JULIE ALYSON MARCH
Brazilian Agrarian Reform: Potential, Problems & the Quest for Sustainability
(Under the direction of CARL F. JORDAN)

For five hundred years, Brazilian landless farmers have struggled for access to land. Government land redistribution through agrarian reform has been slow, causing grassroots peasant settlement groups to grow in popularity and strength. Over 600,000 families have been settled through grassroots and government settlement initiatives. While this effectively deals with land redistribution, the farmer's fate, once he is settled, is uncertain.

Many settled farmers question the success of Agrarian Reform as they continue to find themselves living an impoverished existence. Reform which fails to secure environmental and economic sustainability could leave settled farmers in worse situations than when they worked in the sugarcane fields.

This study attempts to provide a comprehensive analysis of factors contributing to the success and failure of the reform movement at the individual and community level. This study is multifaceted and includes ecological, economic and social aspects. Two communities of farmers in the Northeastern state of Pernambuco, Brazil were studied for approximately two years. Eight farmers from each site were interviewed on a weekly basis for one year.

The major research topics include: the relation between soil quality and individual and community performance; the potential for small subsistence farmers to succeed in the market economy; how funding initiatives influence land use decisions; the role of plot size as a factor in determining the viability of an individual's plot; and the role of social and political factors in shaping a community.

It became evident that no single factor causes the difficulties encountered in reform areas. Rather, success and sustainability hinge on a subtle blend of ecological, economic and

social factors. Soil quality was relatively unimportant in comparison to economic incentives and plot size in influencing community prosperity.

INDEX WORDS: Agrarian reform, Sustainable agriculture, Agro-ecology, Brazilian Land reform, Landless movement

BRAZILIAN AGRARIAN REFORM:

POTENTIAL, PROBLEMS, & THE QUEST FOR SUSTAINABILITY

by

JULIE ALYSON MARCH

B.A., University of Virginia, 1996

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

ATHENS, GEORGIA

2001

BRAZILIAN AGRARIAN REFORM:

POTENTIAL, PROBLEMS, & THE QUEST FOR SUSTAINABILITY

by

JULIE ALYSON MARCH

Approved:

Major Professor: Carl F. Jordan

Committee: Ron Carroll
Peter Brosius
Miguel Cabrera
Andrew Keeler

Electronic Version Approved:

Gordhan L. Patel
Dean of the Graduate School
The University of Georgia
December 2001

DEDICATION

Dedico este trabalho aos meus grandes amigos do Diamante e Ubu. Eles viverão sempre no meu coração. Que Deus lhes acompanhar na luta e que lhes der amigos para compartilharem a viagem. Vou lembrar de voces sempre. Gente mais fina nunca encontrarei.

ACKNOWLEDGEMENTS

I would like to thank my advisory committee (Drs. Carl Jordan, Ron Carroll, Pete Brosius, Miguel Cabrera and Andy Keeler) for their insight and unwavering support during this project. They accepted the challenge of accompanying and aiding me on my interdisciplinary journey. I am grateful for the patience and enthusiasm of each committee member. Dr. Jordan, my advisor, deserves special thanks for encouraging me to create and complete a project that was not a re-invention of the (ecological) wheel (as he likes to say).

There were many people along the way who made this project both possible and enjoyable. I would especially like to thank the Staff at the Institute of Ecology. The people in the Soil Biology Lab and the Systems Computer Lab were particularly helpful. I thank all involved for your hours of patience and kindness. I would also like to thank Chris Miller and Eduardo Asanza, my unofficial lab group and mentors. You made my early days at the Institute much easier and more productive. Thanks especially to the North carrels crew (Josh Ness, Kate Schofield, Nanette Nelson, Seth Wenger) and many others (Jill Goldstein, Cathy Gibson…) for your friendship and many hours of entertainment.

This work was funded by a Fulbright grant, for which I am forever grateful. Initial survey funding was provided by the Center for Latin American & Caribbean Studies at UGA. A University Wide Fellowship for dissertation writing from the University of Georgia allowed me the time to write the pages that follow.

So many people in Brazil shared their time and knowledge with me. Among these are the communities of Diamante & Ubu, the Bank of the Northeast (Almir), IPA Research Laboratory (Manoel Americo), Projeto Lumiar (Zè Fernandes) and EMATER (Ismael) and the National Agrarian Reform and Colonization Institute (Ermìrio). Dr. Castellanet, Dr. Guedes, UFRPE, and the Antunes family extended their hospitality during various stages of my research. Muito obrigada! There were many other individuals whom I have not included here (for lack of space), that went out of their way to make me welcome and help with my research. I am thankful to all of them.

The sixteen farmers at the two communities were some of the most amazing individuals I have ever met. I thank them for sharing their friendship and their lives with me. The community leaders were incredibly helpful and open. All of the farmers with whom I interacted taught me what the words determination and dedication really mean. They are people with whom I have (literally) shared blood, sweat, and tears. I will forever consider them my extended family and close friends.

To my most helpful field assistant and friend, Christopher Eckenroth - Thank you, for the walkie-talkies, for the beautiful site maps, and most importantly, for the hours you spent with me in the field, in the lab, and on the phone. Your support was essential to this project.

And finally, thank you to my family, especially my Mom, Dad & Brother who unselfishly allowed me to pursue my project (and many others I have come up with over the years), while knowing that I would be gone for a considerable amount of time. You never even flinched when I called to say I was off to live among fighting farmers in the tropics. Well, at least you never let me see you flinch and I thank you for that. Your encouragement was unwavering through this entire adventure, and it meant the world to me.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

In the sugar-producing zone of the Northeastern state of Pernambuco, large landholdings have dominated the landscape since the beginning of colonization of Brazil in the 1500's. Even now, land concentration by the wealthy makes it exceedingly difficult for the rural poor to access land to farm. For nearly five hundred years, Brazilian landless farmers, including descendents of former slaves, indigenous people and immigrant laborers, have continued to struggle for a piece of land. Government redistribution of land through the agrarian reform program has been a slow process, causing grassroots peasant settlement groups to grow in popularity and strength. To date, more than 600,000 families have been settled through a combination of grassroots and government settlement initiatives. While this process effectively deals with the issue of redistribution of land, the fate of the farmers once settled is uncertain.

Many settled farmers have begun to question the success of the program as they continue to find themselves living an impoverished existence. A very real concern is that a reform which fails to secure environmental and economic sustainability could leave settled farmers in worse situations than when they worked in the inhumane conditions of the sugar cane fields.

A more effective agrarian reform is urgently needed, both in terms of raising the standard of living of the rural poor, and to promote landscape level changes with minimal negative environmental impacts.

As agrarian reform is a highly politicized issue, the reality of the situation can be obscured by propaganda and political agendas. The situation is often misrepresented in the growing body of literature, as much of it is politically oriented and strongly biased either for or against the reform movement and its participants. In reality, reform communities are neither altruistic environmental stewards, nor evil destructors. Filtering out the propaganda and basing reform plans on unbiased information is essential for an effective program.

It is important to forecast the effects of reform before the process is finished, because the cumulative effect of a spreading movement will be greater than the localized changes. The more than 19,188 families settled in Pernambuco will help shape the environmental quality and agricultural productivity of the region (www.fisepe.pe.gov.br, www.mst.org.br). There is little leeway for ineffective and potentially detrimental reform plans because 4 million landless families still wait for land, ensuring that the demand for land conversion will not slow in the near future.

This study attempts to provide a comprehensive analysis of some of the factors contributing to the success and failure of the reform movement at the individual and community level. The research dispels some of the overly simplistic explanations that are frequently offered to account for the lack of sustainability and success encountered at many reform sites. Some of these explanations include: misinformed farmers, low soil quality, and poorly constructed government plans. This study is unique in that it acknowledges the good aspects of the reform program while also pointing out the weaknesses.

The strongest evidence of reform gone awry is the 30% attrition rate of settled farmers (Secco, 2000). Thirty percent of the farmers who camped out on roadsides and faced hunger and police brutality have given up and left the fields for which they fought so hard.

This was not the intention of agrarian reform and makes the need to reevaluate the process even more apparent.

As farmers flee from rural areas to the cities, several things have become evident. The first is that a failed or only partly successful agrarian reform will have detrimental effects on the cities of Brazil, where unemployment, violent crime and homelessness are on the rise (BBC, 2001). The second is that a partly successful reform will have detrimental effects in the countryside where poverty will increase and environmental and economic conditions will worsen. Veja, a Brazilian news magazine, estimates that of the families settled through agrarian reform, only 30 % actually increase their standard of living (Secco, 2000).

Study Sites

Site Selection

Two settlements of formerly landless farmers in the Northeastern state of Pernambuco, Brazil were the focus of the project. The communities were selected based on their location and their willingness to participate in the study. Each was comprised of recently (less than ten years) settled farmers who were practicing small-scale agriculture and had been landless. Originally, just one site was to be selected but a bidding war ensued when subtle suggestions were made indicating that one community should be chosen rather than the other. Both communities were selected to eliminate competition between the two, and to allow for a comparative study.

Prior to the twelve-month research project, several contact periods totaling approximately one year took place. Community life and activities were participated in during this time. On four occasions, community meetings were held for discussion of this project and the community's decision to participate. As cross- cultural understanding increased, members of both communities participated more readily and conversed more freely.

This greatly facilitated interviewing and data collection. All interviewing and data collection was done in Portuguese.

Site Characteristics

Both of the study sites, the Assentamento do Engenho Diamante or Settlement of the Sugarcane Plantation Diamante, (Diamante) and the Assentamento do Engenho Ubu or Settlement of the Sugarcane Plantation Ubu, (Ubu), are areas previously occupied by large-scale sugar cane production. They are now home to families settled through the agrarian reform movement. The National Institute of Colonization and Agrarian Reform (INCRA) divided the large plantations into plots that were then inhabited by the families participating in the occupations. The groups of plots were then organized into communities of settled families.

Diamante was settled peacefully by submission of a petition to the government. Most of the families who organized to petition together had worked on the sugarcane plantation of Engenho Diamante. These families perceived an opportunity to gain access to some of the land they were working on and decided to present a petition to the local government and the agrarian reform agency. This petition was eventually accepted and the land was purchased from the original owner and surrendered to the group.

Ubu was obtained through an actual invasion. Several farmers from neighboring areas, both sugarcane plantations and other settlements, heard that there was going to be an invasion and decided to participate. The initial planning was secretive and the location of the invasion was not divulged until immediately before the invasion. After invading, they camped in various locations on the property over the course of nearly two years and were involved in repeated conflicts with the landowners and the military police.

Eventually, INCRA ceded the land after making arrangements with the owners who were in debt to various people.

Although the level of success and sustainability of both communities turned out to be different, they are, in many ways, typical of other areas settled through the reform movement. They share the same production methods, crop selection, environmental conditions, market access, and economic constraints with many other settlements throughout the state.

The main agricultural activity is production of staple food crops (subsistence crops) or "*lavoura branca*", such as cassava (*macaxeira, roça*) and yam (*inhame*) for sale and consumption. These crops have long cultivation periods ranging from six to eleven months (Agenda do Produtor Rural, 176). Small-scale production of food products for family consumption includes staples like beans and sweet potato, and fruits like avocado and mango. The family provides almost all of the agricultural labor.

Labor is not regularly mechanized because of the scarcity of available capital and the high price of tractor rental ($R 15 - $R 30, roughly $US 7.00 - $US 15.00 per hour). All values are reported in Brazilian Reais. At the time of this research, $US 1 = $R 2.

Site specifics

Assentamento do Engenho Ubu

Ubu consists of 178 families settled on a total area of 1,509 ha. Each farmer's plot is between seven and eight hectares in size. (For the purpose of calculations in this dissertation, an average of 7.5 ha was used.) There is partial electrification and irrigation. Buildings include: 2 churches, 1 school, 1 roadside commercial stand with approximately 40 stalls for selling produce, 1 meeting pavilion, and a communal area. Farmer's plots are less than 5 km from the major highway of BR101 where they can sell their produce at the stalls.

They are also 44 km from the major commercial center of Recife and 22km from Goiana, another commercial area.

The conversion from sugarcane to small family farms took place in 1995. Prior to that, sugarcane was continuously planted on the area. The Usina Santa Tereza and Usina São Jose, both active sugar cane plantations, border the settlement.

The soils are podzolic red/yellow latosols, and distrophic red /yellow latosols. In some places, hydromorphic podzols are found. (INCRA, 1995)

Assentamento do Engenho Diamante

Diamante was converted from sugarcane to small farms in 1992. Seventy-five families live there, each settled on plots of approximately 2.5ha. The total area is 165ha. There is 100% electrification, and nearly 40% irrigation (60 hectares). There is 1 church and 1 cassava processing building. Both a factory for dairy products and a pulp-processing area have been funded but not built yet. From the farmer's plots, it is greater than 4 km to the nearest commercial center of Goiana where their produce can be sold, and approximately 65 km to the major city markets of Recife.

The soil is comprised predominately of red-yellow podzols and latosols (INCRA, 1995) and has been in subsistence crop cultivation since 1992. Prior to that date, sugar cane was continuously planted on the same area.

Methodology

At both sites, Ubu and Diamante, eight farmers were selected to participate in the year - long study. Their involvement included participation in informal weekly field interviews and a final, more comprehensive oral survey. The information collected was based on questions about planting methods, crop productivity, marketing of produce, participation in development projects, and their access to capital.

The settlement leaders suggested the potential study participants. After a series of initial contacts, the leaders were asked to provide the names of four farmers who they believed to produce well and farm well and four who, for whatever reason, were not productive or did not farm well. This request was to eliminate the chance that the group leaders select only the best farmers to try to make their community look better than the other. In addition, neighbor's opinions were informally gathered in order to evaluate the suitability of the choices provided by the community leaders. The selection of effective and ineffective farmers was also in the interest of assembling a representative group that would reflect the variations in productivity and success within each community. The suggested participants were contacted and consent to participate solicited.

Each farmer was interviewed once a week over the course of a year. A component of the informal interviews were weekly field visits. This time was spent in a number of ways such as talking on the front porch, participating in activities like planting, or being led around the area to see new plantings or problem areas. In this way, information collected through interviews and surveys was substantiated by direct observation and through the building of trust between researcher and participant

Each crop or item found on the farm was counted and the number of farmers at each site with a particular item and the area allotted the item was calculated from analysis of survey responses and plot maps that were constructed**.** The cataloguing consisted of:

1. Identification of crops and animals, and quantification of items at each site
2. Calculation of area allotted each item
3. Explanation of why item and location were selected
4. Evaluation of productivity and marketing of each item

In addition, when appropriate, various issues were discussed with each farmer. These conversations happened on different days to accommodate the natural flow of an interview. For example, if one farmer was particularly talkative and had available time, several issues would be covered on the same day. In contrast, if on the same day, a farmer was extremely time limited, discussion was left for a more appropriate time.

The topics covered with the farmers included but were not limited to the following:

- Factors they believed were impeding their progress and financial security
- Their evaluation of financing and loan programs
- Their evaluation and perception of the quality of their lives before and after they participated in the reform process
- Their views on community leadership and extension services.

In addition to interviews and field visits, monthly meetings of the communities were attended. This was especially important because this was often the time when projects and loans were proposed and discussed by the funding agencies and by the farmers.

Chapter Progression

In chapter two, the history of the agrarian reform movement in Brazil and its current conflicts are discussed. Only with an understanding of the history of the movement and its socially motivated origins is it possible to begin to understand the current situation.

Three research chapters, all based on the work with the two communities of formerly landless farmers, follow the introductory chapter. These chapters investigate the cause of difficulties, both economic and environmental, at the reform settlements. The progression of the chapters also illustrates the development of ideas about the cause of difficulties over the course of the research.

The third chapter investigates the role of environmental parameters in forecasting and accounting for success and sustainability. The initial research phase was designed after combining information gleaned from conversations with development workers and farmers, and current literature. Many of these sources referred to the assumption that the settlements fail due to their situation on marginal land. This directed the initial focus of the study. Soil parameters were chosen as the environmental factor to investigate because of the attention they received both from farmers and extension agents. The relation between soil quality and individual and community performance is further investigated in this chapter. It also treats the conflicting opinions that in the conversion from sugar cane to subsistence cropping, the small farmers improve the environmental conditions and conversely, that this conversion greatly increases environmental degradation.

Soil parameters did not prove to be the sole source of the troubles. As a result, another likely cause of the difficulties was sought. The interviews by this time, were revealing a pattern of criticism about the economic situation. The frequency of complaints about economic hardships was greater than that of soil fertility or environmental concerns. This observation led to development of the second phase of the research, which is presented in Chapter four. This chapter looks at the economic viability and difficulty of the two study sites. The potential for small subsistence farmers to succeed in the market economy is explored while considering how funding initiatives influence land use decisions.

Once again, a particular research venue did not provide a complete explanation for the differences in success and sustainability that were becoming evident between the two communities. The economic chapter provides clear evidence that there are differences in the level of satisfaction of the farmers at each of the two settlements. One group, Diamante, had more positive evaluations of their land quality and overall situation.

The factors of soil quality and marketing explored had not accounted for the gap between the farmer's perceptions of land quality that were presented.

To direct the final phases of the work, similarities and differences between the two communities were considered. Two large differences between the communities are their respective average plot size, and their leadership. These two factors were investigated to gauge their contributions to the differences in the two areas. Chapter five considers the role of plot size as a factor in determining the viability of an individual's plot. The current conception is that farmers with large plots do better than farmers with small plots. This chapter explores the role of plot size and the advantages and disadvantages of large plots. It also serves as an example of how misinformation can lead to ineffective policy and addresses the need for experience-based knowledge of the reform movement. This means that the people that create the policies must have an informed understanding of life at the settlements.

Chapter six deals with the social parameters of community development. These include items such as cohesion of the community association, and the influence leadership has on community progress. This is an extremely important yet often overlooked aspect of community evaluation.

The conclusion offers some final insight into the situation and the future prospects of the reform movement and the settled farmers. Finally, suggestions for improvement of the reform process and policies are offered in consideration of the findings of this work. .

CHAPTER 2

AN INTRODUCTION TO BRAZILIAN AGRARIAN REFORM - PROBLEMS AND PROGRESS

Introduction

The agrarian reform movement has been called many things, from the panacea for the rural masses to the curse of hardworking farmers. Agrarian reform has spread across many Latin American countries with varying degrees of success. At times it has been a swift redistribution of land, involving the division of large land holdings (*latifundia*) for expropriation to poor peasant farmers. In other cases, it is much talked about, yet never comes to fruition. Brazil is an example of the latter type of reform. Historically, Brazil's agrarian reform has been used as a platform issue for elections more than as a vehicle for large-scale social change. Newspapers from the 1950's forward have headlines claiming things like, "This time, reform will really happen and it will be done correctly".

The focus of reform is still centered on political dimensions of the issue. Much of the current literature highlights politics rather than what is actually happening in the field (Veja, 2000) Whether administrations are pro-reform often receives more attention than discussions on how the settled farmers lives have changed or the quality of the reform program. The intense politicization of the issue is partially to blame for the fact that four decades later, there are still more than four million landless families waiting for land, and of those who have received land, many are disappointed with the results.

The peasants have grown tired of waiting for a piece of land and have taken matters into their own hands. Peasant-led invasions have been the impetus for a large number of the land expropriations taking place in Brazil. Whether or not effective reform policy is in place, reform is actively progressing, with or without governmental support as the landless take control of the movement. Reform in Pernambuco is currently a combination of government settlement projects and landless invasions.

A brief examination of the history, problems and progress of reform in the Northeastern state of Pernambuco, Brazil, specifically in the sugar cane producing region of the Zona da Mata, will be examined. The Zona da Mata (forest zone) runs parallel to the coast of Pernambuco, between the coastal zone and the sertão, extending up to 200 km inland.

A History of Marginalization

In 1531, the Portuguese landed on the Northeastern coast of Brazil, in what is today Pernambuco state. (USAID, 14) The Portuguese King divided the area (which covers parts of several Northeastern states), into 12 large plantations. Soon after, these plantations became centers of sugarcane production and concentrated wealth. These areas relied on slave labor and monopolization of land by the wealthy minority to ensure their success. Dom Joao IV's decision to concentrate land among an elite few created an imbalanced distribution, leaving the masses with little to no land. (Andrade, 43) The landed were generally wealthy settlers from Portugal, while the landless were immigrant laborers, indigenous populations, slaves, and the descendents of these groups.

The tradition of inequality still persists. Large properties blanket agricultural areas, especially in the Northeast. Small properties with less than 100ha cover only 20% of the total land area, but they constitute 90% of the landholdings (OAS, 2000).

In Pernambuco, unequal distribution of land is quite severe. Pereira, quotes an early letter from which stated, " The Brazilian northeast... is the largest concentration of mass poverty in the western hemisphere and is known for its hunger, misery, recurring droughts, and hugely inegalitarian agrarian system". (Pereira, 1997) Little has changed in the distributional equity since that letter was written. This has escalated the fervor of the landless in the region, evidenced by the higher than average incidence of invasions. In the 9-month period between January and October 1998, there were 161 landless invasions recognized by INCRA in the Northeast, compared to just 11 in the North and 56 in the South of Brazil (INCRA balanço 98/99).

A Slow Revolution

Agrarian reform policy has not been an area of active implementation. In the ongoing debate over how to solve the gross distributional inequality, numerous plans and policies have been approved but never put into action. From 1985 through 1998, only 505,539 families were settled through the government sponsored National Colonization and Agrarian Reform Institute, (INCRA) (INCRA, 1995). The current estimate for the total number of families settled is 618,000. There still remain an estimated 12 million landless peasants (4 million families) throughout Brazil (Petrarolha, 1997), many concentrated in the Northeast.

Brazilian sociologist Gilberto Freyre pointed out that, of the few reform initiatives that were actually enacted, most focused primarily on technical details, with little thought given to the effect on the people or their long term situation Plans that were implemented were often based on secondary motives such as supplying metropolitan areas with sufficient quantities of low cost food crops (Forman, 1975). At times, it appears that implementation is rarely motivated by the moral obligation of providing a more equal opportunity for economic progress.

Over the course of the sluggish reform process, aptly categorized as “minimalist reform” by Thiesenhusen, (1995, 162) much time was lost. In the interim, the population of the landless grew as the situation of wage laborers declined due to mechanization of sugar processing. As the landless grow frustrated with the rate of the government settlements, grassroots peasant movements have flourished. These groups provide organization and strong representation for the peasant farmers.

Building upon the premise of the Peasant League unions formed in Pernambuco in the 1950’s & 1960’s (Moraes, 1970), the landless have organized a grassroots movement to pursue land on their own. A United States Agency for International Development (USAID) report from 1970 naively expressed the idea that the reform movement would be “an initiative taken by the government, not by the peasantry…Mobilization of people is then, an after the fact (land acquisition) event.” (USAID, 39) Active pursuit of land is in the hands of the people in today’s movement, as they have tired of waiting for the “after the fact” call for equal economic opportunities and social justice.

The most visible of these grassroots movements is the Movimento dos Trabalhadores Sem Terra (MST), which came into existence in the early 1980’s and currently has 7,192 settlements and 200 invasions in the state of Pernambuco alone (www.MST.org.br). Many years of half hearted government action have kindled the explosive northeastern situation in which a large percentage of the population is landless and frustrated. The tension is quite high in regions such as the Zona da Mata, Pernambuco where there is a concentration of many landless workers, a high rate of seasonal unemployment, and large sugarcane plantations. In the Zona da Mata it is estimated that outside of the harvest season for sugarcane, over 49% (Simas, 88) of the population is unemployed for six months of the year.

A typical invasion by the peasant groups involves large numbers of farmers arriving en masse for a surprise occupation of a plantation or other large landholding. Organizational meetings are held prior to occupations but these are generally announced only to those planning to invade. The actual location of the invasion is sometimes not disclosed until right before they occupy the land. Other land occupations do not involve invasions and are carried out through a petition submitted to the local government and agrarian reform agencies. This method is less common among the grassroots groups but has proved successful.

Until the late nineties, with media and popular support behind them, the movement continued to grow and increase the number of mass invasions and settlements. With slogans like "Resist, Occupy and Produce", the landless began their own reform process. Some peasants are led by the MST or the Pastoral Land Commission (CPT), others by the simple conviction that they deserve a piece of what was unfairly claimed by the landed few. These mobilizations and invasions are having a real impact on land distribution patterns, especially in the Zona da Mata where new invasions are continuously underway.

The grassroots groups and the government have been fairly successful at initiating invasions and settlements. While this is true, the long-term success of the quickly built communities is questionable. Pro-reform propaganda (MST, CPT) claims that they are almost all better off than before, yet it was found, through direct observation and interviews with settled farmers, that this is not necessarily the case with many communities. This is especially evident after the critical point in time when bank funding slows for the community, usually about five to seven years after settlement.

Agrarian reform in Brazil has become an avenue to channel the nations poor and marginalized population away from the cities. Those who have nothing to lose have adopted

the struggle for a piece of land as their personal battle. Agrarian reform moved long ago from the hands of the politicians and into the realm of the popular. But as the loop is closing and the poor once channeled out to the country funnel back into the cities, the first signs that the reform process has gone awry are becoming evident. One example is the rural exodus.

Professor Eliseu Alves of the Empresa Brasiliera de Pesquisa Agropecuaria (EMBRAPA) warns of a population bomb to be dropped on the cities of Brazil as " more than 10 million people could leave the country and move to the cities" (Secco, 2000b) in response to their inability to support their families in the country.

Reforming Reform

The rural exodus and the conditions at some of the settlements have suggested that reform needs to be reevaluated. A logical starting place is with the government and the government's role in promoting effective reform so far. While many of the statements on agrarian reform by the government create an image of prosperity and progress for all settled farmers, the reality is often another.

The government's attitude towards reform has not been one of focused dedication to the completion of the agrarian reform process. Throughout the history of reform, the Brazilian government has offered conflicting views, alternating between supporting the movement and condemning them. For example, while the budget for reform programs was increased by several million dollars, the week before this decision, the president Fernando Henrique Cardoso irreverently addressed the slaying of a landless protester. He warned, "The death of the worker should serve as an alert to those who disrespect democracy (implying the landless who invade plantations)." (Oinegue, 2000)

At the heart of the conflict is that the government is attempting to promote a reform program that directly challenges the social structure of their country, while at the same time protecting the interests of large landholders. The distribution of land and wealth in Brazil favors the extremes. There are a small number of people who are extremely wealthy, while the largest percentage of the population is very poor with very little access to land or property. By supporting agrarian reform, the government is supporting to some extent, a reconfiguration of the current distribution that favors the rich minority.

The conflict was clearly seen when President Cardoso, who publicly supports agrarian reform and acknowledges the importance of providing land for the peasants, called in the national military to protect his own personal farm when landless squatters tried to invade it. Cardoso stated, " This threat is not only a threat against private property, but also a threat against the symbol of authority of the Brazilian people." (Reuters, 1999)

The government's role has become that of financier after the landless invade productive and unproductive farms, and demand parcels of land. The landless enter into conflict with the landowners and set in motion the eventual petition for rights to the land. If this land is not for sale or not appropriate for seizure, INCRA will often arrange for the purchase of a similarly sized property nearby. The government responds to increasingly aggressive actions on the part of the landless even though they repeatedly threaten to cease support when violence is used. Action is taken when pressure nears the point of explosion. The national coordinator of the Movement for Landless workers (MST) Lucìdio Ravanello agreed, " Unfortunately, in this country, agrarian reform only advances with mobilization [by the peasants] and pressure." (Jornal do Commercio, 1999). Eleven thousand landless descending on the capitol to demand reform offered a show of solidarity, confirming that

reform will be strongly pursued by the peasants if not by the government. (www.mstbrazil.org/manifesto.html).

The real issue now is whether or not the government reform movement and the peasant led agrarian reform movement have been done correctly. Sorely needed is an evaluation of the current potential to provide a higher standard of living with economic sustainability for those settled, and environmental sustainability for the regions modified through the reform process. Unbiased, comprehensive evaluations of the reform movement so far and an analysis of the regional effects (economic and ecological) of the settelments, are lacking.

Statistics from a national (Brazilian) survey of settled farmers point to a system that is not empowering but entrapping families in a continuous cycle of reform and poverty. It was estimated that of the families settled, 40% report that they are able to generate just what is necessary for subsistence.(Secco, 2000a)

Brazil does not need a simple land reform that consists solely of division of large areas into small parcels for peasant families. At times, the farmer's focus on land distribution obscures what the rules mandate and what common sense dictates. In the Land Statute, it clearly spells out that the goal of reform is to provide not only agricultural development, but also economic and social development for the settled families.

This multifaceted development rarely occurs. Many of the settlements crumble as farmers leave or "surrender" (sell) their parcels in response to lack of technical assistance, growing debt, shrinking capital and complete vulnerability to climatic pressures. Graziano, one time head of INCRA, concurs, " The economic unviability of the new settlements means one of every four settled families sells off their land at the first chance they get." In the push for reform, both sides pay insufficient attention to details that later become the impetus for the exodus**.**

A Stability Tradeoff

The sugar zone of Pernambuco has long been a region where social tensions grow as the haves and the have-nothings live side by side. To avoid catastrophe, both the government and the people sporadically relieve pressure through makeshift arrangements. This approach never addresses the fundamental problem deeply rooted in the Brazilian social structure, which is the uneven distribution of wealth and land. A properly carried out agrarian reform could challenge the very social structure of Brazil that has been preserved since colonization.

These temporary solutions may release some of the tension, but they also become a more threatening prospect for the sustainability of the area every year. Where there should be comprehensive planning, there is dysfunctional application of stop - gap measures, offering little foundation for the future of the region.

The pattern of land distribution dominated by sugarcane plantations and large properties has never, at any time, offered a socially viable solution for the Zona da Mata region in Pernambuco and other sugar areas along the northeastern coast of Brazil. While it was unfair, the system of large landholdings for the rich and little for the poor was quite long-lived and stable. There is great risk involved in transforming an unjust yet stable system into a more “equal” yet considerably more unstable land use.

Although subject to the highs and lows of the internal and external sugar market, the sugar empire has been economically stable enough to keep the money and power concentrated in the hands of the few. While several large sugar plants are folding and consolidating, (Diario de Pernambuco, 2000) this has not changed the fact that the majority of the land and money is controlled by a small percentage of the population.

Small farms have not experienced the same longevity. Brazilian Institute for Geography and Statistics (IBGE) data report that nearly one million farms were dissolved between 1985

and 1996, and 96 percent of them were smaller than one hundred hectares (www.ibge.gov.br). Agriculturally, the sugarcane system has perpetuated itself through cheap labor that makes planting in a more beneficial (self-perpetuating) way possible. Because much of the labor is done manually, the cane fields are always planted on a contour. Men can plant in ways that tractors cannot on the inclined land, thereby preserving valuable soil resources. It appears that this fact combined with the plantation owner's ability to provide soil amendments such as fertilizer has contributed to the stability of the system.

Socially and politically, the unified front of the rich with government bureaucrats has contributed to the stability of the *latifundia* (large landholding) system. For a long time, these connections were much stronger than the peasant organizations. For almost five hundred years, little wide-scale, organized resistance has occurred. There were many smaller insurgencies, such as the *quilombos* - runaway slave communities, but not until recently had any organized movement posed a palpable threat to the rich minority.

The landless have turned the tide by challenging the system. Their ability to do so is limited though, by their immediate needs that have to be met. The demand for land is so strong that the landless frequently settle for less than what would be ideal for effective reform. They often accept areas that are not conducive to agricultural success.

These include areas that lack some of the following: access to water, infrastructure, roads, schools, markets and medical care. There is also no promise on the part of the settling agency to remedy the situation. What one family would not take, another landless family very likely would so there is little leverage in the terms of settlement negotiation process. In addition, many are eager to escape the precarious conditions they live in during the fight for land that includes constant danger and frequent hunger and discomfort.

These are issues that only come up later when they begin to influence their quality of life and income. By this time, INCRA has usually offered title to the land, declaring the communities self-sufficient and no longer their sole responsibility.

Danger of an Inefficient Reform

The creation of vast numbers of settlements has generated very real regional and micro-regional effects. Implementation that ignores sustainability could ultimately create more environmental damage and a lower standard of living for the once landless farmers. Sustainability should be a prime concern for all of these endeavors. With over four million families waiting for land, there is little leeway for the unsound farming methods and ineffective policies proliferating at the sites.

The results of this study and several others (Mutume, 2001) suggest that the reform process is falling short of one of its primary goals - providing the means for settled farmers to achieve a higher standard of living for themselves and their children. This is one of the primary dangers of an inefficient reform. Others include: greater social unrest; an increased localized environmental degradation; a cyclical nature of reform; dissatisfied farmers fleeing the fields for the cities; and alteration of the local market economy due to the abundance of subsistence crops supplied by the growing number of settlements. Each of these items is discussed in more detail in the section that follows.

Lower standard of living for already settled families.

Although many perceive the struggle for the expropriation of land as the greatest hurdle, the hardships for the settled families are not over. Financial situations often worsen in the post-settlement phase. The average family struggles to make over $60US per month Financially burdened, many of the farmers find themselves living at nearly the same economic level as when they cut cane in the fields or lived in the overcrowded, poor

neighborhoods of the cities. An extension worker at one of my sites shook his head in dismay as he said, "Sometimes, I fear that what we are doing is creating the rural *favelas* (slums)." Rural favelization is a phrase coined by the president of INCRA. There is no denying that the people who have been offered a piece of land have not been guaranteed a better life.

The limited capital the settled families have make it difficult for them to increase or update the methods of production they use. Labor comes from the family, often including the children. What little cash the families generate is used to pay the bank or to buy necessities like food and medicine.

Increased localized degradation of environment and resources.

In many ways, settlements have the potential to either improve or degrade the local environment. Unfortunately, due to economic pressures and labor constraints, it appears that degradation is frequent. This occurs in many ways, including destruction of natural areas, mining of soil nutrients, sale of wildlife, and poor soil management (such as erosion or compaction).

The nature of the land conversion and the change in management following conversion can be environmentally detrimental. One example of management effects is the difference in the amount of land set aside for forest growth between settlers and the plantation owners. The settlers farm their entire areas because their plots are usually not large enough to afford selection of only prime planting areas. This is not the case with sugarcane plantations that frequently have many hectares of areas less suitable for cane growth due to their incline or nature of the soil. These areas are often left forested while the more suitable areas are planted in cane. Once the land is expropriated for small farmer use though, a greater percentage of the land is used, and many of the forested areas are eliminated. In the very

earliest days of reform, some settlements were sited within areas of primary forest. In one case, the cane plantation owners did not want to surrender all of their land and so made a deal to hand over a large area of primary Atlantic forest. The settlers were given the land and cleared the entire area

In addition, the guidelines for protection of natural areas within a settlement are not always complied with. One example is the mangrove bordering one of the study areas. With increased planting of subsistence crops like yam, which requires a stake, there was accelerated harvesting of trees from mangrove area. This destroyed vital habitat for many crab and small fish species.

Soils are prone to erosion in some settlements. In the sugar cane areas, the soil is held firmly by a dense planting and thick root system. In contrast, on the farmer's plots, areas are frequently left bare until they can be planted or until seeds can be purchased for planting.

In other instances wildlife sales, specifically birds, have been used to supplement a low agricultural income. In this case, the environment carried the burden of a poorly structured reform process.

Cyclical nature of reform

A partially successful reform will not cause a substantial rise in standard of living for settled families. A significant rise in the quality of life would include the economic ability to procure health care and education. It would also include the possession of skills that allow for both agricultural and non-agricultural employment.

This is often not the case at the settlements. As a result, the children of the farmers continue to be susceptible to the same ills that their parents suffer. These include little formal education, high illiteracy rates, poor health, and few opportunities for work that does not involve manual labor with a hoe. A result of these conditions is a cyclical reform that is

perpetuated by the children of settled farmers who have few options as they mature but to join the movement for their own piece of land.

As the children of settled families come of age, they will be encouraged to participate in new invasions in other locations. The question then becomes, where will it stop? This is already a regular occurrence among many of the settled farmers. Many expect that their children will someday leave to fight for their own piece of land.

The lack of matching between family size and plot size also created a difficult situation. For example, a farmer at one of the sites has two small boys and 8 ha of land. In contrast, another farmer has 2.5 ha and 10 children, four of them young-adult males. If there was more of an effort to match a family with a suitable plot, there is a possibility that the children could farm on the parent's plot when they mature. This proposition is more considerate of differences in families, but it could also have the unwanted effect of encouraging families to have many children that would place a greater burden on their already limited resources. The degree to which the situation could be made better or worse is also ultimately limited by the finite amount of land each family has.

Exodus to the cities - > more crime and violence

The pressure between the landless and the rich has culminated in a variety of negative responses, the first being a great exodus of rural poor to the cities. This situation was already visible in the 1960 's when Gilberto Freyre called Recife a "swollen city", full of people and lacking sufficient infrastructure or employment for them. It is estimated that during a four-year period (1995 - 1999), over four million people migrated out of rural areas (www.mst.br.org). The latest Organization of American States document on human rights in Brazil estimated that 66% of Brazil's rural population is below the poverty line while 38% of the urban poor fall below the poverty level. The number of urban poor is growing though,

due to the migration of the rural poor into the cities (OAS, 1997). The conditions in the cities are worsening with increasing unemployment, homelessness, violence, and crime.

Violence between the peasants and landowners is also frequent and regularly overlooked by the authorities. In less than three years, between 1995 to Nov. 1998, 151 rural workers were assassinated, many due to conflict with landowners (INCRA, 1995). International attention to the situation has increased since several conflicts received global attention. Both the Organization of American States and Amnesty International have cited the violence between the landless and the landowners in their human rights watches.

Flooding of local markets with subsistence crops

A very common occurrence in the settlements that do not provide sufficient marketing infrastructure or strong community cohesiveness is the concentration of land and resources in subsistence crop production. These crops include yam, cassava and sweet potato. With the increase in the number of settlements, regions heavily populated by invasions and reform communities quickly become flooded with subsistence crops. This results in declining profits for the farmers. In response to dropping prices, many of the farmers increase the amount they plant of the same item for the following year in an attempt to break even. This behavior contributes to the future flooding of the market and an increase in the degradation and nutrient depletion of their plots. Limited economic resources in the early stages often lead the settlers on the downward spiral to monoculture production of subsistence crops. Farmers opt for the proven producers, cassava or yams, partly because they have limited inputs such as labor, money and fertilizer. The Agrarian Reform process is creating a new regional monoculture. Where sugarcane once spanned miles of continuous fields, now there is a similar expanse of cassava and yam, broken only by the farmer tending each small plot with his hoe.

What eventually happens is that the farmers earn just enough income to be able to plant their next crop. Often they use seeds from the previous harvest. Sometimes an additional amount is purchased as well to increase the planted area. The economic situation combined with the planting demographics suggests that they will not be able to plant anything aside from the staple food crops without reliance on bank money or outside loans. The low income they receive from sale of their crops makes it nearly impossible for them to upgrade their production systems. For example, they cannot add irrigation or purchase equipment that would allow them to process their harvest. These types of changes to their production could make the farmers less dependent upon the middlemen buyers who name the price depending on the quantity of product in the market and the amount of time the farmer can store his crop without it perishing.

Many farmers maintain their status at the poverty level but have added the new dimension of being in debt. This can be partly attributed to the consistent funding incentives for the planting of staple food crops. Among the farmers at two settlements, most said that while they were happier, they were slightly worse off financially than when they were landless. This situation once again defies the hope that agrarian reform should provide both agricultural and economic development, as stated in the Land Statute.

There is a distinct difference between agrarian reform and land reform. Land reform encompasses the act of issuing a piece of land, usually in small parcels for family farms. Some claim agrarian reform should follow the same model, beginning and ending with issuance of land to a previously landless farmer. The more optimistic view is that it will also include development of markets, price security for farmer's products, creation of infrastructure, ample technical support, innovative planting strategies and communal projects for the settlements.

Ideally, the reform movement would create agricultural communities capable of producing food products, providing a higher standard of living for its members, and a means of agricultural, environmental and economic sustainability. All of these goals were outlined in the initial proposal for agrarian reform (1964), when Brazil was still under the control of a military dictatorship. These goals still elude government reform agents and settled farmers alike. Perhaps a more realistic goal is for agrarian reform to ameliorate the extreme poverty of the rural laborers by offering an area in which to grow food and earn some money without working in oppressive conditions.

Conclusion

While agrarian reform will not cure all of the ills of a system that is socially unviable, it can address the symptoms. One symptom is the disadvantage the poor have as part of a system controlled by a rich minority. Agrarian reform will not automatically ensure financial equality, but it will allow the landless the opportunity to change their current situation for themselves.

There is an inherent danger in setting in motion the wheels of social change without fully embracing the potential consequences. The effects of a half-hearted attempt can be seen in the negative outcomes of the reform movement that were discussed, including more land degradation and weakening local markets. The contradictory approach of the government has not explored the potential of agrarian reform. This could be because of the ongoing conflict of interests. It may not be in the government's interest to fully promote agrarian reform because of the possibility of a more equitable distribution of wealth and opportunity among the entire population, especially the rural sector.

.

CHAPTER 3

SOIL PARAMETERS & THEIR FUNCTION IN PREDICTING THE SUCCESS AND SUSTAINABILITY OF AN AREA

Introduction

Soil quality has played an important role in the Brazilian agrarian reform debate. Poor soil has been labeled both the cause and the effect of unsuccessful agrarian reform. Invasions and new settlements are multiplying, especially in the Northeast of Brazil. The rapid spread of reform settlements has raised concerns about the cumulative effect on soil resources. A precise definition of what these effects are though has been tainted by the polemics of the issue, motivated by equally strong pro and anti-reform sentiments.

In this chapter, the ability of soil parameters to reflect the environmental effect of the communities and to predict a community's performance is explored. Evidence of either improvement or degradation of the soil was looked for within the soil data collected from the reform settlements and bordering sugar cane plantations. In addition, the existence of a correlation between soil quality and farmer and community performance was examined.

The soil parameters investigated were total carbon and total nitrogen, C/N ratio, pH, infiltration rate and aggregate stability. These tests were used to evaluate the effect of conversion from sugar cane production to small-scale farming at Ubu and Diamante, two agrarian reform settlements in the sugar-producing region of Pernambuco.

The soil data was compared with information gathered in interviews and surveys of the study groups to check for a consistent representation of the prosperity and/or sustainability

of the area. This was to evaluate how closely environmental indicators are correlated with environmental, economic and social conditions.

Soil quality as an Indicator

It is unlikely that a single factor such as soil quality will be representative of overall community sustainability. Repeatedly though, analyses of reform communities are based on one factor, from which all other parameters are extrapolated. In cursory studies of reform communities, the lack of comprehensive data encourages the creation of myths about the movement and its effect on the environment.

