invested time, energy, and money into the lands that they occupy. The ethnographic research that I conducted in the

[32] Afro-descendant communities are referred to as 'ethnic minority' communities within the Autonomy (Law 28) and Demarcation (Law 445) Laws.

region provided a host of examples in which land colonists made it clear to communities throughout the Basin that as a result of their investments they have no intention of peacefully abandoning their settlements. Community leaders from around the Pearl Lagoon Basin maintain hope that the national military will take responsibility for carrying out the removal of those illegally occupying territorial land. However, up until now there has been little tangible assistance from the central government in the 'cleaning up' processes. Further, anecdotes from local informants suggest that any attempts by the central government or military to intervene would result in violent confrontations.

My work shows that there is heterogeneity within the land use practices of the migrant mestizo population—as well as among members of the indigenous and afro-descendant communities. In particular, mestizo farmers that are involved with the agricultural development organizations working in the region tend to have small farms that are highly agrobiodiverse. Further, mestizo families who have assimilated into indigenous and afro-descendant communities—and as a result adopted land use practices in line with community norms—are not viewed as threats, but members of the community. Therefore, rather than undertaking the Sisyphean, and potentially violent task of evicting migrants who are often landless in the regions of Nicaragua from which they migrated, I encourage local policy makers to consider an alternative strategy.

For example, my research suggests that a system of land taxation imposed equally upon *all farmers* in the region might mitigate the negative impacts of expansive land use. Such a tax should only apply to farmers cultivating or ranching areas of land above an agreed upon threshold, such as the mean area currently being used by farmers within the Basin's indigenous and afro-descendant communities. Such a tax would increase exponentially per unit area that a farmer utilizes above the mean. The ultimate goal is to dissuade extensive land use in the region, regardless of the farmer's identity. Tax revenue could also support the extension of the efforts of FADCANIC and other organizations working to promote sustainable agriculture in the region to *all local resource users*.

8.4 Future Research

The results of my investigation of the socio-political factors and phenomenon that structure farmer land use decision-making in the Pearl Lagoon Basin, Nicaragua provoke research questions that go beyond the immediate scope of this project. In particular, this research connects the land use decisions of farmers in the Pearl Lagoon Basin to processes related to the increased connectedness of the region to extra-local political, economic, and social systems. Further, this work shows how agricultural biodiversity maintenance is associated with these land use decisions, thereby providing an assessment of the impacts of the region's increased connectedness on agrobiodiversity. Notably, residents of the region are characterized by diversified livelihood strategies that draw upon resources stored in both managed and unmanaged terrestrial systems, as well as from the aquatic system. It remains unknown how the increased connectedness of the region and the potential shifts in livelihood strategies that accompany loss of resource stability in one part of the socio-ecological system may impact resource dependence in another part of the system.

Additional process that impact biodiversity in different parts of the regional socio-ecological system are occurring in concurrence with the activities of organizations working with farmers in the region to promote agrobiodiversity conservation and sustainable agriculture, as well as the increased presence of migrant farmers clearing land in the hinterland around the lagoon. This includes the rapid and unprecedented decline of the fishery that makes up a key part of local subsistence strategies (Nietschmann 1973; Helms

1971; Stevens 2014) and rosewood logging deep in the forests of the Basin and abutting territories. These concomitant and associated changes are thus both positively and negatively affecting ecosystem valuation and use within this Biodiversity Hotspot. It is unknown how these impacts and feedbacks will impact biodiversity and ecosystem stability at a regional scale. Therefore, future research in the region should seek to link these interdependent changes in resource use, management, and valuation to determine how globalization processes are impacting biodiversity within this socio-ecological system across scales.

8.5 Conclusion

Ultimately, this dissertation research moves thinking forward regarding agrobiodiversity, land use decision-making, and complex feedbacks within socio-ecological systems. However, macro-level processes occurring in Nicaragua's Atlantic Regions call into question the importance of micro-politics and household-level resource use in the region. Specifically, the already-initiated construction of a trans-isthmus shipping canal will likely reshape life on the Atlantic Coast. The planned canal would compete with the Panama Canal, providing a larger path through which ships and cargo could move between the Caribbean and the Pacific Oceans. This combined effort of the Chinese government, Chinese and other foreign investors, and Nicaraguan national leaders has the potential to completely alter the social and ecological landscapes of the Atlantic Region, and the entire country, through the development of what is proposed to be the world's largest canal system (Anderson 2015).

