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FARMER RESPONSES TO LAND DEGRADATION IN GIKONGORO, RWANDA

by

Jennifer Maria Olson

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Geography

1994

ABSTRACT

FARMER RESPONSES TO LAND DEGRADATION IN GIKONGORO, RWANDA

By

Jennifer Maria Olson

This dissertation is the study of one aspect of the chronic process of impoverishment of rural Rwanda, land degradation. It examines the societal origins of land degradation, its effects upon the population, and farmers' responses to it. The study draws on a variety of information including historical records, policy documents, published statistics, household- and field-level surveys, aerial photography interpretation and interviews with farmers and government officials.

The dissertation is grounded in the society-environment tradition in geography and derives its conceptual framework from Regional Political Ecology (RPE). RPE explores society-environment relations in terms of the temporal, diachronic interactions between societal and environmental processes. An understanding of the system requires analyses that reach beyond the level of the field or hill and examinations of the gradual and abrupt changes in the socio/cultural, economic and political structures that have impacted the farmer and the soil. The study addresses questions common to RPE research, including differential access to resources, the relationship between factors from the local to the international level and an explicit examination of the role of power and the state.

The dissertation approaches the study of land degradation in Gikongoro from the viewpoint of the farmer. Farmers view the contemporary processes of accelerated soil degradation from the perspective of a society that cultivated the same land for hundreds of years, and they have strong opinions concerning soil fertility maintenance. The reasons farmers provide for soil fertility decline relate to wider changes in society that reduced their access to resources and ability to practice the techniques necessary for soil fertility maintenance. Many of their responses to declining soil fertility relate to adjusting their agricultural system to new pressures on resources so they can again practice the old techniques. The continuing decline in food production and increasing poverty, however, has led to out-migration and changes in the family structure that lowered birth rates.

The research was conducted before the 1994 tragedy in Rwanda. The RPE approach adopted in the study provided insights into the building up of pressures that eventually led to the conflict.

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GLOSSARY OF KINYARWANDA TERMS

ifumbire:	manure
igikuka:	valley field (during rainy season)
imirima:	permanent field, next to urutoke
indare:	permanent field, fallowed
imigende:	valley field (during dry season)
isuli:	erosion
ubuhake:	patron/client contractual system
umuganda:	communal labor, enforced by administrators
urugo:	homestead, or the house with its enclosure
urutoke:	first field nearest house, usually with banana plants
urwuri:	out-field, often used as pasture

CHAPTER I

INTRODUCTION

A. Approach to the Problem

The highland prefecture of Gikongoro in Rwanda has been experiencing serious declines in agricultural production which have led to severe food shortages in recent years. The immediate cause of this diminished productivity is considered by researchers and farmers to be soil degradation. To combat the problem, farmers are adapting their agricultural system to this degradation of the physical environment. The relationship between the phenomena of increasing pressures on food production, land degradation and the evolving agricultural system is not simple but involves the interaction of a variety of societal and environmental factors over time, space and scale.

This dissertation approaches the study of responses to land degradation in Gikongoro from the viewpoint of the farmer. Farmer voices are heard throughout the text: their explanations of the reasons behind land degradation, their descriptions of the impact of degradation on their families, and their attempts to respond to the problem. Farmers view the contemporary process of accelerated soil degradation on their fields from the perspective of a society that had successfully cultivated the same land for hundreds of years, and they have strong opinions concerning soil fertility maintenance. The reasons they provide for the rapid loss of soil fertility relate to wider changes in society that have reduced their own access to resources and ability to practice the techniques necessary for soil fertility maintenance. Many of their

responses to declining soil fertility relate to adjusting their agricultural system to the new pressures on resources so they can again practice the old techniques.

With the above understanding in mind, the historical cultural/political structure in which the techniques had been developed and that shape current farmers' views of soil maintenance are examined. The new pressures on resources that have reduced farmers' ability to practice the techniques are then investigated. An understanding of the changes in the system requires analyses that reach beyond the level of the field or hill and review the abrupt and gradual changes in the socio/cultural, economic and political structure that impacted the farmer and the soil.

The linkage between the society and the environment is complex and requires an investigation into changing access to resources, the evolving role of agriculture within the economic and social system, and land degradation as a process resulting from an evolving societal and environmental context. Regional political ecology is a theoretical approach in which the relationship between these various factors are explicitly examined over time and space. This study is based on the questions posed in regional political ecology research, including differential access to resources between groups, the relationship between factors from the local to the international level and an explicit examination of the role of the state and of power (Blaikie and Brookfield 1987; Campbell and Olson 1991). In sum, the dissertation addresses farmers' responses to land degradation as an example of a dynamic human/environment problem to be understood by examining links between socio-cultural, economic, political and environmental factors over time and space.

Figure 1 Locational map of Rwanda

B. Delimitations of the Research

The study concentrates on the contemporary situation of farmers in Gikongoro. To understand the socio-cultural and political roots behind farmer perceptions of soil changes and reasons for their choice of responses, a historical view of changes in the area is presented, especially those events following World War II. The study is based in Gikongoro but comparisons between the situation of farmers of Gikongoro and that of other prefectures are provided to illustrate certain themes. Similarly, the events occurring at the field or individual level are placed within their regional, national and international context.

Finally, this is not a study of the soil or of its physical properties but is concerned solely with farmers' *perceptions* of the soil and how those perceptions have altered farmers' behavior. Farmers are particularly concerned with declining soil fertility, and this is, therefore, the focus of the study. The definition used throughout the thesis is the farmers' own, and encompasses deteriorating productivity and decreasing organic matter content.

C. Overview of the Dissertation

The dissertation is organized chronologically, examining the historical context, contemporary pressures on resources, the impact of these circumstances on the soil and how farmers have responded to the changes in the soil.

Chapter II discusses the human/environment literature in geography, comparing those who examined the impact of the environment on human activity with those who were concerned with the impact of humans on the environment. Most

studies on Rwanda have been examples of the former approach. Political ecology is presented as an approach that attempts to view the human/ environment relationship as dynamic.

Chapter III reviews the sources of data and analyses used to examine the problem. The basic unit of analysis is the field or the farm, and farmer surveys and interviews provide the bulk of this information. Current contextual information is provided by farmer group meetings, interviews with governmental and project staff, analyses of agricultural and population statistics, and documents. Interpretation of aerial photography is included to provide a regional view of the sum impact of changes of the agricultural system on the landscape. The historical section is based primarily on documentation collected mainly from libraries in Europe.

Chapter IV presents the historical and political processes that have shaped farmers perceptions of what soil fertility maintenance should be; these processes also laid the political and economic groundwork that later undermined farmers' ability to practice those techniques. The historical and political processes are particularly meaningful in light of the 1994 tragedy.

The contemporary pressures, many originating from those historical processes, are outlined in Chapter V. These include rapid population growth, loss of communal pasture and forest land, unequal distribution of land and other resources, and the deteriorating macro-economic structure. The sum impact of these processes on regional land use are examined with interpretation of aerial photography from northwestern Gikongoro.

The results of these pressures on the soil are then presented in Chapter VI. Included is the impact of declining soil fertility on groups of farmers with differing levels of resources.

In Chapter VII, responses by farmers and the government to the declining fertility are described. The government reacted with fervor to control erosion whereas farmers fought to increase the organic matter content in the soil. Farmers experimented with other methods in increase soil fertility, as well. Meanwhile, the continuing decline in food production and increasing poverty forced changes in the family structure that lowered birth rates and led to out-migration.

The discussion chapter, VIII, places the results of this human/environment problem in terms of the literature. The importance of dynamism in agriculture, and in the human/environment relationship, is emphasized. In this case, soil degradation acted as a stimulus to redirect the intensification of agriculture. The importance of contextualizing soil degradation in its wider socio-cultural, economic, political and environmental context also is underscored. Instead of simply examining the impact of this wider context on the farmer and on the soil, however, it is important to view the multi-factorial reactions of the farmers to the new situation.

In the epilogue, the implications of the findings of this study for understanding the roots of the 1994 conflict are discussed. The tragedy has its roots in the same issues that farmers related as contributing to their chronic impoverishment. This demonstrates that RPE cannot be viewed simply as an abstract scientific framework.

People live and die by the exercise of power in the interest of elites, and to the chronic, and in Rwanda catastropic, contemn of the poor and marginalized.

CHAPTER II

REVIEW OF THE HUMAN/ENVIRONMENT LITERATURE

A. Introduction

The prefecture of Gikongoro is experiencing serious declines in agricultural production and increasing poverty which have led to severe food shortages in recent years. The immediate cause of the diminished soil productivity is considered to be soil degradation due to the increasing pressure placed upon the land. The farmers are now in the process of readapting their agricultural system to this degradation of the environment. This loop of humans affecting the environment and the environment affecting humans is an example of the types of problems examined in the society/environment tradition of geography. The linkage between society and the environment is complex, however. Farmer responses to land degradation, for example, is a dynamic society/environment problem requiring investigation of the links between socio-cultural, economic, political and environmental factors. Regional political ecology (RPE), an approach emanating from the society/environment tradition in geography, explicitly examines the complex relationship between these factors over time and space from the local to the international level, and addresses questions of the role of power and the state.

This chapter reviews the society/environment tradition in geography. The conceptualization of society/environment problems are classified into broad approaches: how humans have influenced (usually despoiled) the environment, how the environment has dominated human civilization and history, and a possible

synthesis in RPE which considers the impact of each force on the other. The chapter then describes how this study was formulated within RPE which guided the formation of the research questions, the gathering of data and the analysis.

B. The Human/Environment Linkage

Many of the most vital and controversial research and policy issues today pertain to the relationship between people and the environment, presumably classic man/land or society/environment concerns of geography. Geographers share a long, checkered history of thought on the society/environment relationship that continues to influence their theoretical, research and policy approaches to current problems.

This question is pertinent for geographers as well as others because much of the current debate on these issues recalls debates that have occurred in geography during the past 100 years. Whether the environment has dominated society or vice versa, whether policy should serve environmental conservation or economic development, if environmental limits exist to economic activities, and ethical questions of the role of people as one species on earth are all examples of questions geographers have wrestled with for many years. These questions are now verbalized clearly in the policy arena and lessons learned from the history of geographic thought are very applicable.

Much as these issues of geography overlap those of other disciplines and policy, geographic thought has been influenced by events outside the discipline. One of the difficulties of tracing the influence of the history of geographic thought on current geographers is that of separating geographic teachings from outside events.

These events can be of overriding importance in determining the direction of theory and research (e.g. exploration, Marxism, the environmental movement) (Table 1). They will be mentioned when significant, but the focus will be on geographic literature.

Thought on society/environment in geography has been classified into broad approaches, and a brief description will illustrate how the approaches currently influence research and policy. Thus complete history of thought from Strabo onwards will thus not be related. The classification divides the approaches into two oft-contesting groups: one concentrating on how humans have influenced (usually despoiled) the environment and the other on how the environment has dominated human civilization and history. These groups in myriad forms are all alive today both within and outside of geography. Their history is long; Glacken (1967:vii) has reduced the great variety of thought on nature to three:

> "In the history of Western thought, men have persistently asked three questions concerning the habitable earth and their relationship to it. Is the earth, which is obviously a fit environment for man and other organic life, a purposefully made creation? Have its climates, its relief, the configuration of continents influenced the moral and social nature of individuals, and have they had an influence in molding the character and nature of human culture? In his long tenure of the earth, in what manner has man changed it from its hypothetical pristine condition?"

The division in geography has led to relatively little attention being paid to the interrelationship between human and environmental processes over time, a question with which some geographers are now wrestling using tools ranging from mathematical models to general conceptual frameworks (Langran 1991, Blaikie and Brookfield 1987). Kates (1987), Turner (1989), Hanson (1991) and others feel that geographers bring to the study of society/environment problems a synthetic,

integrative view others lack and that this synthetic view is the most important contribution of geography. Nevertheless most geographers are trained as and remain specialists in either a human or physical sphere, and the history of geographic thought and most current research can be divided into one of the two groups.

A rough timetable of society/environment study in geography as classified by "dominate force" (the environment dominating society or vice versa) is provided in Table 1. Events outside academic geography that have played an important role in geographic thought are listed in the left column; many are guideposts to the contemporary cultural attitudes towards nature. Six broad approaches have had a direct impact on current work and are discussed. On the side with the focus on the impact of the environment on society (middle column) are environmental determinism, natural hazards research in human ecology and in political economy, and population/resources debates. On the opposite side, with society seen as the dominant force affecting the environment (right column), is the Marsh school. Political ecology is placed as a possible synthesis, considering the impact of each force on the other. Interestingly, the approaches with the *environment* as the driving force tend to be dominated by *human* geographers and those with *society* as the driving force tend to be dominated by *physical* geographers. Of course the divisions are rough and many works and authors overlap categories. A brief history of the major approaches and how they have affected current thought are assessed below.

Table 1 Society/environment perspectives in geography

WORLD EVENTS	GEOGRAPHY: PERCEIVED DOMINATING FORCE	
	ENVIRONMENT	SOCIETY
Exploration	Ritter 1779-1856	
Malthus *An Essay on the Principal of Population* 1798		
Darwin *Origin of the Species* 1859	Environmental Determinism Ratzel 1844-1904	George Perkins Marsh *The Earth as Modified by Human Action* 1874
Marx *Das Kapital* 1867	Semple *Influences of Geographic Environment* 1911	
	Lebvre "possibilism"	
Frontier Economics: economic growth imperative, "the environment as resource"	Ellsworth Huntington "scientific determinism"	
	Griffith Taylor "stop and go determinism"	
	Human Ecology Barrows 1923	Carl Sauer "The Landscape School"
	Hazards/Human Ecology Gilbert White *Human Adjustment to Floods* 1945	W.L. Thomas *Man's Role in Changing the Face of the Earth* 1956
The Environmental Movement Rachel Carson *Silent Spring* 1962 Erlich *Population Bomb* 1968		The Environmental Movement: Where is Geography? In Space?
Sahelian Drought 1968-1974	Burton, Kates and White *The Environment as Hazard* 1978	Manners, Mikesell *Perspectives on Environment* 1974
Global 2000 1980 (Carter)	Hazards/Political Economy Hewitt *Interpretation of Calamity* 1983	
Simon *Resourceful Earth* 1984 (Reagan)	Glantz et al. *Drought and Hunger in Africa* 1987	
Brundtland *Our Common Future* 1987	Population/Resources Bernard et al. 1989	Simmons *Changing the Face of the Earth* 1989
	Kates as Director of the World Hunger Program	Goudie *The Human Impact on the Natural Environment* 1990
Global Change: greenhouse effect, ozone layer, etc.	Internationally funded research on effects of environmental change: Turner, Kasperson et al.	Climate models, GIS models of deforestation etc.
	Political Ecology Blaikie & Brookfield. 1987, *Land Degradation and Society*	

C. The Impact of the Environment on Society

1. Environmental Determinism in North America

Environmental determinism is important to consider, perhaps less for what it contributed permanently to geographic thought than for the negative reaction it engendered and continues to engender in academic geography. On the other hand, geographers and others are using basic (unacknowledged) premises of environmental determinism in their studies of population/resources, "human carrying capacity" and the impact of climate change. The basic tenets and the romanticism of nature found in environmental determinism are also being unwittingly recreated and embraced by people on the fringes of the environmental movement (e.g., the "Gaia hypothesis" [Joseph 1990] and deep ecology [Colby 1990]).

Environmental determinism was developed in the late nineteenth century during the age of exploration. The attraction of the movement grew from consideration of the great contrast in nature and cultures between different places in the world which was eventually used to explain the wide variety of human cultural and biological differences. Malthus (1976) was attracted by environmental deterministist theories of the influence of environments on, for example, limiting social and demographic development. He took the idea of environmental limits literally and wrote how Man is dependent on the limits of the land and that the limits determine the size of a surviving population. The "father" of environmental determinism in geography is seen as Carl Ritter (1779-1859) whose anthropogeography was based on the theme that the environment was capable of determining the course of human development. He believed that by examining nature, one could discover not only natural laws but also God's will since what was nature

was also moral (a "natural mysticism") (Simmons 1989). Charles Darwin's *Origin of the Species* (1859), with its discussion of the close relationship between organisms and their habitats, introduced the notion of the pressure of natural selection which was then extended by Lamarck, Spencer and others to human populations (social darwinism). This encouraged development of a "scientific" environmental determinism.

The glowing writings of Ellen Churchill Semple (1863-1932) introduced determinism to the American geographic community. Nature, or Earth, was given forceful qualities such as developing, nurturing and guiding the human body and spirit, luring people in to perform certain behaviors (Semple 1911). Huntington (1876-1947) detailed the effect of climate on human behavior including migration, the growth of great civilizations and national personality characteristics. He found that "levels of civilization" corresponded with climatic regions, and that the climate best suited to intellectual activities and progress was one with a well defined seasonal pattern (Visher 1948). The temperate environments, in particular those in Europe and North America, were shown to induce the highest levels of industry, reason and civilization. Humans never emancipate themselves from the control of nature as they develop, however, but actually multiply the sum total of each particular dependence. Nature continues to provide strict limits (Huntington 1924).

Richard Peet (1985) and others later analyzed environmental determinism as an outgrowth of the social and economic conditions present in the late nineteenth century and as a "scientific" rationalization of racism, imperialism, the "manifest destiny" of the white man and Nazism. As Peet (1985:326) uncompromisingly writes, "this

approach did not result exclusively or even primarily from the internal dynamic of geography's development but from the discoveries of evolutionary biology and from the urgent need for a theory legitimating capitalist social relations, intersociety strife, and geopolitical expansion in an age of imperialism."

Environmental determinism was an idea pushed to an extreme up to the beginning of the twentieth century, when the pendulum swung dramatically. Determinism was diluted first to probabilism and then to possibilism (Gould 1985). In possibilism, the physical environment is passive and man is the active agent able to choose between environmental "possibilities." The environment, however, has limited resources and places restraints on his choice (Palm 1989). Strict and milder forms of determinism were subjected to criticism by Barrows (1923) who argued that human/environment relations also must take human adjustments into account and that the role of the environment in determining human behavior should be placed within such a cultural context-- the basis of the work of cultural ecologists today.

Hartshorne in The Nature of Geography (1939) sought to end the domination of environmental determinism in geography and to change the definition of geography from the study of the relationship between natural and human forces. Instead he encouraged a return in geography to the more "balanced view" of chorology, the science of regions, in terms of the study of the relationship between all different types of forces in specific areas (Hartshorne 1939; Sack 1989). Hartshorne's book was considered definitive and Hartshorne himself the "philosopher-general" of geography (Peet and Thrift 1989). His book was used as the principal text in courses on the

history of geography at US universities in the 1940s and 1950s, when many geographers currently teaching were trained (Howard Olson personal communication).

An example of how the teaching of environmentalism was rejected in the 1940s is seen in the teaching and writing of Platt at the University of Chicago (Platt 1948a, 1948b) . Platt felt very strongly that environmentalism and milder forms of environmentalism were dangerous and false guides in geography, and that geographers should not view the environment as a major causative factor in the development of society. People live differently in similar environments and differently at different times in the same environment. Nature can be understood "only in terms of our life, history, and culture; and conversely, our life, history and culture and be understood only in our natural environment" (1948a:354). His strong misgivings concerning the environment as a causative factor helped change the philosophy of the geography department at the University of Chicago and environmental studies then focused on the environment as a resource. Gilbert White, at Chicago, led an ambitious research program in resource management and later in the practical "scientific" means of alleviating the effects of natural hazards (discussed below), ironically placing focus again on the impact of the environment on society (Kates and Burton 1986).

Sauer (1956) was also a vocal critic of environmentalism and disagreed particularly with the transposition of divine law into omnipotent natural law. He recognized the intimate environmental knowledge and sound culture of people nominally "backward" and wrote on how they shaped their landscape. He concluded that human behavior involved culture as the active agent in the relationship with the

environment. This view of culture was later incorporated into cultural or human ecology, an alternative to environmental determinism.

The internal geographic criticism and the changing social circumstances discredited environmental determinism, and it became an embarrassment to post-World War II geographers. Partly as a reaction against the failure of environmental determinism, geography evolved into a social science interested in areal differentiation, as Hartshorne had advised. Instead, it focused on urban, regional and environmental management. In the late 1950s and 1960s, quantification became the favored method, and a new emphasis on the geometry of a "de-naturalized space" was adopted as the alternate theoretical foundation (Gould 1985, Peet and Thrift 1989). At the same time, Rachel Carson was alerting the world to the dangers of environmental pollution, starting a popular environmental movement outside geography, within geography Brian Berry published his central place theory and set the stage for the movement towards quantification and spatial analysis.

Geographers, especially those educated soon after World War II, are still very sensitive about being associated with environmental determinism while simultaneously attempting to regain a reputation in human/environment study (Manners and Mikesell 1974; Kates 1987). The theory of the domination of the human spirit by the physical environment is perhaps the most extreme example of structure overriding agency in the history of geography (Sack 1989). In the counter-movement against environmental determinism, one of the harshest criticisms that can be levied against a geographer's approach is that it implies a determinism of a sort (e.g., spatial or economic determinism; see Gore 1984). Reaction against environmental determinism thus was a

factor in the adoption of a new focus on the modern "scientifically neutral" techniques of spatial analysis in geography. Yet a significant group of geographers did not heed Hartshorne to abandon their interests in the human/environment relationship. Their interests evolved into natural hazards research, studies of population/resources, human and political ecology and today's concern with the human dimensions of global environmental change.

The geographers who have continued in society/environment study have adopted perhaps unconsciously many assumptions of environmental determinism. The more offensive aspects of environmental determinism, such as the justification of racism and imperialism, are no longer visible, but others remain.

2. Environmental Determinism in Rwanda

The work of geographers in Rwanda reflected the evolution of the discipline. Indeed, one of the most honored geographers in Belgium and France, Pierre Gourou, conducted his doctoral research in Rwanda (1953). The thesis he produced was an important colonial document for Belgium and influenced the approach of other francophone geographers on the study of population distribution. It is a classical work of environmental determinism, documenting the close correlation between the spatial patterns of population density and high altitude. The explanation he offers considers the effects of the environmental variables of rainfall, temperature and slope, which are closely associated with altitude (Figures 2 and 3). These affect many facets of human activity, including human health (particularly malaria), cattle health (trypanosomiasis) and crop production. Gourou noted the high rainfall and moderate temperatures in the highlands allow several cropping seasons per year. He also

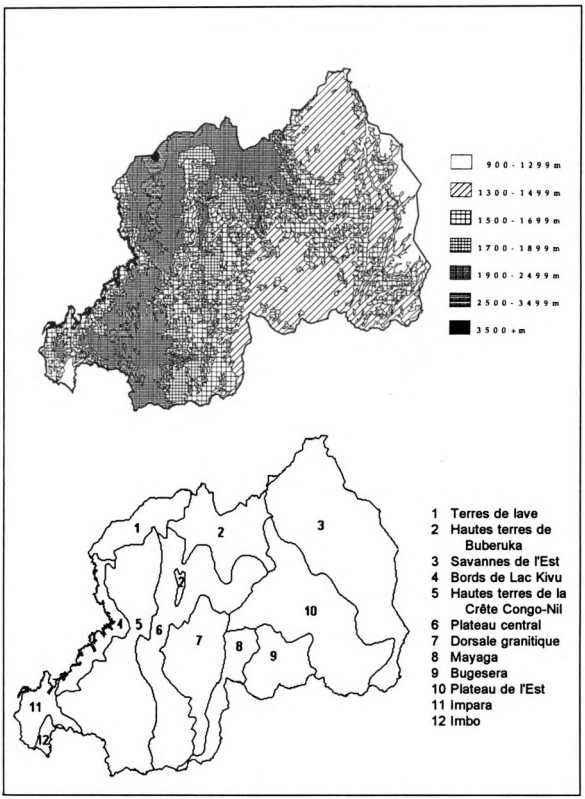

Figure 2 Elevation zones (adapted from Prioul and Sirven 1984) and agroclimatic zones of Rwanda (adapted from Delepierre 1975)

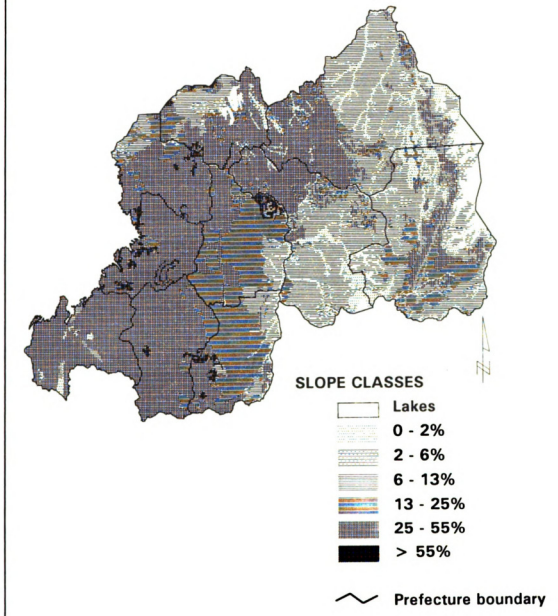

Figure 3 Slope classes in Rwanda (data source: Carte Pedologique du Rwanda 1992)

remarked upon the highly labor-intensive agricultural system that had developed. From these and other variables, Gourou concluded that the reason the population density in the Rwandan highlands was the highest in Africa was due to the convergence of favorable environmental factors. The basic tenet of Gourou, that altitude is the determinant of population distribution and agricultural systems in Rwanda, continues to be accepted by geographers and others. Several carrying capacity models have been written based on the same environmental variables, attempting to predict when a region would become "overpopulated" and food production inadequate (Préfol and Delepierre 1973; Albert et al. 1982; Futures Group 1981). Indeed, geographers have devoted much effort to defining regions based on environmental variables that would describe the agricultural systems. The earliest, in 1950, was based on natural regions the local people identified "instinctively," but a later regionalization was based primarily on soil types (Rép. Rwandaise 1970). The definition of Delepierre (1975) of 12 agricultural regions, however, has become the standard. The 12 regions are based on altitude, soil type and rainfall since, as he writes, "other criteria such as natural vegetation and even population density are directly related to these principal factors." In fact, a separate study defining regions based on crops grown resulted in boundaries comparable to those of Delepierre (Charlery de la Masselière et al. 1986).

Delepierre and authors of subsequent studies recommended that particular cash crops, improved agricultural techniques and soil conservation programs should be organized around the regional classification (e.g., Jones and Egli 1984; Berry et al 1982). The government of Rwanda planned the *paysannats*, the organized settlement schemes, based on these recommendations and continues to be interested in promoting

a more "rational" spatial distribution of crop production to maximize the environmental advantages of each region. The current plan for the *régionalisation des cultures* is a logical outgrowth of the view that agricultural systems are derived solely from environmental phenomena (Projet de Développement Agricole de Gikongoro 1991).

3. Population/Resources

Current population/resources research provides an example of an assumption of environmental determinism which is still in use. The assumption of strict limits to the ability of the environment to support a given human population without environmental degradation, or "human carrying capacity," is a concept that comes directly from the writings of Malthus and Ratzel. It was derived from biology and was extended to apply to people, primarily to subsistence agriculturalists. Carrying capacity has been the basis for measuring a population/resource ratio in population pressure studies, especially in research on Africa where limits to the size of a population have been defined in terms of productive potential of the environment as measured by soils and climate (Zelinsky 1970; Porter 1978). Other non-environmental factors such as technology and off-farm employment opportunities have been recently added to the equations (Bernard and Thom 1981; Bernard et al 1989).

The concept of carrying capacity is considered unsuited for human application because it is limited to subsistence agriculture, ignores the effects of trade and nonfarm income, and is too restricted in terms of spatial scale and (Mahar 1985, Campbell and Olson 1991, Migot-Adhola pers. comm.). The assumption that people would starve when population densities reached a certain limit was challenged by the

economist Boserup (1965) and geographers Gleave and White (1969). Independently they arrived at a similar hypothesis, arguing that an increase in population densities stimulates technological change, allowing the population to produce more food on the same amount of land. This Malthus/deterministic and Boserup/possibilistic debate on population/resource limits is one that continues to be been rediscovered and renewed in geography (Burton and Kates 1965, Kates 1987).

The debate was widened beyond the role of technology in the population/resource relationship to one of *access* to resources by geographers tracing their intellectual roots to a different nineteenth century thinker, Karl Marx. Harvey (1974) critiqued the prevailing Malthusian population doctrine in which the poor are the worst affected in disasters due to a tendency to breed to fast. Harvey saw this as a classic example of blaming the victim instead of recognizing the consequence of a lack of resources or power. Blaikie (1985) analyzed soil erosion not as a result of "overpopulation" beyond carrying capacity but as the result of economic and political forces marginalizing segments of society and forcing them to survive using unsustainable agricultural practices. The political ecology argument against the study of environmental problems as a population/resource imbalance was further explained by Blaikie and Brookfield (1987) and Blaikie (1989) as a question of lack of access to resources. As Blaikie and Brookfield (1987:34) explain, an open mind to the relation between population pressure and land degradation must be retained since degradation can occur under rising pressure, under declining pressure and without pressure. Nevertheless, environmental problems in the third world continue to be explained as overpopulation on resources (e.g. publications of World Bank economists Lele and

Stone [1989] and World Resources Institute staff members Robert Repetto and Janet Brown).

