

## ABSTRACT

DAWSON, NEVIN SCOTT. *Counting Down To Change: Identifying Early Adopters and Effective Extension Multipliers of Cashew Agroforestry in Senegal.* (Under the Direction of Erin O. Sills.)

Soil degradation, persistent drought, and a decline in peanut prices combine to put Senegalese farmers in a difficult position. To avoid a complete system collapse, many have called for a shift in emphasis from production to resource conservation and regeneration with the participation of rural populations (Advisory Committee on the Sahel et al., 1986; Cook, 1989; Rodale Institute, 1989; Chemonics International Inc., 2000; Franzel and Scherr, 2002). Cashew (*Anacardium occidentale*) alley-cropping represents an ideal opportunity for restoring soils while maintaining productivity, but farmers take time to adopt such new technologies. Some farmers are naturally more receptive to these new ideas than others (“early adopters”), and some farmers are more likely to encourage others to try new ideas (“effective advisors”). This thesis defines and identifies observable characteristics of these two types of farmers, arguing that they are the best extension multipliers and therefore good points of contact for extension agents to effect quick diffusion of the innovation through the village. This thesis contributes to the literature first, by considering time of adoption using quantitative methods that have typically been applied only to the decision whether or not to adopt at a particular point in time, and second, by incorporating into the model spatial and social relationships that are often ignored in adoption literature. The study was conducted in two small farming villages in the Sine-Saloum region of Senegal—Mamouda and Simong. I lived in Simong for nine months and learned about the local culture and environment (June 2003-February 2004). I returned for three months of interviews and spatial data collection (February-April 2005). Qualitative and spatial data were analyzed, and quantitative data

were used to estimate survival and probit regression models for time until cashew adoption, and OLS models for advisor effectiveness in cashew promotion. It was found that an effective extension multiplier will have assets and land with which to absorb any possible costs of failure, will have fields that are highly visible and centrally located in an area appropriate for cashew production, will be in the elder age class (> 60 years old), and will be socially well-placed as an advisor to many and an advisee to none. Understanding the characteristics of early adopters and effective advisors will allow extension agents to quickly identify the few farmers who are most likely to adopt on the advice of an outsider and without the prior sanction of their peers, and who will then demonstrate and extend the innovation with little outside assistance. Focusing efforts on these key players should increase the effectiveness of the agent's time spent in the village, and after a successful training and trial, the new technology should then spread with little further intervention through farmer to farmer contacts (Advisory Committee on the Sahel et al., 1986; Bunch, 1982; Rodale Institute, 1989). This should result in a quicker and more effective impact of extension on the welfare of these poor farming communities.

**COUNTING DOWN TO CHANGE:  
IDENTIFYING EARLY ADOPTERS AND EFFECTIVE EXTENSION  
MULTIPLIERS OF CASHEW AGROFORESTRY IN SENEGAL**

by

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A thesis submitted to the Graduate Faculty of  
**North Carolina State University**  
in partial fulfillment of the  
requirements for the Degree of  
Master of Science

**FORESTRY & ENVIRONMENTAL RESOURCES**

Raleigh, NC

2006

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## **BIOGRAPHY**

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## ACKNOWLEDGEMENT

My sincere gratitude to my friends and neighbors new and old; to Caren for her dear friendship and council; to the 3016 crew, BJ, Nia, Liz, and Jill, for their constant source of distraction and encouragement; and again to Nia for her econometric prowess; to my family for their unfaltering support of my various life choices; to Fodé for his accurate advice and analysis; to my committee for their help and flexibility; to Kelly for her pioneering spirit and shining example; to Erin for her unwavering guidance, humble yet awesome knowledge, and tremendous capacity for understanding; to Aziz Diatta for his hospitality and enthusiasm; to Keeba Sane for his refusal to accept payment for his vital help with my fieldwork; to my Senegalese host father and Touré koundankol bee for keeping me sane in a crazy new world; and most of all, to all the people of Simong and Mamouda, without whose enthusiasm for cashews and glad acceptance of strangers this study and life-changing experience could never be possible.

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## **LIST OF DEFINITIONS**

ADVISEE -- A farmer listing a certain advisor as a source of advice. One advisee may have multiple advisors.

ADVISOR -- A villager listed by one or more farmers as a source of advice. An advisor is also an advisee if he himself listed any advisors.

ELDER -- A male in the oldest age class, greater than 60 years.

EXTENSION MULTIPLIER -- A villager chosen as a contact point by an extension agent who will demonstrate and extend innovations with little outside assistance.

FARMER -- A villager with full use rights to at least one parcel of land (field).

VILLAGER -- A resident of either study village.

## **1. INTRODUCTION & LITERATURE REVIEW**

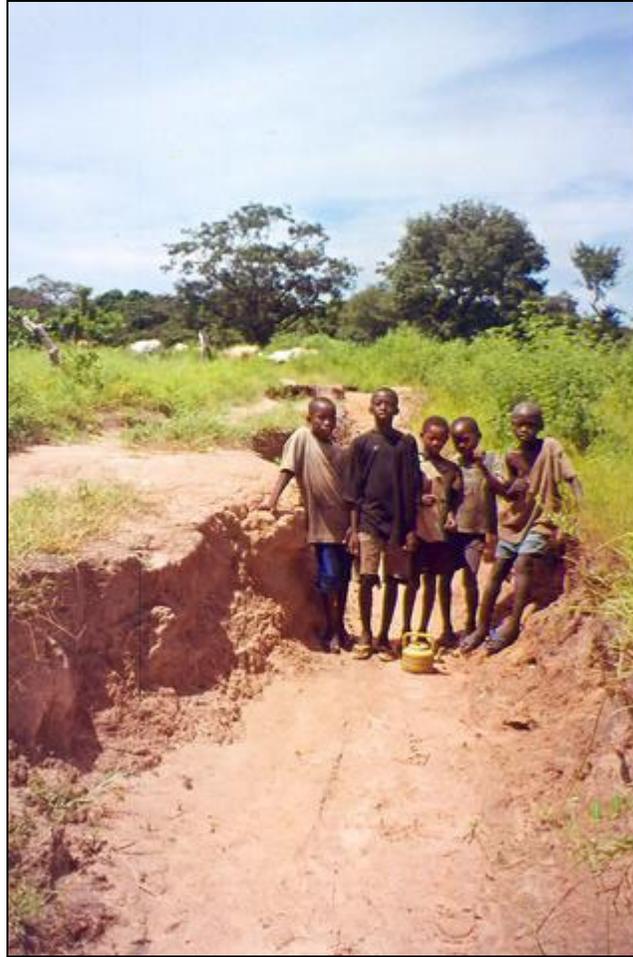
Soils are the raw material from which farmers reap the livelihoods for themselves and their families. Africans have been farming for centuries and developed a balance with the environment long ago. Increased population pressure and advances in technology have upset this balance through more intense utilization, leading to severe soil degradation. This is a primary reason for the promotion of agroforestry by development agencies. Cashews in particular offer an opportunity to restore soils while providing income to farmers equal to or greater than that of the peanut crops they would replace. This thesis explores the dissemination of cashew-based agroforestry in Senegal.

The mechanization and animal traction promoted by early government extension efforts in Senegal have allowed farmers to increase production through the expansion of land area that is farmed each year, but at the expense of fallow time and tree abundance (Rodale Institute, 1989; Chemonics International Inc., 2000). The amount of planned fallow has decreased from 12% of arable land in 1979 to 1% in 1983 in the Sine-Saloum region. Where fields were once allowed to “rest” for 5-7 years at a time, developing enough biomass to replenish levels of organic matter depleted by farming, fallow is now limited to 1-2 years and generally to times of seed shortage (Rodale Institute, 1989). By another account, the traditional rotation schedule was 3-4 years of cultivation followed by 15-20 years of fallow (Advisory Committee on the Sahel et al., 1986). Attempts to include periods of fallow in field management are often interrupted by claims for seasonal tenure by land-poor farmers. These claims must usually be granted under a cultural “subsistence ethic” policy, in which land-rich

farmers must assist land-poor farmers in maintaining subsistence levels of production (Grigsby, 2002). Without the fallow time long enough for periodic regeneration, the sandy Dystric Nitisols (Development Ecology Information Service, 2005) soon lose much of their fertility and capacity for production (Rodale Institute, 1989). Lack of non-crop vegetative cover during the wet season allows for intense water erosion in the region (Figure 1.1) (Chemonics International Inc., 2000). The common practice of removing crop residue for construction and fodder compounds the soil fertility problem, removing valuable nutrients (Gray, 2005) while leaving soils bare and exposed to wind erosion for the entire dry season (Rodale Institute, 1989). A persistent drought<sup>1</sup> since the late 1960s (Pfeiffer, 1987) and the mid-1970s drop in the market price for peanuts (Badiane and Kinteh, 1994), the primary cash crop in the region, add to the severity of the situation that Senegalese farmers currently face. These conditions compel farmers to search for ways to diversify their economic activities (Schroeder, 1999b).

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<sup>1</sup> For the Sine-Saloum region, long-term average: 800-950 mm/yr; short-term average: 600-750mm/yr (Rodale Institute, 1989).



**Figure 1.1. Children demonstrate the extent of water erosion on a slope. (Dawson, 2005)**

These facts paint a picture of massive human-led environmental degradation in Senegal, but the situation is not hopeless. While other Sahelian regions must cope with irreversible desertification, Senegal's landscape has not yet crossed the threshold between 'degraded' and 'desert', meaning that there is hope for recovery. Nevertheless, many have called for a paradigm shift from production to resource conservation and regeneration with the committed participation of rural populations to avoid a complete system collapse (Advisory Committee on the Sahel et al., 1986; Cook, 1989; Rodale Institute, 1989; Chemonics

International Inc., 2000; Franzel and Scherr, 2002). Cashew (*Anacardium occidentale*) alley-cropping represents an opportunity for restoring soils while maintaining productivity, but some farmers have only recently begun to plant cashews despite their long-standing availability in the region. The rate at which this innovation spreads is in part dependent on the ability of extension agents to persuade villagers of its benefits. Some villagers are naturally more receptive to these new ideas than others, and therefore make better points of contact for agents looking to establish demonstration plots in a new village. Other villagers are advisors and pre-existing sources of council for village farmers, some of whom have more early-adopting advisees than others. These advisors are more likely to promote new technologies, and/or are more effective at promoting these technologies. They therefore make good points of contact to effect quick diffusion of the innovation through the village. Identification of villagers who are both innovative and advisors is not always straightforward, as the most innovative in a community can sometimes be social outcasts, and the most respected advisors are often unwilling to risk trying something new (Rogers, 1995). Once the appropriate extension multipliers are identified and an agreement for a demonstration plot is reached, planting may begin. Demonstration plots allow innovations to be displayed in small pieces that show farmers that they do not have to completely change their farm management system in order to adopt. In this way demonstration plots are an effective means of extension (Kerkhof et al., 1990).

An understanding of the characteristics that separate innovators and early adopters from laggards<sup>2</sup> will allow extension agents to quickly identify the few farmers most likely to adopt

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<sup>2</sup> Rogers' (1995) term "laggards" has some unavoidable negative connotations, e.g. someone who wastes time or who is a "stick in the mud". No ill will is intended towards these late adopters who likely have valid reasons

on the advice of an outsider and without the prior sanction of their peers. Identifying characteristics of advisors who are effective in promoting cashew adoption will further narrow the pool of farmers from which to choose the ideal extension multipliers, or the villagers chosen as contact points by extension agents, who will demonstrate and extend the innovation with little outside support. Focusing efforts on these key players may increase the effectiveness of the agent's time spent in the village, and after a successful training and trial, the new technology should then spread with little further intervention through farmer to farmer contacts (Advisory Committee on the Sahel et al., 1986; Bunch, 1982; Rodale Institute, 1989; Caveness and Kurtz, 1993). The flow of information through farmer to farmer channels is also less subject to the culture and trust barriers present when an unfamiliar government agent or project technician attempts to extend new information (Chemonics International Inc., 2000). This mode of operation in extension planning will result in a quicker and more effective impact on the welfare of these poor farming communities. The lessons learned in this research should have the potential to facilitate change not only in agroforestry outreach, but also in broader efforts in sustainable agricultural development (Franzel et al., 2002).

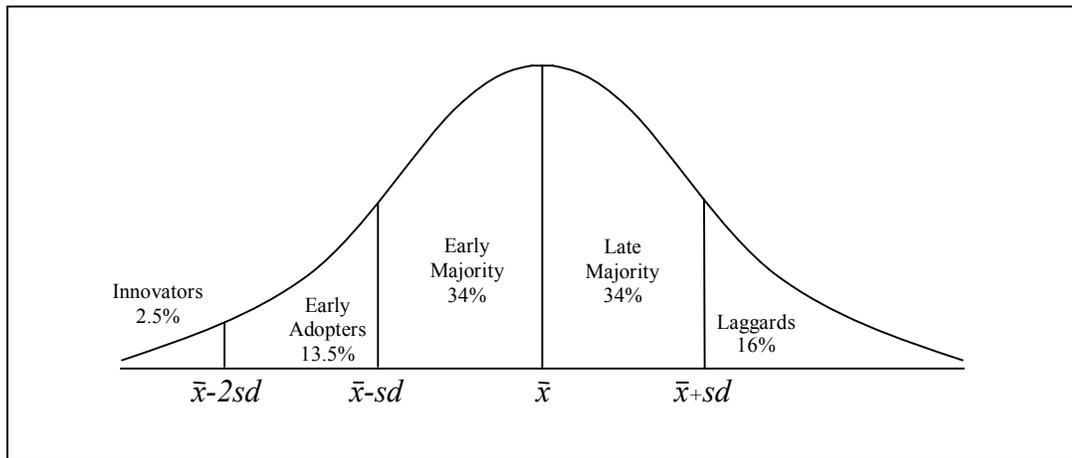
Rogers (1995) defines time to adoption as a measure of innovativeness, and delineates five adopter categories (Figure 1.2). This thesis is also a study of the factors that determine a farmer's place among these categories as defined by their adoption of cashew alley-cropping. The same data and analyses used to identify early adopters and effective advisors are also used to describe and explain patterns of adoption over time, but with the addition of

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for waiting to adopt (see Vanclay and Lawrence, 1994), and it is assumed that any word used would carry similar implications.

qualitative data to explain apparent trends in more depth. This approach is in contrast to a typical empirical adoption study, in which a binary adopt/reject decision is modeled (Pattanayak et al., 2003). Pattanayak et al. (2003) identify five categories of adoption determinants that describe the types of variables usually used in these binary models: farmer preferences, resource endowments, market incentives, bio-physical factors, and risk and uncertainty. Udry and Conley (2005) have studied an additional aspect of adoption, social interaction. Using data on farmer communication patterns, they found that social networks play an important role in farm management decisions when farmers are still unsure of the characteristics of a new crop. They mention that social relationships are difficult to determine and spatial relationships are therefore often used as a proxy. Case (1992) also finds that farmers act upon information gleaned from social contacts, but uses spatial neighbors to define these contacts rather than declared social networks. She argues that omission of these factors from adoption models biases estimations for other variables that may have innate regional influences such as education. Case also mentions the lack of consideration for interaction between farmers in traditional time to adoption literature, and calls for future study to determine whether it might not be a neighbor's attitude toward a new technology that influences a farmer but rather their act of adoption. This study contributes to the literature by bringing together these various strands, considering time of adoption using quantitative methods that have more often been applied to a binary adoption decision, and incorporating spatial and social relationships that are often ignored in adoption literature. Qualitative data are considered in tandem with these results to triangulate conclusions on the extension and diffusion of cashew agroforestry in Senegal.

The combination of qualitative and quantitative methods used in this study follows Rao and Woolcock’s (2003) recommendations for participatory econometrics.<sup>3</sup> This practice allows for change in initial research questions and quantitative hypotheses as the researcher’s understanding of the field situation evolves. This approach allows for the identification and integration of pressing issues which may not have been reflected in prior literature. They posit that in areas such as rural Africa the sole use of quantitative methods without the balance of qualitative methods would fail to identify the cultural ramifications of the study, while qualitative methods alone would not be rigorous enough to garner support, financial or otherwise.



**Figure 1.2. Adopter categorization on the basis of innovativeness (Rogers 1995, p. 262)**

<sup>3</sup> “Participatory econometrics works on the premise that the researcher should begin a project with some general hypotheses and questions, but an open mind regarding the results and even the possibility that the hypotheses and questions themselves may be in need of major revision; that the researcher should both collect and analyze data; that respondents should be actively involved in the analysis and interpretation of findings; and that it is desirable to make broad generalizations and discern the nature of causality—and that as such relatively large sample sizes are likely to be needed, and the tools of econometrics employed on them.” (Rao and Woolcock, 2003)

The study was conducted in two small farming villages in the Sine-Saloum region of Senegal—Mamouda and Simong. As a Peace Corps volunteer I lived with a family in Simong for nine months and learned about the local culture and environment (June 2003-February 2004). I later returned for three months of interviews and spatial data collection (February-April 2005).

Chapter 1, Introduction and Literature Review, presents background information from the literature on cashews, their benefits, and their markets; risk and uncertainty; social vs. spatial determinants; other adoption determinants; and the importance of this study's emphasis on time until adoption. Chapter 2, Background, introduces the two study villages and provides ethnological information as well as the specific role of cashew adoption and cultivation in these villages. Chapter 3, Methods, enumerates the three types of data collection used in this study—spatial survey, qualitative survey, and quantitative survey—and the analysis that followed, including empirical regression models. Chapter 4, Results, gives the output of the analyses described in the preceding chapter. Chapter 5, Discussion and Implications, discusses the significance of the results and makes recommendations for policy changes and future study.

### **1.1. Cashews as a solution**

Cashew alley-cropping offers a solution to the problem of soil degradation facing Senegalese farmers. Beside the wide range of specific benefits cashew trees offer, alley-cropping is an extension of normal farming practices that is in keeping with existing knowledge and techniques. This compatibility may result in easier acceptance by farmers that cannot cope

with the risk inherent in more radical schemes for restoration (Advisory Committee on the Sahel et al., 1986). Cashews also demand less time, labor and fewer inputs than other tree crops (Papademetriou and Herath, 1998). This section first gives a general account of the cashew tree and its cultivation, and then details the specific benefits of cashew trees for both soil and other aspects of rural Senegalese farming and life.



**Figure 1.3. Cashew apples and nuts.** (Dawson, 2005)

#### *1.1.1. The Cashew*

Cashew trees were first introduced to West Africa from Brazil in the 15<sup>th</sup> and 16<sup>th</sup> centuries by Portuguese travelers (Azam-Ali and Judge, 2001). Organized planting in Senegal began during WWII for erosion control along the coast (Mandal, 2000). Trees are evergreen and up to 12 m tall and 25 m in diameter (Azam-Ali and Judge, 2001), with low creeping branches when left unpruned (Figure 1.4). The root system is twice the size of the canopy, and extends 3-4 m into the ground, sometimes providing access to a subsoil water supply (Mandal, 2000). This trait allows for high drought tolerance and subsistence on rainfall of as little as 500 mm per year, but 889-3048 mm is the optimum range (Azam-Ali and Judge,

2001; Mandal, 2000). Deep sandy loam and red soils are best for high production (Azam-Ali and Judge, 2001).



**Figure 1.4. Cashew branches “creeping” along ground. (Dawson, 2005)**

Improved varieties common in the Sine-Saloum region will produce the first fruit in the second year, but it is best to remove these flowers and allow the tree to devote resources to growth until the third year. The first fruits ripen in late March several months before the wet season begins, and harvest continues for about three months. Cashew kernels (the portion that the average consumer is familiar with) are enclosed in a tough casing; together these are referred to as the nut, which is attached to the bottom of a fleshy pear-shaped apple (pseudocarp). Harvesting may continue for more than 25 years (Pfeiffer, 1987) at approximately 10 kg nuts/tree (Falzetti and Faure, 1984). Yield can vary from 2-25 kg nuts/tree depending upon spacing, age, variety, ecological conditions, and management practices, and can average 1000-1500 kg nuts/ha (Mandal, 2000).



**Figure 1.5. A farmer and his helper separate cashew nuts from the apples. Apples can be seen sun-drying in the background. {{77}}**

The apple and nut are harvested by hand, both off the ground and off the tree, and the nut is then twisted off (Figure 1.5) (Mandal, 2000). One person can harvest around 50 kg/day (Azam-Ali and Judge, 2001). Labor use can be inefficient before trees reach maturity or if holdings are very small, as nuts must be collected at least twice a week to prevent rot after dropping to the ground once the rains have begun. This practice could mean long travel and search times for less than 50 kg of nuts in a day for immature trees (Azam-Ali and Judge, 2001).

In Senegal, the nut can be sold unprocessed for export after drying, or to village women for processing and then domestic sale as edible kernels. Alternatively, farmers can pay women to do the processing and then sell the kernels themselves. The manufacture and distribution of specialized cashew kernel extraction machines is currently being promoted in Senegal by several non-governmental organizations (NGOs), but has not yet been introduced to the study area (Ba, 2005). Rather, the nuts are roasted and then the charred casing is removed by hand. This leaves a papery shell on the kernel, which the women processors charge more to remove. The kernel can also be sold with this remaining shell at a lower price. Kernels are sometimes roasted a second time after the inner shell has been removed, but this additional process does not increase their value; they are simply a darker variety.

#### *1.1.2. Cashew establishment*

Alley-cropping is an agricultural system in which rows of trees are interspersed among rows of traditional field crops. In the study region, alley-cropping generally refers to rows of cashews spaced 10-20 m apart with a field crop grown between. This practice can continue for 6-10 years, the rows of cashews growing wider and encroaching more and more upon the intercropped crops, until the farmer must make a decision. He<sup>4</sup> may allow the cashews to continue shading out the intercrop until the canopy closes and the field becomes a cashew orchard, or begin pruning to maintain the viability of the intercrop.

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<sup>4</sup> I use the male pronoun when referring to farmers because almost all cashew growers in my data are men (see section 2.3.3 below).



**Figure 1.6. Young cashew alley-cropping with millet between rows and mature cashews in background.**  
(Dawson, 2005)

Capital required for installation of alley-cropping with cashew is minimal or zero, but the labor required for establishment can be a limiting factor, as establishment activities take place during the wet season when other agricultural work is at its peak. Seeds are available locally from friends, relatives, or the market, and can be sown directly in the fields soon after the rains begin. For a higher survival rate, seedlings can be grown in special tree sacks in a nursery, weeded once or twice, and then outplanted as the end of the wet season approaches. More labor is required for this method, but free sacks can be acquired at the nearest government *Eaux et Forêts* agency about 20 km away, the cost of travel to which can be dispersed among multiple households.

Survival rate is also highly dependent upon the effort dedicated to the care of cashews during the first three years. The most successful cashew fields have a weeded firebreak around the entire field as well as around the individual seedlings (Mandal, 2000). Despite this, a cashew crop can still be productive and marketable with haphazard planting and infrequent care, due

to the lack of market specifications on kernel size and quality, and the general hardness of the tree (Cambon, 2003).

### *1.1.3. Benefits*

Many physical and economic aspects of cashew trees make them an attractive option for alley-cropping. This section first highlights the uses most relevant to the study site, and then completes the list with benefits of which villagers are generally unaware or for which the infrastructure or markets for their exploitation are inaccessible. The primary benefit, sale of the cashew nut or kernel, is discussed in the following section.

A line of cashew trees serves as a firebreak, its dense canopy shading out weeds that could fuel an approaching blaze.<sup>5</sup> This is important in the Sahel, where seasonal fires often damage crops and endanger villages. Any trees planted in agricultural fields will serve as a windbreak (Advisory Committee on the Sahel et al., 1986; Pfeiffer, 1987). This reduction of wind speed is especially important with the region's flat terrain allowing for high wind speeds and the prevalence of spindly 2.5 m tall millet, which is very susceptible to wind damage (Stigter et al., 2002). The benefits of both fire- and windbreaks extend beyond the boundaries of the alley-cropped plots to benefit neighbors as well as owners.

Pruned branches serve as a source of fuelwood that reduces both collection time and pressure on nearby forests. Trees can serve as habitat for animals and thereby increase the availability of bush meat (Advisory Committee on the Sahel et al., 1986).

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<sup>5</sup> Fallen leaves must be raked in order to make cashews an effective firebreak, but leaf-raking is commonly practiced anyway for ease of fruit collection and to deter snakes, and is much less labor-intensive than creating a firebreak through weeds.

Although cashew apples are difficult to market without processing due to quick spoilage (Mandal, 2000), they are an important nutritional supplement as they are very high in vitamin C, calcium, and iron (Azam-Ali and Judge, 2001; Pfeiffer, 1987). They are also recognized as an effective purgative (Mandal, 2000). While kernels are generally sold rather than consumed, they are sometimes snacked upon and provide high levels of fat and protein (Figure 1.7) (Azam-Ali and Judge, 2001).



**Figure 1.7. Children process cashews for snacking.** (Dawson, 2005)

Soil restoration capabilities are especially valuable in fields that have been subjected to many years of peanut farming with limited fallow and the removal of crop residue for fodder and building, practices that lead to severe degradation (Chemonics International Inc., 2000).

Nutrients are the limiting factor in growth rather than water in regions that average more than 300 mm of rain per year, which is the case with the study region (Breman, 2001). Nutrients should therefore be the focus of any attempt at soil amelioration. Tree roots reach deep into the soil and are able to bring nutrients that crops are unable to reach to the surface. These nutrients collect in the leaves and are cycled into the topsoil after leaf-fall (Advisory Committee on the Sahel et al., 1986). The addition of organic matter to the soil in this way leads to the increasing availability and efficiency in use of nutrients and water, and is therefore an essential component to soil restoration. Trees also concentrate nutrients through atmospheric deposition and interception, and store nutrients through the dry season that would otherwise be harvested or blown away if instead absorbed by annual plants.

Perennials are able to take advantage of the entire length of the wet season for nutrient absorption, whereas the growing season for annuals is limited to time of planting to time of harvest (Breman, 2001). Widespread perennial root systems also physically stabilize soil and reduce erosion while facilitating rain infiltration and maintaining soil moisture (Advisory Committee on the Sahel et al., 1986; Mandal, 2000). As long as too much biomass is not harvested from trees,<sup>6</sup> their cultivation will lead to an increase in biomass and nutrients in the soil as well as a reduction in erosion (Breman, 2001).

In addition to physical and environmental benefits, cashew alley-cropping provides operational and economic advantages to adopting farmers. The changeover from

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<sup>6</sup> Fruit harvest has little impact on the effectiveness of the benefits mentioned above (Breman, 2001).

monocropping to alley-cropping takes up to 10 years as the trees grow and shade out more and more of the intercrop. This gradual change allows for adjustments in variables like labor allocation and consumption habits to be made slowly and without the large errors that can accompany drastic sudden changes. The relatively early ripening of cashew fruit allows for its harvest to begin before the cultivation of other crops begins, thus spreading labor out from the bottleneck normally present at the onset of the wet season (Azam-Ali and Judge, 2001). Cashew harvesting is relatively non-strenuous and can be performed by children who would oftentimes be otherwise unemployed (Mandal, 2000). The productivity of both cashews and peanuts is dependent on rainfall to some extent, but peanuts more so than cashews. Cashews are therefore a more dependable source of income in years of low rainfall (Azam-Ali and Judge, 2001; Rodale Institute, 1989). This additional stability is very valuable in these near-subsistence level communities (see section 1.2.1 below). As with any diversification, the addition of cashews to a farming system will increase its ability to absorb shocks from market failure, low prices, and pests or pathogens (Advisory Committee on the Sahel et al., 1986; Current et al., 1995).

Many other products can be made from all parts of the tree, but these uses remain to be developed in Senegal. Some may have been outmoded by modern synthetic products, but others may only require rediscovery.

There is a potential for the development of marketable apple products such as preserves, jam, several types of juices, vinegar, candy, pickles, chutney, and dried fruit (Nanjundaswamy et

al., 1979; Pfeiffer, 1987). The Union of Agricultural Groups of the Sine-Saloum (UGAB<sup>7</sup>), a Senegalese non-governmental organization, is currently extending some of the processing techniques for these products. Wine and brandy can also be made from cashew apple juice and a liquor from the juice of the stem, but the majority Muslim population of Senegal would not provide a market for these products, as alcohol is prohibited by Islam (Rao, 1979; Mandal, 2000). Young leaves are edible as a fish flavoring or as a salad (Mandal, 2000).

A dye can be produced from leaf and bark tannins, a varnish from the fleshy stem, and bark fluid can be used in the manufacture of indelible ink (Mandal, 2000). Cashew Nut Shell Liquid (CNSL) is a raw material used in the production of brake linings, paint and varnish, laminated products, foundry core oil, and rubber compounding. Further development may prove it to also be useful in drugs, antioxidants, and fungicides (Murthy and Sivasamban, 1979). The gum exuded by cashew trees is an insect repellent adhesive used in book binding (Bose and Biswas, 1979). Cashew wood is suitable for light construction and charcoal (Mandal, 2000).

Many different medicinal products can be derived from various parts of the tree including an astringent; a purgative; tooth powder; and treatments for leprosy, warts, worms, ulcers, ring worm, dysentery, diarrhea, and piles (Mandal, 2000).

In summary, cashews add the third dimension to a previously flat landscape and thereby stabilize and restore environmental factors, while also stabilizing income and providing potential for new sources of income beyond the cashew nut itself.

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<sup>7</sup> l'Union des Groupements Agricoles de Niombato

#### *1.1.4. Cashew Market in Senegal and the World*

The primary benefit of cashew trees is the sale of their raw nuts (sun-dried only) or processed kernels (ready for consumption). The world market for raw nuts has seen a steady increase over the past several decades, with the US as the top consumer (Azam-Ali and Judge, 2001; Mandal, 2000). Senegal is the 10<sup>th</sup> largest producer of raw cashew nuts in the world with a total of 12,000 tonnes in 2002. Although this only composes about 1% of the total world production, Senegal is predicted to increase its production more than twofold to 30,000 tonnes by 2010 (Cambon, 2003). Africa as a whole produces 36% of the world's cashews (Azam-Ali and Judge, 2001). Most of Senegal's cashew production occurs in the Casamance, the region south of The Gambia (1.8), but the Sine-Saloum region produced 15% of the country's total. Senegal's production alone is not yet enough to attract large processors and exporters, but its proximity to Guinea Bissau, the fifth largest producer in the world, allows access to markets that would otherwise be off-limits to such a small producer. Some traders have spread from Guinea Bissau into Senegal itself for reasons of security and finance (Cambon, 2003). Senegal's market is completely liberalized with no bans or taxes on raw cashew exports, compared to the 13% tax in Guinea Bissau. Senegal's no-tax policy was initiated in 1986 by the Senegalese-German Cashew Project<sup>8</sup> (PASA) in an effort to encourage cashew adoption throughout the country (Cambon, 2003).

