Home Gardens, Cultivated Plant Diversity, and Exchange of Planting Material in The Pacaya-Samiria National Reserve Area, Northeastern Peruvian Amazon

By

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Abstract

Traditional peoples are often described as "stewards of agricultural diversity", yet little research has been conducted on the determinants of agrodiversity. This thesis focuses on agrodiversity and how peasant farmers build and maintain cultivated plant diversity in home gardens found in three distinct traditional communities along the Marañón river in the Peruvian Amazon – an upland mixed agricultural village, a lowland agricultural village, and a lowland fishing village. Data were gathered through household surveys (n=192) and in-depth interviews (n=112). Substantial variation in cultivated plant diversity was found among and within villages. Residents with the highest home garden agrodiversity tend to be among the wealthier households, and are more likely to have both established their own garden, and tended it for longer periods. Complex planting material exchange networks underlie the establishment and maintenance of home garden agrodiversity. The results underscore the importance of studying local variations in agricultural diversity, and exchange networks that bring agricultural planting stock to peasant farmers.

Résumé

Les peuple traditionnels sont souvent décrits comme "les hôtes de la diversité agricole", pourtant peu de recherches ont été meneés sur les tenants de l'agrodiversité. Cette thèse porte sur l'agrodiversité et sur la manière dont les fermiers-paysans établissent et maintiennent la diversité au sein de leur culture dans les jardins potagers, dans trois communautés traditionnelles distinctes de l'Amazonie péruvienne, le long de la rivière Marañón: un village agricole mixte d'altitude, un village agricole de vallée et un village de pêcheurs. Les données proviennent des sondages des foyers (n=192) et d'interviews poussées (n=112). Une variation significantive de la diversité des cultures a été trouvée entre villages et au sein d'un même village. Les habitants dont le potager a la plus grande diversité viennent généralement des foyers les plus riches et sont plus susceptibles d'avoir à la fois établi leur jardin eux-même et d'en avoir pris soin depuis plus longtemps. Des réseaux complexes d'échanges des plantes cultivables sont à l'origine de l'établissement et du maintien de l'agrodiversité des potagers. Les résultats ne confirment qu'insuffisament l'importance d'étudier les variations locales de la diversité agricole et les réseaux d'échanges qui fournissent l'ensamble des plantes agricoles aux fermiers-paysans.

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Chapter 1: Introduction

In recent years researchers have become increasingly aware of the threat of declining agricultural genetic resources. Since the beginning of this century about 75% of the genetic diversity of agricultural cultivated plants has been lost (Shand 1997:1), and cultivated plant genetic resources are disappearing at a rate of about 1-2 percent per annum (UNFAO 1993:3). Indeed, researchers and organizations fear that the genetic variation needed to sustain agricultural systems may be disappearing (FAO 1993). "What is at stake is nothing less than the biological basis for world food security," the Rural Advancement Foundation International (RAFI) warns (Shand 1997:1). Such concern has lead the international community to find ways to conserve the world's agricultural biodiversity.

Genetic resources for agriculture are unique for having evolved with human cultures. Agricultural products provide not only the food that nourishes people, but countless raw materials and services, such as fiber for clothing, material for shelter, transport, fertilizer, fuel and medicines. Plant germplasm – the genetic information encoded in the seed – is essential for cultivated plant production and improvement. Millions of farmers and forest dwellers, especially in tropical regions, are the primary innovators and stewards of this legacy (Norgaard 1984).

Agricultural diversity – also called "agrodiversity" and "cultivated plant diversity" – refers to the species and varieties of edible or useful plants in a specified area. Included are landraces and cultivars – geographically/ecologically distinctive populations which are diverse in their genetic composition both between and within populations – and high-yielding varieties, or commercially altered "Green Revoluation" crops.

Because of their rich biodiversity, tropical regions have received much attention in conservation and development. A growing body of research examines distinct cultivars, planting sequences, cultivated plant-fallow cycles, and cultivation practices of traditional farmers. Indigenous farming systems are found to provide subsistence and cash income, conserve soil, water and forest resources. Such systems are also considered to be socially appropriate because small land holders can and do employ them. Indeed, agricultural diversity provides indigenous peoples with a wider range of potential adaptive responses to environmental or market risk (Coomes and Burt 1997). For these reasons, indigenous agroforestry systems are being promoted as promising alternate models for rural development (Gómez-Pompa 1996).

Despite this interest and the importance of cultivated plant conservation, many gaps exist in our understanding of cultivated plant diversity and its traditional stewards. Indeed, surprisingly few studies examine local variation in cultivated plant diversity, or the dynamics of local cultivated plant diversity exchange systems. The research presented here is motivated by the need to gain a better understanding of the issues that underpin ongoing efforts to conserve cultivated plant germplasm.

1.1 Purpose and Objectives

In an effort to further cultivated plant conservation, this study seeks to enhance our understanding of agricultural diversity by examining sites of high local cultivated plant diversity, and the households that maintain them. The specific goals of this study are two-fold: (1) to understand variations in home garden cultivated plant diversity; and (2) to uncover the complexities of cultivated plant diversity origins, acquisition and exchange. Both goals should provide insights into aspects of cultivated plant diversity previously overlooked in the literature, and may shed new light on agricultural management in peasant societies.

The remainder of this chapter explores the extant literature on cultivated plant diversity and exchange. Chapter Two describes data collection methods, and the historical, socioeconomic, agricultural and biophysical characteristics of the study area. Chapter Three analyzes cultivated plant diversity in home gardens of the study area, and attempts to explain diversity variations within and between villages, providing both a quantitative and qualitative analysis of cultivated plant diversity in home gardens. Chapter Four extends this discussion by introducing planting material exchange as an integral element for cultivated plant diversity maintenance. Chapter Five concludes by providing a summary of relevant findings, discussing potential conservation and development implications, and identifying issues for future research.

1.2 Literature review

Home gardens

Cultivated plant production adjacent to human settlements is the oldest and most enduring form of cultivation, and tropical home gardens are found throughout the tropics (Wojtikowski 1993). A "home garden" – also known as "kitchen" or "backyard garden" – is an operational farm unit which most commonly integrates trees with cultivated plants and small domestic animals, thereby contributing to the household's subsistence needs by supplying vegetables, fruits, fodder, timber, medicines, and/or ornamentals (Balbin and Llapapasca Samariego 1996; Kumar et al. 1994). Occasionally home gardens also provide cash income or employment opportunities (Esquivel and Hammer 1992; Padoch and de Jong 1991). Indeed, home gardens have been referred to as "the most cost-effective, culturally and ecologically appropriate means of satisfying many of the commonly stated objectives of national development plans" (Clarke and Thaman 1993).

Four recurring themes emerge in the literature on home gardens. First, the most commonly mentioned feature of home garden systems is their high cultivated plant diversity (Alcorn 1992; Clarke and Thaman 1993; Gómez-Pompa 1996; Merrick 1992; Salafsky 1994; Suryanata 1994). As a consequence (or as a result?), home gardens are more intensively managed in comparison to other fields (Hiraoka 1986; Muñez-Miret et al. 1990; Salafsky 1994). High cultivated plant diversity may contribute to increased productivity and sustainability of these tropical systems (Alcorn 1992; Alvarez-Buylla Roces et al. 1989; Arnold 1987; Clarke and Thaman 1993; Kumar et al. 1994; Landauer and Brazil 1990; Nair 1991; Nair et al. 1995; Smith et al. 1995; Torquebiau 1992). Home gardens have been compared in structure, longevity, and function to natural forest ecosystems (Jose and Shanmugaratnam 1993), which again results from high cultivated plant diversity; monocropped and low diversity gardens have only one or two structural layers.

Second, home gardens are used for similar purposes throughout the tropical world. Non-staple utilitarian crops predominate, particularly fruit trees (Alcorn 1992; Anderson and Ioris 1992; Arnold 1987; Bergman 1980; Clarke and Thaman 1993; Marten 1992; Merrick 1992; Salafsky 1994). Unlike other fields, the role of the home garden in the family food supply is to supplement the diet with fruits and medicinal plants, rather than provide necessary staples. Many home gardens also serve as raising grounds for small domestic animals, most commonly chickens, ducks, dogs, pigs, and turkeys (Anderson and Ioris 1992; Gómez-Pompa 1996; Hiraoka 1986; Merrick 1992, Rugalema et al. 1994).

Third, home gardens are sites of experimentation, introduction and testing of new species and varieties of cultivated plants, both local and exotic (Alcorn 1992; Alvarez-Buylla Roces et al. 1989; Clarke and Thaman 1993; Johnson 1971; Smith 1996; Townsend et al. 1995). Both historically and presently home garden systems are sites of crop domestication (Gómez-Pompa 1996; Smith et al. 1996; Smith et al. 1995). Furthermore, home gardens are a reservoir of crop germplasm and endangered species (Alvarez-Buylla Roces et al. 1989; Clarke and Thaman 1993; Johnson 1971).

Finally, home gardens play an economic as well as subsistence/social role. Diverse or well-managed home gardens are a source of pride and a space for social activities (Clarke and Thaman 1993; Merrick 1992). Surplus produce – mostly fruit – of the home garden may be sold as a supplementary source of cash income (Caron 1995; Dury et al. 1996; Hills 1988; Padoch and de Jong 1991; Torquebiau 1992). Home gardens may also be an economic fallback in the eventuality that additional income is needed. In other words, a diverse home garden is a risk-minimizing strategy.

The high intra- and inter-diversity and historical persistence of home gardens has lead many authors to conclude that home gardens are sustainable agroforestry systems. Gómez-Pompa (1996) describes home gardens as "remarkable anthropogenic forests" that are a key component of the biodiversity conservation strategy used by many traditional cultures of the world. "It is also the site par excellence of crop diversity conservation" (Gómez-Pompa 1996: 350).

The picture painted in the literature about home gardens is bright and promising for future agricultural development in tropical regions. Initiatives promoting the adoption of home gardens by households are already being promoted. Despite such interest in home gardens, little attention has been devoted to examining differences in cultivated plant diversity within and among villages in tropical regions. Typically researchers investigate a sample of diverse gardens and limit their reports to descriptions of crop species encountered (Alcorn 1992).

The need to further understand this cultivated plant diversity is clear: if home gardens are to be further promoted as conservation and development initiatives, it is essential to understand patterns of diversity acquisition and maintenance, and the factors influencing home garden diversity.

Contemporary accounts

Much emphasis in recent articles is placed on the loss of cultivated plant diversity in species-rich agricultural communities. Contemporary observers recognize the importance of germplasm exchange among traditional peoples as an essential component in the maintenance of cultivated plant diversity. Exchange and transport of germplasm is a world-wide phenomenon with the continued introduction of new crops and improved varieties (Bellon 1996; Hugh-Jones 1992; Louette et al. 1997; Smith et al. 1996). The performance of seeds is a common subject of conversation among farmers; they closely examine neighbors' fields and may request seeds (Berg 1993). Farmers not only maintain a wide variety of landraces, but evaluate and improve their planting material, exchanging it with other farmers (de Boef et al. 1993; Kainer and Duryea 1992; Merrick 1992). In fact, a continuous flow and selection of seeds is necessary to maintain diversity and reduce risk in agricultural production (Day and Strauss 1993; Tapia and Rosas 1993). Because traditional farmers have selected and saved the best landraces over thousands of years, they conserve genetic diversity and encourage new genetic combinations and adaptations (Frisvold and Codon 1995; Keystone International Dialogue Series on Plant Genetic Resources 1991).

Cultivated plants are sometimes accidentally lost; the rarer a variety, the more likely it will be lost through weed competition, pest attack, or human neglect. This drain of varieties is countered by the influx of new varieties through exchange and nurture of volunteer seedlings (Boster 1984a; Boster 1984b). Even today plant genetic diversity is produced and reproduced through day-to-day activities of farmers (Kloppenburg and Kleinman 1987). Trade also has a diversity-enhancing influence (Oldfield and Alcorn 1991). Indeed, the introduction of previously unknown cultivated plant plants and the spread of weeds due to an increasing exchange of crop-seeds over long distances resulted in a change in species composition in the Amazonian floodplains and elsewhere (Junk 1989).

Exchanges take place not only for their utilitarian benefit; relations of exchange and reciprocity create cohesion within and between households (Benavides 1996). Exchange of manioc varieties in Aguaruna society has more social than economic importance. Close kin are more likely to exchange varieties than unrelated women (Boster 1986). Carneiro (1983) similarly notes that planting material is more commonly traded among relatives.

Planting material is not only required for maintaining high agrodiversity, but is also a necessity for the establishment of new fields. Farmers who routinely cultivate new land require substantial planting material for the initial planting phase. Planting a new average-sized manioc garden in the Amazon involves setting out some 14,000 cuttings (Carneiro 1983). Cuttings are often transplanted from adjacent producing gardens, but the required remainder are obtained from kin or friends (Clarke and Thaman 1993). Most seeds used in crop farming come from part of the previous harvest, selected and stored by the farmer; when that supply is lacking, it becomes necessary to obtain seeds elsewhere (Wiggins and Cromwell 1995). Farmers have developed networks and systems of ensuring a sustained supply of seeds (Worende and Mekbib 1993; Zandstra 1994).

Interest has arisen in traditional agroforestry systems in part because of their high cultivated plant diversity. Cleveland et al. (1994) hypothesize that the loss of genetic diversity within folk varieties may result from a reduction in size of plantings or limited farmer opportunities for selection, management, and exchange of folk varieties. Genetic erosion of traditional varieties in the Amazon is well advanced, in part due to the dramatic drip in aboriginal populations since contact with Europeans in the early 16th century (Smith and Schultes 1990).

Some researchers argue that the introduction of high-yielding varieties of crops will displace traditional varieties (Hawkes 1983). As local communities become increasingly assimilated into mainstream industrial society, traditional markets of kinship networks that served to distribute seeds may change in ways that make it difficult to find seeds of folk varieties. Given the continuing threat to the conservation and use of local varieties by indigenous and small-scale farmers, specific measures to safeguard these varieties for sustainable agriculture at the community level may be needed (Cleveland et al. 1994). Brush (1991), on the other hand, argues that on-site conservation of traditional landraces occurs even as the farming system changes and modern varieties are adopted. Diversity in traditional farming systems is both the source of innovation and the requisite insurance against crop failure (Eyzaguirre 1992).

While many authors recognize the importance of cultivated plant diversity and planting material exchange networks, few explore the issue in much detail. Cleveland et al. (1994: 747) state "there has been little research on indigenous seed supply networks or seed conservation". Recent interest in the use and conservation of landraces underscores the need to understand the social and cultural environments in which crop varieties are maintained (Longley and Richards 1993).

Cultivated Plant Diversity and Exchange in the Amazon

Traditional agroforestry in tropical environments is well known for high agricultural diversity (Nair 1991; Brookfield and Padoch 1994). This section provides an overview of published work – historical and contemporary – on cultivated plant diversity and exchange patterns in Amazonia. Indeed, many reports are found in the Amazonian ethnographic literature of the eagerness of indigenous people to increase their inventory of cultivated plants. Inter-tribal trade exchange networks in historical times point to active systems of exchange of planting material. The best evidence of indigenous people's interest in building agrodiversity is in their enthusiasm to acquire knowledge and planting material of exotic plants.

Three themes in the literature suggest the importance of planting material exchange networks in Amazonia. First, many authors describe indigenous trade networks – historical and contemporary – along which planting material may be traded. Second, several other indicators of the importance of cultivated plant planting material – e.g. social and cultural factor – are given within indigenous groups. Finally, outside influences – colonists, travelers, missionaries – are responsible for many introductions of plants. The following examination of Amazonian ethnographic literature provides some initial insights into the acquisition and maintenance of cultivated plant diversity, and suggest that exchange networks are indeed important to consider.

Indigenous trade networks

Evidence of potential paths of cultivated plant transfer and the search for agricultural diversity can be found in the extensive trade networks of historical times when indigenous groups and relations were intact. Contact was maintained among indigenous groups in order to exchange goods and plants, and/or for social reasons. Two types of exchanges take place among groups: ceremonial and non-ceremonial. Ceremonial exchanges of food are manifestations of relations among and within native groups (Kensinger et al. 1975), providing links among kinsmen (Gregor 1977; Seeger 1981). Ceremonial offerings of food may include both cooked and ready-to-eat meals, and uncooked foods and seeds – which may be used as cultivated plant planting material. Under conditions of relative abundance ceremonial offerings of food and other gifts between affiliated groups expand the range of reciprocal giving and taking (Hill 1993). Ethnographic studies undertaken in mid 1900s report the exchange of young men as another form of ceremonial exchanges to enhance inter-groups relations. Some western Achuara Jivaroans sent young boys to powerful Puyo Runa men known to be harboring revenge motives for killings in the previous generations. Such boys were reared as sons-in law and eventually married daughters of the Puyo Runa. They were encouraged to travel back in order to maintain connections with their own culture and language (Whitten 1976). Similar exchanges took place among the Mekranoti, but the young men did return home and transferred the knowledge acquired in the neighboring group (Verswijver 1996). Such ceremonial exchanges illustrate ties between indigenous groups which may provide the "paths" for the exchange of cultivated plant planting material. Indeed, ceremonial exchanges may have included planting material.

Non-ceremonial exchanges indicate the importance of trade networks. The best example of regional trade in the Amazon basin is that of salt during pre- and post-Columbian times. Indigenous peoples of the lowland Amazon basin have no sources of rock salt in their territories. Northern Andean peoples mined salt and exchanged it with central Andean people and neighboring lowland groups (Hill 1993). The network of indigenous trading partners stretched from the foot of the Andes in the west, to near Iquitos in the east, and from the Napo river in the north, to the Marañón river in the south. As late as the 1970s the network was still maintained. The most complex and intensive trade occurred in the isolated interior, where the native distribution systems remained uninterrupted by white traders or colonization (Harner 1972). Because contact was maintained with neighboring groups to obtain salt, other foodstuffs and goods were also exchanged (Brown and Fernández 1991). The Muisca people who live in the altiplano, for example, cultivate many tropical cultivated plants which were obtained by exchange with lowland groups (De Zubiria 1986). Hugh-Jones observed in the late 1970s that the Tukano still maintained their traditional exchanges with riverine Tukanoan groups, in which meat, curare, and labor are given in exchange for cultivated products (Hugh-Jones 1979).

Rapid post-contact spread of banana is an excellent example of plant exchange networks. Banana and plantain (*Musa spp.*) – with origins in southeastern Asia – were introduced to the New World shortly after contact, most likely in the Caribbean (Sauer 1948). During the second half of the 16th century, plantain was already widely distributed throughout the tropics of the New World. This species is a poor volunteer, and its spread must have been deliberate. Indeed, the plant was found in villages that had not been visited by Europeans (Lery 1927 [1578]). Evidence thus suggests extensive exchange networks, which enabled rapid dissemination of useful planting material such as banana and plantain.

It is not clear to what extent regional trade among groups is maintained today, given that most goods are available from urban centers. Reeve (1994) argues that the indigenous inter-group exchanges made possible by long-distance travel and trade in salt created a post-contact reformation of integration across the region, which remained intact until the mid-twentieth century, and perhaps fragments of which still exist today. Planting material is likely to be most conveniently obtained from family and neighbors within a small geographical region.

Very little direct information can be found in travelers accounts on the exchanges occurring within and between indigenous groups in pre-colonial and colonial times. De Acuña (1641) noted that Indians were repeatedly exposed to powerful floods which incurred a "great loss" to agricultural production. Nature provided the "barbarians" with an easy means of preserving their food, since manioc can be buried in the ground during the time of floods (de Acuña 1641). No mention is made how the indigenous peoples are able to retain all the other cultivated plants.

Other indigenous indicators of importance of planting material exchange

Even though all community members are to some extent involved in maintaining relations with other indigenous groups, evidence suggests that the acquisition of planting material is primarily the responsibility of women. Achuar and Amuesha women get aesthetic pleasure from a diverse garden; hence new plants are often immediately adopted (Descola 1994, Salick et al. 1997). For example, onion and citrus fruits – introduced by Europeans – are not desired for their taste, yet are grown in the gardens of Achuar women simply because they are rare (Descola 1994). Young Aguaruna women ask older kinswomen for cuttings of new varieties because older women have accumulated more gardening expertise (Brown 1985). The movement of new varieties of manioc among Aguaruna women ties into the regional trade network. Aguaruna of the Alto Mayo say that the Aguaruna of the Alto Marañón have better knowledge of magic, especially garden magic. In their contacts with kinswomen from tributaries of the Marañón, Alto Mayo women try to obtain new varieties of medicinal and food plants because they believe that the Marañón women's superior magic will inevitably produce better plants (Brown 1985).

Achuar women constantly requested anthropologist Philippe Descola to bring exotic plants so they could be cultivated (Descola 1994). The Amahuaca similarly have a keen appreciation of the exotic plants and beg new seed varieties (Huxley and Capa 1964). The Shipibo likewise ask about plants unfamiliar to them, and inquire about seeds or cuttings, and whether the plant will grow in their area (Bergman 1980). Even I was asked by peasants of the Peruvian Amazon whether I had any exotic planting material. Given the interest in plants, it is likely that the quest for new varieties and species existed in pre-contact times as well as today.

Trade value of exotic cultivated plants may also be a factor in adoption by indigenous people. The highland Yanomami do not like maize, and they reject beans, tomatoes, and squash as food. It was the possibility of barter that induced them to experiment with these new garden plants. Men accepted seeds originally as a novelty, and as long as the produce continues to have value in bartering they continue to replant. The only utility in these plants lies in their exchange value (Smole 1976).

Trade may be driven not only because of the need or desire for new goods and plants, but also for gaining prestige. Among the Apinayé a leader's prestige depends on his ability to take advantage of his relationships, translating distant links into close ones and making them effective. He can thereby maintain regular exchanges of foodstuffs (Da Matta 1982).

Exchange of cultivated plant planting material is sometimes restricted by secrecy which inhibits the spread of knowledge about who possesses what plants. Among the Aguaruna, some plants are cultivated secretly in order to protect the plant from theft or contamination, and because of the wish to keep ownership of the plant from public knowledge (Brown 1985).

European influences on planting material exchange

The most effective and least costly way for early Europeans settling in the Amazon region to acquire crops needed for consumption and farming was to either steal or barter them with indigenous people, either done directly by robbing crops from their fields (Hardenburg 1912), or indirectly through the debt-peonage system in which indigenous people were forced to buy European goods at exorbitant prices obliging them to continue trading with the Europeans (Orton 1870). Trade also occurred on more equal terms, with indigenous peoples supplying food in return for thread, needles, axes, hoes, knives etc. (Orton 1870). It is difficult to ascertain whether the food exchanged by indigenous peoples was meant for immediate consumption by Europeans, or whether it was in the form of planting material. One direct account of where Europeans obtained planting material was encountered. Waterton writes that "there is a large nursery attached to La Gabrielle [Guyana], where plants of all the different species are raised and distributed gratis to those colonists who wish to cultivate them" (Waterton 1879: 520).

Europeans often introduced new species and varieties of plants – directly or indirectly – into indigenous horticulture. Among the Araweté, many of the varieties of cotton, tobacco, sisal, papaya, banana, pineapple, calabash tree, soapberry, and annatto were introduced by FUNAI (Fundação Nacional do Indio, the Brazilian National Indian Foundation) employees or obtained from non-indigenous peasants, while some were traded with the neighboring Asuriní (de Castro 1992). Similarly among the Siriono, watermelon and rice were introduced by colonists. Two years after the introduction to one village, all Siriono were growing these crops, even some twenty miles east of the site of introduction (Holmberg 1969). Anthropologist Jean Jackson also introduced plants – melons, tomatoes, and green bell peppers – to a Tukano village. Both men and women became involved, examining their plots daily, and rejoicing when a few plants grew (Jackson 1983). The Desana Tukano believe that many plants grown by them were introduced only in recent times, even species of Amazonian origin. For example, the sweet potato is said to have been brought by the Uanano who received it from a mythical personage (Reichel-Dolmatoff 1971).

More is known about the smuggling of plant material to Europe and the rest of the world, the rubber seed being the classic example, but others exist as well. Competition was fierce at times for procuring control over the trade of certain plant species. Naturalist Richard Spruce was sent on an expedition by Her Majesty's Secretary of State for India to procure seeds and plants for the Red Bark tree (Spruce 1908b). In one incident a European in Latin America was asked for seeds of sarsaparilla by another foreigner who was to take them back to establish plantations – the seeds were given to him, but to ensure that they would not retain their vitality, they were boiled first (Spruce 1908a).