The environmental movement in the U.S. and Europe in the 1960s and 1970s has produced, at times, very extreme environmentally deterministic literature concerning population/resources. The Ehrlichs, for example, began an anti-natalistic movement whose assumptions were less optimistic than those of Malthus or Ratzel concerning the ability of a growing population to survive on limited global environmental resources (Ehrlich and Ehrlich 1970). Other ideologies similarly unconsciously repeat similar extreme views of environmental determinism, ideologies such as deep ecology, eco-centrism, bio-equality and the Gaia hypothesis (Colby 1990). Perhaps less extreme was the report written under President Carter, Global 2000, which examined U.S. and global resource limits but still reached pessimistic conclusions (United States Council on Environmental Policy 1980). One response of the government was the establishment of the Environmental Protection Agency, mandated to formulate and enforce legislation to reduce environmental problems. The primary concern was to place limits on emissions of pollutants by factories and vehicles but a widespread effort to change the direction of the development of industries was not attempted. In response to Global 2000, a report was written by Simon and Kahn (1984) for President Reagan. It went to the opposite extreme and dismissed environmental limits as irrelevant and environmental problems as exaggerated. They claimed that population growth, pollution and resource limits were not to be considered problems since the resourcefulness of society would automatically overcome any difficulties (a extreme possibilistic argument).

Few geographers participated in this public policy population/resources debate. The geographers whose specific topic of study was population/resources were doing research primarily in third world countries and they did not express views concerning US issues. These lessons and skepticism geography had learned concerning placing environmental limits within a social context were not shared.

4. Natural Hazards and Cultural Ecology

The study of natural hazards was developed by Gilbert White to inform policy makers on preventing and alleviating the effects of hazards (Kates and Burton 1986). Implementation of the hazards research was assured through sponsorship of the Commission on Man and the Environment of the International Geographic Union (Waddell 1977). White (1973) viewed hazards research as continuing the tradition in geography of "man-environment relationships" study and chided other geographers for losing "an opportunity to apply knowledge, skills, and insights to fundamental questions of the survival and quality of life". Although hazards research only examined one direction in the relationship, that of the impact of environmental events on people, White saw hazards research as countering environmental determinism (G.White 1973). Kates and Burton (1986:xi) begin their two volume series on the work of White with the words: "Gilbert F. White is the outstanding geographer in the man-land tradition."

Nevertheless, hazards research was accused of covert or "naive" environmental determinism, a contention widely voiced in the reactions to hazards research (Waddell 1977; A.White 1986). First, the framework selected was seen as inappropriate, that of roping off natural hazards from the rest of society/environment

relations. Second, not enough recognition was given to society's need to maintain flexibility. Third, despite including perceptions and values in the model, not much attention was given to creativity and innovation.

The geographers conducting this conventional hazards research, however, felt differently. They believed that they were adding to knowledge on the society side of the society/environment relation. According to Kates and Burton (1986), the main contributions of hazards research to society/environment science included the concept of human adjustment, the broad theoretical and practical range of hazards research and the role of perception and decision making in resource management. The models set out innovative thoughts on perception of hazards and behavioral models of choice of adjustment and adaption, an approach that broadened the discourse beyond noneconomic considerations (A.White 1986; Emel and Peet 1989).

Kates incorporated these models into a systems approach and placed hazards research in the "human ecological perspective" in 1971 since:

> "a natural hazard is an interaction of man and nature, governed by the coexistent state of adjustment in the human use system and the state of nature in the nature event system. It is those extreme events of nature that exceed the capabilities of the system to reflect, absorb, or buffer that lead to the harmful effects ... but it is also the continuous process of adjustment that enables men to survive and indeed benefit from the natural world." (Kates 1971:438)

It was this emphasis on continual human adjustment to the environment creating a stable, self-regulating system that led Kates and others to place hazards in the human ecological quarter. Therefore the one-sided emphasis on the impact of the environment was nominally gone, replaced by a perspective closer to that of Barrows and Sauer in which the human/environment relationship was seen to be one of a

continuous process of human adjustment to and of the environment. The adjustment process was seen as modified by cultural and social factors.

This perspective of humans as one component of a human/environment system was influenced by ecology, a new paradigm in the biological sciences which had grown out of the environmental movement and systems theory. Systems theory is holistic, with an emphasis on understanding the parts of the system in their functional relationship with the whole. Thus the perspective was known as cultural ecology--man was one element in the system, adjusting to change within his environment (particularly visible in an agricultural system) (Simmons 1989; Grossman 1977). Although Sauer and other geographers had been conducting cultural ecology and regional systems-type research, the definition of cultural ecology was formed by anthropologists and others before being readopted by geographers (Turner 1989). In geography the work of cultural ecologists has included not only natural hazards and coping strategies with natural hazards research but also regional studies in the third world, studies of population/natural resources and today's inquiry into the human dimensions of global environmental change (Kates 1971; Grossman 1981; Turner and Meyer 1991).

Today cultural ecology remains the chosen approach for conventional hazards research. The Institute of Behavioral Science at the University of Colorado (IBS) (headed by Gilbert White) as well as Clark University hazard researchers Billy Turner and others continue to place their research within the cultural ecology tradition (Palm 1990, Turner 1989). The topics have widened beyond floods and droughts to include global environmental change. Nevertheless, by remaining within cultural ecology,

many of the basic but awkward criticisms launched by the counter-movement, political economy, have not been addressed.

For example, analysis of global environmental change and farming systems research by the Earth Transformed Program at Clark University remains organized around the cultural ecology "POET" model, focusing on population, social organization, environment and technology. Political economy themes of power relations, class conflict and domineering relations between countries are said to be too complex for useful modeling and are only examined peripherally (Brush and Turner 1987; Turner and Meyer 1991; University Corporation for Atmospheric Research [UCAR] 1991). A research framework for analysis of global environmental change based on equity (allocation of responsibility and distributional equity) was written by Kasperson and Dow (1991) of Clark University. It was not incorporated into the research design adopted for the UCAR/Clark's Global Change Institute on Global Land Use/Cover Change, however, perhaps because it was feared that the funders (primarily the US government) would not appreciate those questions.

Risa Palm of the IBS, in a recent book presenting a conceptual framework for hazards research, retained a similarly cautious approach. She attempted to integrate the micro or individual scale of traditional cultural ecology hazards work with the macro societal scale of political economy (Palm 1990). She listed political economy principles to consider, such as the wealth/power distribution and the environmental marginality of the location, as well as individual attributes to include such as awareness of the hazard and beliefs. Her explanation of the linkages between the scales, however, is vague and the case study example does not satisfactorily present

either the political economy of the situation nor the linkages between the scales or the other sub-systems (Wisner 1991).

D. Natural Hazards and Political Ecology

1. Political Economy

The political economy viewpoint of natural hazards research evolved as a critical response to conventional, cultural ecology hazards research. The assumption that societies had slowly adapted to the environment until a homeostatic condition developed, and that suffering due to natural disaster was therefore an aberration of this status, was rejected as simplistic at best and supportive of an oppressive status quo at the worst. Although the critics, like cultural ecologists, believed that societies were the outcome of the gradual adaptation of the society to and of the physical resource base, they differed radically from their colleagues in their perspective of the society. Work of geographers Slater, Blaut and Harvey contributed to the theoretical basis of radical hazard research as progress in the development of geography began to be associated with a more leftward to a liberal-radical position (Corbridge 1989; Riddell 1989). Their perspective included political and power factors from the local to the international scale, and their strength was in explaining the repercussions of a natural hazard in terms of these broader forces. A disaster was not considered a "natural" event amenable to technical solutions, but rather an outcome of human activities and the political or economic structure that accentuated the impact of a hazard (Waddell 1977).

Much of what came to be known as political economy research on hazards and other environmental topics in anglophone geography has taken place in rural third

world societies. It was stimulated initially by the dramatic effects of the Sahelian drought of 1968-74 and the Marxist literature (largely by French geographers [Waddell 1977; Campbell 1990]) explaining the increasing vulnerability to hazards by the impact of colonialism and cash cropping. The integration of communities into domineering national and international economies since colonial times was seen as having transformed the agricultural system upon which the local environmental management strategies were based and weakened the ability of communities to cope with climatic variability (Comité d'Information Sahel 1975; Wisner 1977; Campbell 1977).

The critical response to conventional hazards research gained much of its original insight from Marxian analysis of social class struggle and the notion that the relationship individuals have with nature is rooted in their relationship with each other, the societal structure (Burgess 1978). Although Marx was not explicit in his writings concerning the relationship between nature and society, in his critique of capitalism ("historical materialism"), the concept of nature was implied as being both intertwined with the evolution of societies as their material resource and a dialectic of the culture (Smith and O'Keefe 1980). Concerning the first concept of nature, as a resource, Marx viewed production as a process which alters the form of nature. Simultaneously, however, the laborer is transformed during this process when goods change from having a use-value to an exchange-value. The second concept of nature thus emerges, with the development of a set of institutions to carry out and regulate this exchange and nature becoming an abstract idea (Smith and O'Keefe 1980). The missing element in the conventional White school of hazards was, therefore, the social structure which "determines the form in which men are subjected to these [natural]

laws" (Schmidt 1971 in Watts 1983a:243). The social structure must be seen as the cause and explanation of natural disasters, and the disaster itself only a trigger event revealing vulnerability (Waddell 1977). In a capitalistic society, the social relations with nature results in an institution of class relations and, therefore, the Marxian mode of hazards research examines the differential impact of hazards on classes (Torry 1979).

In a related Weberian critique, Hewitt (1983a) took a bureaucratic view of past hazards research and argued that a bureaucratic ethos had channeled scientists into a highly technical approach that reflected the status quo hierarchy. Fundamental criticisms of conventional hazards research was resisted by these scientists and the archaic, inflexible strategies endured (Emel and Peet 1989). These strategies comprised monitoring geophysical processes, efforts to contain the natural processes, and development of emergency measures for relief— activities primarily in the physical or engineering fields thus reinforcing the technocratic or instrumentalist view of hazards and ignoring social questions of vulnerability.

Watts (1983a, 1983b) expanded the earlier Marxian and Weberian critiques and removed alternative hazards research out of human ecology and into political economy. In a study of the impact of drought in Nigeria, he examined the history of the integration of the society into international market forces during colonialism and the evolution of new patterns of inequality and concluded that natural hazards "had been redefined by the transformation in the social relation of production" (Watts 1983a:251). Instead of rural third world societies seen as closed and homogeneous, slowly evolving a "balanced" relationship with their environment, as in cultural

ecology, they were seen as dynamic entities who had been forced to engage with the western world for many years and whose internal social systems had evolved during this period of exploitation (Watts 1983b). Watts drew heavily on the mode of production theory and placed the local events into a structuralist explanation. Diversity and other strategies that societies had developed to cope with the variations in the environment were viewed as manifestations of common social relation to nature (Emel and Peet 1989). His and others' work emanating from studies of the Sahelian drought evolved into research identifying the adaptive strategies societies developed in response to environmental adversity and variability. Researchers in the political economy approach examined how these traditional "coping strategies" were being affected by colonialism and integration into the international market economy, as well as how different classes in the society were affected and how they reacted (Campbell 1990). Political economy works have detailed the social "chain of explanation" behind a variety of environmental issues such as soil erosion (Blaikie 1985), deforestation (Hecht and Cockburn 1990), land use conflict (Bassett 1988), and drought (Watts 1983b; Campbell 1984).

Susman, O'Keefe and Wisner (1983) developed a theory of marginalization linking vulnerability and disasters to broader processes of social change. People's relationship with the environment was seen as shaped by social processes affecting land use, processes of marginalization, proletarianization and incorporation into the national and international political economy (Susman, O'Keefe and Wisner 1983). This concept of marginalization was expanded by Blaikie and Brookfield (1987) to include economic, ecological, politico-economic and spatial marginalization. When

these factors are correlated, the population is vulnerable to a natural disaster and the land is prone to processes of degradation.

The concept of political economy thus entails a historical analysis of the structural formation, economic forces and political and power relations that determine resource exploitation and distribution within countries. Researchers typically have concentrated on how the internal forces within countries are affected by the national and international political economy and how economic, political and social structure affects classes of land users and thereby the environment (e.g. Bassett 1988). Research topics were widened by the "leftist" researchers from climatic hazards, soil erosion, land use, and other environmental subjects geographers had traditionally studied to cover newer topics such as famine as a socially and climatically induced hazard (Campbell 1981; Blaikie 1985; Glantz 1987; Riddell 1989). Political economy analysis often begins with a comprehensive field study at the local level and then incorporates the influences of each higher levels, like a "framework of Chinese boxes, each fitting inside the other" (Blaikie 1985:88).

This focus on the local scale has induced Blaikie, Rees and others to emphasize not solely the political and economic structure but also geographical context and contingency in explanation, making theoretization difficult (Emel and Peet 1989). Interest in the specificity of place in geography had by necessity returned, perhaps also stimulated by research in realism (Lawson and Staeheli 1990). This interest in understanding the specificities of a region within a global context was behind the development of the "new regional geography." Even Watts, in a study of integration into an outside economy and peasant resistance, wrote that "place is the

crucible within which experiences are contested" (Watts 1988:32). Bassett (1988) wrote that peasant-herder conflicts over land in the Ivory Coast are largely conjunctural and thus difficult to theorize, but they do contain structural elements of the political economy. Torry criticized the overgeneralization of studies in the Marxian framework and called for the matching of these macro analyses with regional and micro-ethnographies of vulnerability (Torry 1986 in Campbell 1990:145). The almost deterministic, structural Marxist explanations of political economy were found to be inadequate in understanding contemporary problems at the local scale.

2. Political Ecology

Blaikie moved from a political economy, structural interpretation of soil erosion in 1985 to a more flexible conceptual framework in the 1987 book he wrote with Brookfield. The authors believe that because land degradation has occurred in "a wide variety of social and ecological circumstances, it is clearly futile to search for a uni-causal model of explanation". They suggest "a general approach to the problem" which links society, political economy and environment from the local to the international level (Blaikie and Brookfield 1987:4). Structural aspects of political economy and theories of ecology are linked with attention paid to the unique situation at the local level to form this new approach labeled *regional political ecology*. The "regional" adjective was added to emphasize the importance of local variability and to incorporate geographical theories of regional growth and decline (page 17).

Although Blaikie and Brookfield (1987) place their approach within the "new" direction of hazards and disaster research (page 23), in one aspect they differ from these works. They contend that the relationship between society and the environment

is "dynamic," in constant flux. The one-sided view of the environment affecting society is replaced by a dynamic in which the influence of the environment on society (for example, competition over prized land) and the impact of society on the environment (land degradation) is explicitly examined. For this reason, I placed political ecology as connecting the two columns in Table 1-- it explores both the impact of the environment on society as well as the influence of society on the environment.

The term political ecology has been readily adopted by geographers and others coming out of the political economy approach and writing about environmental concerns (Schmink 1987; Campbell and Olson 1991, Hecht and Cockburn 1990; Thrupp 1991). In the Peet and Thrift (1989) book New Models in Geography (a political economy perspective), the chapter on models of the environment ends by promoting political ecology as already offering "rich theoretical insights into some of the most fundamental concerns of human geography" (Emel and Peet 1989:72).

E. Society's Alteration of the Environment

This discussion now makes an abrupt switch to examine the work in geography that focusses on the third question of Glacken: how has society changed nature from its hypothetical pristine condition? This question has been less central in the history of geographic thought than the second question concerning the impact of the environment on society, addressed in Section II above (Simmons 1989; Goudie 1990). It has been the topic of philosophical musings and scattered writings in historical western writings, as Glacken documented. In geography for example von Humboldt concluded that the decline in the level of Lake Valencia in Venezuela in 1800 was the result of

deforestation and the cultivation of indigo. Mary Somerville, a physical geographer, warned of the unexpected results that occur as man "dexterously avails himself of the powers of nature to subdue nature" (Goudie 1990:3).

Nevertheless, the extent of the human influence on the environment did not become the topic of a detailed scientific study until George Perkins Marsh wrote Man and Nature in 1874. Marsh was a diplomat living around the globe and his book documented the human influence on the woods, the waters and the sands of the world and found that vast changes had occurred. Huge forests had disappeared, the soil of pastures had been washed away, meadows had died, rivers shrunk, etc. He not only recorded the facts, but reflected on what he felt to be the upsetting of a balance within nature by unwise human action. His book is confined primarily to Western civilization and does not touch upon the midlatitude grasslands; but the persuasive style and scientific presentation of his book made it a landmark in the study of the environment. It is his work which US geographers interested in the consequences of human activity often cite as the source of their approach (Thomas et al. 1956; Kates 1987; Simmons 1989; Goudie 1990). Following Marsh, Reclus, a French geographer, also wrote of the impact of settlement and deforestation on sedimentation of streams. In 1904, Friedrich coined the term "Raubwirtschaft" to refer to the economic plunder or robber economy that accompanies initial economic development, but he believed that it was simply a first stage before adoption of conservation and improvement. This idea influenced the writings of Shaler at Harvard (Man and the Earth, 1912), but Carl Sauer opposed the idea. Sauer felt that there was no guarantee people would turn to conservation and gave the example of irreversible soil erosion in Mississippi.

During this period of the nineteenth century and early decades of the twentieth century, geographers were concentrating on investigating the effects of the environment on society— environmental determinism. One of the backlashes against this emphasis was by Sauer, of the University of Berkeley, who conscientiously focussed on examining the impact of society on the environment. He reintroduced Marsh to a wide public, theorized on the domestication of plants, documented the evolution of landscapes through human activities and warned of resource exploitation.

Although Sauer inspired the growth of a strong cultural component in geographic analysis, it was Marsh to whom physical geographers paid tribute. A commemorative symposium was held in 1954, which Sauer helped organize, which produced the book Man's Role in Changing the Face of the Earth (Thomas et al. 1956). The multiple impacts of humans as agents of "vast and often fearsome" change in the earth were described. A few geographers have continued in this Marsh tradition of detailing the effect of human activity on the earth's surface. In the past few years, two scholarly books explicitly following Marsh's format were published, Simmons' 1989 Changing the Face of the Earth and Goudie's 1990 The Human Impact on the Environment. Similarly, a book by Lewis and Berry (1988) describes the African environment and the impact of human activity on this environment. The books are very scholarly, and like Marsh very much from the physical geography viewpoint with little attention paid to the theoretical issues human geographers had been discussing for years.

The 1954 Marsh book could have been the stimulus for securing the leadership for the Environmental Movement within geography. However the grassroots movement was

triggered by Rachel Carson's Silent Spring and then propelled by popular concern with pollution. The Environmental Movement was institutionalized with the National Environmental Protection Act of 1969 requiring Environmental Impact Statements and the creation of the Environmental Protection Agency (Simmons 1990). These seemed to be a response to geography's early warnings, but within universities, environmental studies were based not in geography but in other disciplines such as biology, economics, engineering or in new ecology departments. These other disciplines, however, could not provide the historic or integrative view of society/environment relations as could have geography (Kates 1989).

One reason geography did not provide leadership could be that the geography departments capable of training people to "set aside the natural and social science boundary" were few in number or lacking the competence required following the domination of spatial analysis in the 1960s (Kates 1989:526). Another reason could be the division of geography into not only the traditional human and physical, spatial and regional studies but into very specialized domains incapable or uninterested in the challenge of performing the synthetic analysis necessary to understand environmental problems in their social setting (Turner 1989).

Meanwhile, humans have no longer just modified the surface of the earth but have transformed global atmospheric and other fundamental processes. Global environmental change research is inter-disciplinary and many institutions from Europe and the Americas are working on the analysis, but geographers have entered the fray of the public research and are playing a major role. In American research of global warming and other global environmental changes, physical geographers, spatial

analysts and hazards researchers have become important leaders. For example, the graduate school of geography at Clark University developed an environmental program under the leadership of Len Berry and Robert W. Kates which became actively involved first with environmental studies in Africa and other regions of the globe and later in intra- and international studies of global environmental change. Clark geographers led the 1991 Global Change Institute on Global Land Use/Cover Change with the University Corporation for Atmospheric Research. Kasperson is organizing major international environmental and population/resource research programs through the International Geographic Union, the same institutional route Gilbert White used to fund his hazards research (Kasperson and Dow 1991). Geographers specializing in climatology, soils, agriculture, geomorphology, demography and spatial analysis (for GIS) as well as regional geographers are involved. More synthetic geographers, such as Kates, Berry, Liverman, Turner, White, Kasperson, Glantz and others also are active and well known at the international academic and government level (UCAR 1991).

Those conducting this research are not, in general, political economist geographers working on theories of social vulnerability and environmental degradation. Turner writes that he is tired of even hearing about class (Turner 1989:98). The theoretical basis for the work remains in a general sense human ecology, but the attention placed on complex statistical and spatial models and large-scale data analysis obscures the assumptions and theories behind the methods.

In any case, many of the research programs on geographic themes such as environmental change, spatial analysis and population/resources do not include

geographers but are organized around specialists such as biologists, chemists, demographers and economists (e.g. EPAT, CIESIN, the Nexus project of the World Bank and UNEP studies). Perhaps one reason is that well-known geographers involved in inter-disciplinary research are often not identified as geographers (Turner 1989) or that specialized skills continue to be valued over integrative skills.

Nevertheless, starting with the Brundtland commission's report (World Commission on Environment and Development 1987), it has been widely recognized by governments as well as by non-governmental organizations that environmental problems are basically societal problems. The old idea in geography of the inter-relationship and interdependence between the two domains has become the accepted view. This can be seen in the widespread adoption of the term "sustainability" that implies a transformation of society's management of resources to maintain the environment for future generations. It also can be seen in the 1992 United Nations Conference on Environment and Development which was not confined to a particular environmental problem but was to address the relationship between society and the environment. The difficulties of integration of the two domains continues; integration is no longer an intellectual exercise but a challenge necessary to confront global problems.

The role of the geographer in these national and international policy debates is multi-faceted. A range of geographers working on society/environment issues has been described, from those confining themselves to specific environmental problems and not engaging in society/environment theoretical debates to those pushing the theoretical boundaries forward but confining themselves to topics in third world

countries, and to those involved in the international research arena dealing with environmental problems at a global scale. The review presented above suggests that many geographers approach questions from a broad perspective. Geographers often have reacted to social events with a theory attempting to explain a facet of the society/environment relation. In this process, geography has pushed forward and contributed to social science theory. For example, geographers have been at the forefront developing regional political ecology which has overtaken the POET human ecology model. The renewed appreciation for regionalism and for agency vis à vis structure, as well as the difficulties of conceiving a macro theory to account for the extreme variation in society/environment relations, have led to broad approaches rather than theories being proposed. These broad approaches, including regional political ecology, guide research design and analysis.

F. A Regional Political Ecology Approach to Rwanda

Regional political ecology is such an approach that contributes a conceptual framework for addressing the society/environment problems in Rwanda. Key concepts regional political ecologists bring to human/environment study, for example, include (1) an understanding of the social, political and economic *structure* framing land use and other decisions, (2) examination of *scale*, placing the local situation within a broader national and international context, (3) analysis of the *historical* background to problems, (4) examination of the *distribution* of power and resources and *competition* between classes, groups and levels, and (5) attention to processes that have often led to environmental problems, such as marginalization, inequitable control of resources, historic social conflicts and skewed national policies shaped by global market conditions.

It is clear that a political ecology analysis of an agricultural system would be very different from that of an environmental determinist. At the most simple level, political ecologists would want to know, in addition to the environmental variables, the political, social/cultural and economic factors that affected the evolution of the agricultural system. An example comparing the two approaches would be their treatment of the settlement pattern in rural Rwanda. Environmental determinists, as shown in the work of Gourou (1953), would ascribe the distribution of population density and characteristics of the agricultural system as primarily due to environmental factors. Political ecologists would take a more encompassing view and would take interest, for example, in the historic reasons behind the unusual concentration of human settlement and in particular the evolution of the Hutu-Tutsi-Belgian relationship and how it affected land distribution and land tenure. In sum, the political ecologists would be less interested in population *densities* in a given area and more interested in population *distribution* across the region.

Political ecology would analyze the agricultural systems in Rwanda using a set of questions such as the following: How has the social, economic, political, and environmental structure affected the agricultural system of Rwanda? In particular, how have the following aspects of the structure influenced the development of regional systems?

- Political: colonial and independent policies concerning cash crops, migration, and distribution of power and resources

- Economic: integration into the national and global market structure, the inter- and intra-regional distribution of land, labor and resources

- Social: competition and conflict between groups, including socio-economic classes and ethnic groups

- Environmental: distribution of the physical resources (e.g., productive land), possible "ecological marginalization" leading to environmental degradation.

Within political ecology, a clear conceptualization of the role of both time and space is important. Changes in phenomena may occur rapidly but have delayed repercussions as their impact is reflected through the social/environmental system. For example a successful infant health program may lead to increased demand for land a generation later. Other processes, particularly environmental ones, may occur over an extended or cyclic time frame. Soil formation and erosion, for example, have relatively slow natural rates which may be accelerated or delayed by human intervention. Understanding the dynamics of the system would be enhanced by the conceptualization of time not as a single linear route but as a braid made of strands of different time sequences, often resulting in unanticipated synergistic effects (Campbell and Olson 1991).

The role of space or scale is also not a simple dynamic; interactions between factors occur at different scales. At the village level, for example, the agricultural system is influenced by land tenure (social) and land quality (environment). Agricultural production is affected also by exogenous forces operating at a higher scale. For example, a decision taken on the world commodity market to change the price of coffee influences national policy which in turn affects local-level land use practices as farmers respond to price changes.

This analysis of the situation in Rwanda in which societal and environmental processes at different scales are inter-linked over time, and in which the environment plays an *active* role in the human/environment relationship, is a test of the political

ecology approach and of the different conceptualizations of time and scale. This study provides an historical analysis of the process of human/environment interactions in Gikongoro within the broader socio-economic system.

Rwanda is considered a classic example of a country experiencing extreme population pressure; it has the highest population density of any country in Africa, a rapid population growth rate and very limited land. Many authors on Rwanda have framed their analyses upon what they have seen as responses to increasing population density. These responses include short- and long-distance migration in search of additional land in which to settle or in search of urban sources of income, the growth of non- and off-farm income, and, most importantly, increasing agricultural intensity (Grigg 1980, Clay, Kayitsinga and Kampayana 1989, Cambrezy 1984, Prioul and Sirven 1984). As Boserup and others anticipated, agricultural intensification in Rwanda has led to less land devoted to fallow, grazing and forest, the establishment of a system of continuous cropping, adoption of labor-intensive techniques, and shifts to higher yielding crops (Boserup 1965, Lele and Stone 1989, Delepierre 1985, Clay and Magnani 1987). These changes in land use are often associated with soil degradation (Lal 1987). This belief has caused much attention to be paid to erosion in Rwanda, and the government declared 1988 the "Year to Fight Erosion" with communal labor organized to build terraces and dig erosion ditches. However, researchers in the north found that chemical degradation, particularly acidity and aluminum toxicity, was no less important in the understanding declining yields (Yamoah et al 1989).

Most studies in Rwanda assume that population pressure is the dominant force controlling these social and environmental changes (Clay 1992). But studies in Rwanda using population as an "independent" variable to explain changes in the society have not been successful. For example, carrying capacity studies predicting saturation densities for regions have become rapidly outdated as not all people have left nor starved but have adopted alternative economic or social methods of earning a living (Préfol and Delepierre 1973, Futures Group 1981). Similarly, a study attempting to predict out-migration based on population densities was only partially successful due to the significant influence of other political, social and economic factors on migration activity (Olson 1990).

Nevertheless, high population densities may play an important role in the evolution of the agricultural system and the increasing intensity of land use (Bilsborrow 1987). This study addresses the proposition that the responses to increasing population densities have differed during different periods and that the response pattern is an outcome of the interaction between social, political, economic and environmental factors.

The contemporary situation in Gikongoro reflects the predicted impact of increased population density upon the stability of the resource base. Gikongoro is a highland prefecture in southwest Rwanda straddling the Zaire-Nile Divide; it has a mountainous core and surrounding foothills which have traditionally supported high population densities. Changes in the agricultural system and additional land clearing appear to have seriously affected the physical properties of the soil. This has led to diminishing returns to labor and recently to critical declines in yields per hectare

(Lewis et al 1988, Derenne 1989, Meach 1986). Total agricultural production in Gikongoro has declined in the past five to ten years, and the food security situation is critical. Food shortages quickly become famines with an otherwise common perturbation in the agricultural system, as occurred in the 1989/1990 famine cause by a crop disease (Reyntjens 1991) and a delay in the start of the rainy season.

G. Research Questions

This scenario of societal changes leading to land degradation in Gikongoro poses a number of questions in light of the overall theoretical goal of understanding the relationship between changes in the agricultural system and land degradation within their wider societal and environmental context. To answer these questions effectively, this study focusses on the farmer. Specifically, there are five basic questions: (1) within the historical context of the agricultural system of Rwanda, how has the system changed in response to increasing population pressures over time, (2) what are the immediate causes, including increasing population pressure, behind the evolution of the agricultural system that affected the soil, (3) what are the farmer perceptions of the changing soil properties as the agricultural system, land use and environmental factors have evolved, (4) what have been the strategies people have adopted in response to these changes in soil properties, and finally (5) how do these processes differ between men and women and between families with different resource endowments?