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<sup>8</sup>*Projet Anacardier Sénégal-Allemand*

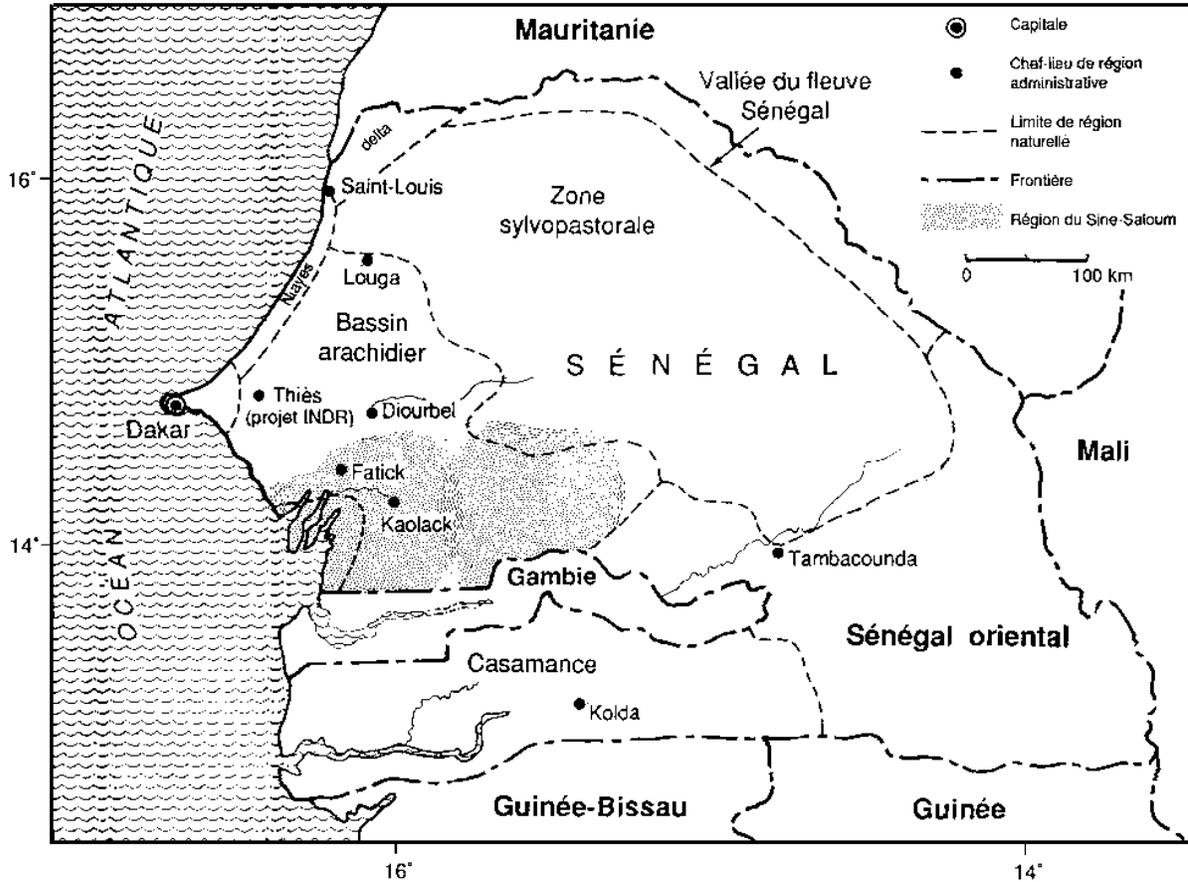


Figure 1.8. Senegal's biophysical regions with the Sine-Saloum shaded. (Buldgen et al., 1992/3)

Senegal exports 90% of its cashew nuts in raw form to Kerala, India where they are added to India's domestic production and processed for export (Cambon, 2003). Processed cashew kernels are a high value luxury commodity with a steady 10% increase in global sales per year, but Senegal has yet to access this market directly due to the inconsistent quality that comes with small scale hand processing (Figure 1.9) (Cambon, 2003). Enterprise Works is an NGO working in the Casamance to mechanize processing and standardize a high-quality product for export (Figure 1.10) (Cambon, 2003). Enterprise Works processors made their first shipment to Europe of 700 kg of processed kernels in 2004 (Enterprise Works, 2005).

The US has a strong influence over the world kernel price, and was paying \$7.2 USD/kg freight on board in 1999 for the popular W320 grade.<sup>9</sup> Cashew prices are stable in the long term and are subject to short term variation (Azam-Ali and Judge, 2001), but kernel prices are more stable than those for nuts in this respect. Kernel prices varied by 20% over three years (Figure 1.10), while nut prices fluctuated between 50 and 100% in the same time period. Following this trend, world kernel prices have declined recently, although raw nut prices have remained stable (Cambon, 2005).



**Figure 1.9. Mamouda women shell roasted cashew nuts. (Dawson, 2005)**

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<sup>9</sup> 320 whole kernels per pound.



Figure 1.10. Women learn machine cashew shelling in Enterprise Works training. (Ba, 2005)

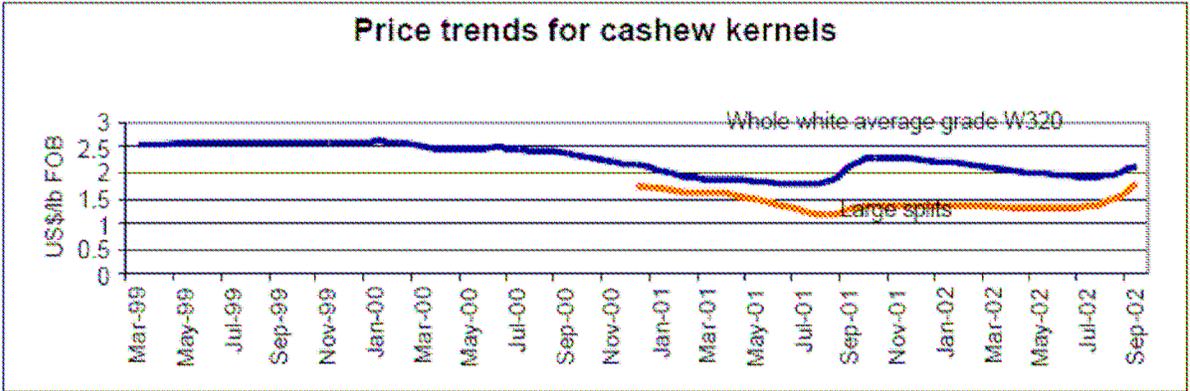


Figure 1.11. Price trends for cashew kernels (Cambon, 2005 p. 12).

## 1.2. Adoption

### 1.2.1. Conceptual adoption model

Drawing on the household production and agroforestry adoption literatures (Zeller et al., 1998; Pattanayak et al., 2003; Mercer, 2004), the following conceptual model describes the role of cashews in a typical Senegalese village with both cash and subsistence crops.

Variables are defined in Table 1.1 below.

Assume

- Farmers seek to maximize their utility, which is a function of
  - subsistence crop yield, a component of the household's daily diet;
  - cash income, allowing purchases of supplemental staples, fish and vegetables, clothing, medicine, and household goods; and
  - leisure time, or time not spent on work outside of the home.
- There is no market for subsistence crops
- Production of subsistence, cash, and tree crops all require labor, but only subsistence crops require fertilizer inputs
- Transaction costs are proportional to quantity of cashews sold ( $\tau$ ); there are no transactions costs for traditional cash crops because the commercialization channels are well established
- External income (wage labor) does not conflict with tree or subsistence crop production (different seasons)

$$\text{Max:} \quad U = u(S, Y, \ell) \quad (1)$$

$$\text{Subject to: } S = H_S(L_S, K_S) * A_S \quad (2)$$

$$F = H_F(L_F) * A_F \quad (3)$$

$$C = H_C(L_C) * A_C \quad (4)$$

$$Y = P_F * F + P_C * C - P_K * K_S - \tau(F) + X \quad (5)$$

$$A = A_C + A_S \quad (6)$$

$$L = L_S + L_F + L_C \quad (7)$$

$$T = \ell + L \quad (8)$$

**Table 1.1. Model variable definitions.**

S	= subsistence crop total yield
Y	= income
$\ell$	= leisure time
H	= yield/unit area
L	= labor time
K	= capital input (e.g. fertilizer)
A	= area
F	= tree crop total yield
C	= cash crop total yield
P	= market price
$\tau$	= transaction costs
X	= other income
T	= total time in wet season

Although there is no labor market, a household's labor resource is valuable for its role in the cultivation of subsistence crops and peanuts during the wet season as well as many dry season activities. Because the optimum time for seeding and planting cashews is also during the wet season, there is a conflict of labor needs if adoption is to take place (Azam-Ali and Judge, 2001). Assuming a limited labor supply and that crop yield is proportional to labor and capital input, the cost of adoption is equal to the utility of the reduction in yield of subsistence crops plus the reduction in income from peanuts. The price of adoption is defined as follows for the wet season in which adoption occurs:

$$P_A = U_{AS} + U_{AC} \quad (9)$$

Where:  $U_{AS} = U(H_S(L_{AS}) * A_S) \quad (10)$

$$U_{AC} = P_C * (H_C(L_{AC}) * A_C) \quad (11)$$

$$L_{TOTAL} = L_{AS} + L_{AC} + L_S + L_C \quad (12)$$

Where A is adoption, and  $L_{AS}$ , and  $L_{AC}$  are labor that would be used for subsistence crops and cash crops respectively if the technology were rejected, but were instead allocated to adoption activities.

### 1.2.2. Risk & Uncertainty

Even in cases of innovations and new technologies with benefits to the farmer that research has shown to vastly outweigh the costs, potential users must believe this for themselves before they will make the decision to adopt (Advisory Committee on the Sahel et al., 1986). That is, even in the case of an ideal innovation, uncertainty is still a potential barrier to adoption. This section outlines the role of risk and uncertainty in a farmer's decision to adopt.

In any case of new technology, a potential user will not adopt until they have reduced uncertainty<sup>10</sup> to an acceptable level through learning about the new technology, as its characteristics usually will not initially be transparent to the new user (Abadi Ghadim et al., 2005; Evenson and Westphal, 1995). Potential users may be uncertain about both level and

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<sup>10</sup> I will use Knight's (1921) distinction between risk and uncertainty, in which *risk* is a probability distribution calculated using objective data, whereas *uncertainty* is a subjective estimate of probability based on hearsay. It is important to note that it is the subjective uncertainty that is the deciding factor in a farmer's thinking, regardless of the objective risk (Lipton, 1978).

variability of economic return; for example the yields and/or prices of a new crop may vary due to climate, pests/pathogens, or other external forces (Wharton, 1969). After an understanding of the technology's performance characteristics has been reached through observation or trial, a potential user becomes more certain of the actual risk associated with the technology, and adoption may take place if this level of risk is acceptable to the user (Abadi Ghadim et al., 2005).

The information exchange required for this process may be facilitated by the formal education and extension sectors, but it is also often a result of social interaction with peers (Rogers, 1995; Udry and Conley, 2005; Vanclay and Lawrence, 1994; Case, 1992). The nature of this interaction may be explicit conversations on the costs and benefits of the new technology, but may also take the form of silent observations in the field (Lindner et al., 1982). Social relationships, or a network of paths through which explicit learning may take place, can be difficult to identify, and many studies rely on spatial neighbor relationships as a proxy for social relationships (Caveness and Kurtz, 1993; Udry and Conley, 2005). A field trial of an innovation by a peer can substitute for the potential adopter's own trial, and observation facilitates this process (Rogers, 1995). This type of close observation is facilitated by physical proximity to early adopters in the field, such that a farmer with a field bordering an early adopter's cashew field may be more likely to adopt early himself after observing his neighbor's success. Enough evidence of continued cashew cultivation by other farmers may effectively reduce uncertainty for a potential user, or spark enough interest in the technology to validate an investment in learning more about the technology through other channels. Despite the frequent difficulty in separating social relationships that facilitate

verbal learning and spatial relationships that facilitate visual learning, the small village sizes and census nature of this study allow spatial and social relationships to be treated as two distinct entities.

The decision to adopt cashews may appear to be a low-risk venture to an outsider, but when living near the subsistence threshold,<sup>11</sup> any new technology with unknown variance in output presents the possibility of dropping a family's food supply below the subsistence level, even if the initial observed yield, or the long-term average yield of the new technology is higher than the traditional technology (Advisory Committee on the Sahel et al., 1986; Current et al., 1995; Scott, 1976; Wharton, 1969; Vanclay and Lawrence, 1994). This phenomenon helps to explain the slow process of adopting new technologies in low-income agrarian regions. Each farmer's assets act as a buffer between his family and the subsistence threshold. If a farmer has no cash and nothing of value to sell, a bad year of production will yield an amount of food that may not be enough on which to subsist.<sup>12</sup> A wealthy farmer that experiences the same drop in production may liquidate some assets in order to meet subsistence needs for that year, and thus remain above the subsistence line (Figure 1.12). It then follows that a farmer with more assets will have a higher tolerance for uncertainty, assuming that he is more willing to part with his physical capital than his social capital or health.

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<sup>11</sup> The amount of food needed to physiologically sustain the household.

<sup>12</sup> This does not imply that a farmer will starve to death as soon as yield is less than subsistence consumption, as exchange and charity networks are available to fall back on in such cases. However, farmers are not likely to intentionally put themselves in a position in which they may need to rely on these networks. These networks are also a less effective buffer against covariate risk, e.g. due to common weather shocks. Thus a farmer is likely to prefer to self-insure, e.g. with personal assets that can be sold, or diversified production.

Uncertainty is a major hurdle to adoption of a new technology, but may be overcome with sufficient learning. Technologies with relatively great inherent actual risk, however, may still be rejected by households operating without a buffered subsistence threshold even after learning has taken place. Due to the difficulties in observing and measuring risk and uncertainty aversion (Marra et al., 2003), they are not quantified explicitly in this study, but they are essential components in a farmer's decision to adopt or reject an innovation, and should be understood before extension is attempted.

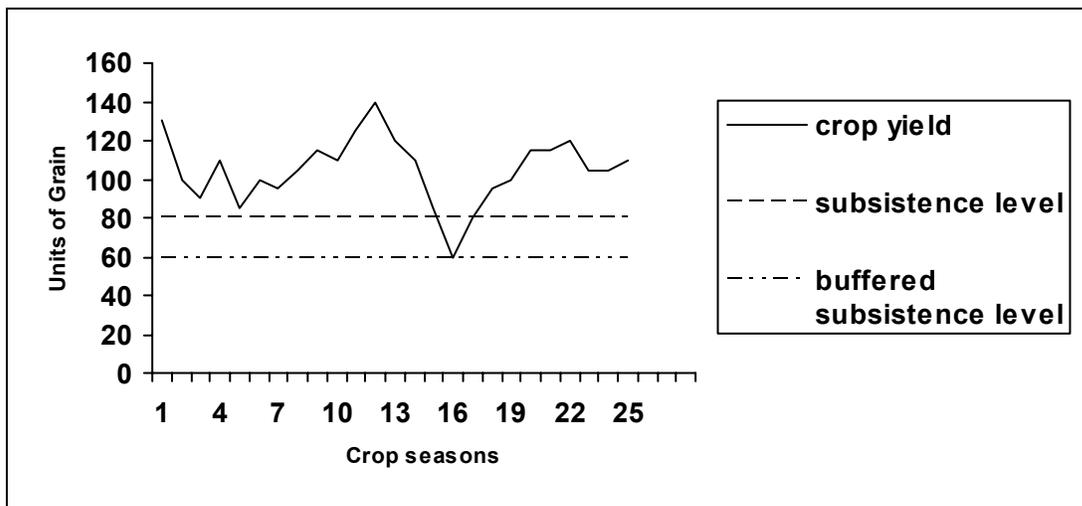


Figure 1.12. Crop yields and subsistence levels for poor and wealthy households (after Scott, 1976).

### 1.2.3. Social vs. Spatial

As explained above, learning is essential to the adoption process. This study examines the relative influence of two sources of information: learning by seeing (spatial), and learning by hearing (social). Time to adoption models often lack explanatory power because they fail to account for spatial variables (Lindner et al., 1982), and spatial network models often fail to account for social factors, placing too much emphasis on spatial proximity alone (Marra et

al., 2003). This study attempts to avoid both of these traps by placing equal consideration on social and spatial components of learning in a temporal context.

Of the three stages of learning defined by Lindner et al. (1982), Discovery, Evaluation, and Trial, this study considers only the second. The Evaluation Stage is the time from awareness of the innovation to its first use by a certain farmer. In villages as small as those in this study, it is assumed that with few exceptions awareness occurred simultaneously upon the cashew extension programs by PASA 25 years ago<sup>13</sup> (see section 2.5 below). The stage terminates upon a farmer's first planting of cashews, signifying his decision that the expected value of cashews or at least the value of the information gained from growing cashews outweighs its expected costs.

The duration of the Evaluation Stage is influenced by the following factors according to Lindner et al. (1982). It is inversely related to the speed at which a farmer collects information, and directly related to the amount of information required by that farmer to make an adoption decision. The amount of information a farmer requires will decrease with the actual profitability of the innovation and the strength of his optimism about the value of that innovation. A farmer's innovativeness is defined by this pre-existing belief. The minimum amount of information required is also determined in part by the distance to the information source—the farther it is, the less certain a farmer is that the information is relevant to his own situation (Lindner et al., 1982). Lindner et al. also show that farmers

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<sup>13</sup> There are cashew and mango trees on the edge of Simong estimated to be 50 years old. However, these trees constitute a large backyard orchard, and therefore cannot be considered as a source of agroforestry information. Furthermore, adoption this long ago with no further planting for 35 years could be considered a “false start”, with no apparent resulting spread of the innovation. Also, their owner resides outside of the village.

with less land available for the innovation will require less information. A better-educated farmer will have lower information collection costs and better powers of deduction, and will therefore adopt more quickly. Education also decreases the dependence of time until adoption on distance to information source (Lindner et al., 1982).

Lindner et al. (1982) found distance to information source to have a significant negative effect on time until adoption that can be mitigated to some extent by education, and that certain early-adopting farmers serve as spatial centers of diffusion. Although the authors question the relevance of these findings to a modern world with easy access to innumerable information sources, these conveniences are little-known to the rural Senegalese farmers in this study, and their findings therefore remain relevant.

When adoption occurs in a group setting, as is often the case, learning about the new technology may be social (Foster and Rosenzweig, 1995; Miguel and Kremer, 2003; Udry and Conley, 2005). Social variables are not often included in adoption studies, and the literature quantifying their impact is small and recent. Many studies use easily observable proxies such as geographic proximity are able to account for difficult-to-observe social interactions (Udry and Conley, 2005). Udry and Conley (2005) conducted a study of social learning among Ghanaian pineapple farmers using data on communication patterns. They found that a farmer changes his own fertilization habits after learning of a success or failure (relative to his own experience) by a member of his social network, that newer pineapple farmers are more likely to act on information from members of their social network, and that

information from social network members holds more weight if it is from a farmer with more experience or with a similar amount of wealth.

Rogers (1995) finds that cosmopolite channels (sources of information outside the social system of study) are more important in the Discovery Stage<sup>14</sup> of adoption, while channels inside the local social system are more important in the Evaluation Stage.<sup>15</sup> That is, while a farmer is gathering basic information on available innovations, less trustworthy outside sources are acceptable. Once a farmer learns of a specific innovation and gains enough interest to gather detailed information, however, informants within his own social network are necessary. Rogers also finds that most farmers require information from local sources before deciding to adopt, but early adopters are satisfied with outside sources of information (such as seeing non-peers growing cashews during travels outside the region) and act on this source alone before localite sources become available (because no one within the social system has adopted yet).

Thus, the literature suggests that both spatial and social proximity to innovators influences a farmer's adoption behavior. This study tests this by mapping farmers' fields and asking about their advisors.

#### *1.2.4. Determinants in adoption*

As Ruttan (1996) explains, the study of adoption and diffusion emerged as a subset of several sociology fields in the 1940s. After a period of rapid growth spanning several decades, the

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<sup>14</sup> Lindner's Discovery Stage is the rough equivalent of Rogers' "knowledge stage".

<sup>15</sup> Lindner's Evaluation Stage is the rough equivalent of Rogers' "decision stage".

rate of addition to the literature began to wane. Amidst the initial rise, however, Griliches (1957; 1958) initiated a second branch of adoption studies with his work on hybrid corn. He was the first to apply economic principles to the field, arguing that social variables often only cancel themselves out. This sparked controversy, but by the mid-1980s rural sociology had relinquished its role in adoption and diffusion studies while economists continued to strengthen theirs. This change in focus was driven in part by development agencies looking to inform their work with empirical findings (Ruttan, 1996). The most common empirical approach is to estimate models of which farmers have adopted a technology at a particular point in time, based on a cross-sectional survey.

This study accepts Ruttan's (1996) assertion that the two viewpoints are complementary rather than antagonistic. Qualitative data are analyzed for sociological phenomena.

Variables representing economic, social, and spatial determinants of adoption are all included in an empirical survival model intended to show the significance and influence of each. This section details the general categories of adoption determinants traditionally used in economics, and their relevance to this study. The five common categories that Pattanayak et al. (2003) found in the technology adoption literature are discussed as well as their meta-analysis findings. The two additional categories described above, social and spatial proximity, are also discussed.

Pattanayak et al. (2003) conducted a broad survey of 120 technology adoption studies and found that adoption determinants can be grouped into five common mutually non-exclusive categories: farmer preferences, resource endowments, market incentives, bio-physical

factors, and risk and uncertainty. This was followed by a vote-count meta-analysis of 23 empirical agroforestry adoption studies with adopt/reject binary dependent variables (Table 1.2).<sup>16</sup> These categories and results provide a starting point for the regression model in this study, which considers time to adoption. Although this is a different question than considered by Pattanayak et al., most of the literature focuses on adopt/reject decisions, raising the question of whether the previous findings also apply to timing of adoption. Thus, the present study will in part serve as a test of the applicability of these categories developed for adopt/reject models to time until adoption. A brief description of the categories and the findings associated with each follows. Subcategories defined by Pattanyak et al. are set off by *italics*.

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<sup>16</sup> An expanded sample of 32 studies was also analyzed, but included studies on soil and water conservation measures less closely related to cashew agroforestry. It will therefore only be the partial sample that is considered here.

**Table 1.2. Votes on the determinants of agroforestry adoption.** (Pattanayak et al., 2003)

	Included	Significant		Insignificant	Included %	Significant % (included studies)	Significant % (all studies)
		Pos.	Neg.				
<b>Preference Proxies</b>					<b>47%</b>	<b>41%</b>	<b>16%</b>
Education	17	3	1	13	77%	24%	18%
Age	14	4	0	10	64%	29%	19%
Gender	8	5	0	3	36%	63%	23%
Social Status	2	1	0	1	9%	50%	4.5%
<b>Resource Endowments</b>					<b>38%</b>	<b>60%</b>	<b>19%</b>
Income	12	6	0	6	55%	50%	27%
Assets	8	8	0	0	36%	100%	36%
Labor	15	5	0	10	68%	33%	22%
Livestock	6	1	0	5	27%	17%	4.6%
Credit/Savings	1	1	0	0	5%	100%	5%
<b>Market Incentives</b>					<b>33%</b>	<b>73%</b>	<b>20%</b>
Potential Income Gain	13	5	1	7	59%	46%	27%
Distance to Market	7	0	5	2	32%	71%	23%
Price	2	1	1	0	9%	100%	9%
<b>Bio-physical Factors</b>					<b>27%</b>	<b>64%</b>	<b>24%</b>
Soil	5	3	0	2	23%	60%	14%
Slope	5	2	1	2	23%	60%	14%
Plot Size	14	7	3	4	64%	71%	45%
Irrigation	0	0	0	0	0%	0%	0%
<b>Risk and Uncertainty</b>					<b>39%</b>	<b>78%</b>	<b>30%</b>
Tenure	11	6	1	4	50%	64%	32%
Experience	10	7	2	1	45%	90%	40%
Extension	6	6	0	0	27%	100%	27%
Membership	7	4	0	3	32%	57%	18%

**Farmer Preferences:** Many factors play into a farmer's adoption decision that are difficult or impossible to measure, such as risk aversion and conservation attitude. An attempt to estimate these preferences through sociodemographic proxy variables is often made, although the relationships can be arguable. Although *education* is expected to increase likelihood of adoption, education variables were only significant in 24% of the studies, possibly because they also proxy for the opportunity cost of labor. That is, more-educated workers are less likely to be available to invest their labor in agroforestry adoption. These conflicting tendencies could tend to cancel each other out. *Age* is positively correlated with adoption in the 29% of the 14 studies including it that found it to be significant. This counters common theories of increasing conservatism with age. Households with a *gender*

ratio heavier in males were found to be more likely to adopt, probably due to both preferences and resources. *Social status* was only found to be significant in one of the two studies to include it in analysis. It was positively correlated with adoption.

Resource Endowments: These variables measure assets and holdings such as livestock, land, and labor that affect the farmer's ability to adopt and profit from adoption. Different suites of resources may be more appropriate than others of the same total value for certain technology types. Resource variables are significant in 60% of the studies including them, and are consistently positively correlated with adoption of agroforestry. *Assets* are particularly notable, as they were found to be significant in all 36% of the studies that included this variable. This corresponds with the phenomenon of risk reduction detailed above (section 1.2.1)—assets provide a buffer that decreases the perceived risk of a new technology. *Labor* is significant in 33% of the studies that included the variable, and *livestock* 17%. Only one study (5%) included *credit/savings*. It was found to be significant.

Market Incentives: Variables that explicitly influence economic costs and profits, such as available prices and markets, transportation costs, and potential income fall into this category. These factors were deemed equal across all farmers in this study, and this category could therefore not be included in empirical analysis.

Bio-physical: Physical factors such as soil quality, slope, and plot size may affect the degree of benefits offered by technologies like agroforestry. Agroforestry practices are generally believed to have a greater potential for high returns on degraded land with low yield and in

need of restoration. This type of variable was included in 27% of the studies. *Soil* quality was positively correlated with adoption in the 60% of the five studies that included the variable, contrary to the expected correspondence between poor soil quality and the increased value of agroforestry reparation. There may exist in these cases a threshold of soil quality beneath which agroforestry no longer holds any power of restoration. *Slope* was significant in 60% of the five studies that included it. As was expected with soil quality, increased slope and the associated higher degree of erosion were generally associated with a higher likelihood for adoption. *Plot size* was significant in 64% of the 14 studies that included it. Direction the correlation was mixed however, probably due to multiple proxy effects.

Risk & Uncertainty: This category reflects unknowns in a new technology like fluctuations in market, yield, and weather; and tenure insecurity. Both perceived and actual risk may be reduced to some extent through association with extension agents, farmer groups, or more-experienced acquaintances. Risk variables were included in only 39% of the studies, but were significant in 78% of them. Variables measuring *experience* in a range of agroforestry-related activities were significant in 90% of the 10 studies that included this variable, and were generally positively associated with adoption. This finding supports the argument that experience reduces the uncertainty associated with adopting a new technology. Six of the six studies including an *extension* variable measuring a respondent's contact with extension agencies found the variable to be significant. These all had the expected positive correlation with adoption. 32% of the seven studies that included *membership* variables found these variables to be significant. All of these were positively correlated with adoption, presumably because of the mitigation of uncertainty that members may glean from each other.

Social Proximity: Udry and Conley (2005) have shown the importance of the experience of others within a social network on a farmer's adoption and management decisions (see Section 1.2.2 above).

Spatial Proximity: Lindner et al. (1982) have shown that the duration of the Evaluation Stage is determined by the amount of knowledge required by a potential adopter, which is in turn partly determined by the geographical distance to the source of information (see Section 1.2.2 above).

#### *1.2.5. Importance of time aspect*

These two villages present a unique opportunity for an adoption study. There is a vast literature on adoption and the factors that influence a farmer's decision to adopt or reject a new technology using cross-sectional data (Marra et al., 2003). In these two villages, however, almost *all* farmers have adopted cashew intercropping to some extent. This unique situation, in combination with the fact that the age of cashew trees is fairly easy to identify by their nature, allows examination of the timing of adoption rather than a binary adopt/reject decision. This temporal element places this study in a second category of adoption studies as defined by Lindner (1987) that determine why some adopters make the decision earlier than others. This type of study is underrepresented, mainly due to difficulties in collecting the appropriate type of data (Marra et al., 2003). This study attempts to fill this gap in the literature. Moreover, many of these studies have analyzed a subsample of farmers who have all been exposed to at least some information on the new technology, which presumably is

not representative of the entire population (Saha et al., 1994). While all farmers in this study have also been exposed to some information on cashew alley-cropping, they *do* comprise the entire population, and therefore do not present a problem with bias.

This chapter has drawn examples from the agroforestry and adoption literatures to lay groundwork for the fieldwork, analysis, results, and conclusions to follow. The next chapter draws instead from ethnological literature and nine months of village life to introduce the study sites, Mamouda and Simong. Regional biogeographic characteristics are presented, followed by ethnographic details on life and work in Mandinka culture in general and these two small rural Senegalese villages specifically.

## **2. BACKGROUND**

This chapter provides a brief overview of the social and cultural context in which this study is set. Details on the region and the study villages, including their culture and agriculture are presented. The potential for improvement in welfare that cashews offer is described. Finally, the history of agroforestry extension in the study villages is reviewed.

This narrative is informed by a review of the ethnographic literature on Mandinka culture, nine months of village life before field work, and semi-structured interviews with key informants during my time in Senegal first as a Peace Corps volunteer (June 2003-March 2004) and then during three months of fieldwork (February 2005-May 2005). In 2003, I participated in eleven weeks of intensive Peace Corps training in Thiès, Senegal followed by nine months as a Peace Corps volunteer in a Senegalese village. It was during this time that I polished my language skills and learned what it meant to be a villager in rural Senegal while living as an adopted member of a 20-member compound headed by Simong's Imam (Islamic religious leader). During this time I kept a journal on cultural activities and issues important to the villagers I lived with.

### **2.1. The Region**

Mamouda and Simong are two small villages of 224 and 228 people, respectively, located 1 km apart in the Sine-Saloum region of Senegal (Figure 2.1). While these two villages are typical of the Mandinka ethnicity prevalent in the region, there are also Serer and Wolof

ethnic groups that differ in language and some cultural aspects. The region is bordered by the northwest corner of The Gambia to the south and a maze of mangroves and then the Atlantic Ocean to the west. The region lies in a belt of tropical semi-arid climate that becomes progressively drier to the north as the influence of the Sahara desert increases, while the east is somewhat hotter but otherwise relatively similar until the border of Mali, after which changes in topography begin to affect climate (Climate Zone, 2004).



Figure 2.1. Senegal. Star locates study site. The Casamance is the region south of The Gambia. Sine-Saloum is roughly defined by the political regions of Fatick and Kaolack.

In the dry season, which begins in late September, the regional landscape resembles grass steppe. A look at an area protected from farming, however, shows that grassland is not the original ground cover; in fact, the region used to be wooded savannah (Figure 2.2) (Advisory Committee on the Sahel et al., 1986). Closer inspection of farmed land will show that what appeared to be dry savannah grasses are actually opportunistic weeds that sprang up to catch the last bit of rain after the harvest, now desiccated and awaiting the farmer's hoe that will mark the coming of the wet season in mid-June (Figure 2.3). The landscape makes a sudden change from brown to green with the arrival of the rains, which average 600-750 mm (Rodale Institute, 1989). What once looked barren and inhospitable quickly becomes lush and inviting. Some areas are more lush than others, however, as a gently rolling topography provides some differentiation in land quality, with higher fertility in the valleys, and more erosion on the slopes and high spots. Temperatures range from average lows of 18° C in January to average highs of 40° C in April (Climate Zone, 2004).



**Figure 2.2. Protected forest land.** (Dawson, 2005)



**Figure 2.3. Dry season grasses surrounding Mamouda. Visible trees are mostly mango. Structure in foreground is Mamouda's French schoolhouse. (Dawson, 2005)**

Farmers in this region face problems of limited rainfall, but live in conditions well-suited for cashew cultivation. The next section overlays cultural elements on this biophysical backdrop.