One of the most persistent myths is that agrarian reform fails because reform communities are situated on marginal lands with low quality soils. If this were the case, then performance of farmers with better soils should surpass that of farmers with weak soils. Likewise, communities situated on poor soils should be less prosperous than those on more productive soils. This simplistic explanation overlooks the fact that prior to land conversion, the very same soils (frequently classified as poor) supported the growth of the sugar industry and its wealth. The enormous plantation houses built during the height of the sugar production attest to the wealth that was generated on the “poor” soils of the sugar zone.

Another prevalent myth is that agrarian reform communities harm the environment. Reform settlements are often blamed for environmental degradation because the farmers are limited by time and motivated by economic pressures. This can cause them to make choices that are inconsistent with the long-term sustainability of their sites. As one farmer in the study reported, "I don’t have five years to wait for the higher yields they promise, even if it is better for the soil. My kids are hungry today." Their bottom line is survival of their family today, often at the cost of ensuring environmental quality tomorrow.

Alternately, reform communities are at times said to improve the environmental quality of the area. The farmer's limited access to fertilizers and mechanized planting, and the use of "traditional" agricultural methods, often gets them categorized as environmentally friendly.

Objectives

To summarize, comparison of the soil parameters with data gathered through interviews and surveys with the reform communities of Ubu and Diamante, will further clarify the following issues:

1. Whether agrarian reform communities contribute to environmental degradation or act as environmental stewards, as evidenced through the soil parameters
2. Whether differences in the community's success and sustainability can be credited to differences in the quality of their land
3. Whether there is a correlation between the quality of the farmer's land and their perception of the quality of the land, or if other factors contribute more to the evaluations of land quality.

Methodology

Paired C / N samples in sugar cane and crop

Paired samples were taken to establish what changes occurred between cultivated areas and the cane areas in total carbon and total nitrogen when land is converted from sugarcane production to agrarian reform settlements. Several areas were identified for paired soil core samples at each of the communities. The sampling sites were areas of small farmer cultivation bordered by active sugar cane plantations. The cane sections have been in constant cultivation for more than 30 years. Since the settlements were created within the area of the large cane plantations, the cane and the crop (prior to conversion) share the same

cultivation and treatment history. In each sampling area, soil cores were taken 5 meters apart along lines parallel to the border between the sugar cane and the area of cultivation. The paired samples were taken along this line, one sample in the sugar cane and the other on the farmer's plot, with a distance of 10 m between the two samplings. The samples were taken using a steel soil corer, 5 cm. in diameter. Fifty paired samples were taken at Ubu and fifty at Diamante, totaling 200 samples - 100 in the sugarcane and 100 on the farmer's plots.

Each core was divided into two sections, the upper 0 - 5 cm, and the lower 5 - 20 cm. Each section was placed into a labeled plastic bag and left open and undisturbed to air-dry. Drying was completed in approximately 24 - 48 hours. The samples were then transported to the Stable Isotope/Soil Biology Laboratory of the University of Georgia Institute of Ecology. There, each sample was ball-milled for two minutes by placing the soil in a steel cup with two steel balls that was then processed with a Mixer/Mill (SPEX 8000 CertiPrep, Metuchen, N.J). Ground samples were dried in a 60^{o}C oven for 24 hours. Samples of 25 mg to 30 mg were weighed and encapsulated in 5 x 5 mm tin capsules before combustion.

These samples were then analyzed for total carbon and total nitrogen content using the Carlo Erba NA 1500 CHN Combustion Analyzer. The percentage of total nitrogen and total carbon in each sample was calculated, as was the C/N ratio.

To generate average C/N ratios per sample using values for the upper 0-5cm and the lower 5 - 20cm, the following equation was used.

$$((\text{Value } 0 - 5\text{cm}) + (\text{Value } 5 - 20\text{cm} \times 3)) / 4$$

This formula was used to account for the different amount of material involved in each sample section. The bottom sample spans three times more soil than the top 5cm.

pH

The paired samples were analyzed for pH. First, 10ml of soil was mixed with 10ml of de-ionized water for 20 seconds. After 20 minutes, a reading was taken with a Corning 220 pH meter.

Aggregate Stability

Angers and Mehuys define aggregate stability as the resistance of the bonds within the aggregates to external forces of impact, shearing, abrasion, or disruption arising from the escape of entrapped compressed air (Angers & Mehuys, 1993).

Aggregate stability analysis was used to determine what effect the change from sugar cane to small subsistence cropping has had on the stability of the soil structure and soil aggregates. The presence and stability of macro-aggregates can reflect the management practices of a particular soil. Essentially, the more stable, large aggregates in a soil, the more resistant the soil would be to forces in the field, like erosion and compaction. Raine claims that, " Soil aggregate instability and dispersion is the single most important process leading to problems associated with soil erosion, structural decline, and land degradation." (Raine, S.R., 1998) Large aggregates allow for more efficient water and root penetration, and provide macro-pore space where beneficial soil organisms reside. In general, the presence of many, large, stable aggregates signal conditions beneficial for productivity and soil health. Macro-aggregate abundance and stability reflect levels of organic matter and management practices of a soil. Micro-aggregates do not reflect these conditions and were held to be unaffected by management practices or the amount of organic material present (Tisdall and Oades, 1982).

Unfortunately, during the period of sample collection, several violent incidents occurred in and around the sugarcane plantations near the study area. Tensions in the region were

increasing as conflicts between plantation owners and landless increased in number. Sugarcane areas were patrolled for trespassers and squatters. As sampling in the sugarcane involved entering plantation properties - areas that were patrolled by armed men on horseback, the collection of a complete set of samples in the cane was not possible. This resulted in an incomplete data set from the sugarcane for aggregate stability analysis. The cane samples used for carbon and nitrogen analysis were not of sufficient quantity or quality to be used for the aggregate stability analysis as well.

Dry Sieving

Dry aggregate stability analysis was performed to see what size fractions the soils separated into when a force was applied, in this case, manual oscillation of the sample. The subsequent division of the total soil sample into size fractions gives an idea of what percentage of the soil aggregates are stable at a given size fraction. Essentially, the smaller the aggregate, the greater the force required to break it. Angers and Mehuys state, " More information is obtained… when the whole soil fraction is considered. For example, management effects such as tillage, cropping, or addition of organic amendments, are often detected only in a specific size fraction (Angers& Mehuys, 656)." By applying a disruptive force, in this case by agitating the sample, the unstable aggregates break into smaller sized aggregates and pass through one or more sieves. Stable aggregates of a particular size remain intact above one of the sieves.

Three soil samples were taken from each of the sixteen farmer's plots for use in the dry aggregate stability analysis. The samples were taken to a depth of 10 cm with a steel trowel. The samples were then air-dried in plastic bags. Great care was taken not to break the soil aggregates, especially the larger ones, during transport of the samples.

The samples were processed using the Keck SS Sand Shaker. This is a sieve kit that provides grain size analysis through separation of different sized aggregates or particles as they pass through or are retained by sieves with varying opening sizes. The apparatus consists of five acrylic cylinders, each fitted with interchangeable stainless steel sieves. The screens selected for the sieve set were: 1.30mm, .66mm, .51mm, and .147 mm. openings. The sieve set was shaken vertically 200 times after placing 100 ml of sample in the apparatus. After agitation, the amount of material remaining above each individual sieve was bagged and weighed.

The number of agitations was established through preliminary tests to evaluate an appropriate range for the number of times the sample was shaken. With less than 200 repetitions, the aggregates remained large and almost completely intact. Significantly more than 200 and most visible aggregates were destroyed.

Wet Sieving

Wet sieving was performed to evaluate the percentage of the soil aggregates that resist an applied force, in this case, water. It has been suggested that wet sieving reflects a soil's behavior under field conditions. While the applied force may be different than those encountered under real field conditions, the fact that the same force was applied to all samples allows for a comparison of their relative stability. Kemper and Rosenau (1986), point out that, "the ability of aggregates to resist breakdown by continuing or increasing disruptive forces is often an important factor in the phenomenon being studied." - in this case, the change in soil structure resulting from the two different cultivation schemes. Wet sieving could more closely mimic field stresses than dry sieving.

The procedures for wet sieving were derived from the USDA Soil Quality Test Kit Guide (USDA, 69). To wet sieve, approximately 60ml of soil was passed through a 2mm sieve.

What did not fall through was gently pressed through the sieve. PVC pipe joints were fitted with .25mm mesh sieves and weighed before the next step. The sieve size of .25mm was chosen because it would retain the coarse (1 - .5mm) and medium (.5 - .25mm) sand fractions. Ten grams of air-dried soil was placed into the pipe and sieve container. This was then weighed along with the sieve and the exact weight noted. The sieves were then placed on top of a paper towel type material that had been soaked in de-ionized water and left to slowly absorb water for five minutes.

Following this, the sieves were placed in a tub of de-ionized water, which was approximately the same temperature as the soil. The sieves were shaken vertically ninety times for ninety seconds, taking care to immerse the soil yet not allowing it to float out into the water. Following this, the samples were air dried for 36 hours and oven dried for 6 more hours (at 60^0C). The sieves and the soil were then weighed. In the final step, the sieves were placed into the tubs containing a mixture of tap water and Calgon (brand) water softener. The Calgon serves as a dispersal agent, effectively breaking all of the water stable aggregates. The seives were shaken vertically several times and then left to sit in the solution for five minutes. To remove all but the sand from the sieve, water was run slowly over the sample. Anything left above the sieve was sand, as the Calgon had dispersed all of the aggregates and all but the sand particles passed through the .25mm sieve size. These samples were oven dried for six hours and then weighed again. To calculate the water stable aggregates, the following formula was used:

Water stable aggregates (% of soil >. 25mm) =

(Weight of dry aggregates - sand)/(weight of dry soil - sand)

Infiltration

Infiltration rate can provide information about a soil's structure, aggregation, and absorptive ability. Poor soil management is generally reflected by a lower infiltration rate (USDA, 55). Water that is not absorbed by a soil runs off, increasing erosion and decreasing the amount of available water for crops. Infiltration is rapid when the soil is composed of large, continuous pores.

To evaluate infiltration rate in the soils, both the cane areas and the cultivated areas were sampled. The tests were performed in approximately the same location the samples for the total C and total N analysis were taken. To find the infiltration rate, a single ring, 15.24 cm in diameter was sunk into the soil. Large surface debris was moved before performing the test. Into this ring, 118 ml of water was poured. The time it took for the water to infiltrate the soil was recorded for each sample. The timer was stopped once there was no water visible above the soil.

All of the samples were taken on dry days during a period of little rainfall. They were taken under the same weather conditions so existing soil moisture would not affect results.

Perception of Land Quality

As part of a comprehensive oral survey, each farmer was asked to evaluate the quality of their land when they received it as newly settled farmers. The categories provided were Good, Reasonable, or Weak. A follow up question asked them to evaluate the quality of their land now, using the same criteria.

Good, Reasonable, and Weak, were selected as categories based on terminology used by the farmers when speaking about their land. Their perceptions of the quality of their land include such factors as soil fertility (sometimes called strength), productivity, ability to plant

a number of different crops, and ability to retain some of the scarce water resources as soil moisture.

Results and Discussion

Paired C/N samples in sugar cane and crop

The paired samples were analyzed for total carbon and total nitrogen. The C/N values varied from a low of 5 to a high of 26 (Table A1).

For the top five centimeters, Diamante samples showed a statistically significant difference between the cane and crops for C/N ratio, and total N with alpha values of .0046 and <. 0001, respectively (Figure 3.1). The C/N values for cane were greater than crop at Diamante (Figure 3.2). The inverse was true at Ubu where the crop C/N values were greater. The total C values were not significantly different between the cane and the crop with α = .0892 (Table A1). . In this segment, Ubu had a significantly different amount of total N between the cane and crop (α=. 004) and C/N ratio (α=. 0021), but not a significantly different total C (α=. 4496). This could indicate that the amount of organic material has not changed significantly at either site since the land conversion. It was expected that there would be a significant difference in the C/N ratios as sugarcane is a C_4, plant and has a higher rate of photosynthesis in the high temperature and light conditions of the area. It was expected that both sites would show a same directional trend but to varying degrees.

Diamante showed no significant difference between the cane and crop for the total C (α = .8977) or total N (α= .0661) between cane and crop for the 5 - 20 cm samples (Figure 3.3). The values for C/N of the cane were greater than crop at Diamante. (Figure 3.1) Overall though, there was a significant difference between the cane and crop for the C/N ratio (α=. 0243). Ubu showed no significance for the total N (α=. 1598), total C (α= .2986).

There was a significant difference between the cane and the crop for the C/N ratio (α= .0146) from 5 - 20cm(Figure 3.3).

The averaged samples (0 - 20cm, see formula above) for Diamante were very significantly different for all three parameters, total C, total N and C/N (α= <. 0001 for all). Likewise at Ubu, all three parameters were very different for the averaged samples. Ubu had slightly higher α values than Diamante with total C α = <. 0001, total N α = .0012 and C/N α = .0063.

For the averaged samples (0 - 20cm), the C/N ratios were higher at Diamante for the sugarcane than for the crops (Figure 3.1). For Ubu, the opposite was true where the C/N ratio values were greater for the farmer's plots, than the cane (Figure 3.4). The majority of samples for Ubu were clustered between 14 -16. At Diamante, the difference for the averaged samples covered a wider range, with most distributed between 11-18.

While the results for both sites showed that there was a significant difference in the overall C/N ratios for the averaged samples, the fact that the results are inversed at the two sites makes it unreasonable to state that it is clear that the farmers have either improved or degraded the sites (Figure3.7).

pH

The soils range from moderately acidic to slightly alkaline. In general, the high number of samples that had values between 6 and 7.5 (Table A1) indicate conditions that should be favorable for plant growth. The pH values ranged from a low of 5.11 to a high of 8.35. Most of the values were between 5.5 and 7 at Ubu .

For the paired values at Ubu, the cane sample almost always had a slightly higher pH value than the crop (Figure A1-A3). This is the inverse of the situation at Diamante, where

the cane has the consistently lower pH value of the pair. At Diamante, the majority of the sample's pH values fall between 5.25 and 6.75 (Figure A4-A6).

In 60 - 80% of the cases, the pH value was higher for the top 0 - 5cm of the sample When considering the average of each sample's top five and bottom 15 centimeters, Diamante crop and Ubu cane come in with the highest values. Ubu crop and Diamante cane share similar values.

In the 0-5cm samples and the 5 - 20cm samples and the averaged samples (0-20cm) for Ubu and Diamante, there is a significant difference between cane and crop pH values. All have $\alpha <$. 0001, except for the averaged Diamante samples which are $\alpha =$. 0002.

The pH of the average cane samples and average crop samples were compared for the two settlements. Between Ubu and Diamante cane pH values, there was a significant difference ($\alpha <$. 0001) (Figure 3.8). Between Ubu and Diamante crop pH values, there was not a significant difference ($\alpha =$. 1566). This could suggest that the differences in management styles between the two communities are reflected in the pH. It could also reflect the different soil type's response to the change in crop selection.

There does not appear to be a substantial enough difference between the pH values at the communities and the sugarcane to make any generalizations about the effect of the conversion on soil pH. Most of the values still fall within a range that is acceptable for crop production. At Ubu, the effect seems to have been a slight decline in the pH of the soil. Increased acidity could be due to a decrease in the amount of organic material being incorporated into the soil as litter. This, combined with the inherently sandier nature of Ubu's soils, could make the converted soils more prone to leaching.

At Diamante, the soils converted to small-scale agriculture have slightly increased their pH levels.

Infiltration

The average infiltration rate for Diamante was 115.92 ml/second for cane and 49.42 ml/second for the crops (Table A2). At Ubu, these values were 38.23 ml/second for cane and 39.38 ml/second (crop). Based on the USDA's Soil Quality Test Kit Guide infiltration rate classes, Ubu's crop and cane soils had similar distributions of infiltration rate classifications. Nine cane and nine crop samples were classified as having very rapid infiltration rates at Ubu (< 3 minutes/444ml). Four cane and four Ubu crop samples were classified with rapid infiltration rates (3 to 10 minutes per 444ml). These differences were not significant (Figure 3.9).

At Diamante, the cane samples were more spread out, with four very rapid classifications, five rapid, and three moderately rapid (10 to 30 minutes per 444ml). In contrast, the Diamante crop had eight very rapid classifications and four rapid.

The average infiltration rate at Diamante between cane and crop varies greatly, while the average values of cane and crop infiltration rates at Ubu are very similar. The greater difference between the samples at Diamante compared to those at Ubu could be due to the greater time period since the conversion. Ubu was converted in 1995, Diamante in 1992. It could also be due to the textural differences in the two sites. Ubu has considerably more sand and therefore may not reflect as fully the effects of the change in management practices.

Aggregate Stability

Dry Aggregate Stability

The results of all three of the samples for each farmer were averaged to generate one average size class distribution figure for each site (Table 3.1). For both Ubu and Diamante, the largest percentage of the sample's weight sifted into the > .147mm compartment of the

sieve shaker set. At Diamante, this comprised 30.55% of the weight of the sample, (Figure 3.10) and at Ubu, 24.05%. (Figure 3.11)

The values obtained suggest that the largest aggregates are the least stable as they represent the smallest percentage of the samples. This follows the pattern for normal aggregate behavior. The next size sieve (.51mm), presents a peak at both sites, suggesting that these aggregates are more stable than the smaller class (.66mm) that follows with lower values.

From that point on, there is an increase in the percentage found in each class, suggesting that the force applied was not sufficient to break them and send them through to the next level.

Wet Aggregate Stability

The percentage of water stable aggregates was greater at Ubu than at Diamante. The lowest percentage was found at Diamante, where one sample contained only 40% water stable aggregates (Figure 3.12). This could be due to the fact that overall, Ubu had a greater C/N ratio than Diamante did and a greater amount of Carbon, which is partly responsible for the strengthening of the bonds that hold the aggregates together.

There seems to be much greater variation in the wet aggregate stability distribution between Ubu and Diamante than the dry. This could be due to the higher clay content at Diamante that more clearly reflects the effects of management.

Perception of Land Quality

Farmer's initial perceptions were divided between Reasonable and Good evaluations at both sites. No one at either of the sites initially evaluated the land they received through the reform process as Weak. (Figure 3.13, 3.14) These perceptions have changed significantly in the six to eight years between settlement and the time of the survey. At Ubu, the number of farmers classifying their land as Weak rose from 0% to 33.33% (Figure 3.15).

At Diamante, this percentage rose from 0% to 12.5% (Figure 3.16). A more surprising trend at Ubu was the shift from 57.14% Good evaluations initially to 0% at present day. At Diamante, the drop was much less marked with 55.56% claiming their land was Good initially and 50% currently.

The perpetuation of the ideas that poor soil has resulted in the failure of the reform process has misrepresented the real problems at the sites. Even the farmers, often out of desperation, have begun to cling to the frequently repeated explanations. One of the farmers told me if he could just have his soil tested for nutrients then he would know what to do for his cassava and he would not be doing so poorly. While this would have been a tremendous help to him, it would not have addressed the low valuation of subsistence crops or the lack of transportation that truly prevent him from making a profit when he sells his crops. Many of the factors investigated were helpful parameters for the study of long-term fluctuations in soil conditions, but do not adequately represent the current situation within the communities.

These indicators may also under-represent certain types of environmental damage, which are more difficult to see within the narrow focus of site-specific parameters. One easily observed case of this is the poor adherence to maintaining 20% of each farmer's lot in tree cover. If this was enforced, there would be no shortage of wood for the planting of yam and the mangroves would not be assaulted each year at planting time for the scarce wood resources. Many of the farmers suggested last year that they had never seen a dry season as they had that summer. Several offered the explanation that they had brought it upon themselves by cutting so many of the trees down in their settlement. A test of C/N ratios would not generate the same broad level understanding of the environmental quality, at least not on the same time scale.

The people who could best utilize analysis of these parameters are those for whom the intricacies of the situation are clear, the farmers. Many of the parameters analyzed were simple and informative. For example, monitoring of dry aggregate stability is an activity the farmers can do on their own plots as a means of tracking soil conservation and health.

These parameters would be useful for them as well because the time frame for their monitoring could be much more extensive than that of a researcher who is constrained by length of grants and ability to spend time in the field. The farmers are there every day and most do not intend to go anywhere.

Conclusion

To address whether agrarian reform communities contribute to environmental degradation or act as environmental stewards, as evidenced through the soil parameters, clear and consistent trends must be shown to achieve a conclusive answer. There are not consistently significant differences between the sugar cane and the farmer's plots to allow for the conclusion that the reform movement is improving the environment or exacerbating degradation. These parameters seem to be quite site specific, for example, the C/N ratio trends at Ubu and Diamante were reversed, with one having an increase and the other a decrease over time since settlement. While soil parameters do not allow for generalization about the movement as a whole, these parameters could be useful for specific site monitoring over a long time span.

The value of soil parameters as an instrument for achieving a greater understanding of the effects of various management practices is undeniable. It is not though, a good indicator of the health of a predominately social movement. All too often, environmental indicators are treated independently, as if removed from the social and economic forces acting upon them.

TABLE 3.1 SOIL PARAMETERS SUMMARY - CANE VS. CROP :

Soil parameters were examined both at the reform settlements of Diamante and Ubu and at the bordering sugarcane plantations. The average values for the sites (both cane and crop), and the difference between the cane and the crop for the sites are presented.

Parameter	**Diamante**				**Ubu**			
	Average Values (Standard Error Mean)		*Paired Samples (Cane - Crop)*		*Average Values (Standard Error Mean)*		*Paired Samples (Cane - Crop)*	
	Cane	*Crop*	*Average Difference*	*Significance of Difference*	*Cane*	*Crop*	*Average Difference*	*Significance of Difference*
C/N 0 - 5 cm	13.95 (.25)	12.56 (.31)	1.41(.47)	.0046	14.29 (.34)	15.48(.11)	-1.19(.37)	.0021
C/N 5 - 20 cm	12.56 (.18)	11.05 (.38)	1.02 (.43)	.024	13.99 (.43)	15.42 (.32)	-1.43 (.57)	.0146
C/N 0 - 20 cm	17.21 (.23)	12.29(.32)	4.90(.44)	<.0001	14.06 (.39)	15.43 (.25)	-1.37 (.48)	.0063
pH 0 - 5 cm	6.02 (.06)	6.81 (.05)	-.79 (.07)	<.001	6.83 (.10)	6.43 (.07)	.404 (.09)	<.001
pH 5 - 20 cm	5.88 (.05)	6.72 (.06)	-.85 (.09)	<.001	6.74 (.12)	6.28(.07)	.449 (1.04)	<.001
pH 0 - 20 cm	5.91 (.047)	6.57 (.15)	-.66 (.16)	.002	6.76 (.11)	6.32 (.07)	.437 (.098)	<.001
Infiltration (ml/sec)	1.94(.496)	5.25 (1.88)	-3.3(2.14)	.15	5.74 (1.3)	3.87 (.60)	1.87 (1.39)	.204
% H_20 Stable Aggregates		72.46 (3.887)				84.55 (1.62)		
Dry Aggregate Size (g/kg)								
Aggregate > 1.30mm		148.9				148.6		
1.30mm>Agg> .66mm		190.8				214.1		
.66mm>Agg>. 51mm		169.8				178.7		
.51mm>Agg>. 147mm		185.0				218.1		
Agg>.147mm		305.5				240.5		

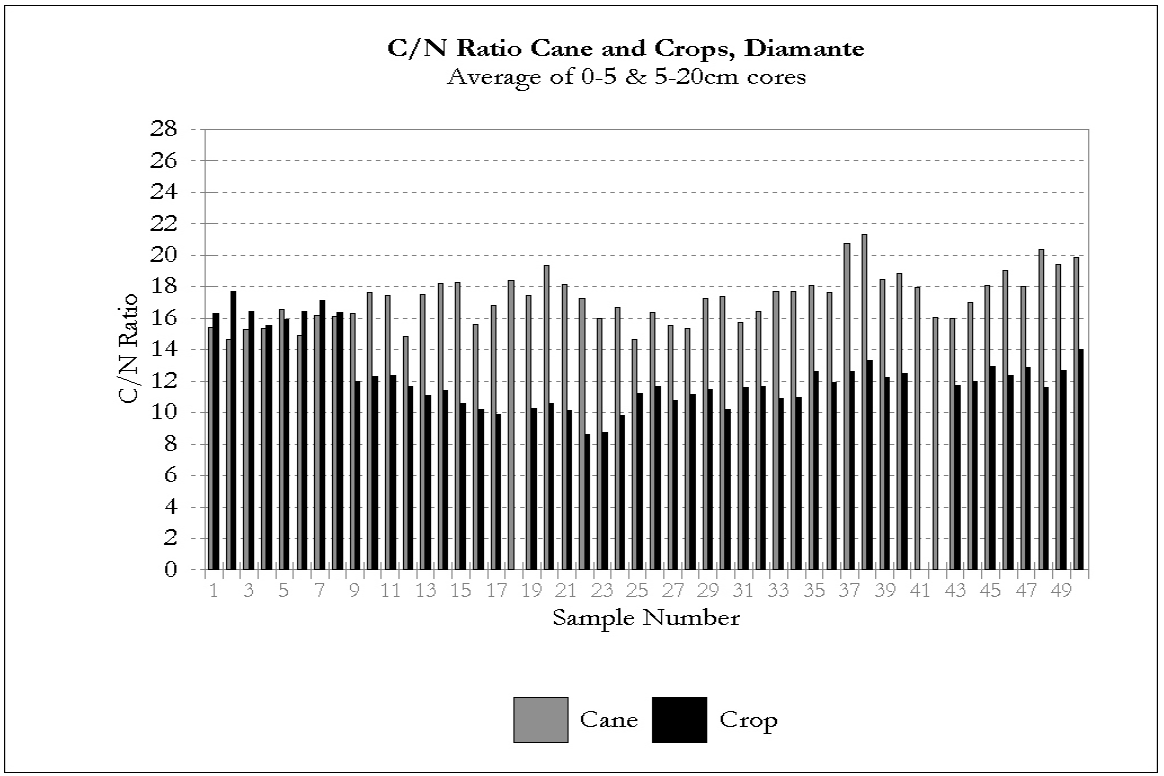

FIGURE 3.1: AVERAGE C / N RATIO 0 - 20CM

C / N values for 0 - 20 cm soil cores (average of 0-5cm and 5 -10cm values) from paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Diamante

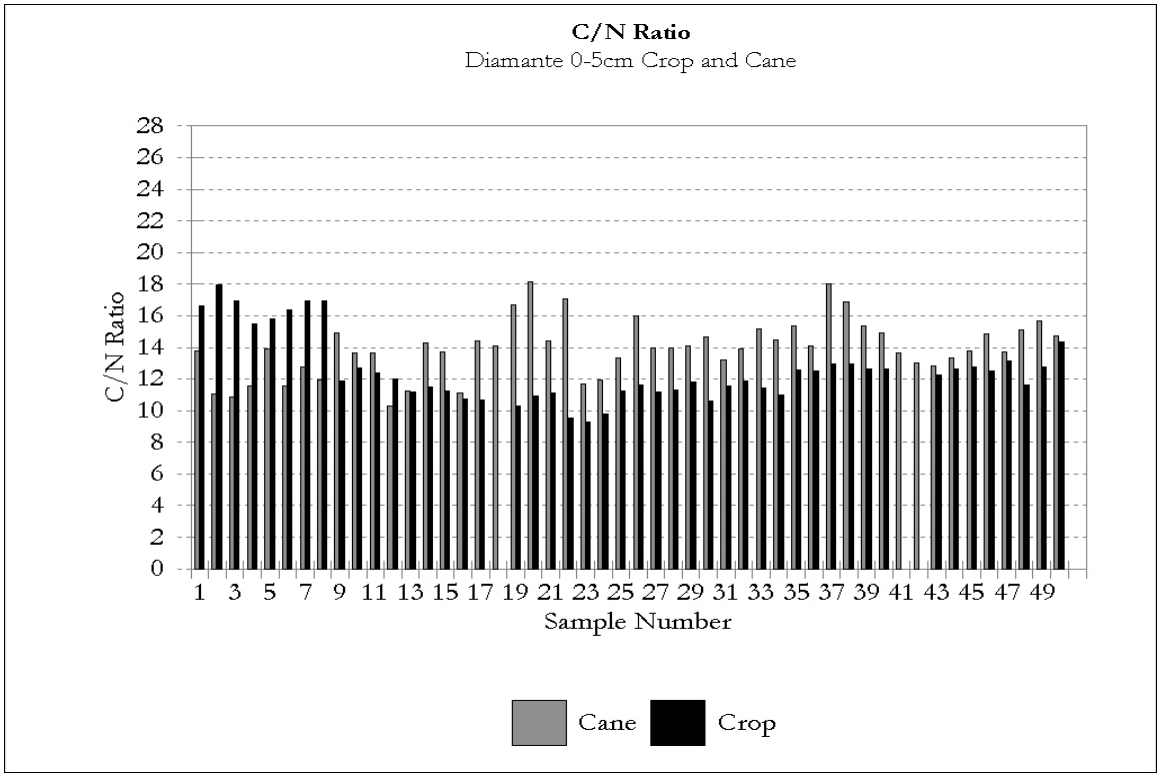

FIGURE 3.2: C/N RATIO 0-5CM

C/N values for 0- 5 cm soil cores for paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Diamante

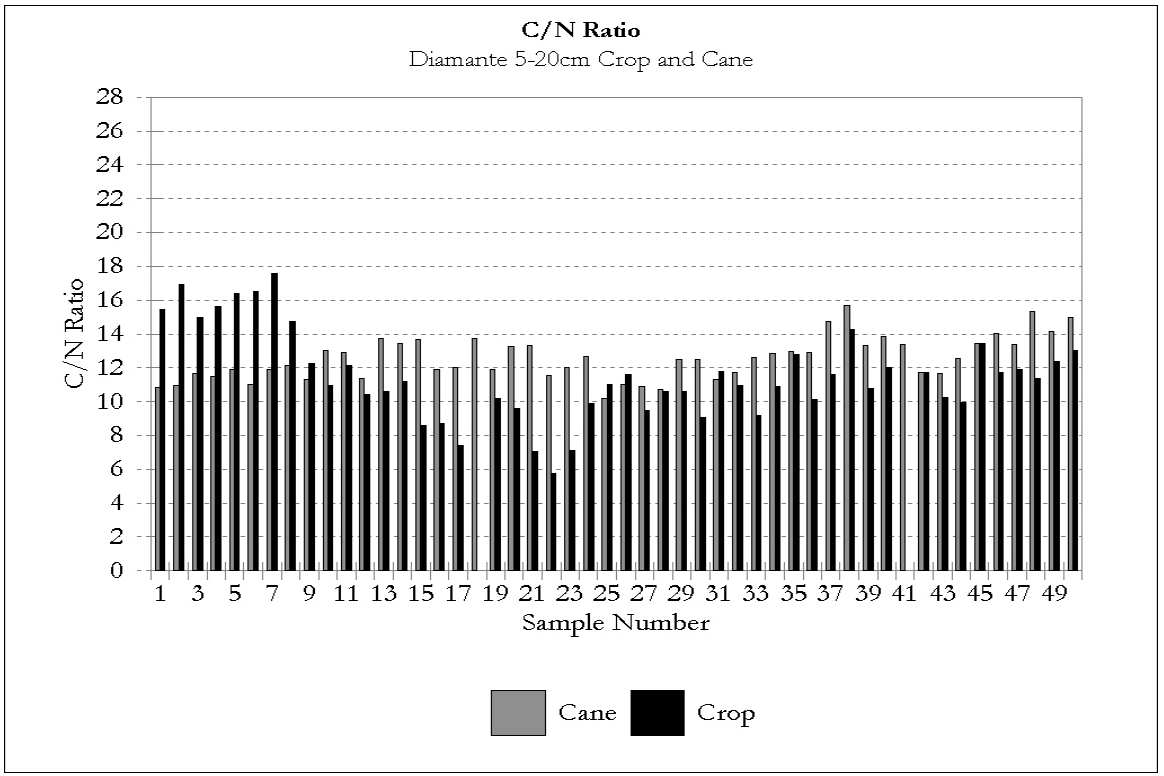

FIGURE 3.3: C/N RATIO 5 - 20CM

C/N values for 5 - 20cm soil cores for paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Diamante.

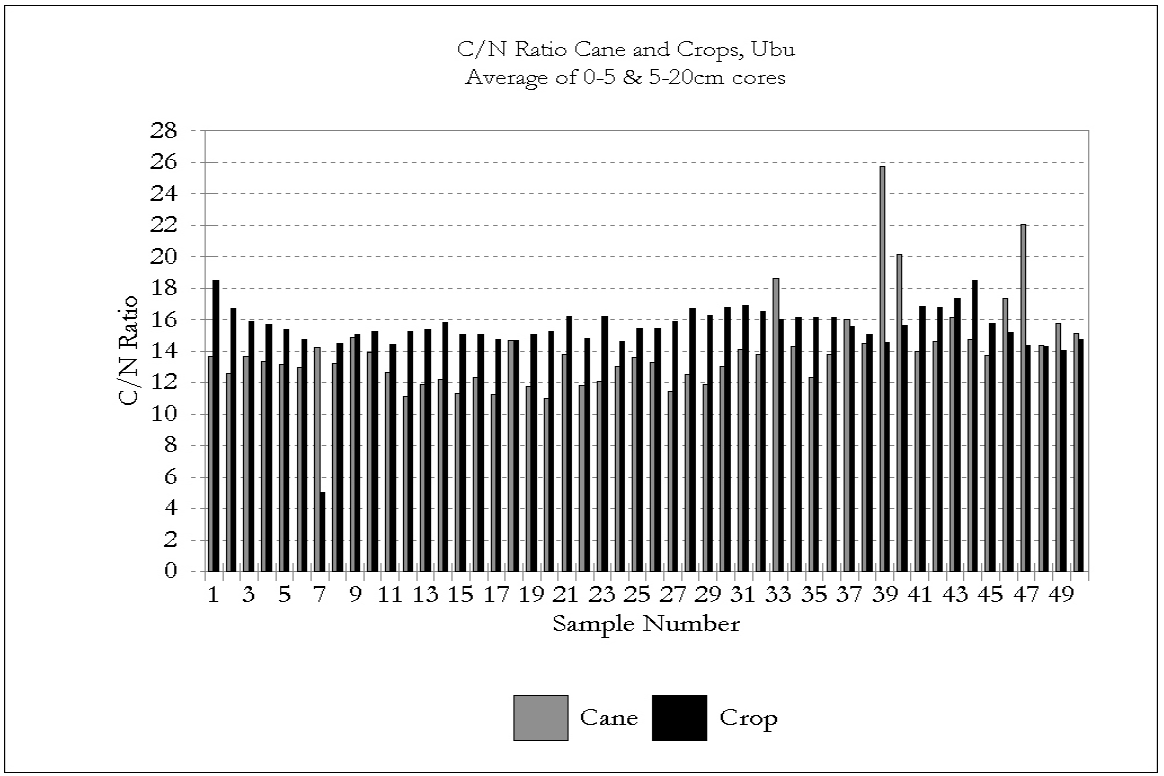

FIGURE 3.4: AVERAGE C/N RATIO 0-20CM

C/N values for 0 - 20 cm soil cores (average of 0-5cm and 5 -10cm values) from paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Ubu

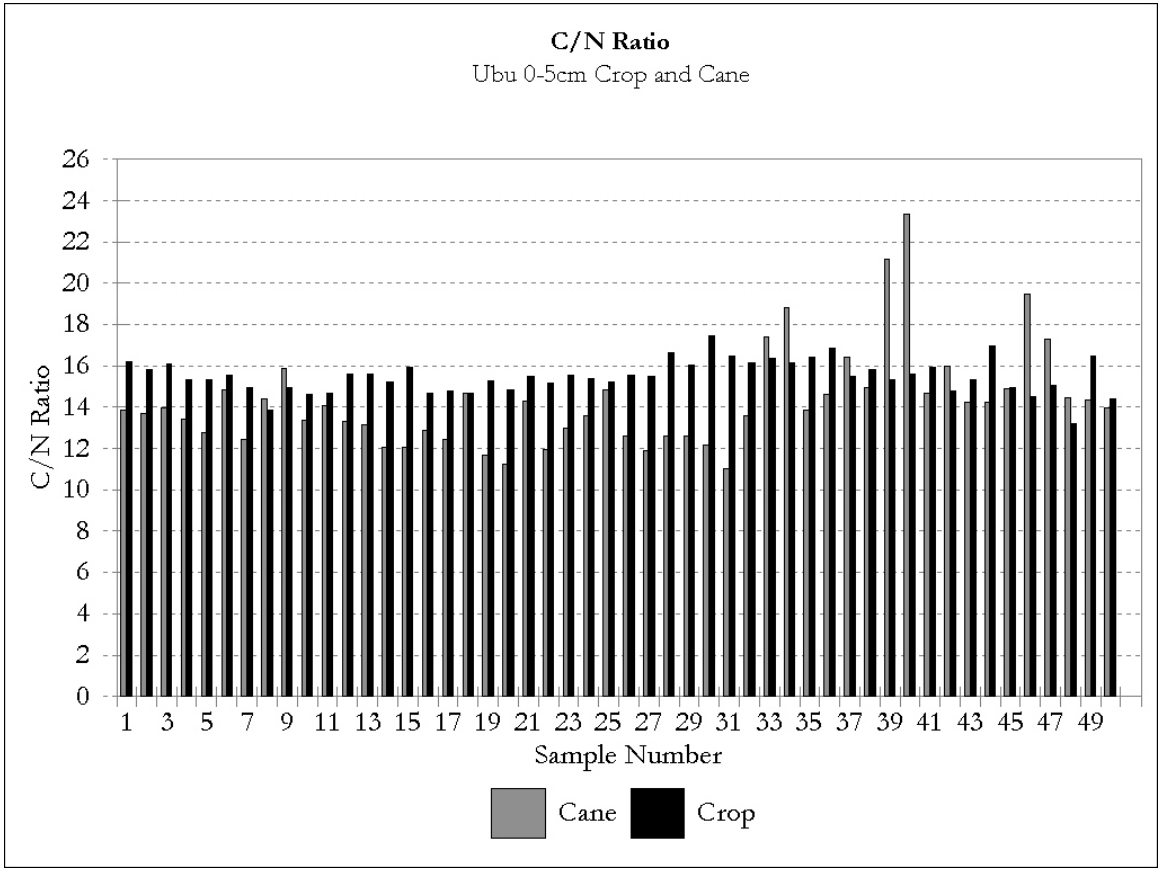

FIGURE 3.5 : C/N RATIO 0-5CM

C/N values for 0- 5 cm soil cores for paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Ubu

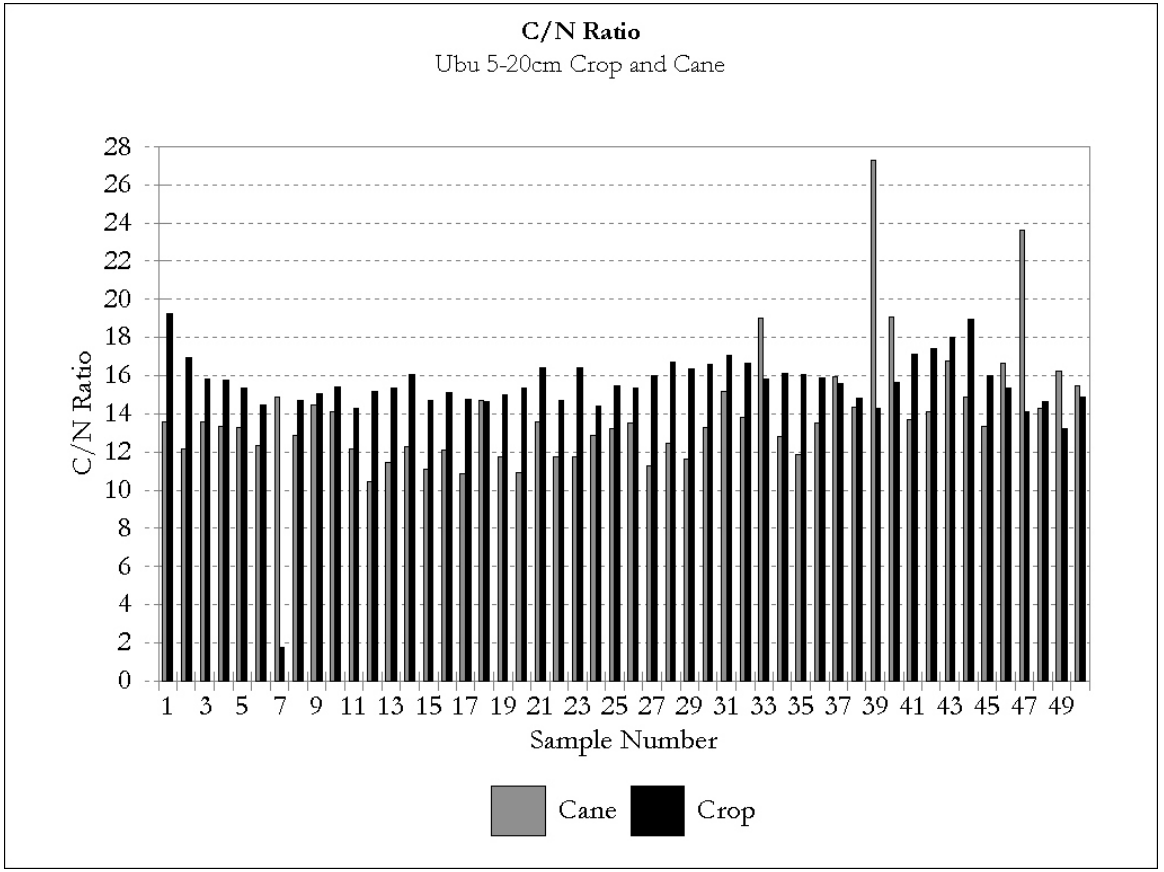

FIGURE 3.6: C/N RATIO 5 - 20CM

C/N values for 5 - 20cm soil cores for paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Ubu.