On several occasions missionaries are documented to have introduced crops to indigenous villages. The black bean was introduced by Brazil-based missionaries to the Yanomami communities in 1961 (Smole 1976). For the Achuar, missionaries make regular visits to communities in order to establish commercial exchange circuits (Descola 1994). It would have been of interest to missionaries to have indigenous groups adopt plants from home country so that food eaten in the Amazon could provide a small level of familiarity.

Conclusion

The literature review yields three conclusions. First, home gardens are the site of high agrodiversity, and therefore of importance to cultivated plant conservation. Second, crop genetic erosion is a growing problem that my have adverse consequences for world food production. Finally, evidence from the Amazon indicates that exchange of planting material is an important phenomenon for local peoples.

Chapter 2: Study Area and Approach

The majority of inhabitants in the Peruvian Amazon are peasant riverine people, or *ribereños*. Settlements of indigenous people are far outnumbered by the ribereño population (Hiraoka 1989). Ribereños are of mixed Amerindian and Iberian descent who pursue mostly traditional livelihoods: they provide for their own subsistence needs, with varying degrees of market interaction. Research conducted to date on resource use in Amazonia suggests that ribereños possess a rich knowledge of their surroundings and a wide range of techniques suitable for various local environments (Coomes 1996; Padoch and de Jong 1987; Padoch and de Jong 1991; Padoch 1988). The research presented here is based on field work conduced in three villages in the Peruvian Amazon in the vicinity of the Marañón river, south of Nauta and close to the mouth of the Tigre river (Figure 1).

2.1 Data collection methods

The specific objectives of the field work were to assess home garden cultivated plant diversity and planting material exchange patterns in the Peruvian Amazon region. Data for this study were gathered in three ribereño communities in the Pacaya Samiria National Reserve (PSNR) region during May-July, 1998. The villages were selected to capture the regional diversity in economic activity and location: an upland mixed agricultural community (San Regis), a lowland agricultural village (Nuevo Miraflores), and a lowland fishing community (Sucre) (Figure 1). The target population includes all peasant households who make a living from the land and/or the river; excluded were school teachers, police officials, priests, and health and other extension workers.

An on-going research project on local socio-economic and resource management by Barham and Coomes aided in selecting the case study villages, and provided baseline household and village demographic, land-use, and capital data to be built upon (Coomes et al. 1998). The field study was undertaken in two phases. Phase one included gaining familiarity with the general characteristics of the villages, getting to know the inhabitants, and interviewing participants. 'Overview' questionnaires (see Appendix 2) were administered by the author and her research assistant, Giorly Geovanni Machuca Espinar of the Universidad Nacional de la Amazonía Peruana. Household heads were asked to respond to questions from a semi-structured questionnaire on home garden cultivated

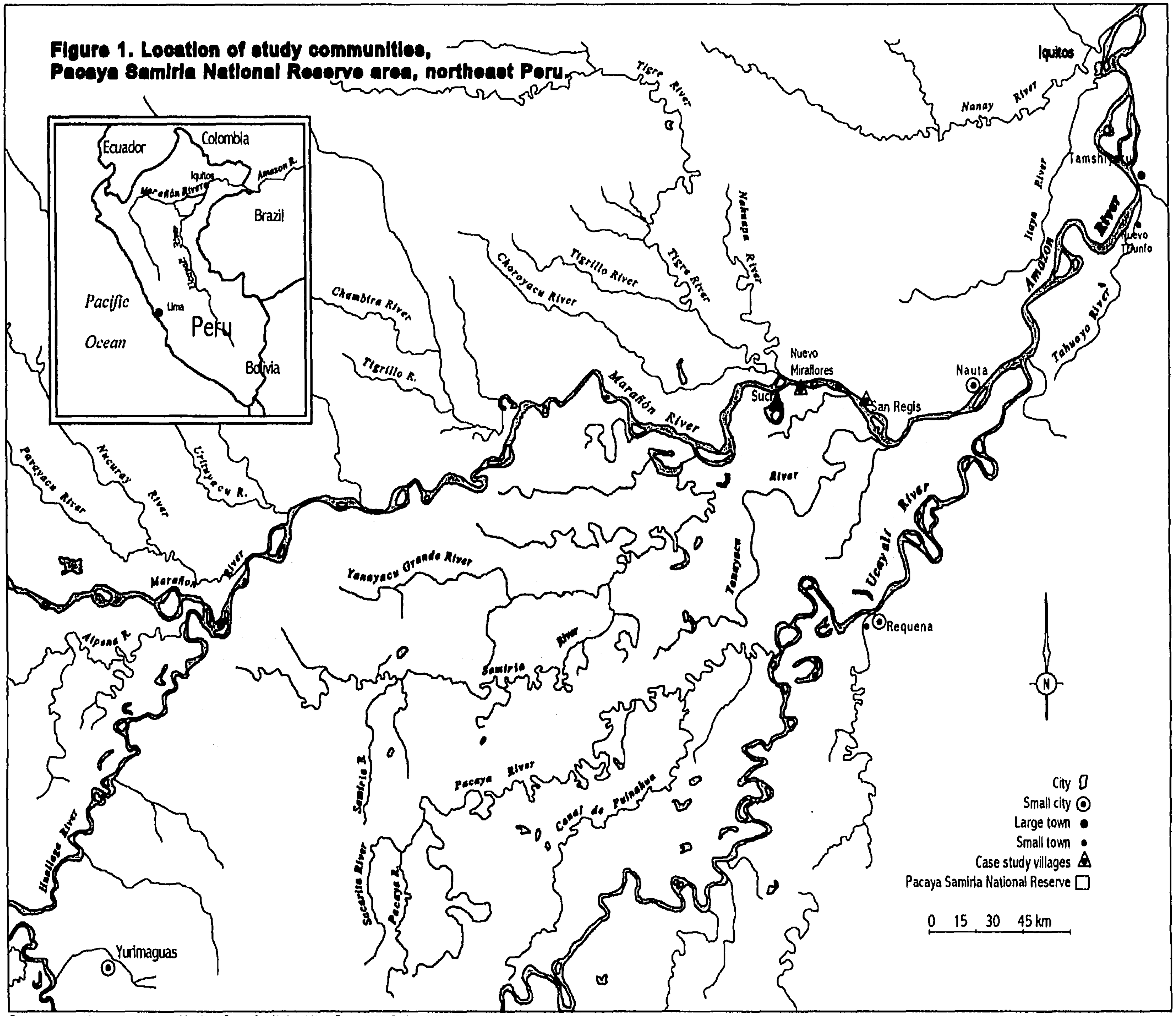

Figure 1. Location of study communities, Pacaya Samiria National Reserve area, northeast Peru.

Basemap source: Loreto. Impreso en el Instituto Geografico National Lima-Peru. 1989. Scale 1:1,600,000.

plant diversity, size, age, history, economic importance, and the household's primary subsistence activity. Participation in the study was voluntary. Representatives of all target households (n=192) were interviewed, capturing 100 percent of the population, and 92 percent of all households in the three villages. Each interview typically took 30 to 60 minutes to conduct. Home garden cultivated plant diversity was determined by asking the informant to show us the garden, identify every cultivated plant therein, and provide the vernacular name of the species and their uses. Only plants that were deemed useful by the participants were included in the diversity count; excluded are weeds and some wild plants. Useful plants, however, need not be domesticates; some semi-domesticates and wild plants that are tended (though not necessarily planted) in the garden are also included.

In-depth interviews were conducted in Phase Two with a subset of households (see Appendix 3). The selection criteria for households to be included in Phase Two differed somewhat from village to village. In Sucre and Nuevo Miraflores, all households with cultivated plants in their home gardens were interviewed (i.e., 77% of households in Sucre, 50% in Nuevo Miraflores). In San Regis, due to the large number of household and time constraints, a stratified random sample of households with home gardens was selected. Based on home garden cultivated plant diversity, households in San Regis were divided into quartiles. Most households in the upper quartile of home garden cultivated plant diversity were interviewed (87%) to capture the mechanisms of cultivated plant exchange for diverse gardens. Of the two middle quartiles, 69% of households were randomly selected for interviewing, compared to 50% in the lowest quartile. Thus a total of 112 households were selected for in-depth semi-structured interviews, which were carried out in June and July of 1998.

Interviews conducted in Phase Two focused on planting material exchange patterns for home gardens. Respondents were asked to identify where and from whom they had received each cultivated plant in their garden, who they had given planting material to, under what conditions, and if they have lost any plants from their garden (and why). In addition, information on demographic composition, landholdings, and capital assets of the participating households was gathered. In Sucre and Nuevo Miraflores, additional questions were asked about the household's experience during the exceptionally high flood of 1993-1994 to capture the exchange of planting material under extreme hydrological conditions. San Regis, located on the upland, was not severely affected by the flood.

Upon return from field work, the data were entered into a database and subsequently analyzed using the software package SPSS Version 8.0 (Chicago, IL, USA) and Microsoft Excel (Seattle, WA, USA). Techniques applied to the data are discussed in the relevant sections of the text. Physical capital wealth data were obtained from the aforementioned Barham and Coomes field investigation in the Pacaya-Samiria National Reserve (Takasaki et al. 1998). The data were updated to the household's physical wealth status based on questions asked during field research in 1998.

2.2 Biophysical environment

The study area lies in the low jungle (*selva baja*) of northeastern Peru. Air temperatures and humidity are typically high throughout the year, and the area receives between 2000 and 3000 mm/year of rainfall (Reading et al. 1995). Though only a few degrees south of the Equator, residents perceive two seasons: the rainy months of December through March known as winter, and summer, the somewhat drier months of July through October. The mean temperature is 26°C throughout the year. The rise and fall of the river is influenced more by the precipitation dynamics in the Andes than by local rainfall. The river begins to rise in February and crests by mid-May, subsiding gradually to reach the lowest point by early September. The change the river level may amount to as much as ten meters (Hiraoka 1985).

2.3 Agricultural practices

Five different types of agricultural terrain can be identified in the Pacaya Samiria National Reserve area: the upland (*terra firme*), which is elevated 15 to 30 meters above the river channel; the *restinga alta* or upper slopes of the natural levee (high levee) subject to only occasional seasonal flooding; the *bajeal*, on the levee backslope but not heavily silted; the *barreal*, or midflats along the river channel; and the *playa*, or sand bars and beaches. Year-round swidden fallow cultivation is practiced on the upland throughout most of the year on the high levee, depending on the severity of the flood. Annual inundation restricts the growing season on the low lands. On the other hand, nutrients deposited by the floodwaters on inundable agricultural lands allow sustained cultivation without rotation or fallowing (Hiraoka 1985).

Households practice three agricultural systems: upland agroforestry, lowland agroforestry on levees, and annual cropping on alluvia. Both upland and lowland swidden-fallow agroforestry system begins with the farmer slashing and burning a patch of rain forest, then cultivating the plot through a sequence of crop phases. In the upland the field is cultivated first as a swidden of short-cycle (1-3 years) subsistence crops. A transitional phase of fruit crops (2-6 years) follows, and then an orchard phase of later maturing fruit trees. At any point the farmer may let the field revert to a secondary forest fallow and begin the cycle anew. Farmers often have several fields in different phases to ensure a constant flow of subsistence and cash benefits (Coomes and Burt 1997).

The lowland agroforestry sequence depends on soil conditions each year after the floods. Plantain and manioc, as well as corn, beans, and watermelon may be cropped annually, and if necessary farmers leave the field as fallow where surviving plantain may be harvested. Mud flats are used intensively for commercial rice cropping. No plowing is required thanks to rich deposition of the turbid waters of the Amazon. Weeding and harvesting for upland and lowland agroforestry require significant time and labor, which, in addition to land are the main limiting factors for farming. No capital inputs such as fertilizer and equipment are used except for minimal pesticide and herbicide application on rice. Marketable surplus is sold to earn cash or exchanged for other products like fish (Takasaki et al. 1998).

2.4 Socioeconomic setting

Two of the villages – Nuevo Miraflores and Sucre – fall within the boundaries of the Pacaya-Samiria National Reserve (PSNR), which covers an area of 20,000km^2, representing the most extensive protected area in the country, and one of the world's richest regions of biodiversity. The reserve is a mosaic of perennially inundated forest, seasonally flooded lowland (*varzea*), dissected by numerous streams and creeks. Over 50,000 people reside in some 100 settlements around the reserve and rely on local resources to meet their subsistence and cash needs (Coomes et al. 1996; Padoch and de Jong 1992). Various organizations have sought to assist communities in the PSNR region to manage resources in a sustainable manner; these include the national government through the authority of the *Instituto Nacional de Recursos Naturales*, the World Wildlife Fund, and the *Fundación Peruana Para la Conservación de la Naturaleza (FPCN)*, funded by The Nature Conservancy and USAID/Peru since 1991. San Regis, the third village, is located on the left bank of the Marañón river and therefore falls outside of the boundaries of PSNR.

Important differences exist in the livelihood (i.e., resource scheduling) strategies of Amazonian lowland villages – such as Sucre and Nuevo Miraflores – versus those of the upland – like San Regis. Two distinct ribereño societies exist side-by-side, interacting with one another while influenced by their respective environments. In the case study villages, the two lowland communities depend on the rise and fall of the river for both fishing and agriculture. Rivers in the Amazon basin do not rise and fall in one continuous motion. Rather, the advent of the high and low water seasons are marked by frequent fluctuations in the water level. It is thus crucial for agricultural lowland villagers like Nuevo Miraflores to pick the right moment for planting lowland crops. If crops are planted too early, the river might rise again and carry away the planted seeds. The harvest season is similarly affected; if crops are left in the ground for too long, the rising river water may sweep them away. Villagers in Nuevo Miraflores reported frequent losses of crops due to fluctuating water levels. In upland communities, fluctuations in the river are also important if lowland fields exist, but do not threaten to destroy the season's crop.

Upland soils, including those of San Regis, are less fertile than lowland soils because of the much lower organic soil content and no regular flooding to provide new soil. However, the presence of upland fundamentally shapes the agricultural portfolio of forest peasant households because it provides two unique investment options: agroforestry and enhanced subsistence insurance (Barham et al. 1998a). If a full agroforestry cycle can be pursued, then returns from sale at the market can be lucrative. In San Regis the upland provides a location for subsistence cultivated plants that are not affected by flooding, a place to hedge risk against unfavorable high water episodes in the lowland. It can ensure food security even if a risky investment in the lowland or other activity fails.

2.5 Sample village characteristics

Household size

A total of 192 households is found in the three case study villages, the majority residing in San Regis (108 households), followed by Sucre (43), and Nuevo Miraflores (41). Residents live in independent households and all are economically poor by any standard. The average number of people per household is 6.3. Sucre has the lowest mean household size at 6.0, Nuevo Miraflores the highest at 7.1 (Table 1). The mean number of dependents per household is 3.2, the mean number of working age people per household being 2.9. Little variation can be seen in working age people and dependants between the villages. On average, the age of the male head of household was 45.8 years (the average age of the wife of the head of household being 40.4).

Land holdings

Legally all lands in the PSNR region are owned by the state, which considers local residents to be squatters. In practice, however, land is privately held, based on usufructuary rights. In this system land becomes a private field when it is cleared and cropped. As in other areas of the humid tropics, land tenure is unstable because communal reallocation can be enforced especially when land is not in use, neglected, or mismanaged and other residents or new-comers demand new fields.

Households differ significantly in terms of their land holdings in the case study villages. The average landholdings in the agricultural villages of San Regis (5.54 hectares) and Nuevo Miraflores (5.35 hectares) are similar, but land holdings in the fishing villages of Sucre are much smaller (1.43 hectares) (Table 1). San Regis has the most diversified landholdings, with all five types of terrain (upland, upper levee, lower levee, mudflats, and sand bars) represented. Villagers in Nuevo Miraflores have relatively high levels of access to both prime rice lands and levee tops, thus having several agricultural options available. Most households in Nuevo Miraflores (96%) have access to floodplain land. In the fishing village of Sucre, however, there is almost no *barreal* and hence very little rice production. Only upslope levee holdings exist, giving the villagers the most limited agricultural investment options. Of the communities, San

Table 1. Household, land holding, and capital holding characteristics of sample households, case study villages, northeastern Peru, 1998.

	San Regis			Sucre			Nuevo Miraflores		
	Mean	Std. Dev.	Range	Mean	Std. Dev.	Range	Mean	Std. Dev.	Range
Mean Household size	6.4	2.21	2-11	6	2.34	2-11	7.1	2.38	3-10
No. working-age members	3.1	1.25	1-6	2.6	0.93	2-5	2.12	0.35	2-3
No. of dependents	3.1	1.76	0-7	3.4	2.06	0-8	3	1.60	1-6
Age of head of households (yrs)	48.6	14.31	23-78	40.1	14.40	20-79	n.d.	n.d.	n.d.
Land Holdings (ha)	5.54	4.95	0-18	1.43	2.20	0-9.5	5.35	3.18	1.2-14.1
Average Capital Holdings (S/.)	1260	2401.5	0-16070	2712	4641.8	0-17450	1082	1524.2	0-5340
No. of Households	108			43			41		

Note: S/. = Nuevo Soles. 1 S/. = US$ 0.36 in 1998.

Regis stands alone in its extensive land availability. In Sucre, all low levee land is in production, while Nuevo Miraflores' land is used less intensively than Sucre (Barham et al. 1998a).

Not only is land distributed unequally between villages, but also within villages among households. Land inequality can be measured using the Gini coefficient, ranging from 0 denoting equal holdings to one when one household owns all of the land. Land inequality is lowest in Nuevo Miraflores at 0.64. San Regis has a gini of 0.72. Evidence in San Regis indicates that households in the lower tercile of land holdings have the same level of inequality as Nuevo Miraflores. The Gini is skewed by the few households with large landholdings. Only in Nuevo Miraflores do households in the bottom tercile of total land owned have comparable access to prime rice lands as do household in the upper tercile (Barham et al. 1998b).

Distribution of non-land wealth

Capital is also unequally distributed among households, both between and within villages. [1] The average capital holdings of San Regis, Sucre and Nuevo Miraflores are S/. (Nuevo Soles) 1423.1[2]. In Sucre, households have substantially larger holdings (S/. 2712), compared to San Regis (S/. 1260), and Nuevo Miraflores (S/. 1082). Sucre also has the highest single capital holdings by a household at S/. 17450, compared to a high of S/. 16970 in San Regis and only S/. 5340 in Nuevo Miraflores (Table 1). In all of the villages there is at least one household with capital holdings of zero.

Education

Although most villages in the Peruvian Amazon now have primary schools, access to secondary education is still limited. In the three villages, four percent of heads of household received no education, seventy-six percent had at least some primary

[1] Data on physical capital wealth were obtained from the Barham and Coomes' field investigation in the Pacaya-Samiria Nationional Reserve. The data were updated to the household's 1998 physical wealth status based on questions asked during field research. The physical capital wealth data gathered in 1996 from households using formal survey methods on the number of holdings they had of each capital item in the list and the value of these holdings. The valuation reported is thus subjective in that the participants were asked to value their own capital holdings at its market value. Such responses could be a source of measurement error, but they also allow the respondent to incorporate the current working condition of the asset into their valuation. The data is limited in that it considers only physical wealth, while excluding social capital due to the limitations and difficulties its assessment (Barham et al. 1998c).

education, whereas twenty percent received some secondary education. No one reported any post-secondary education. Substantial differences in education received are evident in the three villages. Sucre has more than five times as many heads of household with no education (9.5%) than San Regis (1.8%), and twice as many as Nuevo Miraflores (4.2%). However, Sucre leads the villages in heads of households having received some secondary education (28.6%), compared to percent in San Regis (21.5%), and Nuevo Miraflores (8.3%).

2.6 The villages:

Each village in the study area has remarkably distinct characteristics. To try to illustrate the unique character of each of the three villages, a short history of each follows[3]. Oral histories of the villages collected by the author and her research assistant are used to best capture local perceptions of important events in the villages, which in turn show the past and current struggles of meeting subsistence needs in the Amazon.

San Regis

San Regis, the largest and oldest of the three villages, is located on the left bank of the Marañón river, perched on the upland. It is one of the oldest settlements in the Peruvian Amazon. As with many Amazonian communities, its history is marked by European exploitation of the local population until well into the 20th century. Prior to becoming an official settlement, San Regis was an indigenous village, but it is not known which ethnic group originally inhabited the site. In 1720 a group of Jesuit priests traveled down from the Tigre river with the goal of evangelizing the local population. At the time the village was still growing with the arrival of Yamea indigenous people who apparently displaced the original indigenous group. In 1723, because of the evangelical activities, San Regis was officially founded. By 1745 there were some 1064 people living in what is now San Regis; then the Yamea settlement was struck by an epidemic, decimating the local population. It was also around this time that a priest – the most influential of priests of the upper reaches of the Napo river – settled in the village.

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[2] One Peruvian Nuevo Sol (S/) was equivalent to about US$ 0.36 at the time of interviews.
[3] The histories of the villages are based on Carlos Rengifo's and Doris Diaz's interviews with villagers (Rengifo and Diaz 1997), verified and supplemented by my own conversations with ribereños.

In 1830 Señor Anselmo del Aguila arrived in San Regis to work with the natives in the manufacture and sale of Panama hats. Del Aguila established himself as a powerful landlord, and the primary activity of the indigenous people became the manufacture of hats. The second landlord, Arturo del Aguila, crueler than the previous, forced the inhabitants to work even harder. In 1940-1945 Don Alipio Antunes inherited the estate, but not much changed regarding the treatment of the indigenous people. Now residents worked on making manioc flour, harvesting guava, and felling rosewood trees. Anyone attempting to sell any of the produce to travelers was punished. It was not until the 1970s that the estate was dissolved. The history of mistreatment of the people of San Regis has left a sense of skepticism towards strangers even today.

Today San Regis is larger and more developed than neighboring villages, but mixed agriculture and extraction is still the base of livelihood. Both a primary and secondary school as well as a medical post exist in the community. A generator provides electricity from 7pm to 9pm most days, and all night long for parties. Inhabitants of San Regis are peasant people, most of whom are either farmers or fishermen. A handful of villagers dedicate themselves to hunting, whereas others have established small stores that sell basic foodstuffs such as rice, sugar, salt, as well as some other articles such as basic medicines and clothing. Some women prepare meals to sell to the boats that stop in San Regis. Usually at least one boat per day -- sometimes two or three -- stop in San Regis, where they are welcomed by an avalanche of vendors who flock to the boat to sell local produce, including prepared meals of fish and plantain, sweets, and fruit.

Sucre

Sucre is a much younger settlement. Compared to San Regis, none of the villagers have inhabited the site for very long. Around 1940 people started settling on the islands of the lake to fish during the low-water season (summer). Typically people came from Yurimaguas, Iquitos, Tamshiyacu, Panguana, etc. (see Figure 1). There were two landlords at the time, dedicated to raising cattle, manufacturing sugarcane liquor, and buying and reselling the fish. In 1945 the people inhabiting the islands decided to organize themselves in the hopes of receiving a school of their own. Today there is only a primary school in Sucre.

Many of the people residing in Sucre today are not a part of the original settlers, but came from the state of San Martín. There are also many seasonal residents that migrate to the San Pablo Tipishca oxbow lake, where Sucre is located, because of the abundance of fish during the summer season.

The community is located in the lowland. Houses are built on stilts, and the land is flooded during the winter season. There is no land on the upland, nor any on the high levee. During the summer, crops such as watermelon, cucumber and tomatoes are abundant, but during the winter no land can be farmed because of inundation.

Fishing is the main activity of the majority of households; it is an activity segregated by gender: men fish, whereas women care for children, conduct agricultural activities, and tend the house. Fishing is done between sundown and sunrise, while the day is devoted to relaxation. Today as well as over the past couple of years, inhabitants of Sucre are living in a constant fear of losing their fishing privileges. Sucre falls within the Pacaya-Samiria National Reserve, and overexploitation of fisheries resources is becoming a serious problem, recognized by all of the fishermen. Overexploitation might in part be due to the seasonal migrants that flock to the area every summer. The only initiative to date to secure the fisheries has been the prohibition of freezer boats, which preserve the fish for sale at the market. Although thereby also decreasing their own potential profit, the lack of refrigeration discourages more fishermen to migrate to the area and extract fish.

Nuevo Miraflores

Nuevo Miraflores has been the most unfortunate of the three communities. It used to be located at a different site, then called Miraflores. One of the main activities between 1930 and 1960 was the sale of wood to steam ships traveling up or down the Marañón and Tigre rivers. Some of the villagers had settled on an island close to Miraflores. The inhabitants of the island organized a communal work party to build their own school. In the 1950s, the village fission in two, and some people then moved to another island, forming Nuevo Miraflores. In 1961 a primary school was built.