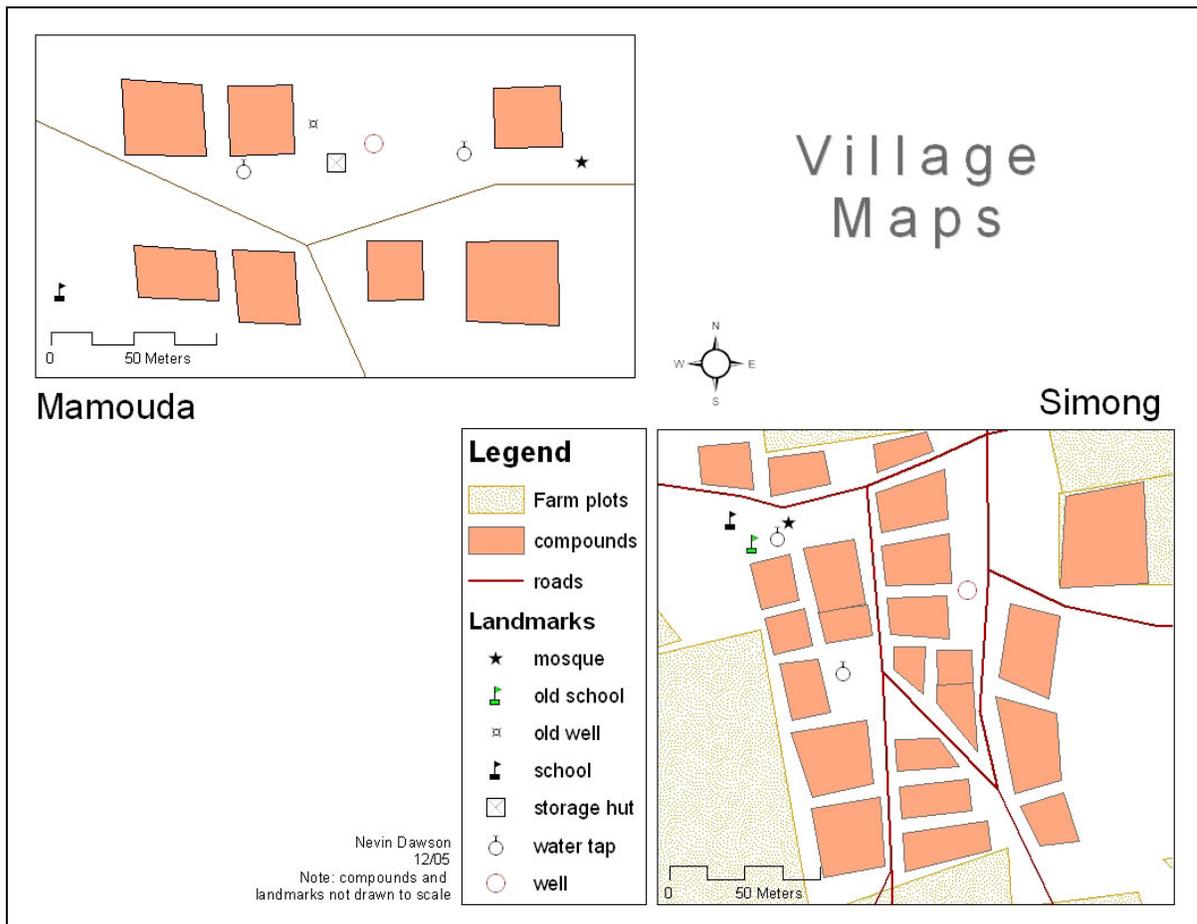
## **2.2. The Villages**

Simong comprises 23 households, while Mamouda has 10 households living in 7 compounds (Dawson, 2005).<sup>17</sup> A seasonal river and the surrounding protected forest divide the holdings

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<sup>17</sup> For the purpose of this study, a compound is defined as a fenced collection of structures that comprises at least one household, and a household is a family unit that shares a single hearth (*sinkiroo*).

of the two villages. Huts are mud-walled and grass-roofed, except those owned by families wealthy enough to purchase corrugated metal. Cement is another luxury item, used to sheath walls and cover floors for durability and cleanliness (Dawson, 2005). Low-voltage solar energy was installed in 2003, and four unreliable water taps were introduced in each village in 2004 (Dawson, 2005).



**Figure 2.4. The layout of compounds and other landmarks in Mamouda and Simong.**

There is a noticeable difference in the physical layout and social organization of the two villages: Simong is a small network of roads with two village centers and an average of 10 people per household, while Mamouda is centered around a single broad road and has an

average of 25 people per household (Figure 2.4). The ‘Main St.’ feel of Mamouda allows for more frequent communal interaction, but there is only one communal shaded sitting spot (*bantabaato*), which limits the duration of encounters out in the open. Simong’s higher number of *bantabaatolu* makes for a more active village square culture. This difference may have repercussions in the structure of the social network in each village.

I chose these villages for this research because of my familiarity with the people and the language after my Peace Corps service there, the high degree of similarity between the two villages, and the recent enthusiasm for cashew alley-cropping. Furthermore, the adoption of cashews by almost all farmers in Mamouda and Simong allows for a study of *when* farmers adopt, rather than the typical approach of studying adopters vs. non-adopters at a particular point in time (Marra et al., 2003). In essence, this is a study of the factors that separate adopters into Rogers’ (Rogers, 1995) classic categories, innovators through laggards. Finally, the small sizes of the villages—in terms of both number of households and extent of agricultural fields—made it feasible to conduct a census rather than a sample. This is ideal for analysis of social networks. In a large society, these networks would be difficult to trace given the exponential nature of social contacts.

### **2.3. Culture**

This section describes the resources and offers an introduction to the culture of Mamouda and Simong, the two study villages, as examples of typical Mandinka villages in Senegal.

### 2.3.1. *The Household*

Households are patriarchies and often comprise members of the nuclear family as well as distant relatives (Schaffer, 1980). The mean household size in Senegal, about nine people, is one of the largest in the world (Garenne, 2002). Households are not only physical dwelling places, but also productive enterprises and representations of a lineage (Carney and Watts, 1990). The Islamic culture allows polygamy, and up to four wives live in the same household, usually in a women's quarter (Schaffer, 1980) (Figure 2.5). Grown and married children often stay in their parents' compound until the husband is able to build, buy, or inherit his own compound and provide for his wife and children (Dawson, 2005).



**Figure 2.5. The four wives of Simong's Imam and one grandson.** (Dawson, 2005)

### 2.3.2. *Religion*

Although Senegal is 95% Muslim as a whole (Bureau of African Affairs, 2005), the proportion in the rural study area is likely 100%. Mandinka religious beliefs are deep (Schaffer, 1980), especially among the older generations. Villagers believe that the cause

and solution to most any problem lies in the hands of Allah (Dawson, 2005). Each village has an Imam, or religious leader. Imams are often the moral authority for the village. Mamouda is rare in that the village chief serves also as the Imam (Dawson, 2005).

### *2.3.3. Agriculture*

Most crops are grown for subsistence, including (in rough order of abundance) millet, rice, sorghum, corn, and beans. Much of the Sine-Saloum region does not offer appropriate conditions for rice cultivation, but it is possible in the study villages due to the seasonal river that runs between the two. Cash crops include peanuts, vegetables (dry season), cashews, and watermelon, and are taken to markets 2-75 km away from the villages. Most crops are cultivated during the wet season, which runs from mid-June to mid-September. Rainfall varies highly from year to year as well as within a single season and is the primary determinant of wet season crop yields (Rodale Institute, 1989). Watermelons are usually planted after harvest around the time of the very last rainfall. The dry rice paddies are also planted with vegetable crops for dry season gardens (Figure 2.6). Onions are the main crop in these gardens, and cherry tomatoes are also important. Vegetables grown on a smaller scale include eggplant, bitter tomato, chili pepper, and cabbage.



**Figure 2.6. Dry season gardens with onions and tomatoes. Protected community forest is in background.**  
(Dawson, 2005)

#### *2.3.4. Labor & Gender*

Labor is one of the most important limiting factors in household production. Access to and control over this resource is therefore essential to a successful livelihood (Carney and Watts, 1990). Most labor is by hand with simple locally produced tools, with animal traction (mostly cattle) for tilling and sowing (Rodale Institute, 1989). There are a very few migrant workers that find seasonal employment in these villages, but in general there is no labor market—most labor is provided by family who are obliged to contribute to household production by their membership in that household. Villagers farming borrowed land are also

called upon by their patrons to work during peak periods (Carney and Watts, 1990). Friends sometimes grant assistance in times of need. Men with no obligations in the village during the dry season often leave for a town or city to look for wage labor until they are needed for crop cultivation the next wet season (Schroeder, 1999b; Dawson, 2005).

Labor is divided among three groups: men, women, and children. Work is divided between genders by task as well as by crop (Carney and Watts, 1990; Schroeder, 1999b). Men are responsible for the cultivation and harvest of all field and tree crops (Figure 2.7), while women do most of the processing (Figure 2.8). Rice and garden vegetables are the responsibility of women from start to finish. Women's obligation to contribute rice to the household rather than sell it for their personal benefit came about after the promotion of peanuts as a cash crop by trading companies in the 1830s. At this time rice production was increased in the lowlands to offset reduction in other subsistence crops in the uplands due to expansion of peanut cropland. This male/female, cash/subsistence crop dichotomy is common in West Africa (Carney and Watts, 1990; Schroeder, 1999b). Gardens were later intensified in the mid-1970s giving women new power and autonomy through a new source of cash, but at the price of increased financial obligations (Schroeder, 1996). Labor division mores have begun to relax further in recent years, and several women now have small peanut fields, while several men garden onions in the dry season. As these changes were not the focus of the study, I did not investigate reactions to these changes in depth. I did note, however, several positive reactions to the men gardeners. As men who stay in the village through the dry season can often be found loafing while women work in the gardens, their new occupation and source of income is generally viewed as a step forward. Children are

often charged with driving livestock, either to and from feeding grounds or out of gardens and orchards. Girls care for their younger relatives. Both sexes also participate to some extent in adult activities such as weeding and harvesting.



**Figure 2.7. Villagers harvest *findoo* (*Digitaria exilis*) with cashew alley-cropping in background.**  
(Dawson, 2005)



**Figure 2.8. Simong girls pound millet into flour. (Dawson, 2005)**

### *2.3.5. Tenure*

Mandinka land tenure is patrilineal, but ownership rights are more similar to stewardship rights than private property rights. By tradition, land belongs to the village or descendants of the village's original settlers who then grant extensive long-term use rights to individual households. By law, land belongs to the government under the National Domain law (Carney

and Watts, 1990; Schroeder, 1999b; Grigsby, 2002).<sup>18</sup> Nevertheless, land is a central source of wealth for a household (Grigsby, 2002) and farmers speak of land in terms of a private possession (Dawson, 2005). Disputes are settled by the village chief, who is the village-level arbiter in all matters, although appeals to official channels of arbitration are slowly becoming more popular (Grigsby, 2002).

There are two types of land ownership within a household's holdings: communal and personal. Communal land is what feeds and supports the household, and is the land on which household members are obligated to work. In exchange for the work they contribute to the household, members are given control of their own personal plots once they reach their late teens or early twenties. The extent of the rights that come with this control varies to some extent, but at least includes the right to keep any profit made from the sales of crops on that land (Carney and Watts, 1990; Schroeder, 1999b; Dawson, 2005). As the ultimate arbiter in allocation of household resources, the household head does not maintain personal fields, and takes what money he needs from household funds. Communal fields are under his control however, and in this study they will be treated in the same manner as personal fields. It will also be assumed for the purposes of this study that household heads act in their own best interest in the management of communal fields, just as other household members managing personal fields would.

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<sup>18</sup>National Domain does recognize customary tenure and the right of women to own land, but is vague in the definition of the relationship between government and village control, often leading to manipulation by those with wealth and power (Bloch and Foltz, 1999).

Rice and garden plots cultivated by women, or *kono banko*,<sup>19</sup> belong to a household lineage and are controlled by the cultivator's husband or father who decides to grant use rights (Schaffer, 1980). Some of these plots are communal and some are personal and rice is distributed accordingly, although all income from sales of garden produce belongs to the cultivator (Schroeder, 1999b). A daughter loses her rights to her natal household's land upon moving into her husband's household, where she must seek new rights to their land (Carney and Watts, 1990). Although plot transmission rights are traditionally not granted to women, Schroeder (1999b) found that in Kerewan, The Gambia, most Mandinka women flout this convention in order to avoid repaying a one-time use fee to the male owner upon transmission.<sup>20</sup> The owners typically had little knowledge of who was actually working the land, and therefore had no means of enforcing payment for the transfer of use rights which often happens between a mother and her daughters or in-laws. The few women with peanut fields in Simong obtained these plots from their husbands, probably as a portion of their personal plots which would normally be parcels of lowland rice land.

As trees are in the male domain and as cashews are not tolerant of flooding, cashew planting takes place almost entirely on male-owned uplands, or *bora banko* (Schroeder, 1999b).<sup>21</sup> There was, however, one instance of a man gifting a small portion of *kono banko* to his sister for the purpose of cashew planting. This man was young and well-educated, two factors that may have increased his openness to new ways of thought. Unfortunately the woman's cashew seedlings were difficult to protect in the highly-trafficked garden area and were also

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<sup>19</sup> Literally, “[pregnant] belly land,” referring to an anatomical feature exclusive to women.

<sup>20</sup> No evidence of this fee was observed in the study site, but as Schroeder maintains that payment is rare in Kerewan, it is likely equally as uncommon in the study site.

<sup>21</sup> Literally, “beard land,” referring to an anatomical feature exclusive to men.

stunted by flooding (Dawson, 2005). This was a rare occurrence, as women traditionally have no way to gain individual tree-planting rights on any of the land they cultivate. There are, however, some cases of women groups acting together to get planting rights collectively (Monimart, 1999). If this were to happen in either study village, women would need to either choose a flood-tolerant species to plant in *kono banko* or take the additional step of acquiring *bora banko*, outside of their traditional domain.

Though there is no unclaimed land, land is not scarce and sales are uncommon. Farmers with limited land resources are usually able to borrow land for free from a friend or relative, but must often seek out new arrangements each season (Carney and Watts, 1990; Grigsby, 2002; Dawson, 2005). Grigsby (2002) borrows Scott's term, "subsistence ethic," to describe an aspect of tenure in Mandinka villages in eastern Senegal. Under this policy, villagers allow the use and degradation of their land that would otherwise lie in fallow and regenerate in order to maintain good social standing. Even though there are large differences between households in the sizes of land holdings, this practice facilitates a much smaller difference in access to land, likely reducing wealth differences between households at any given time (Grigsby, 2002). Lenders are wary of allocating the same parcel to the same person every year, as the borrower can legally claim tenure after six years of continuous cultivation on the same plot. Lenders are usually also unwilling to allow tree-planting on their land, as it is also likely to lead to tenure transfer. This is indicative of the both the power that tree planting holds and the permanence of the use rights that cashew owners have on that land (Dawson, 2005). Extensive tree planting may also have the power to disrupt the "subsistence ethic" described above. Land poor farmers may find it more difficult to locate fallow fields for

short-term loan if land rich farmers are generally adding cashew fields to their portfolio rather than reducing the amount of land in other crops. This strategy would essentially increase the total amount of land under cultivation at any one time, and thereby reduce the area of available fallow land. It remains to be seen whether land rich farmers in the study villages will choose this strategy once their cashew trees are large enough to preclude farming on the fields in which they are planted.

#### *2.3.6. Markets*

Many products from vegetables to stick beds are marketable in the village itself, but demand is not great in such small villages. The local market is also prone to gluts, as many households engage in the same activities at the same time of year (Schroeder, 1999b). Keur Samba Gueye, a medium-sized village about 2 km from the study site, offers a slightly greater demand for produce and can be reached on foot, which allows boys and girls who cannot pay for transportation to sell their wares. Karang is a medium-sized town 8.5 km away with a daily market (Figure 2.9). Large weekly markets can be found at many villages down the road towards Kaolack, and there is a very large one in the Gambian town of Fass. Many villagers take their produce as far as Kaolack, the regional capital 80 km away, once they have harvested most of their crop (usually fruit and vegetables). Each of these steps farther away represents a higher investment in transportation in the hopes of finding a higher price. Prices are sometimes very well-researched by a villager sent ahead to scout out relative prices and report back to the village. In the case of cashews, some men will even make the trip to Senegal's capital, Dakar, about 225 km away.

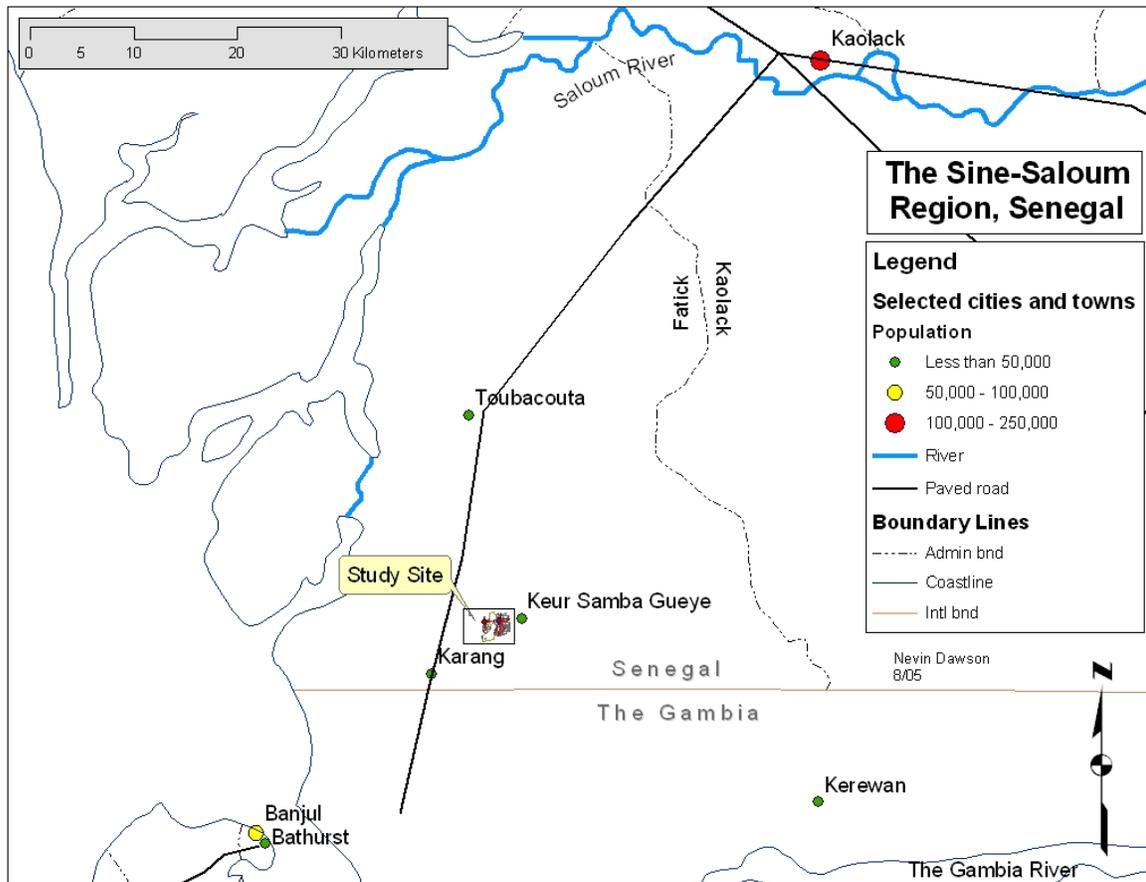


Figure 2.9. Selected cities in towns in the Sine-Saloum region.

#### 2.4. Extension History

Several development agencies have taken an interest in the welfare of Mamouda and Simong over the past few decades. Although able to establish 9480 ha of cashew plantations throughout the Fatick and Kaolack regions since its foundation in 1979 (Pfeiffer, 1987), early attempts by the German and Senegalese joint effort Senegalese-German Cashew Project<sup>22</sup> (PASA) to introduce cashews about in Simong and Mamouda 25 years ago were largely unsuccessful (Dawson, 2005). Many farmers claimed to be unaware of the benefits of cashews at that time, and some said they thought cashews would destroy the soil, despite

<sup>22</sup>*Projet Anacardier Sénégal-Allemand*

PASA's efforts to prove the long-term productivity and environmental benefits of cashew trees. PASA even went so far as to bribe villages into participation through large gifts of cooking oil and dried fish, and the promise of enough barbed wire to enclose a 1 ha. cashew field the first year, with an increasing amount each successive year of successful cashew cultivation.

Other organizations also sent extension agents to the villages to effect the adoption of sustainable tree use, including the United States Peace Corps, The Union of Agricultural Groups of the Sine-Saloum<sup>23</sup> (UGAB), and Waters and Forests.<sup>24</sup> A Peace Corps volunteer spent one year in Dayam extending agroforestry techniques approximately five years ago, and another volunteer spent two years in Simong doing the same from 2001-2003. I took his place in 2003 for nine months, focusing on mango top-working, a method of grafting on mature trees (Figure 2.10). I did most of this work in Mamouda and another village several km away. I also gave a mango grafting workshop in Simong and coordinated a tree nursery sack ordering program in Simong and Mamouda during the period of this research in 2005. Note that Peace Corps involvement began after farmers started plantings cashews.

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<sup>23</sup> *l'Union des Groupements Agricoles de Niombato*

<sup>24</sup> *Eaux et Forets*



**Figure 2.10. Villager with mango tree prepared for top-working.** (Dawson, 2005)

UGAB, a Senegalese non-profit organization, and I facilitated a community cashew nursery in 2003 (Figure 2.11). Plastic sacks for the community nursery were disbursed and all participants were told that they were expected to purchase memberships in the near future for 1000 CFA or about two US dollars at current exchange rates. Surprisingly, many did so even without any apparent threat of repercussions for neglect, and all households received a share of the community cashew seedlings whether or not any members had bought a membership.

It is likely that farmers saw membership not just as a way to buy a share in the nursery, but as an investment in future benefits. It is unfortunate that this somewhat unusual willingness to risk capital for future returns was not well rewarded. Other than some seed trials for women's gardens,<sup>25</sup> UGAB's activity in the area soon slowed to a halt.



**Figure 2.11. Village men weed the community cashew nursery.** (Dawson, 2005)

Waters and Forests rangers representing the Senegalese National Forestry Commission make occasional trips to the two villages and hold meetings to discourage tree cutting (which is technically illegal without a permit) and encourage tree planting and wildfire prevention (Figure 2.12).

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<sup>25</sup> Females also purchased memberships, but did so for garden-related benefits, whereas men did so for cashew-related benefits.



**Figure 2.12. Village meeting with Waters and Forests ranger in Simong. (Dawson, 2005)**

In sum, Simong and Mamouda are two small rural African villages with traditional Muslim and Mandinka views and customs (Dawson, 2005). Farmers in these villages are eager to take advantage of the opportunity for advancement that cashews offer despite the initial lack of response when PASA first promoted cashews. The next chapter describes the research methods used to gather and analyze data on the factors that make some of these farmers more eager to engage in cashew cultivation than others.

### **3. METHODS**

Data on the Senegalese villages of Mamouda and Simong were collected through three principal methods. The first was nine months of village life. Second was a spatial data on the plots were collected using a GPS rover unit and analyzed with ArcGIS. Third, a census of all households in the two villages, applying survey instruments with both closed and open-ended questions. Survey instruments were developed and administered at three levels: households, farmers, and plots. The author designed the survey instruments, conducted all interviews and collected all GPS points, and coded, entered and processed the data. These field methods informed and provided data for three survival regression models of the time of cashew adoption, using data from (1) Simong only, (2) Mamouda only, and (3) all cashew plots in both villages. These models identify the characteristics of early adopters. In addition, the data are used to characterize “effective advisors,” defined as advisors with a relatively large number of advisees who adopt cashews relatively early.

#### **3.1 Prior Fieldwork**

My interest in Senegalese agroforestry began during my one-year stay there (March 2003-March 2004) as a Peace Corps volunteer. Eleven weeks of intensive Mandinka language training as well as technical and cultural courses prepared me for integration into village culture once installed at my site in Simong. The remaining nine months of my first stay in Senegal can be considered as an opportunity to collect background information that later informed the proposal and research design for this study. It was during this time that I

polished my language skills and learned what it meant to be a villager in rural Senegal while living as an adopted member of a 20-member compound headed by Simong's Imam (Islamic religious leader) (Figure 3.1). During this time I wrote unstructured journal entries on cultural activities and issues important to the villagers I lived with. As a Peace Corps agroforestry extension agent I helped coordinate a community cashew nursery and teach mango top-working techniques in Mamouda and Karantabaa, a Mandinka village several kilometers away (see Section 2.4).

My integration into village life began in my household. Adoption by a family, including the taking on of an appropriate first name and the last name associated with the household lineage, is part of the standard installation procedure for Peace Corps volunteers in rural Senegal. Peace Corps representatives are careful to choose families of high socioeconomic standing, and volunteers are often placed with either the village chief or Imam. This practice ensures both that the volunteer will have a fairly reliable source of food, and assists integration into the rest of the village through association with a respected family. Affiliation with a kin-residence group allows access to resources and services like land and the labor of the opposite sex (such as clothes washing, food preparation, and water drawing). Although this affiliation in turn usually requires cooperation in production (Carney and Watts, 1990), my contribution to the community as an extension agent allowed me an exception. I also voluntarily contributed about \$20 USD per month to the household in vegetables and cash. As a member of a family, I ate all meals at a large bowl with my 'father' and up to ten young 'siblings'. I initially spent a lot of time with children, as their language skills were comparable to my own. I gradually increased the amount of time I spent outside the

compound as I grew more comfortable with the language and culture, to the point that my family sometimes complained that I no longer spent any time at home.



**Figure 3.13. Villagers and I braid a fence for my back yard.** (Dawson, 2005)

Upon arriving in my village I was treated as a guest with the associated signs of respect such as insistence on my taking the best seat available and being offered drinking water upon entering a compound. My place at my father's bowl rather than with the other young males in the compound was another sign of high status. Although I always kept my place at the bowl, I began insisting on using the same rough wooden stools or plastic woven mats that everyone else uses when making casual visits to other households to facilitate my integration as a villager rather than a guest. I did, however maintain formal protocol when making interview visits, accepting such signs of respect with gratitude. I made friends with my peers

and gained their confidence through frequent casual contact, while maintaining respectful working relationships with village elders. As the same villagers held roles as my family, friends, and coworkers, it was important to behave in a socially acceptable manner to maintain agreeable relationships in both personal and professional spheres of life. Cultural differences sometimes made this difficult. For example, when visiting another village it is customary to maintain a host/guest (*jaatiyo/luntango*) relationship with one person in particular, usually a close friend or relative. A *jaatiyo* will send for their *luntango* to share all meals, even if they are visiting other households. As I had strong working relationships with several household heads in each of my target villages, I would often receive up to four of these invitations. I would always accept all invitations to avoid offending any of my *jaatiyolu*, despite the awkwardness of rushing from one place to the next and the discomfort of the resulting distended stomach (as it was also rude to eat too little). Living in accordance with these customs and thereby maintaining the respect and trust of my peers likely gave me access to a deeper level of information than similar research without residency would have been able to obtain.

One of the most frequent topics of conversation brought up by villagers was the prospect of them or their children going to America, and how I might facilitate the trip. I usually responded with a joking offer to carry them there in my luggage, followed by an explanation that I had no influence in the decision to grant visas. This conversation was often in conjunction with complaints about the physical rigors of subsistence farming. I would often respond with an explanation of how the U.S. is not the utopia they may imagine, and how hard work is not always enough to ensure easy living in either country. Although the

occupation of almost all villagers is farming to some extent, this was not a frequent topic of conversation.

Medical concerns were often brought to my attention, as my Peace Corps-issued med kit contained the most advanced medicine available in the village, and many villagers assumed that I had some level of ability in Western medicine. I tried to avoid becoming a source of medicine, however, and limited my help to advice except in the most severe cases in close friends and family.

## **3.2 Spatial**

Spatial data were collected in order to visualize the pattern of cashew adoption in the fields of Simong and Mamouda, as well as to compare empirically the significance of spatial vs. social proximity to early adopters. Data were collected with a handheld GPS rover unit and then processed and analyzed in ArcGIS.

### *3.2.1. GPS*

Each farmer showed me the corners of their fields so that I could take GPS waypoints and later perform GIS analyses. Fields belonging to absentee farmers were shown by relatives familiar with the land. Waypoints were taken with a Magellan GPS 315 rover unit and are averages of 100 readings. Field surveys lasted for 20 minutes in addition to travel time to the field of up to 20 minutes round trip. Simong farmers showed me all of their fields,<sup>26</sup> while

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<sup>26</sup> While each farmer insisted that we had toured *all* of his fields, holes in the resulting map left me suspicious. After further questioning, it was revealed that some farmers (especially the elders) were unwilling to show me

Mamouda farmers showed me only their cashew fields due to fieldwork time constraints (Table 3.1). Roads and major footpaths were also recorded for reference.

**Table 3.1. Distribution of surveyed fields.**

	Cashew	Non-cashew	Total
Simong	42	30	72
Mamouda	21	0	21
Total	63	30	93

### 3.2.2. GIS

GPS waypoints were uploaded to a PC with Trackmaker software, and then exported as ArcGIS shapefiles. Lines for field polygons and road polylines were snapped to these corner waypoints. Area of each field and distances between centroids of every possible pair of plots were calculated. To determine the percentage of adjacent and easily observed fields planted in cashews, a “select by location” procedure was carried out for each plot using a 50 m buffer. The plots in the resulting selection set were considered to be adjacent to the target plot, as roads and cattle rights-of-way of up to 50 m in some cases separated fields that were otherwise adjacent and easily mutually observable.

### 3.3. Surveys

Guided by information gathered through nine months of village life, I developed three different survey instruments to collect data on households, farmers, and fields. These were translated into Mandinka and tested in a neighboring village. I personally administered the surveys.

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all of their fields. As Abdou-Rahmane Sehn said, “It’s not good for a guest (*luntango*) to know all of your affairs (*haajoo*). Some things should remain secret.”

### *3.3.1. Development*

Using my local knowledge of the current situation in the two study sites, I aimed to create instruments that would capture as many factors in the adoption decision as possible.

Quantitative questions with coded responses were designed to capture measures of the five categories of adoption determinants described by Pattanayak et al. (2003). Variables in these categories, in addition to social proximity and physical proximity categories, created a data set for use in a regression model describing the number of years a farmer is likely to hold out before adopting cashew intercropping. Several drafts of the instruments were reviewed by members of my advisory committee. The study, including the survey instruments, was approved as exempt from review by the NC State University Internal Review Board for research on human subjects.

### Translation

After my return to Senegal in February 2005, the survey instruments were translated into Mandinka by my Peace Corps Mandinka language instructor, Aziz Diatta. To ensure that the intent of the questions was preserved, we reviewed each question together and made changes when necessary. Diatta also translated the consent form required for research on human subjects.

### Pilot survey

Because the study is a census of both Simong and Mamouda, no pilot testing could be done on non-participants in either of these villages. Thus, seven pilot interviews were conducted in a neighboring village, Dayam. Unforeseen problems were identified and corrected. These included a tendency for household heads to verify the exact age of each household member by searching for their birth certificates or calling in others, a very time-consuming process that led to the use of age classes. Also, the original set of field questions took longer to answer than it did to tour a field, overextending farmers' willingness to stay in the hot sun. Survey questions less pertinent to the research questions were subsequently removed from the instrument. All revisions were checked with Diatta before the final questionnaires were printed.

### *3.3.2. Household*

Thirty-two household surveys (Appendix A) in Mamouda and Simong were personally administered in Mandinka over the course of two months (Table 3.2). Households were defined by “hearths” (*sinkiroo*), the unit of field crop production and consumption headed by the oldest male in the group. The interviews were conducted with the household head and lasted from one to two hours. Questioning only began after the purpose of the study was explained and consent was granted. There were no cases in which consent was denied. Six surveys in Simong were conducted in Wolof with the aid of a translator, as these household heads were of other ethnicities and spoke little Mandinka.

**Table 3.2. Survey distribution**

	<i>Simong</i>	<i>Mamouda</i>	<i>Total</i>
Households	23	10	33
Household Surveys	23	9	32
Farmers	42	19	61
Fields	71	21	92
Cashew Fields	40	21	61
Non-Cashew Fields	31	0	31

Note: One Mamouda household could not be surveyed because its head was consistently away. The corresponding plots for this household, however, are included.

The instrument includes both qualitative and quantitative questions. Qualitative questions allowed respondents to explain their reasoning for both waiting to adopt cashews and then finally deciding to plant them. Quantitative questions with coded responses were designed to capture measures of the five categories of adoption determinants described by Pattanayak et al. (2003). Many of these are household characteristics, including socio-demographics and assets, which characterize all farmers associated with that household. While the opinions expressed in response to the qualitative questions are not necessarily shared by all farmers associated with the household, it can be assumed that the thoughts of subsidiary farmers are closely aligned to those of the father figure in the household due to the strong patriarchal influence present in the culture. I personally entered in MS Access and checked all data. Qualitative data were coded by common categories. The wide range of responses to some questions warranted aggregation into broader categories.

### Women and Children Survey

While all aspects of cashew growing are firmly embedded in the male realm of work, it was also important to obtain a broader perspective on opinions of cashews and their benefits and drawbacks. Thus, a short survey instrument of women and children was designed to identify

any contrasting views. This instrument contained a subset of questions from the household survey as well as several open-ended questions designed to capture diverse perspectives on cashews. A sample of two boys (age 9-17), two girls (age 9-17), and two women (>18 years old) from each village was randomly selected. One boy from Simong could not be contacted. Responses to open-ended questions on the women/children survey were coded categorically and summarized in MS Excel. Close-ended questions were also entered in MS Excel, but did not enter into final analysis.