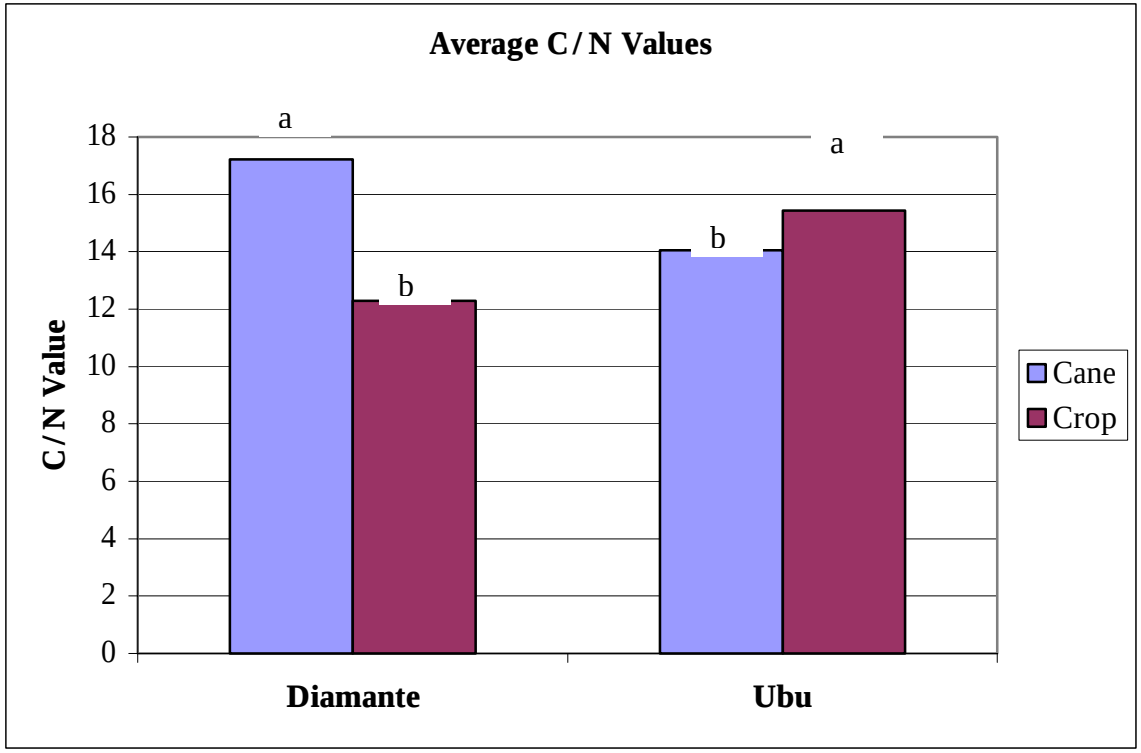

FIGURE 3.7: AVERAGE C / N VALUES 0-20CM, DIAMANTE AND UBU
Average C / N values for paired soil samples from 0cm- 20cm taken in the sugarcane and bordering farmer's plots. Within each group, columns with the same letter are not significantly different according to LSD at 0.05 probability level. (α = .008)

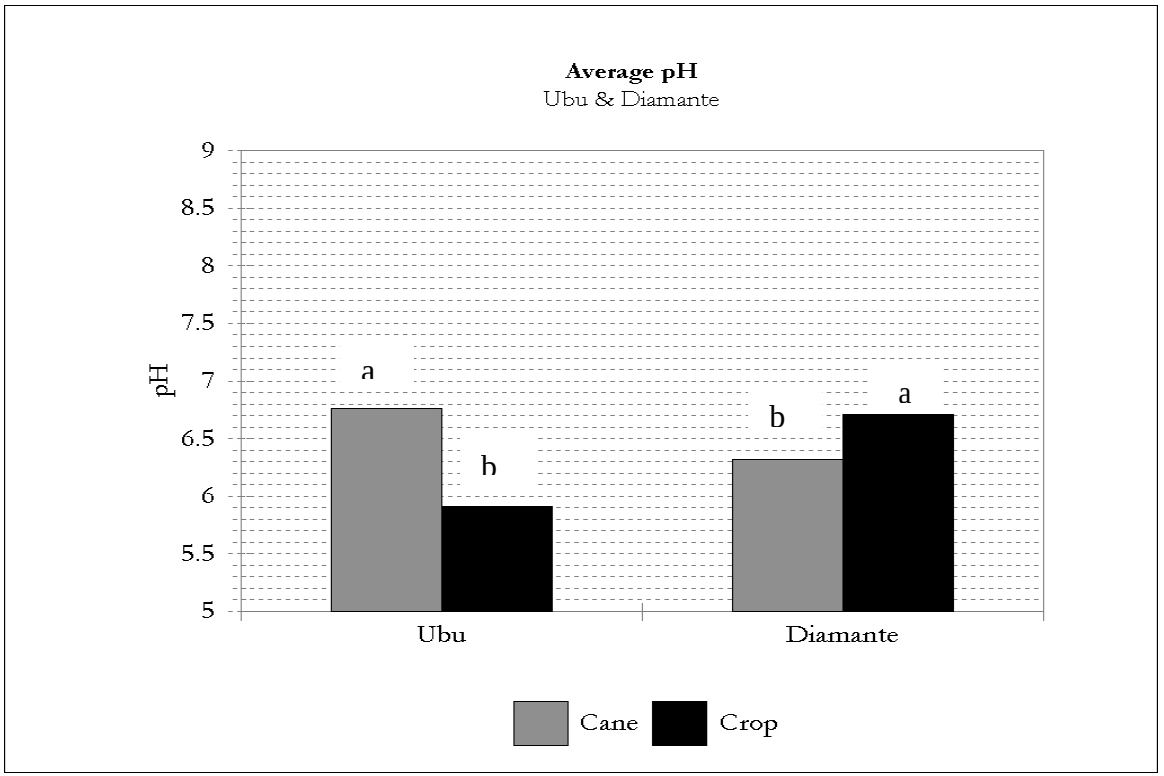

FIGURE 3.8: AVERAGE PH VALUES FOR SOIL CORES FOR 0 - 20 CM

pH for paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlements, Ubu & Diamante. Within each group, columns with the same letter are not significantly different according to LSD at 0.05 probability level.

.

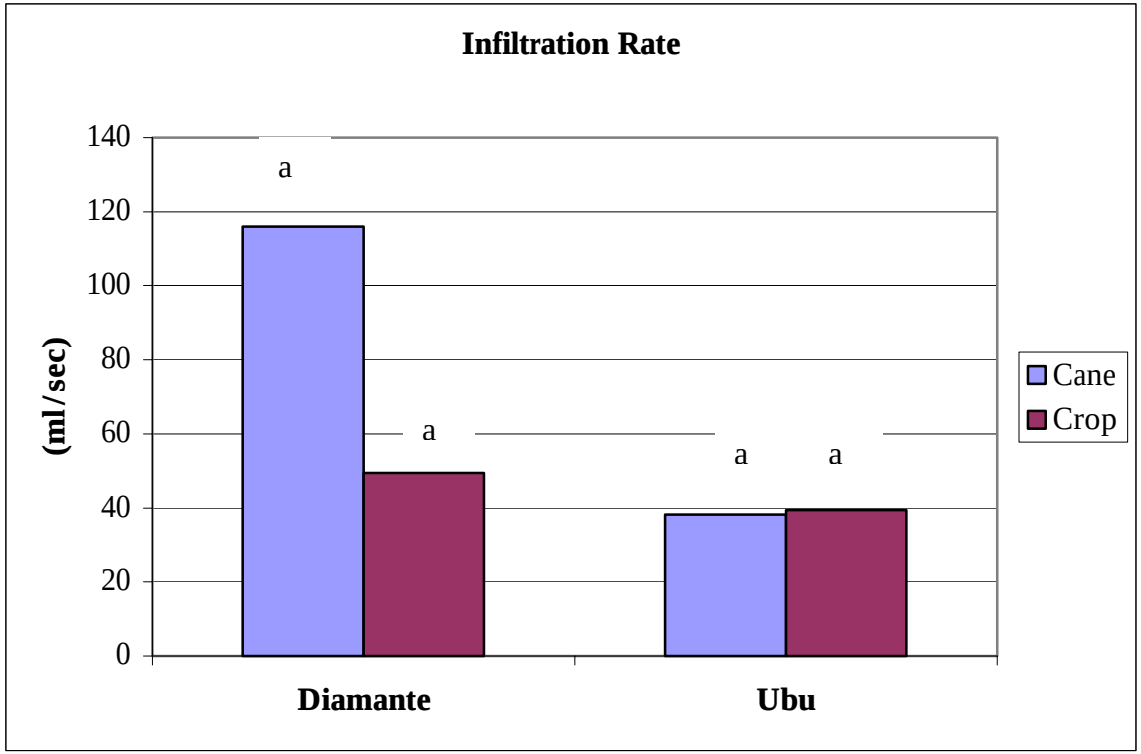

FIGURE: 3.9: AVERAGE INFILTRATION RATE
Paired sampling sites in the sugarcane and on farmer's plots at two communities, Diamante and Ubu.
Within each group, columns with the same letter are not significantly different according to LSD at 0.05 probability level.

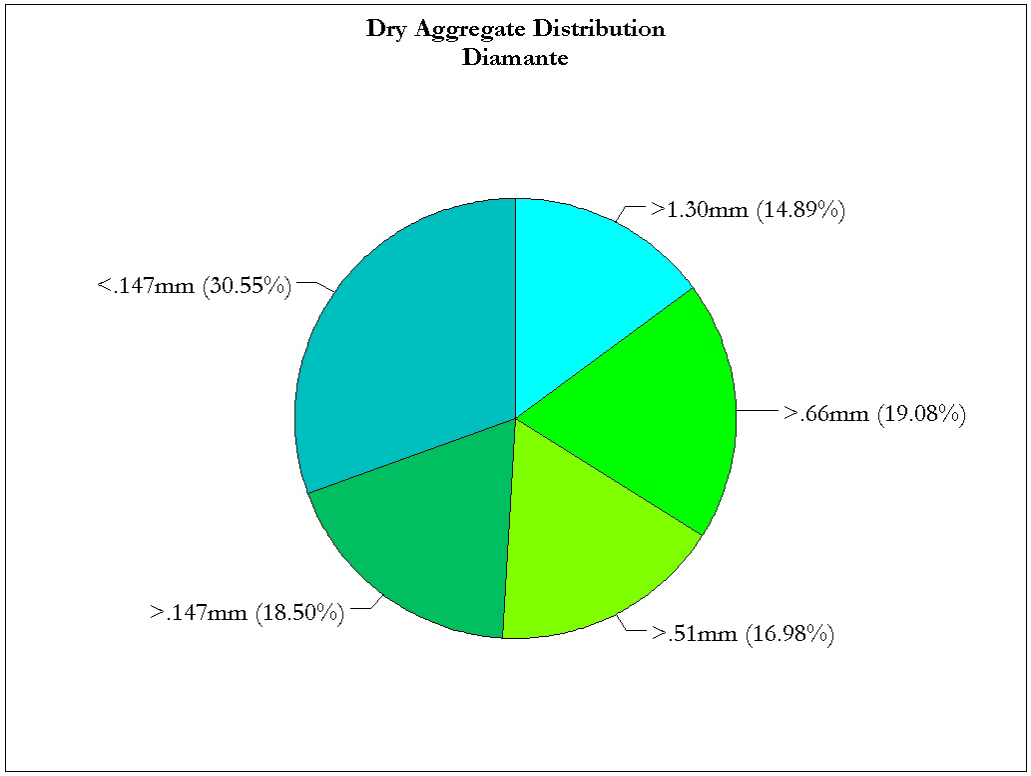

FIGURE 3.10 DISTRIBUTION OF SOIL AGGREGATES IN A DRY AGGREGATE STABILITY TEST
The values given are the amount of soil held above a sieve of the specified opening size (mm) after the sample from Diamante was oscillated to simulate field forces that act upon the soil.

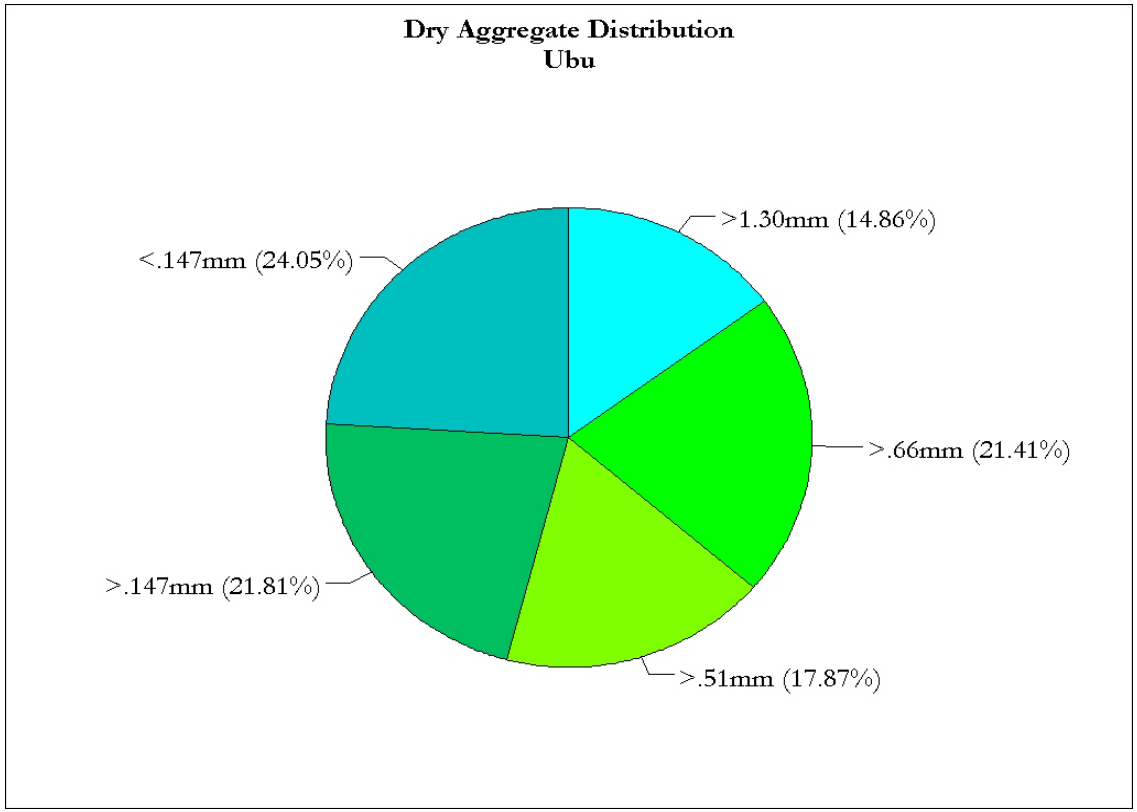

FIGURE 3.11 DISTRIBUTION OF SOIL AGGREGATES IN A DRY AGGREGATE STABILITY TEST
The values given are the amount of soil held above a sieve of the specified opening size (mm) after the soil sample from Ubu was oscillated to simulate field forces that act upon the soil

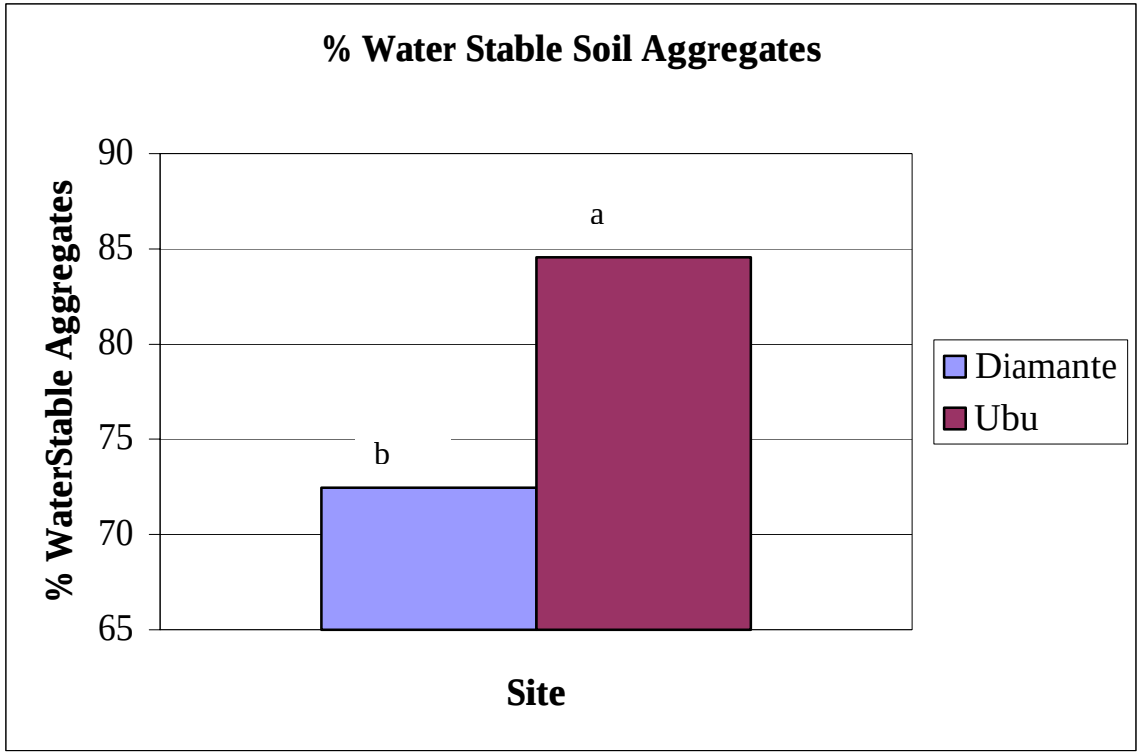

FIGURE 3.12COMPARISON OF THE PERCENTAGE OF WATER STABLE AGGREGATES , DIAMANTE AND UBU
Soil samples were exposed to external forces (water) to simulate field conditions such as rainfall events, and to see what amount of the soil aggregates are stable under these forces. Within each group, columns with the same letter are not significantly different according to LSD at 0.05 probability level.

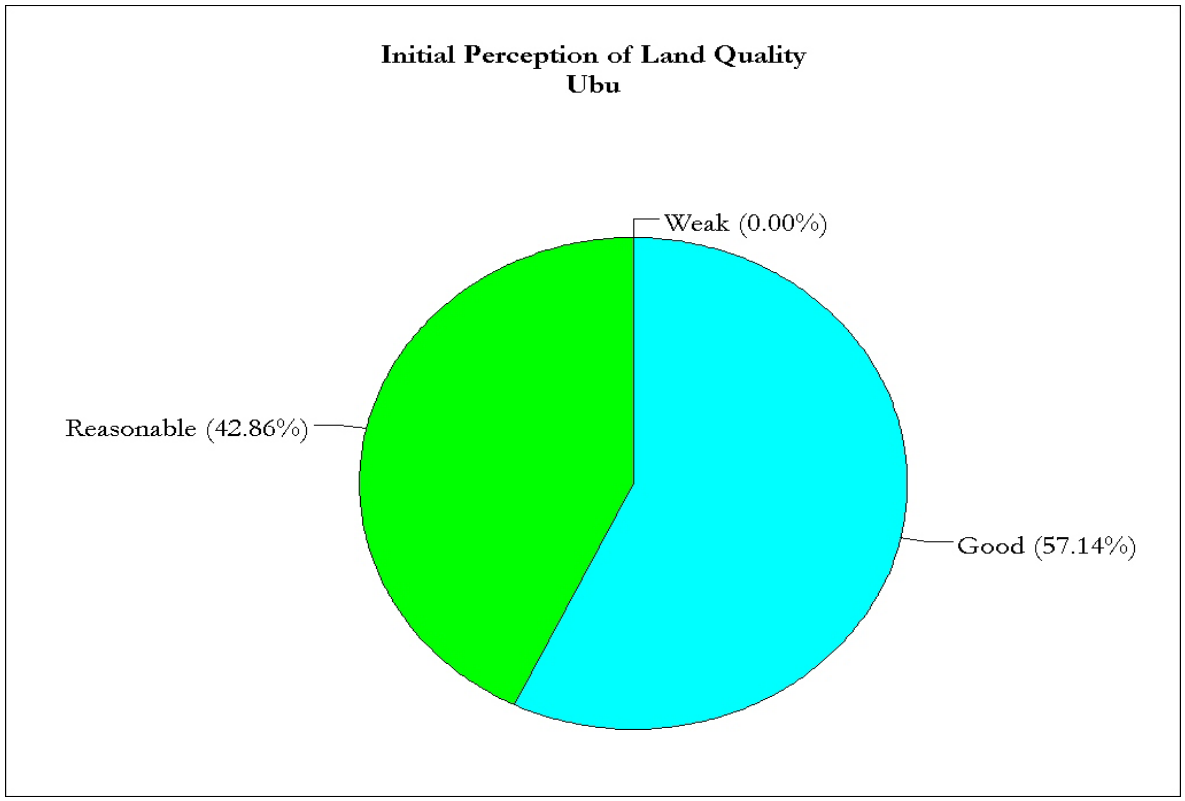

FIGURE 3.13 INITIAL PERCEPTION OF LAND QUALITY.
An evaluation of the plots (Ubu) the farmers received as part of the agrarian reform process.

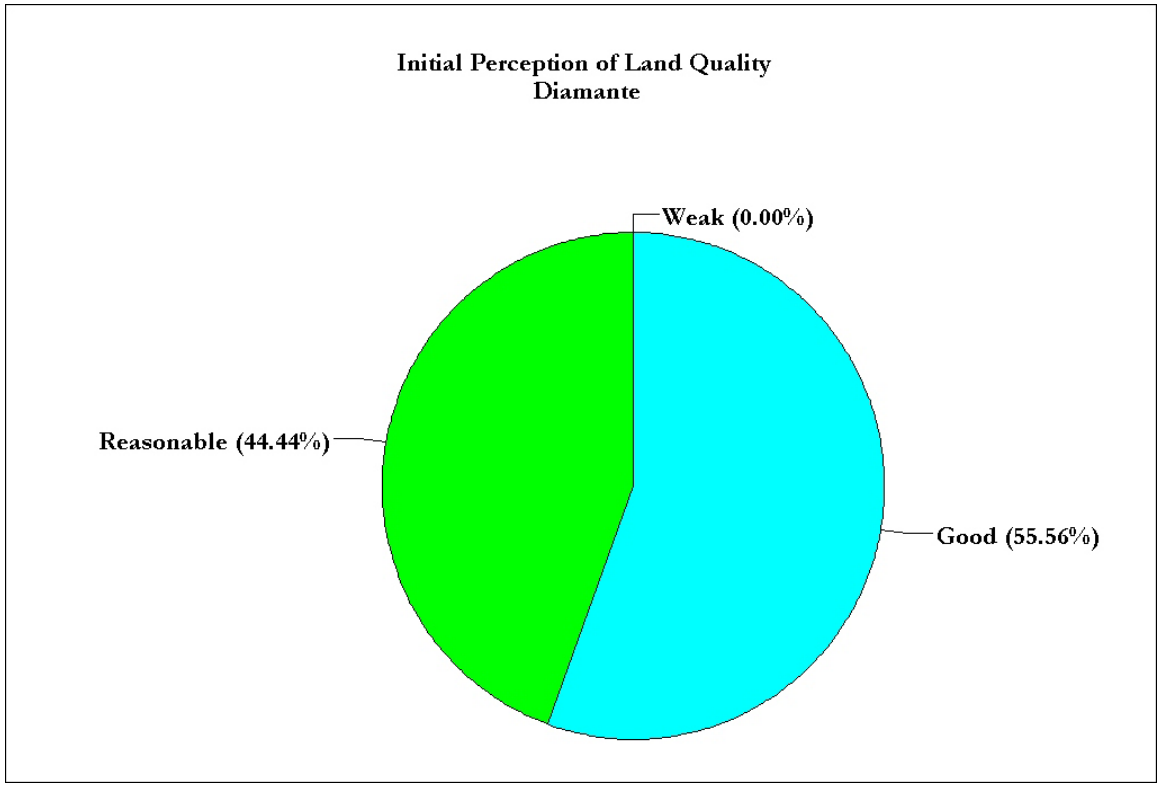

FIGURE 3.14 INITIAL PERCEPTION OF LAND QUALITY.
An evaluation of the plots (Diamante) the farmers received as part of the agrarian reform process.

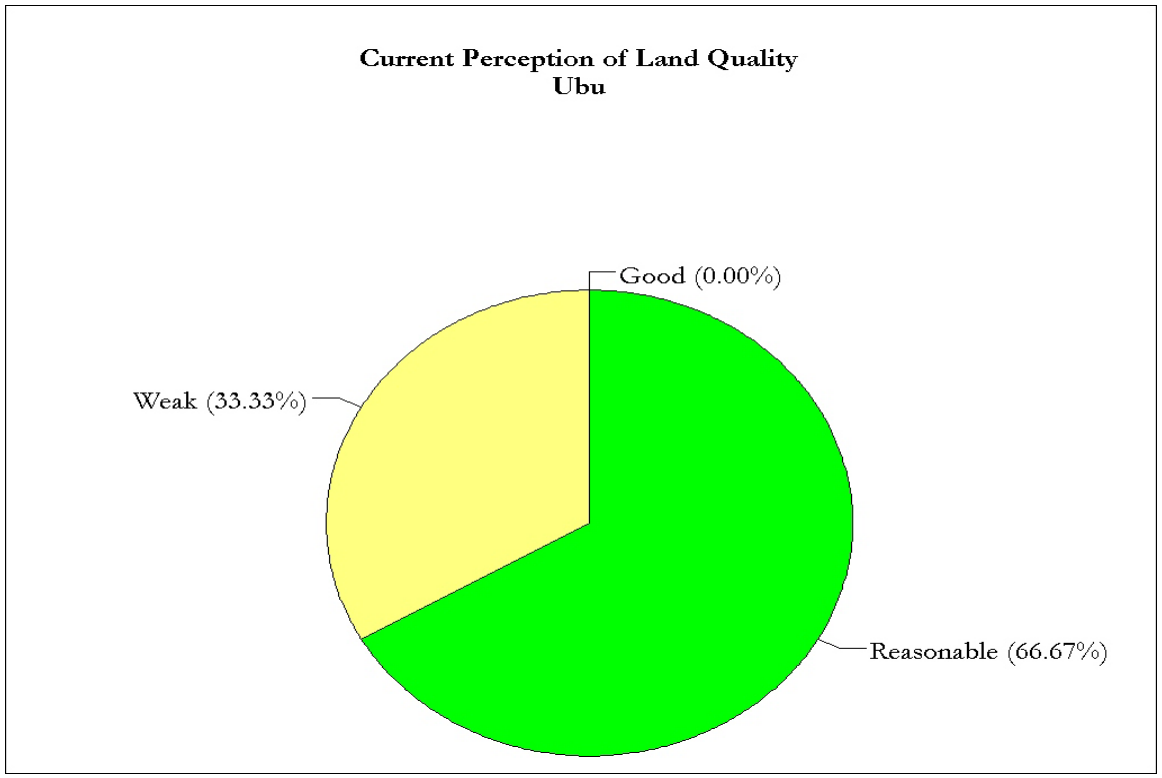

FIGURE 3.15: CURRENT PERCEPTION OF LAND QUALITY.
A present day evaluation of the plots (Ubu) the farmers received as part of the agrarian reform process.

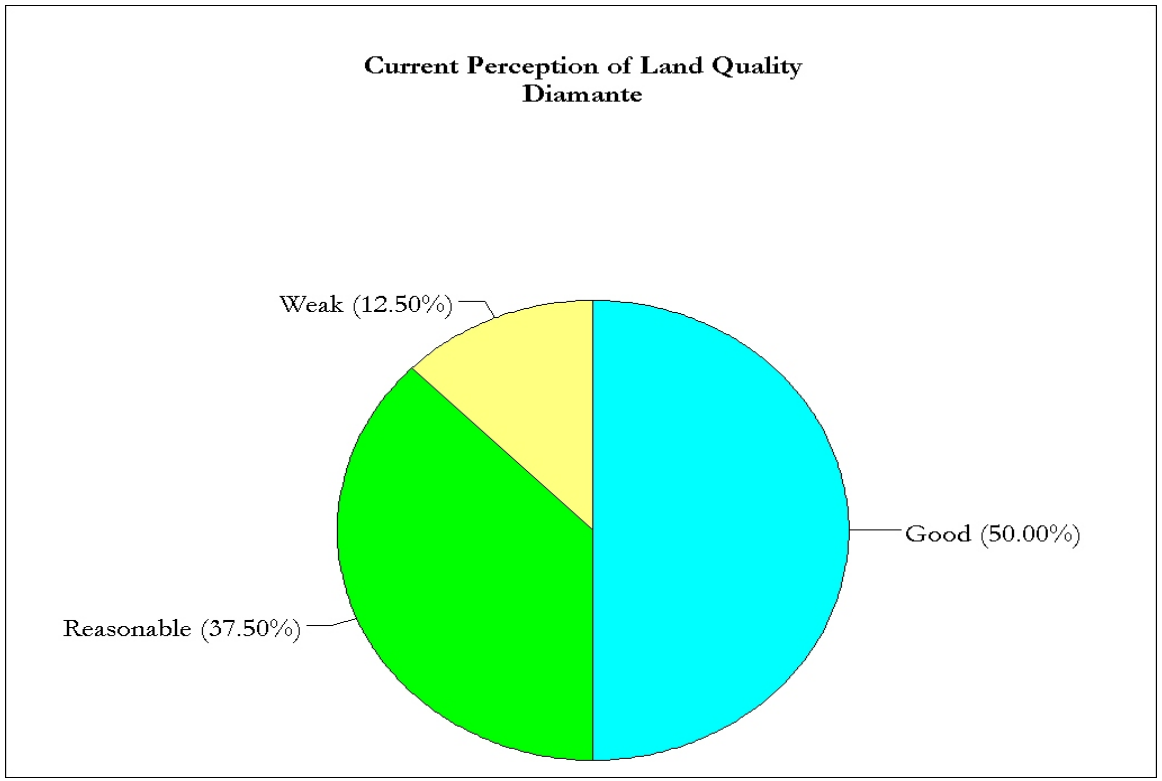

FIGURE 3.16: CURRENT PERCEPTION OF LAND QUALITY
A present day evaluation of the plots (Diamante) the farmers received as part of the agrarian reform process.

CHAPTER 4

ECONOMIC SUSTAINABILITY OF TWO AGRARIAN REFORM COMMUNITIES

Introduction & Background

Economic sustainability is an integral yet often overlooked aspect of the agrarian reform movement. The exodus of settled farmers from rural areas to the cities has given cause for the scrutiny of the reform movement and whether it has improved the economic situation of the rural poor.

The MST and others have specifically blamed the flood of more than four million people from 1995 to 1999, on government agricultural policies that favor large-scale agriculture over small family farms (www. MSTBrazil.org). James Petras, sociologist, reports, " In the first four years of the Cardoso regime, over 400,000 farmers went bankrupt and were driven off the land or converted into landless laborers or employees of the big agro-industrial export enterprises which were the centerpiece of Cardoso's so called 'agricultural modernization export strategy'."(Petras, 2000) The MST offered their view on the market-oriented reform that relies heavily on the provision of loans, stating, "Since its first mandate, Fernando Henrique Cardoso's government has implemented an agricultural model that has marginalized national agriculture and violently impoverished rural workers," (www.mstbrazil.org). These loans increase the burden on the farmers by stimulating production of low value goods that do not guarantee the ability to repay the loans. As one of the farmers in the study explained, they were simply poor before - now they are poor and

in debt. In addition to the usual challenges, they are now faced with the demands of a market economy into which they have not been fully integrated. Between 1997 and 1999, defaulting on rural credit grew by 182% (www.mstbrazil.org).

National economic policy is part of the problem, but the large number of small farmers leaving rural areas casts doubt on the economic viability of resettlement initiatives in general. Peter Rossett of Food First, in his report on Brazilian landless settlements, compares them to similar settlements throughout Central America about which he says, " We found them [the settlements] to intensify land degradation and ecological problems while leaving poor farmers in risky enterprises with high failure rates." (www.Foodfirst.org). Rossett goes on to argue that, "The beneficiaries [settlers] are remarkably better off than the other poor people in Brazil." This statement partly overlooks the fact that the settled farmers continue to battle all of the dangers of poverty such as malnutrition, illness and illiteracy as they struggle to provide a dignified life for their families.

The reform movement's battle cry of "land now" seems to have been a gross underestimation of the elements necessary for successful reform. The debate continues over why communities are failing, but two things are evident. The first is that land alone does not guarantee a successful agrarian reform, and the second is the fundamental importance of assuring economic and ecological sustainability in order to improve the current and future quality of the lives of reform families.

Sustainability is the cornerstone of success for the agrarian reform movement. Without economic sustainability, there will be minimal long-term rise in standard of living of the settled families. The current situation has begun to entrap rather than empower families in a continuous cycle of reform. The children of settled families, when coming of age, will be encouraged to join the movement themselves as the property can not support the growing

family and the families of the now adult children. Juarez Bittencourt, a settled farmer says, “Here, there is no other way. The fate of my granddaughter is to become one of the landless too.” (Secco, 2000a) The resulting spread in family agriculture may also expand environmental degradation as the economic situation of the small farmers generates dependence on subsistence crops that are low risk but also low value with a high environmental cost.

This study was a detailed analysis of two communities in the context of the Brazilian agrarian reform movement. The goal was to identify the factors that were inhibiting the general success and sustainability of the reform movement at the levels of the individual families and communities. More specifically, this section of the study is an evaluation of whether the reform movement has changed the economic situation of the farmers since they received land. Economic sustainability of the two sites is considered by analyzing production and marketing data.

Market Access

Both sites have access to small and large cities for sale of their crops. Ubu is 44km from the large city of Recife, 22km from the smaller town of Goiana, and well situated on the major highway of BR101. There are stalls set up on the road to allow for direct marketing to the public. Diamante is 65km from Recife and 4km to the small town of Goiana

Methodology

Specifically, information was gathered during field visits each week on the amount of crop harvested, its commercialization, for how much it was sold and where, the amount and location of crop planted, and why the crop and location were selected as they were.

Each crop or item found on the farm was counted and the number of farmers at each site with a particular item and the area allotted the item was calculated from survey responses and plot maps that were constructed**.** The cataloguing consisted of:

1. Identification of crops and animals, and quantification of items at each site
2. Calculation of area allotted each item
3. Explanation of why item and location were selected
4. Evaluation of productivity and marketing of each item

Results & Discussion

Crop / Item selection

The major crops found at both sites were subsistence crops, including cassava (macaxeira), yam (inhame), corn, beans, and potato (Table 4.1). All were found on more than 50% of the study plots. Each study plot had at least one type of subsistence crop. Fruit trees such as coconut, cashew, and banana are common and are planted by more than 93.7% of the farmers (Table 4.1). Less common are the garden vegetables such as cilantro, tomato, lettuce and pepper with 25% of the study group having planted them. The sites that had one of the four garden vegetables were more likely to have the others as well. This was probably due to the higher water demands of these types of crops. The farmers who planted them generally had a ready source of water either located nearby to facilitate hand watering or brought up with a small pump and irrigation tubes.

Animals were also counted at each study plot. Eighty one and a half percent of the farmers in the study had chickens for both sale and home consumption. At Diamante, 87.5% of the farmers kept cattle, while none did in Ubu. Surprisingly, space limitations did not strongly influence the decision to keep cattle. The farmers with 2.5 ha (Diamante) successfully raised cattle and calves while the farmers with 7-8ha (Ubu) did not. Ubu had at

one time attempted to have a community cattle/dairy production project. This failed to benefit a large number of community members. As one of the study farmers reported, it was taken over by "actors", everyone wanting the spotlight and no one wanting to do the work.

Division of planted area

Each item was evaluated for the amount of hectares it occupied on the plots at both communities (Table 4.2). While individual crop results are informative, to better illuminate how arable land is allocated among types of items, the crops were grouped into five categories. These groups are:

"Subsistence" crops - yam, bitter and sweet cassava, corn, beans, potatoes

Fruit Trees - banana, papaya, mango, orange, cashew, graviola, acerola, pitomba, pitanga, lime, coconut

Annual Fruits - watermelon, pumpkin, squash, passion fruit, pineapple

"Garden Vegetables" - cilantro, tomato, pepper, scallions**,** lettuce

Other - grass feed for cattle

Subsistence crops covered 52.01% of the total area planted in Ubu and Diamante (Figure4.1). Fruit trees covered the next largest area, 30.29%, followed by annual fruits (12.76%), garden vegetables (4.51%) and other items (.43%). The total area planted at Ubu was 55.25 ha and Diamante 26.62 ha.

The items covering the largest area per community were similar (Figure A9 - A24). The five largest land area per crop allotments for each site were as follows:

Ubu - cassava (sweet), coconut, cassava (bitter), yam, corn

Diamante - passion fruit, coconut, cassava (bitter), yam, cassava (sweet) (Table 4.2)

The way that land is apportioned depends on several things. The first is the cost and availability of a given item. Subsistence crops can be replanted with cuttings or with

inexpensive seeds as opposed to the more costly seeds for peppers and tomatoes. This combined with the bank promotion of subsistence crops make them a preferable choice for many of the farmers.

Food security is also an issue. Many took comfort in the fact that they would not starve because the cassava would likely grow, even in adverse conditions. In more than three cases, the farmers who experimented frequently and were innovators on their plots switched to subsistence plantings when food or available capital became scarce. Riskier crops, more dependent on good weather or irrigation were not planted by as many farmers or allocated as much space, as evidenced by the small percentage of farmers planting garden vegetables (25%). Tomatoes are a good example of this as they are not drought tolerant and require irrigation to make it through the long hot dry season**.**

Value generated per hectare

Of the total amount of Reais reported as gross income from the sale of agricultural products ($R 37,202), the subsistence crops were responsible for 86.56% of the total. Following this were fruit trees with 7.19%, garden vegetables (5.08%), others (.70%) and annual fruit (.47%.), (Figure 4.2).

At Ubu, the top five gross income generators were yam, sweet cassava, tomato, bitter cassava and green sweet peppers. At Diamante they were yams, green sweet peppers, corn, passionfruit and cilantro. (Table 4.3)

The amount of gross income generated by each item was also calculated on a per-ha basis (Table 4.3). For some that were produced on more than one ha, this was calculated by dividing total income generated by the number of ha. For items with less than 1 ha planted, the value is the projected value based on the assumption that the income would stay relatively the same even with an increase in the amount of produce available for the market.

When the amount of $R earned per hectare was calculated, the top five at Ubu were Yam (2434.78 $R/ha), Pepper (568.63 $R/ha), Tomato (469.83 $R/ha), Sweet Cassava (356.67 $R/ha) and Papaya (295.51 $R/ha). At Diamante, these were Peppers (72,916 $R/ha), Cilantro (8000 $R/ha), Yam (870.69 $R/ha), Beans (222.22 $R/ha) and Corn (160.00 $R/ha).

The incredibly high value for peppers at Diamante could be due to several things. The first is that this value was based on one farmer's harvest. His plot is at the very bottom of a steep hill where water and nutrients run down, and is bordered by a river. Due to the plot location, the limiting factors of water and nutrients are much less severe than at other sites. He also planted several times during the course of the year and is one of the most dedicated and attentive farmers in the study. This high value does not mean that everyone should switch to the production of peppers, as the plots will vary in their microclimates and nutrient availability. It does bring to light though, the high amount of production that can be had in a small amount of space. One hundred fifty pepper plants yielded $R350.

Another important difference between the items is the time it takes for them to be marketable. Yams can be harvested just once within a year. Peppers, which earned upwards of $R550/ha can be planted three to four times in the course of a year and once they begin to produce, continue to do so for several weeks/months, as opposed to the one time harvest of the subsistence crops.

Economic results strongly reflect the way in which each crop is marketed. Subsistence crops are generally sold because buyers pass through the settlement, making it easy for the farmers to sell their goods. Other crops, which are either produced in smaller quantities or more difficult to market, are frequently relegated to home consumption.

The items that were produced but not sold have very low value per hectare when value is calculated in terms of gross income from sales. Unless the problems of transportation of goods to market are addressed, the value generated is a fairly accurate representation of the value per item.

The one overlooked value is that of home consumption. Several of the items compose the basis of the farmer's diets. In addition, many of the fruits that are not marketed provide important dietary supplements in the form of vitamins and minerals. Acerola is a good example, with one of the highest vitamin c concentrations of many tropical fruits. The children at the settlements eat acerola right off the bush, providing an important nutrient in a diet of cassava.

Projections for the future

Data on the inclination of the farmers to alter their plots by increasing or decreasing the amount of all plants and animals were recorded. This was to project how their plots would look in the future. For example, did someone who had only cassava planted intend to continue this way or did they have plans to include garden vegetables in the coming year.

To get this information, each item was presented to the farmer with the question, "Next year, do you want to increase the amount you have, decrease the amount you have or have the same amount of a given item?" The results were tallied for each item and then the items were grouped again into subsistence crops, fruit trees, annual fruits, garden vegetables, and other. If they did not have an item and did not intend to have that item the following year, it was recorded as staying the same. The number of responses is higher than the sample size of farmers because several different items were grouped and the responses pooled. For example, the 130 responses for those planning to have the same amount of fruit trees were generated because the group contained several types of fruit trees and the farmer's response

for each type of tree was counted. Very few of the farmers planned to expand the coverage area of garden vegetables. The combined data indicated that just 6.25% of the study group plans to increase their plantings (Figure 4.3).

The number of farmers in the study group wishing to decrease an item on their plots was greatest at both Diamante and Ubu for subsistence crops. This may give the impression that subsistence crops are going to decrease in the coming season but this is not the case as decisions are often highly crop specific. For example, while 64.71% of the study group wanted to decrease one or more of their subsistence crops at Ubu, 100% of the Ubu study group wanted to increase the planting of yam, also a subsistence crop (Figure 4.2 - 4.6).

Yams, a subsistence crop that still sells for a high price of 7R-8R per 15kg, are following the subsistence crop trajectory. An item that earns a reasonable amount one year is often planted in quantities that saturate the market the following year. In response to the high prices, especially in comparison with other subsistence crops, many of the farmers at the settlements increased their plantings of yam. All eight of the farmers from Ubu plan to augment the amount of yam they have planted on their plots.

For each item, the greatest response was to keep the same amount of the item in the coming year. The section that showed the greatest increase was the category of other. Many of the participants responded that they would like to increase in the other category that included capim, an animal feed, and poultry. This could reflect the farmer's perception of their ability to take on extra expenses or labor.

Finally, the number of farmers that reported they neither planned on increasing or decreasing their plantations was greatest for fruit trees (130 incidents). This is nearly as large as the number who wished to increase the planting of fruit trees. Most important here is the number wishing to increase as it would be impossible to decrease plantings without

removing them. Rather than take them out, which could be considered decreasing, the farmers are more likely to neglect the plantings

Profit and Debt

When daily existence costs like gas, water and food are subtracted from the amount of gross revenue generated through the sale of agricultural goods, many of the farmers have a negative value (Table 4.4). Twenty five percent of the farmers in the study actually end up with a monthly deficit when their monthly expenses are subtracted from all of their sources of income, including investment in cattle, and government support in the form of school stipends, retirement and disability payments. These expenses do not include agricultural inputs such as seeds and fertilizer because while many used these things, the sources and costs were extremely varied and difficult to accurately document. The largest expenses of tractor use and additional labor were calculated. The monthly expenditures were calculated based on the amount paid per month for water, gas, electricity, food and other necessities. They would have been higher had there been more cash available. One of the farmer's wives reported their spending on food per week to be $R80. Her husband quickly corrected her saying that she was wrong, they only had $R40 to which she replied " I know, but if we had it, we would spend $R80." Many of the farmer's families make do with less, for example, sending the women to cut wood for the fire rather than buy another gas container to cook on the stove with.