In 1965 a riverbank slump destroyed Nuevo Miraflores, forcing its relocation 100 meters down-river. In 1969 another such disaster occurred, and the village was moved down-river yet again. A third riverbank slump in 1972 destroyed more land, and people left for other villages. For those who remained, relocation was hampered by land tenure issues at the new site. These were not resolved for several years.

Nuevo Miraflores remains in the lowland; houses are located comparatively far apart, with almost 100m between most of the dwellings. Some houses are located in the inundable lowland, whereas others are perched on the high levee, setting them about 1m above the others, allowing a greater variety of vegetation and cultivated plants to grow. The village is very quiet and tranquil. As an agricultural village, daily routine consists of leaving for the fields early in the morning, working all day, and returning to the home late in the afternoon. Life is difficult during the winter (high water season) when basic staples cannot be grown; fish are scarce in the Marañón river and therefore do not provide a substantial portion of the daily diet or have to be brought from elsewhere.

Chapter 3: Cultivated plant diversity in home gardens

Home gardens are recognized as sites of high agricultural diversity. Typically, however, researchers examine only select "high diversity" home gardens, without taking into account those of middle and lower cultivated plant diversity. Indeed, many articles fail to specify the number of species encountered in individual home gardens, reporting instead the total number of cultivated plants (Alavalapati et al. 1995; Brierley 1966; Rugalema et al 1994; Salam et al. 1995). Those researchers that do cite species diversity in individual home gardens do so for only the most diverse gardens (Table 2). Clearly, home garden diversity needs to be examined more broadly – including the least as well as the most diverse gardens – before generalizations can be made regarding the overall home garden cultivated plant diversity.

To gain insight into the characteristics of home gardens in the case study villages, several aspects of the gardens and their owners will be examined. At the inta-village level, the following features are explored: (1) cultivated plant diversity; (2) percentage of households with home gardens; (3) delineation of home gardens; (4) ages of the gardens; (5) economic importance of home garden systems; (6) gender roles in home garden management; (7) cultivated plant composition; and, (8) the evolution of cultivated plant composition by age. At the inter-village level, the overall home garden cultivated plant diversity will be compared and discussed.

3.1 Intra-village home garden characteristics

The presented study focuses on analyzing patterns and variations of home garden agrodiversity in the case study villages. There is some precedent for such analysis. Coomes and Burt (1997) studied upland agroforestry systems to explain intra-field cultivated plant diversity, using independent variables to account for land, labor, and capital holdings. Such variables partially explained the average swidden cycle length, average fallow period, average cropping duration, and inter-field diversity, but no statistically significant relationships were found to explain cultivated plant diversity (Coomes and Burt 1997). The factors influencing intra-field cultivated plant diversity thus remained obscure.

Table 2. Comparison of tropical and sub-tropical home garden diversity in select studies.

Source	Most diverse garden's species diversity	Total no. of species	No. of home gardens examined	Location of study
Smith (1996)	25	77	33	Brazilian Amazon
Padoch and de Jong (1991)	74	168	21	Peruvian Amazon
Kumar et al. (1994)	39		17	Kerala, India
Balbin and Llapapasca Samaniego (1996)		87	28	Peruvian Amazon
Rico-Gray et al. (1990)		135	20	Yucatan, Mexico
Rico-Gray et al. (1990)		133	22	Yucatan, Mexico
Alvarez-Buylla Roces et al. (1989)		341	8	Southeast Mexico
Kimber (1966)	63	87	3	Martinique
Gómez-Pompa (1996)		339	52	Yucatan, Mexico
Coomes and Lerch (1998)	32	99	24	Peruvian Amazon
Lerch, presented study	42	136	112	Peruvian Amazon

Coomes and Lerch (1998) conducted field work in a case study village near Iquitos in the Peruvian Amazon, to explain intra-village home garden cultivated plant diversity variation. Results show that indeed there is much diversity variation within the village, and that land-wealthier households tend to have higher home garden cultivated plant diversity (Coomes and Lerch 1998). The present chapter further explores the variables contributing to cultivated plant diversity variations in home gardens of the three case study villages.

Most households in the case study villages possess a home gardens. Of the three villages, San Regis has the highest percentage of households with home gardens (86.2%), followed by Sucre (79.1%) and Nuevo Miraflores (50%). San Regis has the smallest home gardens (mean = $625m^2$), possibly due to pressures of urbanization on the community. Residents living on the bluff next to the river complain of reductions in home gardens size to accommodate a communal walk-way through the village.

Home gardens in the study villages are not very old – with a mean of less than 15 years – indicating that most gardens have been established in the past two decades. Even in the oldest village – San Regis – home gardens do not span more than two generations. Home gardens also vary in size, within as well as among villages (Table 3).

In Sucre, home gardens were less clearly defined spatially than in other communities. Most villagers possess only one cultivated plant field, located behind the dwelling. Some described the front portion (i.e., the part immediately adjacent to the house) as their home garden, even though the garden carries over to form their swidden field. Others claimed not to have a home garden, instead calling the field their *chacra* (swidden). The delineation of the home garden is thus defined by the perception of participants. The average home garden size in Sucre is $1543m^2$.

Because of the ecological characteristics of Nuevo Miraflores, a mere fifty percent of villagers own a home garden. About half of the households' dwellings are located in the seasonally flooded low levee; these households do not have home gardens. The other half of households live on the natural high levee; although it does occasionally flood, the water does not remain as long as in the low levee. Perennial crops can be grown in the high levee. The average size of home gardens in Nuevo Miraflores is $2500m^2$.

Table 3. Home garden characteristics in study villages, Pacaya Samiria National Reserve area, northeastern Peru, 1998.

		Age of home gardens (yrs)			Area of home gardens (m^2)		
	No. of gardens	Mean	s.d.	Range	Mean	s.d.	Range
San Regis	94	14.1	13.6	0-76	625.2	687.6	0-3600
Sucre	34	5.0	7.4	0-35	1543.1	2225.8	0-9000
Nuevo Miraflores	20	13.6	12.8	0-50	2500.0	2023.4	0-9000

Villagers in San Regis and Nuevo Miraflores have similarly aged home gardens, 14.1 years and 13.6 years respectively (Table 3). Even though San Regis is much older than Nuevo Miraflores, there is a high mobility among households, both within and between villages. Some home gardens are inherited, or passed on from one household to the next as people move. The oldest home garden in the sample is located in San Regis with an age of 76 years.

In Sucre, home gardens are much younger. Until five years ago, several households owned cattle that roamed freely through the village, destroying cultivated plants in unfenced gardens. Only two households reported having protected their home garden; the rest had not established home gardens. Five years ago the villagers decided to ban cattle ranching in favor of farming, an activity accessible to everyone. Thus home gardens in Sucre are young, with a mean age of five years. The oldest home garden is 35 years of age.

Home gardens also vary notably in their economic importance to households. Informants were asked to rank the economic importance of their home garden in relation to other household activities (0 = "no importance"; 1 = "little importance"; 2 = "average"; 3 = "a lot") (Table 4). The economic importance of home gardens is highest in the agricultural village Nuevo Miraflores, followed by Sucre and San Regis.

Women would appear to take on much of home garden management responsibility. In all three villages the majority of caretakers of the home garden were said to be both males and females. Only in San Regis were males more often depicted as managers of the garden. In Sucre and Nuevo Miraflores female garden managers dominated (Table 5). These results, however, should be viewed with some caution. For most interviews, both the male and female head of household were present, and most respondents claimed that both take care of the garden. When talking to women only, on the other hand, they most commonly – albeit hesitantly – stated that they are the caretaker of the home garden; by contrast, most men answered that both took care of the garden. Indeed, women often take on a submissive posture when speaking in the presence of men. Many are reluctant to admit even without the presence of their husbands during the interview that they alone have responsibility of the home garden. Those observed working in the home garden were also mainly women.

Table 4. Economic importance of home gardens, PSNR area, northeastern Peru, 1998 (%).

	"No"	"Little"	"Average"	"A lot"
San Regis	6	21	57	16
Sucre	20	5	24	51
Nuevo Miraflores	0	0	23	77

Table 5. Caretaker of home garden, PSNR area, northeastern Peru, 1998 (%).

	Male	Female	Both
San Regis	32	29	39
Sucre	9	35	56
Nuevo Miraflores	18	41	41

The mean number of cultivated plants encountered in home gardens for all three villages is 8.03, with small differences among villages (Table 6). The range of cultivated plant diversity is highest in Sucre, from zero to 42 cultivated plants; the home garden with the most diversity in San Regis follows with 38 cultivated plants, compared to 26 cultivated plants in Nuevo Miraflores. Home garden agrodiversity is normally distributed in the agricultural villages (Figures 2a and 2c); in the fishing village of Sucre agrodiversity is also distributed over a wide range (Figure 2b). Despite the low mean number of cultivated plant species found in home gardens, certain gardens did have high cultivated plant diversity.

San Regis has the highest total agrodiversity, with 108 species of cultivated plants represented in home gardens – compared to 69 in Nuevo Miraflores, and a mere 52 in Sucre (see Appendix 1). Indeed, San Regis has the highest diversity in all categories of cultivated plants (Figure 3), with the exception of more nutrient-demanding vegetables typically grown in fertile lowland soils. Nuevo Miraflores and Sucre thus have a higher representation of vegetables than San Regis. San Regis has the greatest cultivated plant diversity for three main reasons. First, being located on the upland, we find more perennial cultivated plants grow in San Regis. Second, a wider range of land types are farmed than in the other two villages, including upland agroforestry, lowland agroforestry, and annual cropping on alluvia. Exemplars of cultivated plants cultivated in these agricultural systems are encountered in home gardens. Third, San Regis is the largest and oldest of the communities, housing more people with different skills and tastes, contributing to a higher total cultivated plant diversity.

Home garden plants can be divided into seven categories, according to the primary use of plants: fruit, medicinals, vegetables, seasonings, ornamentals, construction plants, and other. Fruit species comprise more than fifty percent of the average species diversity in home gardens in San Regis and Nuevo Miraflores, and over 40 percent in Sucre. The figure is lower for Sucre because all land is seasonally flooded, and many perennial plants are unable to survive the flood season. San Regis, on the other hand, has two thirds of its agrodiversity in the form of fruit species (Figure 3). The fact that fruit species comprise the most frequent component of crop diversity confirms the thesis that

Table 6. Cultivated plant diversity (no. of species) in study communities, PSNR area, Peru, 1998.

	No. of gardens	Cultivated plant Diversity		
		Mean	s.d.	Range
San Regis	94	8.60	6.75	0-38
Sucre	34	8.00	7.64	0-42
Nuevo Miraflores	20	8.70	6.57	0-26

Figure 2a. Distribution of home garden agrodiversity, San Regis, 1998 (n=94).

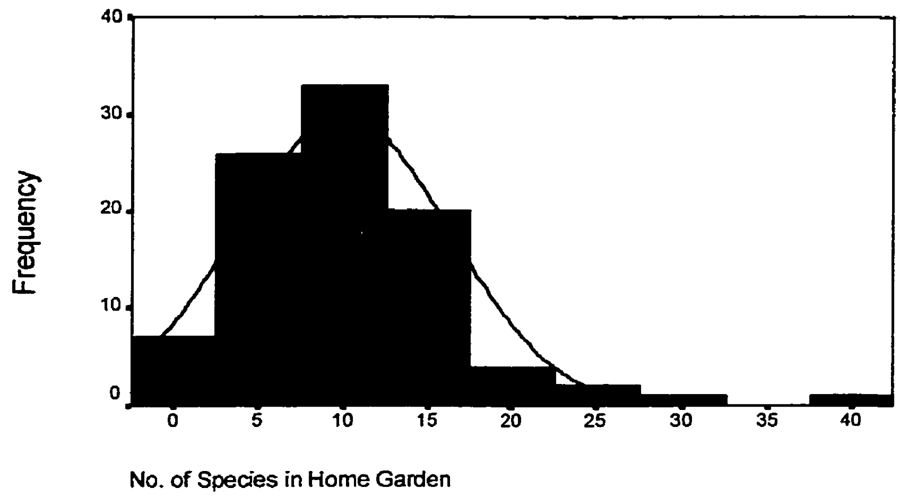


Figure 2b. Distribution of home garden agrodiversity, Sucre, 1998 (n=34).

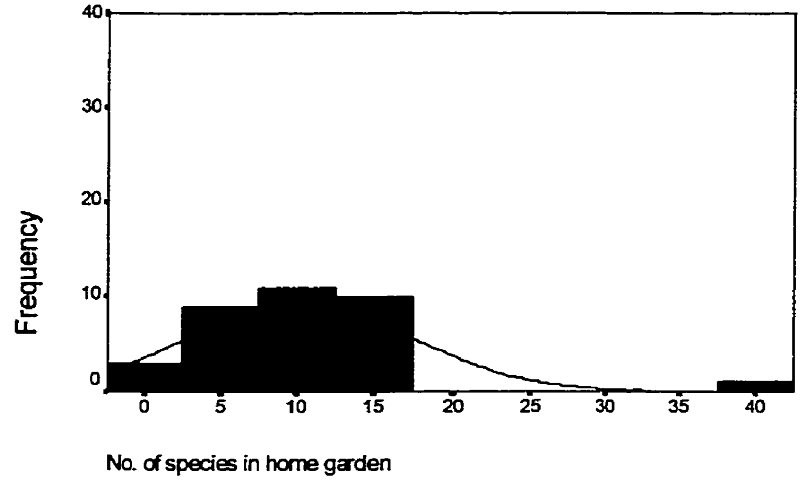


Figure 2c. Distribution of home garden agrodiversity, Nuevo Miraflores, 1998 (n=20).

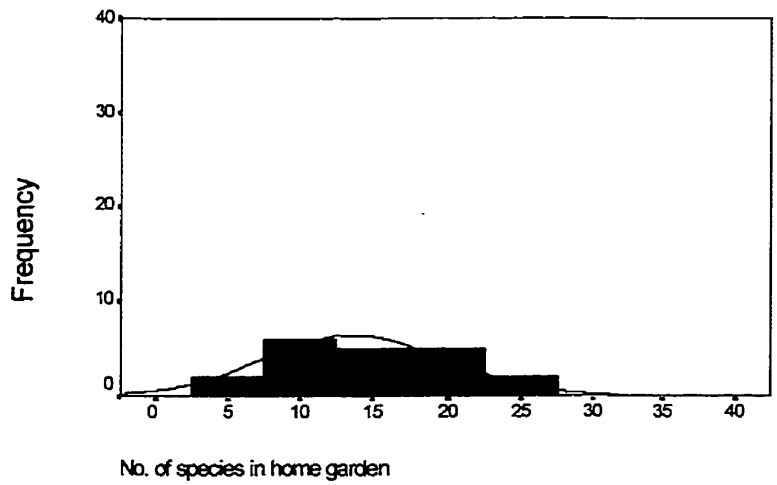
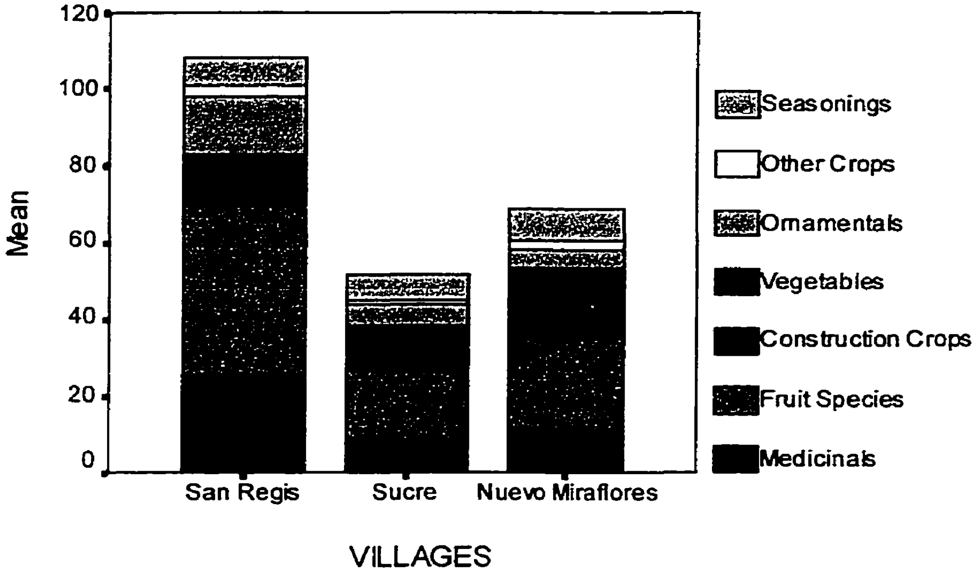


Figure 3. Home garden crop composition by villages, northeastern Peru, 1998.



one of the primary functions of home gardens is to supply supplement the diet, providing non-staple utilitarian cultivated plants.

In the upland village of San Regis, the second most common cultivated plants are medicinal plants, which are third in order of importance in the two lowland villages. Vegetables, which are primarily grown on lowland soils, follow fruit in frequency in Sucre and Nuevo Miraflores (Figure 3).

Home gardens contain most cultivated plants grown in the region, with the notable exception of staple crops. Occasionally plantain and manioc are encountered in a home garden, but most households plant staples only in their swidden fields. Field observations indicate

that home gardens may act also as sites of staple production in the early years of a household's residence in a village. Before swidden fields can be created, the home garden may be used as a temporary substitute to produce the essentials for survival. Once swidden fields are in production, staple crops all but disappear from home gardens. As agrodiversity increases in home gardens, most of the increase in diversity occurs with fruit species and medicinals (Figure 4). In other words, home gardens with higher cultivated plant diversity are likely to have more fruit and medicinals, but not significantly more cultivated plants in the other categories.

3.2 Home garden diversity: quantitative analyses

Our finding in the previous section that agrodiversity in home gardens is highly unevenly distributed begs several questions. Why do some people have more diverse garden than others? What are the characteristics of households with high versus low diversity gardens? What are some of the more qualitative aspects of home gardening? Such questions will be addressed in the remainder of this chapter.

To identify the factors leading to high or low home garden agrodiversity, regression analyses were undertaken at the household level for each of the villages. The independent variables for the regression model were chosen from a list of 21 variables for which data was collected during field work (Table 7). Eight independent variables were selected based on testing for final analysis: caretaker of the home garden, area of the home garden, number of years the household has tended the garden, non-extractive

Figure 4. Crop composition by home garden crop diversity quartiles, northeastern Peru, 1998.

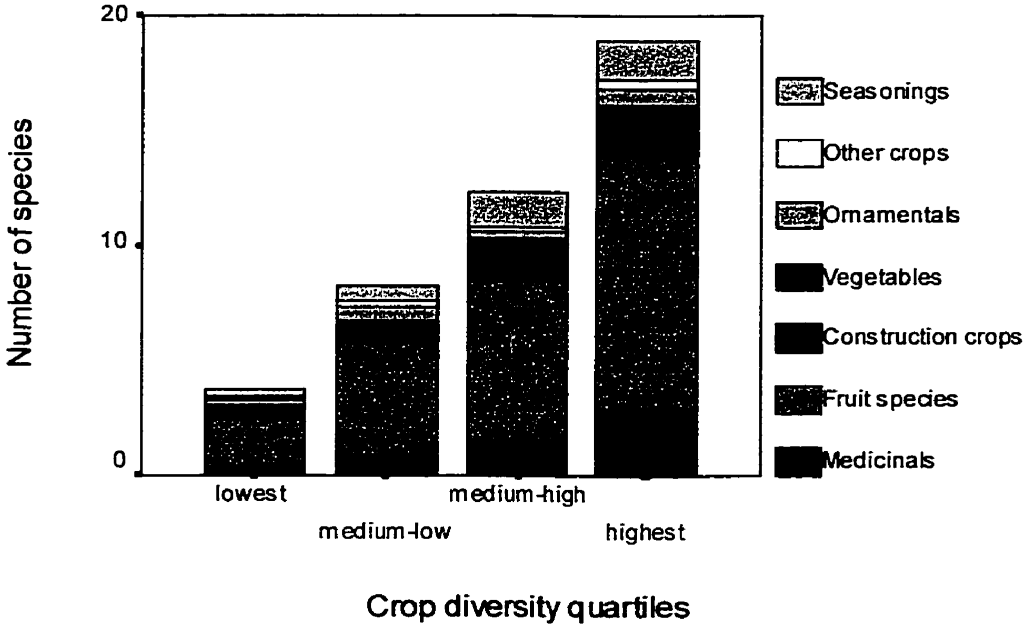


Table 7. Independent variables tested for in regression models predicting home garden cultivated plant diversity.

	Variable Name	Variable Description
Land	HALAND	Hectares of land owned
	HACULTIV	Hectares of land cultivated
Labor	NPEOPLE	No. of people in the household (NWORK+NCHILDRE)
	NWORK	No. of working-age people in household (15-65 yrs)
	NCHILDRE	No. of dependents in household (0-14 yrs + >65 yrs)
Wealth	PESCADO$	Capital value of fishing gear (e.g. nets, boats)
	EXTRACTI	Capital value of extractive assets (e.g., shotguns, chainsaws), includes PESCADO$
	NONEXTRA	Capital value of consumer durables (e.g., radio, sewing machine)
	NONLANDM	Capital value of non-land assets (PESCADO$+EXTRACTI+NONEXTRA)
	CAPITAL	Capital value calculation based on subjective value of each capital item revealed from respondents (NONLANDM+LIVESTOC)
	LIVESTOC	Livestock value is calculated multiplying quantities of livestock of each household by an average price of each animal (chicken: S/11, duck: S/8, turkey: S/9, pig: S/112.5, cattle: S/980, buffalo: S/3200).
Personal	ACTIVITY	Main subsistence and economic activity of household (1=agriculture, 2=fishing, 3=agriculture and fishing, 4=hunting, 5=raising animals, 6=small business, 7=small business and agriculture, 8=hunting and agriculture, 9=hunting, fishing and agriculture, 10=small business and fishing)
	AGEJEFE	Age of male head of household
	AGEMUJER	Age of female head of household
	EDUCATIO	Education of male head of household
Home garden	AREAHUERTO	Area of the home garden (m^2)
	AGEHUERTO	Age of home garden (yrs)
	CARETAKER	Principal manager of home garden (1=female, 2=male, 3=both)
	ECONIMPT	Economic importance of home garden (1=low, 2=medium, 3=high)
	NMALBA	Location of home garden in Nuevo Miraflores (1=low levee, 2=high levee)
	TENDED	No. of years household has tended the home garden
	ESTABLIS	Did household establish the home garden (1=no, 2=yes)

wealth of the household, extractive wealth, livestock capital, land cultivated, and number of people in the household. These variables were chosen to create a comprehensive model that includes variables for land, labor, and capital, as well as key garden characteristics. Home garden cultivated plant diversity – the number of species of cultivated plants – was the dependent variable.

Regression analyses yield statistically significant models for San Regis and Sucre, but not for Nuevo Miraflores (Table 8). For San Regis, three variables are significantly related to diversity: caretaker of the home garden, area of the garden, and non-extractive capital holdings, which explain a significant amount of variance ($R^2 = 0.327$). Households with female caretakers of the home garden in San Regis have higher agrodiversity; more non-extractive wealth is correlated with high diversity; and a larger garden predicts higher diversity. In Sucre, two different independent variables are statistically significant: number of years the household has tended the garden, and livestock capital ($R^2 = 0.836$). The more time spent tending the garden by the current household, the greater the diversity; more livestock is associated with less agrodiversity.

The general regression model underscores differences in explanatory factors by village. To explore diversity and its determinants further, a best-fitting model with three to four independent variables was developed for each of the three villages. Results of the regression model suggest that variables explaining cultivated plant diversity are village-specific. Whereas the general regression model aimed to be comprehensive, covering variables for land, labor and capital, and allowing for inter-village comparisons, the individual
regression models are intended to find the most influential variables for each of the villages.

San Regis

In San Regis, the dominant explanatory variable for home garden agrodiversity is the origin of the home garden; households that established their own home garden have greater home garden cultivated plant diversity (Table 9; Figure 5). The act of creating the garden may inspire the caretaker to devote more effort and time towards its maintenance. Establishing a home garden may symbolize the intent of the household to remain in the village for an extended period of time. Families taking over extant home gardens and

Table 8. Regression models to explain home garden cultivated plant diversity, PSNR area Peru, 1998.