### 3.3.3. *Farmer*

The primary goal of interviews with individual farmers was to identify their social network of farming contacts. Farmers were asked to list the people to whom they would go in their village to talk about farming (Appendix C).<sup>27</sup> These social network rosters were usually completed after returning from an excursion to a field. An earlier version of this question, “Who have you talked to about farming in the past three months?” did not elicit any responses in most cases during pilot testing, with farmers saying that they “don’t talk to anyone about farming,” and that “if there’s a problem we’ll hold a village meeting.” I next tried the question “Name the people from other compounds that helped you farm last year,” but this produced similar reactions. Questions about village friends were discarded because friends are not necessarily also informants about farming. The final version read as follows: “If you want to talk about farming, who will you go to? For example, if your crops had a problem, who would you go to for advice?”

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<sup>27</sup> For each contact listed, further questions were asked to determine the strength of the relationship, such as “When did you and \_\_\_\_ last talk?” and “In general, how many times do you talk to \_\_\_\_ in a month?”

#### 3.3.4. *Fields*

While touring each farmer's fields and collecting GPS data, I asked a series of questions about each plot's cultivation history and biophysical characteristics (see Appendix E).

Although relatives were able to show me the corners of plots in the case of absent farmers, they were not able to answer specific questions other than the age of the cashews on the plot. These field-level survey data were then joined to the corresponding field polygons in the GIS layout.

### **3.4. Time Until Adoption Models**

To test the determinants of adoption as suggested by life in the village and a review of the literature, I estimate a regression model of the year cashews are first successfully planted by each farmer. In particular, life in the village raised the question of how farmers' decisions about new technology are influenced by others in the village, and thus the model specification includes measures of physical and social proximity. Findings will inform extension agents' efforts to choose extension multipliers that not only will be willing to adopt a new technology before it has been tested by other villagers, but also be effective sources of information for other villagers once a successful trial has been established. Pattanyak et al. (2003) summarize the previous empirical literature on agroforestry adoption with a meta-analysis. I use their categories of adoption determinants to specify my model: Preference Proxies, Resource Endowments, Biophysical factors, Risk and Uncertainty. The Market Incentives category is not included, as it does not vary substantially across farmers. While it is tempting to place the majority of conclusive weight on this model because of its multivariate nature, it only includes factors that could be consistently measured for all

farmers or all plots in the villages. Thus, the statistical models are interpreted as just one of multiple methods for understanding the factors determining adoption of cashew alley-cropping, and the estimation results are interpreted in the context of all of the information gathered in the field.

The structure of the data set presents several challenges for model estimation. First, the number of observations is relatively small: 31 households, 62 farmers, and 92 plots. Second, there are missing data, especially on social networks, because this information was unavailable for absentee farmers. Third, time limitations on field work prevented me from gathering data on non-cashew fields in Mamouda. To address the first problem, I use principal components to reduce the number of explanatory variables. To address the second problem, I use averages to substitute for some missing values, and I estimate models with and without the social network variables. The third problem is overcome by modeling several subsets of data separately. These are Mamouda-only, Simong-only, and cashew-only. This solution to the missing fields problem, however, exacerbates the sample size problem by dividing farmers into smaller groups.

#### *3.4.1. Survival/Hazard*

Because nearly all farmers have planted cashews and because the year they were planted can be easily determined by observing the age of the trees, the typical methodology of modeling the adoption decision with a binary dependent variable is not appropriate in this study. Models of elapsed time, typically called survival or hazard models, are most often used to estimate the serviceable life of industrial machines or the survival time of patients with

certain medical conditions. However, this model is also appropriate for the estimation of time until adoption of new technologies. The few farmers that had not yet adopted cashews at the time of the study can be incorporated into the model by using a binary “censor” variable (Heagerty and Zheng, 2003; Kiefer, 1988). In this case, a farmer “survives” until he adopts cashew alley-cropping. The terminology of “survival” fits with the image of a farmer holding out against a new technology until he succumbs to the pressures to adopt. However, the model can just as well incorporate factors, such as capital and labor constraints, which would delay adoption by a farmer despite his interest in planting cashews. The duration of “survival” is the dependent variable, and the independent variables are the factors influencing the number of years until a farmer adopts cashew alley-cropping, defining as planting cashew trees in any one of his fields. It should be noted that this dependent variable is in essence a discrete variable, as adoption may only occur during a certain time of year, the wet season. Data were collected in terms of ‘wet seasons ago’, and are therefore discrete integers.

#### *3.4.2. Filling in the Gaps*

As ten Simong farmers and four Mamouda farmers were absent, resulting gaps in the data greatly reduced the sample size available for modeling. Because the sample size was already small, these gaps were filled with the average for that variable so that these key variables could be included in the model without sacrificing sample size. Mean imputation is a common procedure which does not change the mean of the variable. Although more sophisticated methods of imputation are available (such as hot-deck and regression-based), they are not likely to work well with a small dataset (Little and Rubin, 2002). This practice was limited to three variables sourced from the field survey and one from the household

survey: weighted slope, weighted fertility, tenure, and age, respectively. On the assumption that older farmers have better fields, average values for each farmer age class were calculated<sup>28</sup> across villages and then inserted in the 13 (14) cases of no response in the slope and tenure (fertility) variables by matching age class. Seven missing ages were filled in using the median age class of all farmers (31-60 years old).

### 3.4.3. *Variable Description*

The following variables were created and assigned to the categories described in Pattanayak et al. (2003). Two new categories were added for the purpose of this study: Social Proximity and Spatial Proximity. The working hypotheses are also included for each category in *italics*, based on the household production model underlying the Pattanayak et al. (2003) meta-analysis, adapted to conditions in the study villages. Tables 3.4 and 3.5 at the end of this section summarize all variables and present descriptive statistics.

#### Dependent Variable

*Time until adoption* (log of years to adopt since 50 years ago): Farmers were asked the age of each cohort of cashews in each field. Up to three different ages were recorded for each field, along with the estimated area of the field each cohort occupied, rounded to the nearest third.<sup>29</sup> The maximum cashew age in the farmer's set of fields is defined as that farmer's year of adopting cashew alley-cropping. Because survival models predict "exit time", i.e. the time from an arbitrary start point until the event in question occurs, maximum cashew ages were subtracted from 50 years, the oldest recorded cashew age and therefore the start point

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<sup>28</sup> Only records with reported ages were used to calculate averages.

<sup>29</sup> E.g. a field estimated to comprise 20% 2-yr old cashews and 60% 3-yr old cashews was recorded as 1/3 2-yr and 2/3 3-yr for simplicity.

used for modeling time until adoption. Thus, the dependent variable is the natural log of the number of years after 1955 that a farmer waited to plant cashews. Note that most farmers have only started harvesting cashews in the past five years in part due to the three-year lag between planting and fruit-bearing.

### Preference Proxies

*Farmers with higher social status and from households with better educated members will adopt earlier.* While actual preferences such as trust for new ideas and likeliness to accept change are difficult to quantify, these can be proxied by social factors like education and age.

*Education* (maximum years of Arabic education, maximum years of French education):

Household education is represented by the maximum number of years that any one household member had spent in school. This was asked for both Arabic school and French school. The hypothesis is that education decreases time until adoption through lower information acquisition costs and improved inferential abilities (Lindner et al., 1982) (see section 1.2.2). Education can also be related to cosmopolitanness,<sup>30</sup> as students must leave the villages for larger towns and cities to continue with higher levels of education.

*Age* (farmer age class converted to years): A roster of people who are living<sup>31</sup> in the household was recorded along with each person's age class. Specific ages were asked in pilot surveys, but respondents generally did not know exact ages and felt obligated to find

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<sup>30</sup> "The degree to which an individual is oriented outside a social system," (Rogers (1995))

<sup>31</sup> The Mandinka equivalent of "living" is *siiring* or "sitting." This may include people who spend the dry season (the majority of the year) away from the village performing wage labor, but their presence during the wet season is generally implied. As wet season labor is the variable of interest, this measure is appropriate. Including such wage laborers in the household roster also records an often important source of income.

birth certificates or call in wives for help. As the composition and capacity of the household labor force is the variable of interest, age classes were created (Table 3.3). The average value of the range was substituted for the class number to create a continuous variable for the age of each farmer.<sup>32</sup>

**Table 3.3. Age classes used in household rosters.**

Class number	Age class	Value used	Labor status
0	0-8	4	Little to none
1	9-17	13	Most tasks with concentration on menial and light labor
2	18-30	24	All tasks with concentration on heavy and skilled labor
3	31-60	36	All tasks with concentration on light and skilled labor
4	61+	65	Few tasks with some light and skilled labor

*Gender* (number of males, percent male): Household gender composition was measured using household rosters. The percentage of male household members is expected .

*Social Status* (number of advisees): The social status of the farmer is proxied by the number of other respondents that listed the farmer as a source of advice.

### Resource Endowments

*Farmers with access to more assets will be better prepared and more willing to absorb possible failure of investment and will adopt earlier when adoption is perceived to be risky.*

*Assets & Livestock* (asset index, PC of asset group): A series of questions were asked about livestock and various household items that are good indicators of household wealth. Data on

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<sup>32</sup> This approach was preferred to using dummy variables for each age class because of small sample size.

conditions five years ago<sup>33</sup> before the majority of farmers began marketing cashews were gathered, as increased income from cashew sales could confound resource endowment data. That is, finding that early adopters have more *current* wealth could be a result of early adoption, not its cause. Numbers of the following items and livestock were recorded: television, bicycle, ox/donkey cart, cows/calves, sheep/lambs, goats/kids, tin-roofed huts, cement floors, and huts with cement-sheathed walls. As such a large number of variables would reduce the overall significance of the model, a weighted asset index variable was created and a principal component analysis was performed to reduce the number of variables. The index variable summed possessions while giving more weight to more valuable items, such as cows and carts. The principal component analysis was performed separately the subset of data used in the three models (Simong-only, Mamouda-only, and cashew-only).

*Income* (number of wage earners): Household members with wage labor positions (usually in outside towns or cities) are an important source of income. This is measured simply as the number of household members with wage labor positions. These people usually return to the village for the wet season in order to still be considered part of the household. While current and past household income were also asked, accurate responses were difficult to elicit.<sup>34</sup>

*Labor* (number of laborers, dependents per laborers): Age classes (see above) were used to determine the labor resources available within each household. All household members

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<sup>33</sup> Respondents were asked to give the number of possessions “before Abdoulaye Wade ‘climbed the chair’”. Wade’s election as president in 2000 (five years beforehand) serves as a memorable time marker for a time before the majority of farmers had adopted cashews.

<sup>34</sup> There may have been a tendency to overstate the relative decrease in wealth between five years ago and the time of the survey in order to appear more deserving of foreign aid that I was supposedly in control of (which I was not). Others simply did not know or were unwilling to say.

between the ages of 9 and 60 years were counted as active laborers. The remaining household members were considered dependents. The sum of dependents was divided by the sum of laborers to obtain the dependency ratio for the household, such that households with a high value are likely to have fewer labor resources available for cashew work due to an increased workload per laborer.

*Land* (total field area (ha)): Total field area was calculated for each farmer using GPS data and GIS software. It was assumed that land resources remained static over the past five years. This variable is hypothesized to be *inversely* related to the amount of information required before adoption and therefore time until adoption as Lindner (1981; 1987) demonstrates (see section 1.2.2), contrary to the rest of the variables in this category.

*Credit/Savings* (PC of credit group): Household heads were asked if they thought they could borrow \$200 for one year for farming work, if anyone in their household had taken out a loan of money or supplies, and if they had ever saved money in a bank. Principal component analysis was used to summarize these measures of access to credit or savings in one variable. Principal components were calculated separately for each model's subset of data (Simong-only, Mamouda-only, and cashew-only).

### Bio-physical factors

*Farmers with less need for increased productivity because of better farming conditions will receive fewer relative benefits from cashews and will take longer to adopt.*

*Soil* (subjective fertility weighted by field size): Farmers were asked if each plot was not fertile, fertile, or very fertile for growing millet (the most common subsistence crop). Responses were weighted by field size to create a single weighted average soil fertility value for each farmer.

*Slope* (subjective slope weighted by field size): Farmers were asked if water runs a lot “to go” (runs very quickly), runs a lot, or does not run at all<sup>35</sup> on each field as a proxy for slope. Responses were weighted by field size to create a single variable for each farmer. It is expected that fields with a higher slope will have associated increased erosion, poorer fertility, and therefore an earlier time to adoption. As low slope is coded with a higher number, a positive sign is expected for this coefficient.

*Plot size* (average plot area (ha)): The average area for each farmer’s set of fields was calculated using GPS data and GIS software. This variable is a measure of the fragmentation of a farmer’s plots.

### Risk and Uncertainty

*Farmers with more experience in tree work or contact with extension agencies will have a lower perceived risk of adoption and will adopt earlier.*

*Tenure* (years owning oldest plot): As a farmer’s agricultural knowledge and experience with decision-making increase, his ability to process new information also improves. For this

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<sup>35</sup> I questioned the translator about the apparent lack of middle ground (e.g. the water runs a little bit), and he insisted that these choices were appropriate.

reason, years of tenure may substitute for years of formal education (Lindner et al., 1982). Farmers were asked how many years each field had been in their possession.<sup>36</sup> The maximum value among a farmer's set of fields was used as the value for that farmer.

*Experience, Extension, & Membership* (has done tree work, has worked with Peace Corps volunteer, has any experience with extension agents, experience and extension weighted index, PC for extension & experience group): Household heads were asked if they had ever used any other tree technologies before planting cashews, like live fencing or alley cropping. Household heads were also asked if they had ever talked to or worked with a Peace Corps Volunteer, an *Eaux et Forêts* forester, or any other project representatives about trees. In both cases, it is likely that the information would have been shared with other farmers in the household, at least by giving them an opportunity to closely observe the technology and in many cases probably directly involving them in planting or in conversations with extension personnel. Finally, household heads were asked if any male household members had purchased memberships in UGAB. Membership in these organizations gives farmers access to expert advice and a formal network of peer advice, as well as material benefits. A weighted index was created to account for the sum of a farmer's experience, while placing less emphasis on meetings with *Eaux et Forêts* rangers, which were generally one-hour village meetings, and more emphasis on UGAB membership, which required a substantial financial investment. Principal component analysis was used to capture the variation in these data in fewer variables. This analysis was performed separately for each model's subset (Simong-only, Mamouda-only, and cashew-only).

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<sup>36</sup> Or the number of years "since you took it yourself" in cases where the farmer had worked the field while still in the possession of his father.

### Social Proximity

*Farmers with early adopting advisors will be more likely to adopt early themselves.*

*Advisor cashew relative age* (advisors with older cashews dummy): Social network rosters were used in conjunction with field survey data to determine the presence of an advisor with cashews older than the farmer's cashews. If at least one of the farmer's advisors had older cashews, this variable is coded as one. Farmers who said "I don't have any advisors" and farmers whose advisors had planted cashews more recently are coded as "0." This is one measure of the influence of advisors on the decision to plant cashews.

*Advisor cashew median age* (median cashew age of advisors): Social network rosters were used in conjunction with field surveys to calculate the median age of the farmer's advisors' cashews. The response "I don't have any advisors" is coded as "0." This measure reflects the adopter category (innovator, early majority, etc.) of the majority of a farmer's social network.

### Spatial Proximity

*Farmers with plots in close proximity to older cashews will adopt earlier.*

*Distance to nearest cashew* (distance from cashew plot to nearest cashew plot (m), distance from any plot to nearest cashew plot (m) (Simong only)): The distance between any of the farmer's plots and the closest cashew plot was calculated using a spatial join in ArcGIS. As

only cashew fields were recorded in Mamouda, separate variables were created for the Mamouda-only and cashew-only models using only cashew plots, and the Simong-only model using all plots.

*Percent adjacent cashews* (% adjacent fields planted in cashews (Simong only)): The percentage of adjacent fields (within 50 m of boundary) planted in cashews was calculated using spatial data joined with cashew age. If a farmer has multiple fields, all adjacent fields were totaled and averaged as a conglomerate. As only cashew fields were recorded in Mamouda, this variable is only valid in the Simong-only model.

*Oldest adjacent cashews* (oldest adjacent cashew age): The age of the oldest cashews adjacent (within 50 m of boundary) to any of the farmer's fields was calculated. As only cashew fields were recorded in Mamouda, this variable is not valid in the Mamouda or cross-village cashew model.

**Table 3.4. Descriptive statistics for household regression variables in survival models.**

Household variables	Mean	Std. Dev.	Minimum	Maximum	Cases	Expected Sign
Max. years of Arabic education	7.41	5.84	0	25	61	-
Max. years of French education	1.75	2.29	0	12	61	-
Percent male	0.54	0.2	0	1	59	-
No. of males	6.92	4.07	0	15	60	-
Asset index	48.1	40.0	4	185	58	-
PC of asset group (cashew only)	1.72E-09	1.8	-1.75	11.2	58	-
PC of asset group (Simong only)	-8.50E-09	1.63	-2.17	3.6	40	-
PC of asset group (Mamouda only)	2.47E-17	2.11	-1.99	7.81	18	-
No. of wage earners	0.967	1.52	0	5	61	-
Dependents per laborers	0.531	0.481	0	3	58	+
No. of laborers	8.91	4.87	2	16	58	-
PC of credit group (cashew only)	9.02E-09	1.23	-1.87	1.51	61	-
PC of credit group (Simong only)	-4.29E-09	1.25	-1.96	1.42	42	-
PC of credit group (Mamouda only)	9.24E-02	1.2	-1.66	1.75	18	-
PC for extension & experience group	-7.24E-09	1.25	-1.65	4.15	58	-
PC for extension & experience group	-1.33E-08	1.36	-1.71	2.19	40	-
PC for extension & experience group	4.93E-17	1.52	-2.09	1.6	18	-
Experience and extension weighted index	3.16	2.4	0	7.5	58	-
Has any experience with extension agents	0.869	0.340	0	1	61	-
Has worked with Peace Corps volunteer	0.459	0.502	0	1	61	-
Has membership in UGAB	0.397	0.493	0	1	58	-
Has done tree work	0.328	0.473	0	1	61	-

**Table 3.5. Descriptive statistics for farmer regression variables in survival models.**

<b>Farmer variables</b>	Mean	Std. Dev.	Minimum	Maximum	Cases	Expected Sign
Log of years to adopt since 50 years ago	3.79	0.501	0	3.93	61	Dependent Variable
Farmer age class converted to years	43.4	15.1	13	65	61	-
Number of advisees	1	2.54	0	15	61	-
Total field area (ha)	4.2	4.42	0	18.6	61	-
Average plot area (ha)	2.61	1.72	8.13E-02	7.6	57	-
Years owning oldest plot	16.4	12.5	1	52	61	-
Advisors with older cashews dummy	0.556	0.501	0	1	45	-
Median cashew age of advisors	6.11	3.46	1.5	15	47	-
Distance from any plot to nearest cashew plot (m) (Simong only)	177	179	68.9	1470	61	+
Distance from cashew plot to nearest cashew plot (m)	195	195	98.1	1470	51	+
% adjacent fields planted in cashews (Simong only)	0.664	0.246	0.2	1	40	-
Oldest adjacent cashew age	8.52	11.9	0	50	61	-
Absent dummy	0.23	0.424	0	1	61	+
Subjective fertility weighted by field size	0.767	0.213	0.333	1	61	+
Subjective slope weighted by field size	0.656	0.23	0.116	1	61	+

### 3.5 Advisor Models

Initial analysis of farmer social network data showed interesting trends regarding advisors and their advisees calling for further analysis. Advisors are defined as any villager listed by a farmer as a source of advice, while advisees are the farmers listing a certain advisor as a source of advice. Of the 27 villagers identified as advisors, only 21 could be identified as

reported household members with associated data.<sup>37</sup> These data were linked to household and field data to specify ordinary least square (OLS) regression models predicting the effectiveness of an advisor in promoting cashew adoption using observable characteristics, which could then be used by extension agents in identifying extension multipliers. Advisor effectiveness was proxied with the product of an advisor's number of advisees and the average age of his advisees' cashews, which is equal to the sum of all a certain advisor's advisees' years since planting cashews, or 'total advisee cashew years'. A new variable was created to test the possible role of field location in identification of effective advisors. Four main roads and paths in Simong and two in Mamouda were selected as high traffic routes, frequently traveled by villagers. The number of fields a farmer had along any of these routes was counted and labeled 'road frontage total'. A dummy variable was also created for whether a farmer had any fields along any of the selected routes, called 'road frontage dummy'.

Variables used in the survival models described above with possible significant relationships were selected using a conceptual model based on prior knowledge and trends observed in the field, and added to the road frontage variables to create a set of right hand side variables (Tables 3.6 and 3.7). This set of variables was used to create a table of descriptive statistics comparing advisors effective in cashew promotion, advisors not effective in cashew promotion, and non-advisors. Analysis of variance was also calculated for each variable.

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<sup>37</sup> Some of the remaining five advisors are not actual village residents, while others could not be positively matched with household data.

**Table 3.6. Descriptive statistics for household regression variables in advisor models.**

<b>Household variables</b>	Mean	Std.Dev.	Minimum	Maximum	Expected Sign
Max. years of arabic education	7.43	5.12	0	16	+
Max. years of french education	1.81	2.89	0	12	+
No. of wage earners	1.24	1.64	0	5	+
Asset index	50.7	45.2	7	185	+
PC of asset group	0.265	2.65	-1.75	11.2	+
PC of credit group	0.194	1.21	-1.87	1.51	+
Experience and extension weighted index	3.19	2.60	0	7.5	+
PC for extension & experience group	-0.0109	0.990	-1.65	1.48	+
Has any experience with extension agents	0.905	0.301	0	1	+

**Table 3.7. Descriptive statistics for farmer regression variables in advisor models.**

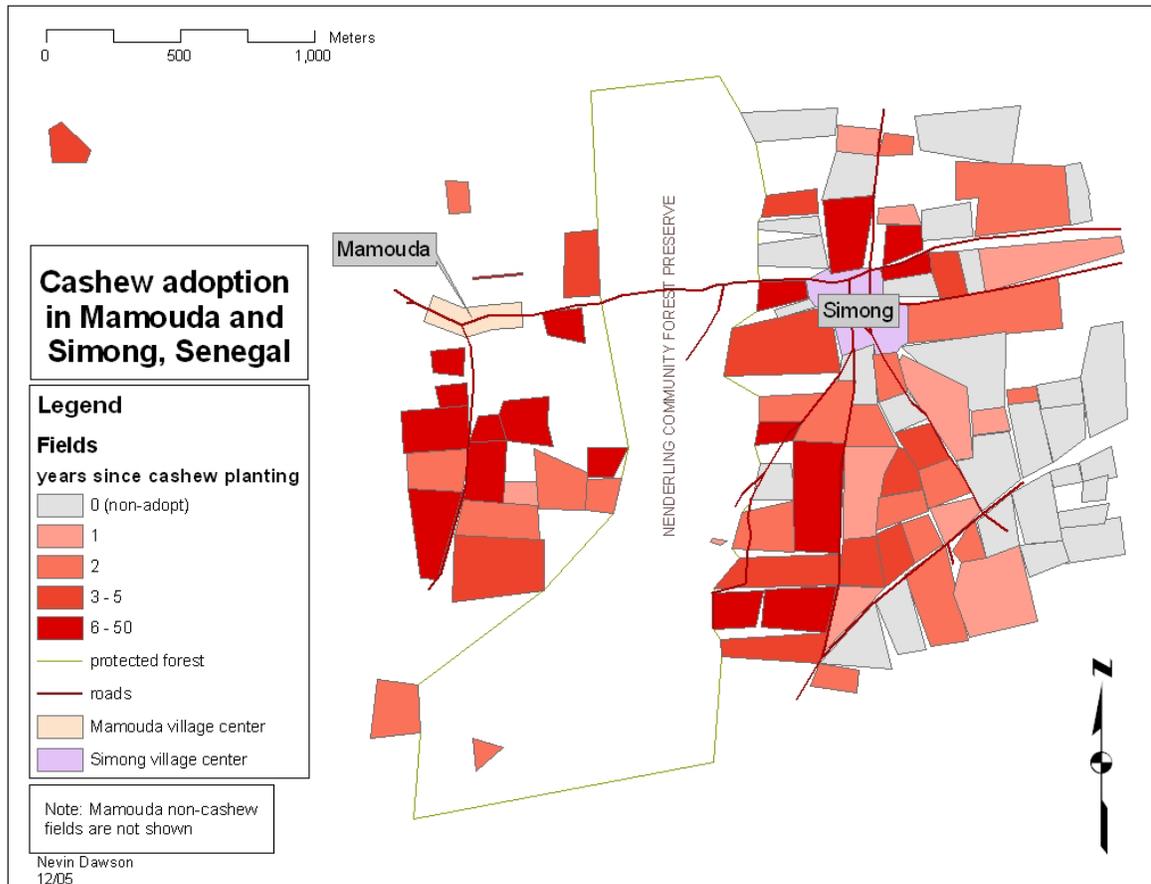
<b>Farmer variables</b>	Mean	Std.Dev.	Minimum	Maximum	Expected Sign
Total advisee cashew years	10.381	9.64612	0	32	Dependent variable
Age of oldest cashews	4.14	5.01	0	18	+
Age class converted to years	51.5	14.5	13	65	+
Total field area (ha)	5.75E+4	5.72E+4	0	186E+5	+
Number of fields on main route	0.762	1.14	0	4	+
Has fields on main route	0.429	0.507	0	1	+
Has worked with Peace Corps volunteer	0.476	0.512	0	1	+
Has membership in UGAB	0.381	0.498	0	1	+
Has done tree work	0.381	0.498	0	1	+

## **4. RESULTS**

This study employs spatial data, three tiers of survey data, and regression models to triangulate common conclusions on “What makes an early adopter?” and “What makes a good extension multiplier?” This chapter presents the results found through the methods described above from each of the three perspectives. The next chapter will synthesize these results and offer conclusions.

### **4.1. Spatial**

Spatial data were collected with a handheld GPS rover unit and uploaded into ArcGIS software. These were then joined to the age of the oldest cashews in each field to show the physical pattern of adoption in Mamouda and Simong (Figure 4.1). Strong spatial diffusion of the innovation from one initial innovator to his neighbors and then to their neighbors would present a bull’s-eye pattern, the fields getting lighter in color as they fan out from the central adopter. This pattern is not present, but there is a general dearth of cashews in the southeast of Simong’s farmland, balanced by some degree of clustering around the roads leading south from each village. These roads provide the quickest route to the nearest mid-sized town and access to all points beyond, and are traveled by several public transportation vehicles each day. These roads are also similar distances from the seasonal river, which runs through the middle of the forest reserve, which could imply similar soil types or other biophysical conditions. Clustering around these roads could be due to their high visibility or to their physical similarities.

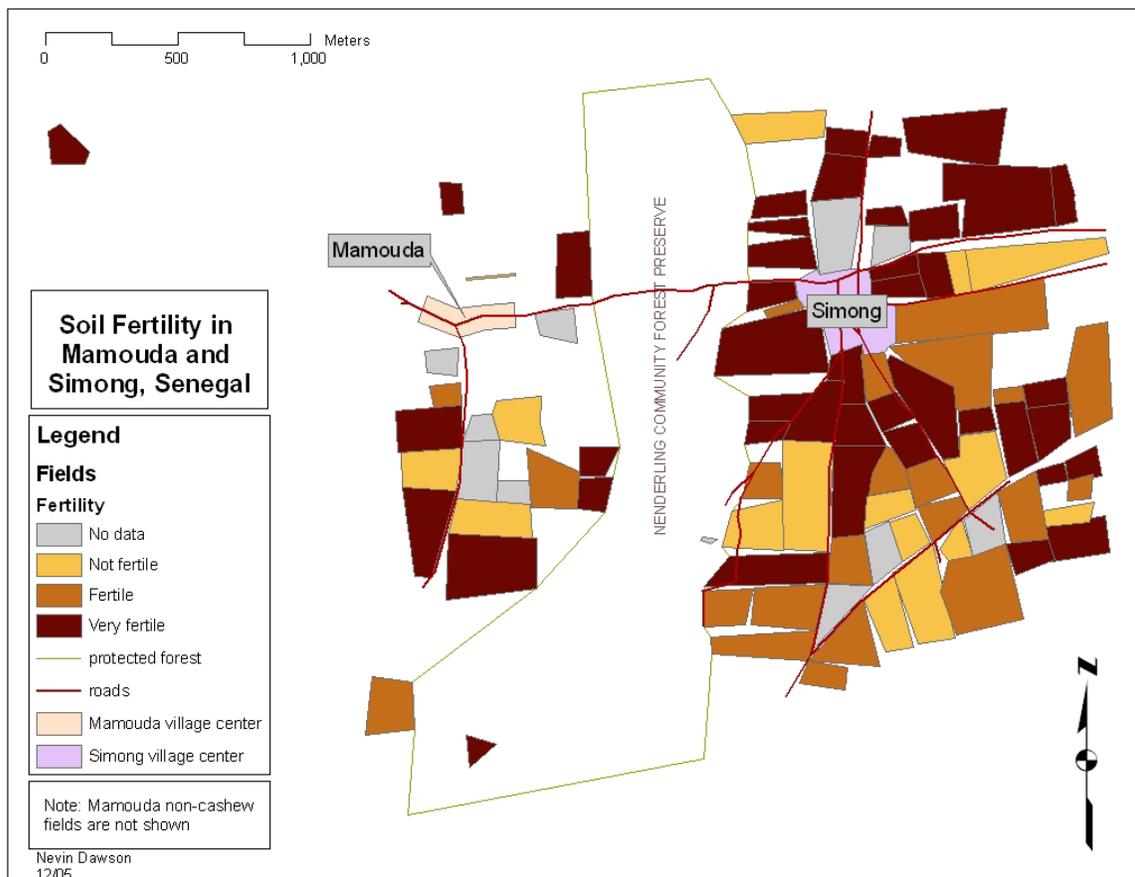


**Figure 4.1. Cashew adoption in Mamouda and Simong. Fields are shaded by the age of cashews.**

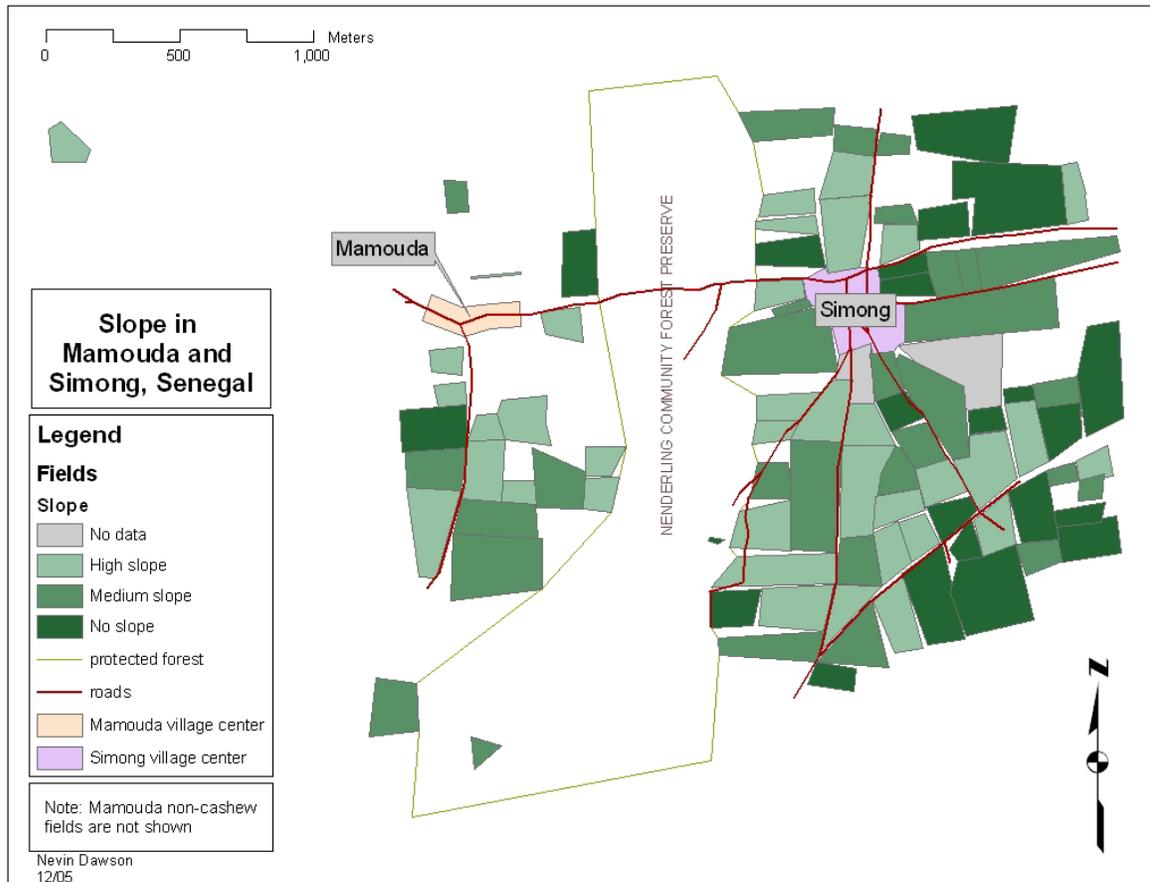
Visual observation of the soil fertility map (Figure 4.2) shows a rough positive relationship between higher fertility and older cashews, but this result is confounded by the fact that cashews improve soil fertility, such that it is difficult to discern whether the observed effect is a cause or a result of cashew planting<sup>38</sup>. The same comparison between cashew location and slope (Figure 4.3) shows a rough correlation between level ground and absence of cashews, especially notable in the southeast corner of Simong's fields. This finding furthers the notion that cashew planting may be clustered due to biophysical characteristics, and that

<sup>38</sup> The measure of fertility is subjective, and could therefore be even further influenced by the presence of cashews. That is, if a farmer believes that cashews improve fertility, then he may be more likely to say that a cashew field is fertile.

farmers are likely to choose fields for early cashew planting that are especially in need of restoration after more severe water erosion due to higher slope. It may also be that farmers believe cashews to grow better on slopes. A third possibility is that non-cashew crops are easier to cultivate on flat land, and farmers are therefore more willing to plant cashews on sloped fields. Although it seems that this relationship should be paralleled by an equal correlation between poor soil and older cashews, it may be that areas of high water erosion and mediocre fertility are more noticeable than those with low water erosion and very low fertility, and are viewed as more urgent problems due to actual loss of arable land.