Without including non-agricultural sources of income (school stipends, retirement payments and disability), eleven of the sixteen farmers (68.75%) had a monthly deficit in earnings (Table 4.4). This suggests that sustainability and self- sufficiency are lacking. This situation will continue as long as the current bank incentives and marketing methods remain

in place. The low prices earned for produce are a hindrance to the farmer's progress, as is the lack of capital for investment in their plots.

The data collected serves as an indicator of the economic situation of the communities. A number of factors have worked together to increase the difficulty of the farmer's economic situation. As mentioned above, a system favoring large scale farming which relies on loans for small farmers has changed the battle from the fight for a piece of land to the struggle for economic survival. Many of the farmers claim that they were better off economically when they worked in the cane fields because then they were "just poor". Now they are poor and in debt. Of the sixteen farmers who participated in this study, 100% owed the bank over $R1000 (Table 4.4). More than a third (37.5%) owed upwards of $R 5000. This is a large amount considering the estimated monthly earning from agricultural products of fifteen of the sixteen farmers (93.75%) is less than one minimum salary per month ($R 137 = $US 76.00).

Another economic hindrance is the marketing of crops. At the sites, most farmers sell their produce to middlemen, called *atravessadors*. This is a person who buys directly from the farmers and resells the goods to other sellers or sells them at the market himself. Prices are generally 40 - 50% greater than what he paid at the sites. These sales are necessitated by the farmer's lack of transportation and time. As one farmer from the nearby Pitanga settlement explained, " Sometimes I sell to the *atravessador*. It's better because they have a truck that comes to pick up [the stuff]. It's better because to rent a truck is very expensive and wouldn't be worth it. I sell 15 kilos of cassava for 3000 (cruzados) , and he sells it kilo per kilo and earns 5000 (cruzados). " Another says, " By selling to the *atravessador* we can get back from the market faster and plant a new area." (Thorlby, 1998) Some see the middleman as a necessary entity that provides a valuable service, other have likened him to a

thief who receives a disproportionate amount of the profit compared to the hours he spends dealing with the crop.

Economic and Social Value

The farmers were asked to compare their current economic situation and social satisfaction with their former landless economic and social situations. It is important to distinguish the two types of value perceived by the formerly landless settlers. In conversation, many of them conveyed the feeling that no matter how difficult their situation currently was, they would not trade it for the lives they had before. One farmer said, " I sleep well. I get up in the morning and know that I have work and that we will not starve. I don't have to work for anyone but myself now." Another replied, "I would rather work ten hours for myself than one more hour for the bosses (of the cane fields)."

The negative comments often referred to the economic situation and the farmer's newly acquired debt. In response to the question evaluating their economic situation now as opposed to before they were settled in their community, no one replied that they were much better off today than before while 18.75% reported no change in their situation (Figure 4.7). A slight improvement was reported by over half of the study group (56.25%) and a decline by a quarter of the group with 12.5% claiming they are doing slightly worse and 12.5 % claiming that they are economically much worse than they were before they settled in their community.

Social benefits were evaluated by asking how the farmers perceive the quality of their lives now compared to their lives before they settled in their community (Figure 4.8). A significantly larger proportion reported an improvement in the quality of their lives, (81.25%) than a decrease in the quality of their lives. Slight improvement was the most

widely reported (43.75%) with 37.5% feeling their lives had become "much better". In the study group, 6.25% each reported no change, slightly worse and much worse.

When comparing results from the two questions, the improvement in quality of life exceeded the improvement in economic situation of the settled families (81.25% and 56.25% respectively). In addition, there were 50% fewer respondents who had perceived a decrease in their quality of life, compared to the percentage of the study group that perceived a decrease in their economic situation (12.5% and 25% respectively).

The distinction between the two indicators is important as it suggests that the reform movement is addressing some of the social situations that necessitated it in the first place, but not necessarily ameliorating the poverty that accompanies the social injustice.

Summary of Perceived Problems & Their Effect

The significant connection between the economic situation and the resulting actions and decisions the farmers make may not be fully evident through simple evaluation of the numbers presented. For this reason, interviews were an extremely important part of understanding this complex issue. A sample size of sixteen allowed for extensive personal interaction with each study participant. Economic difficulties and concerns were discussed frequently and openly.

The major difficulties identified through interviews and personal observations were:

1. Consistent funding for an already saturated subsistence crop market (largely crops like cassava and yams), and an ever-increasing number of settlements (which will increase the supply for the already flooded market)
2. Delayed issuance of promised funding causing planting at a non-ideal time

This was the situation at Ubu where the funding for the planting of coconuts was so delayed that once the funding finally came through and the seedlings got planted, it was too

late in the season. Lack of water resulted in losses of up to 90% of the coconuts planted on some plots. Despite delayed funding, the farmers were still responsible for repaying the money they had borrowed for the project.

3. Funding for an item that does not have a strong or established market at the time of the project

Limes had been promoted two years earlier at Ubu, and loans issued for their planting. In 2000, limes were being sold 100/1R, a price many found insulting and not compensatory for the amount of work it takes to get them to market. As a result, farmers decided to leave the limes on the trees to rot.

4. Blanket funding which does not consider plot differences or farmer preferences, and lack of control over use of funds

In one case, the farmer wanted a chicken house. Instead he was told that he had to use the funding for the building of a corral for the two cows that he would receive from a project. His detailed plans for a chicken coop went to waste as he built the pens for animals he had no experience caring for. The cows soon died and he owed the bank money for the animals he never wanted. Another man wants just animals but must plant subsistence crops to get the yearly funding. This limits the amount of time he can spend per day caring for his animals as he works on low value crops.

Long Term Effects on Economic and Environmental System

Overall, there is a proclivity towards cultivation of subsistence crops such as cassava and yam at both of the study sites. Economic limitations and potential benefit seem to play a large role in crop selection and the amount of area designated for each particular item. If the prices of subsistence crops are falling, one question is why the farmers continue planting them. The reason is, bank and government funding agencies play a large role in the

continued and almost obsessive dedication to planting cassava and other subsistence crops. Continuous cyclical planting of subsistence crops is perpetuated through the yearly bank allotment called "*Custeio*". This generally ranges from $R 500 to more than $R 1000 per farmer and is money designated solely for the production of subsistence crops. This money has a low fixed interest rate of 1 - 2% and a rebate of up to 40% for the year 2000 (Ministèrio do Desenvolvimento Agràrio, Balanço da Reforma Agrària e Agricultura Familiar) Under the original reform plans, the funds were loaned with a 50% rebate. This meant that only half of the money needed to be repaid, further increasing the incentives for planting of subsistence crops. While an important aspect of ensuring the farmer's survival and food security in the first few years of settlement, this funding seems to become a crutch that inhibits the development of self -sufficiency.

If the bank did not provide this money, many of the farmers would have a difficult time in the early stages of settlement when there are not seeds from previous years to ensure their plantation of cassava and yam. While this money is very important to the farmers in the beginning, it also ensures that they will not escape poverty later with their continued dependence on crops whose market is saturated.

Some claim that this is a subversive way to continually ensure cheap produce for the city and national markets while several others have voiced the more radical opinion that this is the way the land reform agency and the government plan to ensure the failure of the movement. Petras proposes, "The economic non-viability of the 'market agrarian reform' is fairly obvious. The Federal Government's purpose however, is political - to eliminate the possibility that the MST's land occupations would lead to successful productive cooperatives (as they have been in most instances around the country.)" (Petras, 2000)

Providing incentives for the planting of subsistence crops also discourages the planting of a more diverse plot. Planting cycle, space and availability of labor often dictate how diverse a plot will be. Once the subsistence crops are planted, there is little surplus labor or land area. The subsistence crops have an extremely long planting cycle (6-11 months), take up a large amount of space (52.01% of total planted area) and are fairly work intensive, often requiring two or more weedings. Economic resources are important as well. Funding is more difficult to obtain for less common plantings such as lettuce, peppers or tomatoes as they are higher risk crops.

Investing in other items often comes from the diversion of funds. To do so places the burden on the farmers to fulfill the planting obligations stipulated by the loan and then plant what they want with the leftover time and resources.

A New Regional Monoculture

Where there was once mile after mile of uninterrupted sugar cane plantations, there are now innumerable landless camps and settlements, almost all catering to subsistence crop production. Bank incentives through provision of low interest loans make the staple food crops an attractive proposition. In addition, there is the high start up cost and high water demands of higher value crops like tomatoes and peppers. The need for food security and assertion of property boundaries has also perpetuated the planting of these crops.

Even as the returns on cassava drop, the farmers continue to plant it. Many explained the decline in the market. In the early years of settlement, in the regions around the Metropolitan Recife Area, it was a seller's market for staple food crops. The farmers at Diamante reminisce about the buyers swarming through the settlement three years ago to buy cassava for markets in Recife. They paid well, bought large quantities, and still the demand was not completely met. In response to the profits, many farmers at this site and

others throughout the state increased their plantations in the years following. This, combined with the exponential increase in the number of settlements throughout the state, quickly created a surplus in the markets of Recife and elsewhere, shifting the process decidedly into a buyer's market.

This is evident in the low prices the farmers earn for their subsistence type crops. The effect of the shift to a buyer's market was seen at Diamante. One couple wished to sell 500 kg of bitter cassava. They would have been paid $R 20 for this. They needed two workers to harvest the crop, as the woman was old and had a bad back and the husband was ill. Each worker required $R 10 payment, plus lunch to harvest the cassava. The couple's net profit would have been $R 0 and they would have sold their main food source. They opted instead to eat what they needed and let the rest rot in the fields. This was a situation frequently encountered in the settlements as the prices continued to fall during the cassava harvest season.

The answer to the problem of falling prices and overproduction would seem to be for each farmer to cut back on their production, and to produce alternative crops. This does not happen though, largely because they cannot afford to invest in any other types of produce. Neither can they afford the additional risk involved with crops that may not be as hardy as the staple food crops. While a group of farmers could collectively decide to plant less, there is no guarantee that other farmers will do the same. Many of them expressed the idea that it is better to earn a small amount than to earn nothing at all.

The farmers also expressed the importance of having their lots look productive. They would feel that using just one small part of the lot for a high value crop and leaving the rest would be judged as "unproductive". There is also the issue of maintaining plot boundaries through continuous occupation of the land. Although no one would admit that they

themselves worried about the issue, many had a “neighbor” who worried that the family across the road would encroach if he did not fully utilize his plot.

All of these factors combined lead to the repeated and expansive planting of monoculture staple food crop areas, especially large areas of cassava.

Environmental cost vs. economic cost

The current system is leading to even higher discount rates for the farmers. That means that they will opt for decisions that yield immediate benefits over those that will yield their benefit in the future. Because of economic pressures, they are forced to compromise the future environmental sustainability of their property for the continued production and sale of cassava at present.

Repeated plantings of the same thing with little return is evidence of the low valuation of the time and energy that the farmers put in. Only one farmer actually put a price on the labor he contributed. The others valued the labor they provided but not in quantifiable terms which influenced their decisions. Only one other compared the time he would spend farming and the amount he would make selling the products versus the amount of money he could make through a construction project. As the revenue generated for crops such as cassava is so low, at times it is a better use of the money and time to divert the funding into something that acts as an investment for the area.

Some of the most successful farmers from an economic standpoint were those who took bank funding and diverted it from the purpose for which it was issued. Diversion of funds is well recognized but seldom discussed in public. Many of the farmers planted subsistence crops (cassava, yam) using their own seeds that they collected the year before. They would then take the bank loan for these crops, having already planted the quota amount that the loan stipulated. They would then invest the loan money. Some use the

funding for staple food crops for material “luxury” goods, such as appliances. Some use it to plant crops that were not funded but which they have a strong interest in planting.

At Diamante, many of the farmers bought calves with excess funds. This was a smart investment as the market for beef is more stable than the crop markets that decline dramatically during the harvest times when the markets become flooded. The important aspect of this example is that the farmers still complied with the loan arrangements of planting the specified area with the specified crop. At the same time, they were able to apply funds in a way that would generate more profit than if they had used the loan to plant more staple food crops and they ensured that they would be able to pay the bank. In another case, a frustrated farmer pointed out, “ We planted like we were supposed to. The neighbors down the road bought a car. Now we have to pay the bank. They don’t have money to pay but neither do we. Who’s better off?”

Spending so much time and energy on a crop which may produce but not net an economic return also discounts the value of the time which could be spent doing something else (opportunity cost), like attending adult literacy classes at night which many fail to attend due to sheer exhaustion.

In addition, little value is given to their inputs such as labor and time. If these were quantified and added to the calculations, the situation would show an even greater negative return. Currently, the low value earned for agricultural goods leads to a limited ability to supply inputs such as mechanized tilling, fertilizer or extra hands to help with harvesting. The economic ability of plantation owners to supply fertilizers and other soil amendments assured the productivity of the sugarcane plantation system. This is not true for the settlements and again raises the issue of a stability trade-off. In the case of the settlements, there is little replenishment of these environmental goods. The value of the outgoing

nutrients and soil can not nearly be compensated by the low price earned for sale of the crops. This could have a positive effect though as it may encourage innovation for replenishment of these goods. One example was the farmer's habit of forming mounds of cut grass and weeds on top of each plant to provide organic material and nutrients that are available in limited quantities from the soil.

The other environmental costs are an indirect result of the economic hardships suffered by settled farmers. For example, to plant yam it is necessary to have long poles to support the plant as it grows. Many farmers are embarrassed to admit where they get their poles. Frequently, the poles are cut out of the mangrove reserve bordering the settlement. At both sites, what little standing forest that remains is often entered to supply these poles.

Erosion is another major environmental problem that is exacerbated due to economic pressures. For example, the farmers with lots bordering the river often plant right to the bank. With limited space, and even more limited capital, it is difficult to convey the idea that the stream buffers will have a greater benefit to them than the additional planted area could generate today. While stream buffers are not used on the sugar cane plantations either, the nature of the crop and its heavy cover and little bare soil, allow for a lower degree of erosion than at the farmer's plots.

Environmental destruction can be profitable. One farmer sold birds, which he caught around the settlement. His wife swore to me that he traded the birds, never receiving money for them. She told me he could be arrested if he actually accepted money for this hobby. One day he contradicted her account and said that the birds were sold and that buyers come from all over the region to pick them up. This is not evidence of ecological ignorance. In fact, this man is an avid naturalist and knows a lot about the native birds and their habits.

It is evidence of an agricultural system that does not allow for economic growth, one in which illicit behaviors are compensated greatly and hard work generates little return.

Suggestions

Lack of a strong infrastructure was a common complaint from both the farmers and the extension agents assigned to work with these two communities. Once the farmers are producing, they need to be able to sell and survive. Investments allowing them to transform their products for a variety of markets would be especially beneficial. The farmers could then combat the dramatic fluctuations in the fruit and vegetable markets when something comes into season. For example, at Diamante they have been able to extract pulp from some of their fruit and freeze it. They now sell the pulp to ice cream manufacturers. This helps them hold on to their product during periods when the selling price is extremely low.

While bank loans should be an incentive to diversify as a buffer against a volatile market, diversification should not be pursued through massive projects proposing that every farmer in a community "diversify" by planting the same item. The negative effects of this type of proposal are well documented.

In Vitoria in the Northeast, the same thing that happened with passionfruit at Diamante occurred with guava. Everyone was encouraged to plant it as a means of diversifying, flooding the local market and causing the farmers to watch in disbelief as the price continued to drop.

In addition, if there is going to be continued support for the planting of staple food crops, efforts should be currently be underway to stimulate national markets and to create international markets. The number of settlements is not going to decline within the near

future., which means that the supply of already plentiful produce is going to continue to grow.

Finally, a more rigid overseeing of the purchase and use of essential implements such as pumps, coupled with more individual freedom in selection of crops or animals is necessary. The communities should be accountable for all equipment that they receive at either no cost or even subsidized. It would ensure the creation of a planting and marketing infrastructure while at the same time allowing the farmers to have control over their plots. Monitoring can be left to community members. If treating equipment well becomes a matter of community pride, there is a good chance that through peer pressure, the community members would not allow for the robbery or sale of an implement that is benefiting members of the group.

Many of the farmers throughout both communities resented the lack of involvement when pump equipment was purchased for one group. The lack of choice caused frustration and ill will, an impetus for many to sell equipment, such as the pumps. The farmers were frustrated because they had received the capability to irrigate before they even had crops planted. They saw this as faulty logic and sold the pumps both out of rebellion and economic necessity. By doing so, they sealed their fate in the subsistence class because the equipment, in this case a pump, was later on necessary for progress and increased revenue on their plots.

Suggestions to improve the situation must take the communities and culture into account. Even the “micro-culture” of a particular community and the intricate history and family relations within it are important aspects in project planning and feasibility analysis. For example, the community of Diamante is much more cohesive than that of Ubu. Several reasons have contributed, ranging from plot size, number of families, and the method of land acquisition, all of which have resulted in very different levels of unity within

the settlements. For this reason, several projects have been attempted at Diamante that would not have been tried at a more fragmented site**.**

The information gathered is applicable to other settlements in the region as they share many of the same characteristics, including the types of problems that impede their development.

Innovative funding projects that offer more options for survival within an unpredictable market are key. The connection between subsistence crops and food security also needs to be acknowledged and incorporated in planning strategies. People who have gone hungry while camping on the roadside are less likely to jump into a new technology or plan without the security of being able to feed their families. An infrastructure which promotes an increase in the farmer's standard of living while at the same time includes the cultural and social ideas which are important to them is essential to an effective program.

Conclusion

It was found that bank incentives and the farmer's desire for food security stimulate the production of long term, low risk, low value crops such as cassava and yam. As a result, many of the markets surrounding reform areas are glutted with subsistence crops, creating an economic situation that is quite difficult for the farmers to prosper in. The situation is worsening as the number of reform settlements grows, and the farmers continue to adopt the planting design of low value, low risk crops. This is taking its toll both on the environment and the local economic situation.

Economic aspects are partly if not largely responsible for the difficulties incurred at many settlements. It is essential to not lose sight of the fact that the goal of reform is not to create communities of wealthy people. The real point of reform is to enable a decent standard of living for the settled farmers. Both economically and environmentally, perpetuation of

sugarcane production will not achieve this. Agrarian reform should include a comprehensive attempt at providing a higher standard of living and economic and ecological sustainability for the relocated rural masses.

If reform is going to progress, it must be done correctly and offer dignity and compensation for those who work from sun up to sun down. Innovative projects that take the communities strengths and weaknesses into account will contribute to a successful reform. Economic weakness in the reform movement is not acceptable or sustainable. Many question the benefit of having reform at all, yet the increase in satisfaction of the settled farmers makes the process, however troubled, worthwhile.

The keys to an economically successful reform are the creation of unified communities, the stimulation of diversified plantings for a variety of markets, the provision of sufficient technical assistance, and capacity building to create additional, non-agricultural sources of income for the settlements. These are long-term goals that need to be continuously worked towards. Not every community will succeed. It is important to build the communities with these factors in mind, hopefully cultivating the conditions that will be most conducive to economic and social progress of the communities. .

TABLE 4.1: ITEM DISTRIBUTION

Item	% UBU Farmers	HA	% DIAMANTE Farmers	HA	Total %
	Who have item		Who have item		U & D
Yam	75	3.68	87.5	2.32	81.25
Bitter Cassava	50	6.26	62.5	4	56.25
Sweet Cassava	87.5	15	87.5	*2.275*	87.5
Corn	62.5	3.4	75	*2.125*	68.75
Beans	62.5	1.85	50	0.225	56.25
Fava Beans	12.5	0.05	37.5	0.083	25
Potato	50	0.525	75	0.37	62.5
Pumpkin	50	0.602	12.5	0.0009	31.25
Squash	0	0	0	0	0
Watermelon	75	2.15	12.5	0.0006	43.75
Passionfruit	37.5	0.6359	62.5	6.921	50
Tomato	37.5	2.0752	12.5	0.0005	25
Pepper	37.5	1.275	12.5	0.0048	25
Banana	87.5	0.7834	100	0.909	93.75
Scallions	12.5	0.0005	12.5	0.0005	12.5
Cilantro	25	0.275	25	0.025	25
Papaya	50	0.0846	50	0.4086	50
Mango	87.5	0.448	87.5	0.2112	87.5
Orange	75	0.6696	62.5	0.1782	68.75
Pineapple	0	0	62.5	0.0308	31.25
Caju	100	3.28	100	0.81	100
Graviola	62.5	0.1548	50	0.0792	56.25
Acerola	75	0.6272	87.5	0.072	81.25
Pitomba	12.5	0.192	75	0.128	43.75
Pitanga	37.5	0.0896	37.5	0.0176	37.5
Lime	62.5	1.0764	25	0.0144	43.75
Coconut	100	10.07	100	4.25	100
Other	50	0.1728	12.5	0.0448	31.25
Chicken	75		87.5		81.25
Turkey	0		12.5		6.25
Guinea	0		0		0
Cow	0		87.5		43.75
Calf	0		75		37.5
Horse	0		50		25
Chick	37.5		25		31.25
Capim (feed grass)	12.5		87.5	1.11	50
Other animals	12.5		50		31.25

TABLE 4.2: AREA AND FREQUENCY OF ITEM

Area Per Item in Hectares				% of Farmers Having Item			
Item	**Ha Ubu**	**Item**	**Ha Diamante**	**Item**	**Ubu**	**Item**	**Diamante**
Pineapple	0	Squash	0	Guinea	0	Squash	0
Squash	0	Scallions	0.0005	Turkey	0	Guinea	0
Scallions	0.0005	Tomato	0.0005	Calf	0	Turkey	12.5
Fava	0.05	Watermelon	0.0006	Cow	0	Tomato	12.5
Papaya	0.0846	Pumpkin	0.0009	Squash	0	Other	12.5
Pitanga	0.0896	Peppers	0.0048	Horse	0	Pumpkin	12.5
Graviola	0.1548	Lime	0.0144	Pineapple	0	Scallions	12.5
Pitomba	0.192	Pitanga	0.0176	Fava	12.5	Watermelon	12.5
Cilantro	0.275	Cilantro	0.025	Other animals	12.5	Pepper	12.5
Mango	0.448	Pineapple	0.0308	Pitomba	12.5	Cilantro	25
Potato	0.525	Others	0.0448	Capim (feed grass)	12.5	Chick	25
Pumpkin	0.602	Acerola	0.072	Scallions	12.5	Lime	25
Acerola	0.6272	Graviola	0.0792	Cilantro	25	Pitanga	37.5
Passionfruit	0.6359	Fava	0.083	Pepper	37.5	Fava	37.5
Orange	0.6696	Pitomba	0.128	Tomato	37.5	Horse	50
Banana	0.7834	Orange	0.1782	Passionfruit	37.5	Beans	50
Lime	1.0764	Mango	0.2112	Chick	37.5	Other animals	50
Peppers	1.275	Beans	0.225	Pitanga	37.5	Papaya	50
Beans	1.85	Potato	0.37	Papaya	50	Passionfruit	62.5
Tomato	2.0752	Papaya	0.4086	Bitter Cassava	50	Orange	62.5
Watermelon	2.15	Cashew	0.81	Potato	50	Pineapple	62.5
Cashew	3.28	Banana	0.909	Other	50	Calf	75
Corn	3.4	Capim(feed grass)	1.11	Pumpkin	50	Corn	75
Yam	3.68	Corn	*2.125*	Beans	62.5	Pitomba	75
Bitter Cassava	6.26	Sweet Cassava	*2.275*	Graviola	62.5	Potato	75
Coconut	10.07	Yam	2.32	Lime	62.5	Capim (feed grass)	87.5
Sweet Cassava	15	Bitter Cassava	4	Corn	62.5	Chicken	87.5
Chicken		Coconut	4.25	Acerola	75	Mango	87.5
Turkey		Passionfruit	6.921	Chicken	75	Cow	87.5
Other		Guinea		Watermelon	75	Sweet Cassava	87.5
Cow		Chicken		Yam	75	Yam	87.5
Calf		Turkey		Orange	75	Acerola	87.5
Horse		Horse		Mango	87.5	Coconut	100
Chicks		Chicks		Sweet Cassava	87.5	Banana	100
Capim (feed grass)		Cow		Banana	87.5	Cashew	100
Other animals		Other animals		Coconut	100	Cashew	100
Guinea		Calfs		Cashew	100	Cashew	100
Total	55.25		26.62				

* italicized items are the average of data reported as a range

TABLE 4.3 $R/ HECTARE

Ubu				**Diamante**			
Item	**Ha.**	**$R Earned**	**R/Ha***	**Item**	**Ha.**	**$R Earned**	**R/Ha***
Passionfruit	0.636		0.000	Pineapple	0.031	0.000	0.000
Other animals				Scallions	0.001		0.000
Capim				Tomato	0.001	0.000	0.000
Chicks				Lime	0.014		0.000
Horse				Pitanga	0.018		0.000
Fava	0.050	0.000	0.000	Fava	0.083	0.000	0.000
Calf		0.000		Potato	0.370	0.000	0.000
Cow		0.000		Pumpkin	0.001	0.000	0.000
Guinea				Squash	0.000	0.000	
Scallions	0.001		0.000	Watermelon	0.001	0.000	0.000
Other				Capim	1.110		0.000
Turkey		0.000		Pitomba	0.128		0.000
Chicken		147.500		Papaya	0.409	0.000	0.000
Pitanga	0.090		0.000	Graviola	0.079		0.000
Lime	1.076		0.000	Mango	0.211	0.000	0.000
Mango	0.448		0.000	Orange	0.178		0.000
Orange	0.670		0.000	Cashew	0.810		0.000
Coconut	10.070	40.000	3.972	Other	0.045		0.000
Pineapple	0.000	0.000		Banana	0.909	10.000	11.001
Cashew	3.280		0.000	Coconut	4.250	60.000	14.118
Graviola	0.155		0.000	Cassava (Bitter)	4.000	92.000	23.000
Acerola	0.627		0.000	Passionfruit	6.921	300.000	43.346
Pitomba	0.192		0.000	Cassava(Sweet)	*2.275*	100.000	43.956
Watermelon	2.150	30.000	13.953	Acerola	0.072	10.000	138.889
Corn	3.400	77.500	22.794	Corn	*2.125*	340.000	160.000
Pumpkin	0.602	70.000	116.279	Beans	0.225	50.000	222.222
Cassava (Bitter)	6.260	850.000	135.783	Guinea			
Beans	1.850	320.000	172.973	Cow		4550.000	
Cilantro	0.275	50.000	181.818	Calf		11200.000	
Squash	0.000	0.000		Horse			
Banana	0.783	150.000	191.473	Yam	2.320	2020.000	870.690
Potato	0.525	150.000	285.714	Turkey			
Papaya	0.085	25.000	295.508	Chicken		0.000	
Cassava (Sweet)	15.000	5350.000	356.667	Chicks			
Tomato	2.075	*975.000*	469.834	Cilantro	0.025	200.000	8000.000
Pepper	1.275	725.000	568.627	Other animals			
Yam	3.680	8960.000	2434.783	Pepper	0.005	350.000	72916.667

TABLE 4.4 INCOME AND EXPENSES

	Farmer	Income from Survey info	Farmer's Estimate Income/month	# Cattle	# Cattle x Value (400$R)	Income with cattle	Income per month with cattle	Other income per month	Expenses / month not incl. ag. inputs	Income (w/ cattle) - Expenses	Income w/ cattle) + Other income - Expenses	Debt
U	U1	4900	> 68.5	0	0	4900	408.33	150	387	21.33	171.33	5050
b	U2	2070	137	0	0	2070	172.50	535	338	-165.50	369.50	6120
u	U3	1700	137	0	0	1700	141.67	400	215.4	-73.73	326.27	6000
	U4	1705	> 68.5	0	0	1705	142.08	0	94.5	47.58	47.58	3700
	U5	5950	> 68.5	0	0	5950	495.83	135	310.29	185.54	320.54	4800
	U6	25	100	0	0	25	2.08	200	164.2	-162.12	37.88	5500
	U7	3100	274 to 685	0	0	3100	258.33	260	565.5	-307.17	-47.17	3750
	U8	845	> 68.5	0	0	845	70.42	225	368	-297.58	-72.58	4450
D	D1	210	137	8	3200	3410	284.17	135	412	-127.83	7.17	7500
i	D2	1420	137	8	3200	4620	385.00	145	441	-56.00	89.00	1500
a	D3	700	> 68.5	5	2000	2700	225.00	0	369	-144.00	-144.00	1100
m	D4	80	> 68.5	13	5200	5280	440.00	270	226.87	213.13	483.13	1300
a	D5	720	137	5	2000	2720	226.67	80	87	139.67	219.67	1800
n	D6	107	> 68.5	0	0	107	8.92	80	179	-170.08	-90.08	5500
t	D7	173	> 68.5	1	400	573	47.75	235	225	-177.25	57.75	1800
e	D8	330	137	5	2000	2330	194.17	405	400	-205.83	199.17	1500
	TOTAL	24035		45	18000	42035	3502.92	3255	4782.76	-1279.84	1975.16	61370
	Total Ubu	20295		0	0	20295	1691.25	1905	2442.89	-751.64	1153.36	39370
	Total Diam	3740		45	18000	21740	1811.67	1350	2339.87	-528.20	821.80	22000

* All values are in Brazilian Reais, $US 1 = $R 2.

TABLE 4.5 GROSS INCOME PER MONTH

Farmer		Income per Month including cattle	Income per month per hectare
Ubu	U1	408.33	54.44
	U2	172.5	23.00
	U3	141.67	18.89
	U4	142.08	18.94
	U5	495.83	66.11
	U6	2.08	.28
	U7	258.33	34.44
	U8	70.42	9.39
Diamante	D1	284.17	113.67
	D2	358.00	154
	D3	225	90.00
	D4	440	176
	D5	226.67	90.67
	D6	8.92	3.57
	D7	47.75	19.10
	D8	194.17	77.67
TOTAL		3502.92	950.17
TOTAL Ubu		1691.25	28.19
TOTAL Diamante		1811.67	90.58

All values are in Brazilian reais. $US1 = $R2.

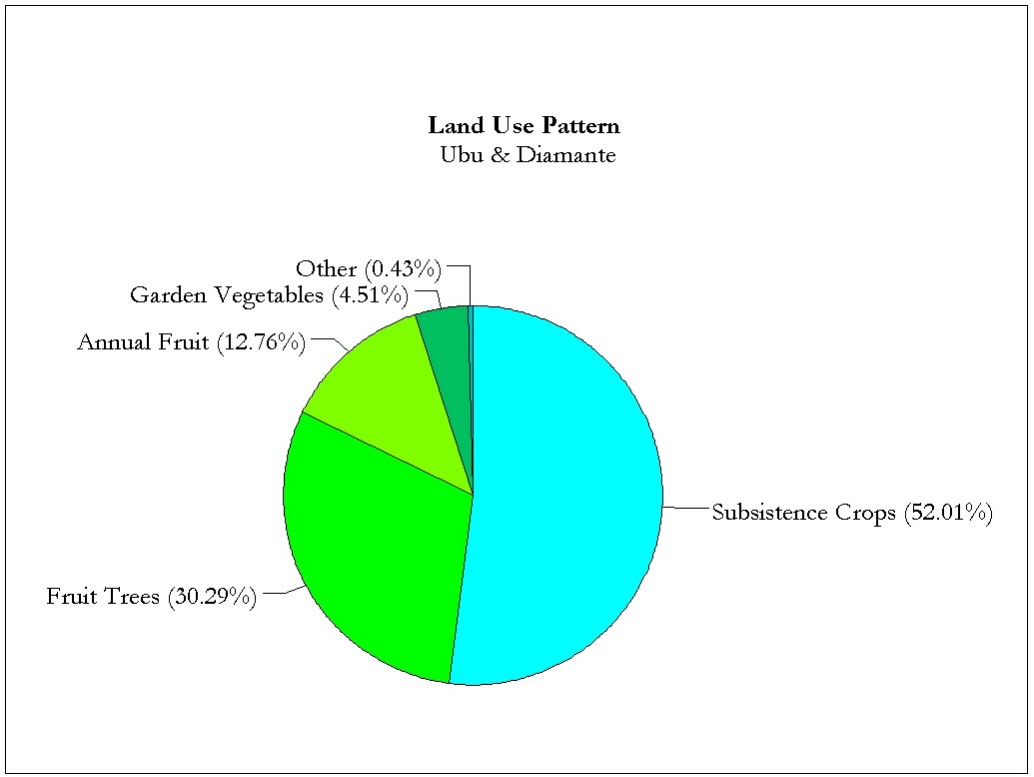

FIGURE 4.1: LAND USE PATTERNS -
Distribution of land by type of crop planted at two settlements, Diamante and Ubu. .

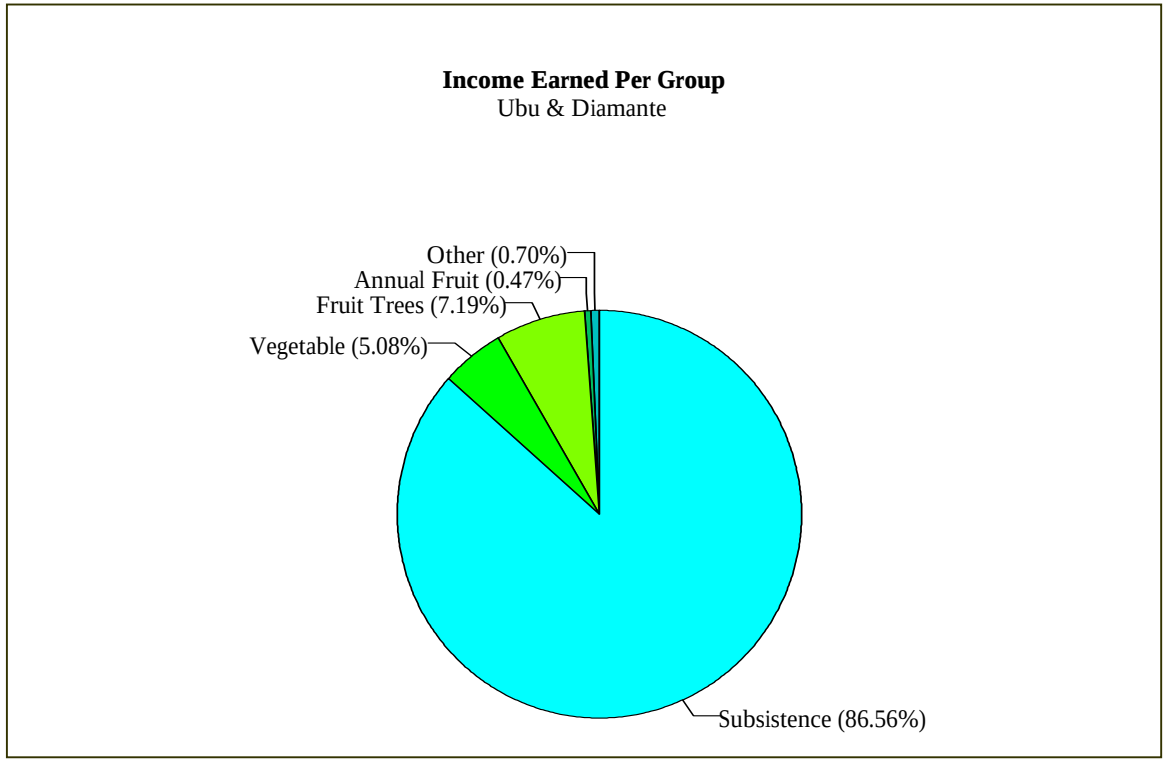

FIGURE 4.2 INCOME PER TYPE OF CROP PLANTED AT TWO SETTLEMENTS
Gross income from sale of agricultural goods.

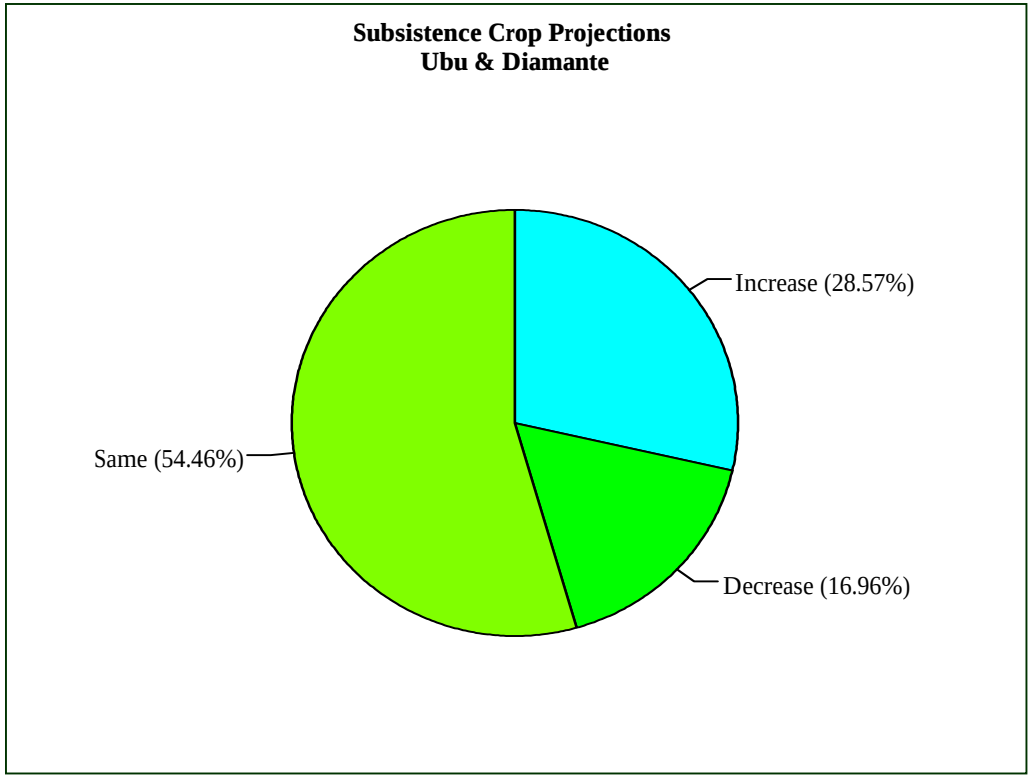

FIGURE 4.3: "SUBSISTENCE" CROP PROJECTIONS
Future crop projections based on farmer's response to a survey question asking if they were going to increase decrease or keep the same amount of a given item.

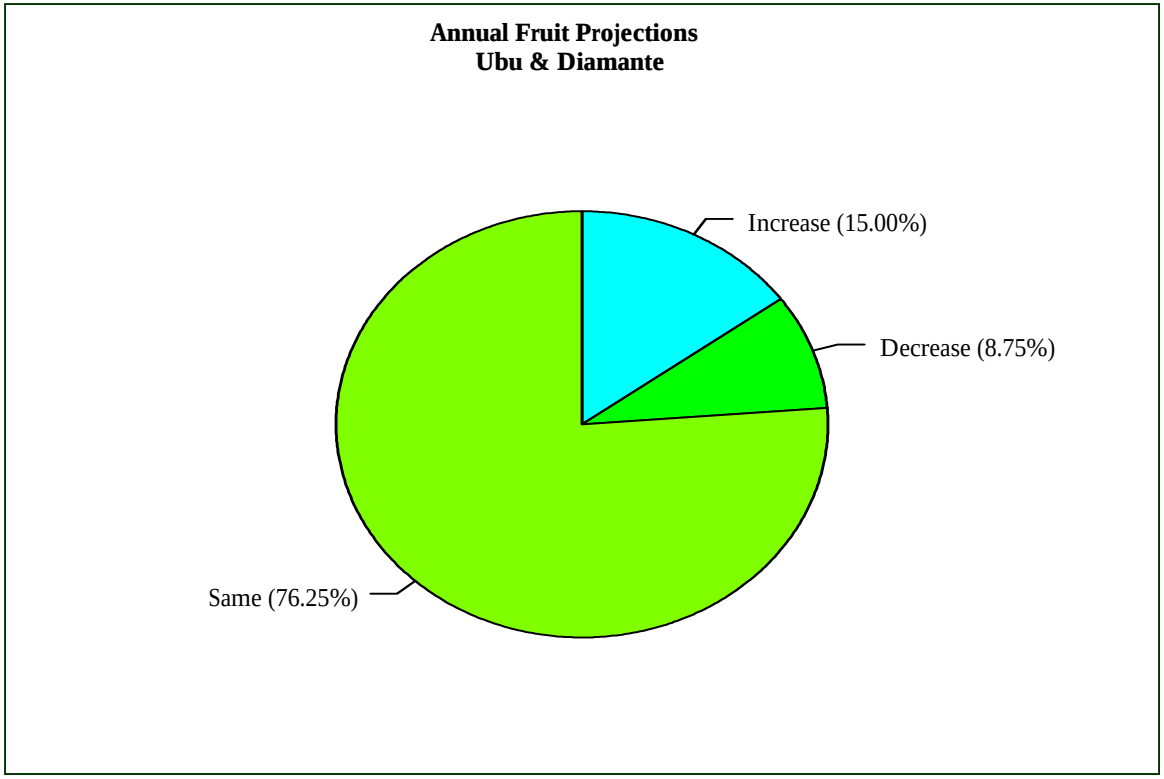

FIGURE 4.4: ANNUAL FRUIT CROP PROJECTIONS
Future crop projections based on farmer's response to a survey question asking if they were going to increase decrease or keep the same amount of a given item.

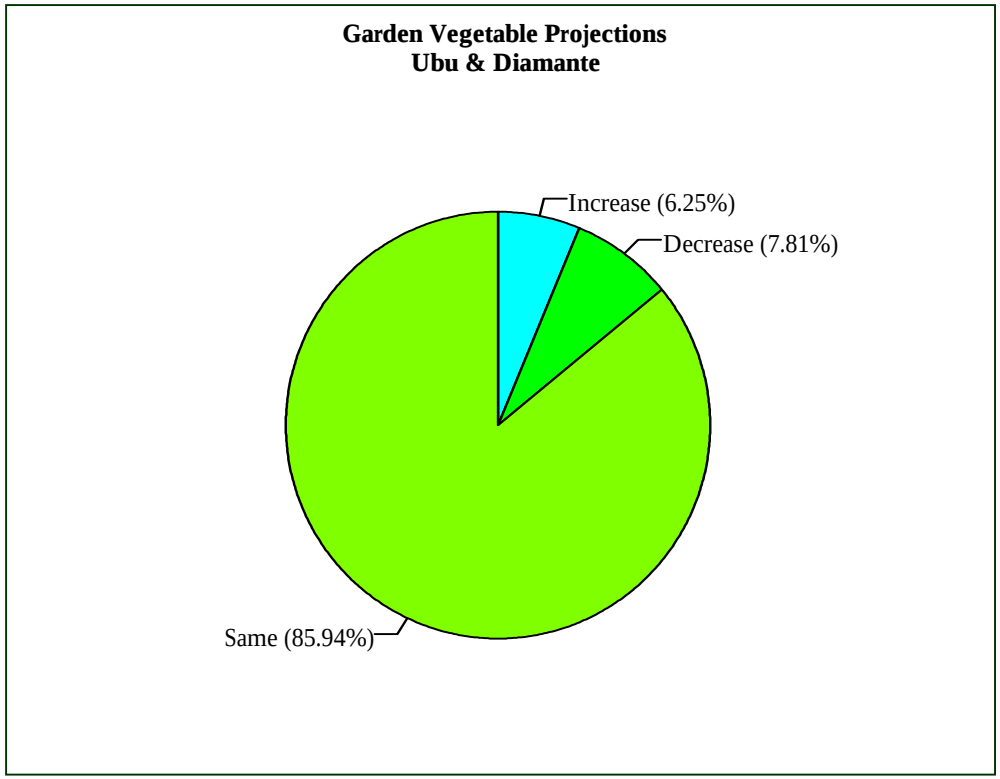

FIGURE 4.5: GARDEN VEGETABLE PROJECTIONS

Future crop projections based on farmer's response to a survey question asking if they were going to increase decrease or keep the same amount of a given item.