While this project has direct implications for local people and the local ecology, the severity of the trans-isthmus canal impacts remain unknown. Yet, considering that the inception of this process involved the seizing land from the Autonomous Region and a disregard for thorough social and environmental impact assessments (Meyer and Huete-Pérez 2014), this development project exposes critical socio-ecological concerns that extend beyond those caused directly by the construction of the canal. This colossal ‘development’ project creates yet another test of the resilience of the people and ecology of the Atlantic Region.

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Appendix A

Agrobiodiversity Survey (English Version)

Date: ____ / ____ / ________
Surveyor Name: ___________________
Community: ______________________
Name of Farmer: _________________________

PART A: Farmer Information

1) Gender: **M / F**

2) Age: _____

3) How many years have you been farming? _________

4) Who farmed this land before you did? ________________________________

5) When did they begin farming this land? ___________

6) Which of the following terms describe you:

a. Mestizo **Yes / No**
b. Creole **Yes / No**
c. Miskitu **Yes / No**
d. Garífuna **Yes / No**
e. Costeño **Yes / No**
d. Other**:** ________________

7) Are you affiliated with the Black Farmers Cooperative, FADCANIC, INTA, NicaCaribe or another agricultural organization?

a. Yes / **No**

b. Which organizations? ____

8) Has anyone from the Nicaraguan government or an agricultural organization, such as FADCANIC, suggested that you grow any specific plants or crops?

a. Which organization(s)? ____

b. Which plants/crops? ____

c. Which of these are you currently growing? ____________________________

PART B: Agricultural Field/Garden Information

9) Total number of fields: ______

10) Do you have a garden around your house? ____________________

11) Area and age of field(s) and garden:

Field 1: size______ age ________
Field 2: size______ age ________
Field 3: size______ age ________
Home Garden: size______ age ________

12) How long (in minutes) does it take to get to your field(s)? _________________

13) Who else helps to take care of your field(s) and garden? _____________________

	Name of Plant	Abundance	Pre-War	Pre-Road	Notes
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	Name of Plant	Abundance	Pre-War	Pre-Road	Notes
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	Name of Plant	Abundance	Pre-War	Pre-Road	Notes
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Appendix B

Sample Interview Questions for Semi-Structured Interviews

Local history

- How have things changed since the road was built?
- Have new people come to the lagoon?
- Are there more or fewer jobs than there were before the road?
- Do you have to buy more or less than you did before the road?
- Are people selling more or less than they did before road?
- Is it easier or harder to sell things now, particularly agricultural products?
- Do you come to the farm more now than you did before the road?
- What about the Black Farmers' Cooperative? Are lots of people members of the co-op? What does it take to be a member?
- Do you work with another group, like FADCANIC?
- When did you start working with them?
- What sorts of plants do they bring you?

Land Use Decision-Making

- How did you get this farm?
- Did you buy it?
- Do you have cows? Why (not)?
- Do you separate your plants or mix them all up in one area? Why?
- Why do you plant [plant species x] in the same place as [plant species y]?
- Where did you learn how to farm like that?
- Did you farm with your parents?
- Does the farm look the same as when they had the farm?
- Do you burn?
- Where did you get [plant species x]?
- Do you sell the food that you grew? Where? To whom?
- Is farming an activity that men do or that women do? Both? Was it that way when you were a child?
- How do you decide what you want to grow each year?
- How do you decide where to grow your food?
- What does a good farm look like?
- How else do you make money? Do you also fish?
- Have you ever lived outside of the Basin?

Ethnicity

- Where are your parents from?
- Which of the following term do you think applies to you (and you can say more than one): Garífuna, Creole, Miskito, Mestizo/Spaniard?
- What makes you [Garífuna/Creole/Miskito/Mestizo/Spaniard]?
- Do you think that there is a difference in the ways in which Garífuna, Creole, Miskito, and Spaniards/Mestizos farm?
- Do you think that there is a difference in what Garífuna, Creole, Miskito, and Spaniards/Mestizos eat?

For NGO Administrators:

- How long has [x] program been working in the Basin?
- Who does the program work with?
- What are the project goals?
- What sorts of activities does the program have in the Basin?
- Who funds the project?
- How did your project get this funding or connect with this funder?
- How is success assessed?
- Does your project bring plants to farmers?
- Which plants?