**Figure 4.2. Soil fertility in Mamouda and Simong. Fields are shaded by subjective soil fertility, as given by farmers.**



**Figure 4.3. Slope in Mamouda and Simong. Fields are shaded by subjective slope, as given by farmers.**

While patterns of spatial *diffusion* are not evident, farmers have planted their cashews in *clusters*. This could be due to the lower risk involved in planting near an already-established cashew field. In choosing from among a suite of fields placed in a variety of locations, a farmer could reduce risk by first planting cashews in those of his fields that are closest to the most cashews. He thereby has some assurance that his cashews will do about as well as his neighbors' due to similar biophysical conditions. Clusters may have formed around the south roads because of the high visibility of cashews in these locations. Although there are older cashews elsewhere, farmers may have chosen these south road cashews to cluster cashews around because they remained foremost in their mind. It follows then that an extension agent

should choose a test plot that is not just suitable for cashews itself, but that is highly visible and located in the center of a large area of biophysical suitability, such that new adopters planting nearby will have results similar to the trial farmer's. This practice complements Franzel et al.'s (2002) recommendation for on-farm testing as a way to allow farmers to assess an innovation under conditions similar to their own fields, rather than what might be present at a remote research station.

This evidence of spatial relationships could be confounded by the presence of older cashew groupings all belonging to households with an overall preference for early adoption. Field maps symbolized by household and cashew age (Figures 4.4 and 4.5) show that some of the clustering effect may be due to grouped household fields. That is, there are several groupings of adjacent fields belonging to the same household that all have cashews to some extent. Particular examples are the brown cluster of four fields just south of Simong (belonging to the village chief's household), and the pale green cluster of five fields at the southern extent of Simong's fields. While these groupings do add to the appearance of the clustering effect described above to some extent, it should also be noted that the oldest cashews in the cluster are spread across different households, suggesting that the effect of household on clustering is minimal in Simong. Three of the oldest centrally grouped cashew fields in Mamouda belong to the same household, suggesting that Mamouda's cluster of older cashew fields may in part be a result of grouped household fields.

Although the household effect on the clustering of old cashews may be minimal, two Simong households appear to have older cashew fields than others. These are the brown fields

belonging to the village chief's household, and the dark green fields belonging to the village Imam's household. Each of these households has two fields that stand out visually as older than the village average. This could be another indication of a household effect in adoption, that is, that certain households are more likely than others to adopt early.

These maps also show that a household's fields tend to be scattered throughout the landscape. Even those households with field groupings also have holdings elsewhere, and most households with fields in the large area devoid of cashews in the southeastern quadrant of Simong's fields also have fields somewhere else that do have cashews. This could be a method of risk reduction, such that a fire or pest/pathogen outbreak would be less likely to destroy all of a farmer's fields at one time. Wide field distribution may also be a method of increasing equality, preventing monopolies on higher quality land that would give a large advantage to certain farmers over others.

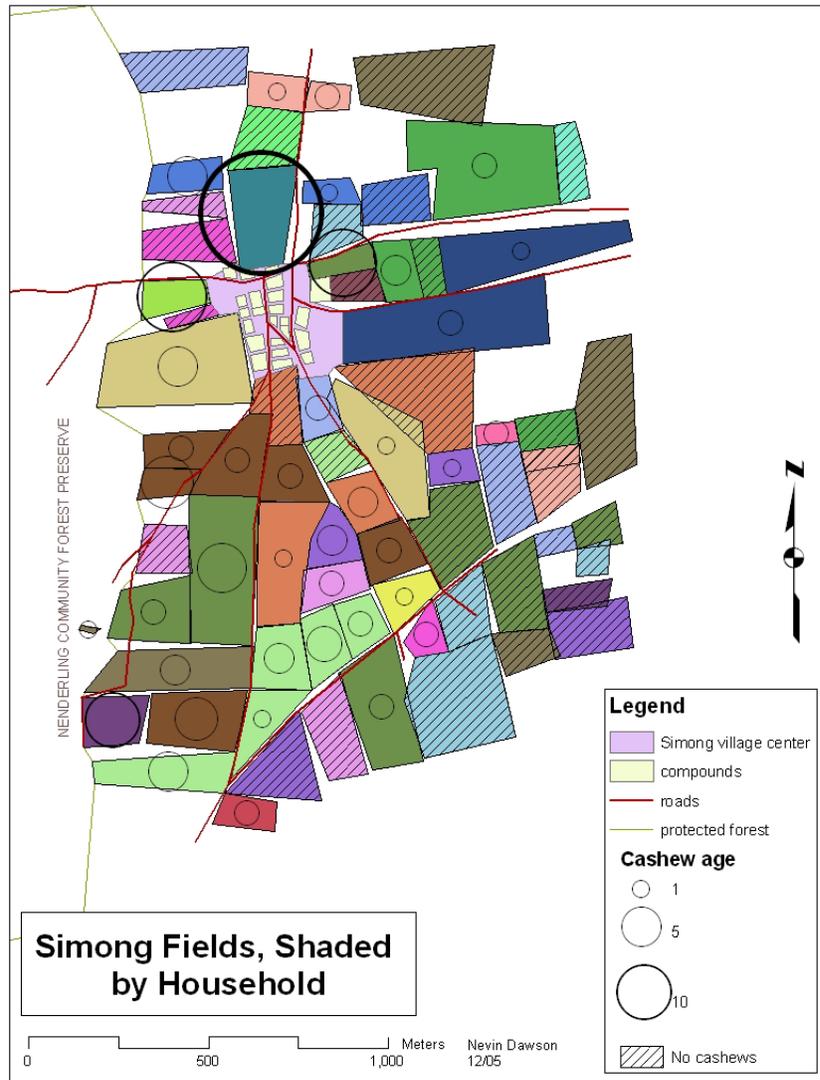
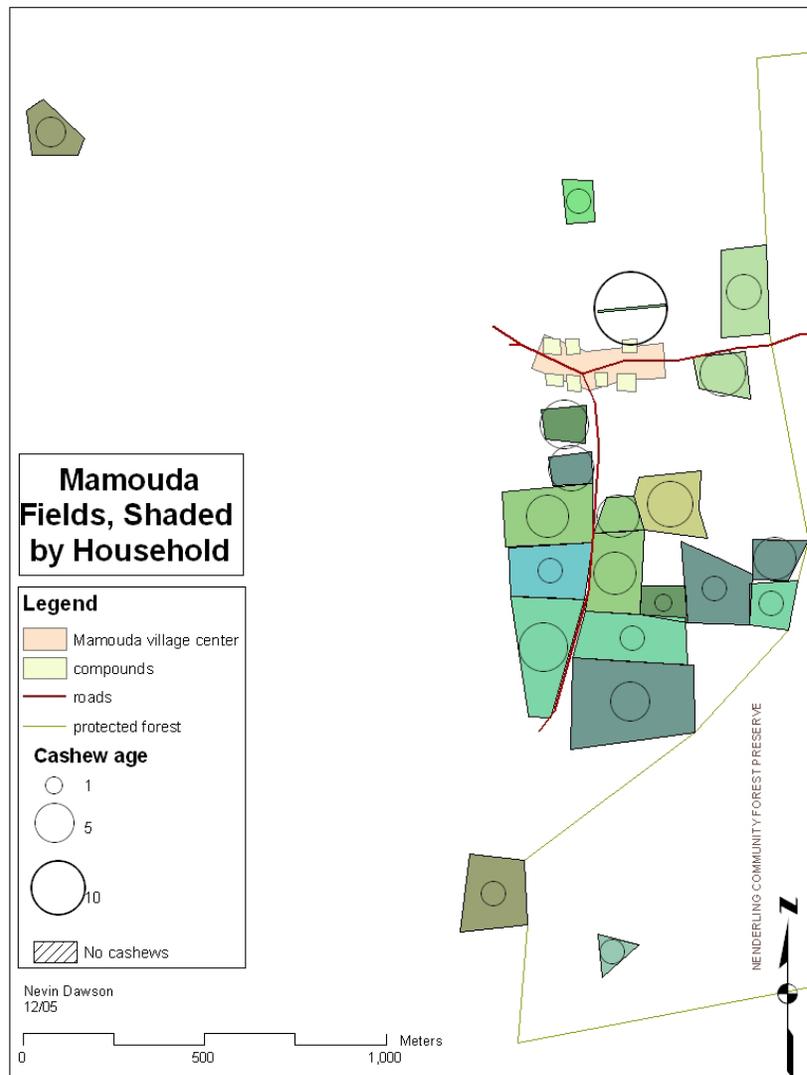


Figure 4.4. Simong fields by household and age. The largest circle indicates the 50 year old orchard.



**Figure 4.5. Mamouda fields by household and cashew age. Note: non-cashew fields are not shown.**

## 4.2. Household

Thirty-two household heads were asked a series of both open- and close-ended questions about general characteristics of their household, as well as their opinions of cashews and their place in Senegalese farming systems. Household descriptive statistics are presented first, followed by a summary and analysis of open-ended questions.

#### 4.2.1. *The Household*

Household heads were asked to list household residents and several of their characteristics. Simong and Mamouda show a noteworthy difference in household structure, related to the difference in physical layout as described in Chapter 2<sup>39</sup>. Although the two villages are populated by roughly the same number of people, Mamouda's wide "Main St." is lined with compounds and households much larger physically and in members as compared to Simong's compounds, which are spread out amongst a web of roads (Table 4.1). Simong's median household size, eight, is close to Senegal's mean household size, about nine people (Garenne, 2002). Mamouda, however, has a much larger median household size, 21 people. Mamouda also has fewer farmers per 100 people (Table 4.2), which may be due to larger landholdings per farmer, less dependence on farming for subsistence and income, or a combination of these two factors.

**Table 4.1. Household descriptive statistics.**

	Simong	Mamouda
Total population	228	224
Households	23	10
Median people/household	8	21
Median household % male	0.49	0.54
HH median maximum Arab education (years)	5	11
HH median maximum French education (years)	1	2
Total # wage earners (entire village)	9	15

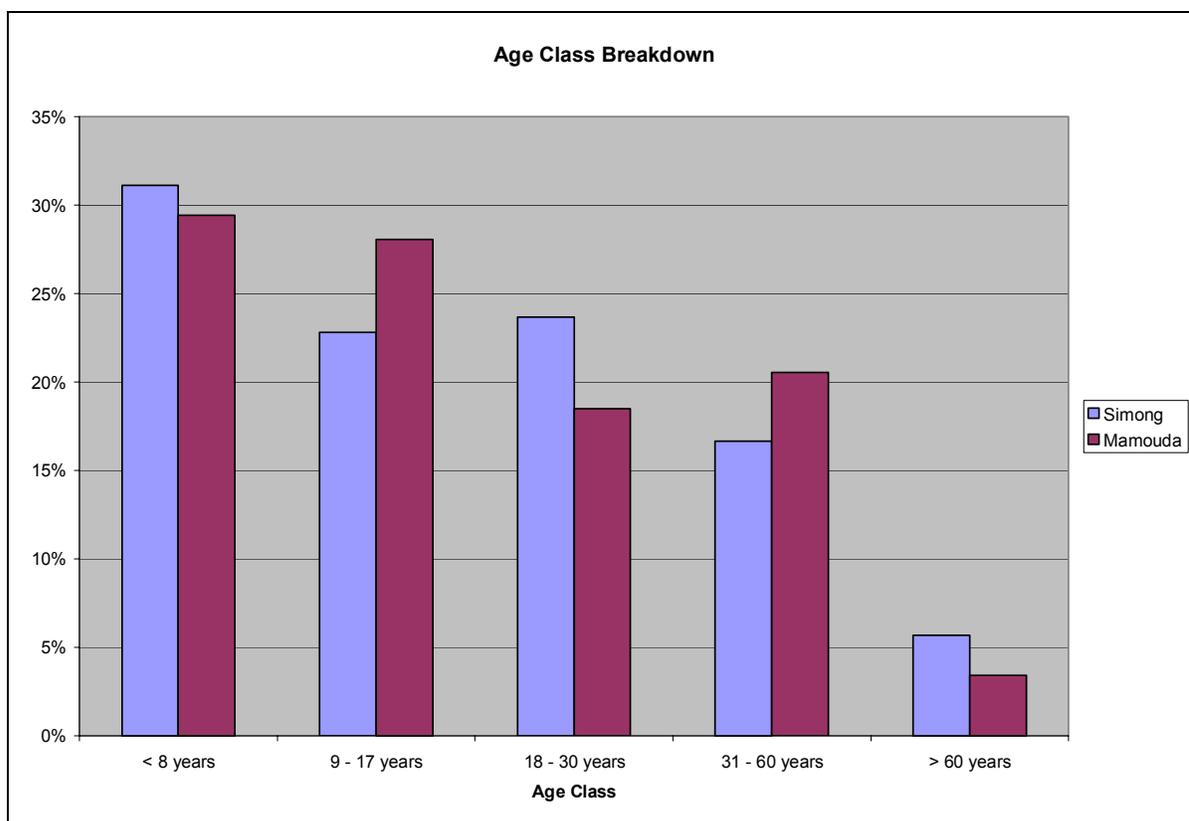
Education levels are dissimilar between villages. While the statistics for French education are comparable between villages, the median of the maximum number of years any one household member has attended Arabic school is 5 years in Simong, but 11 years in Mamouda. Age class distributions are similar between villages (Figure 4.6).

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<sup>39</sup> See Figure 2.4 on page 447.

**Table 4.2. Farmer distribution.**

	<i>Simong</i>	<i>Mamouda</i>	<i>Overall</i>
Households	23	10	33
Farmers	42	19	61
Farmers/Household	1.8	1.9	1.8
Farmers/100 people	14	8	13



**Figure 4.6. Age class breakdown for Simong and Mamouda.**

#### 4.2.2. Uses

Household heads were asked “Why did you plant cashews? What uses do they have?” (Table 4.3). This was intended to gather data on the benefits a household actually gets or plans to get from cashews, but sometimes became a list of everything they had ever heard that you could do with cashews. This resulted in a list of possibilities that were not commonly in practice, like fodder and juice, but the most common responses are telling.

Farmers view the cash income that cashews offer as their primary benefit (81% gave this answer), and secondly, they want products they can use at home (78% gave this answer). Even when asked “What’s good about cashews that *doesn’t* get money?” 41% of the respondents<sup>40</sup> gave a commodity-related answer. Environmental benefits are also mentioned, but only by 19% for the first question and 16% for the second. These data show that soil restoration is not the primary concern of these farmers, and further explain the lack of spatial correlation between cashews and poor soil. This is likely a result of the life near the subsistence threshold. Farmers may only have the luxury of worrying about the future condition of the soil once they have met their needs in the present.

**Table 4.3. Responses by household heads to the questions “Why did you plant cashews? What uses do they have?” (Q1) and “What’s good about cashews that doesn’t get money,” (Q2). If a category was mentioned in response to either question, it was recorded once in the sixth column, "Either". Respondents gave multiple answers, such that percentage totals are greater than 100. n=32. See Appendix A for response breakdown by subcategory.**

Use category	#	%	#	%	#	%
	Responses	Responses	Responses	Responses	Responses	Responses
	Q1	Q1	Q2	Q2	Either	Either
<b>Sell</b>	21	0.66	13	0.41	26	0.81
<b>Consume</b>	16	0.50	15	0.47	25	0.78
<b>Environmental</b>	6	0.19	5	0.16	8	0.25
<b>Other</b>	17	0.53	0	0.00	17	0.53

#### 4.2.3. Cashew vs. Peanut

Peanuts have long been a central part of the local farming system, but many farmers are now finding this cash crop to be unproductive and unprofitable when compared to the cashew.

Cashews were reported to have more buying power than peanuts by 44% of household heads (Appendix A). One farmer estimated that peanuts could yield about \$100/ha, while cashews

<sup>40</sup> Respondents gave multiple responses, leading to totals greater than 100%.

could bring in \$1000/ha.<sup>41</sup> This was apparently not always the case however: “You used to be able to get a lot of peanuts out of a little seed, but now you work until you're tired and get nothing,” (Ousmane Diop) Household heads were asked the first price they ever received for raw cashews and how many years ago that was (Figure 4.7). A definite trend is evident, with prices as low as \$0.04/kg<sup>42</sup>. This places more weight on the decision of the early adopters, who not only ventured into unknown territory, but did so at a time when the margin of benefit was much lower.

Only 16% of household heads mentioned the restorative effects cashews have on the soil. “Peanuts kill the earth in two years; cashews make the soil live,” (Mamadou Diouf). Peanuts and cashews were both reported to have advantages by 28% of the respondents. Some disadvantages were mentioned. An orchard does not give a farmer the option to plant a second crop after the first one finishes production. This practice is sometimes carried out with watermelons after millet or peanut harvest. Another farmer complained about the loss of fodder that peanut residue used to provide (El Hadji Touré).

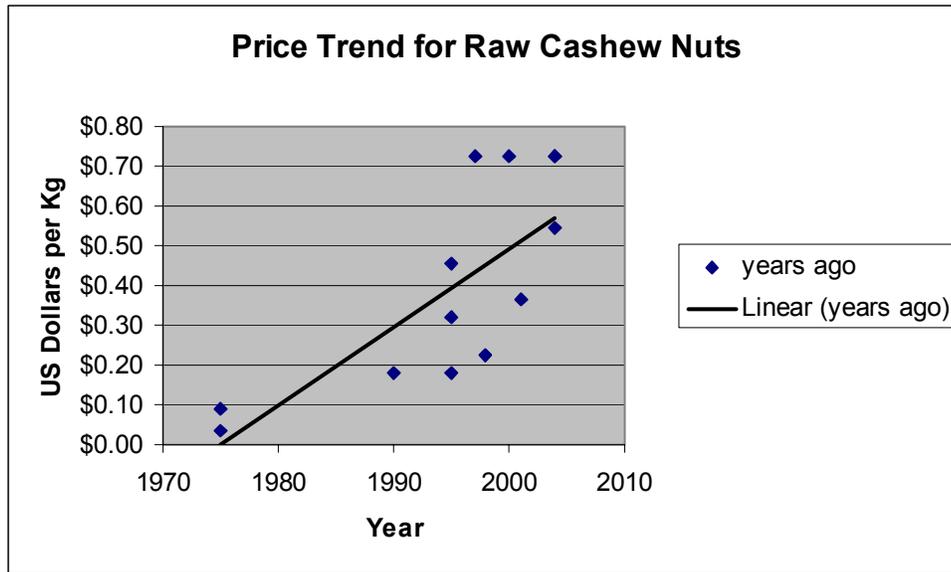
These results strengthen the emphasis that farmers place on the commodities available from a new technology over its long-term benefits. In order for an innovation to be accepted, the benefits to its users must be tangible and pertinent to their immediate situation. Any long-term effects will be viewed as an added advantage rather than a reason to adopt. This finding

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<sup>41</sup> Although most numeric comparisons of profits in support of the profitability of cashews were based on the price per kilogram rather than the price for the yield of one hectare, figures from the literature support their claims of higher profit/ha. It may be that farmers do know this without being able to explain it verbally in mathematical terms.

<sup>42</sup> Prices are not adjusted for inflation or 1994 currency devaluation. The CFA has been pegged to the French franc (CFA 50 = FF 1) since 1941 until its devaluation in 1994 (CFA 100 = FF 1). It is now pegged to the Euro (CFA 666 = EURO 1). (Irving, 1999)

also implies that a farmer's eagerness to adopt is likely to be proportional not to the limitations of his soil, but to relative advantage of the new technology over his current situation. These two factors may be closely linked in the case of cashews,



**Figure 4.7. Price trend for raw cashews as reported by household heads. Prices are not adjusted for inflation or 1994 currency devaluation. \$1 USD = 550 CFA.**

#### 4.2.4. Stated friends vs. fields

Household heads were asked to state which of the following influences were more important first in their own decision to adopt cashews, and then in others' decision: hearing talk about cashews in the village or seeing others cultivate them in the fields. Responses were fairly balanced with a slight preference for "Friends" (Table 4.4). This finding suggests that farmers chosen to multiply extension efforts with trial plots should be socially well-placed with high numbers of contacts and advisees, but also in possession of and willing to use a centrally located field site for the trial. The importance of social interaction in the spread of new knowledge coincides with previous work by Udry and Conley (2005), while the importance of plot location corresponds with Kasuga's observation that a well-placed plot

allows for easy inspection and visits by farmers just passing by {{/a 91}}. These factors may increase the impact of any extension effort.

**Table 4.4. Responses to "Friends vs. Fields" question.**

	<b>n</b>	<b>Friends (%)</b>	<b>Fields (%)</b>	<b>Both (%)</b>
Q1: Do you plant cashews because your friends and other owners talked about it and that caused you to reach for it, or because you saw that people are planting cashews everywhere in their fields, so you did it too?	<b>31</b>	<b>48</b>	<b>39</b>	<b>13</b>
Q2: Do other people plant because their friends and other owners talked about it and that caused them to reach for it, or because they saw that people are planting cashews everywhere in their fields, so they did it too?	<b>32</b>	<b>44</b>	<b>41</b>	<b>16</b>

#### 4.2.5. *Awareness vs. Knowledge*

The primary reason farmers gave for waiting longer than others to plant was “I didn’t see the benefits,” (47% of respondents). It can be assumed that since PASA’s extension efforts in 1980, all farmers were at least *aware* of cashews as an alternative to their standard field crops. That is, cashews were from that point forward a part of their universe of farming options, although the amount of information associated with this option was not necessarily substantial.<sup>43</sup> Awareness alone, however, was not enough to convince farmers to risk investing in cashews. PASA may not have offered the depth or reliability of knowledge required by farmers to reduce uncertainty to an acceptable level. This knowledge must be closer to first-hand in nature, as Mohammed Dramé illustrates: “I didn’t know the benefits at the time. I ate them and they were tasty. I sold them in Banjul and got money. Then I planted”. This type of knowledge, first-hand experience with the costs and benefits of cashews or second-hand information from a trusted informant, later came from other sources.

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<sup>43</sup> This definition is similar to that used in marketing, “A measure of the percent of target customers who are aware of the new product's existence. Awareness is variously defined, including recall of brand, recognition of brand, recall of key features or positioning.” (Sundberg Ferar, 2004)

Cashew cultivation was brought into the region by travelers, cosmopolitan farmers with the resources and desire to see more of the world or expand their business opportunities, and who are “involved in matters beyond the boundaries of their local system” (Rogers, 1995). They imported knowledge from other regions where cashews have been a successful cash crop for years and used it to plant their own trial cashew fields. Fodé Dramé explains “The people who traveled a lot planted early. The Gambia, Guinea Bissau, Casamance have more trees than here—you can see their benefit there”. Ibrahima Diallo said that “I bought cashews and processed them and took them to Dakar. I saw their benefit there and wanted to start my own”. Amadou Cissé added “People hearing how much money other people have made is what gets them started”. Some even found sources that were more local: Amadou Cissé continues, “My friend in another village got me into cashews ... [he] convinced me that cashew money could replace peanut money”.

The first- and second-hand knowledge gained from these other sources reduced the uncertainty of planting a new crop enough for cosmopolitan farmers to plant their own cashew trials in Mamouda and Simong. Lindner (1981) points out that the weight placed on information gained by off-farm sources is dependent upon several factors, including the similarity between the production environments both at the information source and in his own fields. Some of the farmers quoted above observed cashew production in remote locales with growing conditions different from those in the study villages. The fact that their observations abroad were sufficient to prompt cashew trials at home despite the disparity in conditions suggests that the impact of seeing a working cashew production of any sort is very powerful. It also points to the possible inherent difference in the farmers that choose to

travel, who may have an innately lower aversion to risk. These two characteristics correspond with Rogers (1995) description of innovators (early adopters).

The trials planted by these innovators allowed other villagers to also learn the characteristics of cashews, reducing their uncertainty enough to begin planting themselves. The learning process facilitated by these trials can be expected to take longer than with an annual field crop, as the first cashew harvest does not occur for three years after planting, and cannot be expected to replace the utility of the traditional crop for at least six years after planting. This slow maturation period is compensated to some extent by the utility of the intercrops until they are shaded out six to ten years after cashew planting.

The second most common reason for waiting to plant (5%) was a land or tenure issue. Some of these respondents had only moved to the village recently and had not yet acquired any fields of their own, relying instead on borrowed use rights that did not include rights to tree planting. Farmers with only one field were also unwilling to plant cashews when their characteristics were uncertain and lose the ability to farm the crops they are familiar with, as confirmed by Kéba Dramé: “People who planted early had extra fields to risk”. This further supports the large role uncertainty plays in an adoption decision. When a farmer has only one field on which to subsist, the potential for greater benefit that cashews offer is apparently not enough to offset the risk in dealing with the unfamiliar.

#### 4.2.6. *Land scam*

Early extension efforts by PASA were probably failures for the reasons above, but also in large part due to rumors of previous experiences with similar seemingly benign efforts to introduce a new crop that were in reality land acquisition schemes by large corporations. Representatives would come to villages and help farmers start new crops like cotton after obtaining their signature on a contract. Farmers in these rural areas are mostly illiterate, however, and would certainly not be able to decipher the official language in a contract. Several years later the representative would return with papers proving ownership of the farmers' land by the corporation. The farmers had unknowingly authorized this transfer with their signature, and then improved the land with their labor. Any efforts to reverse the transfer were overwhelmed by the power of the corporation and the irrefutability of the signed contract. In the words of Aliou Sehn, "People didn't dare participate in PASA because they knew of people that came to villages and had villagers make an agreement to do work. The company would come back later when work was done and take the land from them".

These stories of scams likely limited the trust that farmers were willing to place in outside organizations that came into the village looking to "help." Farmers were not just reluctant to trust PASA's intentions, but also their information. Many household heads (47%) said that they did not adopt cashews any earlier because they were previously unaware of the benefits, implying that they did not learn the benefits of cashews until after PASA had come and gone. As PASA's goal was to effect cashew cultivation, it can be assumed that they were very explicit about the benefits, but that their information was not internalized by the farmers.

Some said that even after PASA's efforts, they still thought that cashews would "destroy the soil," even though the opposite is in fact true (as most farmers now realize). Even though PASA offered valuable incentives and presumably good information on the benefits cashew cultivation has to offer, there were only one or two farmers who agreed to plant cashews in the two study villages.

#### *4.2.7. Disincentives*

Several reasons were given by respondents to consider in delaying or rejecting adoption. 41% of respondents did not know of any drawbacks to cashews, but the most common disadvantages mentioned were the resulting reduction in other crops (22%), destruction by wildlife (13%), and snakes that are attracted to the shade provided by cashews (13%).

Household heads were consistently cautious of planting all fields in cashews, as 53% said either that it is preferable to have multiple types of crops or that it is not advisable to live off of cashews alone. Some, however, did think it was possible to live only on the profits of cashew cultivation: 34% said either that they planned to live on cashews alone (9%) or that it is feasible to live on cashews alone (25%). This finding suggests that farmers are wary of the risks associated a limited portfolio, such as the potential for total crop failure from a single pest or pathogen, rather than just a portion.

Some respondents mentioned several benefits of planting later rather than earlier, such as taking advantage of learning about optimal spacing and soil types for highest production, or having access to improved varieties that were at first not available. None of these reasons,

however, were considered enough to warrant waiting to plant, as 81% said that early planting is better, implying that even late adopters wished they had adopted earlier. As Kéba Mané put it, “It pains me that I didn’t plant early”. This again reinforces the theory that were it possible to convince all farmers at one time of the benefits of cashews, simultaneous mass adoption may have occurred.

#### *4.2.8. Views of the future*

Villagers are optimistic about the steps forward that cashews may be able to facilitate. The most common reply when asked how cashews can change people’s way of life was “Cashews will allow people to get more things/better houses” (53%). As Amadou Cissé said, in the future “Trees will be plentiful; they will make people free”.

#### *4.2.9. Women and children*

Eleven women and children were also briefly interviewed to observe any differences in opinions on cashews from the men responding to the rest of the survey components (Appendix B). Women and children placed the same emphasis on the sales and consumption benefits of cashews that men did. Two commented that having cashews in a household does add to one’s total workload, but the consensus was that cashew work is easier than other crop labor, and that the availability of pruned branches makes gathering firewood easier. Everyone reported that they reaped some financial or material gain as a result of cashews, even though ownership is all by men. When asked about the difference between early and late adopters, women and children emphasized the importance of the time at which a farmer realizes the benefits, just as the men did. Respondents offered some other perspectives as

well. Aissatou Faye said “Some people think ahead and plant early”. Khady Baro explained that “People that plant early want things—they want business; people that wait don’t want things”. Hussein Ndor suggested that “Everyone wants to move forward, but early planters *really* want to move forward”.

When asked if they themselves would be able to plant cashews if they desired to, both boys and girls were fairly certain that they would be able to. Women, however, were not so optimistic. Fatou Dieng had planted cashews, but even though the trees belong to her, she does not get the money from them. Her husband does because it’s his field. Aissatou Faye said “No, women don’t have *semboo* (strength) here—if they ask, the men say ‘This is my field; how can you plant something here?’”. Jula Dieng replied “No, I’m a woman and my husband won’t agree to give me a field because I’ll get too much benefit from it”. Aissatou Faye later said that “If women can get fields, they [women] will be plentiful in the bush”. These sentiments echo the traditional relationship between land and power revealed when Mandinka women began clearing mangroves for additional rice production in The Gambia. Men vigorously resisted women’s attempts to claim their own land with no household ties, asserting that “Women must not own land,” (Carney and Watts, 1990).

There is a stronger feeling among women and children that seeing cashews in the field is more important than discussion with friends in effecting adoption. “If no one tells you about cashews then you won’t know to ask—you have to see them in the fields first and then ask about them in the village,” said Fanta Siniane. Deté Traore said “People see the planting and that they get money, then they want to plant themselves.” Eight (67%) respondents said that

seeing cashews in the fields is most important, two (17%) said they are both important, and one (8%) said that hearing about them from friends is most important.

In general, women and children had similar positive feelings about cashews as men, but with a stronger focus on the things important in their own lives like firewood. Tenure issues were also revealed, in that women have difficulty getting tree-planting use rights. Girls were more optimistic however, which may be naïveté, but could also foretell more opportunity for the women of the future. This audience placed more weight on the power of observation in the field in multiplying cashew adoption, balancing out the men's slight tendency toward the opposite.