This study addresses these questions within a framework which recognizes that the agricultural system is an outcome of interacting social, political, economic and environmental factors over time and subject to forces of change emanating from both

local and external circumstances. The historical analysis presents an understanding of the evolution of the agricultural system, land distribution, and demographics, but the study focuses on the process of accelerated change that has occurred since World War II. The primary scale examined is the interaction of social, political and economic factors at the local and regional levels, but national and international events also are included in the analysis.

The information gathered is placed into a social, political and economic context by interweaving existing with newly gathered information. The following more detailed research questions guided the gathering of both existing and new primary information.

1. What have been the demographic trends?
   -fertility and mortality rates
   -migration

2. What has been the agricultural and land use response of the rural population to changes in the socio-economic and political system over time?

   How has land use changed in terms of the proportion of farmland devoted to cultivation, fallow, grazing, woodlots and other uses?
   How has land use changed in terms of cultivation of new lands?
   -drainage of swamps and valleys, clearance of forest
   -cultivation of steep slopes and marginal lands
   How have agricultural techniques changed over time?
   -manuring, terracing, hoeing
   How have agricultural "symptoms" of stress changed?
   -size of farms and fragmentation of fields
   -land distribution, tenure system and conflicts

3. What changes have farmers noticed in the soil?
   What do farmers feel is the reason behind the changes in the soil?
   What are they doing to prevent future degradation or to restore the soil?

4. What have been the agricultural and nonagricultural responses to changes in soil productivity?

5. What have been the regional, national and international political, economic and social factors affecting the Gikongoro agricultural system?

CHAPTER III

METHODS OF DATA COLLECTION AND ANALYSIS

The study of the relationship between societal and environmental factors draws on a wide variety of different types of information. A study of farmer responses to land degradation conducted in the society/environment tradition in geography would demand the gathering a variety of information concerning the agricultural system. Important would be data on changes in land use/land cover. This would supplemented by farmer interviews and contextual information, for example, on changing population densities and farm technologies (e.g., Rossi 1984; Ford 1993).

For this study, the decision of additional information to gather has been guided by concepts addressed by the regional political ecology approach, as discussed in the previous chapter. To recap, a political ecology study would include (1) an understanding of the political, economic and social structure framing land use and other decisions, (2) the placement of the local situation within its broader national and international context, (3) analysis of the historical background to problems, (4) examination of the distribution of power and of resources and competition between groups, regions and levels, and (5) attention to processes that have often led to environmental problems, such as marginalization, inequitable control of resources, historic social conflicts and skewed national policies shaped by global market conditions. The development of the specific research questions to be addressed was aided by the use of the "Kite," a conceptual framework originating from regional political ecology, that guides in the examination of specific problems through the

posing of relevant questions at differing levels of interaction (Figure 4) (Campbell and Olson 1991). The interweaving of the various strands of information is aided, again, by the Kite.

A. Collection of Documents

Many research documents exist that are written by government agencies and university students, for example, on relatively narrow technical topics of crops, soils, history, or results of particular surveys. These documents were found scattered through various governmental, project and university offices and libraries in Rwanda. Expatriates in Rwanda and Rwandans studying abroad have also done research on the changing agricultural system but frequently their work is found only in European universities and libraries. Two visits to the *Musée Royal de l'Afrique Central* in Tervuren, Belgium (the colonial archive of the Belgian government) and to the foreign ministry and other libraries in Brussels were made to examine such documents and to review historical records. Published information on recent government policies such as commodity prices was also difficult to find. Interviews with officials, project staff and others, however, provided contextual information, particularly on the impact of recent policies and programs.

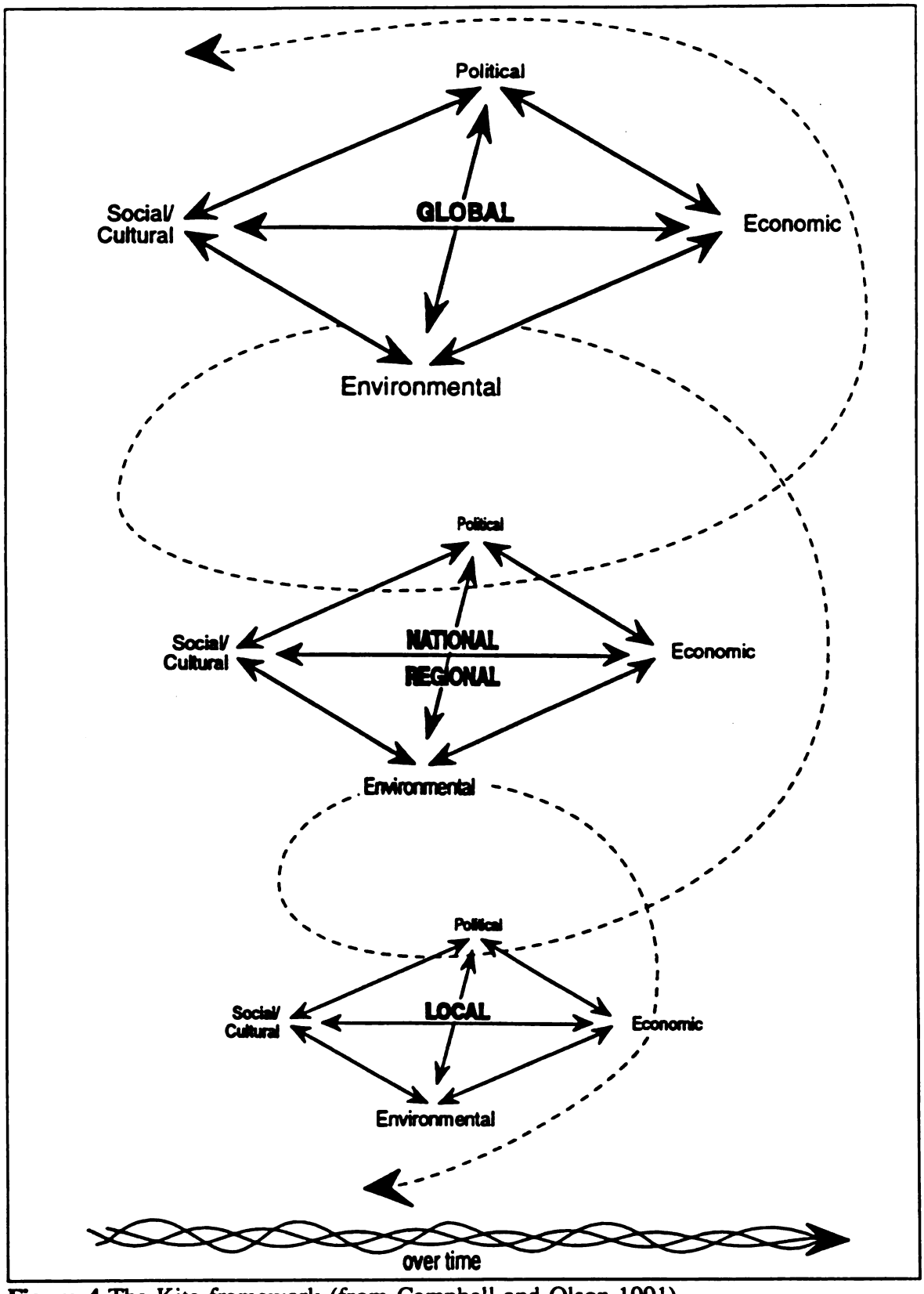

Figure 4 The Kite framework (from Campbell and Olson 1991)

Information on changing soil properties was unavailable. Although research has been conducted by agricultural research stations on erosion, in particular, and on techniques such as agroforestry, chemical fertilizers and improved crop varieties, no research on changing soil properties over time or on soil properties on farms was located. A large soils mapping project was in progress (Projet Carte Pédologique du Rwanda), but their published information was at the 1:250,000 scale and most variables showed little spatial variation across Gikongoro, or even across the southern region.

B. Analysis of Previously Collected Primary Data

Different branches of the Rwandan government generously made available primary data which the author was able to use to conduct original analyses.

1. Household Surveys

The Division of Agricultural Statistiques (DSA) of the Ministry of Agriculture, the institution which with the author was affiliated formally, provided complete access to their survey data files. The DSA had conducted agricultural and socio-economic surveys among farm households on a continual basis since 1983. The approximately 1,248 surveyed farm households were chosen based on a random, stratified cluster sampling frame to represent the ten prefectures, the major administrative units of the country. Each of the 78 clusters nationwide consisted of 16 households, or 1,248 households in the country.

The primary objective of the DSA was to estimate agricultural production. Other information was also collected regularly, including socio-economic information

at the individual level, agricultural production and off-farm income at the household level, and land tenure, field size and cropping density at the field level. Periodic surveys on special topics of interest to the government or donor agencies were also conducted, including the Agroforestry Survey.

The Agroforestry Survey, originally designed by the author in 1990 and fielded by DSA in 1991, provided information on sources of fuelwood, planting of trees and other information important for this study. A few questions on perceptions of declining soil fertility have provided a comparative view of Gikongoro vis à vis other regions, but problems with the response codes made the questions of limited use. For example, the coded responses for a question of reasons of change in soil fertility did not include "lack of manure" as a possibility (the most common response in the author's surveys) and most answers were simply given as "other."

In 1990, the DSA had invited the author to design and implement with their staff a special survey on perceptions of land degradation in the whole of Rwanda. The invitation was renewed upon the author's arrival in Rwanda in 1992. The author decided to conduct this survey, which would provide an important national context for the planned in-depth Gikongoro study (see below for a description of the DSA land degradation survey).

The availability of the DSA data and the offer of assistance of the DSA national and local staff led the author to adopt the DSA sample for her in-depth Gikongoro survey. The same 96 households in Gikongoro that DSA had been

interviewing, and for which so much essential background was available, were interviewed by the author for the Gikongoro study.

The intent of the research was to link household variables gathered during the Gikongoro survey with those of the DSA land degradation survey and those of the previously collected DSA data. It was discovered, however, that the agricultural data for two of the six survey sites in Gikongoro (in Muko and Musange communes) were largely unreliable due to poor DSA enumerators. The statistics were estimated to be 70 percent correct by the DSA prefectoral supervisor, but he could not pinpoint which 30 percent was inaccurate. Data in two other sites (in Nyamagabe commune) was not entirely credible either (the three enumerators were later dismissed by DSA). Therefore, only selected variables from DSA that the author observed to be fairly accurate were linked to the Gikongoro survey data. The data collected by the DSA in special surveys, such as the Agroforestry Survey, suffered from problems linked to inadequate training of the special enumerators (different enumerators from those for the regular agricultural surveys). Information on the number and species of trees on each field, for example, was found to be highly unreliable. Again, only selected variables, primarily those at the household level, were chosen to be linked to the Gikongoro survey data.

2. Population Census

The government of Rwanda has conducted two population censuses, in August 1978 and August 1991, and a post-census survey (or the "Demographic Survey") in 1981. Published data from the 1978 census has been available for some years and provided an important baseline in analyses of changing population densities, fertility

rates and migration patterns. The data files from the 1981 Demographic Survey had been made available to the author earlier. Results from previous analyses of this data, conducted for the author's master's thesis on migration patterns (Olson 1990), provided an important historical context for this study on society/environment interaction. The 1991 census results had not been expected to be available in time for this study, but rapid data entry and the Rwandan Bureau of the Census's decision to conduct initial analyses based on a 10 percent sample resulted in early publishing of preliminary results. Information presented in this study on fertility rates and population density, for example, are from these published results (Min du Plan 1992, 1993).

The Bureau of the Census in the Ministry of Plan also conducted special analyses of unpublished statistics for the author. A formal request by the author to the bureau for information concerning population movements was accepted. The bureau was unable to provide the data tapes but did produce summary tables of movements between prefectures and characteristics of migrants at the author's request. Specific information on the methods of statistical analysis conducted with this data is provided in the chapter describing the results of the analyses (Chapter VI).

3. Aerial Photography Interpretation[1]

Land use/land cover changes were determined by interpreting aerial photographs for the years 1973 and 1990. The initial plan of conducting the

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[1] The interpretation of the aerial photographs was done as partial fulfillment of a contract with the Biodiversity Support Fund, USAID. The interpretation was conducted by Gichana Manyara and the author with the supervision of Dr. David Lusch.

interpretation and ground truthing while the author was in Rwanda was not possible due to delays in gaining permission from the Rwandan government for purchasing the photographs and topographic maps (because of security concerns). Permission was granted in November 1992 for access to the older photographs of 1973 and 1980 and in January 1994 for the 1990 photographs (Appendix 2)[2]. Once permission had been granted, the photos were ordered from the Institut Géographique National in Paris.

The 1973 and 1990 photographs and the topographic maps are at a 1:50,000 scale, while the 1980 photographs are at a 1:20,000 scale. The 1973 photographs are black and white panchromatic with rather poor contrast. The later photographs are black and white infrared and of high quality. The topographic maps by the *Institut Géographique National de Belgique* in collaboration with the *Service de Cartographie du Rwanda* are at the 1:50,000 scale. They are based on interpretation of 1973 aerial photographs, updated with 1:20,000 aerial photographs taken in 1977 to 1982 and ground-truthing in 1986. The maps are also of high quality.

The analysis of land use/land cover change between 1973 and 1990 was done for the communes of Muko and Musebeya in western Gikongoro, the area covered by topographic map sheet numbers 30 and part of 39. Aerial photographs interpreted for 1973 were numbers 500 to 505 in band 8, numbers 523 to 527 in band 9 and numbers 528 to 538 in band 10. The 1990 aerial photographs interpreted were numbers 85 to 87 in band 8, numbers 115 to 117 in band 9 and numbers 335 to 341 in band 10. Since we did not possess 1990 aerial photographs covering a southwestern quadrant

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[2] The photographs were taken over a period of a few years as cloud cover permitted. The letter indicates "1974" aerial photographs but those analysed had actually been taken in 1973.

near Nyungwe Forest, supplemental information was added to the analysis from the topographic map.

Changes that occurred recently in Muko and Musebeya illustrate many of the changes that have occurred throughout Gikongoro (e.g., large scale conversion of pasture land to other land uses). It was decided to use the 1973 and 1990 photos because they provided the greatest amount of information of changes. These photos, along with the topographic maps, were at the 1:50,000 scale so required less manipulation and problems with different interpretations due to scaler variation. Upon visual examination it was determined that little additional information would be gained from interpreting the intermediate 1980 photographs.

The classification of the land cover/land use types was based upon the categories utilized in the topographic maps. Additional sub-classes (wooded pasture, agricultural frontier, project pasture and project cultivation) were created because they were important in the analysis of the societal processes occurring on the landscape. The identification of the categories on the photographs was based on visual identification of the elements shape, size, texture, tone and feature proximity. The minimum size of any feature mapped was 5 mm by 5 mm (6.25 hectares), a size dictated by pen width and ability to visually distinguish landscape features. Therefore, only large features by Rwandan standards (where the average field size is 0.04 hectares) were mapped. Land cover/land use changes occurring within farms was not possible, therefore. The use of magnifying stereoscopes was essential in the interpretation of the highly dissected, high relief terrain of Muko.

Nine land use/land cover categories were employed: natural forest, forest savanna, woodlot, wooded pasture, pasture, project pasture, tea plantation, agricultural frontier, cultivation and project cultivation.

The interpreted information from the aerial photographs was then transferred to the base map. A clear Mylar with contour lines, roads, buildings and place names was created from the topographic maps using a photographic process and this was used as the base map. A Zoom Transfer Scope (ZTS) was used to register the aerial photographic information of each time period to the base map. The normal variation in scale and angle of aerial photographs, combined with the high relief of the area, made distortions common and the use of the ZTS critical. The resultant geo-registered information from the two time periods was digitized into a Geographic Information System using ArcInfo. Land use/land cover change analysis was then performed within ArcInfo.

4. Spatial Data

A Geographic Information System (GIS) of Rwanda with multiple layers of spatial data from various sources had been constructed by the Michigan State University/CIESIN Rwanda Society-Environment Project. Most data originated from published Rwandan governmental documents, such as the 1987 agricultural census, population censuses, a road and administrative map and the soils mapping project (MINAGRI 1989, MINIPLAN 1992, MIRENAMICA 1985, CPR 1992). The Rwanda Society-Environment project was a team effort composed of GIS experts (Charles P. Rader, Daniel G. Brown and Gichana Manyara), the author who acted as the Rwanda field coordinator (collection of data, coordination of the Rwandan team members) and

as analyst, and was led by David J. Campbell. Several of the maps presented in this study, including the soil capability map, the population density map and the animal production maps, were created by the author using this GIS. In addition, some of the findings of this study were presented in working papers of the Rwanda Society-Environment project written by the author (Olson 1994a, 1994b, 1994c).

C. Primary Data Collection

Two separate surveys were conducted, a formal survey at the household level with the DSA and a second, in-depth household and field level survey conducted with the assistance of hired research assistants. The preparation of the two surveys involved making tours of the region, interviewing farmers and other people in the area, conducting numerous pre-tests of draft questionnaires, and meeting various government and project people in Kigali, Butare, Ruhengeri and elsewhere. The preparatory activities for the surveys lasted from March to May 1992.

In neither of the author's questionnaires, or in any DSA questionnaire, were respondants asked their ethnic group. The topic was extremely sensitive and the question considered taboo. Statistical information comparing Hutu and Tutsi farmers, therefore, is not available. In informal discussions and in group meetings, farmers and others indicated that there were no longer wealth or any other differences between Hutu and Tutsi farmers.

1. The DSA Survey.

Upon her arrival in Rwanda in 1992, the DSA renewed an invitation to the author to conduct a survey under their auspices on perceptions of land degradation. The 1,248 nation-wide household interviews were to be conducted by the *équipe mobile* enumerators (a team of ten enumerators trained to conduct surveys on special topics). The questionnaire was written by the author and refined during a period of extensive pretests in different regions of the country. The questions were designed to be compatible with questions posed in the 1991 Agroforestry Survey so that comparisons in responses would be possible. DSA field personnel in Butare and Gikongoro and DSA national staff provided critiques of the questionnaire and assisted in the translation of the questions into Kinyarwanda. Comments on the questionnaires were solicited from personnel of the agricultural research station (ISAR), the FAO *Projet de Conservation de Sol* and the *Projet Développement Agricole à Gikongoro* (PDAG). The interviews with farmers provided initial information, for example, on what soil properties they felt were most important to examine in the degradation process, what they felt were the agricultural or other changes that could lead to degradation, and the most important consequences of soil degradation. The interviews with governmental and project staff provided information on what information they would find most useful, such as farmer opinions of agricultural techniques.

A copy of the questionnaire is provided in Appendix A. The questionnaire is formal in the sense that the wording of all the questions was preformulated and each enumerator was to ask the questions in each household using the same words as those written on the questionnaire. The responses to the questions were all precoded.

Two days before the start of training the enumerators, the director of DSA announced that DSA was unable finance the survey. A portion of a grant provided to the author by NSF was sufficient, however, to allow the survey to be administered in two of the ten rural prefectures of Rwanda, in Gikongoro (the site of the in-depth study) and in Butare (near Gikongoro where many pretests had been conducted).

A training program was given for the two DSA équipe mobile enumerators and the two prefectoral supervisors of Gikongoro and Butare on July 10, 1992. The enumerators conducted the interviews from July 13 to August 31. A total of 256 households were interviewed, 96 in Gikongoro and 160 in Butare. The author closely supervised their interviews, accompanying each of them one day a week on their rounds, reviewing their completed questionnaires and sending them back to reinterview households when necessary. The prefectoral supervisors also visited the enumerators periodically in the field and reviewed the questionnaires. Both enumerators were professional and thoughtful in their approach to the farm households. They knew the households from previous surveys and were experienced in completing questionnaires (the households were, themselves, experienced in answering questions). Each questionnaire took approximately 45 minutes to one hour to complete.

The results of the questionnaires were entered into the statistical program SPSS/PC+ by DSA staff in Kigali. The author cleaned the data and conducted statistical analyses in SPSS/PC+ version 4.0. Information on the methods of data analysis are found in the chapters which present the results. The DSA sampling frame had been designed to provide statistically valid results at the level of the nation and

the prefecture. In DSA analyses, the results from the 1,248 surveyed households nationwide are weighted to represent the entire country's or prefecture's population. In this study, the surveyed households are subdivided frequently, categorized according to gender of head of household or farm size, for example. The resultant smaller numbers of cases in each class are not sufficient to represent the population of the prefecture. In this study, the results of the smaller surveys are not weighted and are not meant to represent the entire population of the prefectures. The number of cases in the different groups is sufficiently large, however, to make statistical comparisons between groups.

The tables presented in this study are the results of analyses of data collected over a 3 year period by DSA and the author from the same 256 households in Butare and Gikongoro. Due to serious problems during the collection of income and production data by DSA in 1991, the unavailability of cleaned 1992 DSA data sets when these analyses were conducted and concerns over the quality of the 1992 DSA Gikongoro data, the DSA data that were joined to the author's variables originate from two different years. The production and income data are from the 1990/1991 agricultural year and the farm size data and characteristics of the head of the household (education, age, gender, etc.) data are from the 1991/1992 agricultural year. The Agroforestry Survey of 1991 provided variables on tree planting and fuelwood collection. All the other data presented were collected by the author in 1992. This includes, for example, data on number of animals raised, constraints to increased production, agricultural techniques, crop changes and perceptions of soil characteristics. The analysis of data gathered from different years may present problems of, for example, calculations of productivity since the factors of production

may have changed somewhat over time. For this reason, only broad generalizations are made comparing groups of households and no attempts to show statistical significance are made for these analyses.

2. The In-Depth Gikongoro Survey

Gikongoro was chosen as the site of an in-depth study of land degradation because Ministry of Agriculture officials had expressed in 1990 their opinion that the impact of land degradation was most severe in Gikongoro. The officials hoped that with additional knowledge of the causes of the degradation and of the responses of the population to the degradation, the problem could be averted elsewhere in the country.

The in-depth Gikongoro survey was not affiliated with DSA but was conducted solely by the author with four hired enumerators. The enumerators were chosen with the recommendation of a geography professor during a visit to the Department of History and Geography at the National University of Rwanda in Ruhengeri. The enumerators were students in the Department of History and Geography and were originally from Gikongoro. Two were able to live at home and the others with family or friends during the period of data collection.

The DSA sample frame of 96 households grouped in five communes (six sectors) of Gikongoro was used to allow a linking of the data already collected by DSA (the new DSA land degradation survey as well as three years of agricultural production statistics, field measurements, socio-economic information, etc.) with the new data collected by the students (Figure 5). The questionnaire was written and pretested during the same period the DSA questionnaire was being prepared. It was

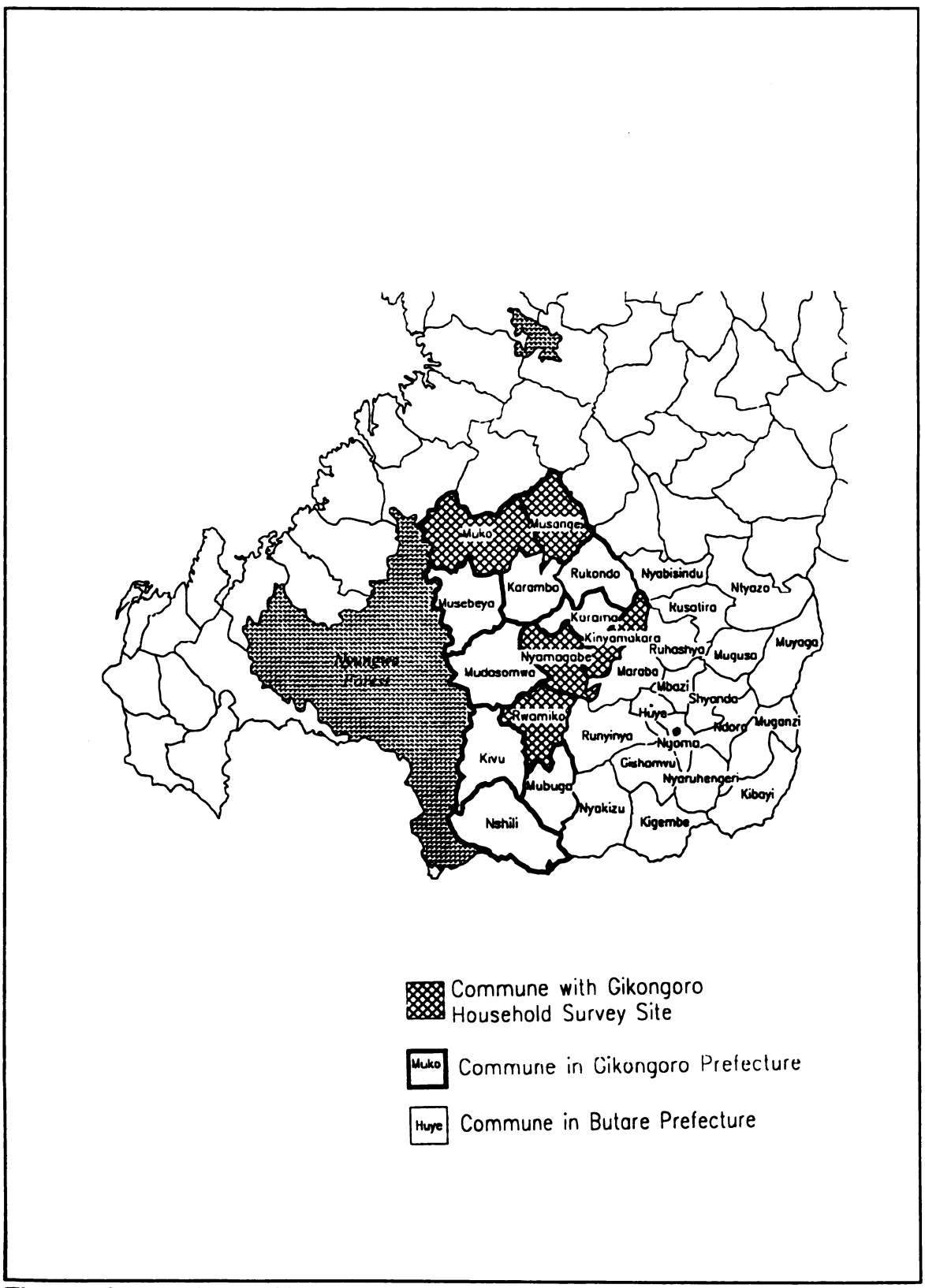

Figure 5 Survey sites in Gikongoro, Rwanda

finalized after the DSA questionnaire had been fielded. Therefore, the questionnaire benefited from knowledge of what issues were most important to farmers and what issues would not come up without prompting (e.g., erosion). A copy of the questionnaire is provided in Appendix B.

The Gikongoro survey was substantially different from the DSA survey because 1) it was not only at the household level but also at the field level (in total 96 households and 551 fields (*blocs* in DSA terminology)), 2) the questions were less formal or restrictive and the responses open-ended, allowing a better recording of how the interviewees felt about the issue and how they phrased their thoughts, and 3) the students were not professional enumerators like those of the DSA but better understood the content of the survey topic. The students were trained to carefully ask each question as written, but also to follow up on answers asking the reasons behind changes in order to discover "the why behind the why." This was important because respondents often gave a short response to a question and a follow up question was necessary to discover the reasoning or logic behind the pat answer. The field-level questionnaire took 20 to 30 minutes per field and the household-level approximately 30 minutes to complete. The average number of fields per household was six; some households had up to 18 fields. Many of the fields were located near the homestead but most households also had scattered fields further away in the valleys or on other hills. The completion of each household's survey required half a day to two days depending upon the number of fields the household cultivated.

The first training program of the enumerators, from July 6 to 8, consisted of two and a half days of intense instruction on survey techniques, a final pretest in the

field by the enumerators and translation of the questionnaire from French to Kinyarwanda. The translation was "double-blind." One group of enumerators translated part of the questionnaire into Kinyarwanda and the second group attempted to then retranslate those Kinyarwanda questions back into French. A comparison between the original French questions and the translated French from Kinyarwanda provoked much discussion of many Kinyarwanda terms, soil degradation and organic matter being two examples.

A second training program, from July 13 to 14, provided the enumerators with final instructions and copies of the questionnaires. After each enumerator had interviewed two or three households, a third two-day meeting took place to exchange problems and experiences and for more training on survey techniques. This third session was perhaps the most rewarding for the enumerators because they were excited by their experiences and the instructions had ready utility. It also allowed the author to review their work and the group to discuss problems experienced in the field with the DSA Gikongoro supervisor. Problems included difficulty in locating households, the fields of the households not matching up with those the DSA enumerators had described, problems interviewing elderly people, households broken up or hard to interview because of personal troubles, and questions that were worded vaguely. The enumerators then went back into the field and the author went on rounds of supervision. Each enumerator was visited several times, particularly those who seemed to have the most problems.