	San Regis		Sucre		Nuevo Miraflores	
	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error
(Constant)	14.718	5.516	9.960	9.315	-6.707	7.294
Caretaker of home garden	-0.460	1.449 **	-0.003	1.387	0.068	1.327
Area of home garden (m^2)	0.404	0.001 **	0.122	0.001	-0.300	0.001
No. of people in household	0.095	0.740	0.049	0.665	(excluded, no data)	
Yrs household tended garden	0.210	0.123	0.797	0.160 **	1.143	0.187
Land cultivated (ha)	-0.297	0.724	-0.186	3.117	-0.332	0.560
Extractive capital	0.190	0.003	0.183	0.001	2.339	0.015
Livestock capital	0.328	0.006	-0.310	0.005 **	-2.522	0.024
Non-extractive capital	-0.206	0.001 *	-0.013	0.001	1.286	0.019
R^2	0.327		0.836		0.588	
Significance of model	0.026		0.003		0.285	

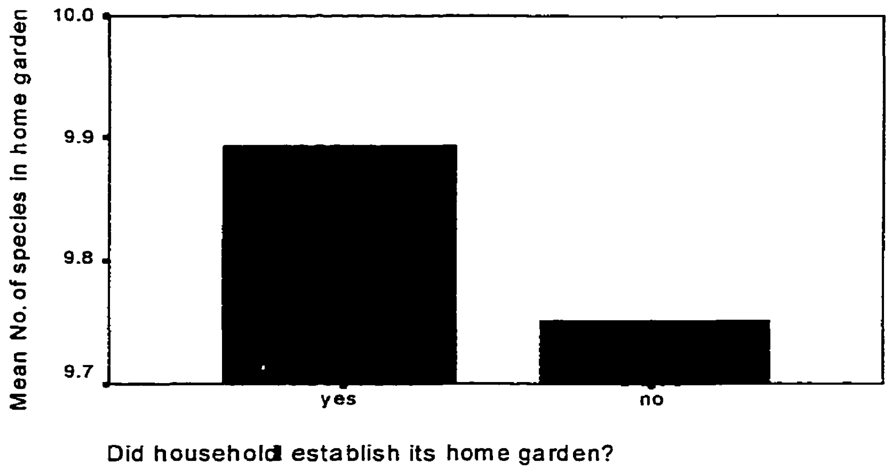
** $P \leq 0.05$; * $P \leq 0.10$

Table 9: Best regression models for home garden cultivated plant diversity San Regis, PSNR area, Peru, 1998.

	Coefficient	Standard Error
Constant	29.012	4.476
Caretaker of home garden	4.871	1.291 **
Non-extractive wealth	0.004	0.001 **
Did household establish home garden?	6.652	2.662 **
Adjusted R^2	0.460	
Significance of model	≤ 0.01	

** P ≤ 0.05

Figure 5. San Regis: Origins of home garden and agrodiversity, 1998.



dwellings are more likely to change residence. In other words, establishment of a home garden may be indicative of a more personal association with the garden.

The gender of the caretaker of the garden is also important in San Regis (Table 9; Figure 6). As was observed and described earlier, women do indeed play a more significant role in the management of home gardens. Households with higher agrodiversity have a much higher proportion of women managing the garden by themselves, whereas the lower cultivated plant diversity home garden quartiles have more men, and both men and women, taking care of the garden (Figure 6). A household with a diverse home garden is thus more likely to have a female taking care of the garden. Men may not have as much time to maintain the home garden, often being away on fishing and hunting trips, or gardening the swidden fields. When both men and women manage the home garden, perhaps neither one truly takes responsibility.

Wealth in consumer durables (i.e., non-extractive capital) also influences home garden cultivated plant diversity. In San Regis, non-extractive wealth (e.g., radio, sewing machine, etc.) comprises the largest proportion of non-land wealth holdings for the typical household. In other words, non-extractive wealth is an indicator of overall household wealth. Wealthier households are predicted to have higher agrodiversity. There are three possible explanations. First, wealthier households may invest more in planting material to maintain the home garden's agrodiversity. Second, wealthier households may be more ambitious than their counterparts, with – in the case of the home garden – the woman investing more time and energy in acquiring and maintaining cultivated plant diversity. Third, consumer durables are a sign of status in the village; perhaps a diverse home garden is also a status symbol, explaining the correlation of the two variables.

Taking the three statistically significant variable explaining home garden cultivated plant diversity into account, more than half of the variation in agrodiversity remains unexplained. The adjusted R^2 of San Regis' regression model is 0.460. Compared to the higher R^2 values Sucre, this result suggests that in a large village such as San Regis more variables contribute to intra-village variations in cultivated plant diversity.

Sucre

The story of home garden agrodiversity is distinct in Sucre. Much of the variation in home garden cultivated plant diversity is accounted for by a small number of

Figure 6. Home garden caretaking by gender, San Regis, Peru, 1998.

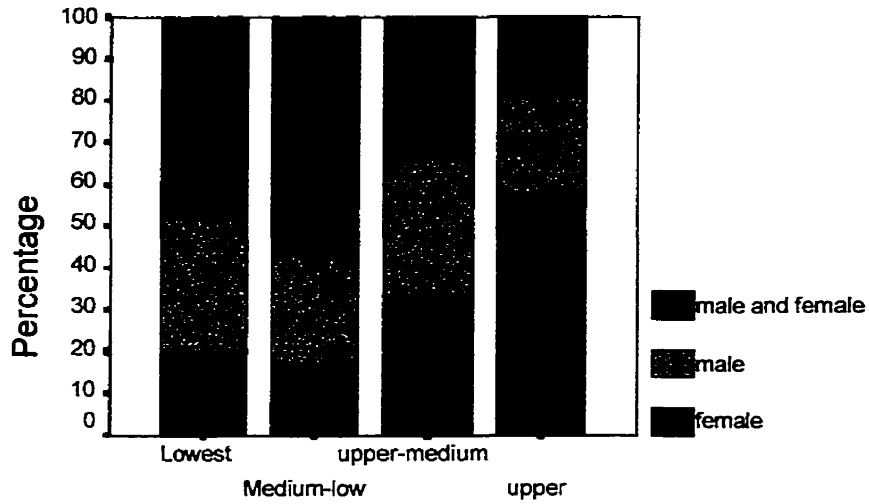


Table 10: Best regression models for home garden cultivated plant diversity Sucre, northeast Peru, 1998.

Sucre	**Coefficient**	**Standard Error**
Constant	14.042	1.400
Years household has tended home garden	1.052	0.070 ***
Livestock capital	-.252	0.004 **
Land cultivated	-.693	0.779 ***
Adjusted R^2	0.857	
Significance of model	≤ 0.01	

*** $P \leq 0.01$; **$P \leq 0.05$

independent variables in the regression model ($R^2 = 0.857$) (Table 10). The primary factor driving home garden agrodiversity in Sucre is the number of years the household has tended the home garden (Figure 7). In other words, households that protected and managed their home garden while cattle roamed freely through the village have more cultivated plant diversity even today. A stark difference is noticeable in cultivated plant diversity between households that established their home garden after cattle had been banned from the village, and those that protected their garden. Perhaps the willingness and availability of resources to build fences and keep cattle out of the garden is a sign of involvement and attachment to the garden. Thus today those households still actively maintain the agrodiversity in their home garden.

In contrast to San Regis, wealth is not a contributing factor to agrodiversity. In fact, households with less cultivated land (also a measure of wealth) have higher home garden agrodiversity. As a fishing village, most time is spend on lakes and rivers, less time devoted to gardening. Those that have more cultivated land available may not have time for the care and attention fields need. Those that have less cultivated land may cultivate it more intensively, and may also have more time to manage the home garden.

Similarly, households with more livestock have lower agrodiversity. Because cattle destroy cultivated plants, cultivated plants in home gardens of households without cattle have a much higher chance of survival. As the history of Sucre has shown, livestock can be detrimental to home gardens.

Nuevo Miraflores

A robust regression model was developed to predict home garden agrodiversity in Nuevo Miraflores (R^2=0.85) (Table 11). By far the most prominent of the independent variables is home garden location, whether the garden is located on the occasionally inundated upslope (high) levee, or frequently inundated low levee. Home gardens on the high levee have an average of fourteen cultivated plants, compared to only seven cultivated plants on the low levee (Figure 8). Indeed, few households on the low levee possess home gardens (n=3); those that do have a home garden are unable to grow many cultivated plants due to seasonal inundation.

The second variable driving home garden agrodiversity in Nuevo Miraflores is that of kin group membership. Households belonging to certain kin groups have higher

Figure 7. Years home garden has been tended, Sucre, 1998.

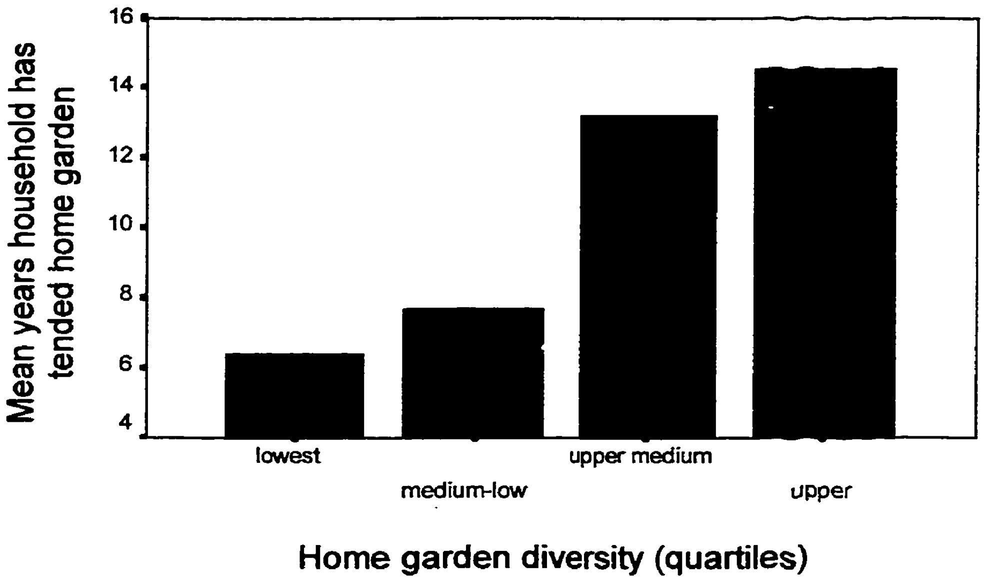
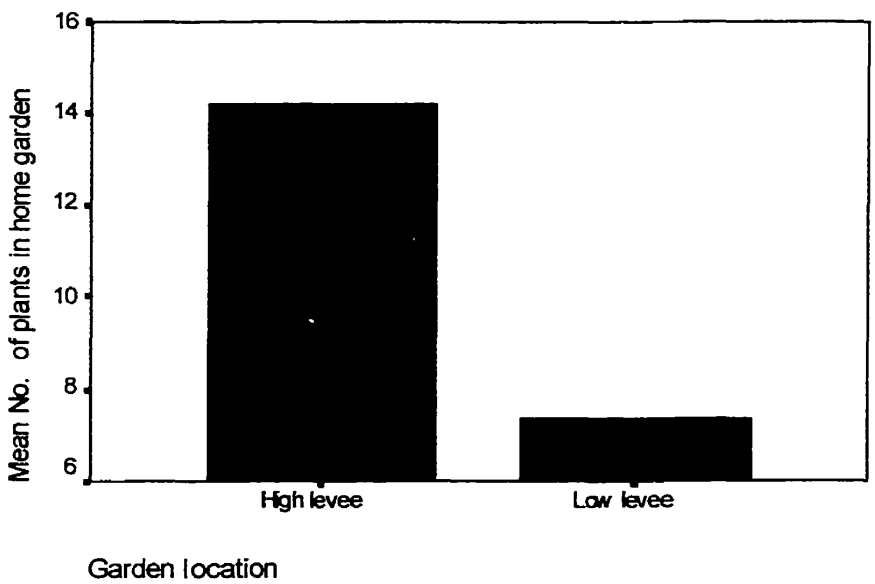


Table 11: Best regression model for home garden cultivated plant diversity Nuevo Miraflores, northeast Peru, 1998.

	Coefficient	Standard Error
Constant	23.716	3.343
Extractive capital	0.013	0.003 ***
Home garden location (high levee=1, low levee=2)	8.880	1.959 ***
Kin connection	-1.609	0.621 **
Adjusted R^2	0.850	
Significance of model	≤ 0.01	

*** $P \leq 0.01$; **$P \leq 0.05$

Figure 8. Average crop diversity of home gardens, High levee vs. low levee, Nuevo Miraflores, 1998.



agrodiversity than others (Figure 9). Three distinct kin groups inhabit Nuevo Miraflores[4]: the Rodriguez kin, living in both high levee and low levee; the Iruyari kin inhabiting the high levee, the Garcia kin of the low levee. In addition, six households to neither kin group. The Iruyari kin have the most home garden agrodiversity (Figure 9), whereas none of the Garcia kin members possess a home garden.

The original settlers of Nuevo Miraflores belonged to the Iruyari kin, who had access to and built upon the most secure village lands, the high levee. The Rodriguez kin arrived next, when some high levee land was still available. Newer arrivals, however, had to locate in the low levee. In other words, households on the high levee were the first arrivals to the village, and consequently have inhabited the village for the longest period of time.

Extractive capital is another statistically significant independent variables in the regression model explaining home garden agrodiversity. Once again wealth is a contributing factor to home garden cultivated plant diversity. Because the economic importance of home gardens was not found to be significant, the argument cannot be reversed to imply that high agrodiversity leads to more wealth.

3.3 Discussion of regression results

In all three villages a variable for wealth enters significantly into the equation (i.e., extractive capital, non-extractive wealth, and livestock capital). For the agricultural villages the relationship is positive: more wealth is related to greater agrodiversity in the home garden. In contrast, the trend is negative in the fishing village; less livestock capital and less cultivated land, greater cultivated plant diversity.

In San Regis, households that established their own garden tend to have higher cultivated plant diversity. Households that did not establish their garden may have inherited it from previous generations (in which case it seems more likely for cultivated plant diversity to be higher because the garden is older and different tastes of people will have contributed to greater cultivated plant diversity), or the garden has been passed on

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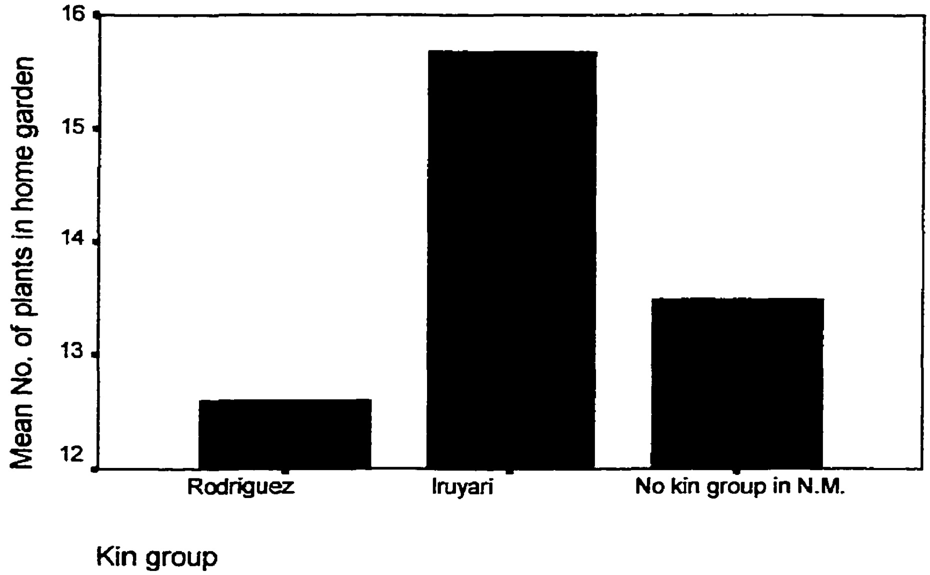
[4]To protect the anonymity of respondents, pseudonyms are used.

Figure 9. Kin groups and home garden crop diversity, Nuevo Miraflores, 1998.



from families who had lived there previously. Indeed, inter and intra-village mobility is high in the region (Coomes et al. 1998). Mobile families are less likely to spend much time augmenting home garden cultivated plant diversity, their preoccupation lying in cultivated plant production for subsistence. Perhaps more sedentary households seek to build up home garden cultivated plant diversity.

Another possible explanation is that, when families move, home gardens lie abandoned until the next owner arrives. Meanwhile the garden is susceptible to raids from other villagers, some of whom openly admit to stealing plants. If the garden lies abandoned even for brief periods, secondary forest succession plants will rapidly invade. Further research is needed to determine with greater confidence the actual story behind the establishment of home gardens.

In Sucre, the most important factor influencing home garden agrodiversity is the number of years the household has tended the garden. Indeed, households protecting their home garden from roaming cattle prior to cattle-raising restrictions maintain higher home garden agrodiversity than those that have recently established their garden.

Nuevo Miraflores has yet another home garden agrodiversity dynamic: location (high levee *vs.* low levee) clearly influences home garden agrodiversity. Being the first kin group to settle on the village lands, households of the Iruyari kin group had access to the most secure and highest lands, better suited for home gardening than the low levee. In addition, members of one kin group have greater cultivated plant diversity than others, perhaps because of better networks of planting material acquisition and exchange.

In conclusion, results of the regression analysis suggest that three factors are important: location, household wealth and time. Household wealth and home garden agrodiversity are positively correlated in agricultural villages. In the fishing village, however, this trend reversed, with poorer households having more cultivated plant diversity. Home garden cultivated plant diversity may well be a form of supplemental cultivated plant production for fishing households that otherwise have fewer resources. Households in San Regis that have established their own gardens – and in the fishing village that have tended them for a longer period – are predicted to have higher cultivated plant diversity. Thus households that have had more time and motivation to build up cultivated plants will have higher overall diversity.

3.4 Home garden life-stories

Whereas the quantitative analysis of cultivated plant diversity is useful in characterizing households with high and low cultivated plant diversity, the qualitative side can shed helpful insights into the experience of gardening, the struggle to make ends meet, and the benefits reaped from high cultivated plant diversity. Three examples of home gardeners are presented: (1) an "expert" farmer with high cultivated plant diversity; (2) a farmer losing the struggle against the forces of nature on his garden; and (3) the case of a more "typical" home garden owner.

"Expert" farmer

Whereas in two of the study villages cultivated plant diversity is normally distributed across households, the village of Sucre is set apart (see Figure 3). In this village there is one household with exceptionally high cultivated plant diversity (n=42), while the second most diverse garden has only 17 species of cultivated plants represented. In the other two villages, home garden cultivated plant diversity is much more normally distributed (see Figures 2 and 4). An in-depth interview was conducted with the farmer in Sucre to provide information on how the household differs from others in the village.

Señora Maria[5] is the caretaker of the home garden with the highest cultivated plant diversity in Sucre. She is 47 years old, married to a fisherman, has four children, and together with her husband owns and operates a small store (*bodega*). By local standards the family is wealthy, with capital holdings of S/. 12 542, compared to the village average of S/. 2712. Household members have lived in the village their entire lives, but the home garden, of average size, was not established until five years ago when cattle raising in public spaces was banned. Thus the high cultivated plant diversity in the home garden is even more fascinating given that it was accumulated in only five years.

Señora Maria is what might be called a "master" or "expert" farmer. Such farmers are observed in the study area and elsewhere in the Peruvian Amazon (Coomes, pers. comm. 1998). Although all subsistence farmers are essentially competent, many are quite indifferent to farming. An expert farmer, on the other hand, is a person with an exceptional love for farming, and a much higher than average cultivated plant diversity --

[5] Again, pseudonyms are used.

and perhaps also complexity -- in the gardens. When Señora Maria was asked why she had the number of cultivated plants that she does, her reply was "for the love of plants and gardening".

Señora Maria has gained important social benefits by being the main supplier of cultivated plant diversity for the village. By taking on this specific role in the village, she has created a social niche for herself, and thereby higher status than would otherwise be held. In addition, she may also benefit from future economic returns from a diverse home garden.

As is the case with señora Maria, expert farmers can also be an inspiration to fellow villagers as well as a source of planting material, thereby allowing others to increase their home garden agrodiversity, perhaps also improving nutrition by increasing the variety of cultivated plants consumed. Home gardening in Sucre is not an easy task, as all land is subject to seasonal flooding, and only very few cultivated plants are sufficiently resistant to survive the flood. Señora Maria is an inspiration to many villagers who established home gardens after roaming cattle were restricted to enclosed areas.

Not all villages have such an "expert". San Regis, for example, has several households with high cultivated plant diversity in the home gardens, but none that equals the magnitude and influence of Señora Maria. In the literature, shamans and women are often hailed as keepers of cultivated plant diversity. Among the Aguaruna people, for example, older kinswomen tend to have accumulated the most gardening expertise and cultivated plant diversity (Descola 1994, Brown 1985). It is not known what makes somebody an expert farmer, other than the love for plants and gardening; perhaps that is sufficient.

A losing struggle

Señor Ernesto of San Regis has not been nearly as fortunate as Señora Maria in his attempt to develop his home garden. Indeed, his home garden is an example of many of the problems that may arise in home gardening. Señor Ernesto is the head of the household, residing in a house inherited from his parents with his wife and five children. They face the common trade-off of raising livestock (pigs in this case) in their home garden. Pigs ravage the garden, consuming any edible plant within reach. The cultivated plants in this household's home garden have therefore been reduced to scattered fruit trees, which are too old and therefore too tall to be damaged by the pigs. After several attempts to increase the cultivated plant diversity in the garden, Señor Ernesto gave up.

In addition to the destruction of cultivated plants by pigs, Señor Ernesto's garden is also located in a small valley with poor drainage. Frequently with rain the garden is transformed into mud, becoming useless for most cultivated plant production. With high soil moisture his surviving plants are attacked by fungus, slowly killing the plants. Despite his initial struggle to maintain some cultivated plant diversity in the garden, Señor Ernesto has given in to the forces of nature. He no longer tries to maintain his home garden agrodiversity, instead letting the pigs reign over the garden.

Everyday concerns

Señora Elena of Nuevo Miraflores has what can be considered a "typical" home garden with ten cultivated plant species present. Taking care of a household with six children and two adults, her husband and Elena spend much of their time in the family's swidden field where they raise short cycle cultivated plants – a thirty minute walk from their house – to meet the family's subsistence needs. Although the home garden is located next to the house, Elena finds little time to work the garden. Upon returning from the field, dinner needs to be prepared, and little work can be done in the garden after dark.

Without constant weeding and tending, plants in the home garden are frequently attacked by pests. Beyond the garden is secondary growth rain forest, giving easy access to the home garden to rodents and deer, which find fruit particularly tasty. Leaf cutter ants (*curihuinsi*) swarm the home garden periodically, destroying many of the smaller cultivated plants. In addition, the manioc plants are subject to attacks by larvae, which eat the leaves, and banana trees frequently become infested by fungus.

Cultivated plant diversity in the home garden is maintained only by Señora Elena's effort of acquiring new planting material to replace the damaged cultivated plants. Without such effort the home garden would gradually be lost.

3.5 Summary and conclusion of home garden agrodiversity findings

Many of the home garden characteristics described in the literature are confirmed in this study, while the overview and analysis of cultivated plant diversity indicates that there are characteristics and trends not commonly reported. There are six primary findings to summarize. First, the average home garden cultivated plant diversity in study villages is eight cultivated plant species, much less than exuberant claims found in the literature. Home gardens may still be more diverse than swidden fields, but less diverse than previously thought.

Second, a wide range of variation in home garden agrodiversity exists in the gardens studied. Home gardens contained as many as 42 cultivated plant species, but some contained none. It cannot be assumed that home gardens are inherently diverse.

Third, home gardens are the domain of women more so than men. Women are more actively involved in the management and maintenance of home gardens. Although women are more active in home gardening, home gardens are not necessarily the sole responsibility of women.

Fourth, the majority of cultivated plant diversity increase occurs within the cultivated plant category of fruit, and to a lesser extent medicinals; the other categories vary little. More diverse home gardens possess more fruit species and medicinals, but seasonings, ornamentals, vegetables and construction cultivated plants do not vary much.

Fifth, the upland village in the sample had a much greater total cultivated plant diversity – 108 species of cultivated plants – than the lowland villages. Although some vegetable and fruit cultivated plants are adapted to lowland environments, the upland can harbor many perennial species that cannot withstand the seasonal floods in the lowland, resulting in a higher total species diversity in the upland.