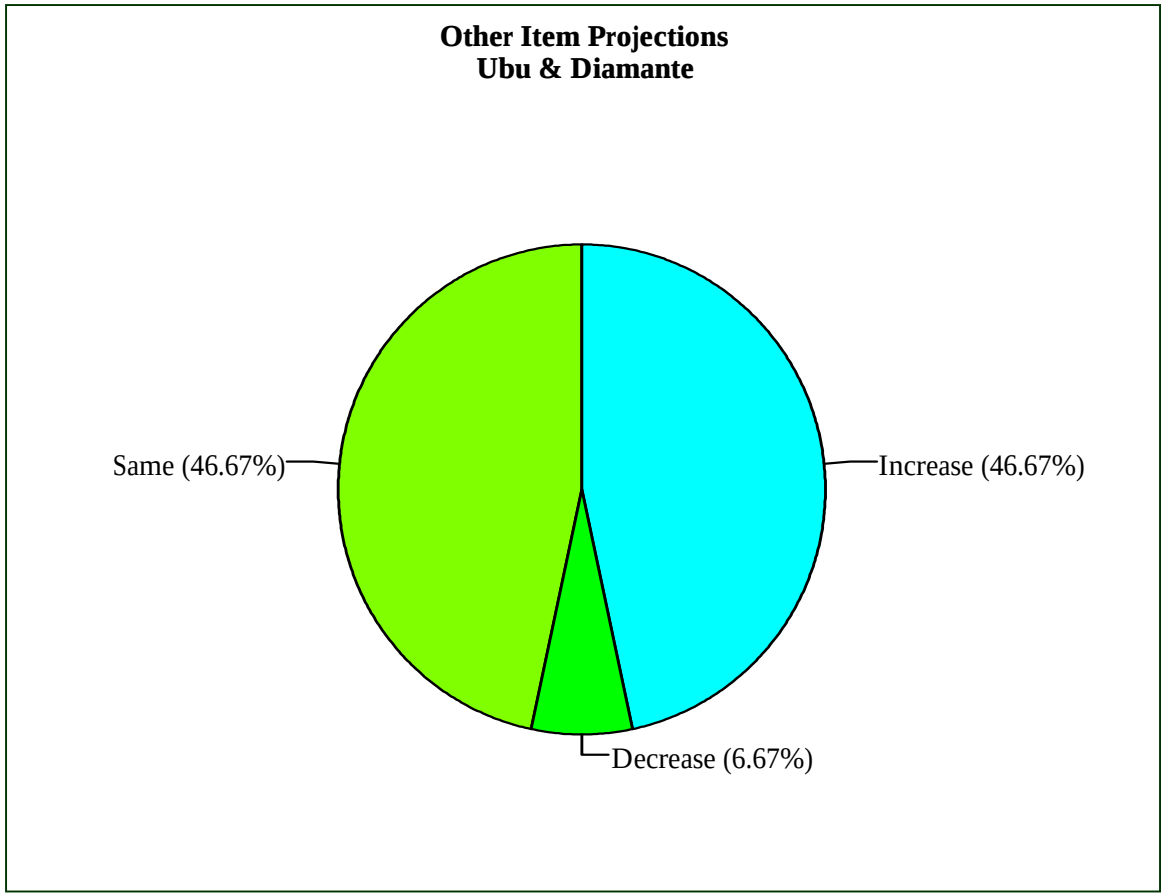

FIGURE 4.6: "OTHER", FUTURE CROP PROJECTIONS
Projection for "other" crops like scallions and cilantro,based on farmer's response to a survey question asking if they were going to increase decrease or keep the same amount of a given item.

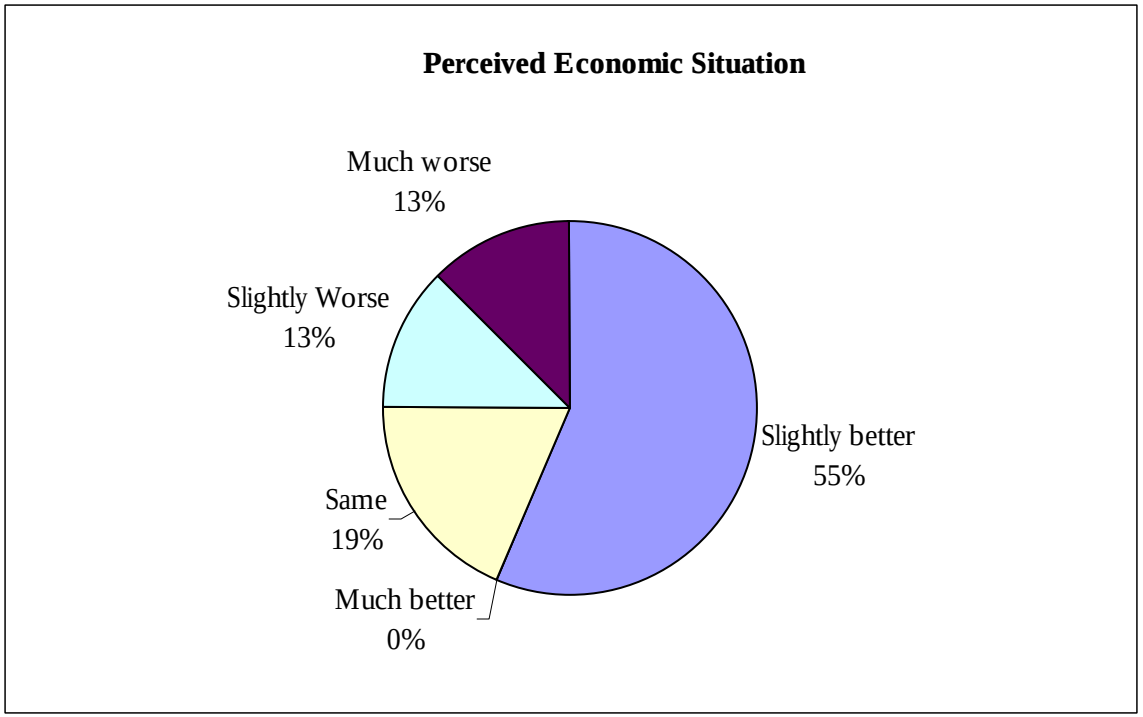

FIGURE 4.7: PERCEIVED ECONOMIC SITUATION: UBU & DIAMANTE

This information is based on the farmer's evaluation of their economic well being now, compared to that before participating in the agrarian reform program. The general term economic situation included their feelings on their amount of available capital and existing debt as well as their ability to generate income.

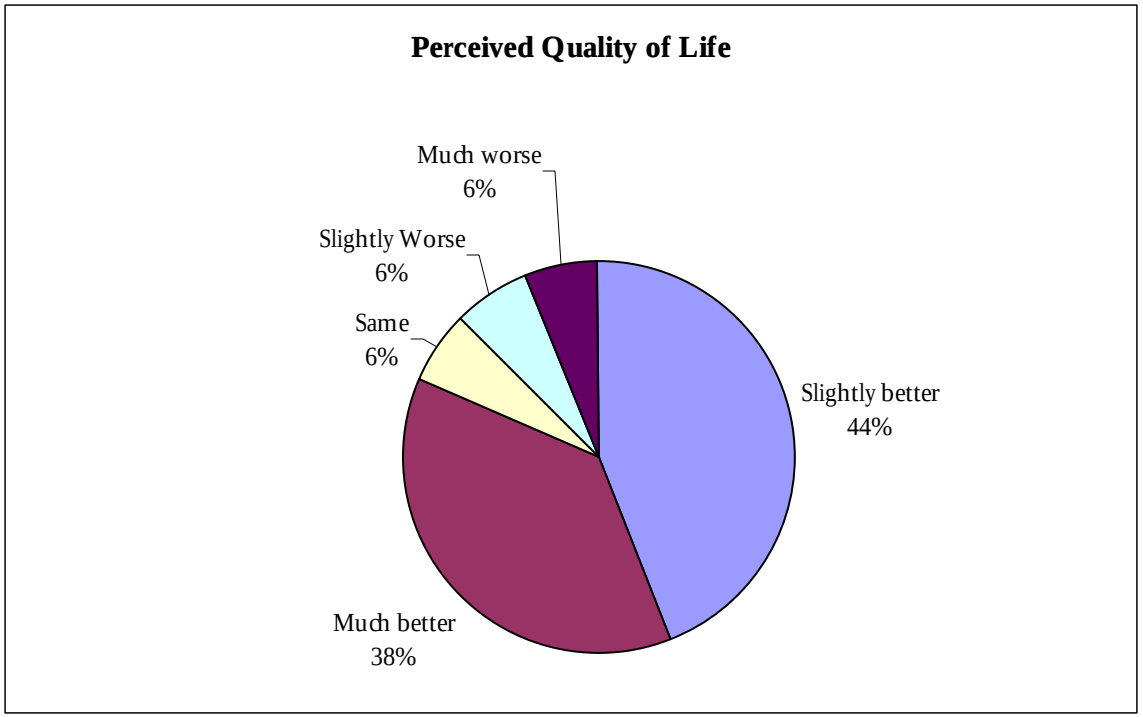

FIGURE 4.8: PERCEIVED QUALITY OF LIFE FOR UBU AND DIAMANTE.
This information is based on the farmer's evaluation of their quality of life now, compared to their lives before participating in the agrarian reform program.
.

CHAPTER 5

BIGGER IS RARELY BETTER - PLOT SIZE AS A COMPONENT OF FARMER SUCCESS

Law # 4,504 November 30, 1964 Land Statute - Chapter 1 Principles and Definitions of Article 4, Section 2.

" **Family Property**", the property that, directly and personally developed by the farmer and his family, utilizes all of their work force**, guaranteeing them subsistence and social and economic progress**, with the area to develop, and eventually, work with the help of a third party.

Pg. 19 Land Statute, (Estatuto da Terra)
Ministerio da Reforma e do desenvolvimento agrario - MIRAD
Instituto Nacional de Colonizacao e Reforma Agraria - INCRA

Introduction

Agrarian Reform continues to be one of the most controversial issues throughout Latin America and Brazil. As such, it has generated strong pro and anti-reform propaganda (www.mst.org,/www.lepanto.org.br). Amidst the varying opinions, one message is coming through clearly - that agrarian reform as it is currently carried out is not raising the standard of living of all settled families. The average monthly earning from agricultural products is under one minimum salary per month, currently about $US 70. Many of the trademarks of poverty are found within the settlements. These include a high illiteracy rate, diseases such as mumps, and poor health care. The fact that the farmer's situation has not improved has led to speculation as to whom and what are to blame for the difficult situation of the settled farmers.

In pursuit of answers, many have pointed to the size of the plots assigned to individual farmers. The idea that larger plots are better prevails among farmers and extension agents.

Several sources, from the Movement for Landless Workers (MST) to the former head of INCRA, have claimed that plots of less than 20 - 50ha are not viable. (INCRA, personal comm., Soca, World News)

It has been proposed that the small plots pose such a great obstacle that farmers are destined to fail from the beginning. INCRA officials complain that the insufficient plots lead to the downfall of the reform they have tried so hard to build. Many of the men who occupy these positions though, are men who grew up farming with equipment and technology, not a hoe. What many of them see as successful agriculture is large-scale, technology intensive agriculture.

One aspect of this study was to determine whether small plots truly inhibit the economic growth and environmental health of sites. This involved first determining why the areas issued are consistently smaller than the recommended plot size. Plot size specifications were outlined by INCRA after an analysis for county specific estimations of the smallest viable plot size. Secondly, and perhaps most importantly, is determining what the effect has been of disregarding the stipulated module sizes in favor of smaller parcels.

Plot measurement specifications are one of the few aspects of the Brazilian Agrarian Reform Process with clearly documented policies. Since the publication of the Estatuto de Terra (Land Statute) in 1964, legislation has clearly spelled out how properties should be divided. Since that time, INCRA has expanded the specificity of the process and created even more detailed guidelines for determination of an appropriately sized lot based on county-by-county analyses. Even so, a great discrepancy exists between what reform policy mandates and the smaller plots which are allotted.

At the study sites, the regulation module size was 14ha of arable land per family. The actual size of the farmer's lots was 2.5 ha. at one site and 7.5 ha. at the other. The minimum viable size proposed was 10 ha.

Many question why the lots are generally smaller than the specified module size, and why the landless settle for them. Part of the reason is the immense pressure from both the farmers and the reform agencies to process expropriations quickly. For the farmers, the desire is for better living conditions. Quality of life is severely compromised during the squatting process.

Squatters can spend up to two years living under black plastic tents, subject to extreme weather conditions. When distribution begins, they do not haggle over "module size" or what is stipulated in the reform regulations, which many could not read even if they had access to the documents. Understandably, they are eager to begin their new lives on plots of any size. When speaking about her life today, a young girl from Ubu said, " It's better than when we were camping. Sometimes when we camped we only had crackers to eat. Sometimes not even that." The government wants it to go through because once it is done, they can deal with the other farmers who are waiting.

INCRA and other settlement agencies are often under severe pressure from the farmers demanding settlement. On a visit to INCRA in June 2000, the front entrance to the building was secured with locks and chains after they learned of one group's plan to storm the building to emphasize the need for rapid expropriation of a property. The farmer's threats could be to their eventual detriment, as their urgency does not allow time for matching families with suitable parcels. Currently, little is done other than a rapid lottery to place families on lots.

The strong sense of solidarity between the camped farmers makes distribution of lots difficult. In many cases, the families are hesitant to split the group that has invaded together. For example, if the land under the exact module specifications could only accommodate 50 families with 14 ha each, they are likely to accept 7ha each for the 100 families camped out. This stems from group cohesion during this phase and the hesitancy of each family to volunteer to wait for a larger piece of land due to the fear that it may never come. The settling agency generally complies.

This was the case in the nearby settlement of Pitanga. The families accepted lots of a smaller size to accommodate the whole group that had taken part in the invasion process. Later, when they complained about the size of their plots, these farmers were encouraged to purchase the lots of their less competent neighbors. Encouraging consolidation of small properties into larger landholdings within the framework of agrarian reform is in itself evidence of reform gone awry. Land consolidation is the very behavior the reform movement was created to combat.

The decision to site farmers on smaller plots involves political issues as well. In some cases, INCRA officials are trapped within the framework of a government that is still largely controlled by the rich, many of whom are landholders. As a result, the policy created for agrarian reform is contradictory, attempting to promote reform while at the same time protecting the interests of the rich, landed minority. In this way it fails to confront the basic social causes of the problem. This has resulted in inefficient reform policy and frequent failure to comply with reform regulations issued in the Land Statute of 1964.

In addition, INCRA is suffering the effects of a faltering Brazilian economy. They lack sufficient agents and funds for a thorough job. One of the settlements I worked with, Ubu, is still waiting for delineation of plot boundaries by INCRA. They were settled more than

five years ago. This is increasing frustration and agitation between neighbors and stifling long-term investment in plots. Farmers do not want to invest in land which they are not sure is theirs. This could be remedied quickly and easily with better equipment (Global Positioning Systems for example), and more manpower to perform plot delineations in settled areas. These areas are often neglected as new ones demand attention.

Site Size

The Assentamento Diamante has 75 farmers situated on 2.5 ha each (Fig A7), and Assentamento Ubu has 175 families situated on approximately 7.5 ha each (Figure A8). Diamante's total area is 165 hectares. Ubu's is 1509 hectares.

Methodology & Specific Questions Addressed

For more information on survey methods, participant selection or interviewing techniques, see Methodology, Ch. I.

Ability to provide inputs

The farmers were surveyed on a number of issues related to the inputs that they were able to contribute to their farms. These topics included hired labor, use of a tractor, and family labor. In theory, if the farmers were able to provide inputs other than family labor, they would have achieved some level of economic stability that would enable them to do this. This question was also asked to see how the plots were managed. For example, did a tractor clear the land, or was it cleared by men with hoes. The purpose was to evaluate whether the availability of inputs varied as a result of the size of the plots or whether there was no correlation between the two.

Diversity

The number of different items at each site was surveyed. In addition, the amount of space allocated for each item was surveyed and calculated through the creation of plot maps

of each farmer's site. Crop diversity has been specified as one of the major ingredients in more sustainable agriculture. Generally, a less diverse area is more vulnerable to pests and disease. In addition, the more economically vulnerable the farmer is if the particular item fails for any reason during a season.

Land Use Decisions

The motivating factors behind the farmer's management decisions were considered. This was to evaluate what role farm size played in determining use. The main question was whether larger plots increased the farmer's options or if they limited the choices the farmers have. For example, did having a plot more than two times as large as Diamante's allow Ubu's farmers to diversify and generate a greater income, or did the extra land place such a burden of excess labor on the farmer that low maintenance crops were chosen for mass plantings? The influence of available labor and capital were considered for their role in a farmer's land use decisions as well.

The development plans for their land were also researched. How do they plan to develop their lots and why? Selection of items for future plantings indicated to some extent, the factors which direct their choices. The major obstacles that have impeded their plans for plot development were also discussed and documented.

Income

The quantity and area allotted all items were recorded as was the income gained from the sale of agricultural goods. Each site was evaluated on an income ($R)/ha basis from the sales of agricultural goods.

Ideal size of Property

All of the farmers in the study were asked to identify the dimensions of their ideal plot. They were then asked what they thought would happen if they had a larger plot, but the

amount of funding and labor stayed exactly the same. This question was then posed for smaller lots, once again assuming the same amount of resources available to the farmer.

In addition, they were asked what difficulties their particular lot presented. This was to identify how important they considered plot size compared to other factors.

Finally, they were asked to identify the largest problems they and their family had. The responses were recorded and ranked for frequency. Their responses will help gauge validity of the repeated claim that small plot size is responsible for the difficulties encountered in agrarian reform communities.

Results and Discussion

Ability to provide inputs

The ability to provide inputs is often strongly correlated with the availability of cash resources. Consideration of available income was an important component of the ability to provide inputs. It was expected that the value of agricultural goods from 2.5 hectares would be substantially less than the income from 7.5 hectares. In actuality, Diamante exceeded the gross income per month of Ubu (Figure 5.1). On plots nearly three times the size, the total gross combined income for the eight Ubu farmers was $R1691.25. (Table 4.4) At Diamante, the combined income for the eight farmers was $R1811.67. These figures are for agricultural products, not including additional sources of income. This data clearly does not uphold the theory that farmers need larger plots to earn more.

The use of mechanization (tractors) was nearly five times greater at Ubu than at Diamante (Table 5.1). This means that a large percentage of their income was spent on plowing land for planting. Neither site allows use of the plow without paying for the services ahead of time so rental could be classified as income spent, not debt accrued. The high cost of the tractor ($R20 - $R30/hr), leaves little excess cash to invest in high-risk

crops. The need for a certain, albeit low, economic return combined with the desire to plant quickly before weeds took over, made staple crops a favorite for the plowed areas. The size of the area for a single family, combined with the crop choice, seems to necessitate mechanization.

The amount of tractor use is indicative of the extent of subsistence crop coverage at each site. Generally, the greater the tractor use, the larger the amount of cassava or yam. Those farmers with large plots, who could not afford to use the tractor, had unplanted areas. Those who could afford it had a sea of cassava and yam. The greater tractor use at Ubu cannot be explained by the difficulty of planting the area, since the sandy soil at Ubu is easier to work manually than the heavier, clayey soils at Diamante.

The number of weeks that workers were hired for manual labor varied little between the two sites. Diamante had a total of 27.5 weeks and Ubu had 30 weeks. Considering the smaller size of Diamante, there was a much more intense use of additional labor compared to Ubu.

The difference in the type of labor inputs (manual vs. mechanized), offers clues to the nature of the plantings at the two sites. Workers are generally hired to help with things tractors cannot do. For something like clearing the land to plant cassava, the tractor at $R20 -30 an hour is a better value than hiring men to work at $R10 per day because of the greater area it can cover in less time. Activities which tractors are not used for include planting passion fruit and fruit trees such as bananas and papaya, weeding, and digging holes for yam. The greater use of mechanized labor by Ubu's farmers, signals dedication of a greater percentage of their areas to planting crops such as cassava. In contrast, it suggests the greater use per area of more labor-intensive crops at Diamante, for example the passion fruit, which must be trained around wire supports.

Diversity

The diversity at Diamante was considerably higher on a per hectare basis than at Ubu. The items/hectare average was 7.2 items for Diamante and 2.02 for Ubu (Figure 5.2). Even on the scale of number of different items per plot, Diamante came out with an average of 18 items per plot, greater than that of Ubu's 15.

A noticeable difference is Diamante's high number of animal varieties, including fowl and large animals like donkeys, mules, cows and horses. This was surprising at first. How were they raising livestock on 2.5 ha if the people at Ubu had not managed it on 7.5 ha?

In several ways, the smaller plots have made it more feasible for Diamante's farmers to raise animals than at Ubu's. This is because the farmers are not overwhelmed by the amount of work needed to care for 7 - 8 hectares of land. Small plots allow the farmers the time they need each day to collect grass to feed their animals. In addition, the large plots (Ubu), having less diversity, are more intensely planted with subsistence crops that are labor (both mechanized and manual) intensive. Alternately, the fruit trees and other items comprising the rest of the diversity at Diamante are generally less labor intensive, requiring only periodic weeding around the base.

The grazing process has, in the Brazilian Amazon and elsewhere, accelerated the degradation of land used for pasture. In Diamante's case, the majority of the land is used for agriculture with room set aside for animal pens. While feeding the animals may be more labor intensive than sending the cattle out to graze, it more effectively ensures the quality of the area in the future. In addition, by penning the animals, the farmers have a constant supply of rich organic material that they mix with straw, compost, and spread on their crops. The cattle are also good investments. They are the equivalent of live savings accounts, to be cashed in whenever the farmer needs to pay debts or make an investment in their lots.

In general, the consistently lower diversity in the larger plots is evidence of the effects of increased total labor and capital demands of larger plots. Careful management of a plot becomes more difficult when the labor demands exceed the families ability to supply it. In response to scarcity of resources, there is often an increase in the density of low cost, low risk items.

Not only is lower diversity less favorable from an ecological standpoint, it is economically risky as well. There is the danger that one item will not produce in a given year. This could be due to weather conditions, pests, bad seeds or the end of a plants productive life cycle. It could also be that the item will produce but the market for it will experience a downward trend. The farmer with a diverse plot is buffered against these situations. The farmer with fewer items will feel the effects of failure of a particular item to a greater extent.

Food security and quality are also issues. The more diverse a planting is, the more likely the families will meet their nutritional needs. Growing a variety of tropical fruits provides an array of vitamins. A good example is the acerola, which the children pick off the bush and eat. Acerola fruit has one of the highest natural concentrations of vitamin C.

The general impression is that farmers with monoculture production of a particular crop depend on the money they make from the sale of that item to provide their necessities, including other fruit and vegetable items. Therefore, in theory, a farmer planting essentially a monoculture of cassava will have to rely more on outside goods, to meet the nutritional requirements of his family. This scenario is not at all realistic though. The reality is that these farmers earn so little from the sale of subsistence crops that they have few resources to procure outside goods. This means that their diets will consist largely of cassava, which provides few of the vitamins and minerals needed. (FAO) To some extent, the more diverse a plot is, the more it contributes to the health and survival of those who live there.

There was also a difference in plot arrangement and appearance based on size differences. While main crops like cassava and beans were still planted in sections comprised of rows at the smaller plots, the smaller parcels began to take on the look of more mature settlement areas. They were planted with more long-term investments like fruit trees and had more, dense tree cover near the houses. While Diamante is three years older than Ubu, it does not seem likely that the diversity of Ubu will equal that of Diamante in three years time. This is largely because many of the farmers are constrained to planting for survival and sale and do not have extra cash to begin experimenting with different crops.

Land Use Decisions

The motivating factors behind the farmer's land use decisions were considered. Two questions were asked during an oral survey and the responses were ranked for frequency of appearance. The questions were, 1. What are the major difficulties that you and your family face, and 2. What are the negative aspects of your particular plot? For the first question, it was stressed verbally that the problems were not meant to be of a personal nature, but problems they confront as they try to produce and earn a living through agriculture.

The responses recorded included: lack of resources (personal and sponsored finances and funding), lack of water, low productivity & loss of crop, distance from market and other areas of interest, lack of transportation, soil conditions (including rocky and sandy), inadequate health care, neighbor's animals eating crops, inadequate technical assistance, inadequate plot size, inclined property, and lack of wood resources. (Table 5.2). Insufficient plot size was only mentioned by one of the sixteen farmers. For frequency, it was tied with, among other things, the neighbor's chickens eating the participant's corn.

The person that responded with plot size as one of his major difficulties is also the father of 18, ten of who live on the 2.5 ha and 4 of whom are adult males.

Consideration of land use decisions identified some of the more important site and community development suppressors. The most commonly cited problem was the lack of resources. This category includes lack of income, lack of liquid capital, and lack of bank funding. At various times throughout the year, the farmers on the larger plots were stalled waiting for the release of bank funds. Since income per farm is similar for both sites, small farmers were not dependent on bank funds to the same extent of the larger plot farmers. With a finite amount of money, the farmer with the larger plots has an area three times as great to invest his money in. This in turn fosters a greater reliance on the provision of funds by the Bank of the Northeast and other funding agencies. In addition, government funding when issued, is notoriously late, causing a variety of problems. The largest problems are delays that cause crops to be planted later in the season than the ideal time period. Many of the farmers in the study lost up to 80% of specific crops, including coconut and oranges because they planted late. The money to buy those particular seedlings had not been available until two months after the planting season.

Distribution of survey responses indicates that plot size is less responsible for poor performance than are other factors that suppress development including economic pressures and water scarcity. When the farmers were asked about what they would like to plant in the future, many of them would indicate a particular item and then follow it with the stipulation, " If funding comes out", or " Only if we get irrigation."

A small plot necessitates more planning and evaluation of the function and potential of everything put into it because there simply is not room for errors. At Diamante, what came across in interviews was the fact that the decision to plant something involved consideration of economic, environmental and labor constraints. One farmer had patches of experiments all over. For example, he planted papaya in several spots throughout his plot. He decided if

they did well he would plant them, and he wanted to see where they would grow. He also told me that he knew there was a market for them and he was selecting seeds from the trees bearing the most marketable fruits. There were a few farmers with a similar inclination at Ubu, but in general, the planning process there was less involved and more dependent on economic constraints.

Income

Although the incomes per farm were very similar, there was a large difference in the average monthly income per hectare of the farmers at Diamante and Ubu. The value for Diamante was $R90.58 compared with that of Ubu, $R28.19. On a per farm basis, Ubu's farmers earned an average gross income from agricultural goods of $R211.41, and Diamante's - $R226.46. These values were based on the sale of agricultural goods and did not include additional sources of income.

Again, the numbers seem to indicate that the larger plots generate larger plantings of low value crops and less careful use of space either due to labor or economic constraints.

Ideal size of Property

The farmers were asked to name the ideal plot size. It was difficult to get an answer to this question. As a result, it was posed in several different ways, for example, " If INCRA showed up and said, do you want more land, what would you say?" was one of them. The difficulty seemed to stem from an inability to conceptualize land being given without a fight and without sacrifice. Once they got over the absurdity, many expounded upon what they would want and why. The farmers with larger plots had a higher upper limit than did the farmers with small plots. The largest request at Diamante was for ten hectares while at Ubu it was for thirty hectares, although both of these represent a fourfold increase in plot size. Two of the farmers at Diamante wanted to maintain their current plot size while at

Ubu; four participants did by requesting either 7 or 8 hectares. This could be an indication that a greater number of the farmers are feeling the limits of their abilities to provide additional inputs, including cash and labor, at the larger sites than at the smaller sites.

The farmers indicated that with the same amount of resources, a larger lot would not be beneficial. The requirements mentioned repeatedly were an increase in funding, more access to mechanization, and a system of irrigation. No one indicated that they wanted a smaller plot.

Overall Economic Effect

The results suggest that smaller plots are more profitable than larger ones. Smaller plots grossed more on a per hectare basis, earn approximately the same on a per farm basis as the larger plots. They also allow for more diverse plantings and use of cash and labor resources, which provide greater security against hardship caused by a crop blight or pest of a particular item. There seems to be a strong correlation between plot size and farm income. Larger plot sizes pressures the farmers to make decisions that are not in their immediate or long-term economic interest. It also leads them to place a low value on soil quality as they mine soil resources with repeated plantings of cassava with little economic return. Lack of attention to soil will continue to worsen their economic situation.

The time devoted to large lots has another economic cost, the opportunity cost. This is the value of things one must give up because they make a choice to do something else. In this case, the inability to attend night literacy classes because of exhaustion from working 8 ha of land as opposed to 2.5ha. A larger percentage of the farmers on the small plots were enrolled in literacy classes than were the farmers on the large plots. Some turn down other jobs that could yield more returns than planting and harvesting so they can fulfill the bank loan requirements. These often state that project money issued for *custeio* (staple food crops)

be applied to plant a specified area of a given crop, which must be available for presentation if the farmers are called upon. They did not turn the funds down altogether because having them allows them some extra money to use for other things. Among the farmer's on larger plots, there was only one farmer who calculated the amount he would make from construction work vs. the amount he would make spending the time to plant an area in cassava. Several of the farmers did calculate the amount it would cost them to plow and plant cassava vs. the amount they would earn and opted to leave the field uncultivated. Most farmers would not leave large amounts of their plots uncultivated though. It is a matter of pride to have the area filled with crops. There are also residual concerns over land tenure issues. The fact that plot boundaries are still not officially delineated adds to the desire to plant entire areas.

Overall Environmental Effect

Settlers are forced to expand their area of subsistence crops because they are trapped by poor market conditions for subsistence crops, and generally without funds to invest in higher value, riskier items. To keep up with the falling prices they plant more, spurring on the downward trend. Creation of a new regional monoculture is likely as sugarcane is replaced with cassava.

For all of the reasons a monoculture of sugarcane is detrimental, so too is a monoculture of cassava. Monocultures in general do not make as efficient use of resources, depleting one nutrient pool or mineral and leaving another. For example, a monoculture crop may require a high amount of nitrogen but trace amounts of another element. The nitrogen will be continuously tapped while the other mineral will build over time because it is not being utilized.

Structurally, smaller, more diverse plots more closely approach the ideal of an agroforestry system in which tree crops result in soil conservation, nutrient recycling, and improved microclimatic conditions. Where more subsistence crops are planted, there are fewer trees. Many of the farmers begin to question the cumulative effects clearing the forested areas on their plots has had as they face unusually long periods of droughts and increasingly severe rainy seasons.

It is apparent in some cases that the environmental cost is not clear to the farmers. Many responded to the question of whether they were producing more or less each year by saying more. What they failed to mention was that they had planted twice the area for a marginal increase in production. This was especially true of the farmers with larger plots.

While some do not realize the cost, others do not feel able to do anything about it. One farmer mocked an extension agent's method of planting cassava, which was supposed to be better for the soil. He said, " Here I got 500, they only got 200 (kilos). I don't have five years to wait for the 700 they promised. We need something to eat today."

The environmental benefit that large plots could offer is the ability to set land aside to lie fallow and regenerate. Several farmers cited this as the reason they desired upwards of 20ha. Extra land alone could not produce this beneficial result though. Education is required. Without a shift in the thought of the farmers, the danger is that, 20 ha of cassava will be planted instead of the 8 that are currently planted. Steps are being made towards diversifying planting by reform agencies. Both INCRA and the Bank of the Northeast have been instrumental in offering capacity building workshops on soil management and environmentally friendly agriculture. Until the process is carried out from the classrooms to the fields, there exists the very real threat of succeeding only in expanding the area of subsistence crops and putting small farmers further in debt.

Farmer's Motives and Limitations

The actual projected module size of fourteen hectares at these sites would over-exert the abilities of a family to plant, harvest and maintain their lots. This would not be the case if the settled families had access to large, low interest bank loans, an outside labor force, and external inputs like fertilizers and tractors, and perhaps most importantly, a developed market. In reality though, many farmers struggle to buy seeds and use tractors infrequently, only when funds allow. The money used for these items comes from other necessities.

The idea that a family at either of the two sites could comfortably farm 14ha is unrealistic, at least in the initial stages of settlement. For several reasons, if the current regulations were fulfilled and larger areas issued, the consequences would be significant. The families coming into the new plots are severely limited by the amount of capital they bring with them. A few have some furniture, one or two may even have a working car, but the vast majority come with the clothes on their backs and a few household items like plastic buckets.

With no seeds stored from previous plantings, there is also a great need for the capital to be funneled into the purchase of seeds. There is no food storage from previous years so feeding the families is also a priority. While settlement deals are often made including one year of monthly food packages, the people of Ubu received one month of the promised twelve. The responsibility of providing for their family weighs heavily on the new settlers. Although many promises are made for support, these are often broken or delayed, putting the full burden on the families to take the land and use it for their subsistence.

The settled farmers are also concerned about clearly staking claim to their lots. They attempt to show that they are fully utilizing the plot by cutting down brush and small trees and planting as large an area as possible. The fear of losing area because of large unused parts is quite real. The farmers also strive to use the area as a way of proclaiming themselves

settled and therefore different from the squatters. There is not much danger of other squatters moving in on their land, as the community would likely shun anyone who did not participate in the invasion. There is a chance that unused areas would signal to the settling agency that they could fit more people on the land.

Generally, the newly settled farmers use whatever money they receive to plant an amount sufficient to meet the needs of their families. At the smaller plots, the amount of funding likely exceeds the amount they need for their initial plantings. This starts off the smaller farmers with a small amount of money to begin to invest in their site. To satisfy the needs of the family, the farmer must plant enough to provide food, seeds for the following year's planting, and leftover produce to sell to provide cash for necessities. The plants chosen are those with little associated risk that the farmers are fairly certain will grow, namely subsistence crops like cassava. Cassava has a very low market price in comparison with other crops such as corn and cilantro, takes up a lot of space, and has a very long growing season before harvest. Each year the farmers plant more to be able to equal or surpass production of the year before. This is necessary because as the price continues to drop, a greater amount of product is required to equal the cash earned from the previous year. As one farmer put it, "It's bad to plant and sell so low, but its even worse to not plant or sell at all." He mentioned this as he pointed out a neighbor who had not planted anything and was selling the plot because his family did not even have food to eat.

Conclusion

Smaller plots can provide a higher standard of living by stimulating more diverse plantings and encouraging more careful use of resources. Small plots do not place the same demands of labor and capital that large ones do, allowing for experimentation with different

crops and management schemes. Excessively large plots and limited resources lead to less careful use of the area and greater plantings of subsistence crops that ultimately have a much lower value, both economically and ecologically.

While small plots will clearly have an upper limit to the amount of income and produce which can be generated upon them, they are more likely to have those limits explored and expanded in innovative and more sustainable ways than the large plots. What happens in the first few years is critical. If there is no economic progress made because the resources are insufficient for the area allotted, the settlers could be worse off as debt accrues. This is sometimes the case in the larger plots. Smaller plots provide a more suitable area for family agriculture. These can be carefully managed, as opposed to a large plot, which can seem overwhelming to a single family.

Plot size is not the single factor responsible for hardship or success of any given family, but it does play a strong role in the process. Among the many factors, this is one that does not receive a lot of attention due to the highly politicized nature of the issue. If one advocates smaller plots, they may be labeled anti-reform. By recommending large plots, they may be seen as a landless sympathizer, working against the powerful landed minority. The creation of a standard formula for determination of plot size has been suggested. This would incorporate factors such as family size, availability of resources, proximity to commercial centers, etc. The premise fails to recognize that settlers will use all of their available land, and in so doing, dilute their effort.

TABLE 5.1: AGRICULTURAL INPUTS

	Farmer	# Weeks Hired Worker	# Tractor Hours
UBU	U1	1	1.5
	U2	6	7.5
	U3	12	24
	U4	1	0
	U5	10	18
	U6	0	5
	U7	0	8
	U8	0	6
DIAMANTE	D1	12	3
	D2	4	0
	D3	0	0
	D4	0	0
	D5	3	8
	D6	0.5	1.5
	D7	?	0
	D8	8	2
Total Ubu		6	70
Total Diamante		3	14.5
Total		9	84.5

TABLE 5.2: DIFFICULTIES IDENTIFIED

Difficulty Identified	# Responses Ubu	# Responses Diamante	Total # Responses Per Category
Lack of Resources	6	4	10
Lack of Water	1	3	4
Low Productivity/ Loss	1	3	4
Distance	3	0	3
Transportation	2	1	3
Soil Conditions	2	1	3
Health Care	2	0	2
Neighbor's Animal Eating Crops	0	1	1
Lack of Technical Assistance	1	0	1
Plot too Small	0	1	1
Inclined Plot	0	1	1
Wood Scarcity	1	0	1
Total	**19**	**15**	**34**

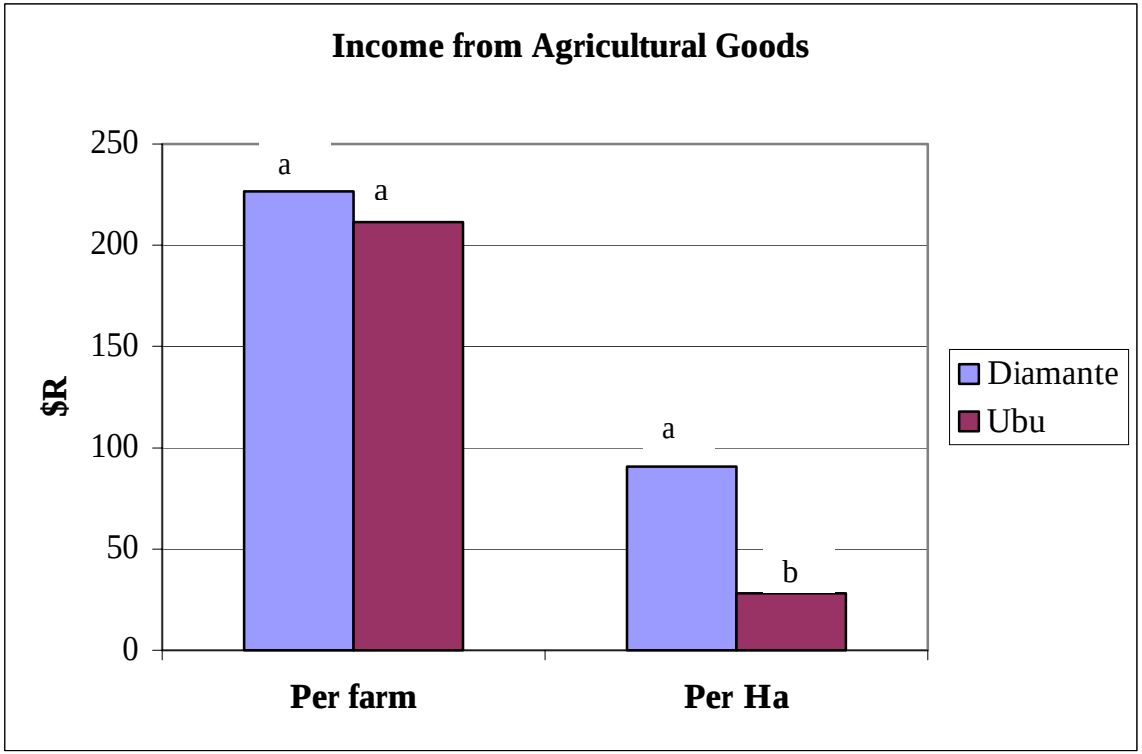

FIGURE 5.1: INCOME FROM AGRICULTURAL GOODS
The total value of the items sold were calculated for each of the eight farmers at both sites (16 total). These were compared on a per farm and a per hectare basis. Diamante's farms are 2.5 ha in area, Ubu's 7.5 ha Within each group, columns with the same letter are not significantly different according to LSD at 0.05 probability level..

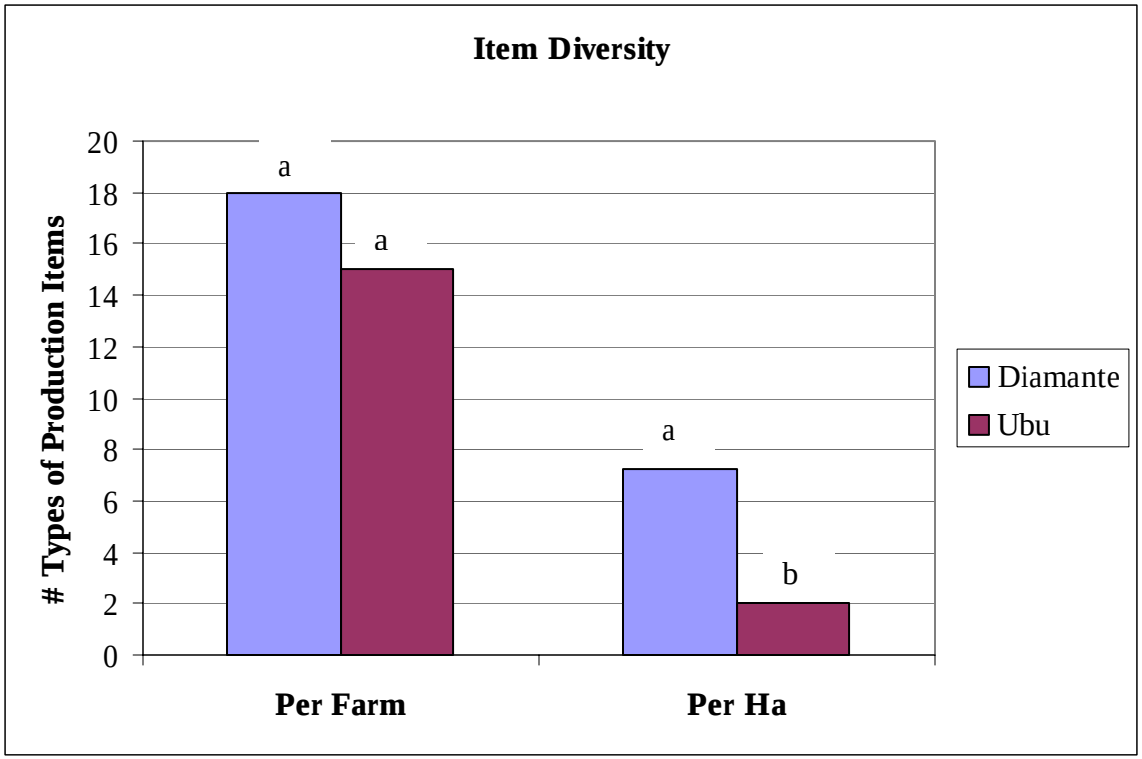

FIGURE 5.2: DIVERSITY OF ITEMS
The total number of different production items were calculated for each of the eight farms at both sites (16 total). These were compared on a per farm and a per hectare basis. Diamante's farms are 2.5 ha in area, Ubu's 7.5 ha. Within each group, columns with the same letter are not significantly different according to LSD at 0.05 probability level.