Once most of the interviews were complete, the group met for a *réunion de synthèse* (a summary meeting) from August 16 to 17 to discuss problems the enumerators had experienced and their general impressions and findings of the interviews. The meeting was very informative since the content of the interviews was fresh in the enumerators' minds. After this session, two enumerators returned to the field to complete the two remaining secteurs.

Finally, on September 14 and 15, a second, combined *réunion de synthèse* was held with both the student and the DSA enumerators to go over the problems they had experienced, to compare areas, to discuss findings, and to speculate on possible solutions to the soil degradation/poverty cycle.

The students had no or very little previous experience as enumerators and had received only the training provided them by the author and a university course on surveying. Their background as geography and history students, however, gave them an understanding of the context and logic behind the survey, and they were well able to follow up with questions to arrive at complete answers. In addition, the students were from the areas surveyed so knew the people and understood the local situation. Three of the four students worked very well. They approached farmers easily, gained their confidence and listened to what farmers said. A fourth student, however, was less willing to do the hard field work and had falsified several questionnaires. Most of his questionnaires were re-fielded by a DSA enumerator.

All the enumerators for the study were men because all DSA enumerators were men and all the university students from Gikongoro in the history and geography

department were men. The enumerators felt more comfortable and felt they were getting "better" answers from the men in the households. Women were interviewed more frequently, however, because approximately 30 percent of the households were headed by women and women were at home more often.

To estimate the extent of any differences in responses between men and women, separate group meetings were later held for men and women. In the group meetings, it was found that men knew more of the history of the area and the long-term reasons for the decline in soil fertility. This is perhaps due to the virilocal rules of residence: women move to their husband's region at marriage. On the other hand, the women could respond with more details on the effects of soil changes on crop production, the effect of plant diseases, etc., perhaps because they spend more time in the fields than men. Older people tended to provide much more comprehensive responses to questions on changing soil properties and especially to the question of changing access to resources over time.

3. Group Interviews, *Réunions des groupements paysans*

To complement the standard household survey interviews, meetings of groups of around ten to twenty farmers were held in the same areas in which the surveys had been conducted. Eight group meetings were held. Men and women met separately in an effort to encourage the women to speak freely. Usually the enumerator of that area notified farmers beforehand that we were to have a discussion session. The author and assistant (one of the better enumerators) then went to the area and a group of people gathered. The meetings were recorded on tape and later translated into French and transcribed in their entirety by another person (a university student studying French

and Kinyarwanda). The transcriptions of these meetings are cited in the text of the dissertation as "group meetings" with the commune in which the meeting was held identified. Individual farmers are not cited for confidentiality reasons.

The questions that were written down to be addressed had been topics of particular discussion during the household interviews or during the *réunions de synthèse*, such as why the number of cows had declined in the region, the difference between the soil of rich and poor farmers, and the relative importance of the lack of manure and other causes of soil degradation. These questions were at times elipsed by people expressing their resentment at loss of access to land, pasture and other resources (often due to appropriation by the government), the enforced nature of erosion control techniques and the disappointing results of agricultural programs. The group interviews, in short, provided a broad historical and especially political context to supplement the narrower answers given by individuals concerning their own fields and farms.

4. Interviews with Government and Project Personnel

Several visits were made to a variety of organizations associated with agriculture, erosion control, agroforestry and the environment. Following is a partial list of organizations and their members that were visited to interview staff and to collect documents:

- the National University of Rwanda, the departments of Geography and History (Uwizeyimana, Gatera), Sociology (Nkundabashaka) and Agronomy (Muhawenimana, Hanegreef)

- the Ministry of the Environment and Tourism (Rukangira, Nkundineza, Winterbottom)
- the FAO Soil Conservation Project (Berding)
- the soils mapping project, *Carte Pédologique du Rwanda*
- the Cartographic Center of the Ministry of Public Works
- the Forestry Directorate in MINAGRI
- the AFRICARE soil conservation project of Ruhengeri
- the agricultural research station (ISAR) director and staff of the departments of *Etude de Milieu et Systèmes Agricoles*, Soil Fertility and Erosion Control, Agroforestry
- the CIAT Great Lakes Bean Project
- the Institute for Scientific and Technical Research (IRST)
- the Gikongoro agricultural development program (PDAG) and Gikongoro agricultural services
- burgomasters, teachers, extension agents and other bureaucrats in communes in Gikongoro
- the USAID office (director, assistant director, agricultural officer etc)
- the UNICEF nutrition program.

D. Conclusion

Presented above is a description of the variety of information gathered from different sources with varying degrees of accuracy and verification, and spatial and temporal coverage. The framework provided by RPE and the Kite guided in the posing of relevant questions, and also in the approach used to answer those questions. A historical approach, examining how the various societal and environmental

processes interacted and evolved over time, provided the basic framework. Some of these processes varied relatively slowly such as changing birth and death rates, increasing population densities, the national and international economic structure, and the intensification and extensification of the agricultural system. Others appeared to change abruptly, such as the demise of the *ubuhake* patron/client system, the social revolution and coincident redistribution of land and population, and the reintroduction of forced communal labor. When critical events coincided, such as a late rainy season, a particularly difficult national economic situation and legislation of new political freedoms, their effects worked in synergy to transform the entire system. Tracing these changing contextual processes and radical events through time, while addressing the basic questions of changing land use, land degradation and responses to land degradation, required weaving information from the various sources together into a coherent argument. At times this made use of quantitative analysis and at other times the consideration of qualitative information. While RPE and the Kite provide the initial guide and approach, they do not presume to provide the argument, which depends upon the local situation and the problem being examined.

The research climate during the 1991 to 1994 period was difficult. Initial plans to start research in-country in 1991 were cancelled due to the outbreak of the war in September 1990 (further discussion of the war and the 1994 tragedy are presented in the Epilogue). During the field research period in 1992, the country was undergoing disruptions due to the war and, particularly important in Butare and Gikongoro, a political uprising. Violent and non-violent protests against the regime were common in both urban and rural areas. In response, the regime conducted a course of random

bombings in public places and frequent human rights abuses. Foreigners were not targeted, but safety was a concern and dictated when travel was possible. Evacuation was a frequent possibility. The government in Kigali functioned for the most part, but maintaining contact with university professors in Ruhengeri (near the front) was difficult.

People in both rural and urban areas were preoccupied with the ongoing revolutionary political changes and with the war with the RPF during the period of field work in 1992. Farmers, and others, often framed their opinions about whatever topic was being discussed with a heightened awareness of the political situation. Political changes and violent events became daily occurrences and, with freedom of speech laws newly enacted, were the dominant topic of conversation. The commonality of the violence and optimistic hopes for democracy diluted the warnings the violent acts provided.

The magnitude of the threat to peace by extremist groups and by the RPF was not realized by the author until a short, intense visit to Rwanda in January 1994. Several people whom she had then known for four years, narrated their personal stories of survival and knowledge of plans for widespread killings. Those killings, and the war, erupted when President Habyarimana was killed on April 6, 1994. The interpretation of the information gathered from 1990 to 1993 and presented in this study has been affected greatly, therefore, by a new realization and understanding of the severity of the 1990 to 1994 crisis.

CHAPTER IV

HISTORICAL AND POLITICAL PROCESSES

A. Introduction

The agricultural system in Gikongoro has undergone major changes in the past fifty years, changes occurring particularly rapidly in the most recent thirty years. These changes have been associated with abrupt transformations of the political system, a steady increase in population densities, shifts in access to resources and macro-economic fluctuations.

The intensification of the agricultural system has developed within this wider context. The intensification process is reflected in the major changes in land use that have occurred at the level of the farm, the hill and the region. The intensification process has been also reflected, however, in deteriorating soil properties. Although the intensification techniques that had evolved had positive results in terms of initial increases in production, their adoption is now linked to the process of soil degradation.

B. Pre-Colonial Land Use Processes: The Importance of Cattle

Presented here is a historical overview of changing land use in Gikongoro, a Highland prefecture of southcentral Rwanda. It considers the governmental policies, demographic pressures and economic transformations that have influenced the agricultural system, caused major land use changes, and eventually led to land degradation. The findings refute the common assumption that population pressure

inevitably leads to environmental degradation. Instead it was found that in a situation of low population densities, the land was kept relatively unproductive as pasture for hundreds of years. A reversal of the political power structure and increased population densities resulted in pasture giving way to crops and adoption of labor-intensive land management techniques that significantly raised soil productivity. Only recently have demographic forces, in combination with other societal factors, resulted in changes in land use and in reduced availability of manure which have led to soil degradation, particularly in fields of the poorest households and in regions of vulnerable soils.

Gikongoro is within a region of Rwanda, and Africa, with an extremely long, rich history of settlement by farmers and herders. It is an area that already supported high population densities when the first Europeans arrived.

Recent research in Butare indicates that deforestation and settlement in southcentral Rwanda is not a twentieth century phenomenon caused by rapid population growth; the land had been cleared and has been maintained in crops and especially in pasture for the past 2000 years (Schoenbrun 1990). In fact, recent evidence shows that the soil of Rwanda has been farmed since at least A.D. 300. The first farmers probably found an old-growth forest, then went through a period of slash and burn agriculture that changed the land cover to a younger, less dense forest. This eventually was converted to and maintained as grassland through controlled burning to support an agricultural system in which livestock were prominent (Barabwiliza 1980, Schoenbrun 1993).

When the Europeans arrived in the 1890s, they found the southcentral region of Rwanda a highly anthropogenic landscape of grass-covered hills (Johanssen 1915; Maquet 1954). The earliest photographs of the area record the steep hill slopes being eroded, with the only break in the uninterrupted grasslands being the fenced homes and intensely cultivated fields on the hilltops. Records indicate that a major concern for the missionaries and the colonial administrators was the almost total lack of trees for wood to construct their buildings (Everaerts 1939a).

The first demographic survey of Rwanda in 1948 showed that the South-center, and especially the Northwest, had very high population numbers, particularly in the foothills of the mountains (Neesen 1953). Population densities were highly correlated with elevation, leading Gourou (1953), a French geographer, to postulate the determining influence of elevation on settlement patterns. He concluded that the unusual concentration of people was due to high agronomic potential, absence of diseases (tsetse fly, sleeping sickness, malaria) and the pleasant climate. Gourou also felt that it was made possible by a highly-organized central political system (Gourou 1953). Initially Hutu kingdoms and then a Tutsi monarchy provided the tight social structure. Internal wars were rare and not particularly murderous due to the tight discipline and military superiority of the king's army. The depopulation associated with slave trading that had occurred in the nineteenth century elsewhere in East Africa was prevented by the army of the monarchy (Gotanègre et al. 1974).

The political system had evolved over hundreds of years. The mythology of Tutsi rulership is that Nilotic Tutsi pastoralists migrated from the north (Sudan or Ethiopia) with their long-horned cattle around A.D. 1500 and over a period of several

hundred years established a patron/client relationship with the Bantu Hutu farmers who had migrated to the area much earlier (Maquet 1954, Gotanègre et al 1974). Recently, des Forges (1994) and other historians have concluded that, rather than a relatively recent wave of Tutsi in-migration, numerous small groups, some primarily cultivators and some pastoralists, came to Rwanda from many different origins over a long span of time. Pastoralists tended to marry pastoralists, and cultivators married cultivators, which gave rise to identifiable physical types. They developed a single nation as early as the 16th century.

The terms Tutsi and Hutu originally signified individual economic status but as the state became more powerful the Tutsi became identified with the rulers and Hutu as the common people (anyone not in power) (des Forges 1994). The classification of Tutsi appears to have been relatively fluid, and a farmer could earn the status of a Tutsi if he were rich (owned several cattle) (Maquet 1954). A Tutsi who lost his cattle (due to a loss of privilege by the king) would be forced to cultivate to survive (de Schlippé 1957). In this hierarchical structure, only the Tutsi had the right to own cows (whereby the current importance placed on cows, not bulls) and Tutsi held almost all of the political and economic power (some chiefs were not Tutsi, however).

According to Nzisabira (1989), before the Tutsi gained control over the Hutu, the out-field land had been maintained as woodlands for fuel and construction wood and as a reserve for cropping when the population would increase. When the Tutsi gained control over the Hutu, the land of the out-field was appropriated and converted to extensive pasture while the Hutu were confined to cultivating their ancestral in-field

areas. The pasture land became highly eroded with degraded soils and biomass as a result of the periodic burnings.

The early Europeans described a highly structured hierarchical government with an all-powerful Tutsi king who governed through Tutsi chiefs and subchiefs down to the level of a hill, and finally the Hutu serfs. Their descriptions compared Rwanda to feudal Europe, and in doing so they ascribed the inherited right-to-rule and innate superiority from their own monarchic system to the Rwandan king and the Tutsi (Everaerts 1939a). This European belief in the "Hamitic Hypothesis" of Tutsi superiority had a profound impact on their approach to governing (Newbury 1988, Rossel 1992). The actual social structure of Rwanda was, however, less rigid and more complex than early European authors described.

The Tutsi did have power over access to all land. When a young Hutu wanted to marry and start his own farm, he had to request land from a Tutsi chief and by necessity join the *ubuhake* contractual system and become a permanent client for that patron Tutsi (Maquet 1957). In return, the patron and the Tutsi king's army ensured protection for the client (the reason the East African slave traders did not use Rwanda as a source of slaves) (Stanley 1909, Gotanègre et al. 1974). In the system, clients rarely owned cattle but were given usufruct rights over their patrons' cattle and other animals. In return for guarding the patrons' animals, the Hutu received the male offspring, milk, blood and manure (Maquet 1957). A portion of the production of the crops cultivated around the Hutu homesteads, the *urugo*, was accorded to the Tutsi patron.

Various uses of the farmland formed concentric circles around the *urugo* and differed in cropping intensity, value of crops and degree of organic matter placed on the soil (Figure 6). The cultivated land near the *urugo* received organic matter inputs, as well as intense maintenance, and the soil grew fertile through this human-induced process (Coelus 1983, Nzisabira 1989, Schijns 1987). The cattle and other animals grazed during the day in the grass-covered valleys and hillsides and were brought into the corral in the *urugo* to spend the night. Euphorbias were planted around the *urugo*, reducing erosion and eventually the soil of the homestead was leveled.

The *urutoki* fields, those surrounding the *urugo* that usually contained banana plants, beans and vegetables, had moist, fertile soils because most of the household and agricultural residues and manure were placed there. It was not necessary to fallow the soil because of the large amount of organic matter inputs it received. The *imirima* and then the *indare* were the permanent fields for sorghum and other crops or coffee and were located just beyond the *urutoki*. They also received some manure but not in the same quantities as the fields next to the *urugo*. The soil was renewed through the use of fallow at least one year in four. Cattle often grazed on the fallow lands and thus fertilized the soil. The out-fields, the *urwuri,* were often used as family pasture and only cropped with eleusine, peas or another crop a year or two before returning to fallow. The new valley fields, the *igikuka* or the *imigende*, were cultivated with sweet potatoes, sorghum or vegetables in the dry season (Gotanègre et al. 1974, Chrétien 1984).

The existence of special Kinyarwanda terms for "spreading of manure" (*kutabira*) and for the particular moon (the *gitugutu*) during which the spreading

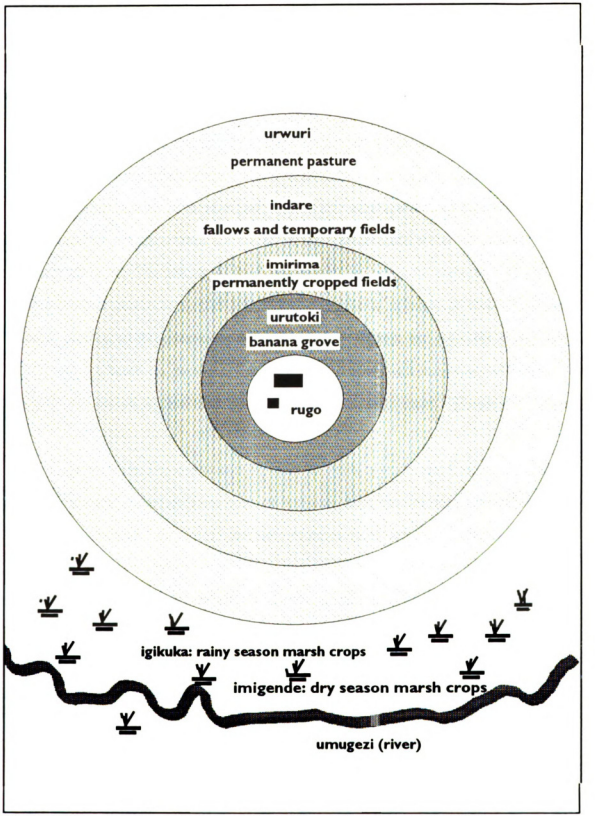

Figure 6 Rwandan farm schematic (adapted from Gotanègre et al. 1974).

would occur indicates the importance and old nature of the practice of spreading manure in the agricultural system (de Schlippé 1957). Another old term, *kuyoreza*, defines the ritual practice of placing squash, eggplant or other seeds on a carpet of manure. It conveyed much magic; it was considered a particularly good omen when children performed the ritual (Chrétien 1984). The Kinyarwanda terms for high soil quality and for organic matter are based on the Kinyarwanda word for animal manure, *ifumbire*. The linking in the Kinyarwanda language for manure, organic matter and soil quality is a reflection of that relationship in farmers' minds (making careful wording of the questionnaires necessary). Similarly, the word for other, new soil inputs are based on *ifumbire*. Compost is "*ifumbire* from household and other wastes," and chemical fertilizers are "foreigners' (or white mans') *ifumbire*."

The high fertility of the soil on these in-fields was the result of the "manure cycle," the transfer and concentration of nutrients from the pasture lands and the extensively cropped fields to the intensely cropped fields primarily with cattle as the intermediary (Angé 1990). There was a net transfer of nutrients from the less productive land to the more productive land to compensate for the export of nutrients from the harvesting of agricultural products. The fertility of the cropped land depended on the global use and management of natural resources on the hillsides and in the valleys. The relationship between the cropped fields and the non-cropped land, from where the nutritive elements originated, was the essential factor in the sustainability of the traditional agricultural system. Agronomists and soil scientists had in the past noted the anthropomorphic influence on soils of banana fields and on the

tops of the hills (e.g., van Wambeke 1963). The soils had a higher humus content, an increase in pH and an especially high content of organic phosphorus (Coelus 1983, Frankart et al. 1974).

This traditional pattern of land use in which so much time and effort was devoted to increasing the fertility of the soil was, perhaps, one reason the Rwandans and Burundians were so sedentary and attached to their farms (they had not used more nomadic techniques of slash and burn for centuries). In 1903, Van der Burgt (cited in Chrétien 1984) observed:

> *"Souvent des familles habitent paisiblement pendant des générations le même "kraal" et profitent des mêmes champs. Du reste, les bananeraies (sic), les imimanda (arbres ficus à habit) et les bons champs, très fertiles après un long labour, donnent une certaine stabilité et fixité aux familles qui y demeurent. C'est pour cela que les Warundi sont les plus sédentaires peut-être que les autres Nègres."*
>
> Often families live in the same homestead and cultivate the same fields for generations. The banana plants, the fig trees and the good fields, very fertile after long labors, give a certain stability and fixity to the families who live there. That is the reason why the Warundi (the people of Burundi) are perhaps the most sedentary of all the Africans.

Because only a small amount of land was cropped, it was intensely cultivated. Trees were confined to forest residuals in marshy valleys or in the extreme high elevations (Loupias 1903; Johanssen 1915). The grass-covered landscape the Europeans discovered upon their arrival, therefore, was the result of centuries of continual land management.

C. Colonial Impositions: Crops versus Pasture

The German and then the Belgian colonialists, who believed in the "racial" superiority of the Tutsi, maintained and solidified political power in the hands of the

Tutsi who kept complete control over land use and access to land (Maquet 1954; Newbury 1988). In order to strengthen their control, the Belgians ensured Tutsi support through military and other means. For example, they deposed an older reticent king and replaced "incapable" Tutsi chiefs by others amenable to the colonialists' ideas (Everaerts 1939b). In turn, the colonialists helped the Tutsi monarchy extend and consolidate its power (Lemarchand 1970, Newbury 1988). The division of power between Tutsi and Hutu was codified and institutionalized by the colonial administrators, for example, by establishing identity cards indicating each person's "race." The Belgians confined colonial governmental benefits, such as education and administrative jobs, to those considered Tutsi. This reinforced the political and cultural system which placed such importance on cattle and cattle ownership.

1. Increasing Population Densities

As health programs for both people and cattle were implemented and new food crops adopted, the human and animal populations increased beginning in the 1930s and then rapidly in the 1940s (United Nations 1953). The Tutsi rulers continued to reserve large tracts of land for pasture even in the face of this rapid population growth and land scarcity felt by farmers. Conversion of pasture land to crops was restricted and the farming population continued to be confined to limited areas. This led to intensification of the farming system in western Rwanda at an earlier date than elsewhere in Africa. Consequently, continuous cropping without fallowing was made necessary due to this lack of cropping land (Min. des Colonies 1954).

Land use conflicts between the groups occurred frequently when the animals of the Tutsi would graze upon and destroy the crops of the Hutu. These conflicts occurred most often in the valleys, especially during periods when pasture became scarce. The Hutu farmers had no recourse, naturally, since the authorities were all Tutsi (Heremans et al. 1982).

Population densities were very high in face of this politically induced population pressure. Famines continued to be a regular, even periodic occurrence. The Europeans ascribed the famines to climatic fluctuations, a continental decline in rainfall, insects, crop diseases and traditional agricultural practices (Fallon 1930, Scaetta 1932, Harroy 1984). More recently Rwandan scholars have written of the famines as a consequence of the colonial period's restrictions on access to land and inequitable distribution of agricultural production (Nzisabira 1989, Uwizeyimana 1990). Belgians early on also expressed concern over erosion and soil depletion due to the intensity of cultivation and high population densities.

Population densities in most of Gikongoro were initially not as high as in Butare and other neighboring regions, perhaps because Gikongoro is a cool, mountainous area with relatively poor soils. People initially settled in the more amenable foothills where bananas would grow (Neesen 1953). Gikongoro is only 25 kilometers from the site of the Tutsi king's central court in Nyanza, Butare, and about the same distance to the colonial capital of Astrida (now Butare town), Butare. Nevertheless, the poor agricultural value of the land and the limited amount of traffic heading west from Butare (the Nyungwe Forest and mountains represented a physical barrier between Cyangugu and the rest of the country) led Gikongoro to remain a

marginal participant in the economic and political activities of Butare, Gitarama and the rest of the country.

Much of the landscape in Gikongoro consisted of the grass Eragrostis boehmii, maintained by controlled burning, and scattered trees. The land was used as seasonal pasture, called transhumance (Frankart et al. 1974, Bart 1993). Entire hills and communes, such as Musange, were reserved by the political system as pasture. A traditional high concentration of cattle and other animals in Gikongoro, compared to elsewhere, has continued to the present.

Central and western Gikongoro are areas of high elevation (over 1900 meters) and cool temperatures with marginal agricultural value. The Nyungwe Forest, a tropical montane forest, covered much of Western Gikongoro. The forest straddles the continental divide and the Zaire-Nile watersheds and contains a source of the Nile. Little information is available on the size of the Nyungwe Forest in Gikongoro before World War II, but the forested area probably extended well beyond its current borders. Access to the forest's resources initially did not command the intense control of the Tutsi political system. The Twa pygmies were considered to have the right to the forest and any clearing of the land by farmers was done with their permission (Maquet 1957).

The period before 1933 is labeled the "laisser-faire" phase by Gatera (1980). The First World War and the coincident severe *Rumanura* famine reduced the slow deforestation that presumably had been occurring, but afterwards forest clearance began again. The poor soils forced farmers to constantly clear new lands. Oral

histories and natural forest remnants indicate that much of the Gikongoro communes of Nshili, Kivu, Rwamiko, Mudasomwa, Musebeya and Muko had been forested previously. By 1933, the forest edge was five kilometers from the administrative centers of those communes (Gatera 1980). Weber (1989) estimated that the forested area shrunk by 6,000 km2 during the time before independence.

In 1933, the colonial government created a system of reserves along the U.S. national park model which established boundaries around the Nyungwe Forest, the Gishwati Forest, the Volcanoes Park, Akagera National Park and the Mutara Hunting Domaine (An. 1952). At the time of their creation, the land within these reserves was not farmed, although there may have been Batwa Pygmies in the forests and Hima, traditional herders, in Gishwati (Offutt et al. 1990). The designation of the Nyungwe Forest as a reserve was meant to control logging, some of which had been legal, and hunting. Logging had effectively eliminated Podocarpus usambarensis and Podocarpus milanjianus from the forest (Barabwiliza 1980). To mark the boundaries of the forest, eucalyptus, cypress and Podocarpus usambarensis were planted (Renier 1951). A service of guards was also instituted. The forest clearance stopped, for the most part.

2. Land in Famine Crops

The colonial government instituted a series of other laws with similar profound effects on the landscape and on the agricultural system. In response to missionaries' angst concerning the famines, the Belgian colonial administrators enacted several policies to prevent continued famines (Everaerts 1939b, Heremans et al. 1982, Harroy 1984). This included large-scale tree planting (22,000 hectares by 1939) to counteract the irregularity of rainfall, the institution of enforced planting of certain crops, the

conservation of seeds and food in granaries, creating compost bins, veterinary services, and the forced expansion of cropped land (Ministère des Colonies 1954).

The infamous law of 1924 obligated every farm to plant and maintain 15 ares of "famine foods" per married adult member. Famine foods were those that did not need to be harvested at the same moment as most other crops, were drought resistant and could be easily transported in case of need (Fallon 1930, Guichaou 1991, Harroy 1984). This increase in land cropped demanded much labor from the farmers, labor for which they did not usually perceive any benefit (Harroy 1984). The crops enforced were cassava (which could remain in the soil for up to three years) in the warmer regions and in the east, white potatoes in the high elevation areas and sweet potatoes throughout the country. The crops were obligated in the sense that farmers were forced to plant them, but their harvest remained the property of the farmer to eat or sell as he wished (Habimana 1980). The introduction of the foods, however, was difficult. Cassava, in particular, was not appreciated by the farmer (it was thought to be poison) and whatever cassava was planted in the presence of the white man were often pulled out and burned once he left (Fallon 1930). The feelings against enforced cultivation of famine foods remained high many years after the laws were first implemented. Thirty years later, in 1958, the laws were abrogated following discussions in the United Nations comparing the enforcement to slavery. It was a period of high tensions between Hutu and Tutsi and between Rwandans and Belgians, and all enforced measures (crops, communal labor, erosion control) by the colonialists were under attack (Habimana 1980). Nevertheless, great efforts were spent to promote the famine crops. Between 1928 and 1938, the area under these crops increased from 150,500 to 249,000 hectares (Everaerts 1939b). The frequency of

famines were reduced, until an extremely serious famine occurred during World War II when 400,000 people died (Nzisabira 1989).

In addition to these 15 ares of cross-seasonal, famine food crops per person, farmers were obliged to plant 35 ares per individual in the households of other food crops (Ministère des Colonies 1954). This obligation was difficult to meet due to the lack of land devoted to cropping. The chief of the agricultural service wrote that this lack could be attributed to farmers' laziness (*fainéantisme*) and short sightedness (partially due to their insecurity of land tenure), and lack of available land. The colonial administrators then went counter to the Tutsi traditional and customary rights of total control over all land and enacted a law giving farmers (i.e. Hutu) rights to cultivate land in valleys (Everaerts 1939b).

3. Valley Development

Thus began the organized campaign that has continued to the current era of "*la mise en valeur des marais*," or "putting valleys into productive use," valleys that had been under pasture (Cambrezy 1981) (Photos 4 and 5). Because the colonial administrators felt that the cattle in the country had no practical use and were much too numerous, they encouraged voluntary slaughter to reduce the pressure on the cropped land created by the large reserve of land under pasture (Meschy 1989, Bart 1993). A new "appropriate" division of land between pasture and cropping was seen as necessary (Fallon 1930). The valleys had been important sources of pasture for the animals during the dry season and particularly during years of rainfall deficit. The valley streams were also diverted to provide the animals with a regular source of drinking water. The Tutsi chiefs, owners of large troops of cattle and the

administrators of the land tenure system, had no interest in implementing the colonialists policy of famine food cultivation and putting their valleys under crops (Heremans et al. 1982). In many areas, any conversion of land that occurred during a supervisory visit by colonial administrators was quickly destroyed after his departure (Meschy 1989).

The conversion of the valleys from pasture to crops was slow, especially in Gikongoro and other areas little visited by colonial administrators. The hectares of drained valleys did increase in Rwanda and Burundi, however, from 75,000 in 1948 to 88,118 in 1952 (Ministère des Colonies 1954). In this process, the valleys earned a special tenure status that has remained in effect and influenced current farmers' access to valley land. During the colonial period, the planting of crops in valleys was considered "obligated" and the farmers were given no rights by the Tutsi chiefs to continue to use that land once the colonial administrators departed or stopped their supervision (Meschy 1989). Whereas cropped land on hillsides is treated as private property of the cultivator, access to most valley land continues to be administered by the authorities. The land is distributed amongst individual farmers by the communal governmental authorities depending, frequently, upon the farmer's current relationship with the authorities.