Sixth, each village has its own the determinants of home garden cultivated plant diversity. In the case of the agricultural villages, wealth and the caretaker of the garden are most important, whereas in the fishing village time and lack of livestock matter most.

Chapter 4: House Gardens and the Exchange of Planting Material

The flow of cultivated plant planting material in peasant societies remains poorly understood and scarcely documented. The previous chapter discussed home garden agrodiversity and differences between households with high versus low cultivated plant diversity in three peasant communities in the Peruvian Amazon. The findings of significant differences in cultivated plant diversity raise the question of how agrodiversity was built up in households' home gardens. Specifically, what are the mechanisms involved in building and maintaining that diversity? The goal of this chapter is to provide a qualitative account of the patterns of planting stock exchange in the case study villages, based on interviews conducted with farmers. Three key questions will be addressed. Where does cultivated plant material originate? Who undertakes the majority of exchanges? What are the terms of trade in planting stock exchange?

In this study, forms of planting material include seeds (e.g., cucumber, tomato, watermelon), as well as fruit from which the seeds may be used as planting material (e.g., mango, oranges, caimito, etc.). Alternatively, seedlings from such plants may also be exchanged and used as planting stock. The other form of planting material in the study area is vegetatively propagated plants. These include tubers and cuttings of manioc, *mallequis* or suckers of plantain and pineapple.

Information on cultivated plant planting stock exchange networks was obtained by asking informants to specify the origins of planting material from their home garden cultivated plants, and whether cuttings or seeds had been passed on. Although most farmers have a vivid recollection of the origin of every plant in their garden, some did not always (or chose not to) remember who had given planting material to them. For example, frequent responses regarding the origin of a plant were that the material was received from “friends”, “family”, or “neighbors”. Seldom did people specify a name or more specific relationship to the person. Thus it will not be possible to document the exact course of flow of planting material; rather, only general patterns of flow can be identified. General categories are employed to facilitate the analysis of informants' answers. Some households did give precise paths of exchange from which more information about kin relations in exchange is extracted.

Two possible reason exist for the hesitant nature of informants' responses when asked to elaborate on their planting material exchange networks. First, the secretive nature of planting material transactions toward outsiders may be an indication of the importance thereof. By refusing to disclose planting material exchange networks, the informant ensures that others will not know about his or her sources, thereby leaving his or her network intact. Second, many of the ribereños in the case study villages are of primarily indigenous descent, and nobody is proud of that heritage – most try to hide it as much as possible. One means of hiding their heritage may be to not mention names of relatives, and refrain from naming indigenous villages with which they trade.

4.1 Acquisition of Cultivated Plant Planting Material

As Chapter Three has demonstrated, home gardens are diverse; indeed some are remarkably diverse. The patterns of cultivated plant diversity acquisition are the subject matter of this chapter. The responses of informants regarding the origins of home garden cultivated plants are divided into eleven categories, shown in Table 12. In turn these categories were aggregated to constitute five broader categories: bought, transplanted, traded, inherited/natural, and other.

"Exchange" refers to the purchase, transplantation, trade etc. of home garden cultivated plants. Each household reported the source of every cultivated plant in the home garden – which was counted as one exchange. In other words, each household reported one exchange for each cultivated plant in their home garden – provided they remembered who it was exchange with. The most common means of planting material acquisition is reciprocal exchange, followed by cultivated plant transplantation from swidden fields. Important also is the purchase of planting material, from urban centers as well as from neighbors and neighboring villages. Some planting material is acquired from surrounding forest, while certain farmers admit to retrieving planting material through theft.

Reciprocal exchanges are the most significant component of planting stock acquisition in the study villages. Between 40 percent (Sucre and San Regis) and 32 percent (Nuevo Miraflores) of home garden planting material is acquired through exchanges (Table 12). Of these, exchanges with neighbors ranks as the most important, followed by exchanges with other villages, and finally with family. The categories of

Table 12. Planting material exchange patterns, study communities, PSNR area: sources.

	Sucre	San Regis	Nuevo Miraflores
Barter	*41*	*41*	*33*
Neighbors	29	22	19
Received from other villages	8	8	12
Family	4	11	2
Bought	*22*	*21*	*20*
Iquitos	5	3	4
Bought from other villages	13	4	8
Bought from neighbors	0	10	5
Balsa rafts	4	4	3
Transplanted	*15*	*23*	*30*
Swidden field	15	23	30
Inherited/natural	*22*	*12*	*17*
Was already there	10	6	9
Occurs naturally	12	6	8
Other (cemetery and school, theft)	*0*	*3*	*0*
Total	*100*	*100*	*100*

"family" and "neighbors" are less distinct than one might expect because neighbors are most often family as well. In each of the study villages, between five and eight kin groups are found. Villages are frequently organized by kin "neighborhoods", as households from the same family tend to conglomerate in the same part of the village. Kin groups inhabit different parts of the village. Such spatial differentiation and clustering is seen even in small villages like Nuevo Miraflores, where residents of the high levee belong primarily to one kin group, and those residing on the low levee belong to another.

Second, cultivated plant transplantation from swidden fields is an important source of planting material for home gardens. Between 15 and 30 percent of home garden agrodiversity is derived from the household's swidden fields. A recent study on the Tahuayo River of northeastern Peru also indicates that much of home garden cultivated plant diversity was derived by transplanting cultivated plants from swidden fields to the home garden (Coomes and Lerch, 1998). Indeed, one potential function of home gardens is as a reserve of cultivated plant diversity (Alvarez-Buylla Roces et al. 1989; Clarke and Thaman 1993; Johnson 1971). Many households appear to use their home gardens as a place to store cultivated plant specimens that they may grow on a larger scale in other fields. The cultivated plants could, in a time of need when planting material is scarce, be accessed from the home garden and be transplanted into the swidden field. Farmers frequently comment that they chose the best specimen of a cultivated plant for safekeeping in their home garden.

Third, and perhaps most surprising, more than one fifth of home garden cultivated plants are purchased, not exchanged. Between four and six percent of home garden cultivated plant planting material is purchased in Iquitos. Indeed, the city may be the most effective means of obtaining planting material from regions other than their own. Even though cash is scarce in the communities, the purchase of planting stock from the city is common. Equally surprising is that in San Regis ten percent of home garden planting material is purchased from neighbors, compared to five percent in Nuevo Miraflores, and zero in Sucre. It is generally assumed that barter and gift-based exchange prevails in traditional societies; it is not usually recognized that money has been adopted for use within villages for such goods. As mentioned previously, San Regis is the most commercialized of the three case study villages; clearly the wide-spread use of money to obtain planting material is consistent with this observation.

An additional source of purchased cultivated plant planting material comes from balsa rafts, or *balsas*, that travel down the Marañón River. The owners of the *balsas* will float down the river for weeks, even months, at a time (most do not have a motor), and attempt to earn money by selling their products along the way in riverside communities. These *balsas* typically originate in Yurimaguas, Tarapoto, or the Huallaga river, and carry with them large quantities of one or more of the following: oranges, mandarins, mangoes, coconuts, and plantain. In fact, most of the orange, coconut, and mandarin trees in the villages were grown from seeds of the fruit that are sold on the *balsas*. No *balsas* stopped in the villages during the time of field work, and thus all accounts of them are second-hand (although some did float by). There are also some motorized boats that travel up and down the river selling plantain suckers, called *plataneros*.

Between 12 and 22 percent of home garden agrodiversity is derived from natural sources or inherited from previous caretakers of the home garden. Cultivated plants that are not intentionally planted include fruit trees which produce fruit that is consumed and the stone then discarded in the garden (e.g., *aguaje*, mango). There are also volunteer plants that propagate without intervention in the region which are deemed useful and tended if they appear in the home garden (i.e., *malva*, *sacha culantro*). Some plants wild plants may have been domesticated, or semi-domesticated, in this manner. Cultivated plants that have been inherited were usually planted by the previous owners of the garden – only eight gardens extend back more than one generation. In most instances, the current caretakers do not know where the last owners obtained the cultivated plants, and thus it was not possible to trace the origins of such cultivated plants. On several occasions informants did indicate that some of their plants were collected from the forest, and transplanted into the garden.

Domestication of cultivated plants may still be occurring in home gardens when farmers return with plants from the forest to plant and care for them in the home garden, eventually adapting them to the anthropogenic environment. Also, farmers sometimes leave native trees when clearing forest or old secondary growth for their homes if they are deemed useful. Furthermore, useful trees deliberately spared from cutting serve as seed sources for progeny to sprout in home gardens (Smith 1996).

The final origin of planting material of 'other' applies only to San Regis. Some households in this community retrieved planting material from the secondary school courtyard, others from the cemetery, and some respondents admitted to stealing cultivated plants from neighbors. In other words, planting material is scavenged from a wide variety of locations.

Planting material origins by cultivated plants: some examples

Exchange patterns of planting material differ depending on the cultivated plant in question. Planting material exchange is thus cultivated plant specific. Indeed, much of the variation in cultivated plant origins discussed in the previous section may be due to the kinds of cultivated plant exchanged. Furthermore, the exchange patterns of cultivated plants can be divided into the means of acquisition: exchange, purchase, inherited, and swidden field. A few key examples depicting the exchange of stock for major cultivated plant types are given.

Manioc is one of the staple cultivated plants of the case study villages. Although swidden fields are the primary site of manioc production, some exemplars are encountered in home gardens. Not surprisingly, home garden manioc plants originate predominantly from swidden fields (Figure 10), followed by intra-village exchange. Manioc is not commonly sold, and thus predictably little of its planting material in the home garden was purchased. Such a pattern will likely also be found in other staple cultivated plants.

A fruit cultivated plant with a similar exchange pattern as manioc is bananas[6], propagated by suckers, and very common in home gardens. Like manioc, they are used mostly for home consumption, and are grown in larger quantities in swidden fields, both upland and lowland. Therefore, as with manioc, the most important source of banana planting material is from swidden fields belonging to the same family (56.9 percent). Bananas are also often inherited from the previous owner of the home garden (12.5 percent), and exchanged with neighbors (9.7 percent) (Figure 11).

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[6]Most *Musa cvs.* in home gardens are varieties of bananas, not plantain.

Figure 10. Sources of manioc cuttings in home gardens, case study villages, Peru.

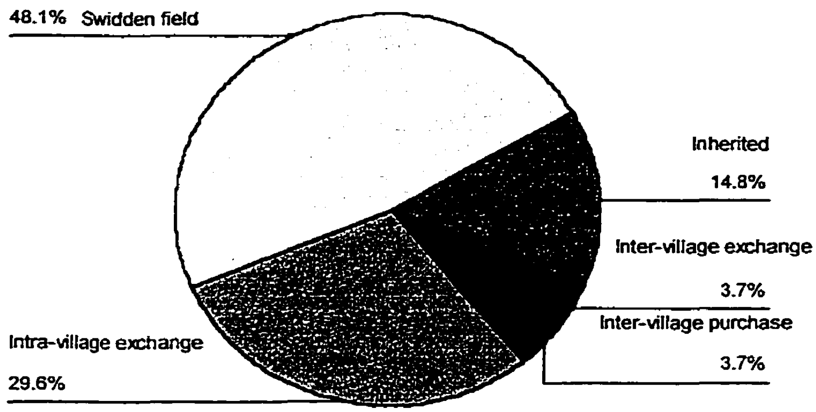


Figure 11. Sources of banana suckers, case study villages, Peru.

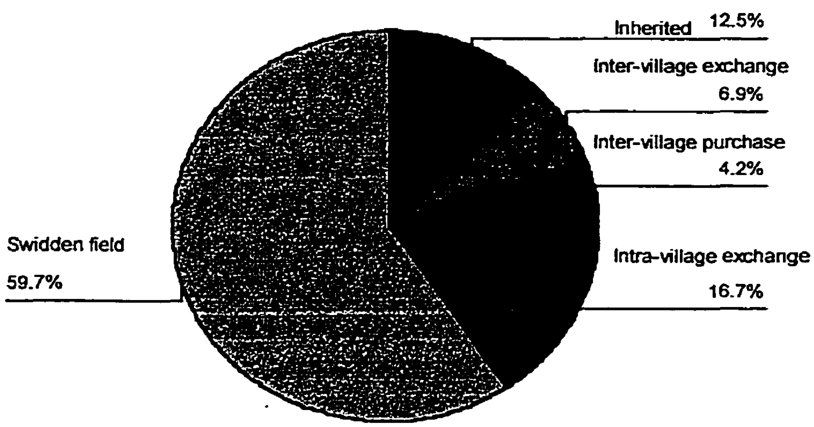
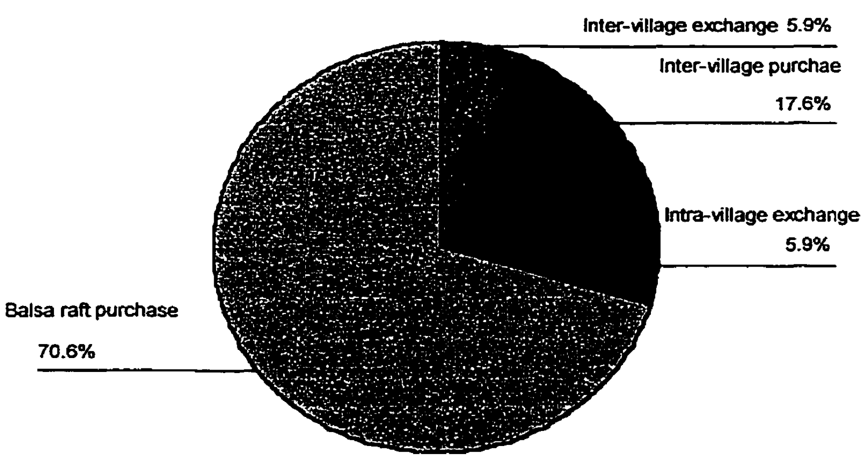


Figure 12. Sources of coconut seedlings, case study villages, Peru.



Exchange patterns of coconuts stand in stark contrast to bananas. Coconuts do not grow well in the region, and therefore need to be obtained from outside sources. Overwhelmingly, balsa rafts supply the coconut planting material to the case study villages (Figure 12). Not many coconut palms in the case study villages have reached maturity, thus any new coconut seedlings need to be obtained from outside. Second, coconut plants are purchased from nearby villages. Thus even though coconut palms are not ideally suited to the region – unfertilized soils do not contain the nutrients coconuts need to grow and mature – households are willing to invest in their planting material.

Similarly, the majority of planting material of oranges is also purchased (Figure 13). Like coconut, oranges do not grow well in the region as soils are nutrient poor and orange trees need fertile soils, and therefore need to be supplied from distant regions. Typically balsa rafts originating from Yurimaguas will be loaded with oranges destined for sale in the communities along the Marañon river. Also, the notion prevails in the villages that oranges from outside of the region are superior to local products, and oranges from balsa rafts become even more appealing. Oranges are available in the study villages, but evidently these are not as desirable.

Mangos are encountered often, used for home consumption as well as occasionally for sale of the fruit. Foremost mangos are inherited from the previous owner of the home garden (26.7 percent), transplanted from swidden fields (13.3 percent), and bought from neighbors (13.3 percent) (Figure 14).

Watermelon is a lowland fruit crop propagated by seeds. Not only does watermelon supplement the food supply during its season (September to October), but it is also an important cash crop. Watermelon seeds come predominantly from neighbors (30 percent), followed by seeds saved from the previous harvest, and crops transplanted from other fields. Even though watermelon does contribute to household income, its exchange predominantly follows along traditional lines of exchange (Figure 15).

Hierba luisa is a medicinal plant used against stomach ailments, and brewed as tea. It is predominantly an upland and high levee crop. *Hierba luisa* is usually exchanged by separating segments of the plant, and transplanting them to the new location. This medicinal is traded with neighbors (45.5 percent), inherited (27.3 percent), and exchanged with family (Figure 16).

Figure 13. Sources of orange seeds, case study villages, Peru.

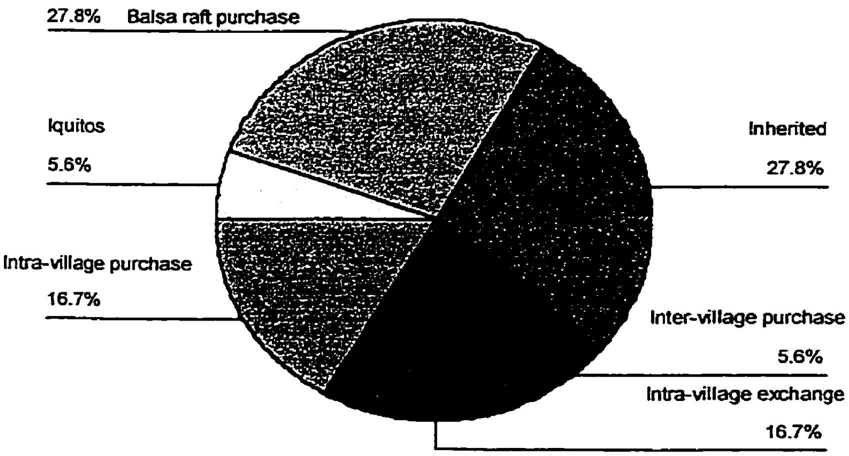


Figure 14. Sources of mango seeds, case study villages, Peru.

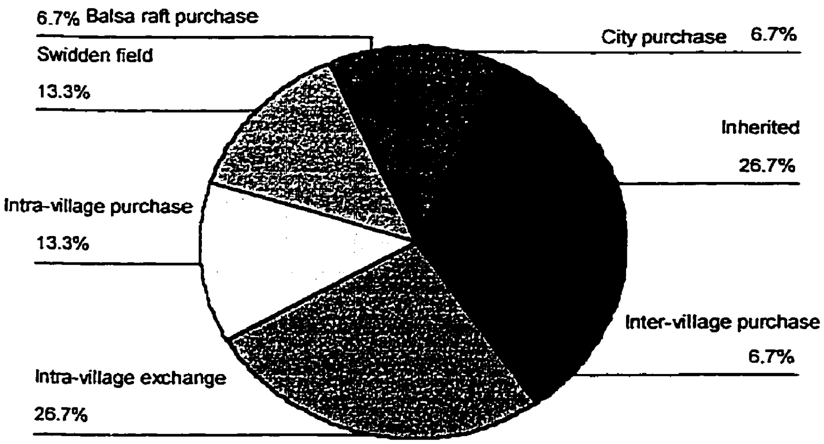


Figure 15. Sources of watermelon seeds, case study villages, Peru.

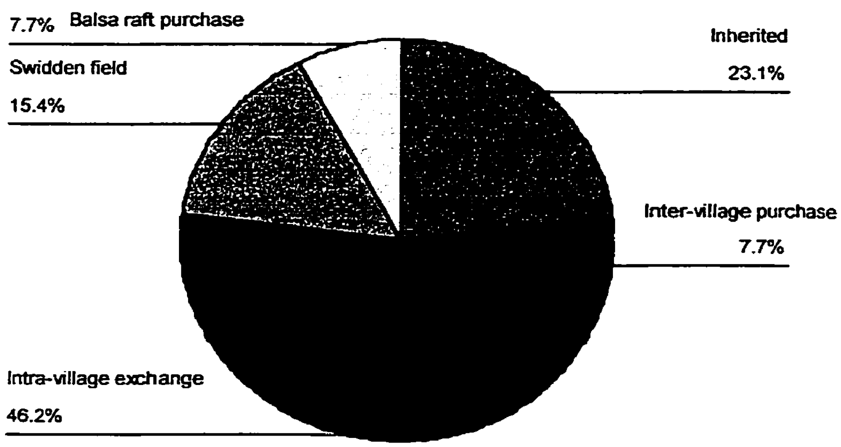
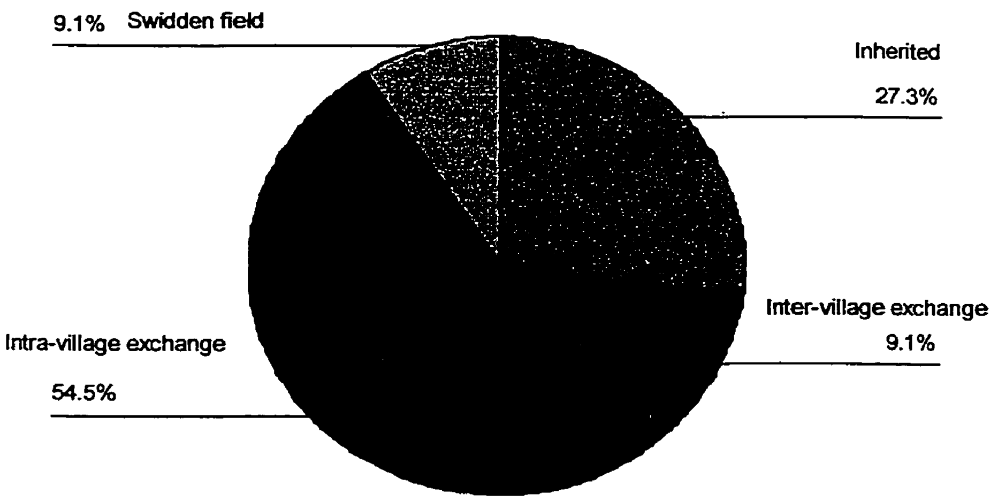


Figure 16. Sources of *hierba luisa* planting material, case study villages, Peru.



Generally, most planting material is derived from the closest and least expensive sources (e.g., neighbors, family, swidden field), or inherited from previous owners of the home garden. Certain fruit crops, such as coconut and oranges, are obtained from outside of the region. Balsa rafts provide a convenient means of transporting planting material. Plants that propagate well locally and are extensively grown, such as manioc and bananas, are typically obtained from swidden fields and through intra-village exchange.

Source Areas

Planting material exchange is not confined to the boundaries of a village, but extends to villages and cities sometimes further than a day's travel (Table 13). Many of the exchanges – an average of 42 percent– occur with similarly-sized villages within a couple of hours by canoe. Most respondents have family members in several of these smaller villages. The communities along the Marañón River undertake visits – weekly or bi-weekly – to a specific village for the socially important soccer game. On such occasions contacts are established and renewed, family members visited, and plants and other goods exchanged. A similar pattern was observed in a village along the Tahuayo River of northeastern Peru, where the gathering of people from several villages during soccer games was used to exchange planting material (Coomes and Lerch 1998).

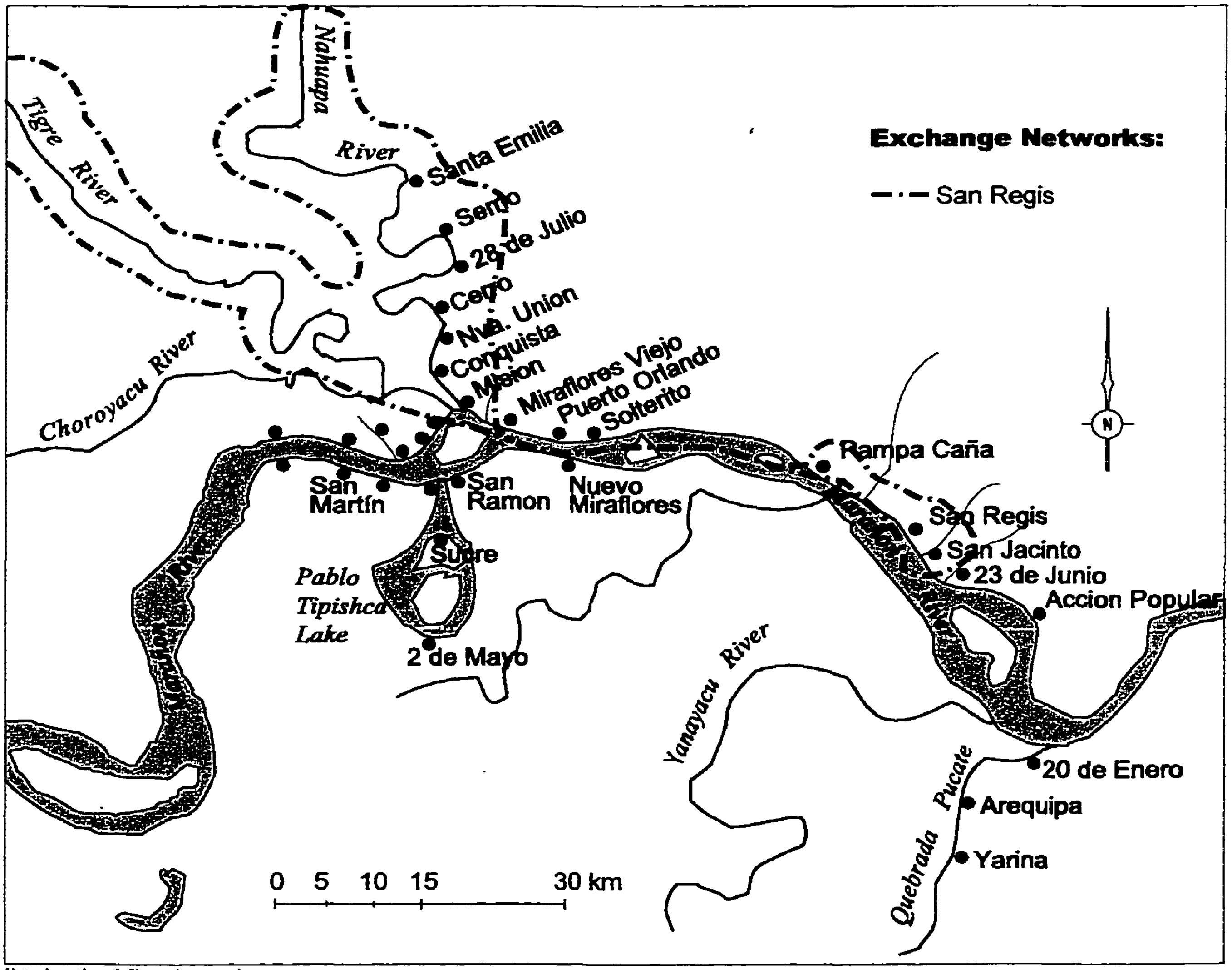
Respondents are in contact with numerous villages that are further away and do not belong to this particular network of soccer-playing villages, but which are also significant in the local exchange network. Households often have relatives in these villages, and when the occasion to visit arrives, the opportunity is used for exchanges; or perhaps the desire to trade is reason enough to travel. Figures 17 to 19 show the extent of the trading network for each case study village. The figures clearly illustrate the duality of exchange networks: planting material is traded with neighboring villages, then the network extends to include the Nahuapa and Tigre Rivers. This pattern is observed for all three study villages.