#### **4.3. Farmer**

All farmers were asked to list the names of other villagers to whom they go for advice on farming. The question was modified several times, but even in its final form, the question did not always elicit the desired list of names, and often received a response such as Ibrahima Diallo's: "We are born into farming so we don't need any advice". Mohammed Dramé explained that there is no purpose in going to others for advice because "everyone in the village thinks the same way." Several farmers gave reasons similar to Abdou Diamé's, "I leave it in Allah's hands". The resulting rosters of advisors proved more selective than intended because of this, but showed some interesting trends nevertheless, which are analyzed qualitatively. The farmers who gave no answers were generally the older household heads, while the farmers listed as advisors were usually these same older men. The number of advisees and age have a bivariate correlation of 0.39. The median age class

of those who gave no names was '> 60 years.' This shows the strength of the patriarchic hierarchy, at least nominally. That is, elders do not seek or at least will not admit to seeking advice from youth, even though some youths have traveled and studied much more than their elders. This finding indicates that elders make an ideal target for extension agents for the following two reasons. Their responses imply that were anyone else in the village chosen as an extension multiplier, the elders would be unlikely to accept advice from them, remaining set in their ways and barriers to diffusion. Secondly, they are already nodes in the social network, facilitating quick diffusion of an innovation once they themselves adopt. The advisor regression model presented below provides further insight into what characteristics are associated with an effective agent of cashew extension within the group of villagers identified as advisors.

#### **4.4. Fields**

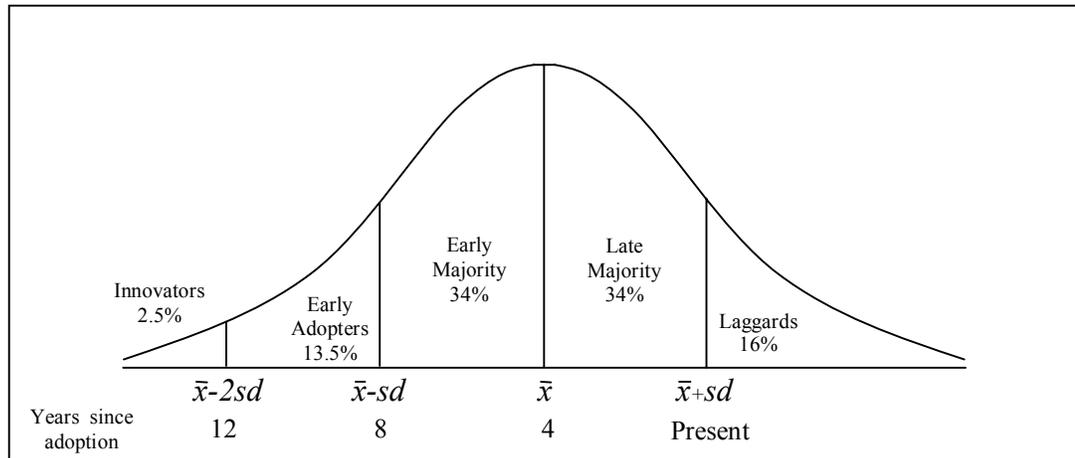
All fields in Simong and all cashew fields in Mamouda were surveyed and data recorded. The age and extent of any cashews present were recorded. This served as the basis for the following results on adoption trends.

##### *4.4.1. Adoption trends*

Farmers were divided into adopter categories as described by Rogers (1995) (Figure 4.8). The standard deviation of years since adoption (4.0)<sup>44</sup> was used to describe lines between categories.

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<sup>44</sup> The 50-year old orchard was deemed an outlier and excluded from this calculation



**Figure 4.8. Adopter categorization based on innovativeness (Rogers, 1995).**

#### 4.4.2. By plot

The following charts (Figures 4.6 - 4.10) describe the adoption trend in Mamouda and Simong. Theoretically, the bars should match Rogers' normal distribution above in shape up to the end of the later majority stage, and they do to some extent, although the peak in a normal distribution should have occurred four years ago rather than two. The spike in adoption two years ago (2003) was in fact the year that I helped coordinate a community cashew nursery in Simong. This likely had a large influence in this spike, but the same jump in adoption is also observable in Mamouda, where I did no cashew work of any sort that year. This could instead represent the peak of the adoption curve. In this case we can expect the rate of adoption to continue to decline as the number of adoptive farmers approaches 100%. As the peak was late when compared to Rogers' curve, it may be followed by an abrupt drop-off in adoption if it follows the pattern of a left-skewed normal distribution.

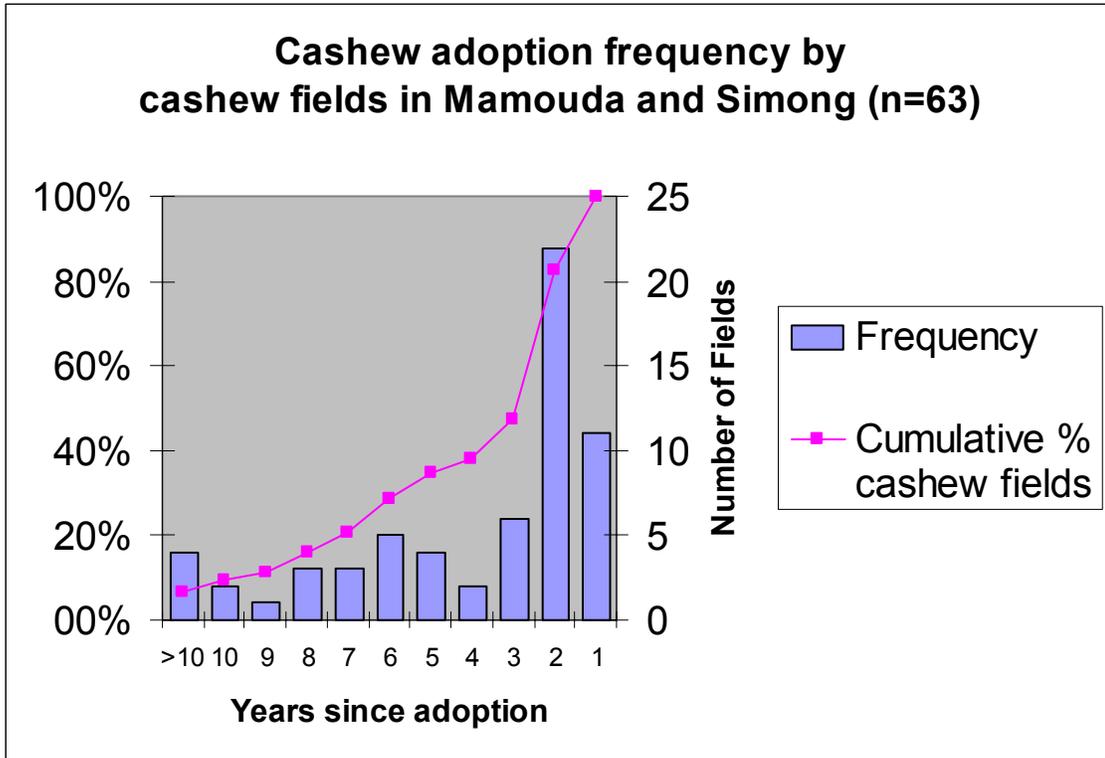


Figure 4.9. Cashew adoption curve for all cashew fields.

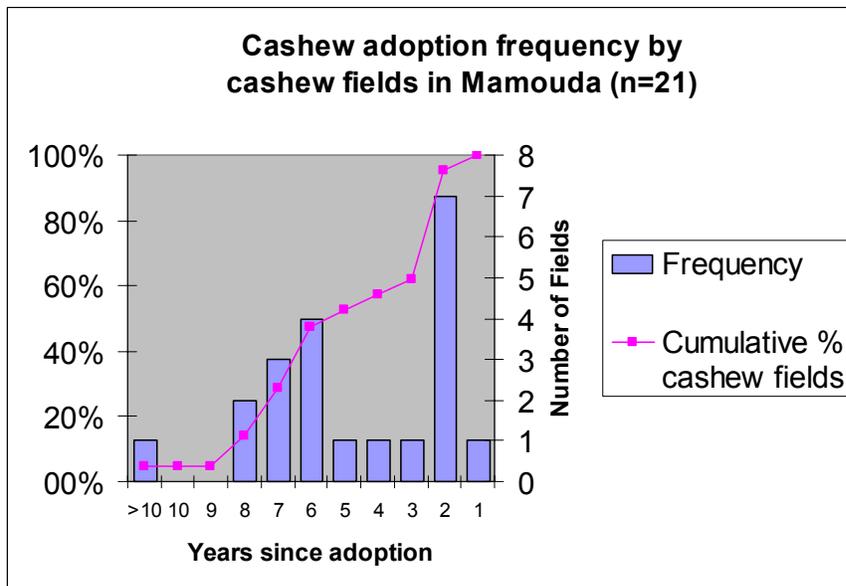


Figure 4.10. Cashew adoption curve for Mamouda cashew fields.

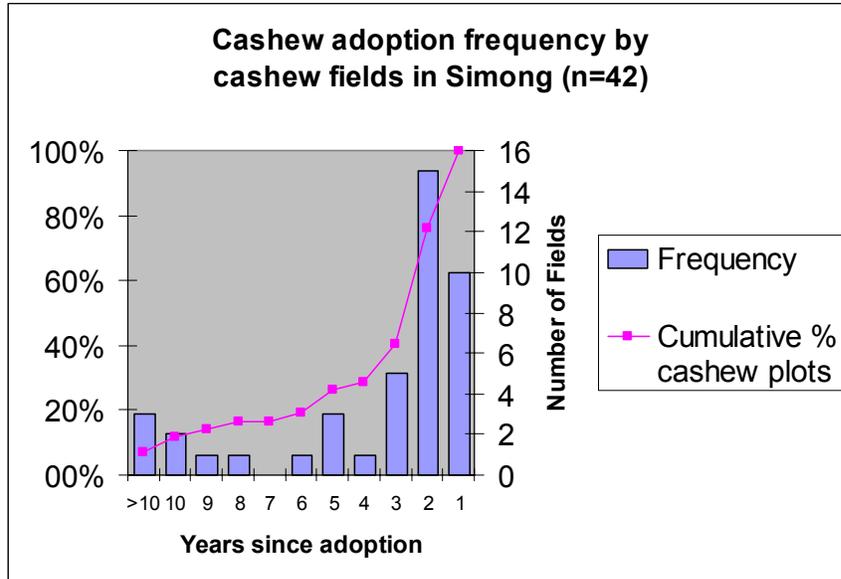


Figure 4.11. Cashew adoption curve for Simong cashew fields.

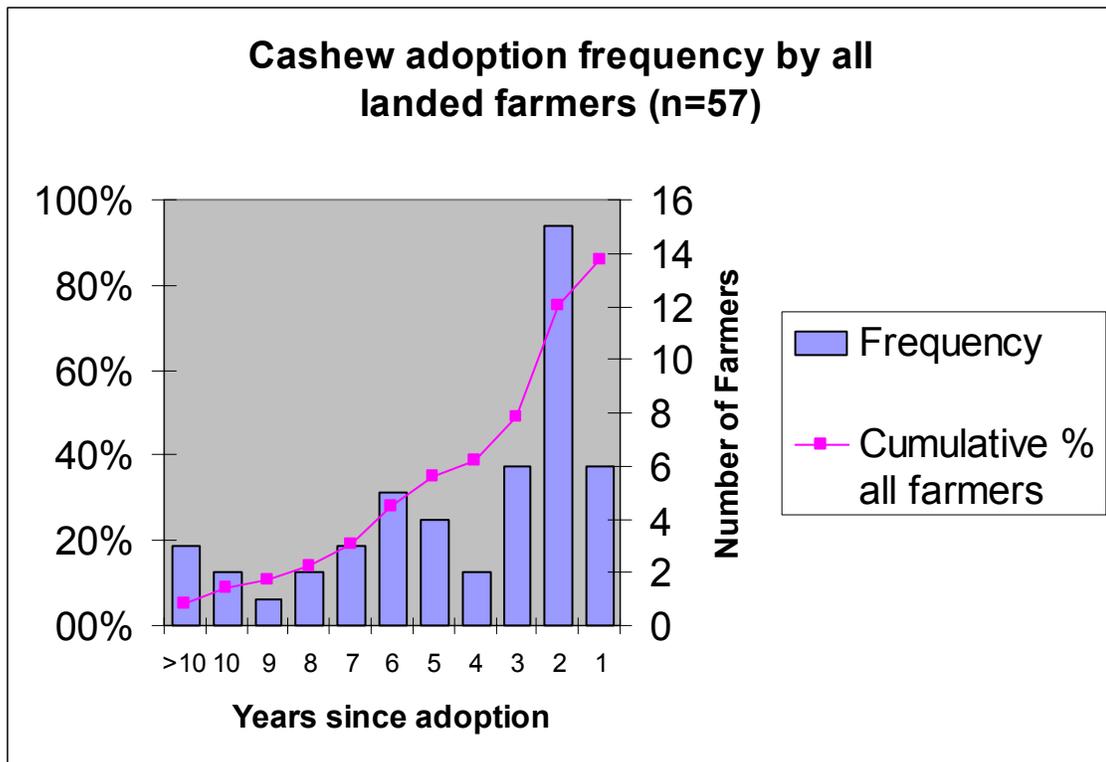


Figure 4.12. Cashew adoption curve by all farmers.

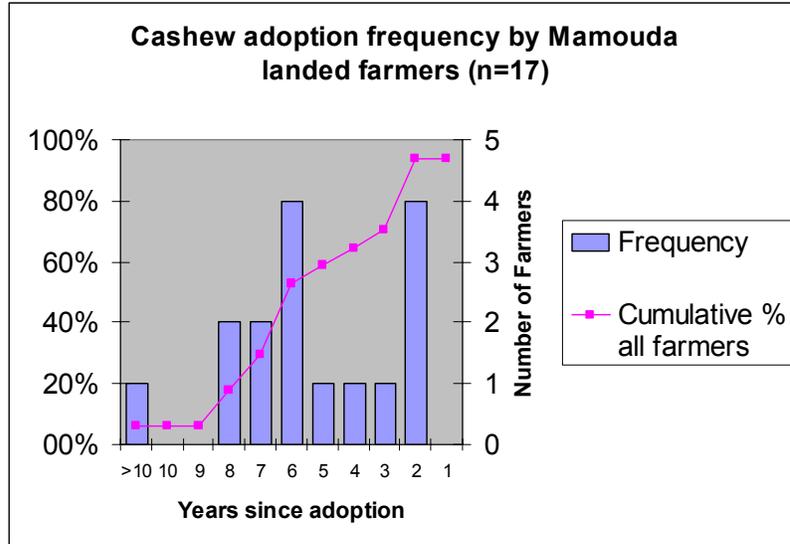


Figure 4.13. Cashew adoption curve by Mamouda farmers.

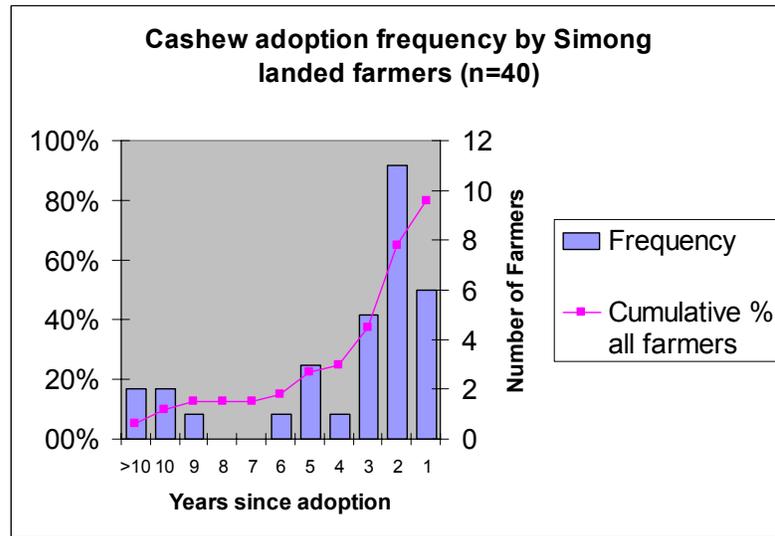


Figure 4.14. Cashew adoption curve by Simong farmers.

If the 50-year old orchard in Simong is considered an outlier and excluded, then the average cashew age in Simong is 3.1 years, Mamouda 5.2 years, and 3.8 years overall. When viewed with education and wage earner data, Mamouda’s quicker adoption suggests that education and cosmopolitanism may be useful indicators not just of an innovative villager (Rogers, 1995), but also of an innovative village. Higher education is related to an increased ability to process new information, a wider range of information sources, and more “cosmopolitanism.”

As higher levels of education requires leaving the village for higher level schools in more urban areas, these cosmopolites could speed up the adoption process with their more worldly viewpoint upon their return. Mamouda also shows signs of more cosmopolitanism in numbers of wage earners,<sup>45</sup> who generally must leave the village in order to work. Data in this study is inconclusive however, as it was not designed to test this premise and two villages are not enough with which to establish a significant trend.

#### **4.5. Time Until Adoption Models**

Six regression models were estimated to predict time until adoption (the year a farmer first plants cashews) using a parametric log-logistic survival function. Gaps in the social network data caused by absentee farmers<sup>46</sup> and the absence of non-cashew field data for Mamouda necessitated breaking the data into subgroups. This practice allows for the largest possible sample sizes while also taking advantage of all data. Including cashew fields from both Simong and Mamouda allowed for the largest sample size (n=55), while using only Mamouda fields and including the social proximity variable would reduce sample size dramatically (n=11), to the point of non-significance. Results from these models are compared to similar specifications of probit models using a dependent dummy variable for early adopters.<sup>47</sup> This comparison will highlight the differences between the adopt/reject analysis typical in the literature and the focus of this study, time until adoption.

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<sup>45</sup> Mamouda has 15 wage earners (7%), while Simong has 9 (4%).

<sup>46</sup> Absentee farmers are generally the cause for gaps in social network data. While data like soil fertility and slope could be estimated from overall averages, doing the same for social network data was deemed inappropriate due to high variability within the data and the added importance of testing this variable as a central theme in the study.

<sup>47</sup> Early adopters have cashews older than four years, as defined by Rogers' adopter categories (Figure 4.1).

#### 4.5.1. *Cashew fields*

Cashew fields from both Simong and Mamouda were pooled to the exclusion of non-cashew fields in Simong. Two models were estimated for these data: one without and one with the social proximity variable. Both models were highly significant overall, and both showed “number of advisees” to be highly significant (Table 4.5). This indicates that opinion leaders are likely to be early adopters and may make excellent field trial hosts. They are both willing to adopt early and are also a preexisting source of information for others. The assets principal component variable is significant in the non-social model, supporting the common finding in the literature (Pattanayak et al., 2003) that some amount of wealth is required to take the risk of adopting a new and unknown technology. This wealth buffers the subsistence threshold, offering means for survival if the venture should fail (Advisory Committee on the Sahel et al., 1986; Current et al., 1995; Scott, 1976; Wharton, 1969; Vanclay and Lawrence, 1994). The social proximity variable, “median age of advisors’ cashews,” is highly significant, but the sign is surprisingly positive. This counters the hypothesis that a farmer is more likely to adopt early if his advisors have all adopted early. No obvious explanation for this incongruity offers itself, but it may be part of a larger trend in which early planters have advisors who are elders reluctant to plant cashews themselves because of a “life cycle” effect, but encourage others to plant. A detailed explanation is offered in Section 4.6 below.

**Table 4.5. Cashew field survival model results. \* Significant (p<0.15); \*\* highly significant (p<0.05); PC = principal component; n.i.=not included.**

	Cashew fields w/o social var. n=55	Cashew fields w/ social var. n=45
Wald test chi-squared; sig. level	36.2; 0.000	22.5; 0.001
Non-labor/labor	-	n.i.
Labor/HH population	n.i.	+
Number of advisees	.**	.**
Assets PC	.*	-
Extension/Experience PC	+	+
Max. adjacent cashew age	+	+
Median age of advisors' cashews (N/R filled w/ average value)	n.i.	+**

The probit models for cashew fields showed assets to be highly significant both with and without social variables, further strengthening the apparent importance of material security in the decision to adopt early (Table 4.6). In the non-social model, maximum adjacent cashew age is shown to play a role in early adoption, suggesting that a farmer's spatial proximity to early adopters increases his likelihood of subsequent early adoption. Increased labor per household population appears to decrease likelihood of early adoption, counter to the hypothesis that greater labor resources would lead to earlier adoption. This could be because smaller households with fewer resources overall and therefore a lower likelihood for early adoption may tend to have higher labor per household population ratios in these study villages. However, the Mamouda time to adoption model below, the general agroforestry adoption literature (Pattanayak et al., 2003) and the literature specific to Senegal (Caveness and Kurtz, 1993) show that labor availability has a positive effect on agroforestry adoption attributable to the associated increase in perceived security. The significance of number of advisees matches similar findings above, showing that more popular advisors tend to also be early adopters. This implies that advisors with large groups of advisees should make good

contact points for innovation diffusion, both because of their connectedness and because of their apparent enthusiasm for cashews. Advisor cashew age is again highly significant in an unexpected direction, showing the same trend discussed above.

**Table 4.6. Cashew field probit model results. \* Significant ( $p < 0.15$ ); \*\* highly significant ( $p < 0.05$ ); PC = principal component; n.i.=not included.**

	Cashew fields w/o social var. n=57	Cashew fields w/ social var. n=45
Number of males	+	n.i.
Labor/HH population	n.i.	-*
Number of advisees	+	+*
Assets PC	+**	+**
Extension/Experience PC	-	-
Max. adjacent cashew age	+*	+
Median age of advisors' cashews (N/R filled w/ average value)	n.i.	-**

#### 4.5.2. *Simong fields*

Data for Simong cashew fields and non-cashew fields were combined and then used to estimate models with and without the social proximity variable (Table 4.7). The addition of non-cashew fields should allow the construction of variables that more accurately reflect the land resources available to a farmer. “Number of advisees” was again highly significant in both model specifications, further strengthening the argument for the suitability of targeting opinion leaders as early adopters. The social variable, “median age of advisors’ cashews,” was also highly significant, and may be explained by the “life cycle” effect described in Section 4.6 below.

**Table 4.7. Simong fields survival model results. \* Significant (p<0.15); \*\* highly significant (p<0.05); PC = principal component; n.i.=not included.**

	Simong fields w/o social var. n=40	Simong fields w/ social var. n=32
Wald test chi-squared; sig. level	25.2; 0.000	19.6; 0.003
No. of HH laborers	+	n/a
Labor/HH population	n/a	+
Number of advisees	._**	._**
Assets PC	-	+
Extension/Experience PC	-	-
Distance to the nearest cashew field	-	-
Median age of advisors' cashews (N/R filled w/ average value)	n/a	+**

Both probit models in Simong show experience with tree work to be significant (Table 4.8).

It makes sense that households with a history of tree work should be more likely to adopt cashews early. Number of males per household population is also significant, indicating that the number of available males may be an important factor in the decision to allocate resources to cashew planting. Caveness and Kurtz (1993) also found the number of adult males to be significant in the adoption of agroforestry in Senegal, and attributed this to their contribution to production and wealth accumulation. Advisor cashew age is again significant.

**Table 4.8. Simong fields probit model results. \* Significant (p<0.15); \*\* highly significant (p<0.05); PC = principal component; n.i.=not included.**

	Simong fields w/o social var. n=40	Simong fields w/ social var. n=32
No. males/HH population	+*	-
Weighted fertility	+	+
Assets PC	-	+
Experience with tree work (0/1)	+**	+*
Max. adjacent cashew age	+	+
Median age of advisors <sup>7</sup> cashews (N/R filled w/ average value)	n.i.	-*

#### 4.5.3. Mamouda fields

Mamouda fields were modeled separately, but as only data for cashew fields were available, sample sizes are very small.<sup>48</sup> These low sample sizes are the most likely explanation for the low significance of the first model, without social variables (Table 4.9), and no significant regressors in the second model, with social variables (which is therefore not presented here). The high significance of “labor/household population” suggests that labor resources are important in the decision to adopt early. Labor can be viewed as a resource similar to land, in that allocating it to a new technology for which the production is unsure comes with a certain amount of risk. That is, putting a unit of labor toward a traditional crop would carry with it some guarantee of financial return or food for the family, whereas putting it toward an unknown entity could result in a loss. This finding supports the theory that better-endowed farmers are better able to cope with the risk associated with the adoption of a new technology before its characteristics are well known. The high significance of the “extension/experience” variable is surprising, as it indicates that contact with extension agencies and prior experience with tree work *increases* time to adoption. This contradicts the

<sup>48</sup> For the model without social variables, n=13; for the model with social variables, n=11.

literature (Rogers, 1995; Pattanayak et al., 2003). One possible explanation is that early planters were less likely to purchase memberships in UGAB because the marginal benefits were less for them, that is, the benefits UGAB had to offer were not significant when compared to the cashew operation the farmer already had in place. Another possibility is that extension efforts were so poor as to decrease farmers' perceptions of the benefits associated with trees. Both of these findings must be taken with due consideration, however, due to the low significance of the model.

**Table 4.9. Mamouda field survival model results. \* Significant ( $p < 0.15$ ); \*\* highly significant ( $p < 0.05$ ); PC = principal component; n.i.=not included.**

	Mamouda fields w/o social var. n=13
Wald test chi-squared; sig. level	5.43; 0.020
Non-labor/labor	n/a
Labor/HH population	._**
Number of advisees	-
Assets PC	+
Extension/Experience index	+**
Distance to the nearest cashew field	+
Median age of advisors' cashews (N/R filled w/ average value)	n/a

Mamouda probit models returned no significant variables (Table 4.10). This outcome is likely a result of the small sample size rather than an actual absence of any identifiable characteristics in time to adoption.

**Table 4.10. Mamouda field probit model results. \* Significant (p<0.15); \*\* highly significant (p<0.05).**

	Mamouda fields w/o social var. n=16
Average field area	+
Farmer age	-
Assets index	-
Extension/Experience index	-
Max. adjacent cashew age	+

#### **4.6. Advisor Effectiveness**

Comparative statistics and additional models were generated to identify observable characteristics of farmers that indicate first, whether they are advisors, and second, whether they are effective advisors. Knowledge of these characteristics would allow an extension agent arriving in a village to look for these characteristics when choosing farmers to work with as extension multipliers. The effectiveness of an advisor in cashew promotion depends on (a) how many farmers he advises, (b) to what extent those farmers take his advice, and (c) whether he advises them to plant cashews. “Advisor effectiveness” is proxied as the product of an advisor’s number of advisees and the average age of his advisees’ cashews, which is equal to the sum of all a certain advisor’s advisees’ years since planting cashews, or “total advisee cashew years”. Larger numbers indicate more effective advisors. This variable was used to classify advisors into effective and ineffective categories, divided at a natural break<sup>49</sup> with 29% (6) advisors classified as effective and 71% (15) classified as ineffective.

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<sup>49</sup> Total advisee cashew years=10.

A list of variables with possible influence on advisor effectiveness based on the literature and field observations was generated from available data.<sup>50</sup> This list includes both household and farmer variables, all of which were expected to have a positive correlation with the effectiveness variable and have a positive coefficient in the regression models. A comparison of descriptive statistics and analysis of variance results (Table 4.11) shows that while household variables do not have much predictive power in advisor effectiveness, several farmer characteristics in the variable set do have a significant relationship with total advisee cashew years. Although age was not significant in any of the time to adoption models, advisor age has a positive correlation with effectiveness and a highly significant difference between advisor groups. This suggests that although elders are not necessarily early adopters, they are still more likely to advise others to plant early. This may be due to a “life cycle effect” in which elders are less likely to plant a crop that takes several years to mature when they may not live to reap the long-term rewards of the up-front investment in planting trees. While their children would presumably inherit their land and their trees, most elderly farmers have already granted some land to their sons and perhaps are more likely to encourage their sons to plant cashews on that land rather than contribute to the bequest value of their other parcels. Neither fieldwork nor the literature presents any firm evidence for this apparent lack of value in investing labor for the benefit of future generations.

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<sup>50</sup> The variables considered for inclusion are as follows: oldest cashew age, HH maximum Arabic education, HH maximum French education, farmer age, HH number of wage earners, asset index, asset principal component, total field area, credit principal component, extension/experience index, extension/experience principal component, extension contact, Peace Corps contact, UGAB contact, and tree work experience. Note that this analysis was not planned for, and variables must therefore be constructed from data collected for other purposes.

This line of reasoning also offers an explanation for the unexpected highly significant negative coefficient for advisor cashew age in the survival models above. Early adopters may be likely to have elder advisors who are enthusiastic about cashews, but who are not likely to adopt early themselves for lack of foreseeable return on their investment. For extension agents, these findings strengthen the argument that older farmers are a good starting point in the selection of extension multipliers.

The remaining significant variables are all field-related, strengthening the argument that physical factors play a role in both adoption and innovation diffusion. The significant difference between groups in both road frontage variables suggests that certain advisors may be more effective in cashew promotion in part because their fields are prominently located along frequently-traveled routes. Any cashews owned by these advisors are therefore viewed more often by villagers, making their owners more prominent sources of information about cashews. That is, if a farmer were to have a question about cashews and was in search of an appropriate advisor, he would be more likely to choose someone whom he knew had experience with cashews. This effect could also result from a relationship between farmer social status, field placement along major routes, and effective cashew promotion. If farmers of higher status (and possibly of older age) are more effective advisors, and higher status farmers are also more likely to have fields along major routes, then it would appear that field ownership along these routes was a cause of effectiveness when the relationship may in fact be spurious.

In addition to supporting the importance of physical factors in adoption and innovation diffusion however, the positive correlation and high significance of total field area suggest that assets are an important characteristic of an effective advisor, just as it was shown above to be an important indicator of an early adopter. This effect could be attributable to a more favorable opinion of cashews or any innovation held by those advisors with more resources to risk. Advisors with a higher opinion of an innovation are probably more likely to subsequently advise others to adopt that innovation. Another possible explanation is that those with more land are perceived as more successful, and others are therefore more likely to both seek and take their advice. Land assets may then relate to all three aspects of effectiveness: farmers with more land may attract more advisees, may be more likely to advise them to plant cashews, and may be more successful in convincing advisees to plant.

The non-significance of years until adoption signifies that early adopters are not necessarily also effective advisors, and also that late adopters are not necessarily ineffective advisors. This lack of correlation between time until adoption and age supports the suggestion that elders, the most effective advisors, may be susceptible to the “life cycle” effect described above. While enthusiastic about cashew adoption overall, they themselves may not adopt early because they do not expect to be able to make enough use of the long-term benefits to compensate for the short-term costs.

**Table 4.11. Advisor effectiveness descriptive statistics for variables with a total advisee cashew year bivariate correlation > 0.15.**

Variable type	Effective at cashew promotion (n=6)		Ineffective at cashew promotion (n=15)		Non-advisors		Bivar. correlation w/ total advisee cashew yrs.	ANOVA p-value	
	Mean	% of sample	Mean	% of sample	Mean	% of sample			
Farmer	Oldest cashew age	5.83	0.095	3.47	0.238	4.52	0.667	0.193	0.775
	Farmer age (yrs)	55.5	0.095	49.9	0.238	39.4	0.667	0.299	0.00692
	Total field area	87200	0.095	45600	0.238	32200	0.667	0.446	0.0127
	Road frontage total	1.50	0.095	0.467	0.238	0.524	0.667	0.552	0.0119
	Road frontage dummy	0.833	0.095	0.267	0.238	0.500	0.667	0.619	0.0551
Household	Credit PC	-0.0555	0.095	0.294	0.238	-0.122	0.667	-0.246	0.541
	Total experience index	4.17	0.100	2.80	0.250	3.09	0.650	0.273	0.501
	Experience PC	0.266	0.100	-	0.250	-	0.650	0.154	0.816
	Peace Corps experience (0/1)	0.667	0.095	0.400	0.238	0.429	0.667	0.184	0.519
	UGAB experience (0/1)	0.500	0.100	0.333	0.250	0.410	0.650	0.197	0.771
	Tree work experience (0/1)	0.500	0.095	0.333	0.238	0.286	0.667	0.291	0.579

To test the combined effect of farmer and field characteristics, OLS regression models of advisor effectiveness (proxied by total advisee cashew years) are estimated. Because of the small sample size of 21 advisors and multicollinearity among field characteristics, the models are limited to two independent variables. The final specifications were selected first for significance and then for variables of interest. Results (Table 4.12) show that total field area and number of fields on a main road are both significant indicators of effectiveness in advising for the early and widespread adoption of cashews. A higher R-squared value shows field location to be slightly more important. It was necessary to specify two separate models, as total field area and number of fields on a main road have a high bivariate correlation (0.670) that negates model significance when both are included. This correlation can be expected, as more hectares of fields naturally led to a higher chance of some of those fields bordering a major road.