Other laws the colonial administrators enacted were not to benefit the farmers or to prevent famines but to produce revenue. The administrators enforced the planting of "industrial" or export crops that placed additional pressure on the expansion of the cropping area. Coffee, in particular, was thought to have great promise by the administrators. After an unsuccessful voluntary program, the

administrators enforced numerous directives concerning coffee bush planting and cultivation in 1933 (Everaerts 1939b). The coffee plants were to be transplanted a certain distance apart in the fertile soils of the banana fields near the *urugo*. They also were to be mulched. By 1938, 22 *million* coffee bushes had been planted (Everaerts 1939b). This enormous effort to place land under coffee, and to enforce detailed rules concerning its cultivation, remained in place the whole of the colonial era and was then maintained and expanded after independence (including details of distance between plants and use of mulch).

4. Planting Trees

The planting of a large number of trees on the "prairie land that is Rwanda" was another new land and labor use enforced by colonial administrators. The lack of wood for constructing colonial and mission buildings and their need for fuelwood was the initial reason for the administrators' interest, but other reasons included the Rwandans use of cattle droppings for fuel and the irregularity of rainfall (Everaerts 1939a). The administrators conducted early research on tree species (the oldest arboretum in Africa is located in Butare) and found that Eucalyptus grew rapidly and well.[1] It, along with Acacia decurrens (black wattle) and Grevillea robusta, were planted in large quantities along roadsides and in government woodlots with enforced communal labor, *umuganda*. A law was enacted in 1931 that every group of 300 taxpayers (adults) was forced to plant ("reafforest") one hectare of trees on their hill (Renier 1951). These form the *boisement communals* (communal government woodlots) of today (Photo 6). By 1939, 22,000 hectares had been planted (Everaerts

[1]Eucalyptus trees were an unfortunate choice for soil conservation due to the allelopathic effect of their roots and leaves. Little vegetation grows underneath the trees so the ground remains bare and crops growing near the trees do poorly.

1939b). Eucalyptus (from Australia) was the most common species planted, followed by cypress and Grevillea.

Policies to reduce the numbers of people on the land were also instituted, including encouraging labor migration and permanent emigration to surrounding regions of Zaire, Tanzania and Uganda. Annual labor migrations to harvest cotton in Uganda, for example, were promoted by the Belgian administration. Permanent migration was encouraged to Katanga (by the *Union Minière*) and to Kivu, Zaire (Tondeur 1948, Harroy 1984). The administration also established *paysannats*, settlement schemes, in uninhabited high-elevation forest or eastern marsh and prairie lands. *Paysannats* were founded to produce export crops of coffee, tea, pythrethum, peanuts and cotton (Gotanègre et al. 1974).

5. The Result: War on Erosion

Nevertheless, population densities continued to be high in the origin areas. The imposition of enforced planting of food crops and coffee also greatly enlarged the land under cultivation. Some pastures were cleared. The Tutsi still had control over the land, however, and did not allow the Hutu to expand cropping onto large expanses of pasture. A more common means of expanding cultivation, therefore, was to reduce fallows in time and space and to cultivate hill fields twice a year, exposing the bare soil to the rains for a longer period. As the agronomist Lens (1949) wrote, the initial result was an abundance of food production, but soon yields declined and the soil became barren. The problem of soil erosion became manifest.

The Belgian Ministry of Colonies increasingly became concerned about soil erosion. More laws were enacted in the 1950s to impose anti-erosion measures "for really attacking the evil at its root and preventing the degradation of the soil by substituting destructive methods of cultivation" (Anonymous 1952). A major study was conducted by a Belgian colonial officer in nearby Kivu, Zaire in 1941 that documented the effect of the widespread forest clearance on soil properties and on erosion (Thomas 1941). Labiau, the Principal Territorial Agent for Rwanda in Butare, and Lens, the agronomist in Ruhengeri, conducted experiments to determine the best method to fight erosion: planting trees and grasslines (but farmers usually left them to die), leaving bands of pasture between the cropped fields (but it was difficult to keep the cattle from roaming the nearby fields), or finally their preferred method, digging progressive terraces (Lens 1949, Dubois 1954).

Fighting erosion became the approved discourse for Tutsi chiefs. One had an article published in a colonial journal on how he would fight erosion by insisting people plant along contours; an indication, as the accompanying text indicated, that he was a "good servant of the Government and example of an elegant Tutsi." The chief also pointed out, however, the importance of cattle as the principal wealth of Rwandan agriculture and farmers' preference to cultivate small rather than large expanses of land (Banakwerie 1946). The colonial governor of Rwanda and Burundi, Petillon (p. 35, 1951), urged the Tutsi chiefs to collaborate with the administrators to fight erosion to "prevent your country from becoming an awful desert, as has happened in so many other countries, where fertile soil turned into sterile sand, where men, villages, entire populations disappeared, chased by drought, by hunger, by death."

Jean-Paul Harroy, who had written his doctoral dissertation on the negative impact of colonialism on soil degradation in Africa (*L'Afrique: Terre Qui Meure* in 1944), became the Resident Governor of Rwanda and Burundi in 1955. One of his major goals was to continue the battle to stop erosion which he saw as a premier problem facing the country. His concern was echoed by Gourou, a respected French geographer, who sounded warnings of escalating over-grazing and over-cultivation leading to erosion and soil depletion (Gourou 1953).

Indeed, new clearances and additional pressures were being placed on the land. Between 1920 and 1950, the human population doubled due to improved health measures and increased food production. A vicious circle began of poverty and erosion (Harroy 1954). Fields were placed on steep slopes, fallow was reduced and fields were cultivated continually (Languy 1954, Ministère des Colonies 1954). During the same period, the cattle population increased by tenfold due to veterinary services. Large troops of cattle continually walked over the steep slopes of hills to get to the drinking water in the valleys, and the pastures were severely overstocked (Languy 1954). The "too deep attachment" of both the Hutu and Tutsi to their cattle, animals that contributed little food to people, was a nightmare for the authorities who attempted unsuccessfully to reduce the numbers of cattle in the country (Harroy 1954). Instead, a major effort was made to stop the burning of grasslands and to enforce erosion control measures on cropped lands (Harroy 1954).

Thus in 1949 began the large program by the colonial authorities to battle the dramatic increase in erosion, caused in great part by processes they had set in motion,

while ignoring and devaluing the method farmers had used for generations to maintain soil fertility, the spreading of cattle manure.

Land use policies reflecting the colonial administrators' understanding of tropical soils were put into effect throughout Rwanda (An. 1952, Languy 1954, Uwizeyimana 1991):

1. Burning of pasture and of fallow fields was outlawed by penalty of fines and imprisonment.

2. Erosion ditches, planted on the upper banks with Pennisetum purpereum grass strips and trees, were installed with *umuganda* (*corvée*, or forced communal labor). "Blind" erosion ditches, not continual, were preferred to prevent ruptures and gulleying.

3. Eucalyptus and other exotic tree species were planted with *umuganda* on steep slopes and on the summits of hills to reduce erosion, as well as along roads and in governmental woodlots.

Implementation of the program began slowly around Astrida, Butare and in Ruhengeri, but in the 1950s planting trees and digging erosion ditches became a widespread program that changed the landscape. The kilometers of erosion ditches dug and planted with grass strips or trees in Rwanda and Burundi increased from 140,000 in 1948 to 170,000 in 1952 (Ministère des Colonies 1954). By 1960, 439,000 kilometers erosion ditches existed (Musema-Uwimana 1979). It was estimated that by 1960, 45 percent of all cropped land and 8 percent of all pasture land were protected against erosion (Nyrop et al. 1969). This was accomplished at the cost of an enormous amount of labor. Leurquin (1963) estimated that, assuming each person dug 10 meters of ditch per day, 55 million work days were required to construct the

ditches. Additional work days were necessary to plant the grass lines and maintain the ditches.

This campaign was accomplished by a massive mobilization of the population, a mobilization that had large repercussions that rapidly altered the basic structure of the society. The mechanism of the mobilization was *umuganda*, or communal labor. The word *umuganda* initially denoted a communal effort to help one's neighbors, especially elderly people or those in special need (e.g., to replace the roof of an elderly widow). In return, one was expected to help out when others were needy. Those who were helped offered beer afterwards as thanks. The colonial administrators borrowed this term for the labor they demanded of people (i.e., farmers, men and women, old and young) to build roads and bridges, to plant trees and, especially, to dig erosion ditches "in their own interest." The labor was, however, unpaid, forced and the farmers were given no respect or thanks afterwards (Barabwiliza 1983). The agricultural problem seen by the administrators, erosion, was treated as a technical problem that the farmers would not understand, and the farmers became simply the recipients of the implementation of a law. The ditches were dug by the farmers under the supervision of an extension agronomist without any explanation given to the farmers (that they remember) of the reasons behind the tremendous effort. Farmers say the most common means used to enforce the digging of erosion ditches was the whip. Harroy, years later, writes that he never pressured Tutsi chiefs or the administrator's technicians to increase the number of kilometers of erosion ditches on their hills. The message Hutu often received was different:

> *"C'est désagréable cette obligation de L.A.E., mais ce n'est pas nous les Tutsi qui la voulons. C'est le Blanc qui te punira si tu ne fais pas ce qu'il dit..."* (p. 150, Harroy 1984)

> This Battle Against Erosion is a disagreeable obligation, but it is not us the Tutsi who wish it. It is the Whiteman who will punish you if you don't do as he says...

In terms of kilometers of erosion ditches dug, the success of the program was enormous. The cost to the Belgian administration in terms of deep and widespread resentment was large. The farmers considered *umuganda* exploitation and an injustice. The result was that erosion ditches were often destroyed as soon as the supervising administrator departed (Barabwiliza 1983). When the farmers were organized in the late 1950's to revolt against the administration, erosion control with *umuganda* was one of their principal complaints. In 1959, a newly formed anti-Tutsi and anti-Belgian political party promised, "As soon as we have chased out the Belgians with the help of the United Nations, this odious slavery of the Battle Against Erosion will be forgotten. Support us!" (Harroy 1984).

D. The Revolution

The resentment by the Hutu towards all authorities, Tutsi and Belgian, developed into a violent revolution starting in 1959 against the monarchy and Tutsi hegemony. A few chosen Hutu had been educated by Catholic missionaries and became the voice of the widespread Hutu rebellion. They eventually became the leaders of new political parties and of the independent government. When it became clear which direction the revolution was heading, Belgium switched sides and attempted to remove itself from the fray (Lemarchand 1970). Meanwhile many Tutsi, and many of their cattle, were killed. Approximately 150,000 Tutsi fled the country to become refugees in Uganda, Burundi, Zaire, Tanzania, and other countries (Watson 1991). The refugees periodically attempted to re-enter Rwanda militarily in

the 1960s, initially to regain power but later to regain citizenship rights.[2] After each attack, the Tutsi within the country suffered reprisals with thousands killed.

The revolution culminated in 1962 when the United Nations oversaw an election and an elected Hutu government was put into place. The overturn of power was termed the "social" revolution since it arose from and overthrew the social inequities of the old system (Lemarchand 1970). The capital was moved from Butare, the site of the Tutsi court and the Belgian colonial capital, to Kigali in the center of the country (Gotanègre et al 1974). This move was symbolic of a shift of power from the ancient heart of the cattle-centered society towards a new frontier for farmers created by the destruction of the old regime. The success of the revolution was a jolt to the old agricultural system. No longer would it revolve around cattle and their needs for pasture. The new force was comprised of cultivators whose demand was for cropping land.

E. Independence 1962: The Importance of Crops

The elected president, President Grégoire Kayibanda, was a Hutu from Gitarama in the center of the country. He halted the most hated of the Tutsi and Belgian laws such as restrictions on where farmers could clear land and settle. The pent-up demand for cropping land was released as land previously reserved for pasture became available to farmers. Two immediate impacts of the revolution were 1) reserved pasture land locally in the west and the entire east of Rwanda was opened to farmers for settlement, and 2) colonial policies towards agriculture were

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[2]The attackers were called the *inyenzi*, the cockroaches, the term applied 25 years later to the RPF.

reconsidered by the new independent government. These political events, as well as demographic and economic changes, led to a major shift in the relative proportion of land devoted to crops, trees and animals. The interactions between changes in policy, economic transformations and population growth and redistribution had important implications for the viability of the land use system in Gikongoro.

One immediate consequence of the revolution was a wave of migration from the densely-populated Western Highlands to the savanna lands of the east (Kigali, Byumba and Kibungo) by farmers encouraged by governmental promises of free land in *paysannats*, settlement schemes. Gikongoro had the highest out-migration rate of any prefecture as young farmers left the prefecture to seek their fortunes. The East was transformed from a savanna, maintained as pasture for the king's cattle, to become a region of relatively wealthy, large commercial farms (Prioul and Sirven 1984, Cambrezy 1984, Olson 1990). Between 1969 and 1979, the total area of Rwanda that was under crops increased from 674,000 to 941,000 hectares (Musema-Uwimana 1983). In Gikongoro and other areas of the southcenter, valleys, parts of hills and entire communes that had been in pasture were slowly converted to crops. This process of extensification was a major contributor to rising food production that paralleled increases in population in Rwanda during the 1960s and 1970s (Uwizeyimana 1991).

The government installed a hierarchical administrative system very similar to that of the pre-independent administration. Slowly, some of the same rules were reintroduced, including *umuganda* for building roads and constructing school and local administration buildings (Guichaoua 1991). The local administrators were

hesitant, however, to press the farmers too hard. They were especially reluctant to ask farmers to work on erosion control projects despite direct orders of Gahamanyi, the Minister of Agriculture. Gahamanyi repeated colonial assertions of the disaster of erosion and declared that without coercive measures to battle erosion the population was heading straight towards a famine. The problem was again seen as technical that could be solved by an engineer with physical structures (Derenne 1989). Nonetheless, local administrators were cautious.

Meanwhile, many of the same discriminatory practices from pre-independence were put into place, but against Tutsi (Lemarchand 1970, Africa Watch 1993). Placements in higher education and in the government, for example, were proportioned with ethnic quotas to decrease perceived Tutsi over-representation. Also maintained from the colonial period was a system of identity cards imprinted with the person's ethnicity.

President Kayibanda was deposed in a military coup d'etat in 1973 and Major General Juvenal Habyarimana, a Hutu from the northwest, took power. He came into power during a period of ethnic instability by promising his supporters from the northwest to deal with the problem effectively. Initially he promoted restoration of national unity, reestablishment of order, and especially, development (Newbury 1992). President Habyarimana slowly consolidated his power. The country was stable politically and progressing economically. Ethnic violence became rare and there was little differentiation economically between Hutu and Tutsi, who were now universally farmers.

President Habyarimana adopted a very militaristic approach to ruling. *Umuganda* activities (now termed "communal labor for development") were insisted upon. The president waxed eloquent on the importance of *umuganda* and insisted that everyone, even government bureaucrats, must participate to develop the country:

> *"La philosophie de l'Umuganda... . C'est la politique de compter sur soi-même. Personne d'autre ne peut venir vous aider à vivre vous-même. Mais les moyens étant limités, on pourra toujours recourir à l'extérieur, à l'aide des amis, des voisins. Voilà la politique de l'Umuganda: compter sur nos propres efforts."* President Habyarimana, February 27, 1982 (cited in Barabwiliza 1983).
>
> The philosophy of umuganda... . It is the practice of depending upon oneself. No one else can help you to live. But in times of need, you can always ask others, for help from friends, from neighbors. That is the practice of umuganda: to count upon our own efforts.

The president led by example, inaugurating the new *Umuganda* program at a large valley development scheme and then visiting work sites periodically. The year 1977 was declared "The Year of *Umuganda.*" Everyone, even high bureaucrats, were ordered to participate one day per week (Wednesday afternoons and Saturday mornings for bureaucrats, all day Wednesday for farmers). The bureaucrats were usually transported in a government truck out of Kigali to work with a shovel, clearing canals along roads or digging drainage canals in a valley, for example. *Umuganda* was often accompanied by *"animation,"* propaganda for the ruling party. Bureaucrats were initially unenthusiastic (Barabwiliza 1983) but the message was later understood that promotions were at risk if they didn't participate. Farmers were put to work on a large nationwide construction campaign to build schools, health centers and other communal government buildings (Guichaoua 1991).

This heightened level of activity was indicative of the government's plans to raise literacy rates, reduce infant mortality and improve the road network. The country was stable and seemed to be progressing economically. Ethnic violence became rare (Newbury 1992). Between the 1978 and the 1991 censuses, life expectancy rose and death rates declined (MINIPLAN 1992). Rwanda became the recipient of much donor attention; by 1990, much of the government's budget was met by donor assistance (World Bank 1993a).

In the early 1980s President Habyarimana began to funnel government investment almost exclusively to his home region, the Northwest, which had always considered itself different from the rest of Rwanda (Newbury 1992). New paved roads, new schools, a university campus, agricultural research stations, etc., were placed in Ruhengeri and Gisenyi Prefectures while the rest of the country received little. Even the educational system was skewed with children from the Northwest needing a test score of only 50 to be admitted into secondary school instead of the usual 80 or 90 for children from the rest of the country. Administrators throughout the country were disproportionately northwesterners. Some of the local burgomasters were poorly educated and/or brutal. The result was a build up of resentment in the rest of the country towards President Habyarimana and his supporters.

The narrowing of government attention to the Northwest occurred while the economic situation of the country worsened. During the 1980's, most farmers, who made up 93 percent of the population, began to experience a situation of increasing pressure on resources made manifest by declining levels of income due to a

combination of local, national and international factors. Farmers of the South Center were particularly affected by the changes.

F. Conclusion

This chapter has presented an historical overview of the agricultural system of Rwanda from the point of view of impacts of the political, economic and cultural system on land use. The schematic of traditional Rwandan agriculture was described, a system developed out of hundreds of years of a tightly bound cultural/political system of the Hutu and Tutsi that placed much value on cattle. Soil fertility was maintained through this cultural/political system, with a transfer of nutrients from grasslands to crop land. With the arrival of the colonialists came new mandates on land use, especially to increase land under crops and to dig erosion ditches. Simultaneously, the Tutsi were favored. The build up of resentments led to the revolution of 1959 to 1962 in which all restrictions on preserving land under pasture were removed. Nevertheless, the independent government retained the restrictive, authoritative approach of the pre-independent systems (Belgian and Tutsi).

Photo 1 A farmer milking his cow. Maraba Commune (photo by C. den Biggelaar).

Photo 2 Banana and other plants in the *urutoki* field (photo taken during the long dry season). Maraba Commune (photo by C. den Biggelaar).

Photo 3 Remnant of *ishinge* (Eragrostis) pasture being prepared for cultivation, Mudasomwa Commune (photo by author).

Photo 4 Valley intensely cultivated by private farmers, Karama Commune (photo by C. den Biggelaar).

Photo 5 Sweet potato plots in a valley development program, Kinyamakara Commune (photo by author).

Photo 6 Coffee field well mulched with Grevillea robusta leaves and Pennisetum purpureum (elephant grass) following government mandate, Maraba Commune (photo by C. den Biggelaar).

CHAPTER V

CONTEMPORARY PRESSURES ON THE PRODUCTION SYSTEM

A. Introduction

This chapter examines the meso-scale factors that directly affected farmers' land use and soil management techniques. These meso-scale factor originate from the historical processes examined in the previous chapter, but new pressures including population increases and economic decline altered the wider system, and altered the farmers' use of the land at the level of the field. Figure 7 illustrates some of the proximate factors behind the increasing pressure on local land resources. These proximate factors visible at the local level are tied to the wider national and international political-economic system (Blaikie and Brookfield 1987; Campbell and Olson 1991).

B. Population Pressure

Rapid population growth is the factor most commonly mentioned by authors as the cause of pressure on resources as increasing numbers of people cultivate a limited amount of land. This has been an important factor in Rwanda which at its peak period of growth in the late 1970s experienced a growth rate of around 3.7 percent, a doubling of the population every 19 years (MINIPLAN 1982).

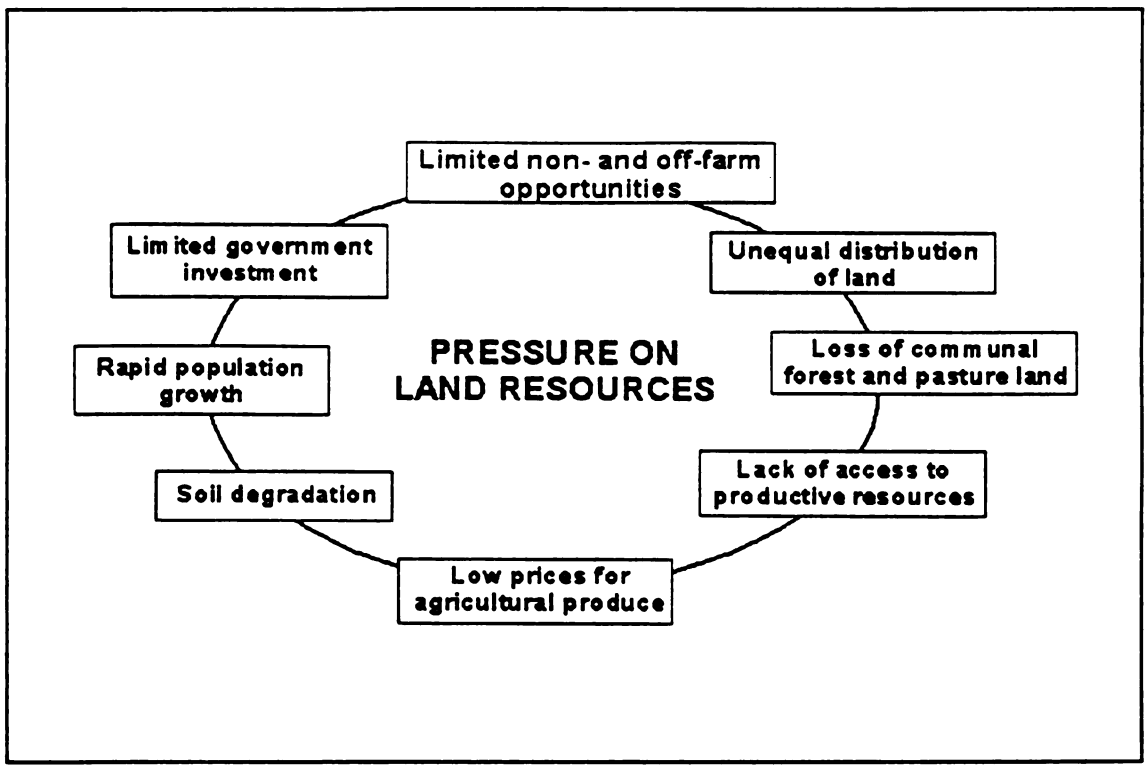

Figure 7 Proximate causes of production pressure on constrained land resources

Rising rural population densities have been important factors in the southwest of Rwanda (Figure 8). The population started to grow rapidly after World War II with the introduction of new crops, a decline in diseases due to improved medical care and hygiene, and the abandonment of traditional forms of child spacing with the conversion to Catholicism[1] (ONAPO 1990). Population densities in Rwanda rose from 77 in 1948 to 150 in 1970 and finally to 277 in 1991 (Prioul and Sirven 1984; Min. du Plan [MINIPLAN] 1982, 1992). The rise in population densities has resulted in

[1] Traditional birth spacing techniques that have declined in practice include prolonged breast feeding and abortion (using medicinal plants) (ONAPO 1990, Barrère 1994).

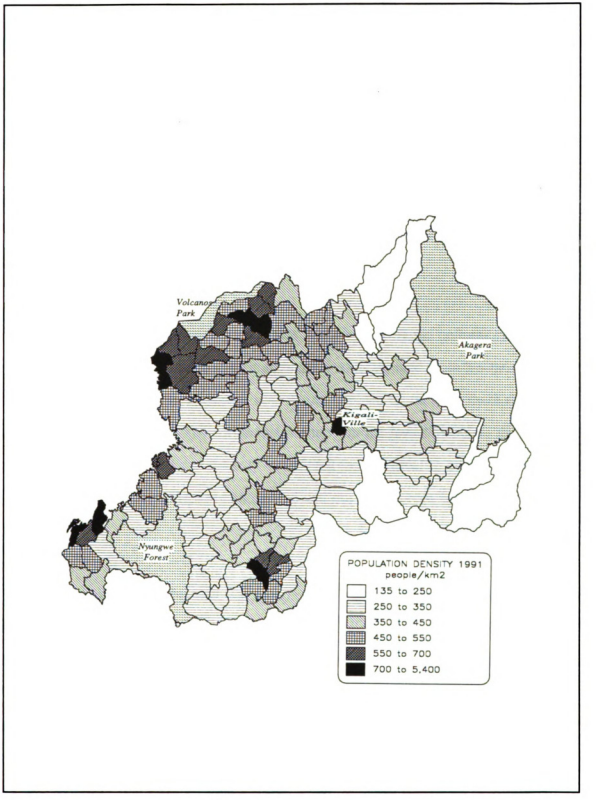

Figure 8 Population density 1991 by commune (data source: MINIPLAN 1992)

an expansion of land under cultivation because farming has remained the primary means of livelihood for rural people due to the slow development of the nonagricultural sector. Substantial short-distance movement occurred as nearby pasture, valley and forest land was converted to crops. Traditionally, extended families placed their *urugo* along the upper slopes of hills and cultivated the land on the hilltops and the upper slopes of the hills, while the steeper bottom slopes of the hillsides and the valleys were used as communal pasture.

The impact of population growth was compounded by the cultural system which provided for each son to inherit an equal amount of land from his father. After the revolution in 1959, the numerous new young families found their share of inherited land insufficient. The communal pastures on the lower hillsides, then the valleys and finally the areas previously considered too marginal to cultivate because of steep slopes or poor soils were all cleared and put under crops by the new generation.

In regions where the land was completely claimed, generations that followed experienced a shrinking of farm sizes. This shrinking of farm sizes combined with loss of communal land resources has led to a Boserupian intensification of land use. Techniques requiring a higher labor input that increase the yield of the land have been adopted. Fallows have been reduced in all fields. Where once fields were fallowed an entire year or more, they are now fallowed for only a cropping season ("*petite jachère*"). Entire fields are no longer placed under fallow but parts of fields are

fallowed independently and infrequently. Hill fields are cultivated during both rainy seasons, and valley fields continuously when they are not flooded. The crop mixture has changed with an increasing proportion of the land devoted to crops with high caloric production per hectare. The increase in proportion of land devoted to sweet potatoes and the reduction of land in sorghum may best illustrates this trend (Coordination des Services Agricoles Gikongoro (CSAG) 1991). Labor intensive management techniques were adopted, such as hoeing twice before planting (also made necessary when burning was outlawed) and constant weeding.

The shrinking of farm sizes has been the experience in Butare, especially, where rural population densities are between 400 and 600 people per square kilometer. In Gikongoro, the population densities were not as high. At the time of the revolution, Gikongoro had much more communal pasture land and forest land available to be cleared. Indeed, old pasture land existing along the Nyungwe Forest boundary in Nshili, Kivu and Mudasomwa is the last remnant of the agricultural "frontier." Each new generation in Gikongoro is discovering, however, the extreme shortage of land resources necessary to support a family.

> *"Le problème de la démographie galopante aurait-il un impact ici? Si oui, comment?"*
> *"L'impact est même très considérable. Les gens doivent se partager les terres. Imaginer le cas de trois fils et des petits fils qui doivent se partager une parcelle! Je vais vous donner un témoignage: Moi par exemple, il y a très peu d'années j'avais vraiment grossi. Je buvais du lait et mangeait très bien. Mon fils était alors en Tanzanie. Mais voyez, lorsqu'il est revenue il avait une femme et trois enfants. Je ne prend plus du lait et le repas n'est plus satisfaisant. Que voulez-vous! J'achetais dix kilos d'haricots, un kilo d'huile, on les mangeait pendant tout un mois. Aujourd'hui je n'achète plus d'huile faute d'argent! La démographie a une très grande influence."* Group meeting, Musange.

"Has the problem of rapid population growth had an impact here? If yes, how?"
"The impact has been considerable. People are forced to divide up their land. Just imagine a situation of three sons and grandsons who must all share one field! I will give you a report: me, for example, a few years ago I had really gotten fat. My son was then in Tanzania. But once he returned [many Rwandan migrants were expelled from Tanzania] he had a wife and three children. I don't drink any more milk and the meals are no longer satisfying. What do you want! I used to buy 10 kilos of beans, a kilo of oil, we would eat from them for a month. Today I don't buy any oil because I have no money! Demography has had a very large influence."

The impact of small farm sizes on households is discussed further in Section D. 1. below. Other factors in combination with rapid population growth have had a profound effect aggravating the *in situ* production pressure on constrained resources. These other factors have been political, socio-cultural, economic and environmental in nature.