Villages along one tributary in particular – the Nahuapa River – are frequently called on for planting material. In fact, about three times the number of cultivated plants are exchanged with people from the Nahuapa tributary than other villages at similar distances (Table 13). The Nahuapa watershed is one of the few more extensive upland areas in the region, albeit located outside of the boundaries of the reserve. The majority of

Table 13. Sources of home garden planting material outside of study villages, PSNR area, Peru (%).

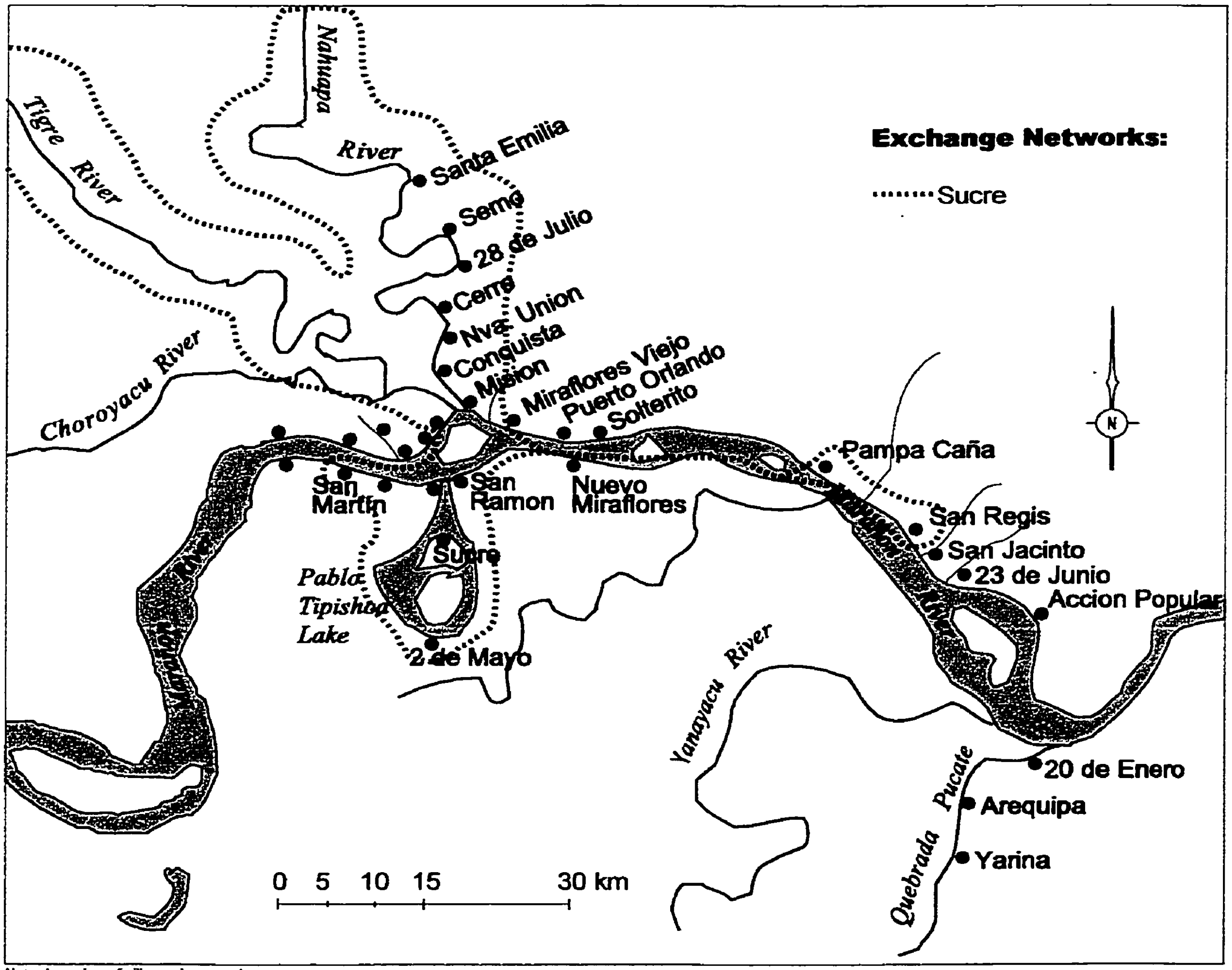
	San Regis	Sucre	Nvo. Miraflores
Neighboring villages ("soccer network")	52	31	38
Distant villages (excluding Nahuapa region)	5	5	0
Nahuapa region	16	10	39
Balsa rafts	17	5	8
Cities	10	49	15

Figure 17. Range of local planting material exchange networks, San Regis, northeast Peru.



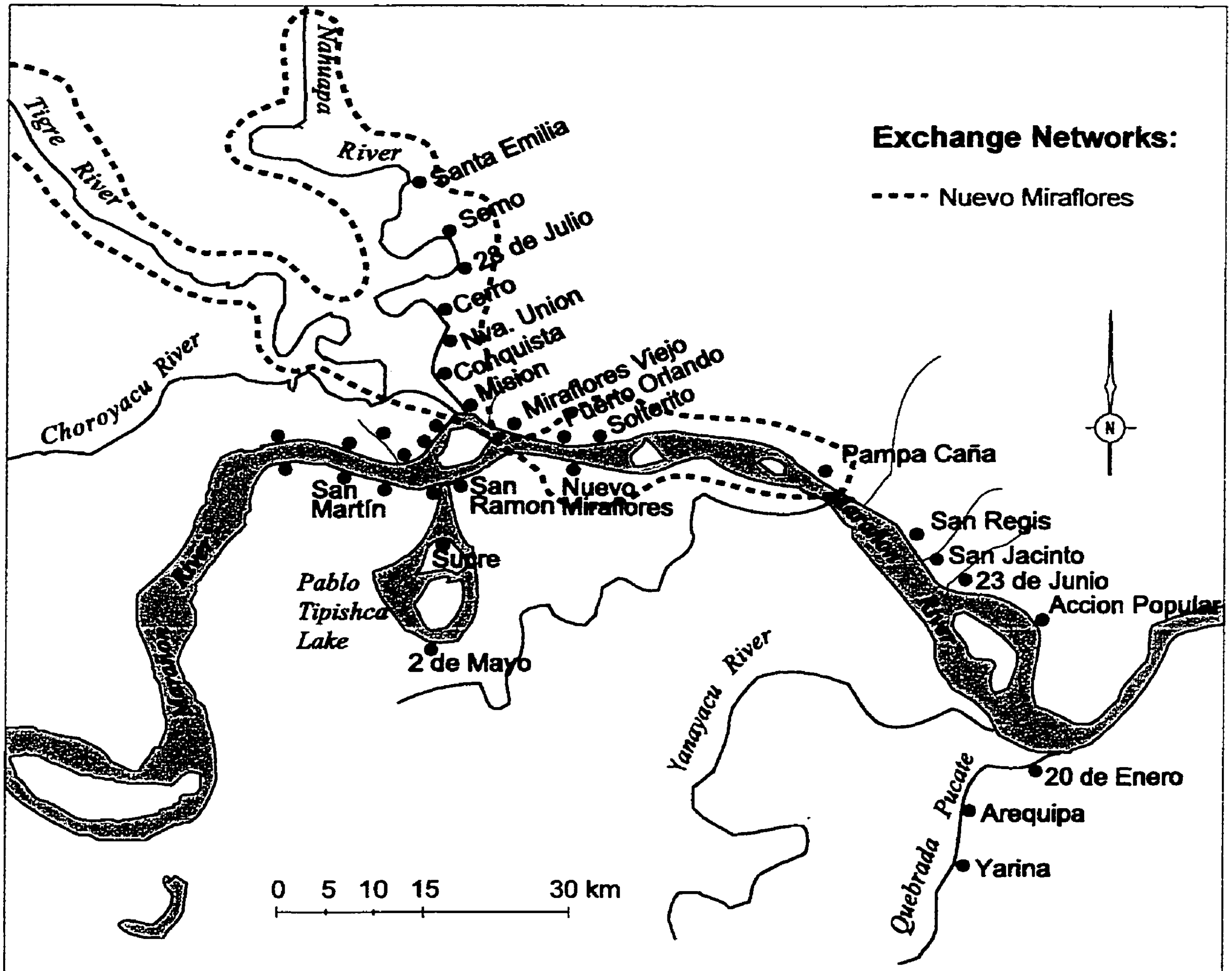
Note: Location of villages is approximate.

Figure 18. Range of local planting material exchange networks, Sucre, northeast Peru.



Note: Location of villages is approximate.

Figure 19. Range of local planting material exchange networks, Nuevo Miraflores, northeastern Peru.



Note: Location of villages is approximate.

villages in the Pacaya-Samiria National Reserve region, on the other hand, are located in the lowland. Many of the perennial cultivated plants are more readily available in upland regions, and are therefore obtained from villages along the Nahuapa river.

The concept of source and sink dynamics[7] can be applied to the study of planting material. The lowland villages in the study are sink areas. The Nahuapa region, on the other hand, appears to be a prime example of a source area. During the flood season most lowland villages lose the majority of cultivated plants to the rising rivers. When the water recedes, it becomes necessary to gather planting material for the new growing season. The Nahuapa watershed plays the role of a major source area in the lowland study villages. The people of San Regis – the upland village – also traded with the Nahuapa area, albeit less frequently than Sucre and Nuevo Miraflores. According to informants, many of the villages along the Nahuapa River are Amerindian communities where inhabitants practice indigenous customs.

Several larger cities and towns are frequented for planting material, including Iquitos, Nauta, Tamshiyacu, Yurimaguas, and Tarapoto. The geographic scope of exchange networks indicates that rural households do have wide-ranging connections. They are not, as is often envisioned, confined to their own villages. It appears as though long distance exchange networks are still important, facilitated by the widespread of use of motorized river boats (*lanchas*) (Coomes 1995).

Cultivated plant planting material sources: High diversity versus low diversity home gardens

The pattern of planting material acquisition is different for households with high agrodiversity (i.e., the highest quartile of cultivated plant diversity) from those with low cultivated plant diversity (Table 14). In San Regis and Sucre, households with the highest cultivated plant diversity in their home gardens received between 25 and 36 percent of

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[7] In conservation biology, the concept that population dynamics may depend on the relative quality of good and poor habitats is called source and sink dynamics (Meffe and Carroll 1994). Good habitats are called sources, and defined as areas where local reproductive success is greater than local mortality. Populations in source habitats produce an excess of individuals, who must disperse outside their natal patch to find a place to settle and breed. Poor habitats, on the other hand, are areas where local productivity is less than local mortality (Meffe and Carroll 1994). Traditionally this concept addresses only wild populations. Applied to planting material, the species themselves do not redistribute themselves; instead planting material exchange is the agent of redistribution.

Table 14. Sources of planting material by highest and lowest home garden cultivated plant diversity quartile, PSNR area, Peru (%).

	San Regis		Sucre		Nuevo Miraflores	
	Highest diversity	Lowest diversity	Highest diversity	Lowest diversity	Highest diversity	Lowest diversity
Bought	25	5	36	0	19	33
Bartered	30	51	36	48	32	22
Transplanted	20	23	10	48	35	28
Inherited	22	21	18	4	14	17
Other	3	0	0	0	0	0

their planting stock through purchases, compared to between zero and five percent for households with low agrodiversity. One interpretation of this finding is that households with high home garden cultivated plant diversity place more value on their diversity, and are willing and/or able to invest in purchasing the necessary planting material. As the regression analysis of cultivated plant diversity (Chapter 3) has shown, households with high agrodiversity have more monetary resources available, and are therefore able to invest in planting stock. Resources, and perhaps trading connections, differ between the two extreme quartiles of home garden cultivated plant diversity.

Households with low home garden cultivated plant diversity acquire a larger proportion of their cultivated plants through barter than those with high agrodiversity, with the exception of Nuevo Miraflores. In San Regis, more than 50 percent of planting material is acquired through barter exchange; in Sucre the figure is just below 50 percent. In other words, households with low cultivated plant diversity rely more on family and neighbors to maintain their home gardens. About one third of planting material in diverse gardens is acquired through barter.

In Sucre, low cultivated plant diversity households acquire almost 50 percent of their planting material from their own swidden fields, compared to ten percent for those with
high cultivated plant diversity. The movement of planting material in low-diversity cultivated plant gardens appears to be from swidden fields to home gardens, which may indeed act as a reserve for planting stock. In high diversity home gardens this phenomenon is not as pronounced, most likely because less commonly encountered plants which need to be acquired from areas outside of the village are found in high agrodiversity home gardens. In San Regis both high and low diversity home gardens receive about 20 percent of their cultivated plant planting
material from their own swidden gardens. Both low and high agrodiversity home garden are reserves of planting material.

In San Regis those households with high home garden cultivated plant diversity are willing to engage in less conventional activities to enhance their cultivated plant diversity. The category of 'other', at 2.5 percent for the highest cultivated plant diversity quartile in San Regis, encompasses such activities as taking cultivated plants from the high school garden, acquiring planting material from the cemetery, and theft. High cultivated plant diversity in the home garden may have special significance to these households.

In contrast to San Regis and Sucre, in Nuevo Miraflores households with low cultivated plant diversity actually acquire more planting stock through trade and transplantation from swidden fields, the inverse of the pattern noted in the other communities. Indeed, the pattern of home garden holdings in Nuevo Miraflores is different from the other two villages, with half of the households located on the high levee with home gardens, and the other half situated in the low levee without home gardens. Perhaps it is because of this that the origin of planting material does not adhere to the pattern encountered in the other two villages.

4.2 Acquisition of planting material: terms of exchange

Information on the terms of exchange was acquired in the interviews by asking informants about the understanding upon which exchanges are founded. Many villagers do not perceive conditions *per se* to exist, perhaps because an accepted part of trade is reciprocity. Thus general reciprocity becomes less of a condition than an intrinsic and implicit factor in exchange. People trading planting material adhere to the "rules of reciprocity". Exchange with neighbors and friends will be reciprocated at some, usually unknown, point in the future. In some instances both partners in the barter exchange goods at the same time, exempting future obligations. In other cases, years pass before the obligation of reciprocity is called upon. Throughout the range of extremes, the simple fact that barter has been engaged in frequently implies that future exchange is possible and likely. Among neighbors and friends, to deny exchange would be viewed as a sign of hostility.

Exchanges within extended family in most cases are viewed as a given. Family ties exist as safety networks to serve members in times of need, as well as to engage in exchange activities during non-crisis times. Such a safety network is most important at times of crises such as loss of all cultivated plants during a high flood or riverbank slump. It is at this time that planting material is most needed to ensure continued production of cultivated plants for survival. As long as help can be given, family members are obliged to do all they can.

Planting material that is purchased, on the other hand, requires no further commitment. When plants are bought in the market place or from the balsa rafts, the transaction is closed. The same is true for monetary purchases of planting material from neighbors and fellow villagers. Perhaps this is a reason for the higher than expected planting material acquisitions with money: the lack of obligations is appealing to those who wish not to be tied into the exchange network any further.

Villagers also commonly believe that planting material obtained outside of their home village is superior to locally acquired material. The eagerness of traditional people to acquire exotic planting material suggests the perceived superiority of such materials (see Chapter 1) (Descola 1994; Huxley and Capa 1964; Bergman 1980). There is perhaps a practical foundation for this belief: by obtaining planting material from plants outside of the local cultivated plant gene pool, agrodiversity can not only be maintained but increased if the incoming flow of genetic material is sufficient. Perhaps this explains the popularity of planting material purchased from balsa floats, which originate in areas local people do not often visit. Oranges are a good example: orange fruit trees do exist and produce fruit in the villages. Yet instead of obtaining seeds from within the village, most purchased oranges from the balsa floats.

4.3 Exchangers of Planting Material

Who among the sample is most active in the exchange of planting material, and what are their motives? A comparison of the household characteristics of households with the most planting material exchanges to the remainder of the sample reveals some insights. The number of exchanges refers only to planting material received, due to the scant information available on planting material given away. Included are all types of received planting material; excluded are plants that people have encountered in their garden, that have grown by means of seeds disposed (not planted) in the garden, or that are natural to the area. The focus is thus on the acquisition of planting material. No statistically significant regression models were obtained for Nuevo Miraflores, which will therefore be excluded from this analysis.

San Regis

Regression analysis reveals characteristics of the households most engaged in exchanges and their home gardens. With "number of exchanges" as the dependent variable the factors explaining frequency of planting material exchanges are village specific – as was the case with the patterns of cultivated plant diversity. In San Regis, the amount of planting material received is influenced by the economic importance of the home garden and number of cultivated plants (Table 15). Households with economically important home gardens tend to produce more market-oriented cultivated plants, and have more of these plants in their garden. Home gardens of low economic importance, on the other hand, have less specialization and therefore more cultivated plant diversity, but fewer exemplars of each cultivated plant. Households with home gardens of little economic importance may also be more inclined to use the space in their garden as a reserve of cultivated plant planting material, whereas those relying on the garden for income would rather plant economically viable cultivated plant species. Figure 20 indicates that in fact home gardens with average economic importance receive the least amount of planting material, whereas those of least economic importance receive the most, with the most economically important gardens in between the two.

The second factor underlying exchanges of cultivated plant planting material in San Regis is that of home garden agrodiversity. As the quartile comparison has shown, highly diverse home gardens receive more cultivated plant planting material than their less diverse counterparts (Figure 21). There are two explanations for this. First, if a home garden has more cultivated plant diversity, more planting material will be needed to maintain such diversity because of losses to pests and diseases, assuming that diversity is the goal. Second, households with more diverse home gardens may have greater interest in gardening, for they have already build up cultivated plant diversity to levels surpassing the average garden in the village.

A third statistically significant variable is extractive capital. Wealthier households may invest more in planting material, and are thereby able to build up cultivated plant diversity. Another possibility is that home garden cultivated plant diversity is indeed a symbol of status, as is wealth, and therefore households need to receive more planting material to build up their cultivated plant diversity in order to achieve a higher status in

Table 15. Regression model explaining frequency of cultivated plant planting material exchanges, San Regis, 1998.

	Coefficient	Std. error
Constant	1.570	1.869
Economic importance of home garden	1.892	0.754 **
No. of plants in home garden	0.875	0.060 **
Extractive capital	0.003	0.001 **
Adjusted R^2	0.879	
Significance of model	< 0.01	

** $P \leq 0.05$

Figure 20. Economic importance and no. of exchanges, San Regis, 1998.

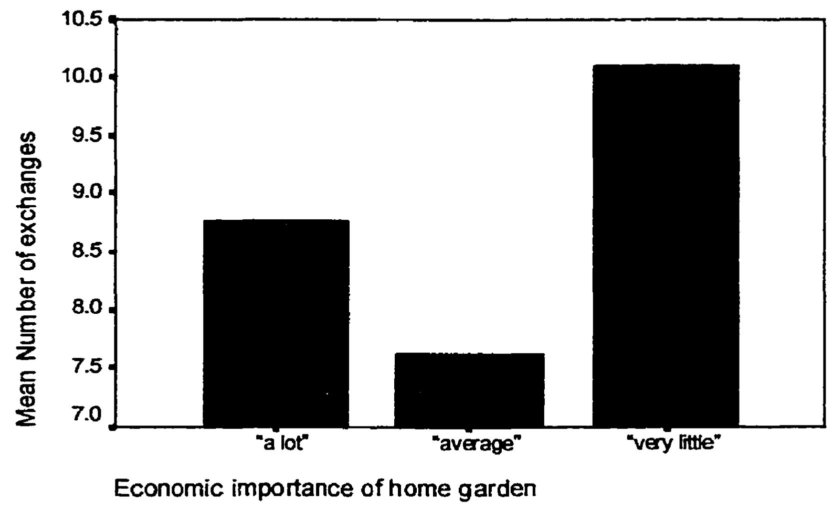
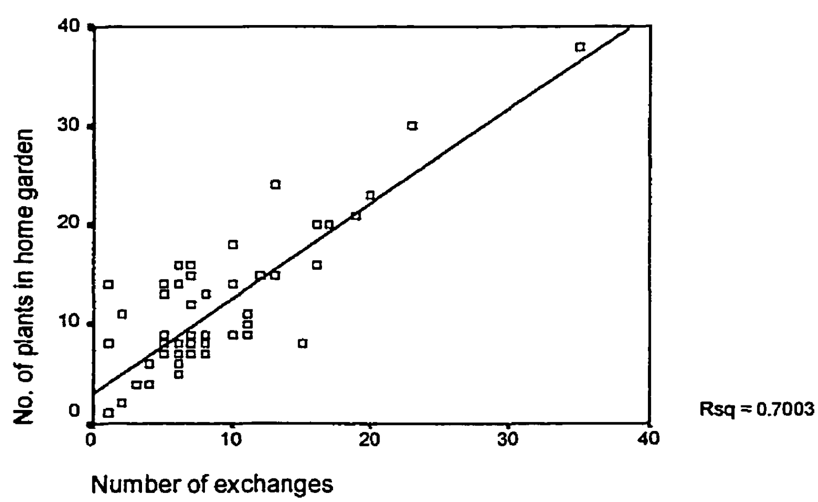


Figure 21. Exchanges and home garden crop diversity, San Regis, 1998.



the village. Or perhaps those more involved in extraction travel more, and therefore have more opportunities to get planting material.

Sucre

The dominant explanatory factors for frequency of exchanges in Sucre are, with one exception, different from San Regis; most important is the gender of the home garden caretaker (Table 16). Female caretakers receive more cultivated plant planting material than their male counterparts; those that share responsibility receive the least (Figure 22). In the fishing village where men spend much of their time on lakes and rivers, away from household and gardening responsibilities, it is no surprise that women are more involved in the exchange of planting material. Indeed in Sucre much of the gardening responsibility is the domain of women.

As in San Regis, home gardens with higher agrodiversity also receive more planting material in Sucre (Figure 23), presumably for the same reasons: with more plants, more planting material is needed to maintain that diversity; with greater cultivated plant diversity comes more interest and involvement in gardening.

In Sucre, the number of years the household has tended the home garden is also significant. Households that have not owned a home garden for some time are currently receiving cultivated plant planting material. These households are building up their home garden agrodiversity, and therefore need to receive more planting material.

As indicated in the discussion of terms of exchange, planting material exchange implies a future engagement in reciprocity. Households that have entered the cycle of planting material exchanges may be locked into the system by the inherent commitment to future exchanges. Whether such a cycle in fact exists remains to be seen, but the prospect of a continuous cycle of planting material exchanges within similar circles of households is interesting.