CHAPTER 6

POLITICAL DIMENSIONS OF COMMUNITY DEVELOPMENT

One day, an ant was bringing water to a forest fire when an elephant passed by. The elephant laughed and said, "This ant won't put out anything with that little bit of water." The ant stopped, stared at the giant elephant and replied, " You're right, I may not put out the fire, but I am doing my part."
- Madalena, Community leader - Diamante

Introduction

The role of social and political factors is extremely important in shaping the future of a settlement. These factors are regularly overlooked in studies of the reform movement and reform communities in Brazil because of the nature of much development research. Limited time and funding have helped create the custom of visiting an area for two weeks and then writing a survey article. The resulting reflection upon the cultural and social subtleties of the area often yields an evaluation devoid of texture and at times, of truth.

Even two years of interaction with two settlements of formerly landless farmers has only provided a cursory glimpse of the many forces that shape a community and determine its future. This is though, an improvement upon reports that completely ignore the importance of these factors. Among the issues that appeared central to the development of the communities that participated in this project were the role of leadership, unity in the community, a sense of purpose and vision for the future.

The information offered in this chapter is based on field experiences with the communities of Diamante and Ubu. All information was gathered through formal and

informal interactions with the community members and leadership of the farmer associations in each group.

Leadership

One of the most notable differences between the two communities was the manner in which they were administered. This was evident during the monthly meetings of the community associations. Both communities have similar organizations with a President, Vice-President, Secretary and Treasurer. The elected officers preside over matters concerning the community association. While structurally similar, the organizations functioned differently. The most notable difference in the two governing bodies was the influence the President had on community life.

Diamante's success is partly due to the dedication and enthusiasm of its leader. Diamante has been under the leadership of the same woman for more than 5 years. Female leadership is a rarity in Brazil where, at times, machismo still reigns. Presiding over the predominately male members of the farmer's association, she has been well received by both the community and the surrounding towns where she interacts with funding agencies and government development groups.

A strong sense of moral obligation, and a no-nonsense leadership style have resulted in successful leadership of the community. Satisfaction with the leadership is quite high among community members. While some did not agree with everything she did, they almost unanimously reported that they did not want to take her job over, that they trusted her, and that there was no one that could do it better.

Satisfaction with the leadership is not as high at Ubu, where considerably more criticisms and suggestions for improvement were offered than at Diamante. Concerns ranged from

the leader's involvement with the landless movement to the likelihood of any leader being able to represent a community of such a great area, with so many families.

Dissatisfaction with the governing body was widespread among different groups within the community. The discontentment was coupled with a palpable apathy to change the situation. When it came time to elect the current governing group, all of the people who had complained about the previous leader, were suddenly quiet. They declined to either nominate themselves, or to identify persons who they deemed suitable. In fact, the election had to be postponed because on the announced deadline for identification of the party tickets, no one would volunteer to run.

Political priorities

Many at Ubu complain that the current leadership is excessively involved in the politics of the reform movement. On several occasions, meetings featured members of grassroots groups (especially the MST), asking for donations or encouraging the community members to continue to fight for agrarian reform. Many of the featured speakers preach the importance of organization to fight for what is owed them. There is a very participatory approach to agrarian reform.

This differs greatly from the approach at Diamante. Repeatedly, the leader and the community members would remind visitors and others that they had been settled peacefully through a petition submitted to the government. The leader of Diamante frequently preached cooperation and the importance of acting respectably and not fighting or resorting to violence. "To get respect you have to earn it", she told the community members -" so help each other and do things the right way".

In contrast, the leader at Ubu was frequently inciting the members of the community to challenge INCRA for the unfulfilled promises. Their most visible demonstration was the

blocking of the major highway BR101. (Jornal do Commercio, 2000) During this protest they threw rocks at passing cars and burned tires in the middle of the road. Not all of the farmers concurred with this behavior. Some vocally disagreed with the decision to block the highway. Regardless, this was not clear in the way their community was represented on the front page of the newspaper the following day. Many travelers who had been delayed in traffic for over two hours yelled to the demonstrators that they would never again buy produce from the farmer's roadside stands. This hurt the community, not the government agency that was the target of the demonstration.

Management styles have a great influence on how a community is perceived. At Diamante the leader operates with behavioral patterns similar to the people she interacts with at the banks and government agencies. Hospitality plays a large role in the image the community is creating for itself. Business meetings are carried out in restaurants or on the leader's front porch where lunch is provided. In another example, when corn was harvested at Diamante, the leader asked each community member bring some to her house. She then assembled large baskets of corn and presented them to the agents that frequently interacted with the community, including people from the Bank of the Northeast and INCRA.

Around the time of the corn harvest, the leader of Ubu was kidnapped for suspected involvement with the MST's invasion of a neighboring sugarcane plantation. He was approached by four men (who later turned out to be police officers) and thrown in the trunk of a car in broad daylight. The community struggled to think what their next step would be if he never came back. Those who were already skeptical of the attitude of the leadership of Ubu, now had in print, "justification" for slighting the community on any number of levels including the issuing and funding of projects and resources.

These examples are not offered with the intention of suggesting that one approach is superior to the other. The fact is that someone needs to continue to promote the revolutionary actions and stir up the landless and recently landless, if the movement is to continue. The reality though, is that the leaders who operate with the same rules and methods as the people they deal with (bank loan officers, government reform agents, agricultural technicians) will have more success in furthering the cause of their community.

By continuing to fight with the same methods they used to secure their piece of land, Ubu's leadership continuously reminds people of the history of the settlement. There is a very real stigma attached to being or having been landless and taken over land. The children at both settlements mentioned that they do not like to tell their friends that they live on an "*assentamento*" or settlement. There is a hierarchy of terminology and the farmers attach strong significance and value to each of the terms. Reform areas evolve from camps to settlements to communities. The farmers at the settlements quickly correct anyone who mistakenly uses the term "*acampamento*", or camp, before the community name, once the group has reached the settlement stage. Camp is reserved for those still entrenched in the land dispute. Diamante is in the last phase of its transformation and is working hard to represent itself as the community of Diamante, not the settlement of Diamante. The leader fosters this distinction by always referring to, "the community of Diamante".

The deliberate choice of the term "community" over that of "settlement" was not as widespread at Ubu. This could be because they have not yet made the transition to being a true community. This is a result of both their internal conflicts and their image as perceived by people outside of the group. As long as some of them continue to express themselves by burning tires in the middle of the road, they remind everyone of their struggle for land and allow the controversy that accompanies land redistribution to resurface.

It is important to distinguish that entering into the game of politics and social interaction does not mean that leaders who chose to do so place themselves in an inferior position to those they interact with. Not for a moment is the female leader of Diamante submissive or yielding. Her power does not come from her might, but rather from her ability to enter and survive within the realm of the other - the landed and the wealthy. This was a learned skill. Her background, both educational and economic, is the same as many of the farmers she lives beside.

Integral Elements for Community Cohesion

In development circles, bottom - up approaches have been presented as a remedy for difficulties of rural development. (Habermeier, 1995). This approach may not work equally well in all cultures though. In a society where the top echelon has exhibited corruption and dishonesty, it is very hard to form the kind of relationships necessary for a bottom-up project to function. Dealing with a marginalized group of people in a country where the rich have advanced, through corrupt measures, generates mistrust and a model of success through false means. It is difficult to develop the type of relationships essential for small group projects to succeed.

Many of the farmers expressed feeling disconnected from the larger realm of national politics. In effect, the settlement becomes a microcosm of the country with its own rules, alliances and politics, except that in this one they participate. Once again the role of the leadership can influence how the community will interact. The leader has the potential to establish what is appropriate and what is not in both word and action. Trust is one of the most important factors in building community relationships, participation and cooperation.

Someone who rules in an egalitarian way and clings to the truth is someone who will have the support of her people. Belief in the leadership at Ubu was compromised when the

previous leader was blamed for misapplication of funds. It was not possible to account for use of all of the funds to build the community meeting pavilion. The pavilion was not finished and the money had run out. Whether this was the case or not was not resolved, the investigation was ongoing. The attitude in the community was not likely to change though whether the leader was cleared of the blame or not. Neighbors became skeptical of one another. Several commented that all governments, be they the Brazilian or the community or local government, have corruption in them.

Community Relationships

Perhaps the largest complaint among the settlers in regards to community dynamics is that there is very little interaction between neighbors. The settlement process creates an incredibly unified group - described by several farmers as a brotherhood. Soon after plots are awarded, all of this dissipates. This story is repeated at settlement after settlement. It became even more apparent as more time was spent in the communities. There were many alliances and rivalries, but very little spirit of a unified front.

This is a serious obstacle to the development of the communities. Many of the farmers already realize that success on their own is not feasible. The most successful projects have been those that incorporate a spirit of cohesiveness. A good example of the different outcomes using cooperation and using an every man for himself approach is illustrated by the approach to selling cassava detailed below.

At both Ubu and Diamante, each farmer worries about how they will sell their cassava and how much they will get for it. As supply has exceeded local demand, it has become a buyers market and the prices have reflected the switch. One of the farmers mentioned, disgustedly that they all needed to get together and agree on a price before the truck came to

buy cassava. He complained that the man that the truck stopped at first always agreed to sell low and thereby eliminated the possibility of anyone else on the street gaining a higher price.

With cooperation and innovation, another group has achieved much different results. A group from Pernambuco organized to obtain computers and training. They are now selling their product over the internet and have a constant stream of buyers.

Capacity building

Courses are regularly offered at both of the sites with varying degrees of success. These are often with the goal of improving production and increasing the income of the households. Course topics range from produce marketing to soil conservation to candy and dessert making. Successfully carrying out the courses proved to be challenging in both communities. For example, people would sign up for the course and then fail to show up or would show up very late or would not bring course materials that they had volunteered to bring.

The difference was that at Diamante, when people did not bring the items they had promised to a course on dessert making, the President went door to door to collect the sugar and the milk. She later publicly scolded the people who had not done what they had promised to do; chastising them by saying that progress will never come for those who are lazy. At Ubu, the man who gave the course told me that he had to go out to the nearest town, about ten km away and purchase all of the items, for which he was never reimbursed.

Also important in these meetings was the way in which the leadership of the community participated. At Diamante, the leaders set an example by actively participating. At Ubu, the prior president often sat off to the side with arms crossed and watched the activities. This made it more difficult to build group cohesiveness or to attain total participation.

At some point though, the community needs to take responsibility for their own progress. Communities that have a very involved leadership undoubtedly have a head start on success, but it is not guaranteed.

Community Prospects

Use of the communal space was a good indicator of how cohesive the community was and what their development trajectory would be in the future. It became evident that in many cases the good of the community was not the utmost concern. For example, once funding was procured for the building of a cassava processing plant the community of Ubu needed to decide where to site it. At the meeting, a number of sound ideas were proposed. Some asked to modify the original site decision because it was not the most effective use of space and because the dust from the cassava processing would blow onto the school and the church and become a nuisance.

The largest resistance to the call to move the proposed site came from people who did not offer any counter to the suggestions except to say, " We decided already, you can't come in here now and change things." The battle was more about mistrust of the community leader and the need to exert some power in a disempowering situation.

Suggestions

One of the easiest ways to remedy the overburdening of leaders is to create a paid position within each settlement. This was an idea proposed by the farmers at both sites. At Diamante it was evident that the long hours and numerous trips to Recife each week were limiting the leader's time for her own farm and family concerns. At Ubu, the campaign for local office was also taking away from the leader's time to dedicate to the community. In both cases, it was evident that everyday responsibilities and obligations were not compatible with the extensive amount of work it takes to be an effective community leader. To ensure

success (that is also not to the detriment of the leader), this role should be compensated. This person would have the sole responsibility of promoting the community, creating and managing community accounts and creating connections with buyers and financing agencies.

Conclusion

Social and political factors cannot be overlooked when examining the potential for a community to develop within the reform framework. While good leaders are integral to the development of a community, they are not the complete solution. They should not be the sole motivating factor behind the progress. A leader cannot single-handedly keep a community together. Their role should be that of facilitator and provider of the skills the group needs to survive. The group must choose to adopt these skills.

In consideration of all of the variables within a community, it is not possible to say what exactly will determine if a community will prosper together or not. It is possible to identify the things that have worked so far.

CHAPTER 7

CONCLUSION

Summary of Major Points

Effective reform and sustainability hinges on a subtle blend of economic and social factors. This idea was reinforced by the conclusions that came from the interdisciplinary investigation of the communities of Ubu and Diamante. A brief summary of some of the main conclusions follows.

The first is that it is not economically advantageous to continue to provide funding for the farmers to plant subsistence crops. This results in a worse return for them due to the flooded markets of subsistence crops. It also appears that smaller plots encourage more diversity and more careful use of resources because they allow for investment of funds rather than overtax the limited funds to plant a large area. Smaller communities also have the potential to foster a greater community cohesiveness that is advantageous in the pursuit of collective projects. Soil factors, while an important indicator of long-term management effects, are relatively unimportant compared to economic and social issues. Poor soil has neither caused nor been expressly caused by reform settlements. These conclusions suggest that to understand the complexity of the issue, it is necessary to consider the situation from an interdisciplinary perspective.

Reforming Reform

What are the options for a reform that may have already derailed? The first step is for Brazil to match their pro-reform propaganda with an actual policy that works to implement not only agrarian reform, but more importantly, successful agrarian reform. They have had a definition of successful reform since the Land Statue was created in 1964.

This statute stated that a family property issued through agrarian reform is one " that, (when) directly and personally developed by the farmer and his family, utilizes all of their work force**,** *guaranteeing them subsistence and social and economic progress,* with the area to develop, and eventually, work with the help of a third party." (Estatuto de Terra, 1964)

Rhetoric and policy are admittedly different entities, but the terms supplied in the Land Statute could be used as the frame around which to build reform policy. The goals are clearly outlined. Analysis of the reform experience so far could inform the policy specifics.

The farmers have already achieved subsistence, one of the goals outlined in the Land Statute. What remains are social and economic progress. Without these and environmental sustainability, the same difficulties faced by the farmers in the study will continue to perpetuate themselves throughout rural Brazil.

The enthusiasm of the landless for invasions and their large number takes the issue to a much larger scale. The effect of one settlement farming cassava is completely different from the cumulative effect of hundreds currently operating throughout the state. The low price they receive and the environmental cost of monoculture production have placed the small farmers in a deficit situation. The people who are benefiting are those who buy their produce in the cities and now have access to low cost produce. The person who is not

benefiting is the one who has pursued land and a better life and found themselves no better off financially than in the days when they worked the sugar cane plantations of the rich.

If agrarian reform will solve the unemployment problem and lack of social equity in Brazil, then it should be actively pursued. On the other hand, the difficulties encountered so far signal that in all likelihood, agrarian reform is a stopgap measure. For some time, dealing with the ills of poverty by giving people a piece of land seemed a viable option. As the settled families give up and leave their sites and return to the overcrowded cities, it becomes evident that the reform process is fraught with difficulties. For those who are pursuing land out of a lack of a better option, it would be more prudent to spend the time and money educating them or equipping them with some type of marketable skill. For those who have found farming to be their calling, they deserve to enter into a system that supports their efforts to a greater extent.

The old agrarian structure is not being changed by the Brazilian reform. Large farmers and landholders are still favored over small producers. There was little planning as to effectively integrating the small farmers into the larger market economy. One example of this is the large amount of low value crops the farmers are producing. Funds were provided for their cultivation, but without thought to the consequences of stimulating the subsistence crop sector. While the subsistence crop production has been stimulated, the markets have not. New uses for cassava abound but very few are widely promoted in Brazil. Alternative uses include industrial starches, a high quality flour substitute, and snack foods Marcio Porto, of the Food and Agriculture Organization (FAO) states, "A broad consensus has been reached that cassava can spur rural development," (www.fao.org). But to encourage economically beneficial rural development, there must be an effort to remove the stigma associated with the settlements and successfully integrate the people into the economy.

Subsidies and policies favoring large export producers need to be expanded or adapted to include the small producers. Right now the majority of the incentives and tax breaks benefit only the export producers.

It is vital to provide support and direction to those who have already been settled. This includes encouraging community development of alternative sources of income. The communities that have done this are starting to reap the benefits. Activities such as providing a restaurant or selling medicinal herbs are ways to use the products and generate alternative sources of income and employment opportunities within the settlements. This is not possible in every community. Many lack the sense of unity to succeed in this type of venture. The communities that are cohesive are the ones that are successful.

Funding agencies generally prefer to fund group ventures. Diamante has been especially successful with group project proposals, gaining funding for a dairy manufacturing building and candy making equipment last year. In another example, one community has organized themselves to the extent that they formed a cooperative and requested funding for a computer and web site development. They are now selling their pooled cassava production on line to buyers throughout Brazil (Jornal do Commercio, 2001)

Environmentally, the large-scale land conversion from sugarcane to small family farms has potential to do much damage if it is not done with sustainability in mind. Economic pressures make the pursuit of sustainability more difficult though, unless there are economic incentives to produce in an environmentally beneficial way (e.g. organic produce).

The highly politicized nature of the issue became apparent as popular conceptions were found to misrepresent the two study sites.

In the search for environmental destruction, I found that the popular conceptions regarding land quality and the farmers misrepresent the conditions at the sites. The farmers were frequently blamed, perhaps because it was unlikely that they would read the articles written about them, which claimed that they wore out the soil and environmental resources of their sites and then moved. They supposedly did this because they were from other areas of the country and did not know how to farm. They would then leave and go take up another plot of land elsewhere, continuing the destruction

First of all, the vast majority of the farmers at the sites had grown up within a twenty km radius of the study sites. Secondly, the farmers do not leave because the soil conditions worsen. They leave because they cannot make a living working more than ten hours a day (or more) with a hoe. One farmer who plans to sell his lot said, " When I leave this place I am going to tie a big bow around my hoe and leave it for the next guy. I don't care what I do next in my life but I know that that thing (the hoe) will not get me anywhere." They leave because they are overwhelmed by the burden of being not just poor, but poor and deeply in debt. They leave because they tire of a situation where the rich continue to prosper and the poor gain nothing. The agrarian reform movement may grant earth to the meek but it certainly does not put money in their pockets.

The situation must change, at least for the sake of the farmer's settled in an attempt to fulfill Brazil's motto of "Order and Progress" (Ordem e progresso). I recently received a letter from one of them that said, " In this land that I live in, I fear order does not exist and progress will never come."

In conclusion, land alone is not enough for a successful agrarian reform. A combination of social and environmental and economic issues must be considered to allow the reform process to achieve its full potential. More importantly, agrarian reform is not the sole

answer to the social ills of Brazil. It is my hope that this study will be useful to the communities already settled through the reform movement, and the more than 4 million who continue to fight for a piece of land on which to live their lives with dignity.

REFERENCES

Andrade, M. C. d. (1989). Historias Das Usinas de Acucar de Pernambuco. Recife, Fundação Joaquim Nabuco, Editora Massangana.

Angers, D.A. and G.R. Mehuys (1993). "Aggregate Stability to Water", p.651 - 658. In, MR. Carter, (ed.) Soil Sampling and Methods of Analysis. Canadian Soc. Soil Sci. , Lewis Publ., Boca Raton.
Banco do Nordeste (1999). Agenda do Produtor Rural, Recife Brasil.

Bock, P. K., Ed. (1969). Peasants in the Modern World. New Mexico, University of New Mexico Press.

Carter, M.R., Ed., (1993). Soil Sampling and Methods of analysis Canadian Society of Soil

Science, Lewis Publishers.

Cehelskey, Ed. (1979). Land Reform in Brazil: The Management of Social Change. Boulder, Westview Press Inc.

Chilcote, R. H. (1990). Power and the Ruling Classes in Northeast Brazil. New York, Cambridge University Press.

Christodoulou, D. (1990). The Unpromised Land Agrarian Reform and Conflict Worldwide. New Jersey, Zed Books Ltd.

Diario de Pernambuco, " Usina ja foi a maior do Nordeste". April 27,2001.

Development, U. A. f. I. (1970). Land Reform in Brazil, Northeast Cuba, Guatemala, Mexico. Washington, USAID.

Eisenberg, P. L. (1974). The Sugar Industry in Pernambuco, Modernization Without Change, 1840-1910. Berkeley, University of California Press.

Foweraker, J. (1981). The Struggle for Land, A Political Economy of the Pioneer Frontier in Brazil From 1930 to the Present Day. New York, Cambridge University Press.

Fowerman, S. (1975). The Brazilian Peasantry. New York, Columbia University Press.

Furtado, C. (1965). Diagnosis of the Brazilian Crisis. Berkeley, University of California Press.

Gibb, Tom, " Brazil Declares War Against Poverty", BBC News, March 9, 2000, Sao Paulo.

Gorgen, F. S. A. (1991). Assentamentos, a resposta economica da Reforma Agraria. Petropolis, Editora Vozes.

Hall, A. L. (1990). Land Tenure and Land Reform in Brazil. Agrarian Reform and Grassroots Movements. R. L. T. Prosterman, Mary N., Hanstad, Timothy M. Boulder, Lynne Rienner Publishers: 205- 234.

Habermeier, Kurt, (1995) Como fazer diagnostico Rapido e Participativo da Pequena Producao Rural, Serie Metodologias Participativas, Centro Sabia, Recife, 1995.

INCRA, Laudo de Avaliação, (1995) Plan elaborated by Incra and Projeto Lumiar, Igarrasu, Pernambuco.

Iokoi, Z. M. G. (1996). Igreja e Camponeses. Sao Paulo, Editora HUCITEC.

Jornal do Commercio, "Governo Se Rende à Pressão dos Sem Terra Recife", 11/23/99.

Jornal do Commercio, " Sem Terra Reocupam Engenho", 01/24/2000.

Kemper, W.D. and R.C. Rosenau (1986) "Aggregate stability and size distribution." In A. Klute (ed.) Methods of Soil Analysis: Part 1, Physical and Mineralogical Methods. 2nd ed. Madison, Wisconsin: American Society of Agronomy, pp. 425-442.

Levi, Y. N., Gedalia (1988). Toward Self-Management in New Land Settlement Projects. Boulder, Westview Press

Martins, J D S. (1989). Caminhada No Chão da Noite. Sao Paulo, Editora HUCITEC.

Moraes, Clodomir (1970). "Peasant Leagues in Brasil", Agrarian Problems and Peasant Movements in Latin America, Stavenhaged, ed., Doubleday, NY.

Mutume, Gumisai, Development: World Bank Land Reforms Collide With Civil Society, Inter Press Service & Food First, April 2001.

North, P.F. (1976) "Towards an absolute measurement of soil structural stability using ultrasound" J. Soil Sci., 27: 451-459.

Oinegue, Eduardo "Sem Terra e Sem Lei", Veja, May 10, 2000, pg 42

Organization of American States, (1997) Report on the Situation of Human Rights in Brazil, Chapter II, Inter- American Commission on Human Rights.

Pereira, Anthony,(1997), The end of the peasantry : the rural labor movement in northeast Brazil,University of Pittsburgh Press.

Petrarolha, The Meek Want the Earth Now, Bulletin of the Atomic Scientist: 52 (6), 1996.

Prosterman, R. L. T., Mary N., Hanstad, Timothy M., Ed. (1990). Agrarian Reform and Grassroots Development. Boulder, Lynne Reinner Publishers.
Prosterman, R. L. T., Mary N., Hanstad, Timothy M. (1990). Issues for the Near Future. Agrarian Reform and Grassroots Development. Boulder, Lynne Rienner Publishers: 311-329.

Reuters, "Brazil sends army troops to guard farm" Brasilia, Brazil, Nov. 19, 1999.

Secco, Movimento dos Sem Causa, Veja, April 26, 2000a, pg 38.

Secco, "Suspiro no Campo", Veja, May 17, 2000b pg. 49.

Simas, Paula, (1997) Acucar Bruto, Editora Universidade da Brasilia, Brasilia.

Sobhan, R. (1993). Agrarian Reform and Social Transformation: Preconditions for Development, ZED Books.

Soca, " Agriculture - Brazil: Land Reform Unviable, Says Former Official, .

Stavenhagen, R., Ed. (1970). Agrarian Problems & Peasant Movements in Latin America. Garden City, New York, Doubleday & Company, Inc.

Thiesenhusen, W. C. (1989). Searching for Agrarian Reform in Latin America. Winchester MA, Unwin Hyman.

Thiesenhusen, W. C. (1995) Broken Promises, Agrarian Reform and the Latin American Campesino / Westview Press, Boulder Colorado.

Thorlby (1998), Pitanga Os Outros Quinhentos, CPT Nordeste, Recife, Brasil.

Tisdall, J.M. and J.M. Oades (1982) "Organic matter and water-stable aggregates in soils." J. Soil. Sci., 33: 141-163.

USDA Soil Quality Test Kit Guide USDA, 1998 pg. 69-71.

Veja, (Cover), " The MST Uses Pretext of Agrarian Reform to Press Social Revolution" May 2000.

INTERNET REFERENCES

Empresa de Fomento da Informatica do Estado do Pernambuco (www.fisepe.pe.gov.br,) Office of information dispersal on the State of Pernambuco.

FAO - Food and Agriculture Organization, (www.fao.org 2000), http://www.fao.org/NEWS/2000/000405-e.htm

Food First, “The Brazilian Landless Workers”, Hooper-Box, C. *The Sunday Independent, South Africa,* August 26, 2001. http://www.foodfirst.org/media/news/2001/brazilland.html

Instituto Brasileiro de Geographia e Estatisticas (IBGE), www.ibge.gov.br/english/default.php, 2001.

Lepanto University, “ Methods of the MST”, http://www.lepanto.org.br/NotMetMST.html

Movimento dos Trabalhadores Rurais Sem Terra- Movement for Landless Rural Workers, www.mst.org.br; www.mstbrazil.org/manifesto.html Aug., 2000

Petras, (2000) Z Magazine, www.zmag.org/ZNET.htm.

Raine, S.R. (1998) Towards a fundamental understanding of soil aggregate breakdown under applied mechanical energies.International Conference on Engineering in Agriculture, 27-30 September, Perth. Paper 98/010

APPENDICES

ACRONYMS

BNB - Banco do Nordeste (Bank of the Northeast)

CPT - Commisão Pastoral da Terra (Pastoral Land Commission)

EMBRAPA - Empresa Brasileira de Pesquisa Agropecuaria (Brazilian Agriculture and Animal Research)

IBGE - Instituto Brasileira de Geografia e Estatística (Brazilian Geography and Statistics Institute)

INCRA - Instituto Nacional de Colonização e Reforma Agrária (National Institute of Colonization and Agrarian Reform)

MST - Movimento dos Trabalhadores dos Sem Terra (Movement for Landless Workers)

MIRAD - Ministerio da Reforma e do Desenvolvimento Agrario(Minister of Reform and Agricultural Development)

USAID - United States Agency for International Development

TABLE A1: DATA FROM PAIRED SOIL SAMPLES AT UBU AND DIAMANTE

Total Carbon, Total Nitrogen, C/N ratio and pH values of samples from sugarcane (denoted with a "c") and crop.

DIAMANTE

Diam 5-20cm	Total N (%)	Total C (%)	C/N Ratio	pH	Diam 5-20cm	Total N (%)	Total C (%)	C/N Ratio	pH	Diam 0-5cm	Total N (%)	Total C (%)	C/N Ratio	pH	Diam. 0-5cm	Total N (%)	Total C (%)	C/N Ratio	pH
d1-1c	0.04	0.40	10.80	6.05	**d1-1**	0.03	0.40	15.45	6.07	**d1-oc**	0.06	0.81	13.75	5.9	**d1-o**	0.04	0.61	16.61	6.27
d2-1c	0.04	0.41	10.95	5.85	**d2-1**	0.03	0.44	16.95	7.06	**d2-0c**	0.05	0.50	11.02	6.15	**d2-0**	0.07	1.23	17.95	6.78
d3-1c	0.04	0.49	11.65	5.23	**d3-1**	0.02	0.37	15.00	6.85	**d3-0c**	0.05	0.52	10.86	5.67	**d3-0**	0.03	0.45	16.92	6.71
d4-1c	0.04	0.51	11.48	5.74	**d4-1**	0.02	0.36	15.62	6.75	**d4-oc**	0.05	0.60	11.56	5.79	**d4-o**	0.03	0.42	15.50	6.92
d5-1c	0.04	0.52	11.89	5.36	**d5-1**	0.03	0.47	16.38	6.96	**d5-0c**	0.08	0.64	13.93	6.13	**d5-0**	0.03	0.49	15.77	7.23
d6-1c	0.04	0.48	11.02	5.34	**d6-1**	0.02	0.35	16.52	6.93	**d6-0c**	0.05	0.62	11.60	5.24	**d6-0**	0.03	0.41	16.39	7.16
d7-1c	0.04	0.51	11.91	5.83	**d7-1**	0.02	0.38	17.56	7.26	**d7-0c**	0.05	0.67	12.78	7.5	**d7-0**	0.02	0.36	16.93	7.25
d8-1c	0.04	0.45	12.15	5.83	**d8-1**	0.02	0.25	14.76	7.53	**d8-0c**	0.05	0.57	11.95	5.84	**d8-0**	0.02	0.38	16.91	7.2
d9-1c	0.04	0.40	11.30	5.79	**d9-1**	0.04	0.43	12.24	7.49	**d9-0c**	0.05	0.81	14.93	6.43	**d9-0**	0.04	0.44	11.86	7.57
d10-1c	0.05	0.67	13.05	5.7	**d10-1**	0.03	0.33	10.95	7.25	**d10-0c**	0.08	1.11	13.68	6.08	**d10-0**	0.03	0.44	12.72	7.29
d11-1c	0.06	0.73	12.90	5.24	**d11-1**	0.03	0.42	12.16	6.92	**d11-0c**	0.07	0.99	13.69	6.02	**d11-0**	0.04	0.52	12.40	7.39
d12-1c	0.04	0.41	11.36	5.11	**d12-1**	0.04	0.37	10.42	6.21	**d12-0c**	0.05	0.48	10.32	5.72	**d12-0**	0.05	0.61	12.04	7.03
d13-1c	0.05	0.64	13.74	5.69	**d13-1**	0.04	0.42	10.62	6.6	**d13-0c**	0.04	0.49	11.27	5.33	**d13-0**	0.04	0.44	11.22	6.78
d14-1c	0.05	0.72	13.46	5.22	**d14-1**	0.04	0.40	11.18	7.43	**d14-0c**	0.07	0.93	14.31	5.69	**d14-0**	0.04	0.44	11.46	6.99
d15-1c	0.05	0.64	13.68	5.35	**d15-1**	0.02	0.17	8.60	7.22	**d15-0c**	0.06	0.77	13.70	5.76	**d15-0**	0.03	0.35	11.26	6.81
d16-1c	0.04	0.50	11.90	5.31	**d16-1**	0.02	0.19	8.70	7.3	**d16-0c**	0.06	0.68	11.13	5.96	**d16-0**	0.03	0.33	10.72	7.42
d17-1c	0.04	0.49	12.03	6.05	**d17-1**	0.02	0.13	7.41	7.24	**d17-0c**	0.06	0.93	14.42	6	**d17-0**	0.03	0.31	10.68	7.52
d18-1c	0.05	0.65	13.73	5.89	**d18-1**					**d18-0c**	0.06	0.91	14.09	5.79	**d18-0**				
d19-1c	0.05	0.54	11.91	5.9	**d19-1**	0.03	0.26	10.20	7.12	**d19-oc**	0.10	1.61	16.68	6.33	**d19-o**	0.03	0.34	10.28	7.15
d20-1c	0.06	0.76	13.25	5.61	**d20-1**	0.02	0.22	9.59	6.77	**d20-0c**	0.09	1.60	18.17	6.51	**d20-0**	0.03	0.35	10.92	7.11
d21-1c	0.03	0.26	13.32	6.62	**d21-1**	0.02	0.13	7.06	7.23	**d21-0c**	0.05	0.66	14.41	6.95	**d21-0**	0.03	0.33	11.14	7.42
d22-1c	0.04	0.45	11.54	6.24	**d22-1**	0.03	0.16	5.75	7.13	**d22-0c**	0.06	0.95	17.08	6.61	**d22-0**	0.05	0.44	9.56	7.11
d23-1c	0.04	0.52	12.04	6.1	**d23-1**	0.04	0.29	7.13	6.56	**d23-0c**	0.05	0.57	11.71	6.68	**d23-0**	0.06	0.58	9.31	6.64
d24-1c	0.06	0.73	12.69	5.39	**d24-1**	0.06	0.57	9.88	6.15	**d24-0c**	0.07	0.79	11.93	5.52	**d24-0**	0.06	0.61	9.76	6.73
d25-1c	0.09	0.89	10.20	6.56	**d25-1**	0.18	2.02	11.01	5.48	**d25-0c**	0.13	1.69	13.35	6.54	**d25-0**	0.18	1.97	11.26	5.99

d26-1c	0.11	1.21	11.04	6.18	**d26-1**	0.18	2.13	11.58	6.33	**d26-oc**	0.18	1.81	15.99	6.24	**d26-o**	0.17	2.01	11.64	6.32
d27-1c	0.09	1.01	10.88	6.38	**d27-1**	0.12	1.14	9.50	6.4	**d27-0c**	0.13	1.88	13.94	5.95	**d27-0**	0.17	1.90	11.21	6.54
d28-1c	0.09	0.99	10.70	6.17	**d28-1**	0.15	1.58	10.63	6.18	**d28-0c**	0.16	2.21	14.00	5.81	**d28-0**	0.16	1.79	11.33	6.34
d29-1c	0.12	1.45	12.52	6.16	**d29-1**	0.14	1.53	10.58	6.28	**d29-0c**	0.15	2.05	14.13	5.98	**d29-0**	0.17	2.04	11.79	6.71
d30-1c	0.12	1.45	12.49	5.93	**d30-1**	0.11	0.99	9.07	6.69	**d30-0c**	0.16	2.29	14.66	6.07	**d30-0**	0.14	1.53	10.60	6.63
d31-1c	0.10	1.10	11.32	6.03	**d31-1**	0.18	2.12	11.76	6.32	**d31-0c**	0.16	2.12	13.21	5.78	**d31-0**	0.17	2.00	11.56	6.34
d32-1c	0.10	1.18	11.75	6.34	**d32-1**	0.14	1.58	10.94	6.56	**d32-0c**	0.14	1.90	13.93	6.02	**d32-0**	0.17	2.05	11.88	6.65
d33-1c	0.10	1.32	12.61	5.61	**d33-1**	0.11	0.97	9.14	6.43	**d33-0c**	0.17	2.54	15.16	5.76	**d33-0**	0.13	1.55	11.45	6.59
d34-1c	0.11	1.44	12.87	5.84	**d34-1**	0.13	1.43	10.93	6.4	**d34-0c**	0.15	2.12	14.49	5.65	**d34-0**	0.14	1.50	10.99	6.37
d35-1c	0.12	1.55	12.97	6.09	**d35-1**	0.16	2.06	12.75	6.37	**d35-0c**	0.17	2.56	15.37	5.63	**d35-0**	0.18	2.21	12.58	6.73
d36-1c	0.10	1.32	12.93	6.26	**d36-1**	0.10	1.01	10.13	6.87	**d36-0c**	0.14	2.02	14.08	5.92	**d36-0**	0.16	1.95	12.53	6.7
d37-1c	0.11	1.64	14.75	6.39	**d37-1**	0.13	1.52	11.59	6.51	**d37-0c**	0.17	3.11	18.05	6.09	**d37-0**	0.16	2.12	12.92	6.62
d38-1c	0.10	1.62	15.69	6.39	**d38-1**	0.18	2.55	14.27	6.4	**d38-0c**	0.14	2.38	16.87	6.51	**d38-0**	0.19	2.43	12.97	6.36
d39-1c	0.09	1.21	13.32	6.27	**d39-1**	0.10	1.10	10.77	6.78	**d39-0c**	0.13	2.04	15.37	6.09	**d39-0**	0.14	1.83	12.65	6.6
d40-1c	0.11	1.57	13.85	5.55	**d40-1**	0.13	1.55	11.98	6.63	**d40-0c**	0.21	3.14	14.92	5.4	**d40-0**	0.14	1.82	12.64	6.78
d41-1c	0.14	1.89	13.38	6	**d41-1**					**d41-0c**	0.16	2.19	13.69	6.23	**d41-0**				
d42-1c	0.10	1.11	11.70	6.05	**d42-1**	0.13	1.58	11.75	6.71	**d42-0c**	0.13	1.74	13.05	5.6	**d42-0**				
d43-1c	0.10	1.13	11.68	5.96	**d43-1**	0.11	1.09	10.21	6.64	**d43-0c**	0.14	1.82	12.80	6.05	**d43-0**	0.13	1.62	12.25	6.58
d44-1c	0.10	1.31	12.55	5.98	**d44-1**	0.10	0.96	9.95	6.77	**d44-0c**	0.14	1.81	13.32	5.94	**d44-0**	0.15	1.86	12.64	6.67
d45-1c	0.10	1.37	13.48	5.97	**d45-1**	0.13	1.78	13.46	6.67	**d45-0c**	0.14	1.97	13.81	6.49	**d45-0**	0.15	1.91	12.74	6.65
d46-1c	0.11	1.52	14.07	6.06	**d46-1**	0.13	1.47	11.72	6.67	**d46-0c**	0.15	2.16	14.87	6.21	**d46-0**	0.14	1.80	12.54	6.7
d47-1c	0.11	1.54	13.39	5.76	**d47-1**	0.15	1.81	11.93	6.58	**d47-0c**	0.15	2.01	13.74	5.66	**d47-0**	0.15	1.94	13.12	6.7
d48-1c	0.13	1.95	15.34	5.81	**d48-1**	0.12	1.38	11.38	6.97	**d48-0c**	0.15	2.31	15.08	5.74	**d48-0**	0.18	2.05	11.62	6.58
d49-1c	0.07	1.06	14.18	5.74	**d49-1**	0.13	1.59	12.39	6.67	**d49-0c**	0.13	2.05	15.70	6.07	**d49-0**	0.15	1.87	12.75	6.83
d50-1c	0.10	1.47	14.97	6.04	**d50-1**	0.15	2.01	13.00	6.44	**d50-oc**	0.14	2.08	14.74	5.8	**d50-o**	0.18	2.61	14.34	6.83