C. Loss of Communal Lands

1. Loss of Communal Pasture Land

Before the revolution, much land was reserved by the Tutsi political authorities as pasture to support their large cattle herds. The lower hillsides and the valleys were commonly reserved as pasture. In some regions entire hills or what are now communes (e.g., Musange in Gikongoro) were covered with grass. Almost all of the eastern half of Rwanda, drier and less mountainous, was reserved as a special pasture for the king's cattle (Prioul and Sirven 1984). Pasture was considered communal property (belonging to the cattle if anyone, not people), although the land chiefs would regulate where people could graze the animals they guarded especially in periods of stress (Maquet 1957).

After the revolution, this communal pasture land was opened by the new government for private claim, was settled by farmers and much of it was converted to crops (see results of aerial photography interpretation Section G). A comparison of Lorenz Curves (an indication of the distribution of land) for 1948 and 1978 show that the land became much more evenly distributed and the concentration of the population sharply declined (Nzisabira 1989). Some farmers planted trees on pasture as a means of claiming the land. Today, this loss of pasture land is felt keenly, and blame is placed on the government for its apparent animosity against cattle and for having allowed the loss of pasture land to occur:

> *"L'état nous a ordonné d'élever une seule vache et de conduire les autres à l'abattoir. Bien sûr que l'état ne nous a pas obligé à vendre nos vaches, mais il a laissé les gens cultiver les réserves destinées aux pâturages, ce qui a justement provoqué la diminution de ces derniers.."* Group meeting, Kinyamakara.

> "The government ordered us to raise a single cow and to bring the others to the slaughter house. Of course the government didn't oblige us to sell our cows, but it allowed people to cultivate the land reserved for pasture, which was precisely what provoked the decline in the number of cows...."

The loss of communal pasture land in the valleys is of particular regret because the valleys had produced grass used for multiple purposes: roofing materials, baskets, rope, etc., and vegetative matter to incorporate into valley soils as green manure. The valleys had also been where the herders brought the animals to drink and was the source of pasture in the dry season.

> *"Avant que les vallées sont devenues complètement cultivées, nous allions là-bas pour chercher les herbes appelés urukangaga qui servaient comme litière. Disons un pauvre avait 5 vaches et un riche supérieur ou autour 16 vaches. Alors, les vaches piétinaient cette litière avec la bouse et après l'ensemble était amené dans les champs. Et puis le sorgho, le haricot, produisaient bien. Après 1960, quand les animaux*

sont diminués, c'est à ce moment que le fumier a manqué." Group meeting Rwamiko.

"Before the valleys were completely cultivated, we would go there to gather a grass called urukangaga [Rhynchospora corymbosa] used for litter. A poor man would have 5 cows and a rich superior [i.e. a rich Tutsi] around 16 cows. Then, the cows would tramp on the litter with the manure and afterwards it would all be brought to the fields. Then the sorghum, the beans would produce well. After 1960 [the revolution], when the number of animals declined, was when the shortage of manure occurred."

The gain in the productive valley land for agriculture, however, was very important. The development of valleys was part of the national governmental plan, and often a program of the agricultural service of the local or prefectoral government. The design of the drainage system, coordination of the digging of drainage ditches (with *umuganda*) and, finally, the partition of the valley land between people was done by the authorities. The tenure system of valley land was in flux, and even if farmers had already been cultivating it, rights to the land remained under the control of the government and the farmers were frequently expelled from the land (Meschy 1989). In Gikongoro, associations were created for those who would benefit from the *mise en valeur* program of the agricultural service, and membership in the associations depended upon a farmer's relationship (or bribing ability) with the local authorities. This was recognized by the Gikongoro agricultural development program. Their new *mise en valeur* plan called for that practice to end because the program was having a difficult time convincing people to invest their labor in the effort required to dig the drainage system when they had no security of usufruct rights (Projet de Développement Agricole de Gikongoro (PDAG) 1991; Heurtas 1991). Nevertheless, access to much of the valley land was, like pasture land, seemingly subject to authorities' whim.

"Il y a longtemps qu'ils sont devenus des propriétés de l'état. Nous sommes obligés de louer une petite parcelle à trois ou quatre cents. Et puis, il faut des engrais pour que les choux puissent bien pousser. En somme se sont des gens moyennement riches qui peuvent planter des choux. Quant à nous, les pauvres, nous travaillons dans les champs de ces riches. On nous donne 80 francs comme récompense de toute la journée; un kilo haricots coûte 50 francs. Que voulez-vous qu'on fasse d'autre?" Group meeting, Kinyamakara.

"It was a long time ago when they [the valleys] became government property. We are obligated to rent a small plot for 300 or 400 francs. Plus, you need chemical fertilizers for the cabbage to grow well. In sum, it is the people who are medium rich that can plant cabbage. For us poor people, we work in the fields of the rich. They give us 80 francs as payment, a kilo of beans costs 50 francs. What would you have us to do otherwise?"

2. Governmental Appropriation of Communal Lands

The communal pasture land was not lost solely to private farmers' crops. The larger expanses of grass, in particular, were appropriated by local governments for themselves. These were used initially as pasture for animals of the new governmental authorities (a simple continuation of pre-independence practices) and later planted with trees to become communal woodlots (see conversion in aerial photography interpretation section). The communal woodlots are important sources of income for local governments because they sell the standing trees to commercial charcoal makers or sawyers for much money.

Large expanses of pasture were also appropriated by the national government, especially in Gikongoro. Parastatal tea plantations, jointly owned by the national Rwandan government and private European companies, were placed in high altitude regions in and near Gikongoro (Nshili/Kivu, Mata in Rwamiko, Kitabi in

Mudasomwa, and Gisovu in Muko and Musebeya) (Mulindabigwi 1990). A farmer remarked:

> *"Les pâturages sont devenus rares: tu vois, on a cultivé du thé dans les marais; ailleurs sur les collines on a la patate douce, donc plus de jachère. Les animaux n'ont nulle part où se paître. Aujourd'hui, tous les champs sont couverts d'arbres. Où peut-on trouver du pâturage? Regardez par exemple cette vache. Elle a passé la journée sur une même place, demain elle sera encore là. Va-t-elle donner vraiment du fumier?"* Group meeting, Nyamagabe Gasaka, men.
>
> "The pasture lands have become rare. You see, they grow tea in the valley, elsewhere on the hills are sweet potatoes, no more fallow. The animals have no where to graze. Today, all the fields are covered with trees. Where can you find pasture? Look at that cow for example. She spent the day in the same spot, tomorrow she'll be there again. Will she really give manure?"

Meanwhile, farmers gain little from the presence of the tea plantation. The income earned by youths picking tea leaves on the Mata tea plantation is extremely low, between 700 and 1000 Rwandan francs per month ($5 to $7/month[2]). Adult men earn the minimum wage of 100 francs per day ($0.70/day) for their work (Group meeting, Rwamiko). Research conducted among households near a tea plantation in the northwestern Rwanda concluded that on-farm tea production is less profitable than food crop production and that households with a member working on the plantation have actually less food to eat than other households (Laure 1986; von Braun et al. 1991).

The national government also appropriated a very large, by Rwandan standards, amount of land that had been under communal pasture and some private

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[2] The exchange rate used throughout this paper is 140 Rwandan francs for 1 U.S. dollar, the official rate for much of 1992. The black market exchange rate usually was 25 to 50 percent higher.

farms and fields when it implemented the Nyungwe Forest Development Plan in the mid-1980s. Economic development/forest preservation projects were designed, financed and implemented by the Rwandan national government and by donor agencies. Land was appropriated that had been used by local farmers for seasonal pasture, fuelwood and/or crop production. The tea plantations and development projects, however, were intended to generate foreign exchange for the national government, either directly through foreign assistance or indirectly through an increase in tourism.

Gikongoro farmers are extremely bitter at the *Projet de Développement Rural de la Zone Centrale de la Crête Zaïre-Nil* (CZN), which covers the area on the northwestern edge of the Nyungwe Forest. The project appropriated what they considered their land without recompense (actually, some farm families were relocated but to extremely marginal land) and then saw jobs and other benefits of the project go to people from outside the area. In answer to a question put to them concerning whether they gain employment in the project, they replied:

> *"On commence du premier au dernier sans être reçu. C'est de là que nous venons! On nous a répondu négativement. Et d'ailleurs, nous n'avons qu'un seul projet, celui du FED dont le personnel se compte dans les dizaines. On y trouve pas de travail sans qu'on ait donné des pots de vin. Il y a toute une semaine que nous nous rendons là-bas."*
> Group meeting Muko.

> "We are the last to be accepted. We are just coming from there! They responded [to our request for work] with a no.' Anyway, we have only one project, that of the EEC, which employs tens of people. No one gets a job with them without giving a bribe. We have been going there now for an entire week."

The CZN, financed by the development branch of the European Development Fund, was designed to be economically profitable through the development of a high-

technology, commercial ranch. It was started in 1982 as a pioneer in Rwanda in the practice of sylvopastoralism, an extensive system to raise animals in a pasture under scattered trees planted for timber production. This system was thought to be one of the few profitable enterprises possible in the high-altitude, acidic soils around Nyungwe Forest. The project planted Grevillea, Calliandra and Leucaena nitrogen-fixing tree species on the grassland (Projet Crête Zaïre-Nil (CZN) 1991).

Selected farmers/pastoralists were invited to sign a contract to allow them to graze their animals on the 850 hectares of improved pasture that was planted on former "forest or fern lands" (Gatali interview). Project administrators complained of nonselected farmers grazing their animals "illegally" on the improved pasture land and local farmers complained that the farmers who were selected were the rich from Kigali. In another aspect of the project, imported brown Swiss cattle, requiring special pasture grasses, supplemental grains and intense veterinary services, were placed on 1,650 hectares of newly planted, improved grasslands (Gatali interview). The CZN project also planted a green belt around Nyungwe Forest Reserve of exotic tree species (pines, cypress and eucalyptus) for wood production and to reduce encroachment by farmers into Nyungwe Forest.

The CZN green belt in northwest Gikongoro is part of a band of planted exotic trees that extends completely around Nyungwe Forest. The other projects within Gikongoro include the *Projet de Développement Agricole Nshili-Kivu* (DANK) in the southwest financed by the German government and the *Projet d'Animation Rurale Mudasomwa* in the center funded by the Belgian government. These two projects seem to have not gained the same degree of animosity as the CZN, perhaps because

they engaged farmers in economic activities that helped to offset the loss of the land; the projects did reduce farmer access to the forest by this appropriation of land. The greenbelt seems to have successfully created a physical and proprietorship barrier preventing local farmers from growing crops and collecting fuelwood in the forest. Unfortunately, the CZN project did not provide a substitute source of fuelwood or other compensation to the farmers, as will be seen later in a section discussing changing fuelwood availability. The planted trees in the greenbelt were clearly governmental or project property that local farmers could not harvest. The Muko farmers were clear in expressing the impact of the loss of their land and their pessimism toward the future. In fact, many had hoped the land around the forest, and indeed in the forest itself, would provide a resource for their children.

> *"Ces espaces occupés par les forêts nous donnaient jadis beaucoup d'espoir. Maintenant, il est défendu d'y mettre le pied. On y récoltait beaucoup d'haricots, de petits pois, d'éleusine, de maïs et de pommes de terre. On y voit que les iminigi. Nos enfants meurent chaque jour de malnutrition."* Group meeting, Muko.

> "The space occupied by the forest had in the past given us much hope. Now, it is forbidden to put your foot there. We had harvested many beans, peas, eleusine [Eleusine coracana], maize and white potatoes there. Now we only see iminigi [planted project pasture, Pennisetum clandestinum]. Our children die everyday of malnutrition."

The almost complete conversion of the formerly widespread pasture land to other uses has resulted, therefore, in a loss deeply felt by the farmers. The small pieces of pasture land remaining in the communes are in private hands and clearly understood to be private. Renting pasture land costs up to 1,000 Rwandan francs ($7) per month. Transhumance (bringing the animals to the forest edge during the dry season) is a declining practice due to the difficulties of finding pasture and the cost of paying a herder (400 to 500 Rwandan francs, or $3 to $4, per month plus food). The

loss of communal pasture has had an enormous impact on the ability of farmers to raise animals, especially cattle, and they attribute their soil degradation directly to this loss of manure. The only sources of pasture remaining are grasses growing under trees in private or communal woodlots and the grass lines planted along erosion ditches (that needed to be cut and brought to the animals).

Although farmers themselves gained a large acreage of cropping land in the conversion of pasture, they are very bitter about the land that was taken from them, they felt, by the authorities. Some hills were appropriated by the local government, planted with trees by the farmers in the *umuganda* program and then used as a source of cash for the local governments. Access to highly valued valley land also could be difficult and again depended upon the authorities. Finally, the national government and parastatal projects have more recently taken a swath of land along the Nyungwe Forest edge to implement income-generating programs and to plant a green belt that is designed to restrict farmer access to the forest. Any loss of land placed more pressure on the increasingly scarce resources. People living along the forest edge in particular felt the appropriation of land very acutely.

> *"Peut-on dire que vous manquez de terre à cause de la population qui a augmenté?"*
> *"Ce n'est pas cela. C'est plutôt l'étendue des terres qui a diminué. On a boisé tous les champs. La commune et le projet ont enlevé de force les champs aux paysans. Certains de nous avez trois, quatre champs, on les a tous pris; que voulez-vous."* Group meeting, Muko.
>
> "Can you say that you lack land because of the growth in population?"
> "That's not it. It is instead the amount of land that has declined. They planted trees on all the fields. The communal government and the project took farmers' fields by force. Some of us had three, four fields, they took them all. What do you want?"

D. Distribution of Land and Access to Productive Resources

1. Farm size

A third important cause of the increased pressure on resources is the inequitable distribution of land, animals and other productive resources. The historical inequities in land distribution between Hutu and Tutsi have been followed by comparatively minor, but nevertheless disturbing, disparities at the local level between richer farmers and others are near-landless. The situation appears to be worsening despite a 1980 government law forbidding trade in farmland meant to prevent emergency sale of land by poor families.[3]

a. Age of Head of Household

Any generalization of farm size and changing farm size is complicated by the influence of the life cycle affecting the amount of land a family cultivates (Table 2).[4] When a young man marrys, he inherits his share of his father's land, divided more or less equally among the sons. The wife does not inherit land from her parents, indeed

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[3]Statistics on changing farm size over time are unavailable. The DSA has been collecting statistics since 1984 but has changed its definition of "total farm size" (land owned, rented in and/or rented out) twice making comparisons not possible.

[4]One hectare is composed of 100 ares, and 1 are equals 100 square meters. A "Large Animal Unit" (*unité bétail tropical*) was calculated as 1 cow, 0.2 sheep, 0.2 pigs or 0.125 goats equaling 1 unit. The amount of manure produced by the animals was estimated as one cattle producing 12 tons per year and one goat, sheep or pig producing 1.2 tons per year (Bonnefond 1980). The actual amount of manure available to spead on the fields varied by method used to raise the animals: all of the manure was considered available from animals that were permanently stall fed, one half available if the animal was "semi-stall fed" (the term used when the animals returned to the homestead at noon for several hours, or were tethered) and one quarter available if the animals were free ranging and came back to the homestead only at night. Farmers estimate that one cow fertilizes 2 to 3 fields (of around 4 ares) whereas a pig fertilizes less than one field.

Table 2 Household characteristics by age of head of household, Butare and Gikongoro (data source: DSA 1991a, 1991c; Olson 1992a).

	AGE OF HEAD OF HOUSEHOLD					TOTAL
	< 30	30 to 39	40 to 49	50 to 59	60 +	
GENDER:row percent						
male	11%	35%	18%	16%	20%	100%
female	3%	13%	24%	26%	33%	100%
:column percent						
male	90%	88%	67%	63%	62%	73%
female	10%	12%	33%	37%	38%	27%
TOTAL	100%	100%	100%	100%	100%	100%
MARITAL STATUS						
single	10%	1%	0%	0%	0%	1%
married	43%	70%	55%	48%	52%	56%
divorced	0%	3%	0%	0%	0%	1%
widow(er)	5%	6%	22%	26%	38%	20%
separated	5%	6%	6%	15%	3%	7%
union libre	38%	15%	16%	11%	7%	15%
TOTAL	100%	100%	100%	100%	100%	100%
LARGE ANIMAL UNITS	.49	1.23	1.31	1.26	1.17	1.18
MEAN FARM SIZE (ares)	45	88	98	96	89	88
LAND/PERSON (ares)	15	18	16	20	22	19
N (households)	21	73	49	46	58	247

women cannot own land. As the family grows larger, it often buys, rents or is given other land and the farm size grows. This new land is necessary to provide food for the additional household members, and the members (when old enough) help to cultivate the supplemental land (Clay and Johnson 1992). When the family's sons prepare to marry and inherit land in their turn, the older couple's farm size shrinks. Other family goods may be divided up at that point, as well. Who has ownership or usufruct over the trees on the land inherited, for example, must be negotiated (a common source of conflict between father and son, and between brothers). Animals, too, are often apportioned then. Brides' families are also compensated. The usual brideprice from the groom's parents to the bride's parents is a cow or its monetary equivalent. When a daughter marries, her parents are expected to contribute beer, provisions and other goods. This bequeathal of land and other properties by the parents results in older couples having smaller farm sizes and fewer animals, much as younger couples.

Life cycle transformations provide only a partial explanation of the current variations in farm size (Tables 3 and 4).[5] With the declining availability of additional land for young couples to rent or buy, many have been unable to maintain the pattern of augmenting their inherited property. Their sons, in turn, inherited smaller amounts of land and fewer animals, the basic production units of farms. With the loss of communal pasture land, private sources of pasture, i.e. large farm size, are required to maintain cattle. The impact of differential farm sizes on the number of cattle and

[5]Farm and field size data was collected by DSA ennumerators and consists of all land cultivated. Land rented in, therefore, is included whereas land rented out is not.

Table 3 Household characteristics by farm size, Butare and Gikongoro (data source: DSA 1991a, 1991c; Olson 1992a).

	FARM SIZE (ares)				
	0 to 25	25 to 50	50 to 75	75 to 100	100 +
PERSONS/HOUSEHOLD	3.3	4.1	5.3	5.4	6.1
ADULT EQUIVALENT (consumption)	3.1	3.7	4.7	4.8	5.6
AGE OF HOUSEHOLD HEAD	43	47	45	49	48
GENDER OF HH HEAD					
male	71%	62%	79%	69%	80%
female	29%	38%	21%	31%	20%
TOTAL	100%	100%	100%	100%	100%
MARITAL STATUS					
single	0%	4%	0%	0%	0%
married	0%	46%	67%	55%	73%
divorced	0%	2%	2%	0%	0%
widow(er)	36%	24%	18%	24%	15%
separated	7%	11%	5%	10%	3%
union libre	57%	15%	8%	10%	8%
TOTAL	100%	100%	100%	100%	100%
CAN READ AND/OR WRITE					
yes	29%	27%	48%	45%	48%
no	71%	73%	52%	55%	52%
TOTAL	100%	100%	100%	100%	100%
LEVEL OF EDUCATION					
never attended school	79%	67%	51%	52%	52%
some primary ed.	14%	22%	34%	45%	30%
completed primary ed.	7%	11%	12%	3%	16%
post-primary ed.(CERAI.)	0%	0%	2%	0%	0%
some secaondary ed.	0%	0%	2%	0%	2%
TOTAL	100%	100%	100%	100%	100%
N (households)	14	55	61	29	73

Table 4 Income by farm size, Butare and Gikongoro (source: DSA 1990, 1991c).

	FARM SIZE (ares)				
	0 to 25	25 to 50	50 to 75	75 to 100	100 +
PRODUCTION CONSUMED ON-FARM (Frw)	4921	8910	14195	17544	27520
NET SALES OF PROD. (Frw)	2502	5928	8638	12331	18149
SALE OF AG LABOR (FRw)	2067	1385	1767	769	1453
SALE OF NON-AG LABOR (FRw)	655	2489	1943	3394	7494
TOTAL LABOR SALES (FRw)	2722	3874	3710	4163	8947
TOTAL REVENUE (FRw)	11375	19387	26738	33343	53119
PER HOUSEHOLD MEMBER: REVENUE / MEMBER (Frw)	4274	5314	5549	6849	9614
PROD. CONSUMED/MEMBER (Frw)	2116	2587	2897	3633	5122
PROD. CONSUMED/ARE OF CROPPED LAND (Frw)	390	312	309	280	308
N (households)	15	57	61	30	75

other animals raised on the farm is somewhat mediated, however, by the continued practice of an old cultural custom in which the poor raise the rich people's cattle (today termed "borrowing cows" and done as a means of gaining manure).

The prospects for the younger heads of households are not bright. These sons are land-poorer than their parents and even less able to provide education and land to their children.[6] They also are less able to gain high paying nonfarm employment due to their own lower education, they harvested less per person due to their inability to invest in their farms and the smaller amount of land cultivated, and they are forced to work as low-paid agricultural laborers to buy food for their families. The proportion of total income contributed by subsistence food production is surprisingly low. Even in the poorest Rwandan households, only half the income comes from subsistence production with the remainder coming from selling their production, working as agricultural laborers and from other sources (Loveridge 1992). The annual income in Butare and Gikongoro for those with less than 0.25 hectares was equivalent to $82 per household or $31 per household member.

The farmers with larger farms, on the other hand, were better educated and had more animals to bequeath to their children. They earned higher incomes from nonfarm employment, and hired agricultural laborers. Investments in their farms, other than agricultural labor, included manure and chemical fertilizers. These investments were made possible not only from income earned from off-farm employment but also from the "luxury" of reserving some land for uncultivated uses.

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[6]Childrens' education is a major expense for parents. School uniforms, notebooks and other materials must be provided by the parents. Since the implementation of a structural adjustment program in 1991, school fees have also been charged to parents.

The amount of land uncultivated was significantly larger in the wealthier farms, and that allowed the households to replicate on a small scale the traditional system of transfer of nutrients in the form of animal and green manure from the uncultivated to the cultivated fields. The amount of land cropped per person, an important indication of the impact of land scarcity, was significantly higher, as well. Even on larger farms, however, the amount of land cultivated per adult (around 34 ares), is much less than the 50 ares per adult recommended by the Belgian colonialists to prevent famines (Everaerts 1939b).

Finally, the value of the agricultural production per person in the household with large farms was higher than in households with smaller farm sizes. Their ability to invest in inputs on the farm in addition to labor, and their ability to rent or buy fertile land, significantly raised productivity per household member.

This ability to afford inputs was at times augmented by the tendency for the government and projects to "reward the wealthy." The Gikongoro agricultural development project discovered after conducting a survey that the farmers receiving extension services cultivated the largest amounts of land and possessed twice as many animals as the average farmer (PDAG 1991). The project tended to label the rich as pilot farmers and provide special attention and fertilizers, seeds, valley land etc:

> *"Ce sont les riches paysans qui ont des champs modèles et qui de ce fait recevaient des engrais et des haricots volubiles en guise de récompense."* Group meeting, Kinyamakara.
>
> "It is the rich farmers who have model fields and who therefore receive fertilizers and climbing bean seeds as a reward."

This provides an indication of the impact of land scarcity: the marginal productivity of labor is less than zero. An additional unit of labor on small farms no longer translates into an equivalent increase in production of the former household members. This also provides a confirmation of the conclusion of Clay and Johnson's paper (1992) that one reason larger farms have more members (children) is because they are better able to nourish their children, which lowers the infant mortality rate. The Boserupian intensification of the agricultural system, therefore, is no longer able to increase land productivity at the same rate as increases in population.

The reason some farm families were wealthier than others, besides often initially having a larger inheritance and being better educated, included the location of their farms (Table 5). For example, the size of a farm in Gikongoro had less of a positive impact on the household's ability to hire agricultural labor or buy agricultural inputs than in Butare. This was due to the lower productivity of Gikongoro farms as measured in value of production per person or per hectare. Even members of some "large" farms in Gikongoro were forced to work as agricultural laborers (often in the Mayaga region of Butare). In short, farms in Gikongoro produced significantly lower levels of income than the same sized farms in Butare. This difference can be partially explained by the poorer, more degraded soils in Gikongoro. It is also due to economic and political factors, as discussed below.

Table 5 Income by farm size and prefecture, Butare and Gikongoro (source: DSA 1990, 1991c, Olson 1992a).

	BUTARE			GIKONGORO		
	1 to 50	50 to 100	100 +	1 to 50	50 to 100	100 +
LARGE ANIMAL UNITS	.42	1.03	1.97	.76	.96	2.09
MANURE PRODUCTION (tons/yr)	2.0	4.8	8.3	3.4	3.0	8.9
CULTIVATED LAND/MEMBER OF HH (ares/member)	8	11	19	9	10	15
LAND CULTIVATED AS % OF TOTAL LAND	77	72	68	79	74	48
LAND NOT CROPPED (WOODLOT ETC) (ares)	7	20	50	7	18	109
PURCHASE OF LABOR (FRw)	439	1244	3550	82	395	1003
SALE OF AG LABOR (FRw)	1324	947	465	1765	2512	3021
SALE OF NON-AG LABOR (FRw)	3344	2080	6756	670	3194	8666
PROD. CONSUMED ON FARM (FRw)	8687	17010	33605	7353	11551	17869
PROD. CONSUMED/MEMBER (FRw)	2603	3490	6431	2355	2373	3047
PROD. CONSUMED/CULTIVATED LAND (FRw/are)	365	332	350	285	228	240
TOTAL REVENUE (FRw)	18891	30817	59393	16316	24783	43168
REVENUE/MEMBER OF HH (FRw)	5378	6362	11207	4767	5142	7086
N (households)	39	62	46	33	29	29

3. Gender of Head of Household

Farm size and access to other resources also depends on the gender of the head of the household (Bucyedusenge et al 1990) (Table 6). Only men inherit land, and women do not have legal or cultural rights to inheriting or purchasing land, so their access to land depends upon their relationship with their husbands or fathers. When women marry, they move to the land their husbands have just inherited. The land then remains the husbands. Women become heads of households in rural Rwanda usually due to the ending of their marriage, caused by the separation of husband and wife or the death of the husband.

Polygamous marriages are not infrequent (around 14% of the marriages in Gikongoro, usually older people (Bucyedusenge et al. 1990)) and they result in the husband moving out of the household of his first wife and moving into a new home (on the same farm) with his second. Instead of the husband contributing equally to both households, in south-central Rwanda the first wife usually is, as it is frequently termed, "*abandonée.*" This and other forms of marriage dissolution result in the wife losing most access to the land, animals and trees on the farm.

A married woman is usually granted rights by her husband's father or by the courts to cultivate a small amount of land to support themselves and, more importantly, their sons (or she returns to her parents' farm). A woman not married but living with a man (termed "free union") have fewer accepted rights and if the marriage dissolves she often must return to her parents (6 percent of all adult women are in this situation). Younger women can also become de facto head of household when their husbands leave the region to search for employment (resulting in

Table 6 Place of women in rural households, Butare and Gikongoro (source: DSA 1991a).

	MEN		WOMEN	
	% adults	mean age	% adults	mean age
HEAD OF HOUSEHOLD				
single	0%	25	0%%	27
married	53%	48	2%	66
free union	15%	39	2%	37
separated/divorced	1%	44	2%	50
widowed	2%	70	14%	59
(SUBTOTAL)	(71%)		(20%)	
SPOUSE				
married	1%	42	45%	42
free union	1%	51	13%	32
separated/divorced			0%	45
(SUBTOTAL)	(2%)		(59%)	
CHILD				
single	26%	25	12%	23
free union	0%	55	1%	25
separated/divorced	0%		6%	30
widowed	0%		1%	52
other			0%	21
(SUBTOTAL)	(26%)		(20%)	
OTHER RELATIVE				
free union	0%		0%	28
single	1%	29	1%	25
TOTAL %	100.0%		100.0%	
N (individuals)	300	300	347	347

Table 7 Resources in farms headed by men and women, Gikongoro (source: DSA 1991a, 1991c; Olson 1992a).

	GENDER OF HEAD OF HOUSEHOLD	
	male	female
NUMBER OF MEMBERS IN HH	5.6	3.7
TOTAL FARM SIZE (ares)	98	43
CULTIVATED AREA (ares)	48	33
LAND IN WOODLOTS (ares)	27	2
TOTAL LAND/MEMBER (ares)	19	13
CULTIVATED LAND/MEMBER	10	10
LARGE ANIMAL UNITS	1.5	.6
MANURE PRODUCED (ton/yr)	6.0	2.0
N (households)	69	25

"incomplete" households). This type of household, headed by a woman presumably temporarily, often were extremely poor when complete, the reason the husband needed to leave. Widows often have small plots of land, as well, since much of their land would have been inherited by their sons. The households headed by women, therefore, are often the poorest households with the smallest farm sizes.

The land that women gain access to cultivate after the dissolution of the marriage traditionally is the field immediately surrounding the house and not the more fertile valley fields, the fallow or pasture land, or the woodlots (Table 7). Their fields tend to be very intensively cultivated, therefore, with fewer additions of leaves and grasses from off the field. Women are rarely given caretakership of their former husbands' cattle (and cannot own or buy cattle themselves according to social mores) and have few resources to feed the animals. The result is that women-headed households have only a third of the manure of men-headed households to spread on their fields. Rights to plant and, therefore, to own, trees are usually reserved for men, except for certain trees used for medicine or food. Single women are considered "men" and are allowed to plant trees but rarely do so in practice (den Biggelaar 1994). Households headed by women are rarely given control over existing woodlots.