After controlling for field characteristics, age is not a significant factor, suggesting that elders may not always be the best points of contact for quick and widespread diffusion of cashew agroforestry.<sup>51</sup> Although the significance of road frontage may be an indicator of the role of social status in advisor effectiveness to a limited extent, with higher status farmers having more centrally located and easily accessible fields, it is more likely an indicator of the importance of plot location in maximum promotion of a technology to others. Similar to the results presented above, these results suggest that farmers with road-front cashews may be more likely to be chosen as sources of advice when others have questions about cashews, but may also be an indicator of a relationship between status, field placement, and number or receptiveness of advisees.

These findings imply that when searching for ideal extension multipliers, an extension agent should perform a quick survey of the fields lining highly-trafficked roads and paths to identify their owners, and then follow up by interviewing these owners for key characteristics of effective extension multipliers identified elsewhere in this study. This practice can be reduced even further to a method probably already in practice by agents pressed for time or averse to additional work: simply going to the first farmer seen working in the fields along the road into the village. These results show that this method, while crude, does have a good chance of identifying some of the potentially most effective extension multipliers in the village.

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<sup>51</sup> Bivariate correlation (n=21) for farmer age (yrs) and field size: 0.425; farmer age (yrs) and total road frontage: 0.425.

**Table 4.12. Advisor OLS model results. Dependent variable = total advisee cashew years; n=21 \* Significant (p<0.15); \*\* highly significant (p<0.05); n.i.=not included.**

	Using total field area	Using road frontage
R-squared	0.213	0.309
Total field area	+*	n.i.
Farmer age	+	+
Number of fields on main road	n.i.	+**

## **5. CONCLUSIONS & IMPLICATIONS**

The research reported in this thesis provides insights into the decision processes that farmers employ in choosing when to adopt a new technology, and extension techniques that can encourage early adoption. These insights are most directly relevant to adoption of cashew alley-cropping by the relatively poor agrarian population of the Sine-Saloum region of Senegal, but they are suggestive of more general patterns and provide hypotheses that could be tested elsewhere and with other technologies. This chapter synthesizes these findings to answer the questions “Who adopts early?” and “Who will get others to adopt?” Topics for further study are also suggested.

### **5.1. Who will adopt early?**

An important step in improving extension effectiveness is increasing agents’ understanding of the decision processes a farmer goes through in deciding whether and when to adopt. This understanding will help extension agents mold their programs to the needs of farmers, rather than attempting to impose their own agendas.

#### *5.1.1. Social*

Farmers with more advisees (other farmers who listed them as advisors) were consistently shown by the four significant survival models and by one of the probit models to adopt early. This finding shows early adopters to be socially well-connected, which not only makes potential early adopters easy to identify, but also makes them an excellent source of innovation diffusion, as they are already nodes in the social network. This finding meshes

well with Rogers' (1995) generalizations that early adopters have more social participation, are more highly interconnected through interpersonal networks in their social system, and have a higher degree of opinion leadership than later adopters.

### *5.1.2. Resources*

The resources available to a farmer play an important role in the amount of perceived risk he is willing to accept when adopting, and therefore his time until adoption (Caveness and Kurtz, 1993). The cashew non-social model supports this theory by showing assets to reduce adoption time significantly. Other more specific variables also corroborate the importance of resources in the adoption decision.

Labor is an important resource, and can be the limiting factor in a decision to adopt a new technology. In the context of agroforestry, which is firmly within the male sphere of labor, the number of males in a household can also be viewed as an asset. The significance of number of males per household in the Simong non-social probit model suggests that households with more males are in fact more willing to adopt early, possibly because they have more labor resources to devote to an activity with uncertain outcome (Caveness and Kurtz 1993).

Another useful measure of labor resources is number of laborers per total household members (the inverse of a dependency ratio). This shows the proportion of productive laborers to the total number of "mouths to feed," or consumptive units. As expected, the Mamouda non-social model shows that more available labor per consumptive unit decreases

time until cashew adoption. That is, the more labor resources a household has available, the quicker they adopt. This model has low significance however, and estimation results therefore must be interpreted with caution. The statistically significant and negative coefficient on labor per household population in the cashew social probit model throw the importance and influence of this measure further into doubt. This is an example of different results obtained from the survival versus the more typical probit model. The survival model makes fuller use of available information and is more consistent with the literature, which generally suggests that more labor resources in a household make farmers more likely to adopt early (Pattanayak et al., 2003; Caveness and Kurtz, 1993).

## **5.2. Who will get others to adopt?**

The traits of early adopters do not necessarily identify the most effective extension multipliers, defined as a villager chosen as a contact point by an extension agent who will demonstrate and extend innovations with little outside assistance. Rogers (1995) argues that innovators are sometimes so innovative and risk-loving that they ostracize themselves from the community and are no longer viewed as a valid source of information. This section provides tips on avoiding this trap by combining innovativeness and social status, while also taking advantage of the characteristics of innovation diffusion and effective advisors as discovered in this study.

### *5.2.1. Social vs. Spatial*

Results suggest that both spatial and social connections and relationships contribute to the learning necessary to reduce the uncertainty and the perceived risk that are barriers to

adoption of any new technology. When asked directly in the household survey, men placed slightly more weight on social information, while a small sample of women and children placed a heavier weight on the actual cashew cultivation that one sees in the fields. Model results bear this out with significant variables in both spatial and social categories. These results suggest that both channels of information (seeing and hearing) are important in the adoption decision and should both be considered in planning an extension program and choosing village partners for extension.

The importance of targeting elders with extension information was highlighted by the trends in the social network data, the advisor ANOVA, and empirical model results. As elders have an apparent stronghold on advice, age is one key factor to consider in choosing the villagers with whom to work closely in a new village. Choosing the “universal advisors,” or those who were listed by others as an advisor but who in general did not admit to having any advisors themselves, can provide an instant source of information multiplication, thus replacing the legwork of an outsider extension agent with the free innovation diffusion of a trusted village fixture. Sources of information already known to villagers have been shown to be more effective than unfamiliar government agents and project technicians (Schroeder, 1999a).

The spatial data did not show any evidence of the classic bulls-eye pattern of spatial diffusion, with farmers learning visually from their field neighbors and then passing it on to their neighbors, etc. However, cashew fields are clustered along highly-traveled roads. This may reflect spatial diffusion from the plots that are most highly visible. The cluster could

result from farmers' desire to plant in an area where performance characteristics are already known (Lindner, 1981; Lindner et al., 1982). There is also some relationship apparent with slope, fields with less slope having younger or no cashews. These results suggest that extension agents should seek to establish demonstrations and trials on plots that are not only highly visible, but that are also located centrally in an area well-suited for cashew production (or at least less-well suited for the traditional crops). Adopters forming a cluster around the trial (i.e., farmers with neighboring fields who adopt the technology) should then obtain results similar to what they expected after observing the trial.

This strategy would also be consistent with findings on effective advisors: advisors with more fields along well-traveled routes are more likely to be effective in cashew promotion, as measured by the 'total advisee cashew years' index. Total field area is another indicator of advisor effectiveness. Although extension agents with limited resources may not have the time to complete an accurate survey of all fields in a village to identify the farmers with the largest holdings, a quick survey in the village should be adequate to generate a rough short list of the farmers with the most land. This practice can be reduced even further to a method probably already used by agents pressed for time or averse to additional work: simply going to the first farmer seen working in the fields along the road into the village. These results show that this method, while crude, does have a good chance of identifying some of the potentially most effective extension multipliers in the village. These various findings supporting the importance of spatial relationships in a farmer's decision to adopt are in part an extension of Lindner's (1981; 1982), Lindner et al.'s (1987) and Case's (1992) findings

that spatial factors are important to the adoption decision, but go further to suggest that biophysical field characteristics may also play a role in spatial adoption trends..

### *5.2.2. Other Considerations*

Potential adopters are most interested in the monetary benefits of a new technology rather than its environmental benefits, suggesting that potential income should be emphasized in extension efforts. An effective extension multiplier therefore must be willing to share information on his profits from the innovation and compare them to profits from the traditional methods on the same land. Real numbers will offer convincing evidence to potential adopters.

## **5.3. Extension Multipliers**

Many extension agents may think that their goal is to inform as many people as possible of the range of innovations available to them. This however, is not likely to be the most effective form of extension. As seen in the case of PASA, awareness of a technology does not necessarily result in its adoption. A higher level of understanding and knowledge was required. This deeper level of understanding is not easy for a single extension agent acting alone to convey to the farming population. Fortunately, there are farmers in every village who are more willing than the rest to listen to what an extension agent has to say, and who are more willing to put their words to the test. Some of these farmers may also be effective advisors, pre-existing sources of council and information for villagers. These farmers can take much of the burden off of the agent. A successful trial on a highly visible field owned by an effective advisor could be the most cost-effective extension strategy. The endorsement

of an innovation by a well respected village advisor should encourage the generation of the farming subculture necessary for mass adoption of a new idea (Vanclay and Lawrence, 1994). Choosing farmers who will become extension multiplier then becomes the critical task for extension agents. The following description summarizes the traits of farmers who were found to be the best extension multipliers in this case study.

Effective extension multipliers have relatively more assets and land. This is consistent with previous literature, which has found that technology adoption is more likely by farmers who can absorb any possible costs of failure. Effective multipliers also will have fields that are highly visible and centrally located in an area appropriate for cashew production, will be in the elder age class (> 60 years old), and will be socially well-placed as an advisor to many and an advisee to none. Well-traveled villagers may be more likely to adopt early, but may not be available to care for the cashews or to effectively promote the technology to other villagers.

The easiest first step to identifying villagers with these traits may be to perform a simple social network survey such as the one implemented in this study. Asking a sample (or if feasible, a census) of villagers to name their sources of advice (who they go to when they have a problem or a question) and then tallying the results to find the most frequently mentioned advisors can be a relatively simple way to identify these social nodes. A simple survey of the villagers with the highest rankings can determine the most appropriate extension multiplier based on the remaining characteristics: assets, well-placed fields, and age.

#### **5.4. Policy Implications**

Cashews are an excellent tool for satisfying both extension and development agencies' goals for long-term environmental stabilization and restoration, and local villagers' need for a crop that can bring them the cash that peanuts no longer can<sup>[c5]</sup>.

Cashew alley-cropping is more likely to be adopted early by farmers with more assets, possibly due to the security they offer in the case of a failure of the innovation. This suggests that a risk management program, such as cashew crop insurance, would allow farmers who are less well off (i.e., who own fewer assets) to adopt earlier<sup>[c6]</sup>. Such a program could reduce uncertainty and provide the sort of safety net that wealthier farmers have. This attempt to equalize opportunities could prevent further growth of the gap between the rich and the poor.

As shown by household survey testimony to the foreign origins of cashew knowledge (Casamance, Guinea Bissau, etc.), innovators are travelers and are more cosmopolitan by nature. They get the information they need for adoption from outside sources. An average farmer, on the other hand, has less exposure to new technologies and is less likely to accept knowledge from sources outside their own social network. This finding suggests the use of field trips to productive cashew sites to encourage innovators who may have otherwise missed observation of this technology in their travels. This type of extension programming may be costly, but others have argued that the results are likely to be worthwhile (Kerkhof et al., 1990). For example, a prior Peace Corps volunteer in Simong took three farmers to a

demonstration site in the Gambia on a small grant from Peace Corps, resulting in a large boost of enthusiasm for agroforestry techniques upon their return (Norikane, 2005).

This research shows the importance of new technologies infiltrating from the bottom up through personal interaction with individuals rather than from the top down through village-wide programs. PASA's attempt to persuade entire communities to adopt at one time failed, suggesting the ineffectiveness of broadcast efforts by extension agents. The adoption of cashew alley-cropping was only set in motion once well-traveled villagers saw first hand the benefits being reaped in other regions and applied this knowledge to Mamouda and Simong. Cashews were adopted not because they restore the soil, but because they can be productive in the poor soil. Cashews, then, are important to development agencies and extension agents because they satisfy the often contrasting agency goals of regional-level, long-term environmental benefits, and villager goals of increased cash income in the short term.

## **5.5 Limitations**

Several aspects of this study constrain the broader applicability of the conclusions. Time constraints in the field precluded the collection of several types of data that would have offered additional depth and clarity to the results. Foremost is the absence of data on non-cashew fields in Mamouda. A full set of non-cashew field data would have allowed for larger sample sizes in quantitative analyses and a more thorough and rigorous overall comparison between the two villages. This could have included an analysis of the difference in size of land holdings suggested by the very different number of people per farmer in the

two villages. The absence of a kinship survey prevented analysis of adoption trends by family ties outside of individual households, weakening conclusions on the effect of family on time to adoption and spatial adoption trends. Although social data represent admitted social contacts, family ties may also have an important influence in advice networks of which farmers themselves may not be aware.

A farmer's level of risk aversion is an important factor in his decision to adopt, but this study did not explicitly measure attitudes towards risk, using proxies such as experience instead. Hypothetical games have been developed to test respondents' degree of risk aversion, allowing for the inclusion of such characteristics in regression models. The number of wives in a household is another variable that may have improved the strength of the regression model results. This figure can be interpreted as a measure of material wealth and as a production resource, as a bride price must be paid to the bride's father upon marriage, and wives are expected to contribute a certain amount of work to a household (Caveness and Kurtz, 1991, 1993). A greater number of variables on the farmer level rather than the household level also could have reduced reliance on the assumption that household members hold similar opinions to household heads and share in household assets, and thereby increased the explanatory power of the models.

The conclusions drawn from the results in this study are based on the data, previous findings in the literature, and my personal experiences. A component missing from interpretation of these results is the opinions of the villagers themselves. As time for field work was limited, analyses were completed *ex situ*, allowing no opportunity to present the results to the

respondents for their interpretation. This may have lead to conclusions only possible from the perspective of a native.

Simong and Mamouda are two small rural African villages with traditional Muslim and Mandinka views and customs. Conclusions drawn in this study should apply to villages of similar descriptions, but the degree of their applicability to larger and/or more urban villages, and to villages of other ethnicities with different cultural policies is unknown. Further study with a broader geographical scope and a tighter focus on the factors shown here to be key to the extension and diffusion of cashew agroforestry could expand the applicability of these conclusions<sup>[c7]</sup>.

## **5.6. Further Study**

The data generated in this study provide many opportunities for study beyond the scope of this thesis, as well as ideas for further research requiring additional data collection. Some of these possible directions are presented here. The study and identification of a definitive set of social status indicators in the field could be used to replace the proxies used in this study, such as assets and number of advisors, thus further refining the time to adoption models.

A deeper analysis of qualitative responses with respect to adopter category is possible, for example the development of profiles for innovators through “laggards”, although the multi-level nature of the data presents challenges. Farmer time to adoption could be merged at the household level with a weighted “innovation index” for each household combining the relative innovativeness of each farmer residing there. The research question would then be

“Do heads of more innovative households have different characteristics than heads of more laggardly households?”

Probably the largest untapped source of valuable information is in the extent of adoption. The conclusions reached in this study are valid for the trial stage of cashew adoption, but may not hold up to long-term trends in full-on cashew cultivation. Recent adopters, especially those whom have invested very little, may decide to disadopt and revert to traditional crops. Including extent in the time until adoption model will place additional weight on early adopters who not only trialed early, but also invested a large proportion of their land resources in cashews. This improvement will result in a more refined estimation of the relative importance of the factors separating innovators from laggards.

Responses to open-ended questions in the household survey revealed that travelers are more likely to adopt cashews earlier than others. Not only are these villagers more willing to accept knowledge from sources outside their own social network, but they also have the advantage of seeing cashews in full production along with all the benefits they have to offer in regions where cashews have been in production for much longer than the Sine-Saloum. Other villagers have limited means to observe the advantages associated with cashews, as most local farmers able to provide an example are only just beginning to harvest cashew nuts in earnest. This trait may present a challenge to extension agents, because if the most innovative villagers are also the most well-traveled, they may not actually be a good choice for an extension multiplier, as they are likely to be frequently away from home and difficult to coordinate with. Of the farmers interviewed in this study, some of those with the most

extensive cashew and other tree productions were difficult to contact due to frequent trips to urban centers. These conclusions are still somewhat in the realm of conjecture, however, as this study was not designed to measure travel as an indicator of innovativeness. Further study with allowances for a more rigorous test of these premises may be enlightening.

Just as factors such as assets and education are important in choosing a farmer as an extension multiplier, these factors could also play an important role in the choice of villages that an extension agent decides to focus initial efforts on. The higher levels of travel and education in Mamouda may be related to its earlier average time to adoption, suggesting that overall village characteristics may be indicative of that village's innovativeness. Education is associated with the ability to process new information and also cosmopolitanism, as higher levels of education require students to leave the village for bigger schools. These traits are commonly attributed to early adopters in the literature (Rogers 1995, Pattanayak et al. 2003).

This study was not designed to test this hypothesis however, and two points of reference are not enough from which to draw firm conclusions. Future research with a more extensive scope could show that some villages are indeed better suited for initial extension efforts due to a higher level of innovativeness, and then identify characteristics of such villages. Seeding a new technology in such a village could increase regional extension efficiency and effectiveness the same way that choosing an innovative villager could increase extension efficiency and effectiveness on a village level. Once the technology is established in this pilot village, field trips can be coordinated for extension multipliers from other villages to observe the technology and take the knowledge back to their own village. Excursions of this

sort tend to provide vivid impressions and have the ability to greatly influence attitudes (Kerkhof et al., 1990). Successful implementation of this plan can lead to geometric growth of a technology, as long as it is appropriate and useful.

### **5.7. In Closing**

An understanding of the characteristics that separate innovators and early adopters from laggards will allow extension agents to quickly identify the few farmers in a village most likely to adopt on the advice of an outsider and without the prior sanction of their peers. Identifying characteristics of advisors who are effective in promoting cashew adoption will further narrow the pool of farmers from which to choose the ideal extension multipliers who will demonstrate and extend the innovation with little outside support. Focusing efforts on these key players may increase the effectiveness of the agent's time spent in the village, and after a successful training and trial, the new technology should then spread with little further intervention through farmer to farmer contacts (Advisory Committee on the Sahel et al., 1986; Bunch, 1982; Rodale Institute, 1989; Caveness and Kurtz, 1993). This mode of operation in extension planning will result in a quicker and more effective impact on the welfare of these poor farming communities. The lessons learned in this research should have the potential to facilitate change not only in agroforestry outreach, but also in broader efforts in sustainable agricultural development (Franzel et al., 2002).

Rogers (1995) defines time to adoption as a measure of innovativeness, and delineates five adopter categories (see Figure 1.1). This thesis is also a study of the factors that determine a farmer's place among these categories as defined by their adoption of cashew alley-cropping.

The same data and analyses used to identify early adopters and effective advisors are also used to describe and explain patterns of adoption over time, but with the addition of qualitative data to explain apparent trends in more depth. This approach is in contrast to a typical empirical adoption study, in which a binary adopt/reject decision is modeled (Pattanayak et al., 2003). Many studies have used variables in five categories of adoption determinants to model the binary adopt/reject decision: farmer preferences, resource endowments, market incentives, bio-physical factors, and risk and uncertainty (Pattanayak et al., 2003). Others have studied social interaction as a factor in the adoption decision (Udry and Conley, 2005), and spatial proximity to early adopters as a determinant in the decision to adopt (Case, 1992). There has also been a call to avoid dependence on either quantitative or qualitative methods alone, as the sole use of quantitative methods without the balance of qualitative methods would fail to identify the cultural ramifications of the study, while qualitative methods alone are difficult to generalize (Rao and Woolcock, 2003). This study contributes to the literature by bringing together these various strands, considering time of adoption using quantitative methods that have more often been applied to a binary adoption decision, and incorporating spatial and social relationships that are often ignored in adoption literature. Qualitative data are considered in tandem with these results to triangulate conclusions on the extension and diffusion of cashew agroforestry in Senegal.

Future extension efforts should incorporate the findings of this study by targeting one-on-one education and demonstration programs on a few key farmers in each village after determining that an innovation is appropriate for that particular situation. Working closely with one or two wealthy, spatially and socially well-placed farmers and convincing them to

plant a demonstration plot should prove much more effective than efforts to convert entire villages at one time. This study suggests that extension programs should target one-on-one education and demonstration programs to a few key farmers who can serve as extension multipliers. Assuming that the innovation being promoted is appropriate for the goals of the farmers in a given village, this approach of targeting key fields and farmers is likely to be an effective way to encourage adoption of the innovation. If extension agents choose to work through extension multipliers (rather than seeking to contact and convince all farmers in a village), they should focus on relatively wealthy, spatially and socially well-placed farmers. Farmers may not be willing to accept dictates from above and should be a part of the process from the beginning in order to feel ownership of the project. Working closely with a few key farmers and then allowing them to do the real extension work should give villagers the sense of involvement and ownership they require for long-term success.

Some parallels can be drawn between the choice of extension methods and the choice of plant propagation methods. There are some plant species such as rice that have high success rates after broadcast seeding. Seeds of this type require little care due to their sheer volume, but each individual is small and has a low chance of survival. On the other hand, other species like cashew do best with individual care for each plant. These seeds are larger but also less numerous and therefore more expensive. Broadcasting the latter type is cost-prohibitive, and caring for just a few of the former type will result in a low survival rate. The choice of propagation systems is then very important for the success of the end product. This is also the case in agroforestry extension.

The literature suggests that subsistence farmers are especially reluctant to invest in risky new technologies until they have sufficient information. Thus, adoption of new agroforestry technologies that present significant uncertainties to farmers requires large seeds of information and intensive support. Given budget and personnel constraints on extension programs, broadcasting information widely is unlikely to be intensive enough, that is, the seeds will be too small, to provide the amount of information necessary for sufficient risk reduction and adoption. Planting only a few seeds and taking careful care of them, however, should produce a successful stand, which will upon reaching maturity reproduce and flourish into a healthy forest through self-sustaining social and spatial interactions.

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## APPENDICES

## Appendix A. Characteristics of quoted villagers.

	Respondent	Individual characteristics			Total field area (ha.)	Number of advisees	HH characteristics	
		Gender	Age*	Oldest cashew age			HH name	HH population
Simong	Ousmane Diop	M	3	0	0	0	Diop	5
	Mamadou Diouf	M	4	0	0	0	Diouf	7
	Abdou-Rahmane Sehn	M	4	2	9.8	10	Sehn	17
	Aliou Sehn	M	2	6	4	0	Sehn	17
	Abdou Diame	M	3	0	0	0	Diame	10
	Amadou Cisse	M	3	10	2.3	1	Cisse	20
	Keba Mane	M	4	3	3	1	Mane	8
	Mamadou Cisse	M	2	2	1.5	0	Cisse	6
	Aissatou Faye	F	50	N/A	N/A	N/A	Sarr	16
	Khady Baro	F	19	N/A	N/A	N/A	Sarr	16
	Fanta Siniane	F	21	N/A	N/A	N/A	Ndiaye	6
	Hussein Ndor	M	15	N/A	N/A	N/A	Mane	8
Mamouda	El Hadji Toure	M	4	4	3.1	0	Toure	33
	Mohammed Drame	M	4	8	8.2	6	Drame (1)	21
	Fode Drame	M	4	2	3.2	0	Drame (2)	20
	Ibrahima Diallo	M	3	6	3.9	3	Diallo	24
	Keba Drame	M	4	0	0	1	Drame (3)	24
	Fatou Dieng	F	30	N/A	N/A	N/A	Drame (4)	17
	Jula Dieng	F	40	N/A	N/A	N/A	Toure	33
	Dete Toure	F	15	N/A	N/A	N/A	Camara	NR

\* Farmer ages were recorded in categories; women and children ages were not.

\*\* Mamouda household field numbers represent cashew fields only.

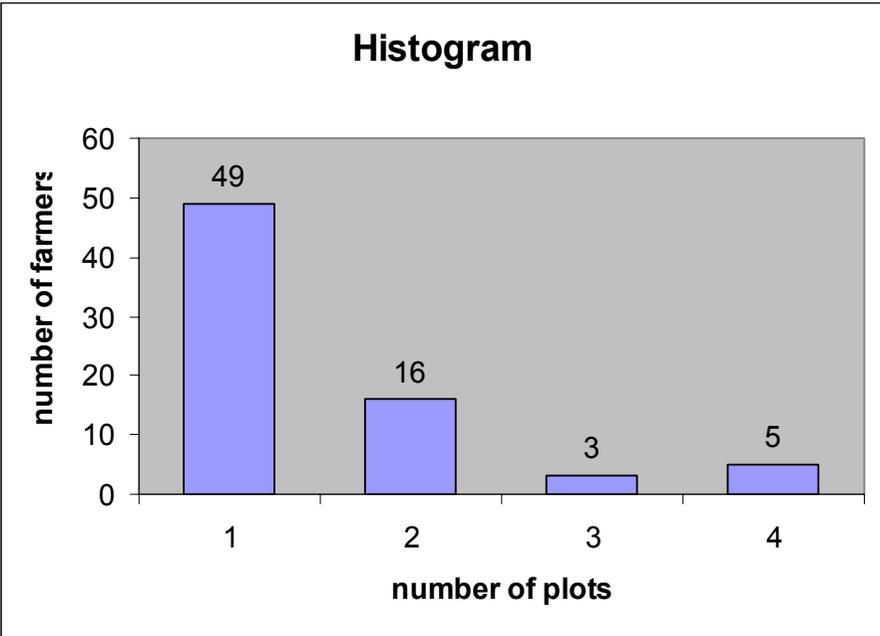
## Appendix B. Household Survey Summary

Nevin Dawson

Villages: 2

	<u>Simong</u>	<u>Mamouda</u>	<u>Total</u>
# households	23	10	33
# household surveys	23	9	32
# plot owners	42	19	61
# plots	71	21	92
# cashew plots	40	21	61
# non-cashew plots	31	0	31

Note: One Mamouda household could not be surveyed because its head was consistently out of town. The corresponding plots for this household, however, are included.



**Household Head Survey**

Date \_\_\_\_\_ Time (circle) AM PM

Who and who are living in this compound that are not guests?

	# of people	# of people age 0-8	# of people age 9-17	# of people age 18-30	# of people age 31-60	# of people age 61+	Percent male	Max years of French education	Max years of Arabic education	# of plot owners	# of wage earners
SIMONG											
Sum	228	72	52	54	37	13				42	9
Avg. people/HH	9.9	3.1	2.3	2.3	1.6	0.57				1.8	0.4
Median people/HH	8	3	2	3	1	1				2	0
% w/in HH averaged across HHs		0.285	0.200	0.267	0.184	0.063	0.493	2	5.6	0.244	0.082
% w/in HH median across HHs		0.25	0.173	0.227	0.167	0.043	0.5	1	5	0.182	0
% in Simong		0.316	0.228	0.237	0.162	0.057					

Uncorrected\*  
MAMOUDA

	# of people	# of people age 0-8	# of people age 9-17	# of people age 18-30	# of people age 31-60	# of people age 61+	% male	Max years of French education	Max years of Arabic education	# of plot owners	# of wage earners
Sum	224	48	51	32	39	6				34	15
Avg people/HH	24.9	5.3	5.7	3.6	4.3	0.7				3.8	1.7
Median people/HH	21	6	6	3	4	1					
% w/in HH averaged across HHs		0.237	0.244	0.159	0.183	0.029	0.538	2.2	11.6	0.166	0.077
% w/in HH median across HHs		0.25	0.238	0.143	0.2	0.022	0.542	2	11	0.182	0.022
% in Mamouda		0.214	0.228	0.143	0.1744	0.027					

**Corrected\***  
MAMOUDA  
corrected  
n=146

	# of people	# of people age 0-8	# of people age 9-17	# of people age 18-30	# of people age 31-60	# of people age 61+	% male	Max years of French education	Max years of Arabic education	# of plot owners	# of wage earners
sum	224	43	41	27	30	5				34	15
avg people/HH	24.9	6.1	5.9	3.9	4.3	0.7				3.8	1.7
median people/HH	21	6	6	3	4	1				4	1
% w/in HH averaged across HHs		0.289	0.282	0.189	0.206	0.034	0.511	2.2	11.6	0.166	0.078
% w/in HH median across HHs		0.3	0.292	0.15	0.2	0.048	0.534	1.5	11.5	0.182	0.022
% in Mamouda		0.042	0.281	0.185	0.205	0.034					

\* Correction represents statistics excluding 2 households with incomplete data: respondents were unwilling to list all members due to very large size of these two households.

## Qualitative

- Q1: Why did you plant cashews? What uses do they have?
- Q2: What else do you know that makes cashews good to plant in your fields? For example, you know that cashew fruit is very tasty, but there's not a lot of money there. What else is there that is good but that doesn't get money?
  - Numbers in parentheses correspond to categories below.
  - Respondents listed multiple uses resulting in a total (60) greater than the number of respondents (32).
  - Percentages are respondents who listed that benefit in their list of cashew uses.

uses by HH	Q1	%	Q2	%	Both	%
Sell nuts (1)	19	0.59	10	0.31	25	0.78
Eat fruit (2)	12	0.38	8	0.25	18	0.56
Eat nuts (2)	7	0.22	4	0.13	10	0.31
Sell fruit (1)	4	0.13	5	0.16	7	0.22
Firewood (2)	2	0.06	6	0.19	7	0.22
Purchasing power (4)	6	0.19	0	0.00	6	0.19
Easier work (4)	5	0.16	0	0.00	5	0.16
Health/medicine (2)	2	0.06	4	0.13	5	0.16
Nut products (1)	3	0.09	1	0.03	4	0.13
Helps family and himself (4)	3	0.09	0	0.00	3	0.09
Your kids will steal other peoples' cashews if you don't have your own (4)	3	0.09	0	0.00	3	0.09
Fertilizer (3)	2	0.06	3	0.09	3	0.09
Charcoal (2)	1	0.03	2	0.06	3	0.09
Rain (3)	2	0.06	0	0.00	2	0.06
Consistent production (4)	2	0.06	0	0.00	2	0.06
Diversifies cash crops (4)	2	0.06	0	0.00	2	0.06
Wildlife food (3)	1	0.03	1	0.03	2	0.06
Fodder (2)	1	0.03	1	0.03	2	0.06
Juice products (1)	1	0.03	1	0.03	2	0.06
Shade (3)	1	0.03	0	0.00	1	0.03
Windbreak (3)	0	0.00	1	0.03	1	0.03
<b>(1) Sell</b>	<b>21</b>	<b>0.66</b>	<b>13</b>	<b>0.41</b>	<b>26</b>	<b>0.81</b>
<b>(2) Consume</b>	<b>16</b>	<b>0.50</b>	<b>15</b>	<b>0.47</b>	<b>25</b>	<b>0.78</b>
<b>(3) Environmental</b>	<b>6</b>	<b>0.19</b>	<b>5</b>	<b>0.16</b>	<b>8</b>	<b>0.25</b>
<b>(4) Other</b>	<b>17</b>	<b>0.53</b>	<b>0</b>	<b>0.00</b>	<b>17</b>	<b>0.53</b>

- When you planted cashews, why did you choose this field and not that one?
  - *Most common: "I want to still be able to farm as well" (9), "this field is good for cashews/it has white sandy soil" (7) and "I don't have enough fields" (6).*
  - *Note: this question was difficult to make respondent understand, hence the slightly off-topic answers.*

- The first cashews you planted, how did they go for you? Did they all appear and none died, or some appeared and some didn't; were they all born that way? Did you plant lots more cashews after that? Was the second way you planted different from the first way you planted?
  - *Most common: "I planted directly in ground the first year, and then used a nursery the second year" (10), and "livestock destroyed the cashews" (5).*
- What else do you know that makes cashews good to plant in your fields? For example, you know that cashew fruit is very tasty, but there's not a lot of money there. What else is there that is good but that doesn't get money?
  - *See table above (Q2).*
  - *Most common: "to sell nuts" (10), and "to eat fruit" (8).*
  - *Note: respondents listed multiple uses resulting in a total (33) greater than the number of respondents (32).*
- What else do you know that makes cashews not good to plant in your fields? For example, you know that cashew trees attract lots of snakes; that's not good. What else is there that is not good?
  - *Most common: "don't know of any" (13), and "reduction in my other crops" (7).*
- Are there people that planted cashews before you (that beat you to cashew planting)? If that happened, what makes you different? Why did they plant early and you waited?
  - *Most common: "I didn't know the use of cashews at the time" (15), and "I had limited fields/tenure issues" (6).*
- Whose had more fruits? Whose got a better price?
  - *Most common: "Planting early means that you get more seeds" (16), and "Modern [wide] spacing will give you higher production" (5).*
- Where you are now, do you think that if you plant cashews early or if you don't plant cashews early, which is better? Why did/didn't you plant early?
  - *Most common: "early planting is better" (25).*
- What advice would you give someone who is thinking about planting cashews?
  - *Most common: "cashews are good to plant because of their multiple uses" (14), "cashews are good because the money that comes from them lets you get things [like better houses and fences]" (6), "plant trees/cashews" (6).*
- If you planted cashews where you used to farm millet, will the amount of millet you get decrease? How will you get food if you plant only cashews and you don't farm millet?