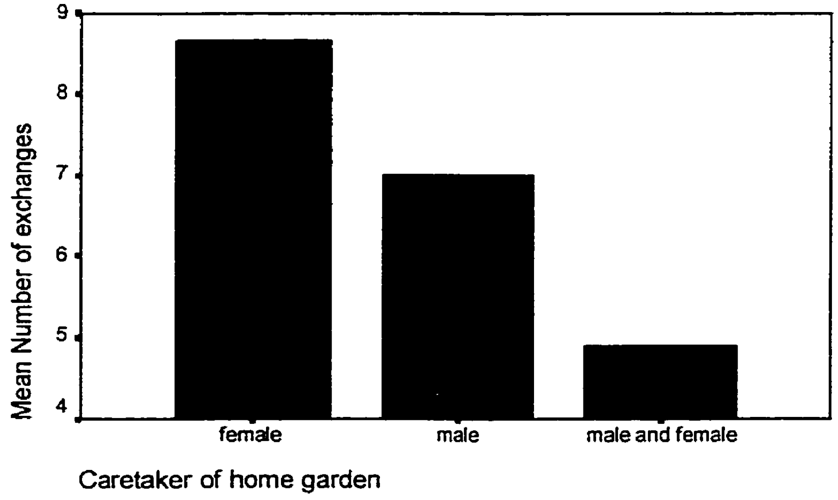
Households with high agrodiversity do exchange plants at a higher rate than those with little cultivated plant diversity. In both San Regis and Sucre, the defining element of persons engaged in many planting material exchanges is their high cultivated plant

Table 16. Regression model explaining frequency of cultivated plant planting material exchanges, Sucre, 1998.

	Coefficient	Std. Error
Constant	9.691	1.934
Caretaker of home garden	1.407	0.708 *
No. of plants in home garden	0.323	0.003 **
No. of years households has tended home garden	-0.132	0.059 *
Livestock capital	0.006	0.003 *
Adjusted R^2	0.685	
Significance of model	< 0.01	

** $P \leq 0.05$; * $P \leq 0.10$

Figure 22. Exchanges and caretaker of home garden, Sucre, 1998.



diversity. In San Regis, households in the highest quartile of frequency of cultivated plant exchanges had an average home garden agrodiversity of 18.5; the figure is at 18.8 for Sucre. Households in the lower three-quarters of frequency of exchanges have a home garden cultivated plant diversity average of 8.4 in San Regis and 7.7 in Sucre (Table 17).

Evidently, those who exchange little also have less agrodiversity in their home gardens. The fact that households with high agrodiversity engage in more exchanges than their less diverse counterparts is an indication of their commitment to agriculture and perhaps the conservation of cultivated plant genetic material. Furthermore, based on field observations, households with higher rates of exchanges not only receive more cultivated plant planting material, but also have a higher rate of giving planting stock to others. Given the high degree of uncertainty in informants' answers about the giving of planting material, in-depth comparison of planting material received versus given is not possible.

4.4 Examples of exchange networks

To illustrate some of the mechanisms and complexities of planting material exchange in the case study villages, I examine the acquisition history of a case drawn from each study village. Households with more diverse gardens were generally better able to recall the origins of their plants; such households appear to have greater pride in and attribute more value to their cultivated plants.

Señora Luisa owns the most diverse home garden in San Regis. She is an older lady who shares her dwelling with her husband, children, and grandchildren. At the time of the interview, she was suffering from a wrist injury and was about to travel to Iquitos for examination. There are 38 cultivated plant in her home garden which have originated in various villages and cities throughout the Peruvian Amazon. Relatives in San Jacinto gave her the planting material for *guindo,* while she bought ginger seedlings from other people in the same village. Friends from Tamshiyacu, almost twelve hours by boat, presented her with *chirimoya* seeds, while she traveled as far as the Nahuapa tributary to obtain coffee seeds. Her Brazilian guava (a landrace of guava) originated in Zenca, a village downstream from Nauta.

Figure 23. Exchanges and home garden crop diversity, Sucre, 1998.

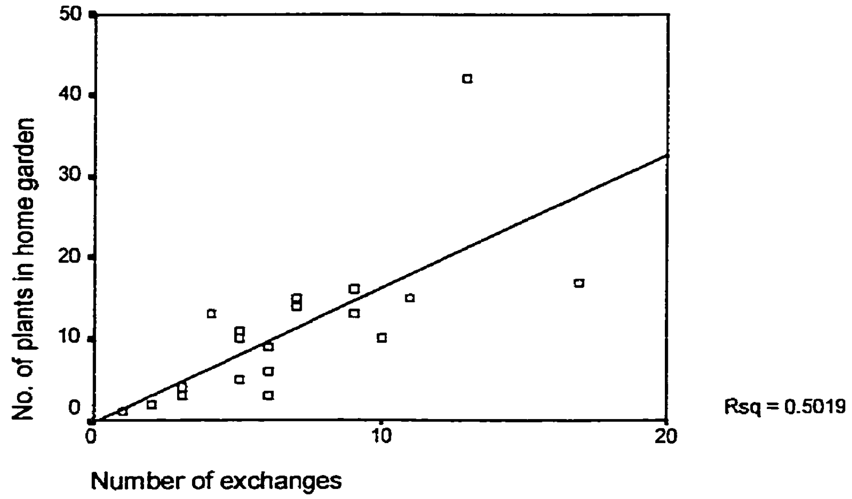


Table 17. Household characteristics of highest quartile planting material exchange households compared to other quartiles, case study villages, 1998.

	Number of exchanges		No. of plants in home garden	
	Upper quarter	Lower quarters	Upper quarter	Lower quarters
San Regis	17.73	6.05	18.53	8.41
Sucre	16.67	5.00	18.83	7.67

Some of the plants in Señora Luisa's garden were received because of her keen sense of observation. She saw that other villagers had the plant in their gardens, and bluntly asked for the planting material. For example, she saw a strong cashew plant in a neighbor's garden while doing communal village work. Similarly she requested and received seeds from a mango plant in a neighbor's swidden field. Her *sidra* fruit tree originated from a young *sidra* plant growing near the port of the village, which she transplanted into her own home garden.

Most other plants were taken from her own swidden fields to be safe-guarded in the home garden. Other plants were traded with neighbors and fellow villagers. Interestingly more planting material was bought from neighbors than traded with them. It seems like Señora Luisa prefers not to participate in the exchange network. When asked about planting material that she had given to others, she replied that people do not usually come to her to ask for it. She does frequently give various kinds of fruit to neighbors for consumption, the seeds of which they could use for planting material. Seeds – which can only be used for planting material – stay within her own gardens.

In Nuevo Miraflores, Señor Jorge has 19 cultivated plants in his home garden. Several of his plants were also obtained from outside of his village. His plantain, turmeric, and ginger originate from the Nahuapa tributary, where he traveled in order to purchase the planting material. In Iquitos, Señor Jorge bought *lancetilla* seeds from plant healers at the market. He has family members in the village of Pampa Caña, from whom he received *piñón* and *toronja*. Most of his other garden cultivated plants were exchanged with family members in Nuevo Miraflores who have old fruit trees with high quality fruit. A medicinal plant, *hoja del aire*, came from his aunt who acquired it from another (unidentified) village and then distributed seeds to family members. Some other plants he traded with or bought from neighbors.

Señora Maria's home garden is the most diverse in Sucre with 42 cultivated plant species. Some common cultivated plants she received from neighbors (e.g., plantain, manioc, turmeric), but since most villagers only established their home gardens five years ago when cattle raising on village grounds was prohibited, availability of cultivated plant planting material is limited in the village. Therefore much of the diversity present in her garden had to be acquired elsewhere. Some cultivated plants (e.g., tomato, *llamaplata*, *sharamasho*, mint) were purchased in Iquitos, whereas others originate from the surrounding villages of San Martín, San Regis, the Nahuapa tributary, and other villages which she could not remember (or chose not to recall).

Señora Maria's love of plants and quest to continue building up her home garden cultivated plant diversity was witnessed during our stay in the village. She requested seeds for several different species of beans from us, which we had brought along as food, while also attempting to get our carrots and beets. We gave her as much as we could to experiment with, and they might now be a part of her home garden. During the interview she was evidently very proud of the immense cultivated plant diversity in her garden, but at the same time she seemed somewhat reluctant to share information regarding the origins of her plants. Her secrecy may be an attempt to prevent public access to her own sources of cultivated plant planting material.

Many villagers in Sucre rely on Señora Maria, or have relied on her in the past, for cultivated plant planting material. When asked if she has given away any planting material recently, her reply indicated surprise: of course, she gives away planting material all the time and to anyone who asks. This was confirmed by many of the other villagers, who stated that indeed much of their planting stock originated from Señora Maria, and that they were inspired by her to start planting a home garden. Perhaps most important is that in return she has gained an excellent reputation and admiration in the village. Other villagers do also provide her with planting material if they are able to obtain a plant she does not already have.

These three case studies of home garden planting material origins and exchange points toward three themes in cultivated plant diversity accumulation. First, travel, or having connections and receiving visits from people of other villages and cities, can enhance home garden cultivated plant diversity, especially for plants that are currently unavailable in the home village. Second, family ties and kin connections do have a special significance in the exchange network. When family members live nearby who have diverse home gardens, they are often called upon first for planting material. Similarly, planting material is frequently exchanged with kin living in nearby villages. Third, as illustrated by the contrast in frequency of giving away planting stock by Señora Luisa and

Señora Maria, the degree to which fellow villagers take advantage of diverse gardens for planting material varies widely. In San Regis no-one asked for planting material from the household with the most diverse garden, whereas in Sucre it is the source of most of the village's planting stock. In other words, the different moments in development of home gardens are reflected in the study villages.

4.5 Planting material exchange in times of crises

Occasionally the Marañón river's water rises more than usual, carrying with it the means of survival of traditional people inhabiting the lowland: subsistence cultivated plants, and thus also the planting materials for the next growing season. Without the means to plant swidden fields from the past years' cultivated plants, it becomes critical for households to obtain planting material by the time the flood water starts to subside. The most important planting materials in such times are cuttings of manioc and plantain suckers. Unlike in the exchange of planting material to enhance home garden cultivated plant diversity, vast quantities of planting stock are needed.

The reports of villagers of the impact of the flood period is indeed frightening. Eighty percent of inhabitants interviewed in Sucre and Nuevo Miraflores (San Regis, located on the upland, was not severely affected by the flood) experienced a severe lack of foodstuffs during the 1993/1994 flood period – the second highest flood since 1989 (Coomes 1998, pers. comm.). In Nuevo Miraflores, 73 percent of villagers were affected by diseases such as malaria, cholera, yellow fever, and dengue fever. The occurrence of diseases was lower in Sucre at 20 percent. Livestock were affected as well. Ownership of livestock represents a significant investment, and insurance of sorts, for villagers. During the flood, some chickens were accommodated in dwellings, but virtually all other livestock was lost, representing a severe blow to households.

In Nuevo Miraflores, 73 percent of villagers lost all home garden and swidden cultivated plants – and thus their planting material. In Sucre this figure is an even more staggering – 87 percent. In Nuevo Miraflores 27 percent of villagers lost most – though not all – plants. In Sucre 10 percent lost most and 3 percent lost some plants. The situation in the two villages was devastating: virtually all plants and planting material had been destroyed by the flood, leaving no planting material for the new season once the flood subsides from fellow villagers.

In both villages, the Nahuapa river region plays a significant role in providing cultivated plant planting stock (Table 18). There are various ways in which villagers obtain planting material from this upland region. The majority of planting material was acquired by traveling to other villages and cities in the quest to obtain the necessary planting stock to survive (52 percent in Nuevo Miraflores, 64 percent in Sucre). Few villages, however, were spared from the flood; most shared a similar fate to Sucre and Nuevo Miraflores. Some households had family in neighboring villages who were able to spare a few seeds, but most of the planting material needed to be acquired either from upland villages, from cities, or from villages further away that were unaffected by the floods. Villages traveled to include the Nahuapa region, Solterito, San Andres, the Tigre river, the Tigrillo tributary, San Regis, San Martin, 23 de Enero, and San Pablillo. Cities visited in this quest include Iquitos, Yurimaguas, Nauta, and Tarapoto. Villagers of Nuevo Miraflores and Sucre travel to the Nahuapa region to purchase their planting material.

Second, people from the Nahuapa tributary also travel through lowland villages, carrying with them supplies of planting material to be sold to those in need. However, a large problem is presented to households that do not have the cash to purchase the needed planting stock. A third way of obtaining planting material from people from the Nahuapa region is through trade. Several households mentioned that they acquired planting material from there by exchanging it for fish. One cash-poor head of household in Nuevo Miraflores reported exchanging his labor for planting material. For every day of labor he would receive a sack of planting material of plantain and manioc.

The Nahuapa is by no means the only source of planting material during times of crises. Some households (22% in Nuevo Miraflores; 15 percent in Sucre) saved planting material from the previous harvest. Others do not have this opportunity because the saved planting stock – rice in particular – is the only food source available during the flood and are eaten out of hunger. All villagers know that the next year's flood may be potentially devastating; it is unlikely that many villagers are unable to foresee future needs; they are simply unable to meet them. A mere two percent of planting material was saved from

Table 18. Sources of planting material after 1993/94 high flood season, northeast Peru (%).

	Nuevo Miraflores	Sucre
Nahuapa	22	42
Saved seeds	22	16
Family	9	8
Neighbors	9	
People that come to sell	4	11
Balsas	4	
Solterito	4	
San Andrés	9	
Rio Tigre	9	
Tigrillo	4	
Iquitos	4	2
Yurimaguas		2
Nauta		2
San Regis		5
Department of San Martín		5
Tarapoto		2
Swidden field		2
23 de Enero		2
San Pablillo		2

Note: The percentages in this table represent the sources of planting material – including home garden and swidden cultivated plants – obtained after the high flood season, aggregated by village. In Sucre, for example, 42 percent of cultivated plants were obtained from the Nahuapa region. A household may receive planting material from more than one location. The number of exchanges mentioned by household was added to obtain the percentage figures.

swidden fields Sucre (none in Nuevo Miraflores). In Nuevo Miraflores planting material exchange occurred among villagers (9 percent), but very few households had enough planting stock to spare. Kin relations are also significant, with 9 percent of planting material obtained from family in Nuevo Miraflores, and 7 percent in Sucre. Again, very few family members could spare any planting material because all were affected in the villages. Figures 24 and 25 illustrate the extent of planting material exchange network in times of crises in Sucre and Nuevo Miraflores.

Some of the planting material that is saved from the previous harvest does take the form of seeds (tomatoes, cucumber, squash, etc.), but many cultivated plants propagate vegetatively (including the staples plantain and manioc), and are thus much harder to store during the flood season when land is inundated. Farmers overcome this problem in several innovative ways. First, some households store plants in *barbacoas*, small raised wooden platforms on which a sample of cultivated plants are planted, and thus saved from the inundation. Second, other households plant certain cultivated plants in baskets or buckets, which are then kept in the house; this allows only for saving of a few exemplars of cultivated plants, not the quantities needed for the planting season. Third, one household in Nuevo Miraflores had built a wooden float solely for the purpose of planting material storage. This was one of the few households that did not require much aid in obtaining planting material after the high flood.

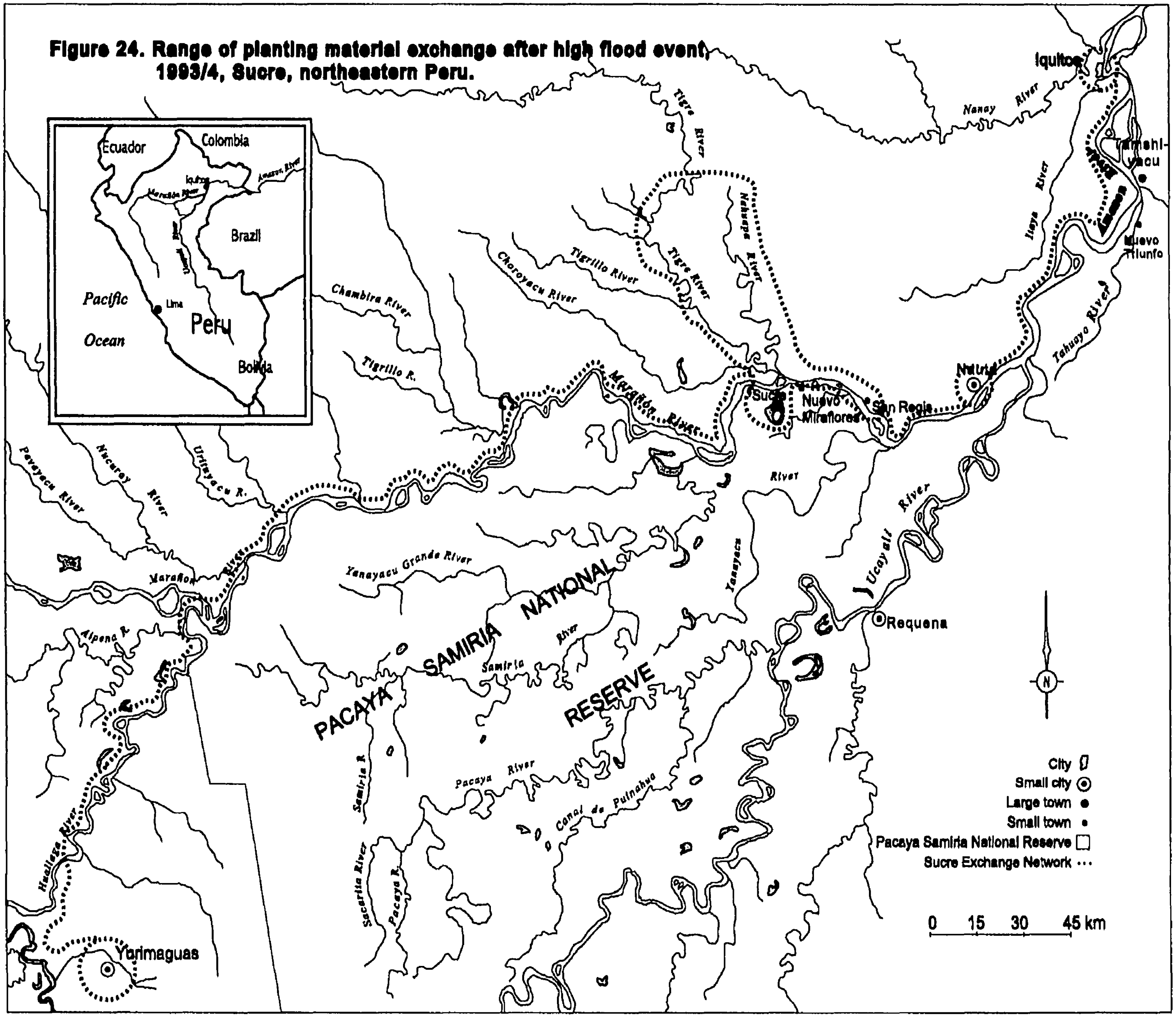


Figure 24. Range of planting material exchange after high flood event, 1993/4, Sucre, northeastern Peru.

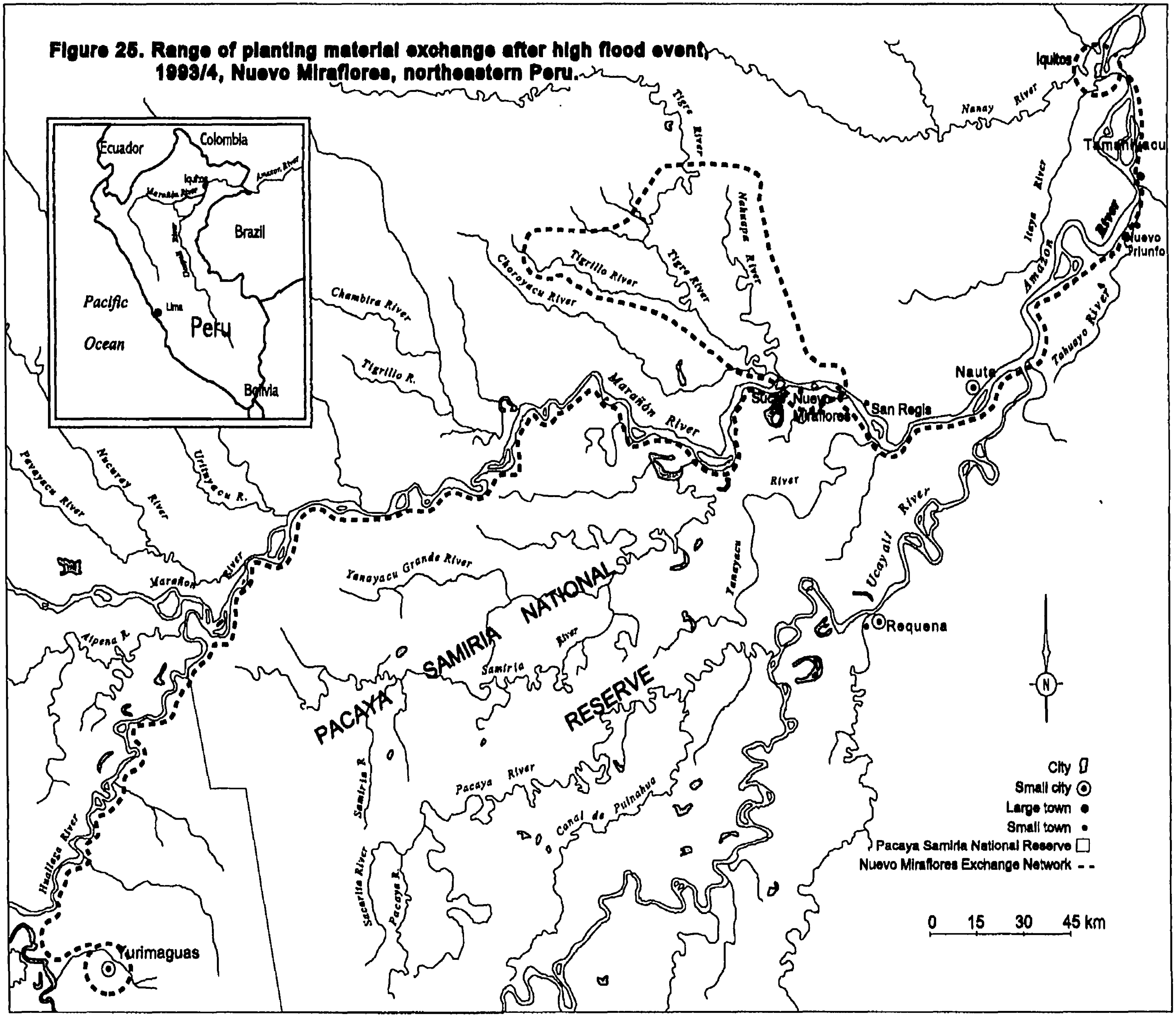


Figure 25. Range of planting material exchange after high flood event, 1993/4, Nuevo Miraflores, northeastern Peru.

Chapter 5: Summary and discussion

This study of cultivated plant diversity and planting material exchange patterns in the Pacaya Samiria National Reserve region of northeastern Peru was undertaken in response to a growing concern about the fate of agricultural genetic diversity in the Amazon. The research project examined patterns of home garden cultivated plant diversity, and traditional people's acquisition and maintenance of agrodiversity in three distinct communities along the Marañón river – an upland mixed agricultural village, a lowland agricultural village, and a lowland fishing village. Data were gathered through household surveys (n=192) and more in-depth follow-up interviews (n=112). In this final chapter, I summarize the findings of this study, and discuss some of the implications for conservation-development.

5.1 Summary of relevant findings

This study of agricultural diversity among three traditional villages along the Marañón river among peasant households has yielded findings that contribute to our understanding of the origins and exchange patterns of agricultural diversity in the Amazon.

1. Home gardens in the study area – on average – are not as diverse as reported from studies of home gardens elsewhere. The mean home garden cultivated plant diversity in case study villages is only eight cultivated plants – far short of the 20 or more species typically noted from similar sized gardens in the literature (Smith 1996; Padoch and de Jong 1991; Kumar et al. 1994; Kimber 1966). In many of these studies, researchers focus on select home gardens – without specifying the selection criteria. These home gardens may well be among the most diverse in the respective villages, lending the impression that home gardens are typically highly diverse. In our study villages considerable variation in cultivated plant diversity is observed, from gardens with only one cultivated plant to as many as 42 cultivated plants. Selecting only a few home gardens for study would not have represented adequately the nature and diversity of home gardens.
2. Households with diverse home gardens tend to be wealthier, to have established their own home garden, and to tend it for a longer period of time. Some village-specificity

was noted in the explanatory factors of home garden diversity. Similar results in a study of home gardens in Nuevo Triunfo on the Tahuayo river, northeast Peru, indicate that home garden cultivated plant diversity is correlated with home garden age and land wealth (Coomes and Lerch, 1998). Most studies in the literature do not identify the specific determinants of diversity; others note that cultivated plant diversity is influenced primarily by the caretaker's preferences and general factors such as economic condition (Clarke and Thaman 1993).