In sum, households headed by women have less manure and fewer other sources of organic matter to add to their fields and the land is fallowed less often. Because off- and nonfarm economic opportunities are also much rarer for women, they must intensely cultivate the land they have.

4. Impact on Resources Available

Households with very small farms, whether headed by men or women, experience a similar shortage of uncultivated land, trees and animal resources that are important in the maintenance of soil fertility on their cultivated fields (Table 8). They rarely have land in woodlots, fallow or pasture since they must cultivate most of their land to produce sufficient food to feed their families. Their land, therefore, is intensively cultivated while receiving little organic matter from the applications of leaves or grasses as green manure. These households also have fewer animals, especially cattle, to produce manure since they must often sell their animals in times of debt or to buy food, and their poverty does not permit them to buy replacements. The shortage of fodder also restricts their ability to maintain any animals, further diminishing their ability to apply manure. Households with small farms still reserve land for trees, usually land near the homestead and on the edge of fields (den Biggelaar 1994). The presence of the trees may be partially due to labor constraints in poorer households since the husbands are frequently working off-farm and tree cultivation is less labor-intensive than crop production. Nevertheless, the households' general lack of resources increases the pressures placed on their land and restricts their ability to maintain the soil's fertility.

> *"Ici c'est seulement le fumier qui garantit une bonne production. La pratique de jachère n'améliore rien quand on a pas de fumier sauf justement pour ceux qui ont de vaste propriété. On ne peut pas faire de jachère avec une parcelle. Il faut noter que même ces grands propriétaires ont obligatoirement des animaux. Les riches seront toujours riches, n'est-ce pas?"* Group meeting, Kinyamakara.
>
> "Here, it's only manure that can guarantee a good production. Fallowing doesn't improve anything when you don't have manure, except for those who have large farms. You can't fallow with only one field. You should note, however, that even those with large farms still need to have animals. The rich will always be rich, won't they!"

Table 8 Land, labor and inputs by farm size, Butare and Gikongoro (data sources: DSA 1990, 1991a, 1991c; Olson 1992a).

	FARM SIZE (ares)				
	0 to 25	25 to 50	50 to 75	75 to 100	100 +
LABOR:					
MEMBERS/HOUSEHOLD	3.3	4.1	5.3	5.4	6.1
CULTIVATED LAND AVAILABLE:					
CULTIVATED LAND (are)	14	29	45	59	93
LAND NOT CULTIVATED (WOODLOT ETC) (are)	4	8	16	26	73
PERCENT OF TOTAL LAND THAT IS CULTIVATED	75%	79%	74%	70%	60%
TOTAL LAND/MEMBER (are)	7	11	13	18	31
CULTIVATED LAND/MEMBER are	6	9	10	13	17
ANIMALS OWNED AND BORROWED					
CATTLE OWNED	.00	.23	.34	.75	1.15
CATTLE BORROWED	.00	.25	.16	.29	.31
GOATS OWN	.21	.28	.70	.50	1.05
GOATS BORROWED	.29	.32	.18	.32	.39
SHEEP OWNED	.00	.09	.25	.18	.35
SHEEP BORROWED	.00	.11	.05	.07	.26
PIGS OWNED	.00	.15	.43	.46	.77
PIGS BORROWED	.43	.13	.18	.25	.18
INPUTS:					
TOTAL MANURE PRODUCTION (ton/yr)	.6	3.2	3.5	5.8	8.5
MANURE PER CULTIVATED ARE (ton/yr/are)	.05	.13	.08	.10	.10
PURCHASED LABOR (FRw/yr)	73	326	870	1199	2565
TOTAL PURCHASED INPUTS (FRw/yr)	73	337	900	1205	2620
N (households)	15	57	61	30	75

E. Declining Purchasing Power

In addition to low levels of agricultural production, poverty has intensified due to low prices of the agricultural products traded. Unfavorable terms of trade between the rural production and urban consumer markets, a limited national market for agricultural products and declining coffee prices on the international market resulted in extremely low prices at the farm gate throughout the country (Ansoanuur 1992). Again, regional differences were important with areas able to produce and sell high-value produce doing much better than the others. The large commercial farms of the East, for example, were linked to the external market network and they could easily sell high-value bananas or sorghum. Farms of the Northwest could sell their white potatoes to traders from the capital city. In contrast, the South Center is less tied to the nationwide commercial network. Gikongoro, in particular, suffered from the relative remoteness of the region, the difficult state of the roads beyond the main national roads and the long distance to the main urban market, Kigali. Commercial crop buyers from outside the region interested in purchasing local products were rare.

Farmers in Gikongoro had a lower purchasing power than farmers elsewhere in the country. Gikongoro farmers produced low-value commodities, such as sweet potatoes, and bought high-value commodities such as beans and bananas. The example commonly mentioned by farmers is the relationship between the price of sweet potatoes, which they sell for 20 francs for a large basket (of around 25 kilos), and beans, which they buy at 60 to 80 francs a kilo. Indeed, Gikongoro farmers were net buyers of food. They sold 8,400 and bought 11,400 Rwandan francs worth of agricultural products per household in 1990 (Loveridge 1992). The difference was

made up by selling of their labor both locally in Gikongoro and Butare as agricultural laborers, and in the capital city (see Chapter VII).

The new crops introduced by the Gikongoro agricultural services were not yet helping the situation. In 1992, the services were actively encouraging farmers to produce white potatoes with purchased seed potatoes and fertilizers (CSAG 1992). Commercial buyers rarely arrived to buy the harvest, however, and the price of potatoes fell to 2 to 3 francs a kilo in the communes. Many potatoes rotted while farmers waited for buyers. Wheat, pushed as an import-substitution crop and considered by bureaucrats as the potential savior of Gikongoro agriculture (CSAG 1992), suffered from some of the same problems. Purchased inputs (fertilizer and lime) were necessary to produce the crop, but the returns barely covered the price of the inputs (Gatali interview).

Meanwhile the price of imported food rose following a 40 percent devaluation of the Rwandan franc in 1992 as part of a structural adjustment program (World Bank 1993a). The price for almost everything farmers bought, from hoes to clothes, increased. Contrary to what was assumed by the World Bank and Rwandan ministry bureaucrats, imported food was an important staple in the rural Rwandan diet. The most important foods imported were the same foods that Gikongoro farmers said they buy. The major imports into rural households in Rwanda were beans (60,000 tons) and sorghum (26,000 tons), probably from Zaire and Uganda. Exports from the rural areas included large quantities of white potatoes (probably those produced in the northwest), banana and sorghum beer, and labor to the cities (Loveridge 1992; Loveridge 1988). This large degree of exchange occurring in rural areas resulted in

farmers being very sensitive to the increases in prices of the food they purchase. The decline of purchasing power was keenly felt:

> *"Je voudrais y ajouter une chose. Nous avons des patates douces en suffisance; mais on nous donne 20 francs pour une corbeille pleine. En plus, nous n'avons pas de projet dans notre commune. Comment voulez-vous que le paysan ait assez d'argent pour s'acheter une houe, une chèvre, etc.?"* Group meeting, Kinyamakara.
>
> "I would like to add one thing. We have plenty of sweet potatoes but they give us 20 francs for a basketful. Plus, we don't have a project in our commune. How do you expect a farmer to have enough money to buy a hoe, a goat, whatever?"

F. Employment Possibilities and Government Investments

Low farm revenues and declining farmland availability have combined so that agriculture is no longer able to support the rural population in much of the West. This has increased the role of non- or off-farm employment as important and very necessary sources of income in rural areas.

The availability of these opportunities differed between regions and between people in regions. The East, well tied to the external market and with large commercial farms, had agricultural wage labor employment possibilities. The Northwest had been the recipient of many development efforts in the form of new schools, a university campus, new roads, and agricultural projects since the early 1980s. This was due to the former President Habyarimana and the people he had selected for important governmental posts concentrating governmental funds in their home region (Newbury 1992). Presumably some rural people were employed directly by or otherwise benefited through economic multiplier effects from these activities. Again, the South-Center had fewer opportunities. Agricultural wage labor was the most common form of earning off-farm income, but the wages were very low ($0.60

to $0.70 per day). Other common sources of income included construction work, trading and fabricating construction materials such as bricks and clay tiles (Clay et al. 1989). Salaried income outside of agricultural labor, however, was very rare in Gikongoro:

> *"Nous avons des problèmes d'emploi. Ce qui fait que notre situation économique reste précaire. Nous avons du mal à trouver de quoi acheter les vivres. Pas d'argent pour satisfaire nos besoins de santé. On peut passer tout un mois sans trouver un billet de cent francs. Les enfants quittent l'école suite au manque de frais de scolarité. Les besoins sont nombreux mais ne sont jamais satisfaits."* Group meeting, Kinyamakara.
>
> "We have problems of employment. This keeps our economic situation precarious. We have a difficult time finding money to buy food. No money to meet our health needs. You can spend an entire month without finding a bill of 100 francs. The children quit school because of a lack of money to pay school fees. The needs are many but are never met."

Meanwhile government and project investment in Gikongoro agriculture was low and rarely benefitted the farmer directly. Several small agricultural projects existed in Gikongoro funded by the Rwandan government, the FAO, the World Bank, and the German and Belgian governments (Table 9). The communes of the prefecture were divided up amongst these various projects. The largest covered only seven communes, the Projet de Développement Agricole de Gikongoro (PDAG) funded by the government, FAO, IFED, UNDP and WFP and implemented by the government (PDAG 1991). Other projects covered one or two communes (CSAG 1992). The multiplicity of efforts and frequent changes in Rwandan and expatriate staff make generalizations difficult, but they shared several of the same goals (from CSAG 1992) including:

Table 9 List of agricultural projects. Gikongoro

Name of Project	Start	End	Zone	Source of Funds	Amount (Frw.)
DANK (Projet de Développement Agricole Nshili-Kivu)	5/10/1986	July 1988	Headquarters: Munini Address: B.P. 50 Butare B.P. 1211 Kigali	Germany Rwandan Govt	264.907.000 46.171.000
Projet d'Animation Rurale Mudasomwa	1981	1990	Headquarters: Mudasomwa Address: B.P. 513 Butare Zone: Commune Mudasomwa	Belgium Rwandan Govt	44.201.000 4.210.000
Projet de Développement Rural de la Zone Centrale de la Crête Zaïre-Nil (C.Z.N.)	October 1983	1988 to 1989	Headquarters: Gatare Address: B.P. 582 Kigali Zone: Gikoro:Nuko-Musebeya Zone: Kibuye:Gisovu	EEC Rwandan Govt Food Aid FAC	1.173.000.000 13.200.000 25.000.000 42.200.000
Protection et Conservation de la Forêt Naturelle de Nyungwe (GBK II)			Zone: Interior of Nyungwe Forest	World Bank	2.950.000.000
Projet de reboisement en commune Mudasomwa	1/6/1984	1988	Headquarters: Mudasomwa Address: B.P. 513 Butare Zone: Mudasomwa commune	Belgium (Gift)	33.641.260

Source: Agriculture Rwandaise: Problematique et Perspectives by Jean Bosco Nzehose. INADES-Formation Rwanda, 1990.

1. Increase farmer production of export, import-substitution or internally traded commodities (white potatoes, wheat, climbing beans, sweet potatoes and coffee) through the marketing of seeds, fertilizer and lime. This was part of a national policy of "regionalization" of crop production and increased commercialization of food crops. These efforts were visible in certain communes, but usually only on farms of those who could afford the inputs, and marketing the produce was often a problem.

2. Afforestation of the land along the Nyungwe Forest and in communal woodlots that had been burned (during political protests) or harvested. This activity had occurred most often in the 1980s (see aerial photograph interpretation section below). The benefits of these activities (the sale of wood) went to the government and projects.

3. Increased acreage under the *mise en valeur* program of the valleys and recuperation of the high-elevation acidic land (under Eragrostis pasture along the Nyungwe Forest) for cropping. This continued the expansion of cropped land onto pastureland and the conversion of communal to private land. The benefits, again, did not always return to those who had been exploiting the land originally.

4. Installation of demonstration radical terraces throughout the prefecture. The erosion ditches existing throughout the area were considered insufficient in the steep terrain of Gikongoro, and the solution was determined to be radical terraces (Berding 1991). The high cost of installation and heavy inputs required to restore productivity to the new topsoil, however, confined terracing to project demonstration sites.

In sum, much of the visible activity on farms was related to the first goal: attempting to increase production of certain commercial crops. The implementation of this program mirrored the problems of many of the other programs, and the benefits often went to a few. Fertilizers were expensive, beyond the reach of most farmers, and they were usually available only in areas immediately surrounding project headquarters. The government and projects also tended to reward the wealthy. After conducting a survey, the Gikongoro agricultural development project discovered that the farmers receiving project extension services were those cultivating the largest amounts of land and possessing twice as many animals as the average farmer (PDAG

1991). Projects tended to label the rich as pilot farmers and grant them special attention as well as fertilizers, seeds, valley land, etc. In short:

> *"Ce sont les riches paysans qui ont des champs modèles et qui de ce fait recevaient des engrais et des haricots volubiles en guise de récompense."* Group meeting, Kinyamakara.
>
> "It is the rich farmers who have model fields and who, because of this, receive fertilizers and climbing bean seeds as a reward."

On the other end of the spectrum were the very poor. A second survey by PDAG attempted to ascertain what people were the most affected by the famine that occurred in 1990 in Gikongoro. The results of the survey indicated that 74 percent of those affected had farms of less than 25 ares of arable land and 96 percent had farms smaller than 50 ares. Forty percent of the affected households were headed by women (Nsengimana 1991). Since farm size and gender of head of household were factors the project could not alter, the PDAG concluded in its annual report that reducing famine was beyond its control (PDAG 1991). A follow-up PDAG report by Gascon (1992) on the very poor again found that most were households with very little arable land, headed by women and/or those composed of elderly people. These very poor comprised 25 percent of all households and were suffering from serious food insecurity. Actions to improve their situation were proposed but with little optimism.

A common view among farmers who were far from the valley improvement program was that they saw few benefits of the project:

> *"Donc, les véhicules, nous les voyons en circulation mais le projet n'a jamais approché le paysan."*
> *"Le projet n'a rien réalisé ici pour vous?"*
> *"Rien, aucun conseil. Même celui-là [qui parlait du PDAG] c'est parce qu'il sait lire. Pour nous, nous ne savons rien à propos de ce projet. Probablement que même le bourgmestre voit seulement les véhicules à travers la route."* Group meeting, Rwamiko.

"So, we see the vehicles on the road but the project has never approached a farmer."
"The project hasn't done anything for you?"
"Nothing, no advice. Even he [who mentioned the vehicle] knew it was PDAG because he can read. For us, we don't know anything about that project. Probably even the burgomaster only sees their vehicles on the road."

Although some of the expatriate-funded projects may have been a rare sight in rural areas, the burgomasters and their communal government staff controlled many aspects of on-farm agriculture very tightly following national laws. Fines and imprisonment were the usual means of enforcing the rules. Many of the old policies concerning agriculture from the colonial administration had been maintained and were being enforced still by the independent government. These laws affected land use profoundly. In sum (and to repeat policies mentioned previously), they included:

a. Land reserved previously for pasture became open for settlement and cropping. The policy was coincident with rapidly increasing human population densities that created a large demand for new farm land. The result was a process of rapid land conversion from grass to crops.

b. Burning fields and grasslands continued to be prohibited. Therefore pasture was difficult to maintain and intense labor was required to convert land to cropping and to prepare soil for planting. This policy is still resented today (some people recently returned to burning as governmental authority broke down).

c. Tree planting continued with *umuganda* on farms and in government communal woodlots. The government and agro-forestry projects also established tree nurseries and encouraged tree planting. The results include an increase in availability of seedlings and knowledge of tree planting (den Biggelaar 1994), more trees in government woodlots and more trees on private farms (PDAG 1991). This has coincided with an increase in the demand for tree products (fruit, fodder and wood) as natural forests and forest remnants have been converted to cropped land.

d. Colonial policies that enforced digging of erosion ditches and planting grass strips were at first abandoned because they were seen as a colonial imposition. In the mid-1970s, the government reversed its policy and once

again *umuganda* became the vehicle to force construction of ditches throughout the country. Digging and maintaining compost bins became another requirement for farmers.

e. Drainage and clearance of valleys for cropping land continued. Although farmers have drained valleys incrementally during their search for more and better land, the government also has instituted large-scale drainage programs. This hastened the conversion of land from pasture into crops that had been occurring on the hillsides.

f. Mulching, pruning and other maintenance of coffee bushes was required. The need to fulfill the mulch requirement has increased the demand for grasses. A required minimum of 10 ares in coffee bushes had been enforced but abandoned in the early 1990s.

These governmental policies were very important in directly shaping the evolving land use pattern, thus reinforcing the importance of examining the role of the state in analysis of land use change. In addition to governmental policies, the processes occurring at the farm level, intensification of the agricultural system on the farm and extensification of cultivation onto pasture land, had a similarly profound effect on land use change.

G. THE MANIFESTATION OF LAND USE CHANGES: AERIAL PHOTOGRAPHY INTERPRETATION

An aggregate of the historical trends of land use changes is visible on aerial photographs. A comparison of 1:50,000 photographs of 1973 with those of 1990 revealed the extent of the conversion of land use (see Chapter III for further explanation of methods of interpretation and analysis). The area examined is the northwestern quadrant of Gikongoro along the Nyungwe Forest Reserve, from just south of the paved road to the northern prefectoral boundary. It covers most of the forested and unforested sections of the communes Muko, Musebeya and Mudasomwa. The area represented is approximately 23 kilometers east/west and 36 kilometers

north/south. The smallest size of polygon mapped, due to pen width and interpretive limitations, is 6.25 hectares. Since the average farm in Gikongoro covers less than a hectare, land use changes occurring within farms or on individual hills are not captured. Only the broader, regional land use/land cover changes are visible and chronicled. Ten land use/land cover types were identified and plotted:

Forest: Natural forest cover. Rough, heterogeneous texture, dark tone.

Forest savanna: Prairie grasslands within the natural forest, often along high altitude ridges. Smooth texture, light tone.

Woodlot: Trees, usually of homogenous species (often eucalyptus or pine), planted contiguously in plots. Evenly patterned (planted in lines), dark tone, smoother texture than natural forest.

Wooded pasture: Numerous scattered clumps of trees in pasture land. Light tone and relatively smooth textured area with frequent, irregularly placed darker masses with a rough texture. Class found along natural forest boundary.

Pasture: Grasslands created and maintained for grazing (often Eragrostis). Relatively smooth, evenly textured. In IR light grey toned, in panchromatic grey.

Project pasture: "Improved," planted grassland with no clumps of trees for pasturing project animals (Pennisetum clandestinum). Very smooth, homogenous texture, light tone.

Tea plantation: Tea bush fields and associated factory buildings. Very light tone in IR photos, light grey tone in panchromatic. Very smoothly textured. Several large rectangular buildings in center of area.

Agricultural frontier: Area predominately pasture but with lines of houses and fields. Smooth texture and light color on hillsides with small buildings and associated small, darker blocks. Along roadside, and between area of intense cultivation and pasture.

Cultivation: Settled areas by farmers with almost continuously cropped surfaces. Small urban and market centers subsumed under this class. Very heterogeneous: mixed tones often in small block patterns, rough texture. Frequently find single trees, small clumps of trees or lines of trees. Some progressive terracing.

Project cultivation: Area with radical terracing and cultivated fields planted with single crop. Patterned lines of steep terraces in area within project boundaries.

The land in northwestern Gikongoro represented one of the last agricultural frontiers of Rwanda in 1973 with large expanses of land still being maintained as pasture (Figure 9). Most of this pasture was near the cultivated areas along the forest boundary and on remnants of what had been large expanses of pasture within the cultivated region. The grasslands were anthropogenic, created through controlled burning, although the Belgian soil scientists labeled the region a "*prairie d'altitude*" and created a soil class, "*sols eragrostis*," specifically for the acidic grasslands (van Wambeke 1963). Much of the pasture along the forest edge was for transhumance, i.e. herders brought cattle up from the farms of the lower elevations to graze their animals during the dry season on the high-elevation pasture lands.

The area under pasture in 1973 was the remainder of large expanses of pasture that had covered Gikongoro before independence. A transitional land cover class between pasture and cultivation existed in 1973, the agricultural frontier. Farmers were breaking up the old matted eragrostis grass cover to plant crops. The fields were visible as long narrow strips of bare land cut into the hills covered otherwise with grass. These areas did not yet have the trees, houses, erosion ditches or other characteristics of the intensely cultivated areas. A second transitional land cover class was also identified on the aerial photographs, that of wooded pasture, between the natural forest edge and the pasture lands. This cover type was primarily grasslands but had numerous clumps of trees that resembled the trees of the forest. Within the forest itself, naturally occurring forest savanna was aligned along the highest ridges.

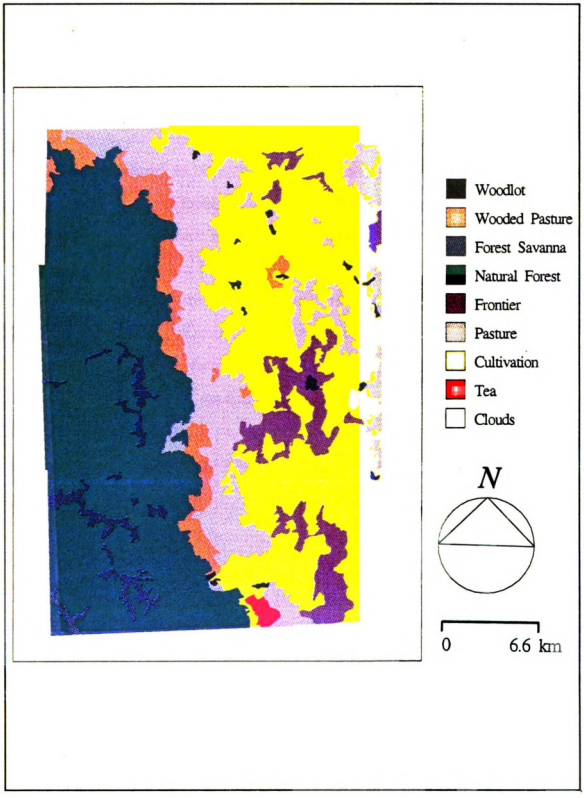

Figure 9 Land use/cover types along the forest edge in northwest Gikongoro, 1973

Finally, two small land cover classes were registered, one of a tea plantation (Kitabi) to the south of the road with a few small woodlots of planted, exotic tree species within the cultivated area, and one along the forest edge (Mudasomwa).

With time, the Nyungwe Forest Reserve had lost its status as being a difficult-to-reach, distant enclave. In 1962, the restrictions on converting pasture lands to cultivation were lifted and farmers moved up to settle in the high-altitude areas, including alongside the Forest, and down to the savanna areas of the east. The road traversing the forest between Butare and Cyangugu was paved in the mid-1980s. Parastatal tea plantations were founded on land adjoining the forest. The tea plantations use an enormous amount of fuelwood when processing tea leaves, wood that initially came from the natural forest and only recently from planted woodlots (Barabwiliza 1980). In 1978, the threats to the forest were publicized by the Swiss Projet Pilot Forestier. These threats included logging alongside roads and on the forest border, gold mining in the rivers, expanding tea plantations and population growth (Sorg 1978).

The land use/land cover in 1990 resembles the 1973 coverage in two respects: Nyungwe Forest Reserve still covered a large continuous block to the west, and cropped land still consisted of a large continuous block to the east (Figure 10). The large changes in land use/land cover occurred in the area between those two masses. Pasture land, which had been the third largest use of land in 1973, had shrunk to an island on a small steep ridge in the middle of settled land. As discussed above, this loss of pasture was related to a sudden shift of political power in 1962, radical changes in government policy and increases in the size of the farming population.

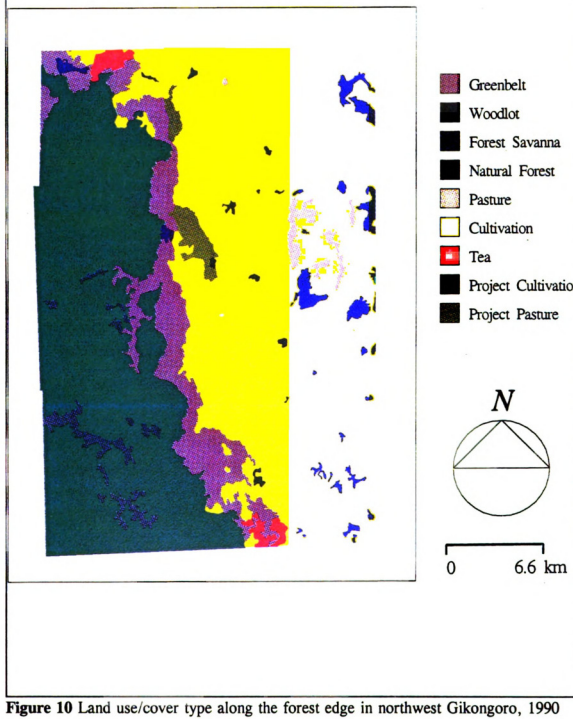

Figure 10 Land use/cover type along the forest edge in northwest Gikongoro, 1990

The conversion of land use/land cover from pasture to crops was the largest land use change that occurred between 1973 and 1990 in this area (Table 10 and Figure 11). The loss of extensive pasture land was almost total, a "frontier" of farmers breaking the sod no longer existed. What had been frontier in 1973 had become part of the larger, intensely cropped expanse by 1990.

The 1973 pasture and wooded pasture, however, were not consumed solely by farmers moving in with their hoes. Three new land uses came into existence between 1973 and 1990, and two others that had been minor in 1973 became important in 1990. These five land uses were all governmental: a new tea plantation to the north (Gisovu), a green belt along the forest edge, improved pasture land reserved for a project's animals, project cultivation (demonstration terraces) and communal governmental woodlots.

These governmental land uses represent a variety of government levels. The woodlots are owned by the communal governments who use them as a source of income. The trees are harvested periodically, the wood sold to commercial charcoal makers or sawyers, and the hills replanted. Although most communal woodlots were small, covering a hill, others were quite large. Most woodlots were planted by farmers with *umuganda*, forced communal labor, on land that had been pasture. Farmers frequently considered these woodlots as a symbol of governmental repression and corruption since they were created from farmers' land and planted by the farmers while the profits often became the personal property of the burgomasters. The tea plantations, the project pasture and cultivation, and the green belt were also tied to the Rwandan government, but at the national level, as well as to European, North

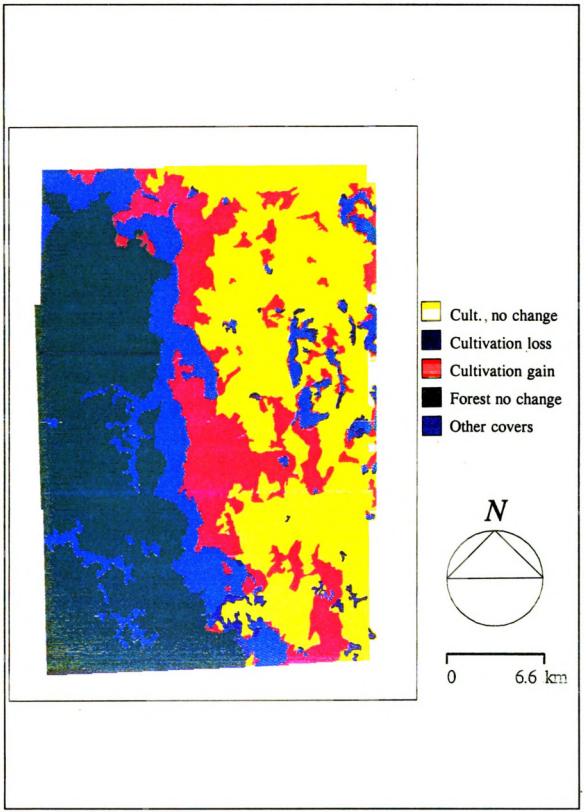

Figure 11 Land use/land cover change 1973 to 1990

Table 10 Table of land use/land cover changes 1973 to 1990 (hectares)

1973 → 1990	Greenbelt	Woodlot	Wooded Pasture	Forest Savanna	Natural Forest	Frontier	Pasture	Cultivation	Tea	Project Cultivation	Project Pasture	Clouds	TOTAL
Greenbelt	0	0	0	0	0	0	0	0	0	0	0	0	0
Woodlot	58	179	0	0	16	0	0	5 151	0	0	0	0	409
Wood Past.	2,096	8	0	0	103	0	0	961	0	130	3,224	0	6522
Forest Sav.	300	0	0	751	459	0	0	0	0	0	0	0	1510
Nat. Forest	1,597	0	0	240	23,891	0	0	0	77	11	0	0	25,816
Frontier	0	301	0	0	0	0	51	3,993	0	0	0	0	4345
Pasture	1,528	594	0	0	99	0	385	7,394	446	22	851	0	11,319
Cultival'n	318	608	0	0	15	0	175	24,891	10	0	4	0	26,021
Tea	74	0	0	0	0	0	0	31	160	0	0	0	265
Proj.cult	0	0	0	0	0	0	0	0	0	0	0	0	0
Proj.past	0	0	0	0	0	0	0	0	0	0	0	0	0
Clouds	0	25	0	0	0	0	0	49	0	0	0	0	74
TOTAL	5971	1715	0	991	24,583	0	611	37,324	844	163	4079	0	76,281

American and bilateral agencies. The tea plantations were parastatal, partially owned by the Rwandan government and partially by private European companies. Tea was the second largest earner of foreign exchange for the government after coffee. The green belt and the project land uses were also designed to provide foreign exchange to the national government through foreign aid and tourism.