UBU

Ubu	**Total N**	**Total C**	**C / N**	**pH**	**Ubu**	**Total N**	**Total C**	**C / N**	**pH**	**Ubu**	**Total N**	**Total C**	**C / N**	**pH**	**Ubu**	**Total N**	**Total C**	**C / N**	pH
0-5cm cane	**(%)**	**(%)**	**Ratio**		**0-5cm crop**	**(%)**	**(%)**	**Ratio**		**5-20cm cane**	**(%)**	**(%)**	**Ratio**		**5-20cm crop**	**(%)**	**(%)**	**Ratio**	
u1-oc	0.09	1.19	13.84	6.17	**u1-o**	0.07	1.19	16.20	6.23	**u1-1c**	0.07	0.93	13.55	5.93	**u1-1**	0.07	1.27	19.23	6.74
u2-0c	0.08	1.06	13.71	6	**u2-0**	0.09	1.40	15.81	6.25	**u2-1c**	0.04	0.55	12.17	6.1	**u2-1**	0.08	1.35	16.96	5.75
u3-0c	0.09	1.32	13.95	6.17	**u3-0**	0.07	1.15	16.07	6.1	**u3-1c**	0.09	1.17	13.56	5.95	**u3-1**	0.06	0.98	15.80	6.14
u4-oc	0.10	1.32	13.42	6.32	**u4-o**	0.07	1.05	15.31	6.09	**u4-1c**	0.08	1.12	13.34	5.58	**u4-1**	0.09	1.37	15.77	6.04

u5-0c	0.08	1.08	12.75	6.2	**u5-0**	0.09	1.36	15.34	6.15	**u5-1c**	0.09	1.15	13.30	6.13	**u5-1**	0.09	1.31	15.38	5.96
u6-0c	0.07	0.99	14.85	6.37	**u6-0**	0.08	1.27	15.53	6.02	**u6-1c**	0.06	0.76	12.36	6.04	**u6-1**	0.08	1.11	14.46	5.81
u7-0c	0.08	0.96	12.45	6.3	**u7-0**	0.06	0.93	14.94	6.1	**u7-1c**	0.08	1.18	14.85	6.43	**u7-1**	0.05	0.72	1.75	6.01
u8-0c	0.07	1.05	14.38	6.21	**u8-0**	0.05	0.70	13.86	5.97	**u8-1c**	0.07	0.96	12.88	6.1	**u8-1**	0.06	0.84	14.69	5.81
u9-0c	0.09	1.37	15.89	6.47	**u9-0**	0.07	1.07	14.96	5.95	**u9-1c**	0.09	1.24	14.50	6.1	**u9-1**	0.08	1.19	15.09	5.89
u10-0c	0.09	1.18	13.35	6.21	**u10-0**	0.08	1.18	14.61	6.06	**u10-1c**	0.08	1.06	14.13	5.77	**u10-1**	0.06	0.86	15.43	5.76
u11-0c	0.08	1.11	14.10	6.93	**u11-0**	0.06	0.87	14.70	5.97	**u11-1c**	0.06	0.78	12.16	5.87	**u11-1**	0.05	0.69	14.31	5.93
u12-0c	0.07	0.87	13.34	6.09	**u12-0**	0.06	0.90	15.59	5.98	**u12-1c**	0.04	0.46	10.41	5.68	**u12-1**	0.05	0.79	15.16	5.92
u13-0c	0.07	0.98	13.17	5.93	**u13-0**	0.06	0.96	15.60	6.34	**u13-1c**	0.05	0.57	11.43	5.72	**u13-1**	0.05	0.76	15.32	6.17
u14-0c	0.07	0.87	12.04	6.4	**u14-0**	0.05	0.84	15.22	6.11	**u14-1c**	0.06	0.70	12.26	5.74	**u14-1**	0.05	0.82	16.04	5.88
u15-0c	0.07	0.88	12.06	6.31	**u15-0**	0.06	1.03	15.95	6.26	**u15-1c**	0.05	0.58	11.08	6.25	**u15-1**	0.07	0.99	14.71	6.02
u16-0c	0.08	1.01	12.87	6.46	**u16-0**	0.06	0.91	14.70	6.17	**u16-1c**	0.06	0.78	12.09	6.13	**u16-1**	0.05	0.74	15.13	5.92
u17-0c	0.07	0.91	12.43	6.62	**u17-0**	0.06	0.85	14.80	6.3	**u17-1c**	0.07	0.71	10.84	6.38	**u17-1**	0.05	0.76	14.74	6.02
u18-1c	0.08	1.23	14.69	6.23	**u18-1**	0.07	1.02	14.67	6.52	**u18-1c**	0.08	1.23	14.69	6.18	**u18-1**	0.07	1.02	14.67	6.25
u19-oc	0.06	0.73	11.71	6.45	**u19-o**	0.06	0.98	15.26	6.36	**u19-1c**	0.06	0.66	11.73	6.09	**u19-1**	0.05	0.81	15.01	6.95
u20-0c	0.06	0.62	11.21	6.24	**u20-0**	0.07	0.99	14.84	6.46	**u20-1c**	0.06	0.66	10.92	6.1	**u20-1**	0.08	1.29	15.36	6.16
u21-0c	0.09	1.24	14.32	6.2	**u21-0**	0.06	0.86	15.48	7.5	**u21-1c**	0.07	0.95	13.59	6.49	**u21-1**	0.05	0.74	16.44	7.75
u22-0c	0.05	0.64	11.97	6.89	**u22-0**	0.05	0.81	15.15	6.85	**u22-1c**	0.05	0.59	11.75	6.85	**u22-1**	0.03	0.51	14.71	6.32
u23-0c	0.05	0.71	12.95	6.36	**u23-0**	0.06	0.95	15.52	6.95	**u23-1c**	0.04	0.46	11.75	6.62	**u23-1**	0.05	0.77	16.41	6.61
u24-0c	0.07	0.93	13.57	6.57	**u24-0**	0.08	1.17	15.36	7.02	**u24-1c**	0.06	0.75	12.87	6.11	**u24-1**	0.06	0.88	14.41	6.58
u25-0c	0.06	0.95	14.85	6.49	**u25-0**	0.07	1.08	15.22	6.4	**u25-1c**	0.06	0.81	13.20	6.46	**u25-1**	0.07	1.04	15.48	6.19
u26-oc	0.06	0.80	12.62	6.65	**u26-o**	0.07	1.08	15.55	5.94	**u26-1c**	0.06	0.82	13.52	6.95	**u26-1**	0.07	1.04	15.38	5.74
u27-0c	0.06	0.66	11.91	7.39	**u27-0**	0.05	0.87	15.47	5.74	**u27-1c**	0.05	0.58	11.24	6.76	**u27-1**	0.06	0.89	16.00	5.7
u28-0c	0.06	0.81	12.61	6.68	**u28-0**	0.05	0.75	16.65	5.85	**u28-1c**	0.05	0.64	12.44	6.48	**u28-1**	0.05	0.85	16.73	5.7
u29-0c	0.06	0.81	12.63	6.48	**u29-0**	0.05	0.80	16.02	5.88	**u29-1c**	0.05	0.56	11.62	7.14	**u29-1**	0.06	0.97	16.33	5.77
u30-0c	0.05	0.62	12.19	6.4	**u30-0**	0.04	0.72	17.43	5.88	**u30-1c**	0.06	0.86	13.31	6.5	**u30-1**	0.04	0.74	16.57	6
u31-0c	0.04	0.46	11.04	6.46	**u31-0**	0.04	0.65	16.47	5.82	**u31-1c**	0.08	1.17	15.16	6.9	**u31-1**	0.04	0.72	17.07	5.97
u32-0c	0.06	0.76	13.58	7.02	**u32-0**	0.05	0.74	16.14	5.85	**u32-1c**	0.05	0.76	13.83	7.11	**u32-1**	0.06	1.08	16.61	5.68
u33-0c	0.06	1.04	17.41	6.6	**u33-0**	0.05	0.79	16.38	5.88	**u33-1c**	0.06	1.21	19.01	6.37	**u33-1**	0.05	0.79	15.85	5.89
u34-0c	0.06	1.05	18.80	6.47	**u34-0**	0.05	0.85	16.15	6.41	**u34-1c**	0.05	0.64	12.79	6.26	**u34-1**	0.05	0.83	16.14	6.1
u35-0c	0.05	0.70	13.83	6.3	**u35-0**	0.08	1.27	16.42	6.22	**u35-1c**	0.04	0.49	11.86	6.14	**u35-1**	0.05	0.82	16.03	5.6
u36-0c	0.07	0.98	14.61	7.67	**u36-0**	0.06	0.92	16.87	6.77	**u36-1c**	0.07	0.99	13.50	7.53	**u36-1**	0.05	0.82	15.87	6.6
u37-0c	0.11	1.80	16.38	7.84	**u37-0**	0.06	0.96	15.46	6.67	**u37-1c**	0.08	1.29	15.91	7.8	**u37-1**	0.05	0.84	15.58	6.57

u38-0c	0.08	1.22	14.95	7.48	**u38-0**	0.07	1.02	15.80	6.76	**u38-1c**	0.06	0.85	14.33	7.91	**u38-1**	0.06	0.85	14.81	6.44
u39-0c	0.06	1.21	21.17	8.34	**u39-0**	0.07	1.05	15.32	6.87	**u39-1c**	0.05	1.28	27.28	8.35	**u39-1**	0.06	0.88	14.31	6.58
u40-0c	0.04	0.95	23.31	8.31	**u40-0**	0.06	0.95	15.61	6.72	**u40-1c**	0.04	0.71	19.09	8.34	**u40-1**	0.05	0.85	15.63	6.48
u41-0c	0.04	0.59	14.67	7.7	**u41-0**	0.06	0.86	15.92	6.61	**u41-1c**	0.05	0.66	13.72	7.9	**u41-1**	0.05	0.92	17.10	6.64
u42-0c	0.07	1.09	16.00	8	**u42-0**	0.06	0.89	14.78	6.84	**u42-1c**	0.04	0.59	14.13	8.09	**u42-1**	0.04	0.77	17.41	6.59
u43-0c	0.10	1.37	14.23	8.09	**u43-0**	0.05	0.87	15.34	6.75	**u43-1c**	0.07	1.18	16.76	8.1	**u43-1**	0.06	1.02	18.00	6.76
u44-0c	0.06	0.85	14.25	7.09	**u44-0**	0.07	1.03	16.98	7.73	**u44-1c**	0.06	0.84	14.85	7.27	**u44-1**	0.05	0.91	18.94	7.92
u45-0c	0.06	0.83	14.90	7.35	**u45-0**	0.07	0.97	14.96	7.6	**u45-1c**	0.04	0.54	13.36	7.9	**u45-1**	0.08	1.26	16.02	7.32
u46-0c	0.06	1.10	19.47	8.39	**u46-0**	0.06	0.84	14.52	6.85	**u46-1c**	0.05	0.85	16.66	8.29	**u46-1**	0.06	0.94	15.38	6.75
u47-0c	0.06	1.02	17.29	8.19	**u47-0**	0.08	1.09	15.03	6.7	**u47-1c**	0.06	1.44	23.62	8.14	**u47-1**	0.05	0.76	14.12	6.69
u48-0c	0.08	1.20	14.46	7.72	**u48-0**	0.06	0.98	13.20	7.24	**u48-1c**	0.06	0.91	14.31	6.88	**u48-1**	0.06	0.86	14.62	6.87
u49-0c	0.08	1.11	14.35	7.11	**u49-0**	0.07	0.94	16.48	6.8	**u49-1c**	0.08	1.35	16.27	7.69	**u49-1**	0.06	0.73	13.23	6.67
u50-oc	0.09	1.27	13.95	7.2	**u50-o**	0.04	0.61	14.42	6.81	**u50-1c**	0.07	1.06	15.49	7.24	**u50-1**	0.05	0.76	14.85	6.78

TABLE A2: INFILTRATION RATES:
The infiltration rates were calculated for paired samples in the sugar cane and on the small farmer's plots. The sample numbers correspond to the soil sample site number at which the infiltration test was performed.

Diamante			**Ubu**		
Sample #	Cane (ml/sec)	Crop (ml/sec)	Sample #	Cane (ml/sec)	Crop (ml/sec)
1	1.69	4.92	12	1.69	1.64
3	1.69	5.90	15	2.36	3.19
6	1.04	3.47	18	4.54	3.93
9	0.88	2.62	21	3.37	9.08
12	5.90	0.91	24	0.91	3.37
15	2.95	1.97	27	2.23	1.57
18	0.94	2.62	30	3.37	2.15
21	2.51	2.46	33	16.86	3.47
24	0.46	1.51	36	5.90	3.69
42	4.37	1.26	39	9.83	3.81
45	0.49	23.60	42	3.37	6.56
48	0.47	11.80	45	8.43	1.97
			48	11.80	5.90
Total	23.40	63.03	**Total**	74.65	50.32
Average	1.95	5.25	**Average**	5.74	3.87

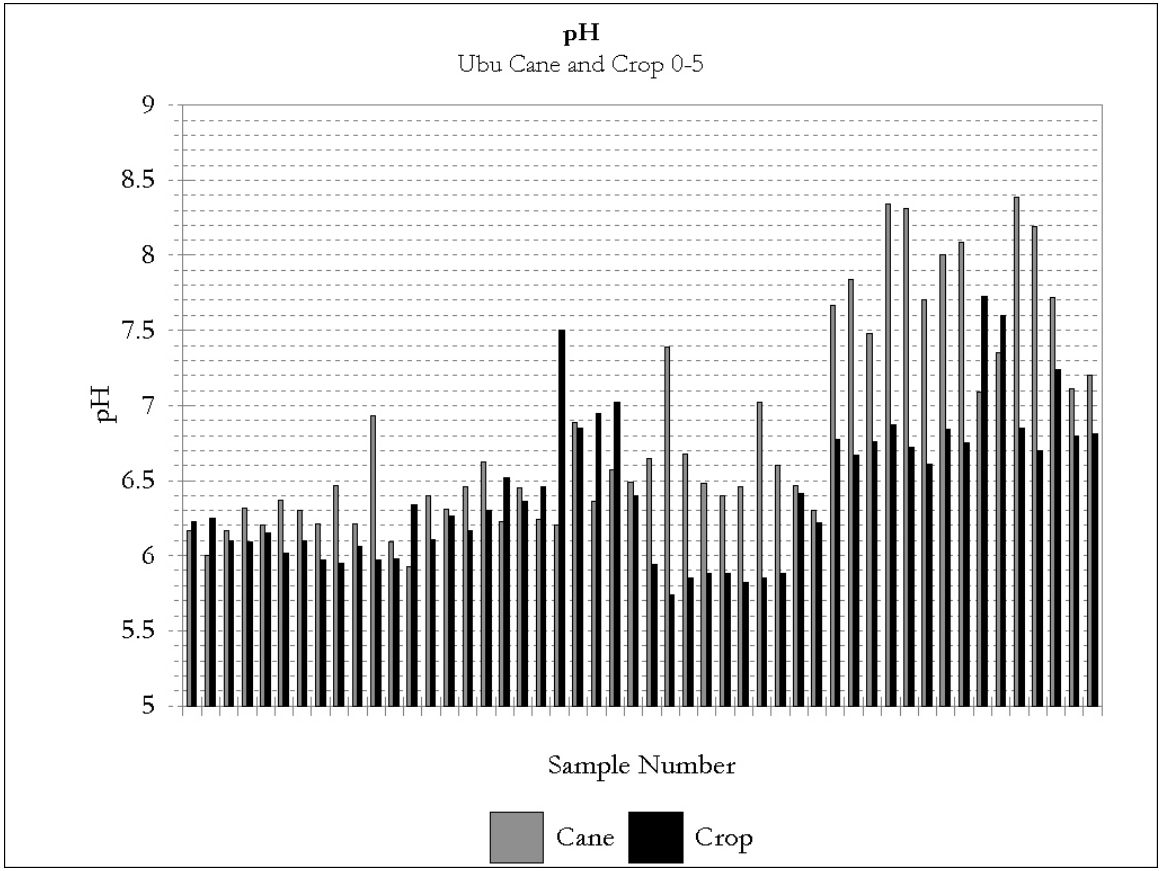

FIGURE A1: PH VALUES FOR SOIL CORES 0 - 5 CM

Values for paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Ubu.

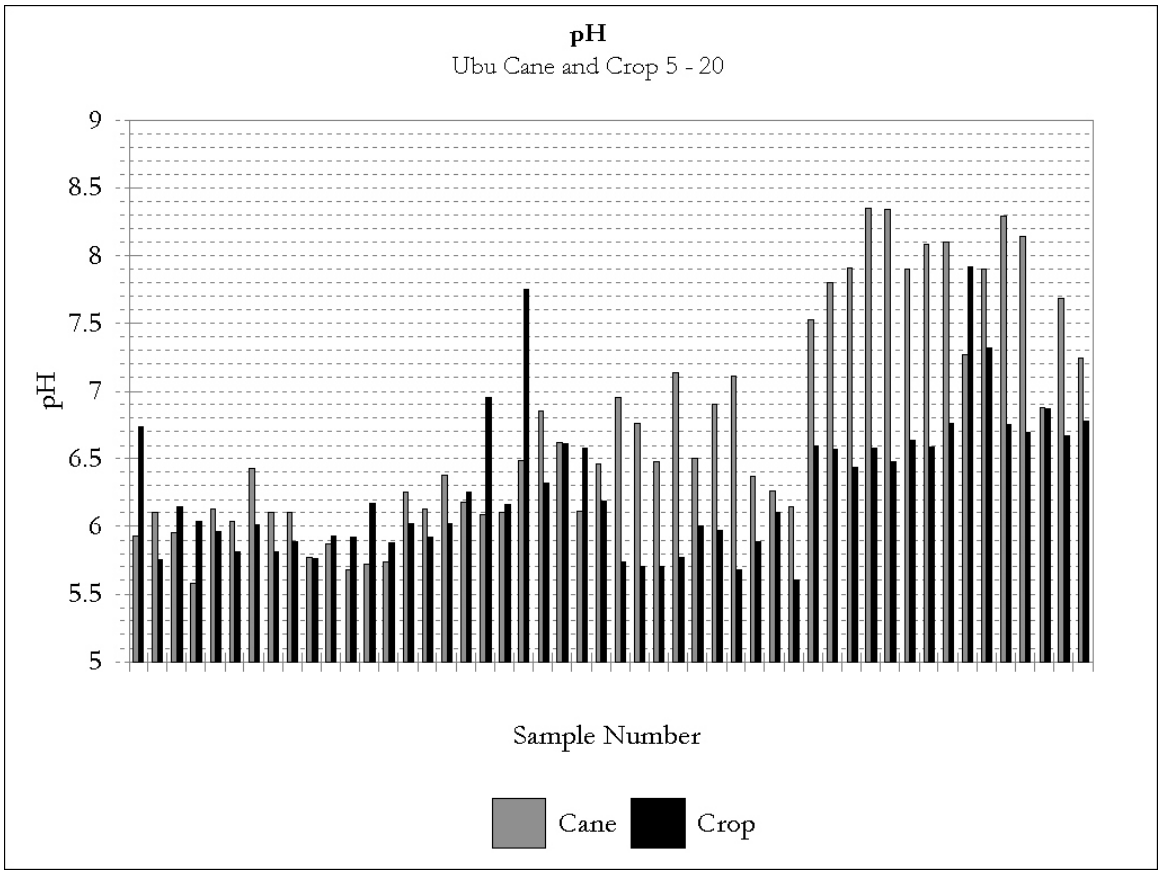

FIGURE A2: PH VALUES FOR SOIL CORES FROM 5 - 20 CM
Values for paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Ubu.

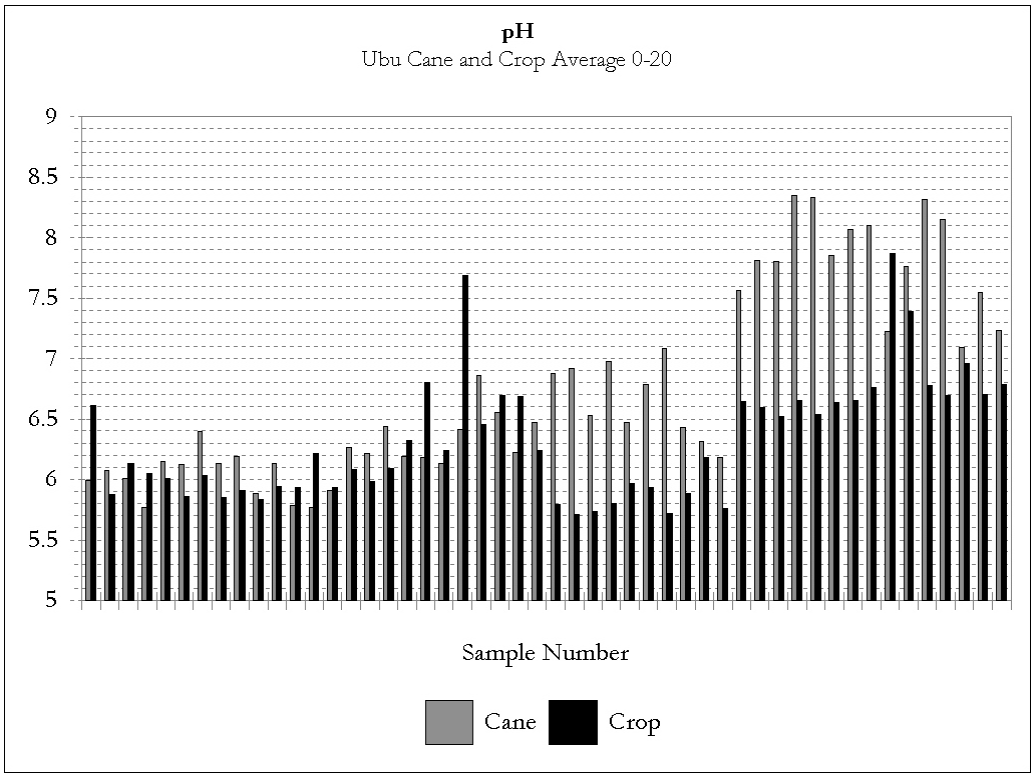

FIGURE A3: AVERAGE PH VALUES FOR SOIL CORES FROM 0 - 20 CM
Values for paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Ubu.

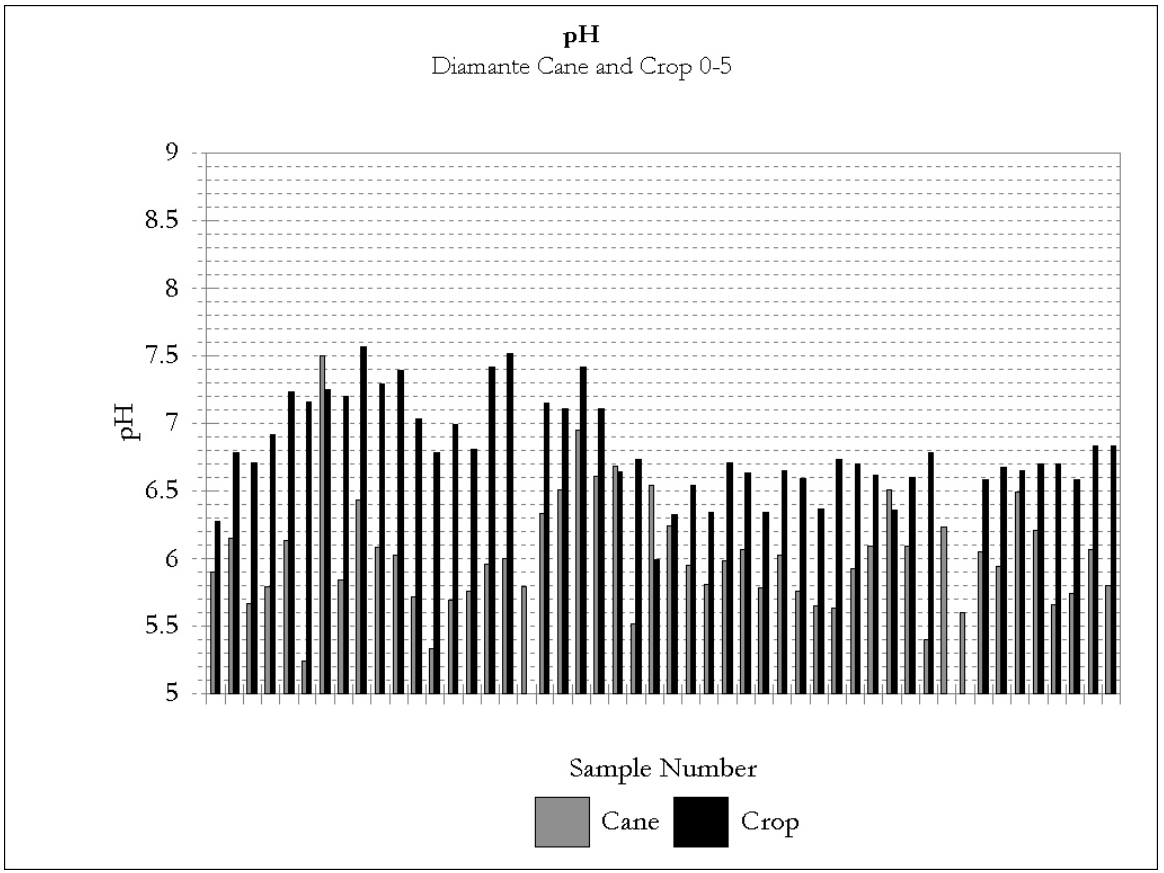

FIGURE A4: PH VALUES FOR SOIL CORES FROM 0 - 5 CM

Values for paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Diamante

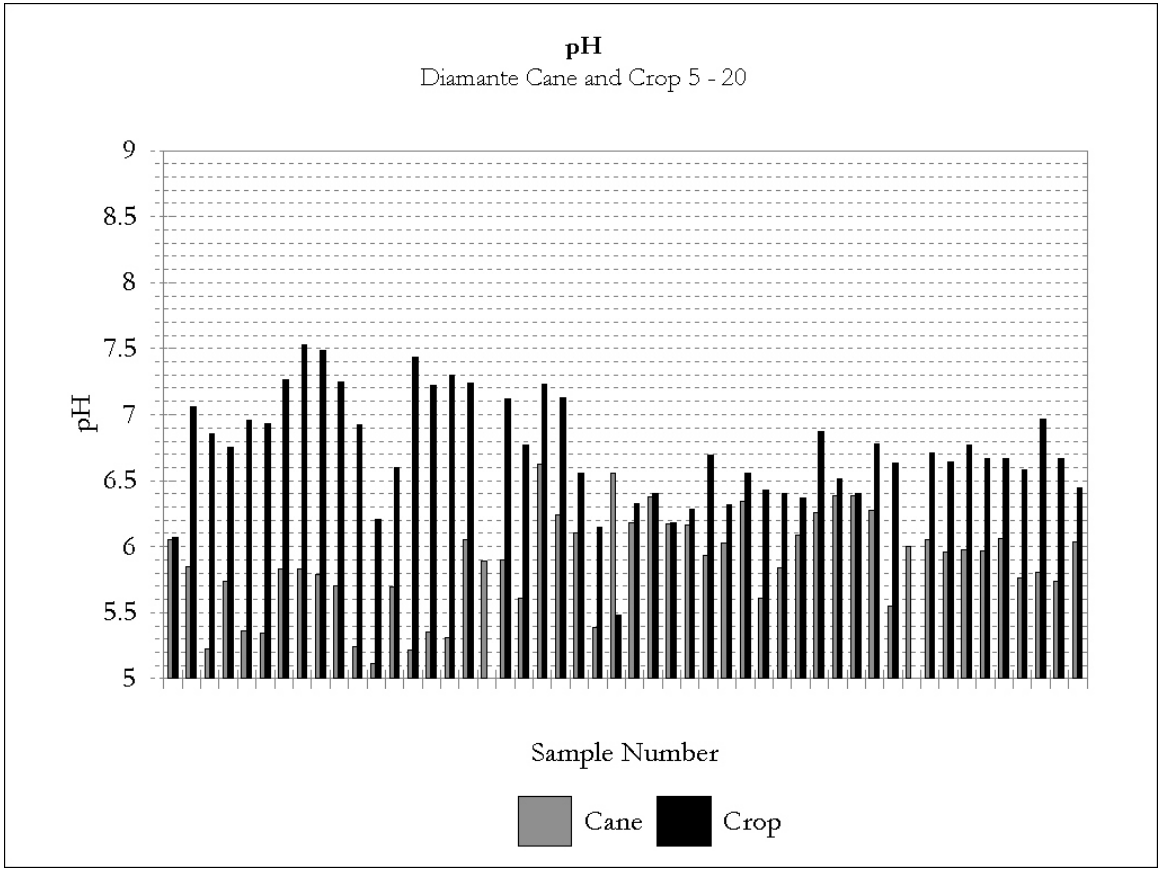

FIGURE A5: PH VALUES FOR SOIL CORES FROM 5 - 20 CM
Values for paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Diamante.

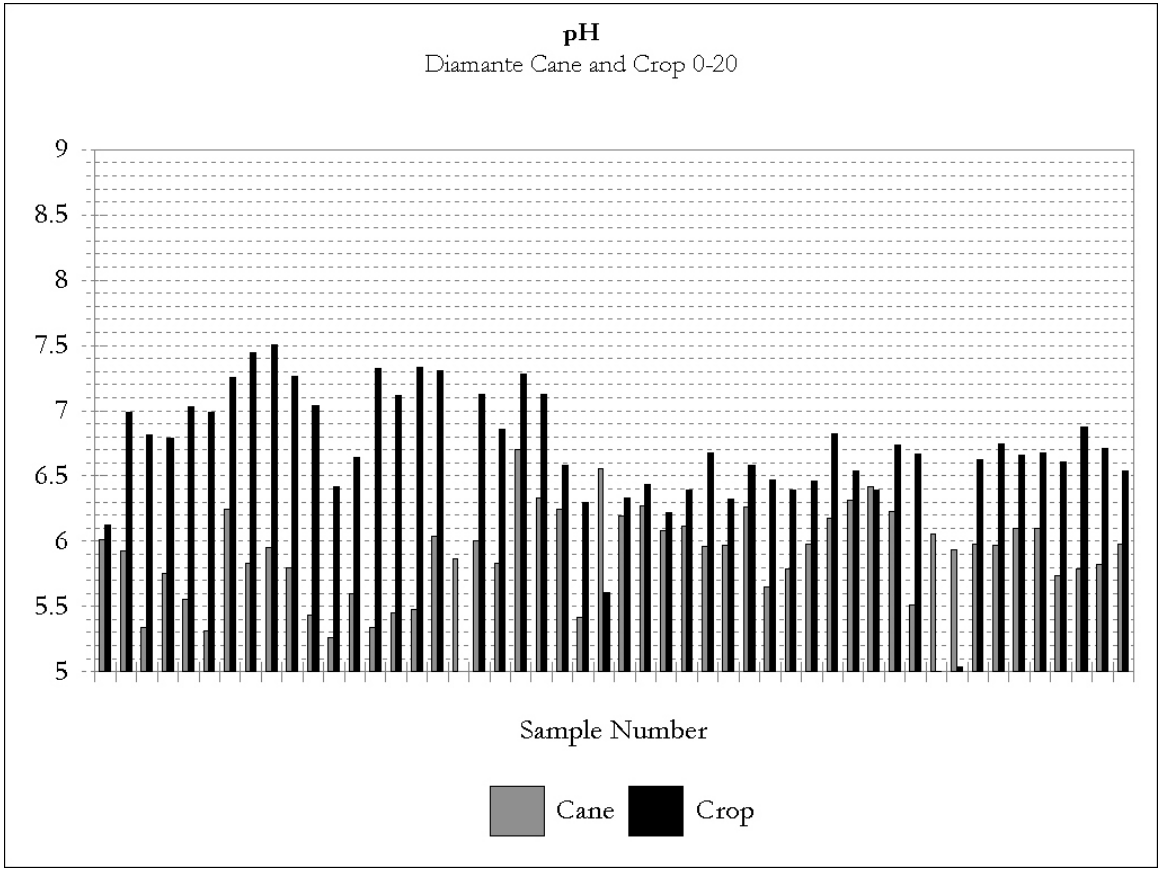

FIGURE A6: AVERAGE PH VALUES FOR SOIL CORES FROM 0 - 20 CM
Values for paired samples taken in the sugarcane and on farmer's plots at an agrarian reform settlement, Diamante.

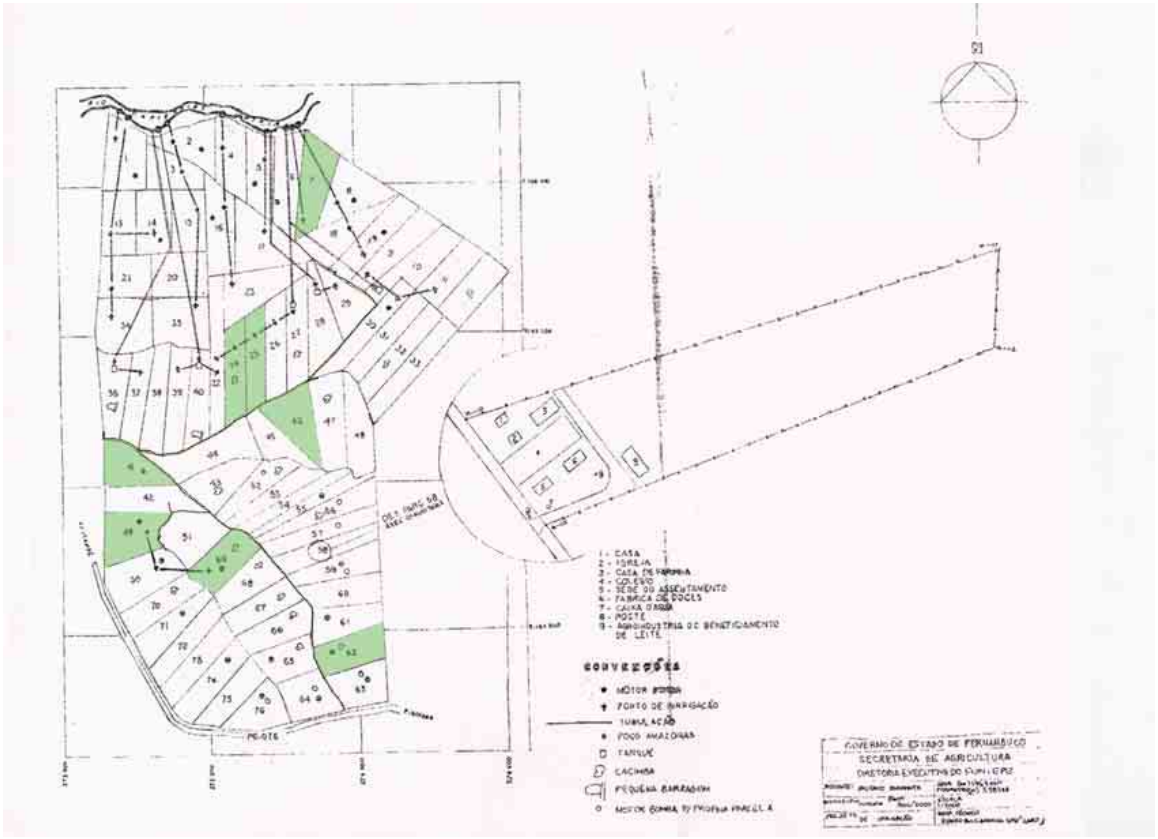

FIGURE A7: DIAMANTE

Parcels in green were study plots. Map courtesy of INCRA.