3. Women are more involved in home gardening than men. Indeed, in the agricultural villages, women tend most diverse home gardens. In contrast, shared responsibility – man and woman as caretakers – is associated with the least diverse home gardens. Studies of Amazonian Amerindian people also note the dominant role of women in gardening (Brown 1985; Descola 1994; Salick et al. 1997).
4. The highest village-level home garden cultivated plant diversity was encountered in the upland village of San Regis (n=108). In *terra firme* environments, perennials, which are unable to survive the flood season in the lowland, flourish and contribute to the overall home garden diversity. In addition, residents of San Regis have home gardens in lowland has well as upland environments, thereby including cultivated plants that are well suited to both of these environments. The mean village-level cultivated plant diversity in the literature is 160 cultivated plants (calculated from figures shown in Table 2) – San Regis thus ranks below average.

These findings suggest the importance of studying variations in home garden agrodiversity at the community and household level, and underscore the need to include the caretakers in any study of home gardens.

Research on planting material exchange networks among households in the three study communities provided the following insights:

1. Complex exchange networks contribute to the establishment and maintenance of home garden agrodiversity. Most planting material is derived from intra-village trade and exchange with neighboring settlements. Ethnographic studies of Amerindians emphasize the importance of exchange networks in traditional societies (Kensinger et al. 1975; Gregor 1977; Seeger 1981; Harner 1972; De Zubria 1986; Hugh-Jones

1979). The present study confirms the importance of planting material exchange networks.

2. Households with high home garden agrodiversity are more involved in exchange networks. Highly diverse home gardens need more planting material to maintain diversity against losses due to pests and diseases.
3. A surprising proportion (up to 22%) of planting material was exchanged through market (i.e., cash) transactions. Planting material is purchased from urban centers and passing balsa rafts, as well as from fellow villagers – especially in San Regis. The use of cash implies that households with greater economic endowments are at an advantage in the acquisition of cultivated plant diversity. In fact, wealthier households were found to purchase more planting material. It cannot be ascertained, however, if those households purchased more planting material because of the greater availability of cash, or because of the original higher agrodiversity in the garden and subsequent interest in maintaining and improving cultivated plant diversity.
4. Source and sink areas of cultivated plant planting material are found in the study region. The lowland study villages are sink areas – they receive considerable planting material which often is carried away by the annual flood. The region that supplies the villages with the most planting material, especially in times of crises, lies along the Nahuapa river, a tributary of the Tigre river.
5. In times of crises, such as the high flood event that occurred in 1993/1994, the trading network of planting material expands from local villages (i.e., the "soccer" network), to more distant villages and cities. Lowland study villages are particularly susceptible to periodic losses of most, and sometimes all, planting material.

Although many authors mention the potential importance of planting material exchange networks among traditional Amazonian peoples, studies on the subject matter are few. This research suggests that a wealth of information on planting material transactions waits to be uncovered. Such a focus may indeed provide new insights into studying traditional Amazonian societies and their links to each other and the market, while revealing potential strategies for on-site cultivated plant conservation.

In addition to the above findings, I find evidence in the study villages to support extant propositions in the home garden literature. The study has confirmed both of the propositions that home gardens are dominated by non-staple utilitarian cultivated plants, and frequently double as a raising ground for domesticated animals (Anderson and Ioris 1992; Marten 1992; Merrick 1992). Fruit trees and medicinals in the study villages predominate in home gardens. In fact, as diversity in home gardens increases, the majority of the increase takes place among fruit and medicinal plants. Domestic animals, especially chickens, are found in many of the home gardens in the case study villages. However, incorporating larger animals into the home garden system brings other risks that could reduce agrodiversity. Pigs in particular devour any edible plants within their range. Indeed, raising animals in the home garden may not be compatible with the home garden's role as a reserve of agrodiversity.

The role of home gardens as sites of cultivated plant experimentation (Alvarez-Buylla Roces et al. 1989; Smith 1996) and as reserves of cultivated plant diversity (Clarke and Thaman 1993) are confirmed by results of the study. Residents stated that they use the home garden to safeguard cultivated plant samples, and transplant cultivated plants from swidden fields into the home garden for this purpose. There are also some indications that home gardens are used as sites of cultivated plant domestication in the case study villages. Certain households reported having transplanted cultivated plants from the forest into their garden, whereas others tend several species of naturally occurring plants in the home garden.

Households in the study villages sold fruit from their home gardens, supporting the proposition that these gardens are a source of cash income (Caron 1995). Yet many farmers also reported buying planting material to increase cultivated plant diversity. It is much more likely that home gardens are a form of investment and food security, than a source of income.

For select households with high agrodiversity, home gardens are indeed a source of pride (Clarke and Thaman 1993; Merrick 1992) though few social activities were observed to actually take place in home gardens. In the study villages, home gardens appear to be a space for family gatherings rather than larger-scale social activities. In a broader sense of the term 'social', home gardens may indeed be important. Women share resources, and gain prestige through the reciprocal networks described in Chapter 4. Thus home gardens are a locus of social sharing.

5.2 Implications for development/conservation practice

Home gardens are identified in the literature as sites of high cultivated plant diversity, and many authors have suggested these gardens as foci for crop conservation (Gómez-Pompa 1996). Moreover, some observers believe that home gardening is a promising path for agricultural development in tropical regions (Alcorn 1992). Findings of the present study offer some guidance, and suggest the need for caution in the promotion of home gardens for conservation and development purposes.

Non-governmental organizations (NGOs) and other groups working to promote home gardens and agrodiversity face at least three challenges. First, who should be targeted? The conservation of cultivated plant diversity would require that support is given – financial or otherwise – to households that hold the highest agrodiversity. Wealthier households in the study villages are found to be more likely to manage diverse gardens. These households are most actively involved in the exchange of cultivated plant planting material, and therefore might be more interested in the conservation of agrodiversity. This finding, however, suggests a dilemma for development-conservation programs aimed at furthering both peasant livelihood and agrodiversity. On one hand, NGOs seeking to help the poorest of the population will not be working with those who can most afford to acquire and maintain the highest agrodiversity. Alternatively, by working on promoting agrodiversity with better-off households, NGOs risk widening the wealth gap between rural families.

If the aim is to find households with the most cultivated plant diversity, the best strategy would be to identify "expert farmers", such as Señora Maria in Sucre, who have a special love for plants and gardening. In the study villages, the role of home garden manager fell mostly into the hands of women – who cannot be ignored if conservation programs are to succeed. Women were observed to be more active in planting material exchanges and cultivated plant diversity acquisition. It needs to be noted, however, that home gardens are not the sole responsibility of women; many men are also active home gardeners. Indeed, the study has shown that home gardens are a result of the whole region's biodiversity through exchange networks. Moreover, this provides another reason to focus on the regional scale in biodiversity conservation.

Second, villages and/or regions need to be identified that contain a high agricultural diversity. Such villages would be found in "source areas". Villages that have fields on both the lowland and upland are likely to have a greater total (i.e. village-level) agrodiversity because cultivated plants from both habitats will be present. The results of this study indicate that lowland villages are unlikely to have the highest cultivated plant diversity, but – due to seasonal flooding of agricultural lands – cultivated plant exchange networks are more important. Highest cultivated plant diversity may be found in interfluvial areas adjacent to the floodplain, such as San Regis. In upland communities, home garden cultivated plant diversity is likely to be stable year-round. In lowland villages, however, cultivated plant diversity is highly dynamic – highest in the midst of the planting season (May to November), lowest during the seasonal floods (December to April). In the lowland, the best season to carry out cultivated plant inventories is during the low water period.

Third, cultivated plant conservation cannot succeed if the focus of efforts is the home garden alone. Indeed, home gardens in the study villages have shown that constant intervention is required to maintain cultivated plant diversity. An unattended garden will soon be dominated by wild species. In other words, home gardens need to be actively managed. Households with low home garden agrodiversity are minimally involved in the acquisition and exchange of planting material. Alternatively, households with high home garden agrodiversity participate actively in the exchange of planting stock, and are thus able to acquire and maintain the high diversity encountered in their home gardens. Without continuous involvement in planting material exchange, home garden cultivated plant diversity would likely diminish because of plants lost to disease and pests.

These three challenges clearly indicate that careful planning is needed to accommodate the complexities of traditional cultivated plant conservation practices. Home gardens could indeed be effectively used as sites of cultivated plant conservation. Conservation-development efforts, however, can only be effective if the above challenges are met.

5.3 Future research

This study provides some initial insights into the determinants of agrodiversity that may serve to facilitate efforts to conserve the agricultural genetic diversity and heritage of traditional peasant communities in the Amazon. Much more remains to be learned about home garden cultivated plant diversity, acquisition and maintenance. Several issues are worthy of further investigation.

First, further research is needed on patterns of planting material exchange of staple cultivated plants (e.g., manioc and plantain in the case of *ribereño* people). Whereas the present study examined home gardens, staple cultivated plants are crucial to the seasonal cycle of tropical agriculture. Vast quantities of planting stock are required for each new field (at intervals of approximately one to four years per household). Lowland communities are vulnerable to losses of planting material during seasonal floods. Also, many different landraces of staple cultivated plants are planted in swidden fields, some of which may be rare or unique to certain communities. Understanding the exchanges and origins of landraces maybe beneficial to agricultural conservation efforts.

Second, many villages in Amazonia are facing growing land scarcity, resulting in shorter swidden-fallow cycles and loss primary forest (Coomes and Burt 1997). Understanding the effect of land scarcity on farming intensity and cultivated plant composition of both swidden fields and home gardens may further our knowledge of the patterns and process that give rise to agricultural diversity. When land shortages arise, are home gardens farmed more intensively? Does cultivated plant diversity increase or decrease? Do the functions of home gardens also change?

Third, urbanization and its impact on cultivated plant diversity in home gardens is little studied. In San Regis, for example, home gardens were reduced in size because of competing land use in the town. Is this a common trend? Does urbanization in rural areas threaten agricultural diversity? Home gardens also exist in urban areas, and are suggested to be a potential site of agricultural diversity conservation. How do urban home gardens compared to the rural counterpart?

Finally, what is the relationship between cultivated plant diversity (and hence a more varied diet) and nutrition? If high cultivated plant diversity gives rise to improved nutrition, then the cause of cultivated plant diversity conservation my be aided by providing an additional rationale for home garden promotion. If cultivated plant diversity provides significant nutritional benefit, more households may also be willing to participate in cultivated plant conservation initiatives. A strong relationship between good nutrition and cultivated plant diversity may suggest another important implication into the effects of global cultivated plant genetic degradation.

Clearly, much still remains to be learned about cultivated plant diversity and exchange of planting material among traditional peasant farmers of the Amazon. The most important overall finding of this research project is that home gardens are typically not highly diverse, as commonly suggested in the literature and among conservation-development circles. Home gardens are highly dynamic, and local variations are inevitable. Planting stock destined for home gardens move through complex, and as yet little studied, networks of exchange which are instrumental in the building of local agricultural diversity. If home gardens are to be promoted through conservation-development initiatives, much more needs to be understood about the local variations and dynamics of the systems. This research project represents a first step in that direction.

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Appendix 1: List of Cultivated Plants Encountered, Study Area, Peru.

Vernacular Name	English Name	*Scientific Name*	Principal Use
Aceituna	Olive	*Sizigium jambolana*	Fruit
Achiote	Annatto	*Bixa orellana*	Coloring
Adam con Eva			Ornamental
Agengibre	Ginger	*Zingiber officinale*	Seasoning
Aguaje		*Mauritia flexuosa*	Fruit
Aji bolita	Hot pepper	*Capsicum sp.*	Vegetable
Ají dulce	Sweet pepper	*Capsicum sp.*	Vegetable
Aji piquante	Hot pepper	*Capsicum sp.*	Vegetable
Ajo sacha		*Mansoa alliacaea*	Medicine
Albaca	Basil	*Ocimum basilicum*	Seasoning
Algodón	Cotton	*Gossypium herbaceum*	Medicine
Amancadora			Medicine
Anona	Sweet sop	*Annona sp.*	Fruit
Arroz	Rice	*Oryza sativa*	Vegetable
Ayapana			Medicine
Bijau		*Calathea inocephala*	Vegetable
Buseta			Ornamental
Cacao	Cacao	*Theobroma cacao*	Fruit
Cactus		*Opuntia ficus-indica*	Ornamental
Café	Coffee	*Coffea arabica*	Fruit
Cahuena		*Ayapana pilluanensis*	Medicine
Caigua		*Cyclanthera pedata*	Fruit
Caimito	Star apple	*Chrysophyllum caimito*	Fruit
Camu-camu		*Myrciaria sp.*	Fruit
Caña de azúcar	Sugar cane	*Saccharum officinarum*	Other food
Capirona		*Capirona decorticans*	Construction
Carambola	Star Fruit	*Averrhoa carambola*	Fruit
Cashú	Cashew	*Anacardium occidentale*	Fruit
Cedro	Cedar	*Cedrela odorata*	Construction
Charichuelo		*Rheedia gardneriana*	Construction
Chiclayo, Caupi	Cowpea	*Vigna unguiculata*	Vegetable
Chirimoya	Soursop	*Annona muricata*	Fruit
Chonta		*Diplotropis purpurea*	Fiber
Cinamillo		*Oenocarpus mapora*	Seasoning
Ciruela		*Bunchosia armeniaca*	Fruit
Coco	Coconut	*Cocos nucifera*	Fruit
Cocona	Peach tomato	*Solanum sessiliflorum*	Fruit
Corazón de Cristo			Ornamental
Corazón de Jesús	Jesus's heart	*Caladium bicolor*	Ornamental
Cresto de gallo		*Celosia argentea*	Ornamental
Cucarda		*Hibiscus rosa-sinensis*	Ornamental
Culantro	Coriander	*Coriandrum sp.*	Seasoning
Dale dale		*Calathea allouia*	Root crop
Flor de las once		*Portulaca pilosa*	Ornamental
Frejoles		*Phaseolus vulgaris*	Vegetable
Guanabana	Soursop	*Annona muricata*	Fruit

Venacular Name	English Name	*Scientific Name*	Principal Use
Guava		*Inga spp.*	Fruit
Guayaba	Guava	*Psidium guayava*	Fruit
Guindo		*Prunus cerasus*	Fruit
Guisador	Tumeric	*Curcuma longa*	Seasoning
Hierba Luisa	Lemongrass	*Cymbopogon citratus*	Medicine
Hierba santa		*Cestrum hediondinum*	Medicine
Hoja de santa maria		*Potomerphe sp.*	Medicine
Hoja del aire		*Kalanchoe pinnata*	Medicine
Huingo	Calabash	*Crescentia tapia*	Fruit
Huito	Genipap	*Genipa americana*	Medicine
Jagua			Medicine
Lancetilla		*Peperomia rubea*	Medicine
Lengua del perro			Ornamental
Liguirilla			Ornamental
Lima dulce		*Citrus spp.*	Fruit
Limón	Lime	*Citrus aurantifolia*	Fruit
Lirio	Bytterfly lily	*Hedychium coronarium*	Ornamental
Llanten		*Plantago major*	Ornamental
Llama plata		*Lindernia crustacea*	Medicine
Macambo		*Theobroma bicolor*	Fruit
Maiz	Maize	*Zea mays*	Vegetable
Malva		*Malachra capitata*	Medicine
Mamey	Mamee apple	*Mammea americana*	Fruit
Mandarina	Tangerine	*Citrus sp.*	Fruit
Mango	Mango	*Mangifera indica*	Fruit
Maní	Peanut	*Arachis hypogaea*	Vegetable
Melón	Melon	*Cucumis melo*	Fruit
Menta	Mint	*Menta linnaeus*	Seasoning
Mishquipanga		*Geogenanthus rhizanthus*	Medicine
Mucura		*Petiveria alliancea*	Fruit
Naranja	Orange	*Citrus sinensis*	Fruit
Ojé		*Ficus insipida*	Medicine
Oregano		*Oreganum vulgare*	Seasoning
Pacay		*Inga macrophylla*	Fruit
Paico		*Chenopodium ambrosioides*	Medicine
Paiyi Rulo			Medicine
Palillo		*Campomanesia lineatifolia*	Medicine
Palma aceitera		*Elaeis guineensis*	Vegetable
Palta	Avocado	*Persea americana*	Fruit
Pampa Oregano	Oregano	*Lippia alba*	Seasoning
Pandishu	Breadfruit	*Artocarpus altilis*	Fruit
Panyagre			?
Papa	Yam	*Dioscorea sp.*	Vegetable
Papa huitina		*Xanthosoma violaceum (?)*	Vegetable
Papaya	Papaya	*Carica papaya*	Fruit
Parinari		*Couepia sp.*	Construction
Patiquina		*Dieffenbachia spp.*	Ornamental
Pepino	Cucumber	*Cucumis anguria*	Vegetable
Pijuayo	Peach Palm	*Bactris gasipaes*	Fruit
Piña	Pineapple	*Ananas comosus*	Fruit

Venacular Name	English Name	Scientific Name	Principal Use
Piñón blanco	Physic nut	*Jatropha curcas*	Medicine
Piñón colorado	Physic nut	*Jatropha curcas*	Medicine
Piri piri		*Eleuterine bulbosa*	Medicine
Plátano	Plantain, banana	*Musa spp.*	Fruit
Pomarosa	Rose apple	*Sysygium jambos*	Fruit
Repollo	Cabbage	*Brassica oleracea*	Vegetable
Retama		*Cassia reticulata*	Ornamental
Rosa cisa		*Rosa indica (?)*	Ornamental
Rosario		*Rosmarinus officinalis (?)*	Seasoning
Sacha culantro	Wild coriander	*Ernygium foetidum*	Seasoning
Sacha mangua		*Grias peruviana*	Fruit
Sacha papa	Yam	*Dioscorea trifida*	Vegetable
Sandía	Watermelon	*Citrullus lanata*	Fruit
Sangre de grado	Dragon's blood	*Croton lechleri*	Medicine
Santa maria		*Piper peltata*	Medicine
Sapote		*Quararibea cordata*	Fruit
Sharamasho		*Ocimum americanum*	Ornamental
Shimbillo		*Inga spp.*	Fruit
Shimi pampana		*Maranta arundinacea*	Medicine
Shiringarana		*Sapium glandulosum*	Medicine
Sidra		*Citrus spp.*	Fruit
Suelda		*Phthirusa adunca*	Medicine
Tamara		*Leonia glycicarpa*	Medicine
Taperiba		*Spondias cythera*	Fruit
Toé del yacuruma		*Brugmasia aurea*	Medicine
Tomate	Tomato	*Solanum lycopersicum*	Fruit
Toronja	Grapefruit	*Citrus paradisi*	Fruit
Trigo tropical	Wheat	*Coix lacryma-jobi*	Vegetable
Trujillo		*Impatiens balsamina*	Ornamental
Tumbo	Giant granadine	*Passiflora quadrangularis*	Fruit
Tutumo		*Crescentia cujete*	Medicine
Ubos		*Spondias sp.*	Fruit
Umarí		*Poraqueiba sericea*	Fruit
Ungurahui		*Oenocarpus bataua*	Medicine
Uvilla		*Pourouma cecropiaefolia*	Fruit
Verbena		*Verbena littoralis*	Ornamental
Yarina	Ivory palm	*Phytelephas macrocarpa*	Construction
Yuca	Manioc	*Manihot esculenta*	Vegetable
Yute	Jute	*Urena lobata*	Fiber
Zapallo/Zapote	Squash	*Cucurbita pepo*	Vegetable

(Sources: Duke and Vasquez 1994; Mejia and Rengifo 1995; Schultes and Raffauf 1990)

Appendix 2: Phase One Questionnaire

Encuesta general del huerto

Fecha:_______________________

Comunidad:___________________

Código de casa:_______________

Nombre y appellido del jefe:_______________________________

Planta y variedad	Uso	¿Para vender?
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		

Código de casa

Planta y variedad	Uso	¿Para vender?
23.		
24.		
25.		
26.		
27.		
28.		
29.		
30.		
31.		
32.		
33.		
34.		
35.		
36.		
37.		
38.		
39.		
40.		
41.		
42.		
43.		
44.		

Comentario:____
____
____
____
____
____
____

Tamaño del huerto (m*m):____________________________

¿Cuántos años han vivido en esta casa?__________________________________

¿Había huerto cuando Uds. han llegado?_________________________________

¿Cómo era el huerto cuando Uds. han llegado?

____

____

____

____

____

¿Cuántos años tiene el huerto?____

¿En su familia, quién se encarga más del huerto?

____

¿Cómo han obtenido el huerto? (comprado, como regalo, herencia, etc.)

____

____

____

____

____

¿Cuales eran las condiciones?

____

____

____

____

____

¿Tiene importancia económica su huerto?

Mucho Normal Nada

¿Ud. o su familia, cómo gana su vida? (quiere decir, ¿que es la actividad más importante?)____

____

____________(agricultura, pesca, caza, etc.)

Terreno

Fecha:________________________

Comunidad:_____________________

Código de casa:__________________

Nombre y appellido del jefe:__________________________________

Tipo de chacra (altura, barreal, restinga; yucal, platanal, piñal, etc)	Tiemp y dirección al terreno (p.e., 20 min. a pie, nor-este)	Superficie (m*m)

Historia demográfica

Fecha:______________________

Comunidad:___________________

Código de casa:________________

Nombre y appellido del jefe:______________________________

Por cada miembro de la familia (presente o ausente):

Genero	Edad	Relación	Donde nacido	Done vive	Ocupación

Inventario de bienes

Fecha:______________________

Comunidad:__________________

Código de casa:________________

Nombre y appellido del jefe:______________________________

	Cantidad
Máquina de coser	
Reloj de pared	
Escopeta	
Moto sierra	
Canoa (tamaño)	
Peque-peque (8hp / 16hp)	
Motor fuera del borde (25hp / 40 hp)	
Bote (capacidad)	
Red (brazos)	
Tarrafa (kg)	
Trampa (brazos)	
Radio	
Televisor	
Grupo electónico (watts)	
Trapiche	
Casa en otro lugar	
Pollos	
Patos	
Chanchos	
Ganado/bufalos	
Bodega	
Chingana	
Transferencias de dinero	
Habilitado	
Habilitador	

Appendix 3: Phase Two Questionnaire

Plantas

Fecha:______________________
Comunidad:__________________
Código de casa:_______________

Nombre y appellido del jefe:______________________________

Tipo de planta y variedad	RECIBIR: ¿de donde? ¿cuando? ¿de quien? (relacion)	DAR: ¿A quién? ¿Cuándo?	¿Si perdieron esta planta, lo quisieran obtener otra vez? ¿De quién?

Código de casa

Tipo de planta y variedad	RECIBIR: ¿de donde? ¿cuando? ¿de quien? (relacion)	DAR: ¿A quién? ¿Cuándo?	¿Si perdieron esta planta, lo quisieran obtener otra vez? ¿De quién?

Código de casa

Plantas que tenían, pero no tienen más:

Tipo de planta y variedad que no tienen más	¿Por que (o cómo) lo han perdido?	¿Por que no lo han obtenido otra vez?

Plantas que quisieran tener, pero no tienen:

Tipo de planta y variedad	¿Por que no lo tienen?

Encuesta general del derrumbe en Sucre y Nuevo Miraflores en 1993/4

Fecha:_______________________
Comunidad:____________________
Código de casa:_________________

Nombre y apellido del jefe:________________________________

¿Ud. estaba en este caserío cuando ocurrió la crisis? Si No

Cómo afectó la creciente a Ud. y su familia?

¿Qué pasó a su huerto

¿Ud. ha perdido plantas del huerto durante la crisis? Si No

¿Cuáles?

¿Despues de la crisis, de donde y de quién ha adquirido las plantas?

Aparte de cause del derrumbe, ¿ha perdido gran cantidad de plantas?

¿Cuándo y por qué?

Durante el derrumbe, ¿ha perdido plantas de sus chacras también? ¿Cuáles?

¿De donde y de quién lo ha adquirido despues de la inumdacion?