- *Most common: “the cashews in one field can make enough money to buy the food that you used to grow in that field” (13), and “you cannot/shouldn’t live off of cashews alone” (12).*
- For example, time past, you used to farm peanuts that gave you money, but now where you used to farm peanuts, you plant cashews there. Why do you think cashews have a greater use?
  - *Most common: “cashews have more buying power than peanuts” (14), and “peanuts are actually better in some situations” (9).*
- Think a little bit: According to you, this village will happen how in 15 years? Are that and this different or will it stay the same way? How? Do you think cashews can change peoples’ way of life? How?
  - *Most common: “cashews will allow people to get more things/better houses” (17), and “the size/population of the village will increase” (9).*
- People plant cashews in mixed ways. You, do you plant because your friends and other owners talked about it and that caused you to reach for it, or because you saw that people are planting cashews everywhere in their fields, so you did it too? [0:both, 1:friends, 2:fields]

- 

	#	%
Both	4	0.13
Friends	15	0.48
Fields	12	0.39

- What about other people? Do they plant because their friends and other owners talked about it and that caused them to reach for it, or because they saw that people are planting cashews everywhere in their fields, so they did it too? [0:both, 1:friends, 2:fields]

	#	%
Both	5	0.16
Friends	14	0.44
Fields	13	0.41

- Why?
  - *Most common: "I've seen other people getting things" (5), "friend's influence" (3), "money" (3), and "I see cashews everywhere" (3).*

### Transport/price

#### NOTES

- *While most households have cashew fields, many of these trees are still too young to produce a marketable crop. Thus many households had no response to the questions in this section.*
- *Number of responses for particular question = n.*
- *Responses are averages unless noted otherwise.*
- *(500 CFA = 1.00 USD)*

- The first time you sold cashews, how much was one kilogram?
  - *215 CFA/kg (n=13)*
- That time and now, how many years are between?
  - *10 years ago (n=14)*
- Last year, how much money did you get from cashews?
  - *109,000 CFA (n=9); Standard Deviation=125,000*
- Last year, how many times did you yourself take cashews away from here to take to an outside village to sell? (99: more than 20)
  - *1 time (3), 3 times (1)*

All of these other questions are about this selling method.

#### CIRCLE ONE

- In general, you sold at what price? *350 CFA/kg (n=3)*
- Last year, what was your best price? *350 CFA/kg (n=3)*
- Last year, what was your worst price? *350 CFA/kg (n=3)*
- How many kilos did you sell in this way? *310 kg (n=4)*
- How did you carry the cashews? *Cart: 2; car: 1; minibus: 1*

- Did you pay to carry them? How much was one trip?  
*No: 1; Yes: 3. Avg. 2600/trip*
  - Where did you sell them?  
*Karang: 3; Dakar: 1*
  - Last year, how many times did you sell cashews here, in the village?  
(99:more than 20) *Average: 2.7 times (n=6); 99: 4*
- All of these other questions are about this selling method.
- In general, you sold at what price? *308 CFA/kg (n=9)*
  - Last year, what was your best price? *340 CFA/kg (n=9)*
  - Last year, what was your worst price? *294 CFA/kg (n=9)*
  - How many kilos did you sell in this way? *294 kg (n=9)*
  - Do you have relatives or friends that buy cashews? *No: 10; Yes: 22*
  - Do you have relatives or friends with a car? It can be a little car or a big car.  
*No: 11; Yes: 21*
  - Where you are, if your cashews have grown until they're mature and they produce fruits as a mature tree does, do you think you will sell the seeds the same way as when you first started? *No: 20; Yes: 8*
  - If not, in your mind, how do you think you'll sell them then?
    - *Most common: "will wait for a buyer to come to the village" (10), and "will take my cashews somewhere else to sell" (8).*

#### Experience

- Before you planted cashews in your field, did you ever use any other tree technique (agroforestry), like a live fence or alley cropping [show example]?  
(0:none, 1:alley cropping, 2:live fencing, 3:other) *None: 21; Other: 11*
- In your compound, are there any male members of UGAP?  
*Yes: 17, No: 15*
- Has a Peace Corps volunteer and any household member ever  
*Talked about trees: 4; done any tree work: 15; None: 11*
- Has someone from another project and any household member ever  
*Talked about trees: 3; done any tree work: 10; None: 19*
- Have you and anyone from Eaux et Forets ever talked?  
*Yes : 15 ; No : 17.*
- When was the first time you talked?  
*Past three months: 2; last year: 1; past three years: 1; longer: 11*
- What did you talk about?  
*Most common: Plant trees (7), Don't cut trees (6).*

#### Assets

Before Abdoulaye Wade "climbed the chair" [was elected in 2000—a historical time marker to find conditions before the majority of cashew adoption took place], how many of these things did you have that I will ask about? What about now, how many do you have, is it more or less?

- |                                       | BEFORE             | NOW                |
|---------------------------------------|--------------------|--------------------|
| ● Do you have a working TV? How many? | <i>03% have TV</i> | <i>22% have TV</i> |

- Do you have a working bike? How many? *(n=31)* 59% have bike 22% have bike
- Do you have a working cart? How many? *(n=31)* 69% have cart 44% have cart
- Do you have cows/calves? How many? *(n=31)* 5.4 cows 4.1 cows
- Do you have sheep/lambs? How many? *(n=31)* 5.1 sheep 1.3 sheep
- Do you have goats/kids? How many? *(n=31)* 6.7 goats 3.1 goats
- In a year, all of the people in your house make how much money? (0: lower than other, 999: higher than other) 296,000 CFA 150,000 CFA *(n=20)*

**Now,**

- How many buildings are in this compound? *Dev.=5.1* 6.2 bldgs.; *St.*
- How many buildings have a tin roof? *Dev.=4.9* 2.8 roofs; *St.*
- How many buildings have cement on the ground? (Those that have cement in all the rooms?) *Dev.=4.8* 2.2 floors; *St.*
- How many buildings have cement on all the walls? *Dev.=3.7* 2.0 walls; *St.*

**Credit/Savings**

- If you find that you need to borrow money for your farm work, would you be able to borrow ~\$200 for one year? If so, where would you borrow from?  
*Bank or other money storage place: 11; NGO: 2; your friend: 8; none:11*
- In your household, is there anyone that you know that borrowed anything from a bank or other money storage place like UGAP or a NGO, such as money, tools, fertilizer, or seed?  
*Never: 17; in the past: 14; now: 1*
- Have you ever saved money in a bank?  
*Never: 15; in the past: 15; now: 2*

## Appendix C. Women and Children Survey

Data collected by Nevin Dawson

Numbers in parentheses are numbers of responses.

	Male	Female	Total
Respondents	5	6	11
Children (12-19 yrs old)	3	4	7
Adults (21-50 yrs old)	0	4	4
Mamouda	2	4	6
Simong	1	4	5

- According to you, why do people plant cashews? What uses do they see there?
  - Emphasis on eating and selling.
  - Responses not heard from men: buy clothes (3); burnt shells are fuel (2); fix up *inside* of house; shade reduces tiredness, increases happiness.
- How do cashews make your work easier? How do they lessen your work?
  - Cashews reduce the amount of food you need to cook so cooking is easier (because family members aren't as hungry after eating cashews); you clear the field once and then no more work until harvest--farming, the whole rainy season you work; firewood is easier to collect from cashew trees than from the bush.
- How do cashews make your work harder? How do they increase your work?
  - Doesn't increase work/cashew work is easy (5); fire and smoke can bother you; when you're shelling, if they're not ripe the juice will make you itch; picking the nuts and clearing the fields is hard; cashew work is in addition to household work, so there's more work altogether.
- Do cashews increase your money? Do you yourself get cashew money? Do cashews increase your family's possessions?
  - Everyone replied "yes" to at least some of these questions.
- What else do you know that makes cashew planting in a field good? For example, you know that cashew fruit, it's very tasty, but there's not a lot of money there. What else is there that's good but that doesn't get money?
  - Firewood (4). Responses not heard from men: stops spread of fire; roasted skins are a termite repellent.
- What else do you know that makes cashew planting in a field not good? For example, you know that cashews attract lots of snakes; and snakes aren't good. What else is there that's not good?
  - Dangerous/destructive animals/spirits (7); doesn't know of anything (3).

- You know that when cashews are ripe, all of the children pick up cashews, they roast them, they eat them. According to you, does this ruin their other work?
  - No (6); yes (4). Note: women were split 2/2. Even though children should be biased towards saying that cashews don't destroy their other work (cashew-roasting for snacking is viewed as a fun activity that they would want to defend), there were still 2 "yes"s (and 4 "no"s).
- People that plant cashews early and people that plant cashews late, what makes them different?
  - Early planters saw the benefit earlier (5); people who plant later have seen early planters getting things from their cashews (3); some people weren't able to plant early (2); some people think ahead and plant early; people that plant early want things, they want business, people that wait don't want things; everyone wants to move forward, but early planters *really* want to move forward.
- Where you are, do you think that if you plant cashews early or if you don't plant early, which has the bigger benefit?
  - Early planting is better (10); they both have big benefits (1).
- If you wanted, could you plant cashews in a field?
  - Yes (7), no (2), maybe (1).
  - She has planted cashews in a field, but even though they're hers, she doesn't get the money from them, her husband does because it's his field.
  - No, women don't have strength here—if they ask, the men say "This is my field, how can you plant something here?"
  - No, she's a woman and her husband won't agree to give her a field because she'll get too much benefit out of it.
- Think a little bit; according to you, when [village]'s cashews have grown until they're very mature, do you think that those cashews will be able to change [village]'s people's way of life?
  - Money from cashews will allow people to buy better food, better houses, and/or livestock (9); it may be difficult to sell cashews when they're plentiful (2); if cashews are plentiful, people should be able to give up farming; if women can get a field they [women] will be plentiful in the bush.
- People plant cashews in mixed ways; according to you, do people plant because the owners and their friends talked, and that extends the work to them, or did they see that people plant cashews everywhere in the fields, so they also did it?
  - Fields (8); both (2); friends (1).

- What causes it?
  - People see that tiredness/suffering is not there; if no one tells you about cashews then you won't know to ask—you have to see them in the fields first and then ask about them in the village; people see the planting and that they get money, then they want to plant themselves; seeing in the fields is more powerful; he saw it in the fields that cashews are good.
- Last year, did you ever roast cashews and sell them? Yes (7), no (4)
  - How many kg did you buy? How much did you buy one kg for?
    - AVG: 75 kg @ 300 CFA/kg = 22,500 CFA; ~45 USD
  - Did you roast them [a second time]? Did you remove the skins?
    - None (3); roast and peel (3); roast only (1).
  - How many kg did you sell? How much did you sell a kg for?
    - 35 kg @ 300 CFA/kg = 10,500 CFA; ~21 USD
  - Where did you sell it? Simong (3); Gambia (2); Karang (2).

### Appendix D. Farmer Social Roster

Jamaa-jamaa, i ning jumaa nin jumaa le ka kacaa, ning saatee kono? OR

Jumaa ning jumaa le mu i kafuniooma ti, ning saatee kono?

#	name	survey number	Muntuma le keta i ning -- -- kacaa labano ti?	Jamaa-jamaa i ning ---- si kacaa noo siiniaa jelu le karo kono?	Fo i nani taata ----- yaa puru a ye i soo hakiloo la ila wulakono dookuwo faanaa to?	Ning ila senefeng ol ye jankaroo soto, fo i be taala - ---- yaa?	Ni i ning moo lafita kacaala kasuu fiyo fannaa to, misaali fee, ka kasuwol fii rangol la, fo i be taala ----- yaa i ning a ye kacaa a kuwo la?
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

- 1 bii
- 2 kunun
- 3 lookun tambila
- 4 lookun fula tambila
- 5 kari tambila
- 6 kari saba tambila
- 7 serun

### Appendix E. Plot Survey

survey # _____ x		Neighbors				GPS Coords			
Name _____	#	N	E	S	W	Lat		Lon	
Date _____ am pm	1								
	2								
	3								
	4								
	5								
	6								
plot number	1	2	3	4	5	6	7	8	9
How many hectares are in this field?									
Is the soil fertile if you farm millet there? Is it (1) not fertile, (2) fertile, or (3) very fertile?									
How does water run in this field? Does it (1) run fast to go, (2) not run very much, (3) not run at all?									
This year, how many years have you done work in this field?									
Does livestock come to your field to eat?									
This year what will you farm here?									
This year what will you farm here?									
What have you farmed here in the past ten years?									
What have you farmed here in the past ten years?									
What have you farmed here in the past ten years?									
What have you farmed here in the past ten years?									
Are there cashew trees in this field?									
How many years since you've taken cashew nuts from here to sell?									
1st third: cashews present?									
1st third: How many years since you planted cashews here?									
2nd third: cashews present?									
2nd third: How many years since you planted cashews here?									
3rd third: cashews present?									
3rd third: How many years since you planted cashews here?									

Crop code																				
Cash																				
01 Cashew																				
02 peanut																				
03 melon																				
04 vegetables/garden																				
Subsistence																				
11 millet																				
12 sorghum																				
13 rice																				
14 corn																				
15 beans																				
16 findoo ( <i>Digitaria exilis</i> )																				
Trees																				
21 mango																				
22 eucalyptus																				
Do you plan to increase the number of cashews in this field later?																				
Do you plan to decrease the number of cashews in this field later?																				
How many meters are there between trees?																				
How many meters are there between two rows?																				
(1) Will you cut the cashew branches when they have grown until they have grabbed each other between the rows, or (2) will you leave them there, but not farm anything in between? (0) none																				
<i>In general, how did you get the cashew seeds for this field? (0) none (1) They came from your own cashew trees, (2) someone gave them to you [for free], or (3) you bought them.</i>																				
<i>Do you have a method of seed selection? (How do decide that you are going to make this nut a seed?)</i>																				
<i>Did you (1) make a nursery before you planted or did you (2) plant directly [in the field]?</i>																				
<i>Direct: how many seeds did you plant in each spot?</i>																				
<i>Nursery: Did you (1) plant seeds in a can, or (2) in a bag?</i>																				
<i>Nursery: That can or bag, where did you get ti? (1) From your friend, (2) UGAB gave it to you, (3) from Eaux et Forêts, (4) from another project, (5) you bought it at the market, or (6) somewhere else?</i>																				
<i>Nursery: In general, how much did one can or bag cost?</i>																				
During the time that you were planting cashews, was there other work happening at that time?																				
How many times do you harvest cashews in a year?																				
How many times do you weed cashews in a year?																				

## Appendix F. LimDep command files

### Time to adoption survival models

```
create;
  if (EXPPC=2) EXPPCD=1;
  (else) EXPPCD=0;          ?creates dummy variable for having done tree
work with PC
  if (EXPOTHR > 0) EXPOTHRD=1;
  (else) EXPOTHRD=0;      ?creates dummy variable for having talked w/
or done tree work w/ another project
  if (EXPTRWRK > 0) EXPTRWKD=1;
  (else) EXPTRWKD=0;      ?creates dummy variable for having done any
sort of tree work before
  if (EXPPCD=1 | EXPOTHRD=1 | EXPUGAP=1 | EXPEEF=1) EXTEXP=1;
  (else) EXTEXP=0;
  if (EXPCREDI > 0) EXPCREDD=1;
  (else) EXPCREDD=0;      ?creates dummy variable for having ever taken
loan of money, seeds, tools, etc
  if (CREDIT > 0) CREDITD=1;
  (else) CREDITD=0;      ?creates dummy variable for being able to
borrow $200 for one year from any source
  if (EXPBANK > 0) EXPBANKD=1;
  (else) EXPBANKD=0$      ?creates dummy variable for having ever saved
money in a bank

create;
  if (AGE=0) AGEYR=4; ?creates continuous variables for age (0=0-8, 1=9-17,
2=18-30, 3=31-60, 4=60+)
  if (AGE=1) AGEYR=13;
  if (AGE=2) AGEYR=24;
  if (AGE=3) AGEYR=46;
  if (AGE=4) AGEYR=65$

create;

ASSETS=TV0*1+BIKE0*2+CART0*4+COW0*3+SHEP0*2+GOAT0*1+ROOFS*2+FLOORS*1+WALLS*
1$ ?creates weighted index for assets

create;
  EXPTOTL=(1*EXPPCD)+(1*EXPOTHRD)+(0.5*EXPEEF)+(1*EXPTRWKD)+(4*EXPUGAP)$
?creates weighted index for risk/experience category (don't use EXPUGAP in
cashew or Mamouda models)

create;
  CREDITOTL=(1*CREDITD)+(1*EXPBANKD)+(1*EXPCREDD)$ ?creates non-weighted
index for credit/bank experience

create;
  TTLAREAH=TOTLAREA/10000$

create;
  AVGAREAH=AVGAREA/10000$

create;
  LBRDPND=(HHPOP-HHLABORN)/HHLABORN$

create;
  if (MAXCSHYR>20) ADPT20YR=0;
  (else) ADPT20YR=20-MAXCSHYR$
```

```

create;
  if (MAXCSHYR>50) ADPT50YR=0;
  (else) ADPT50YR=50-MAXCSHYR$

create; LOG50YR=log(ADPT50YR+1)$

create; if (adpt50yr>46) early=0; (else) early=1$

?*****
?*      MODELS      *
?*****

?***NON-SOCIAL CASHEW MODEL***
sample; all$

namelist; cshnosoc= lbrdpnd, advseeno, CasetPC1, CExtnPC1, mxadjage$

dstat; rhs=cshnosoc; output=3$

survival; lhs=LOG50YR, censor
; rhs=one, cshnosoc
; model=loglogistic;
wald: b(2)=0, b(3)=0, b(4)=0, b(5)=0, b(6)=0$

regress; lhs=LOG50YR
; rhs=one, cshnosoc$

?***PROBIT
namelist; pcschnosc= hmaleno, advseeno, CasetPC1, CExtnPC1, mxadjage$

probit; lhs=early; rhs=one, pcschnosc$

?***SOCIAL CASHEW MODEL***
sample; all$

namelist; cashsoc= hhlaborp, advseeno, CasetPC1, CExtnPC1, mxadjage,
cntctcs4$

dstat; rhs=cashsoc; output=3$

survival; lhs=LOG50YR, censor
; rhs=one, cashsoc
; model=loglogistic;
wald: b(2)=0, b(3)=0, b(4)=0, b(5)=0, b(6)=0, b(7)=0$

regress; lhs=LOG50YR
; rhs=one, cashsoc$

?***PROBIT
namelist; pcashsoc= hhlaborp, advseeno, CasetPC1, CExtnPC1, mxadjage,
cntctcs4$

probit; lhs=early; rhs=one, pcashsoc$

dstat; rhs=pcashsoc; output=3$

?***NON-SOCIAL SIMONG MODEL***

```

```

sample; 1-42$

namelist; simnosoc=hhlaborb, ADVSEENO, SAssetPC1, SExtnPC1, DISTAC$ ?
ASSETS switches signs in OLS
dstat; rhs=simnosoc; output=3$

survival; lhs=LOG50YR, censor
; rhs=one, simnosoc
; model=loglogistic;
wald: b(2)=0, b(3)=0, b(4)=0, b(5)=0, b(6)=0$

regress; lhs=LOG50YR
; rhs=one, simnosoc$

***PROBIT
namelist; psimnosoc= hmalepc, wgtfert, sasetpc1, exptrwkd, mxadjage$

probit; lhs=early; rhs=one,psimnosoc$
dstat; rhs=psimnosoc; output=3$

***SOCIAL SIMONG MODEL***
sample; 1-42$

namelist; simsoc=hhlaborp, ADVSEENO, assets, sextnpc1, distac, CNTCTCS4$

dstat; rhs=simsoc; output=3$

survival; lhs=LOG50YR, censor
; rhs=one, simsoc
; model=loglogistic;
wald: b(2)=0, b(3)=0, b(4)=0, b(5)=0, b(6)=0, b(7)=0$

regress; lhs=LOG50YR
; rhs=one, simsoc$

***PROBIT
namelist; psimsoc= hmalepc, wgtfert, sasetpc1, exptrwkd, mxadjage,
cntctcs4$

probit; lhs=early; rhs=one,psimsoc$

dstat; rhs=psimsoc; output=3$

***NON-SOCIAL MAMOUDA MODEL***
sample; 43-61$

namelist; mamnosoc=hhlaborp, ADVSEENO, ASSETS, EXPTOTL, DISTCC$ ? signif =
0.02 BUT 0.37 and 0.64 corr coeffs

dstat; rhs=mamnosoc; output=3$

survival; lhs=LOG50YR, censor
; rhs=one, mamnosoc
; model=loglogistic;
wald: b(2)=b(3)=b(4)=b(5)=B(6)=0$

regress; lhs=LOG50YR
; rhs=one, mamnosoc$

***PROBIT

```

```
namelist; pmamnosc= avgarea, ageyr, assets, EXPTOTL, mxadjage$ ?goes crazy
with most changes in specs
```

```
probit; lhs=early; rhs=one,pmamnosc$
dstat; rhs=pmamnosc; output=3$
```

```
?***SOCIAL MAMOUDA MODEL***
sample; 43-61$
```

```
namelist; mamsoc=LBRDPND, ADVSEENO, MAssetPC1, EXPTOTL, DISTCC, CNTCTCS4$
```

```
dstat; rhs=mamsoc; output=3$
```

```
survival; lhs=LOG50YR, censor
; rhs=one, mamsoc
; model=loglogistic;
wald: b(2)=0, b(3)=0, b(4)=0, b(5)=0, B(6)=0, B(7)=0$
```

```
regress; lhs=LOG50YR
; rhs=one, mamsoc$
```

## Advisor Models

```
create;
  if (EXPPC=2) EXPPCD=1;
  (else) EXPPCD=0;          ?creates dummy variable for having done tree
work with PC
  if (EXPOTHR > 0) EXPOTHRD=1;
  (else) EXPOTHRD=0;      ?creates dummy variable for having talked w/
or done tree work w/ another project
  if (EXPTRWRK > 0) EXPTRWKD=1;
  (else) EXPTRWKD=0;      ?creates dummy variable for having done any
sort of tree work before
  if (EXPPCD=1 | EXPOTHRD=1 | EXPUGAP=1 | EXPEEF=1) EXTEXP=1;
  (else) EXTEXP=0;
  if (EXPCREDI > 0) EXPCREDD=1;
  (else) EXPCREDD=0;      ?creates dummy variable for having ever taken
loan of money, seeds, tools, etc
  if (CREDIT > 0) CREDITD=1;
  (else) CREDITD=0;      ?creates dummy variable for being able to
borrow $200 for one year from any source
  if (EXPBANK > 0) EXPBANKD=1;
  (else) EXPBANKD=0$      ?creates dummy variable for having ever saved
money in a bank
```

```
create;
  if (AGE=0) AGEYR=4; ?creates continuous variables for age (0=0-8, 1=9-17,
2=18-30, 3=31-60, 4=60+)
  if (AGE=1) AGEYR=13;
  if (AGE=2) AGEYR=24;
  if (AGE=3) AGEYR=46;
  if (AGE=4) AGEYR=65;
  if (AGE=-999) AGEYR=-999$
```

```
create;
  EXPTOTL=(1*EXPPCD)+(1*EXPOTHRD)+(0.5*EXPEEF)+(1*EXPTRWKD)+(4*EXPUGAP)$
?creates weighted index for risk/experience category (don't use EXPUGAP in
cashew or Mamouda models)
```

```

create;

ASSETS=TV0*1+BIKE0*2+CART0*4+COW0*3+SHEP0*2+GOAT0*1+ROOFS*2+FLOORS*1+WALLS*
1$ ?creates weighted index for assets

create;
  if (MAXCSHYR>50) ADPT50YR=0;
  (else) ADPT50YR=50-MAXCSHYR$

create;
  MEDXNUMB=advecsag*advseeno$

create;
  PCERLY=ERLYADVE/ADVSEENO$

create;
  if (medxnumb>-1) advisod=1;
  (else) advisod=0$

create;
  if (avgxnumb>-1) advisod=1;
  (else) advisod=0$

create;
  if (AVGXNUMB>10) GOODADVS=1;
  (else) GOODADVS=0$

create;
  if (GOODADVS=1) ADVSTYPE=3;
  if (advisod=1 & GOODADVS=0) ADVSTYPE=2;
  if (advisod=0) ADVSTYPE=1$

create;
  if (ROADFRNT>0) ROADFRND=1;
  (else) ROADFRND=0$

sample; all$

reject; advisod<1$

?*MODEL
namelist; advisor4= totlarea, roadfrnd, ageyr$ ?vars have high corr w/
avgxnumb, but also with each other, so low signif model

regress; lhs=AVGXNUMB
; rhs=one, advisor4$

reject; advisod<1$

dstat; rhs=advisor4, avgxnumb; output=3$

regress; lhs=avgxnumb; rhs=one, roadfrnt, ageyr$

```

## Appendix G. Life Cycle Essay

### CYCLES

As you begin your life in your mother's womb, she carries you around without any special care; in fact it's considered bad luck to even make any mention of a baby before a live healthy one is actually birthed. Instead of saying a woman is pregnant she usually just has a "big belly," or, more colorfully, has "swallowed a soccer ball." Although she probably won't make any dietary or lifestyle changes, Muslims don't drink and women don't smoke here, so the two biggest hazards are already moot. Your mother is likely to go to a clinic for your birth if there is enough warning, and maybe even make the trip beforehand for a few per-natal checkups. But it's just as likely that you'll be birthed at home in your mom's hut after she gets back from a normal day's work in the fields.

You begin life surprisingly light-skinned and everyone will say you're pretty because of it. But it doesn't last long, and soon enough people will jokingly call you ugly because you've lost that mark of beauty (you may try to regain this state later in life through special creams and ointments). You'll usually be swaddled in many layers of brightly-colored fabrics given as gifts at the baptism. Literally translated, the Mandinka word for baptism is "head-shaving," which is no misnomer, as one week after birth your head is shaved as a goat is simultaneously slaughtered (Figures 1-2). You'll have no name until this ceremony, maybe so that if you don't make it through that first critical week it's not an actual person that your village loses. Among other tasty treats, 'head-shaving' guests receive cola nuts and sweet rice balls (Figure 3). You're passed around freely, as you're more of a burden than a

cherished possession at this point (which begins to make some sense when you see the number of kids floating around a compound).



**Figure 15.** A village elder shaves a newborn's head. (Dawson, 2005)



**Figure 2. Villagers and I look on as the goat is butchered. (Dawson, 2005)**



**Figure 3. Kola nuts soaking in water.** (Dawson, 2005)

While the infant mortality rate is not astronomical, it is certainly significant and infant health is often difficult to maintain. You're likely to develop open sores, the extent of which probably depends upon the level of nutrition in your mother's milk, which probably depends upon the level of nutrition available in her diet. If they are severe, you may get a supplementary formula of powdered milk and margarine. As you grow you're likely to amuse yourself with things like plastic bags (the kind that say "Don't let kids get near this" in the States), anything you might find lying in the dirt, and often enough the dirt itself. Even though these things usually find their way to your mouth, they are not likely to be the biggest barrier to good health in your life, and you manage to survive. You're likely to have a cute little Buddha belly, which gives many boys the appearance of a pleasantly pot-bellied middle-aged man (although it's a symptom of mild malnutrition).

As you begin to toddle around the compound, you start emulating the actions of your elder siblings. What starts out as playful mimicry all too soon becomes part of the daily grind of chores like pounding millet and driving cattle. As you mature, more and more responsibilities are piled on, like cooking and childcare, or weeding and tilling.

Sooner or later you'll probably get married. The level of input you have in this decision may vary, but you'll probably at least have final veto power. Although it may seem like a big step in life, it may have little impact on your day-to-day routine at first. Most newlyweds don't have the resources to begin their own household, so they generally stay right where they are, often with their parents. This may mean living in separate villages and seeing each other as little as once a month. Despite this, the first baby is usually not much longer in coming than nine months after the ceremony. A baby gives a mother an excuse to stay a home for a month, but because she's probably already been responsible for a younger sibling or niece/nephew, childcare is nothing too foreign. A husband's role in childcare is minimal once the goat and entertainment have been provided for the baptism. He may provide an occasional stipend for clothes and medicine, but even that is optional.

Your workload will probably peak when you and your spouse obtain your own household. With only two adults to do all of the farming, cooking, cleaning, gardening, and child-rearing, leisure time can be very scarce. This is part of the reason why you may not live with your spouse until you've reached 30 years or more, when your first-born children are old enough to make a real contribution to the household. Many couples never move to their own separate site, but simply wait for the husband to inherit his father's household.

As the number and age of your children increases, your individual workload begins to decline as you realize the benefits of economy of scale and division of labor. Where a mother once had to leave some of her onions unwatered so she could get home in time to cook dinner, her daughter can now stay at home and cook while mom properly cares for her crops. Where a father once had to give up a valuable day of planting to sell garden vegetables in town, the son can now do the work in his stead. With wise investment at home and occasional forays into big city commerce (and of course if Allah consents), you may be able to buy things like a moped or a television for your household in your middle ages. You may also be able to graduate from square grass-roofed huts to a long multi-roomed tin-roofed *battement*. When your personal labor force reaches critical mass and your age reduces your productivity in the fields, you may choose to retire, and as a man hand over some extent of farm management to your oldest son, or as a woman become a full-time baby-sitter.

If frailty finally prevents you from actively participating in the household, they may *maabo* you (to hide or to store). It's not quite as bad as it sounds though, and mostly just means that you're bed-ridden. Many elders never pass through this stage however, and may work in the fields literally until their dying day. Although your productivity may decrease and you may come to depend on others for your sustenance as you age, your status will only increase, exhibited by the common phrase after the death of an elder, "Simong will not be sweet again." Your death is announced with the wails of the women who enter your compound, and the dispatch of messengers to family members in other villages. Your funeral will be held the same day, and is likely to bring up to several hundred people. The logistics of

assembling this number of people in less than half a day and then feeding and housing many of them are impressive to say the least, but it's really just an extension of the implied ever-present hospitality that any good Senegalese household offers. The burial and ceremony are attended only by men, who receive the same cola nuts and sweet rice balls that were served at your baptism. The day of the funeral is followed by a week of mourning, in which a lantern is kept lit at your grave, and in which the entire village refrains from any celebration in the form of dancing or music. This applies even to baptisms and weddings. As if to accent the more transparently cyclical nature of things here, in the one month I've been here, already two births have been dampened by concurrent deaths in this manner.

As with all cycles, the life of a Senegalese villager varies in duration and quality. It is likely to lack the variety and choice that we are accustomed to, and may in fact require for contentment due to our advanced education and the resulting complication of our brains, but the simplicity and long-term predictability of village life hold a certain attraction of their own, at least from the perspective of an outsider. Most any villager, however, would vehemently disagree with me on the advantages of village life over our own, justly citing the rigors of constant physical labor and lack of opportunity. I suppose that it is something like the African's constant pursuit for light-colored skin in juxtaposition with the Westerner's longing for a deep tan: that which we want most is that which we don't have. Regardless, the cycle will continue to turn and a few lucky individuals from each side will catch a glimpse of the other.