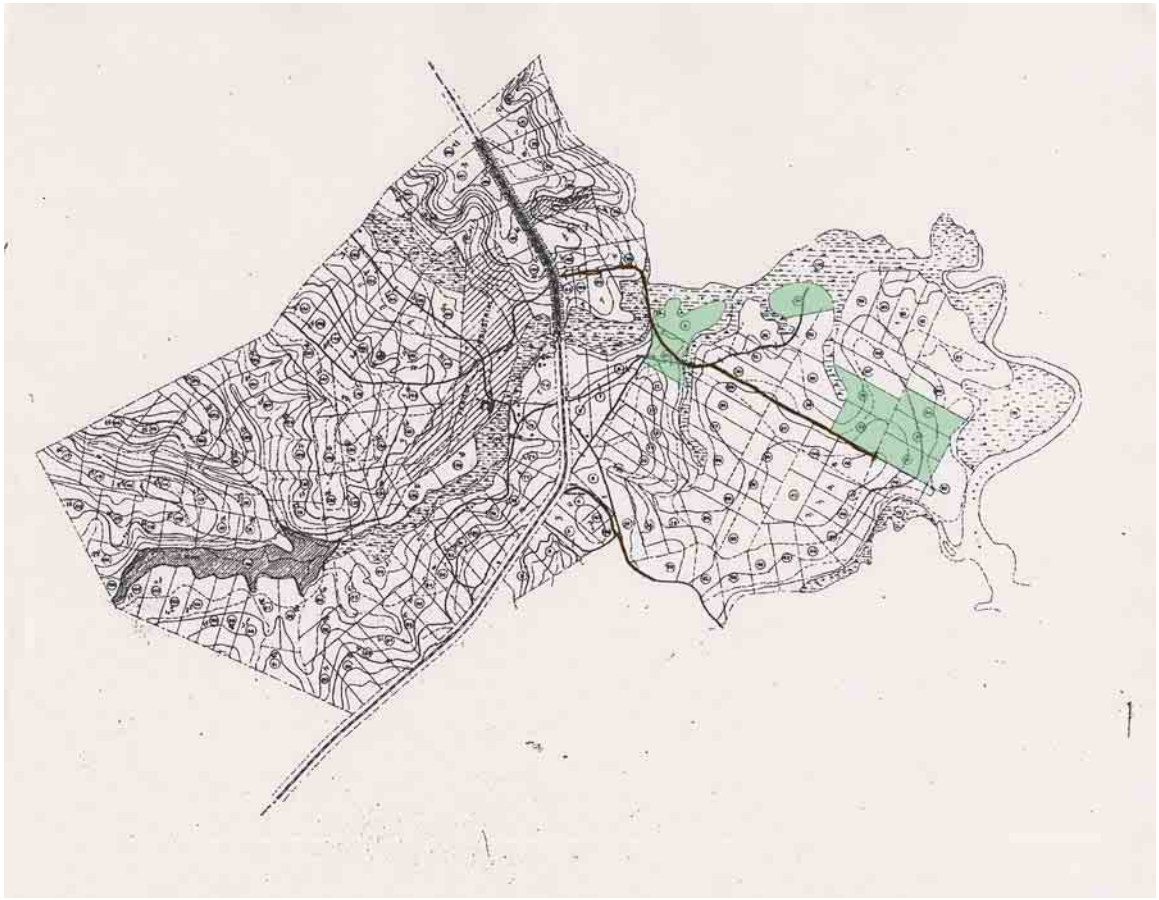

FIGURE A8: UBU
Parcels in green were study plots. Map courtesy of INCRA

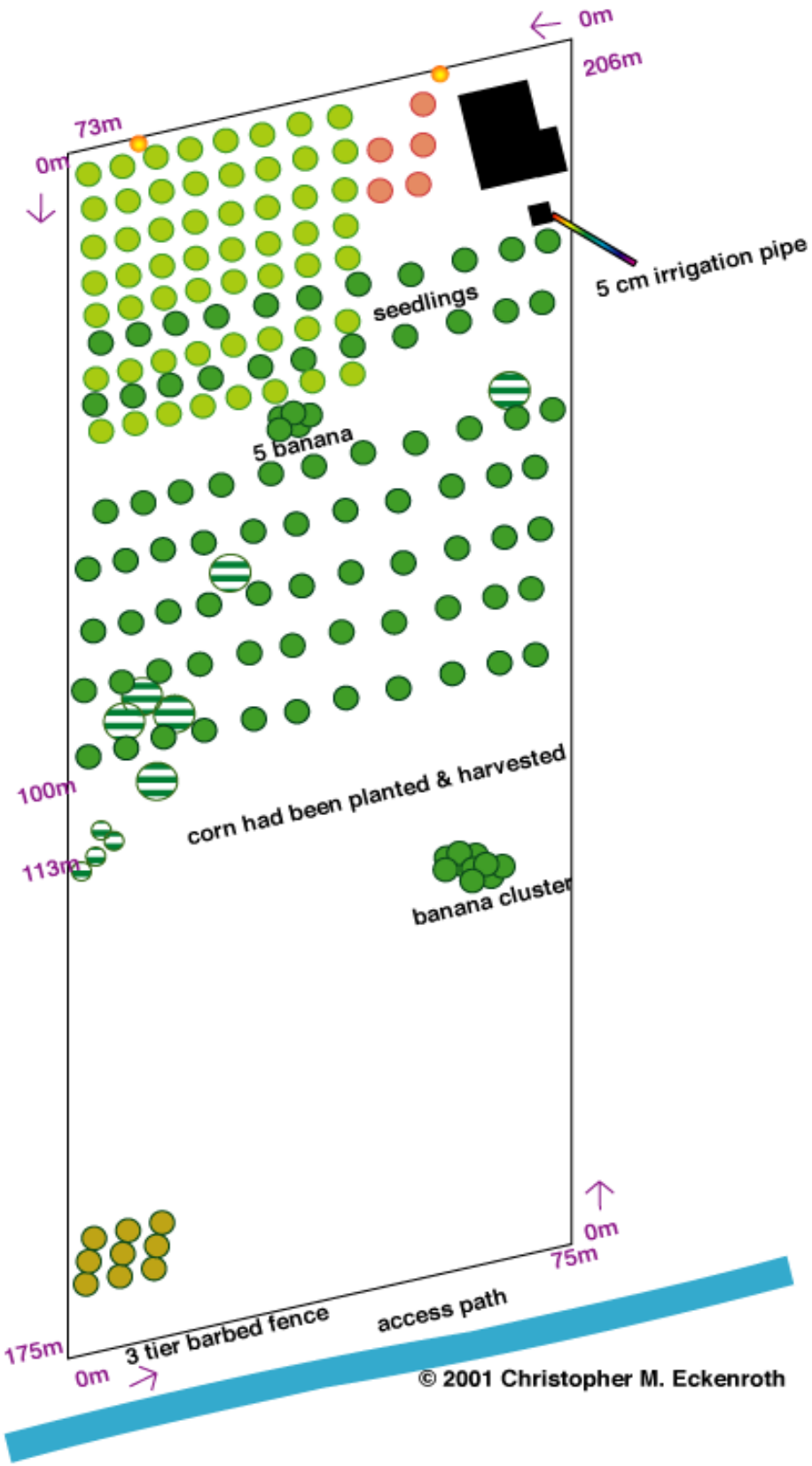

FIGURE A9: DIAMANTE FARMER D1

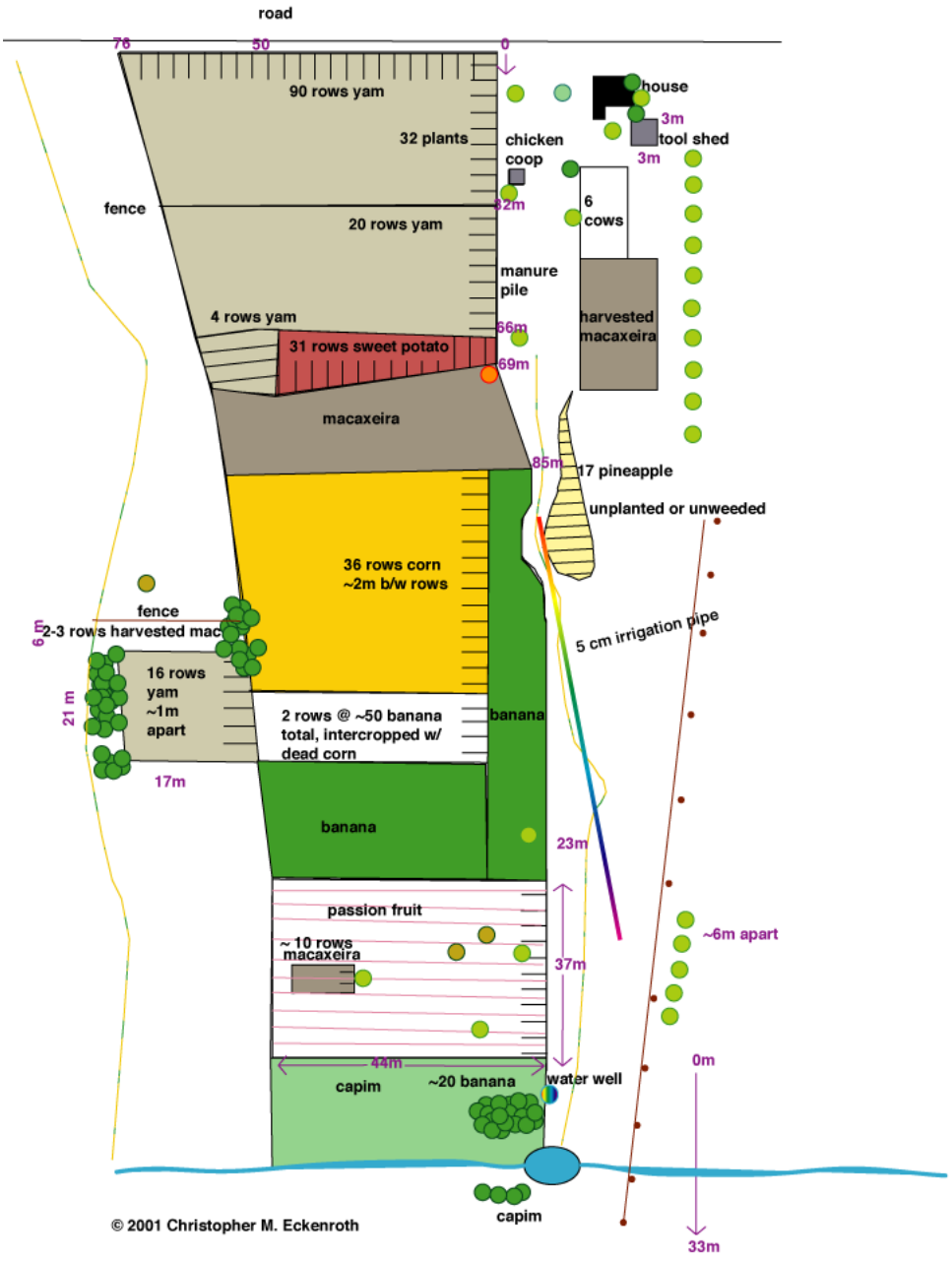

FIGURE A10: DIAMANTE FARMER D2

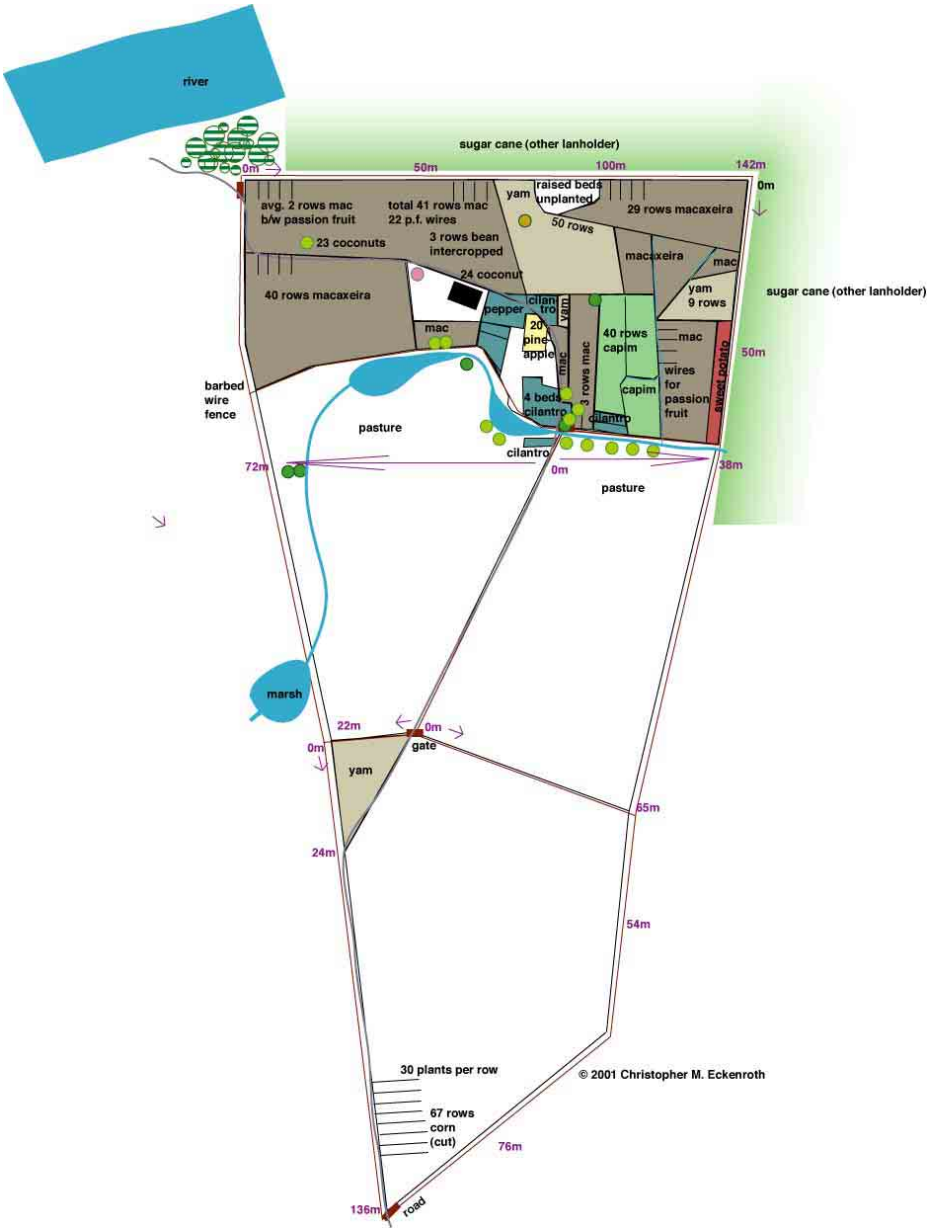

FIGURE A11: DIAMANTE FARMER D3

FIGURE A12: DIAMANTE FARMER D4

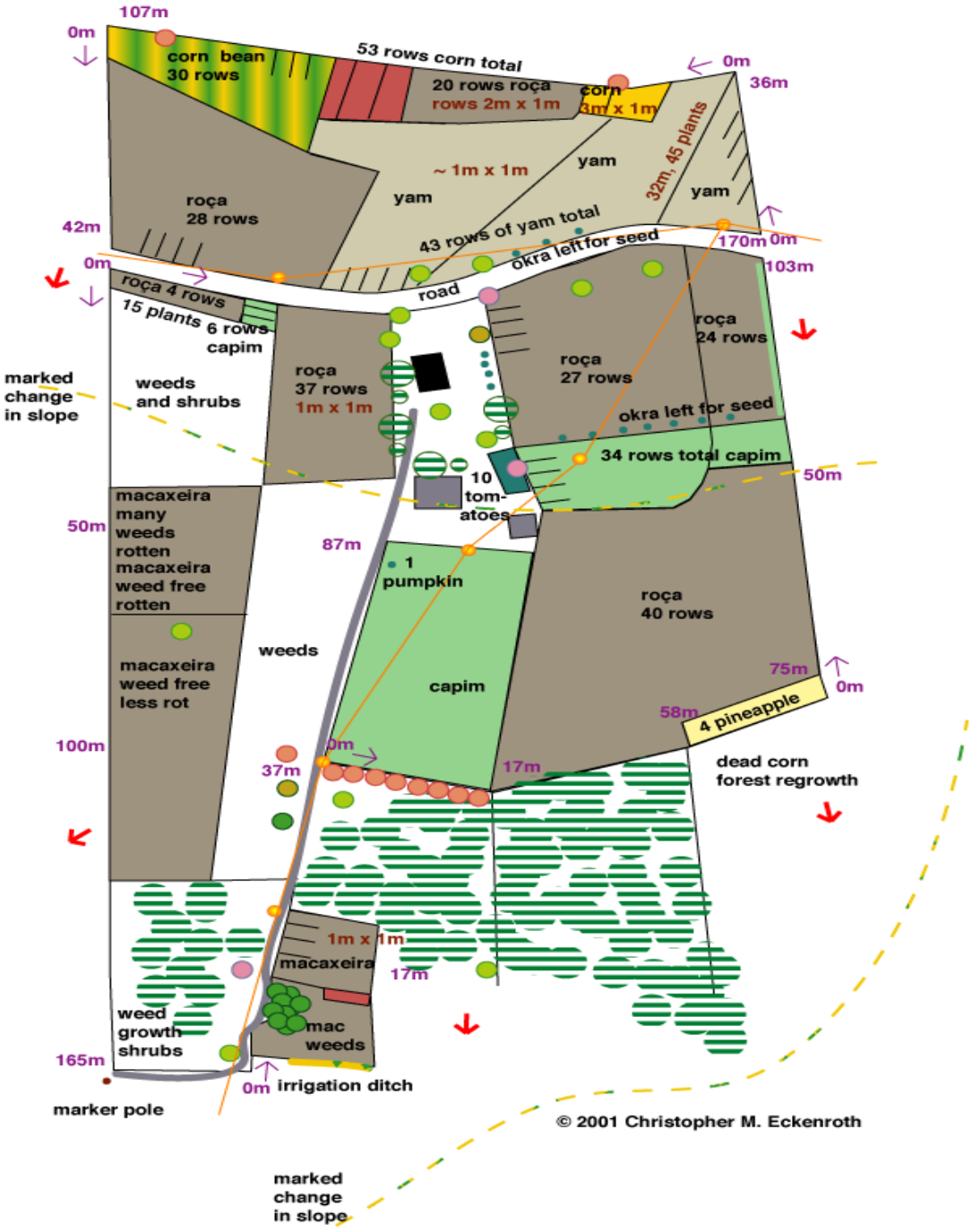

FIGURE A13: DIAMANTE FARMER D5

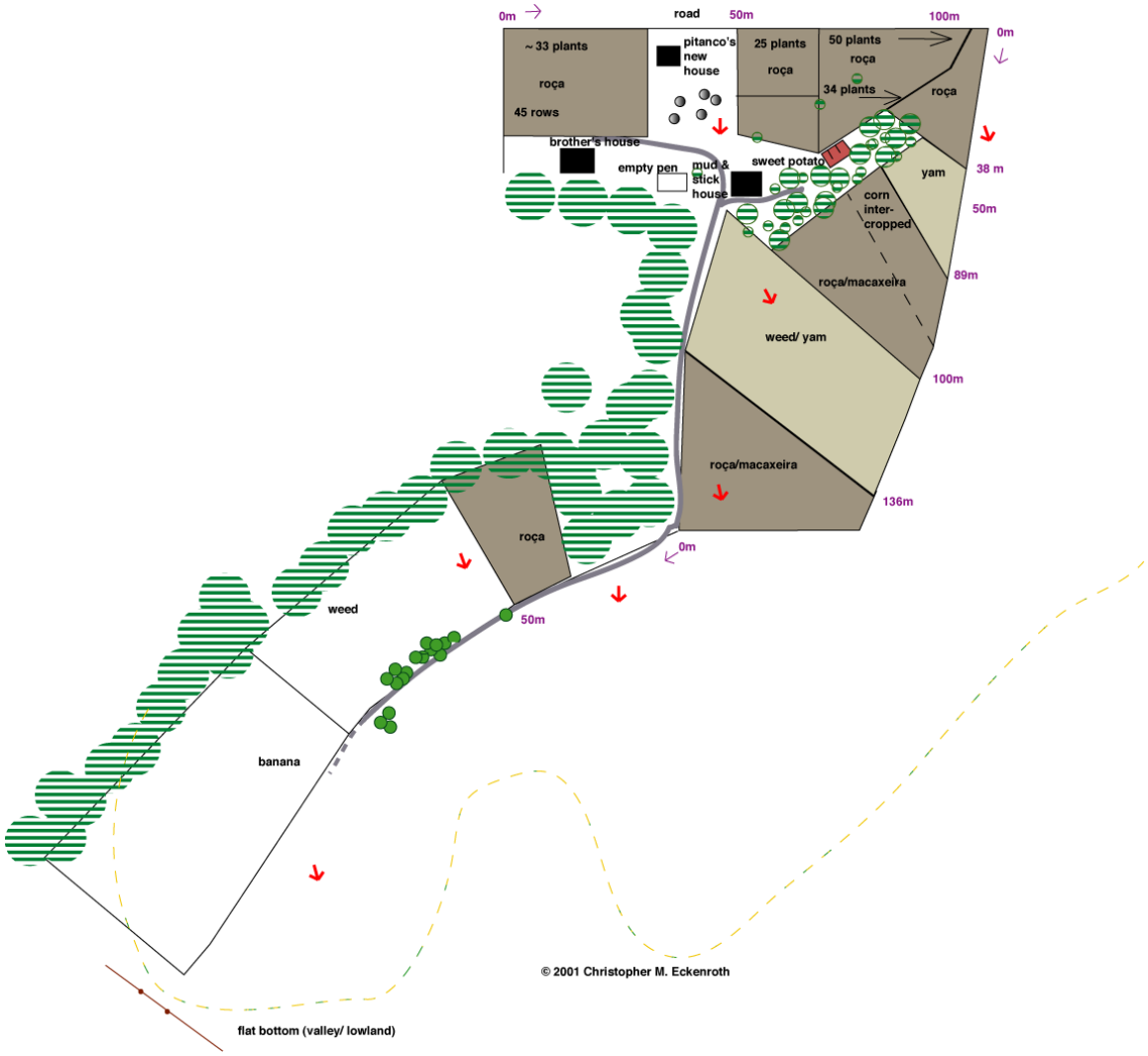

FIGURE A14: DIAMANTE FARMER D6

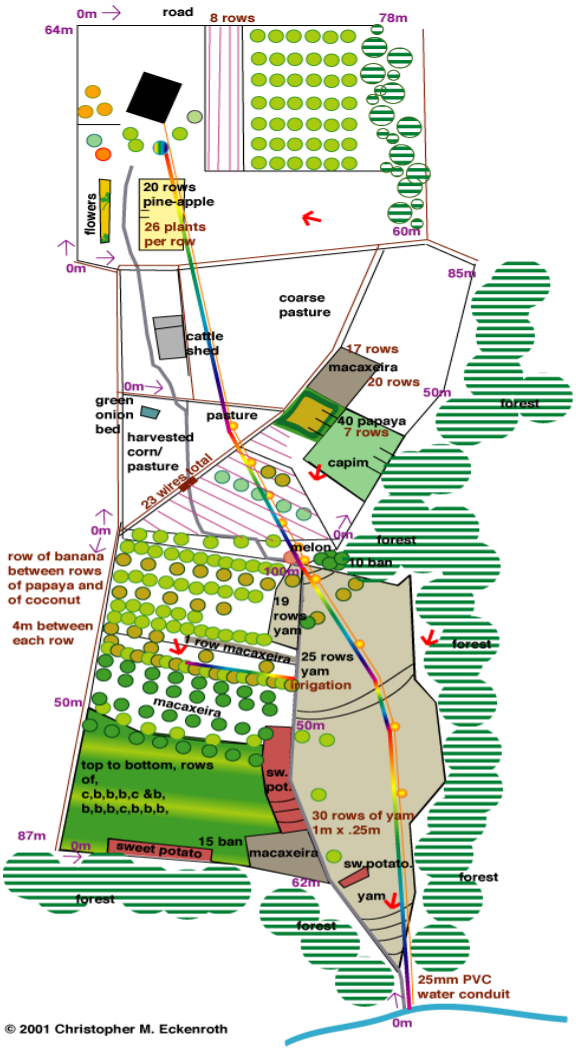

FIGURE A15: DIAMANTE FARMER D7

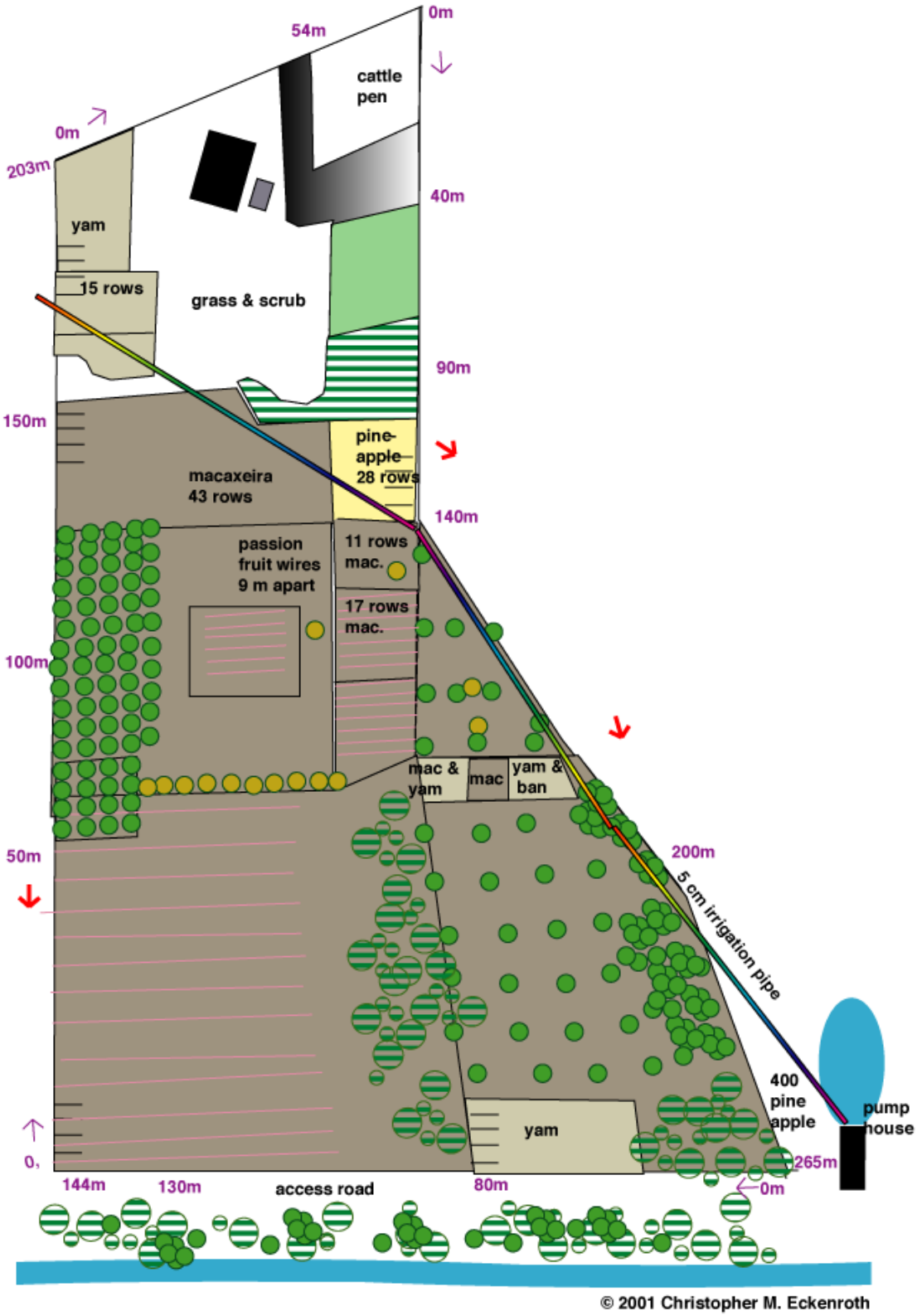

FIGURE A16: DIAMANTE FARMER D8

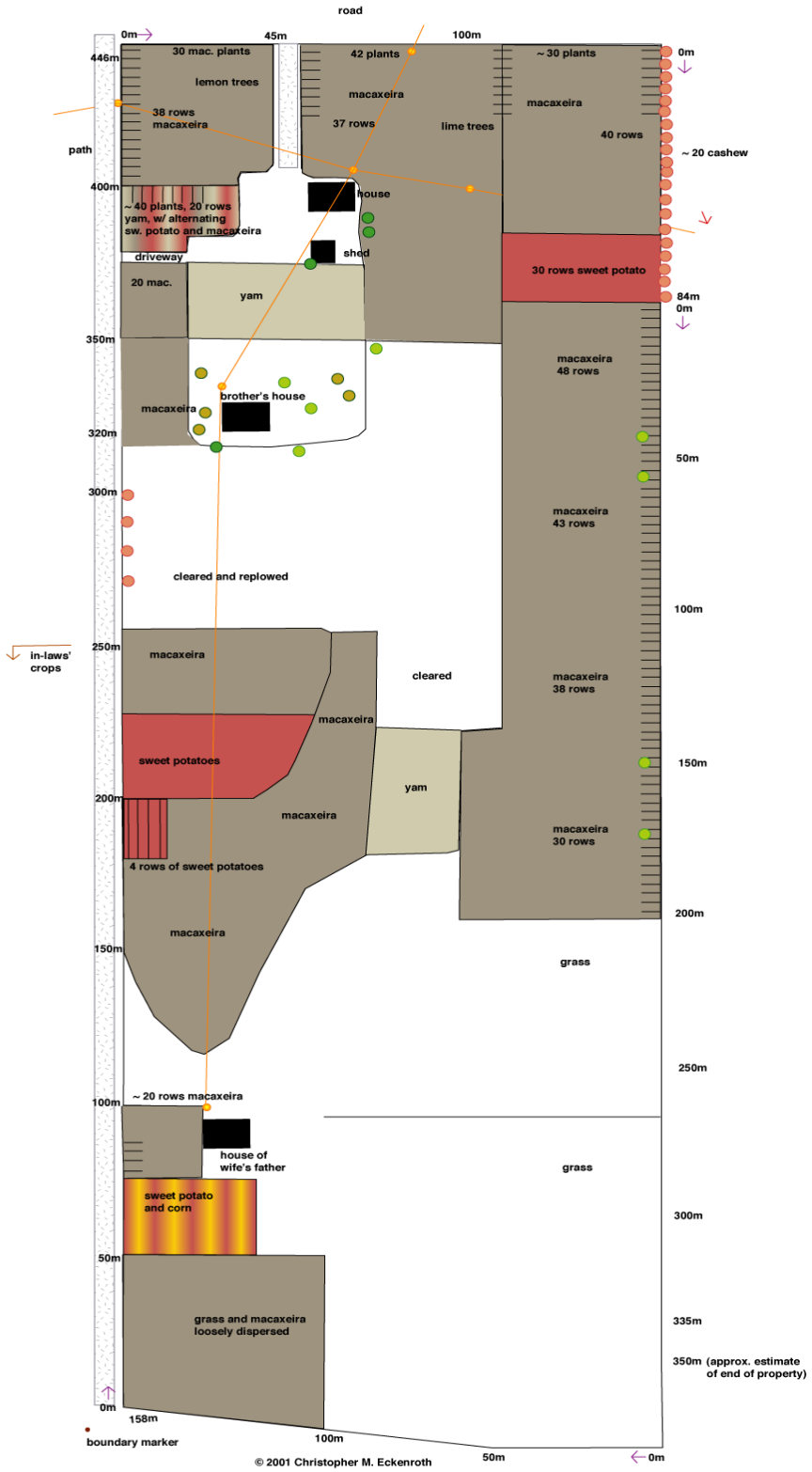

FIGURE A17: UBU FARMER U1

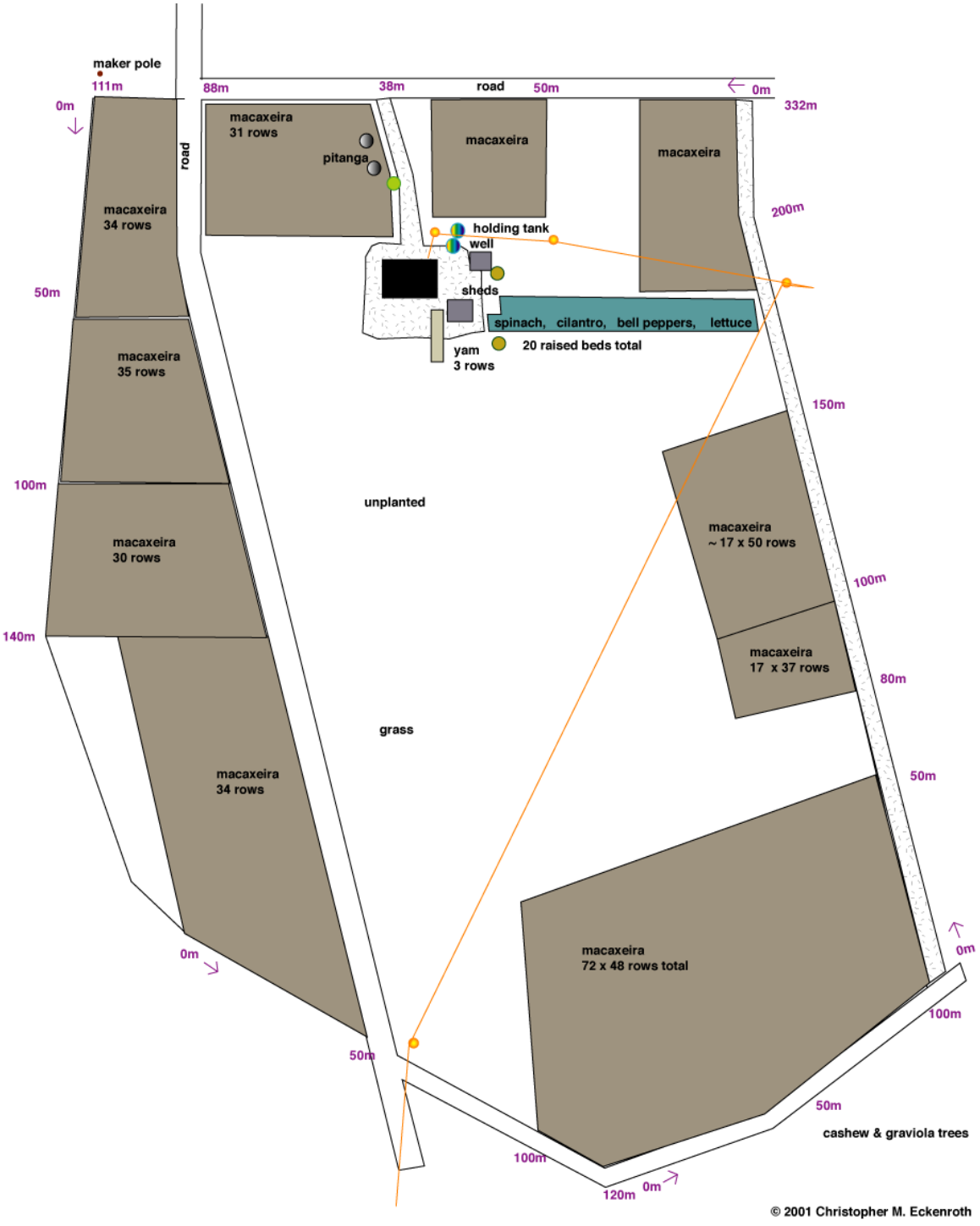

FIGURE A18: UBU FARMER U2

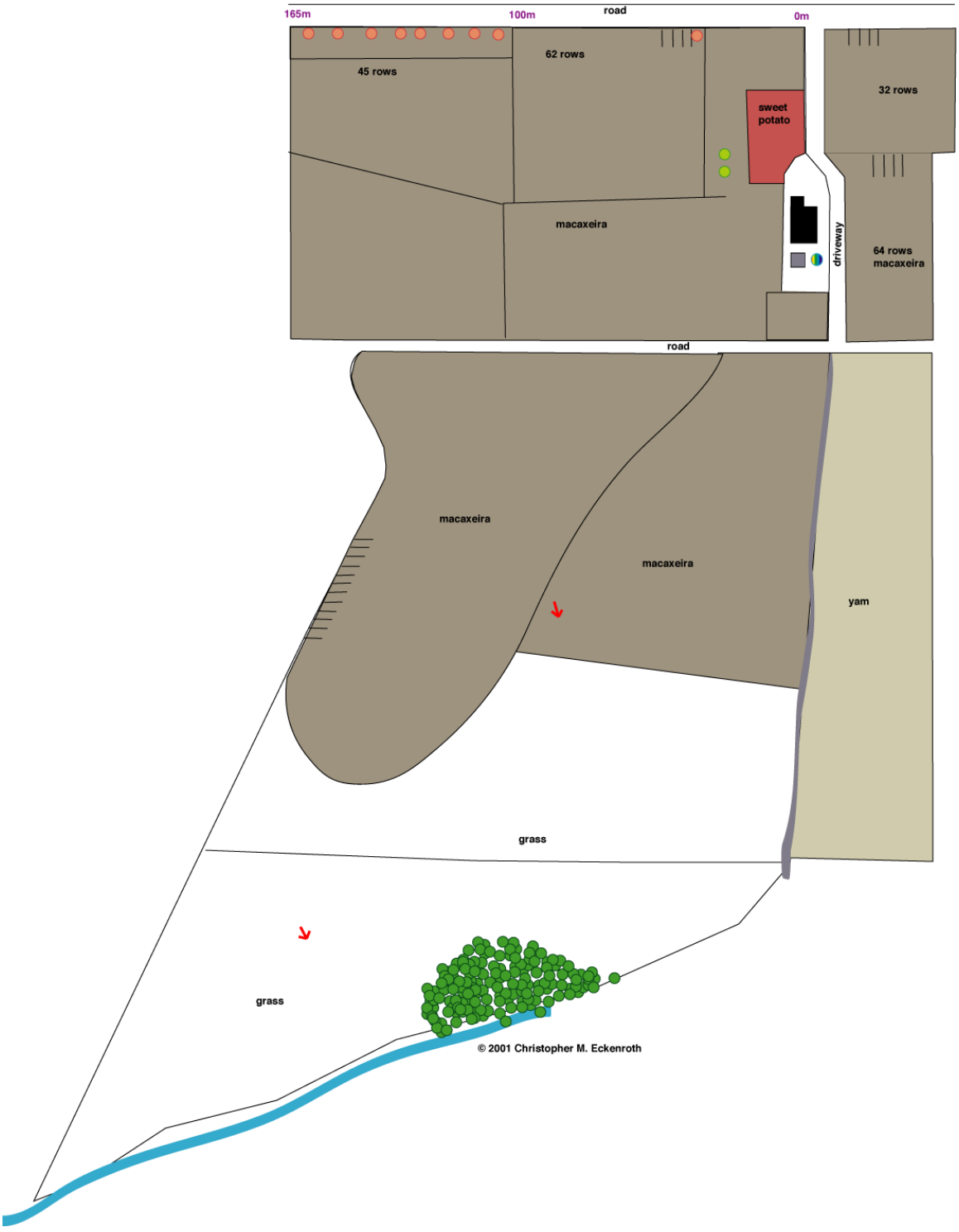

FIGURE A19: UBU FARMER U3

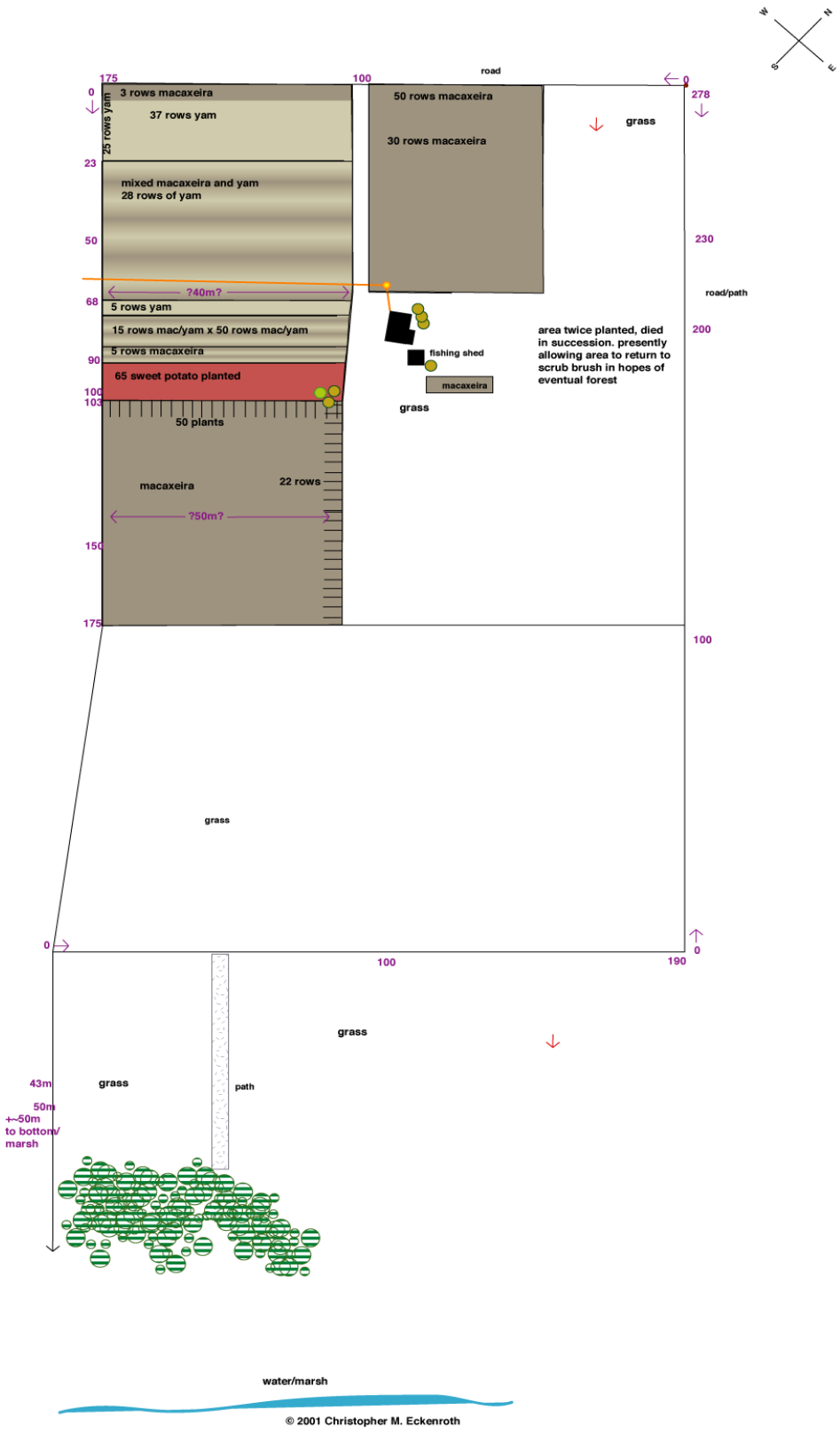

FIGURE A20: UBU FARMER U4

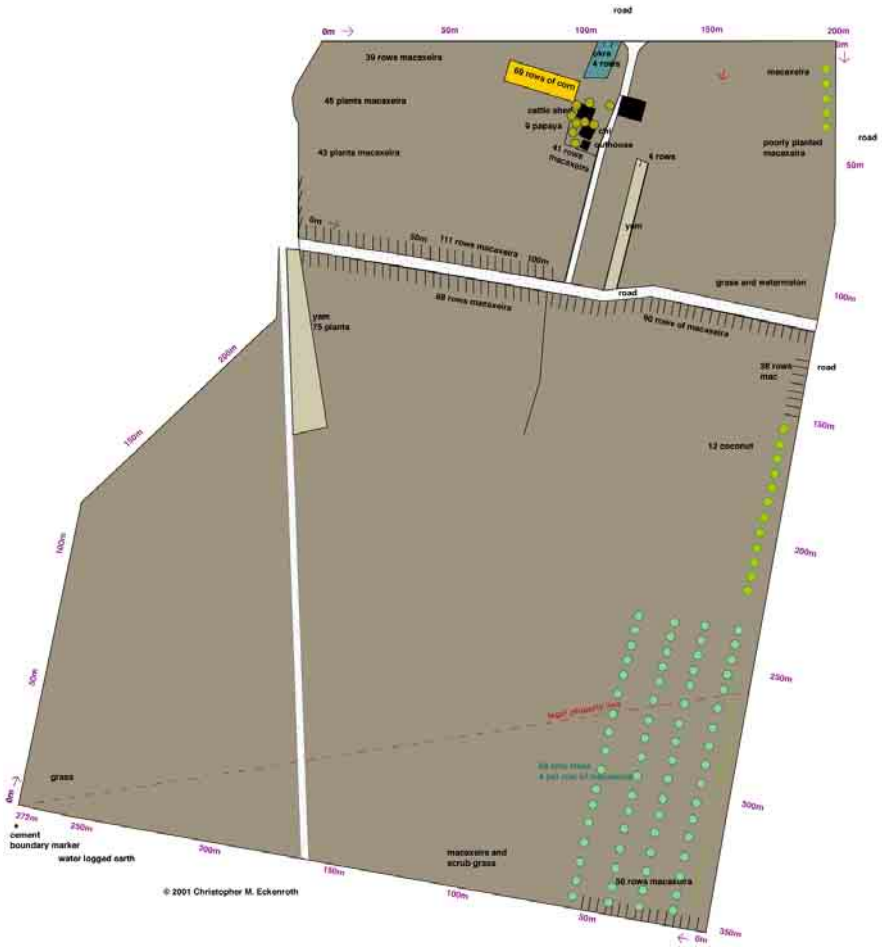

FIGURE A21: UBU FARMER U5

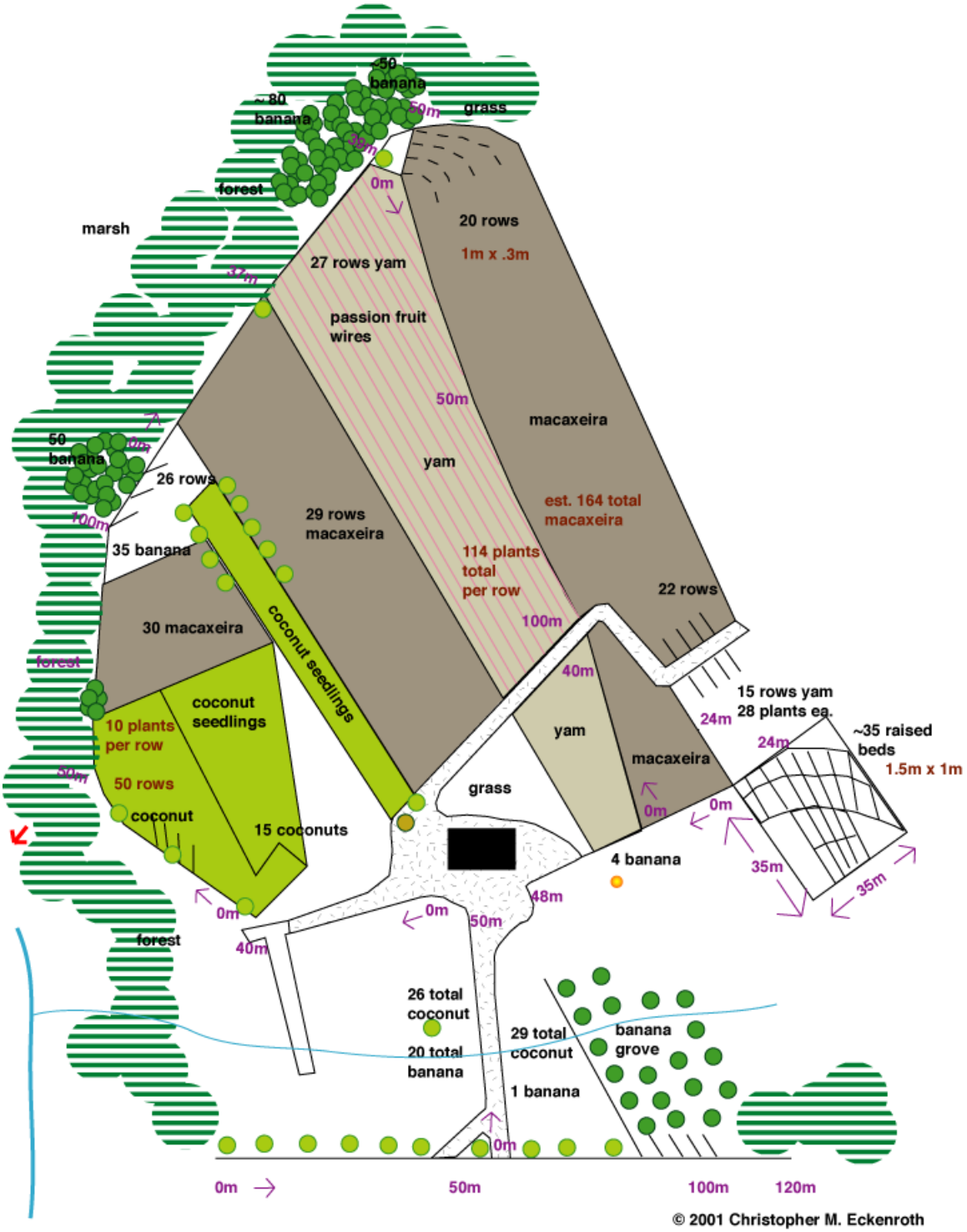

FIGURE A22: UBU FARMER U6

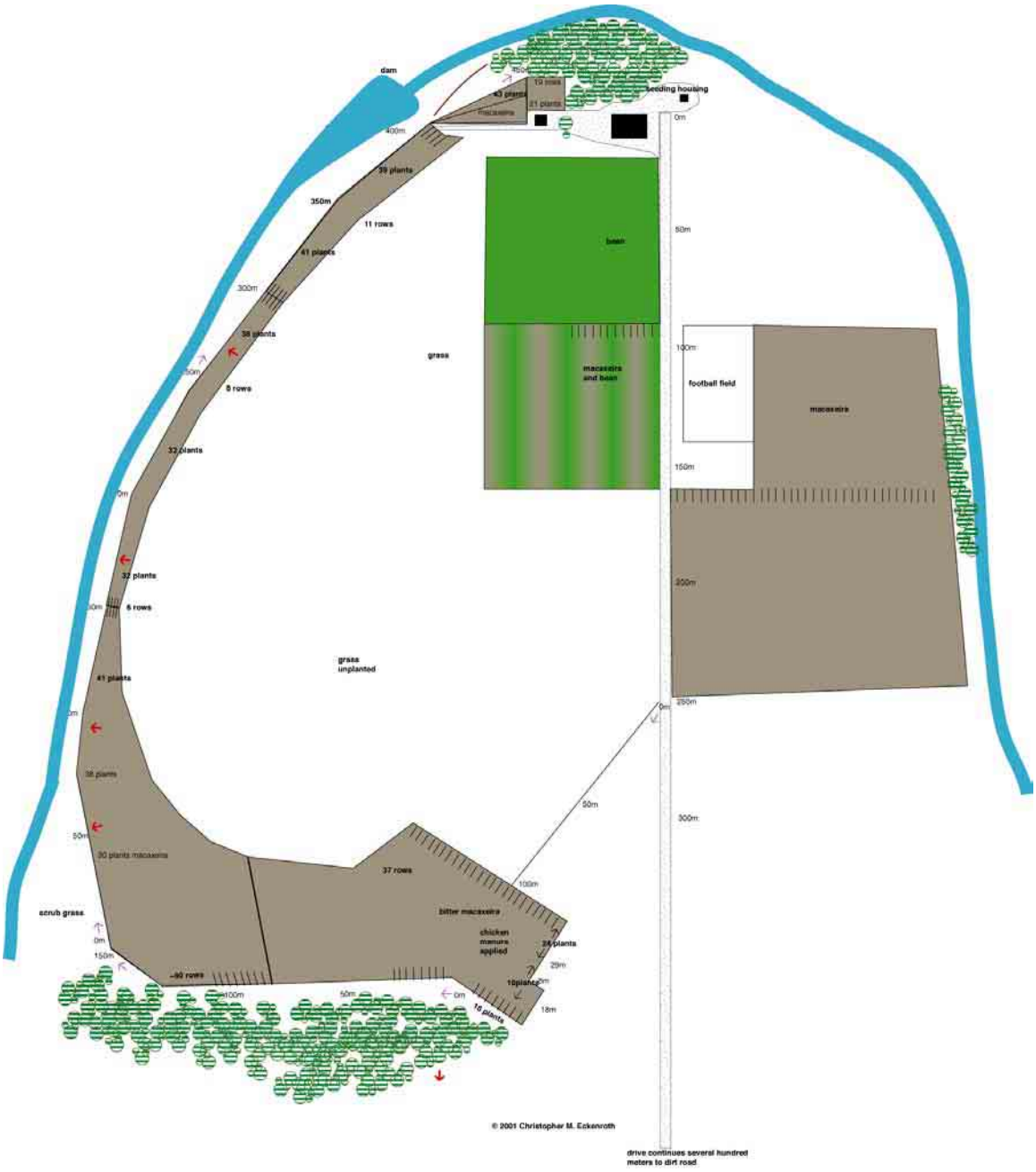

FIGURE A23: UBU FARMER U7

FIGURE A24: UBU FARMER U8

KEY TO MAP SYMBOLS