In 1984, the government adopted an action plant for the forest and initiated several projects in and around the forest. A USAID/Peace Corps project created paths and other amenities in the center of the forest to attract tourists. On the edge of the forest, Swiss, World Bank, E.E.C., Belgian, and German development projects were established. The Nyungwe Forest Reserve was divided into sections to be managed and developed by these different donors. Three of the projects are represented in this aerial photography interpretation: a Swiss forestry project to the extreme northwest; the *Projet de Développement Rural de la Zone Centrale de la Crête Zaïre-Nil* (CZN) along most of the center of the forest edge; and the Belgian *Projet de Reboisement en Commune Mudasomwa* to the south.

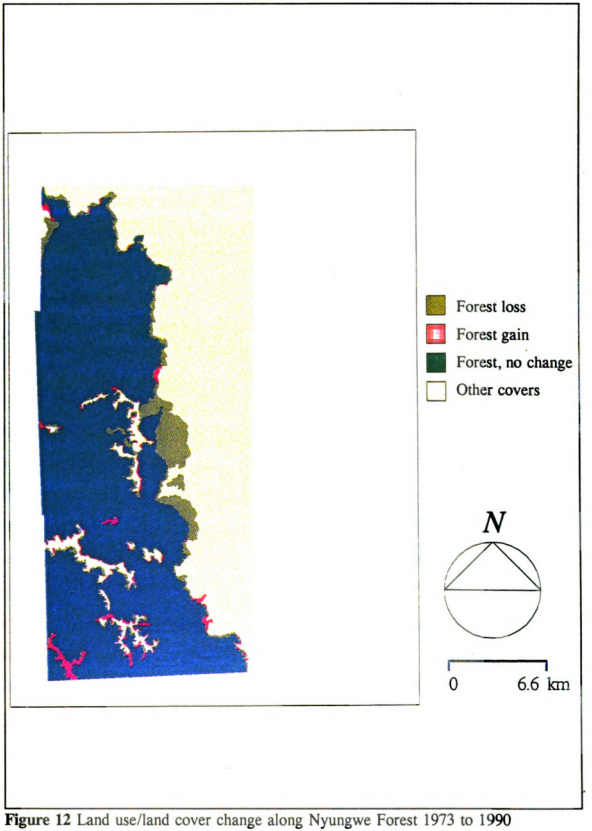

Figure 12 Land use/land cover change along Nyungwe Forest 1973 to 1990

The goals of the projects, which seem to be opposing, were to preserve the forest from encroachment by farmers and to create an income-generating program for the projects and the government. The first goal was met admirably. Between 1973 and 1990, no natural forest land was lost to farmers in the region studied (Figure 12). This is similar to the results of Kristensen et al. (1992) who found that between 1982 and 1991 most forest loss occurred within the reserve boundaries due to gold mining, but not along forest edges. The physical and proprietary barrier created by the green belt and project pasture effectively prevented farmers from using the forest land resources. Fuelwood, for example, became more difficult for farmers to find as former sources within the forest were withdrawn from them. Both the green belt and project pasture were placed on land that had been in use by farmers. Entire farms had been located on that land, other farm households had cultivated fields there, and the pasture had been a communally managed resource. The CZN and other projects resettled some families to other, equally marginal agricultural land with infrastructure improvements but the remaining families were very bitter. The CZN project planted improved pasture grasses for their Brown Swiss cattle on land that had been farmers' fields and pasture, and the farmers were then forbidden to graze their animals on that land. The CZN had not planted the green belt solely on farmers' land, however, but also cleared 1,597 hectares of natural forest in two sections to plant pines, cypress and eucalyptus. A large section of naturally occurring forest savanna also was planted with exotic tree species. A cabin for visitors was built on the high point in the center of this area.

The net result of all land use/land cover changes for farmers in this region was the depletion of all new sources of farm land. The high elevation frontier no longer

existed in Gikongoro except for small areas south of the region analyzed in Nshili and Kivu communes (CSAG 1992). Their children, and themselves, had no new lands to clear and create new farms. The second major change was that the former extensive system of agriculture which had depended upon expanses of pasture land was no longer possible. Only the small amount of grasses growing on their own hills was available to feed their animals.

Western Gikongoro was being forced to intensify its agricultural system as much of Gikongoro and the rest of Rwanda had already done, but western Gikongoro was starting with poor soils, decreasing availability of manure, an underdeveloped commercial system, low-value crops, and ineffective government investment in the agricultural system.

H. SUMMARY OF LAND USE CHANGES

An examination of the changing emphasis on crops, animals and trees in Gikongoro is of particular interest because the region was unique in its long history of land management and the recent rapid evolution of the agricultural system. To summarize all of the changes that occurred in land use, land under grass declined to a very large degree, that under trees somewhat increased and the land under crops enormously increased. The trend of expansion of cropped land was uncertain because farmers found no additional land existed to be put under crops. Meanwhile, farmers continued to place high value on animals since they produced the precious manure, but the resources required to raise animals became impossible to find. As land became increasingly scarce and pressures mounted on the production system, animals and crops became competing rather than reinforcing elements in the system.

The changes in the agricultural system are usually explained as a result of increasing population densities and labeled agricultural intensification. The changes also reflected, however, momentous environmental, socio-cultural, economic and political events. The word "intensification" connotes positive alterations of an agricultural system, with more modern technology being used, a switch to commercial high-value crops and particularly an increase in productivity of the land. In Gikongoro, the system indeed underwent intensification, but the impact of the methods adopted to increase productivity have led to a deterioration of the environmental resource base and a decline in productivity.

The aggregation of these historical and recent trends of extensification and intensification and their impact on the soil can be summarized as follows:

CHANGING LAND USE: EXPANSION OF CULTIVATED AREA

- to land previously reserved for pasture. This has led to fewer animals and less manure, the most important soil additive.
- to marginal lands such as steep slopes, poor soils and high altitude regions. These ares are often more prone to erosion and/or are vulnerable to increasing acidity and aluminum toxicity with cultivation.
- to valleys. The clearing and cultivation of valleys has reduced pasture land and removed an important source of plant material used as green manure. *Urukangaga*, for example, had been a common wild grass cut and incorporated into the soil of valley fields, but it is now difficult to find.
- to fallow lands. Fallow had been an important method of soil renewal but now it is practiced not at all on some fields and only for a short period of time (one cropping season) on pieces of other fields.

DECLINING TRANSFER OF NUTRIENTS FROM OUT-FIELDS TO IN-FIELDS

- the transfer of organic matter and nutrients in the form of manure from pasture lands to cropped areas has declined greatly with the reduced quantity of manure produced and the increase in the area under crops. The decrease in manure availability is perceived by farmers to be the most important alteration of the agricultural system and the principal cause of soil degradation.

- reduced availability of grasses and other vegetative matter from out-fields to add to the soil as green manure or compost.

CHANGING AGRICULTURAL PRACTICES

- crop mixes have changed reflecting the need for higher caloric production per hectare with more tubers grown and fewer cereals and pulses. Tubers require deep hoeing so the soil becomes more susceptible to erosion, and tubers also quickly deplete the soil of nutrients.

- continuous cultivation leads to the soil being bare for long periods of time and hoed and loosened at least twice a year. The soil is therefore usually susceptible to erosion (Moeyerson 1989).

These changes in the agricultural system have resulted in increased erosion and reduced organic matter and nutrients in the soil. Whereas the soil near the *urugo* received a net benefit from the soil additives and intense management and had gained fertility through this human-induced process, today many farmers are unable to provide sufficient amounts of inputs to compensate for the increased stress on the system. Thus soil is losing productivity.

The soils of Gikongoro are particularly vulnerable to these changes in land use because they are derived from granite and schist/shale (CPR 1992). A reduction in organic matter, in particular, leads to a significant decline in the soil's agronomic capability due to worsening acidity and aluminum toxicity (Mutwewingabo and

Rutunga 1987). The steep slopes and heavy, frequent rains of Gikongoro also result in a high potential for damaging erosion. In short, the soils of Gikongoro, especially those in the extreme high elevation areas, had low agricultural potential and were highly susceptible to degradation. The yields in Gikongoro were among the lowest in the country (Figure 13).

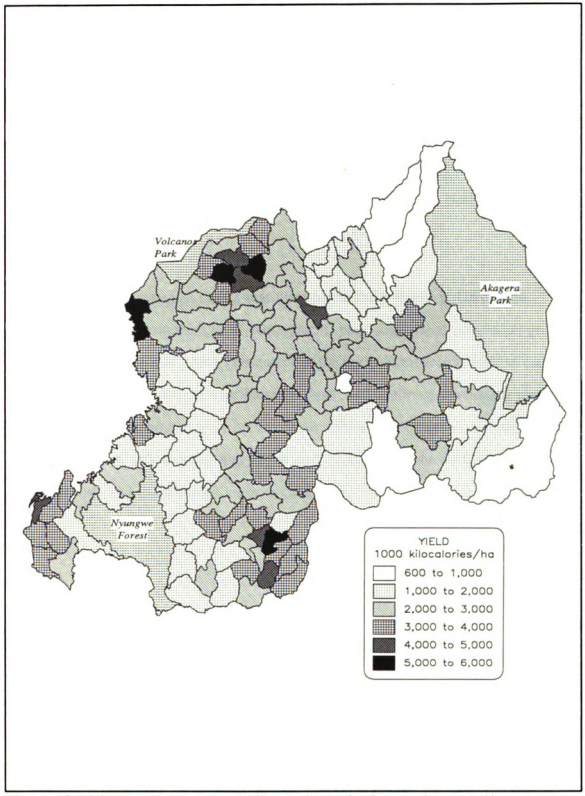

Figure 13 Yield by commune (total kilocalorie production per hectare) (data source: MINAGRI 1989)

I. SUMMARY OF PRESSURE ON RESOURCES

The concentration of these "proximate causes" of pressure on resources led to the South-Center, and particularly Gikongoro, to have the lowest incomes and experience the worst symptoms of stress, such as poor child nutrition, in the country (Tardif-Douglin et al. 1993; Schnepf 1992) (Figure 14). The Northwest actually had a higher rate of population growth and higher population densities, but because other proximate causes were less severe the situation for farmers in the Northwest was much less critical.

The list of proximate causes that were particularly severe in Gikongoro includes limited nonfarm sources of employment, poor soils, rapid population growth, ineffectual government or donor investment in the agricultural sector, lack of access to agricultural inputs, unequal distribution of land, and declining purchasing power. These factors had combined to 1) reduce opportunities for farmers to diversify and earn income from new sources, and 2) intensify pressures on the farm system while making former soil maintenance methods infeasible.

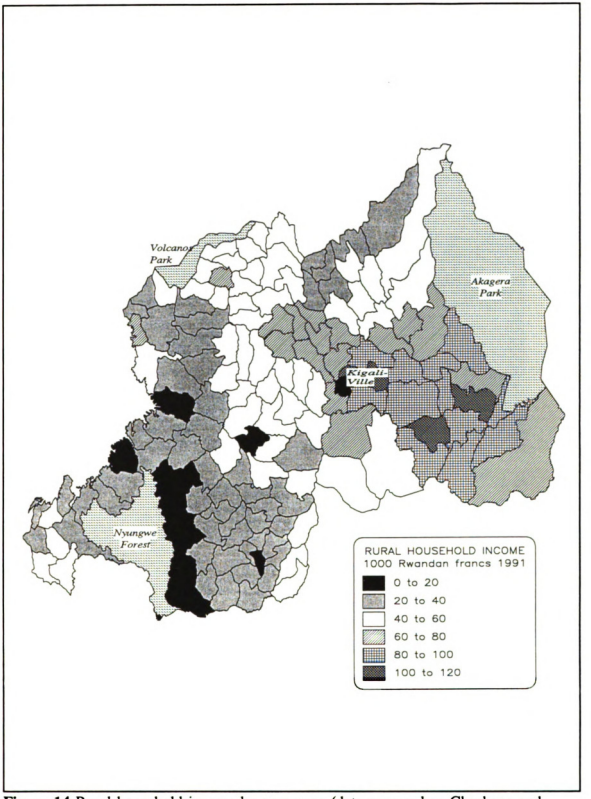

Figure 14 Rural household income by commune (data source: ben Chaabane and Cyiza 1992; MINIPLAN 1992)

Photo 7 Expansion of cultivation onto steep slopes and in valleys, Nyamagabe Commune (photo by author).

Photo 8 High rural population densities in Butare associated with large numbers of trees on farms, Huye Commune (photo by author).

Photo 9 Farmer afforestation of marginal land of low population density. Banana field (*urutoke*) surrounds the house, Karama Commune (photo by C. den Biggelaar).

Photo 10 The clearance of former pasture: Expansion of cultivation on the agricultural frontier near Nyungwe Forest Reserve (photo by author).

Photo 11 Clearcut harvest of a communal government Eucalyptus woodlot. Demonstration plot of radical terraces just above the clearcut, Maraba Commune (photo by C. den Biggelaar).

Photo 12 Grevillea robusta planted along the roadside with *umuganda* communal labor. The trees are intensively coppiced by farmers for climbing beans stakes, Karama Commune (photo by C. den Biggelaar).

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CHAPTER VI

IMPACT OF LAND USE CHANGES ON SOIL

A. Introduction

The historical trends affecting land use, the agricultural system, and the degree of pressure on resources that farmers were experiencing throughout the country are reflected in farmer perceptions of changes in their soil. The area of the country that was experiencing the worst poverty and social problems was also the region experiencing the worst declines in soil fertility: Gikongoro and its neighboring prefecture, Kibuye. Marginal environmental conditions of high elevation, steep slopes and poor soils, combined with marginal social conditions of isolation and a low degree of nonfarm economic activity, are reflected in the large percentage of fields with declining soil fertility (Table 11). Farmers reported that 56 percent of the fields in Kibuye and half the fields in Gikongoro had declined in fertility since the farmers first started cultivating the land. This concentration of degraded soils in Gikongoro and Kibuye was common knowledge in Rwanda, but these survey results indicate for the first time that the problem is widespread. Although worse in the highlands, even the newly settled savanna lands in Kigali and Kibungo farmer notice declining soil fertility. Only farmers of Gisenyi, an area of volcanic soils, were not experiencing declines despite living in the region with the highest population densities in the country.

Table 11 Farmer perceptions of changing soil fertility since cultivating field by prefecture (% of fields) (data source: DSA 1991b).

	PREFECTURE				
	BUTARE	BYUMBA	CYANGUGU	GIKONGORO	GISENYI
CHANGE IN SOIL FERTILITY					
Deterioration	32%	30%	44%	49%	26%
No change	56%	63%	48%	45%	66%
Improvement	12%	7%	8%	6%	8%
Total	100%	100%	100%	100%	100%
MEAN CHANGE IN FERTILITY (from -3 to +3)	-.39	-.58	-.80	-1.01	-.41
n (fields)	1121	608	383	576	503

	PREFECTURE				
	GITARAMA	KIBUNGO	KIBUYE	KIGALI	RUHENGERI
CHANGE IN SOIL FERTILITY					
Deterioration	34%	34%	56%	37%	36%
No change	49%	50%	38%	46%	58%
Improvement	14%	17%	6%	18%	6%
Total	100%	100%	100%	100%	100%
CHANGE IN SOIL FERTILITY (from -3 to +3)	-.45	-.34	-1.06	-.41	-.73
n (fields)	780	395	468	443	892

Although Gikongoro farmers indicated that the soil of most of their fields had been deteriorating, the relative degree of change and the reasons behind the changes varied. Fertility and other soil properties varied according to the location of the field, characteristics of the soil, management techniques used on the soil, and characteristics of the farmer. The farmer's perceptions of the changes reflect the circumstances of Rwanda in which the soil had been heavily altered over many centuries by the people who cultivated the land and grazed their animals on it. The farmers viewed the changing soil properties in light of this history: almost all explanations given for declining fertility, texture, depth of the top soil or growth of plants were seen to be due to modifications of their own soil management practices. The reason behind changes in soil management techniques is related, in turn, to the wider questions of increasing pressure on resources.

B. Methods of Soil Maintenance

In the past, the methods of field management were closely related to the distance of the field from the *urugo*, the homestead. As described earlier, the farm was composed of concentric circles of decreasing intensity of cultivation and placement of soil inputs outward from the *urugo*. The fields nearest the homestead were permanently cropped and their soil fertility maintained through the spreading of large amounts of manure. This schematic is only an idealized version of contemporary agricultural practices, where pasture is rare, fallowing sporadic and almost all land needed to be intensely cropped. The historical high variation in intensity of cultivation across space no longer exists. Nevertheless, an echo of the former pattern had been maintained, with the high-value banana, bean and vegetable plants encircling the *urugo*. The effect of distance on soil management was due to more than simply the

ease of transport of manure and other inputs to these fields, it was also tied to the importance farmers place on bananas (Bart 1993). Similarly, the importance of manure and the rites associated with placing manure was tied to the high value farmers placed on cows. Nevertheless, the former method of transferring nutrients from the out-fields to the inner circle of cropped land has become difficult to maintain.

Table 12 reflects the farmers' view of the impact that the changes of the socio-cultural system had upon the soil.[1] Although the fields nearest the *urugo* continued to receive the most intense maintenance and the largest share of any soil inputs available, the soil on these fields has seen the worst decline. Only 21 percent of *urugo* fields were not experiencing a loss of fertility, and 55 percent of all the *urugo* fields had severe declines. The overwhelming reason the farmers gave for the deterioration was declining availability of manure. The lack of manure was seen to affect all the fields, but the impact was felt particularly on those fields that had been the major recipient of inputs of manure in the past.

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[1] The distance from the *urugo* to the field was estimated by the enumerator in terms of minutes walking. All tables of changing soil fertility present results of field-level surveys and refer to farmers' perceptions of the soil on their own fields since they started cultivated that field.

Table 12 Soil fertility by distance from *urugo* (% fields, Gikongoro) (data source: Olson 1992b).

	DISTANCE FROM URUGO (MINUTES)				
	rugo	1 to 4	5 to 9	10 to 19	20 +
CHANGE IN SOIL FERTILITY					
Much decline	55%	40%	27%	15%	33%
Medm decline	19%	17%	18%	22%	20%
Small decline	6%	10%	12%	7%	5%
No change	13%	23%	31%	42%	33%
Small improvement	4%	5%	6%	3%	5%
Medm improvement	1%	5%	4%	6%	2%
Much improvement	3%	1%	3%	4%	2%
TOTAL	100%	100%	100%	100%	100%
N (fields)	70	134	54	55	40
FIRST REASON FOR DECLINE IN FERTILITY					
Lack of manure	73%	65%	64%	38%	66%
Lack of other organic additives	14%	7%	11%	17%	20%
Lack of fallow	14%	18%	30%	10%	26%
Soil old	23%	24%	16%	29%	23%
Poor soil	0%	5%	2%	2%	0%
Erosion	8%	10%	18%	5%	9%
Trees impoverished soil	8%	7%	9%	5%	9%
Too much/little rainfall	0%	3%	2%	2%	3%
Don't know	3%	4%	0%	5%	3%
Other	6%	6%	5%	5%	0%
TOTAL	100%	100%	100%	100%	100%
N (fields)	64	116	44	42	35
FIRST REASON FOR IMPROVEMENT					
Applied manure	67%	72%	56%	77%	60%
Applied other organic additives	17%	6%	11%	15%	40%
Fallow	17%	6%	0%	0%	0%
Deep hoeing	0%	11%	22%	8%	0%
Good variety of crop	33%	6%	0%	8%	0%
Applied chem fertilizer	0%	17%	0%	0%	0%
Good soil	0%	0%	11%	0%	0%
Don't know	0%	6%	0%	8%	0%
Other	0%	11%	22%	0%	0%
TOTAL	100%	100%	100%	100%	100%
N (fields)	6	18	9	13	5

Manure had been the primary means of maintaining and improving the soil for centuries in this area. Farmers explained that the shortage of manure, especially cattle manure, had occurred in the 30 years following the revolution in 1962. The shortage was the dominant explanation for most changes in the soil. All other inputs or techniques were compared to manure, and farmers felt that almost all of the changes they saw in their soils was due to an increase or decrease in manure. A typical response to the question, "why has the soil fertility declined?" was:

> *"La première raison est le manque de fumier parce que nous n'avons pas d'animaux à élever. Un lapin ne peut pas donner du fumier en suffisance. Nos ancêtres au contraire avaient beaucoup de vaches et de chèvres. Aujourd'hui les terres ne peuvent pas être fertiles étant donné qu'il n'y a plus de vaches ni de chèvres."* Group meeting, Kinyamakara.
>
> "The first reason is the shortage of manure because we don't have any animals to raise. A rabbit cannot give enough manure. Our ancestors, on the other hand, had many cows and goats. Today the lands can't be fertile given that there are no longer any cows or goats."

In accordance with the shortage of manure being blamed for the declining soil fertility, adding manure to the soil was the most common response given for those few fields where the fertility was improving. Manure was the powerful input that would save the soil.

A second reason farmers mentioned as a cause of the decline of fertility was the fact that the soil had become old ("like me," older people usually added). This aging of the soil was a fact, a process that only great efforts could prevent.

> *"Bien sûr que nous le constatons. C'est d'ailleurs pour cela que nous faisons tout pour trouver du fumier. Le sol c'est comme l'homme, plus vous ne manger pas, plus vous vieillissez rapidement."* Group meeting, Kinyamakara.

> "Of course we notice it [the aging of the soil]. That is exactly why we do everything possible to find manure. Soil is like man, the less you eat, the faster you age."

Without constantly adding manure and, if the amount of manure was insufficient, fallowing, the process leaves the soil hard and dead, unable to grow crops.

Fallowing was also a traditional technique that farmers had been forced to almost abandon due to small farm sizes. In particular it had been practiced on the fields further from the homestead. The frequency of fallowing depended upon the amount of manure the field was receiving, the type of crop grown and the productivity of the soil. As would be expected, the fields somewhat further from the *urugo*, those that would have been the beneficiaries of fallow, were those mentioned as losing fertility due to insufficient fallow. Although the ability to spread much manure was often spoken of as a dream from long ago, the loss of the ability to fallow was a more recent event and one that young people often mentioned:

> *"Donc, la cause majeure de la diminution des animaux pour vous les adultes c'est la guerre. Et pour les jeunes?"*
> *"Nous, nous pensons que les cultures ne produisent plus bien parce que les parcelles sont devenues très petites. Ainsi, on y cultive tout le temps sans repos alors que dans le temps on pratiquait la jachère qui renouvelait la fertilité au cour de la saison suivante."* Group meeting, Rwamiko.

> "So, the major reason for the decline in animals for you, the adults, was the war [the revolution]. And for the young?"
> "We think that the crops no longer produce well because the farm sizes are too small. Consequently, we cultivate all the time without a break whereas in the past we practiced fallow that renewed the soil fertility during the following season."

Adding cow manure and practicing fallow were not the sole means of adding productivity to the soil. Other sources of "*ifumbire*" (manure or other sources of

organic matter) were gathered from off the fields and added to the soil. The sources were numerous. Near the homestead, these included ashes from the cooking fire, sweepings from the courtyard and crop residues. In fields in the valleys, *urukangaga* (Rhynchospora corymbosa) grasses were gathered and incorporated into the soil, but they had become rare with the conversion of valley land to crops. Burning small piles of gathered grasses, branches and residues for the ash was also practiced.

According to the farmers, the most important reason for the decline of soil fertility, however, was the loss of cows. Any lesser explanations were dismissed. The value of the cow remained high as a sign of wealth and for use during important social transactions.[2] Conflict resolution and "corruption" (paying the authorities for whatever reason) were sealed with the transfer of a cow. The brideprice, *indongaranyo*, remained a cow or its equivalent. The manure of cattle was preferred over other manure as being better in quantity and quality. Although the raising and sale of goats, sheep and pigs was more profitable, owning a cow was by far preferable due to the precious manure and the prestige gained. Indeed, raising cattle often required the owner to pay for a herder or for other investments and, since cattle were infrequently sold and most areas were outside of the range of a milk factory, cattle had low return values in terms of money. In prestige value, one cow was worth more than 10 goats, and having 20,000 Rwandan francs ($150, the price of a cow)

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[2] "Cow," rather than cattle, is the term used by the farmers when discussing the role of cattle in their system. The heightened value of the cow, rather than cattle in general, was related not only to their reproductive capability and their milk production but was deeply embedded in the cultural value system. The right to own cows, for example, had been confined primarily to Tutsi before the revolution, whereas the male offspring of the cows being cared for would become the property of the Hutu guard (Maquet 1957).

was "meaningless" if one didn't possess a cow. Reasons given for decline in the number of cows included:

- the deaths of cattle that occurred during the revolution;
- the abolition of the *ubuhake* patron/client system;
- the increasing shortage of pasture land;
- animal diseases, especially *muryamo* (rinderpest); and
- the difficulties poor people experienced in keeping cows. They lost their animals in times of emergency, to pay off debts, during the marriage of a son, or to settle conflicts. Once the animal was gone, they found it very difficult to replace. This problem held for the ownership of other animals, as well.

The decline in the number of cows while the land under crops increased had led to what older people regarded as an imbalance in the system. The imbalance occurred when it was no longer possible to transfer and concentrate large amounts of manure to small cropped areas:

> *"Pourquoi la fertilité du sol a baissé?"*
> *"Regardez combien nous sommes, nous les vieux. Regardent nos enfants, nos petits enfants or nos ancêtres avec leur petit nombre cultivaient ici partout. Nous utilisons le même fumier qu'eux et dans plusieurs cultures. Le fumier ne va pas satisfaire tous les champs. La conclusion est que le sol 'a faim', il a besoin du fumier."* Group interview, Nyamagabe.

> "Why did the soil fertility decline?"
> "Look at how many we are, us the old. Look at our children, our grandchildren. But our ancestors in their small numbers used to cultivate around here. We use the same amount of manure they did but across many crops. The manure isn't going to satisfy all the fields. The consequence is that the soil is 'hungry,' it needs manure."

C. *"Fertilité Sociale"*

The ability of farmers to provide the manure needed by the soil requires enough land to raise cattle. With the loss of the communal pasture, private land became the key to maintaining animals. Rwandan agronomists estimate that a farm of at least one hectare is required to support a cow and half a hectare is required to support a goat or pig. Below that level, farmers should raise chickens or rabbits (Gatera interview). In actuality, farmers with middle-sized farms of between half and one hectare often possessed a few small animals and many raised "borrowed" animals belonging to wealthier farmers in return for their milk and manure. Because of the lack of farmland, the constant search for fodder and grazing land went beyond the boundaries of the farm to take advantage of any grasses growing along roadsides, under trees in communal government woodlots (forbidden but common), in pasture owned by the owners of the animals, or elsewhere. Renting pasture land and/or hiring a herder was also practiced by the richer farmers. The amount of land on a farm, however, was the most important limiting factor for raising animals (confirmed by regression analysis). It determined the amount of land that could be left uncultivated as pasture and to produce fodder and reflected the general economic level of the household and its ability to invest in animals.

The economic level of the household, therefore, does have a direct bearing on the capability of the household to maintain the fertility of the soil. The resources required, such as animals and land, were not available in all families, particularly in female-headed households and in poorer families. The term describing the situation in Gikongoro, in which a family's social standing reflected it's soil fertility and vice versa, is *"fertilité sociale,"* or "social fertility" (Gatera interview). Richer families

owned animals and other resources to maintain their soil fertility and that soil fertility reflected their high social status; whereas poorer families experienced poor soil fertility and soil degradation, a reflection of their low social standing.

The social standing of a family, however, was not as important to the soil as manure:

> *"C'est surtout chez ceux qui ont peu de terre mais là aussi ça dépend des méthodes culturales. Si vous élevez des animaux ou si par exemple le champ est tout prés de l'enclos, il est normal que le soja va pousser, conséquence de la fumure. Que ce soit dans l'inombe, mugugu ou urusenyi, la fertilité baisse si vous n'élevez pas d'animaux."* Group meeting, Kinyamakara.

> "It [declining soil fertility] is especially on the farms of those who have small farms, but there again it depends on the agricultural methods. If you raise animals or if, for example, the field is right next to the house, it is normal that the soybeans will grow, due to the manure. Whether the soil is inombe, mugugu or urusenyi [types of soil], the fertility declines if you don't raise animals."

A comparison of soil fertility between Gikongoro households of different farm sizes seems to indicate that farm size plays an important role (Table 13). Whereas 87 percent of the fields of the near-landless households (those with less than 0.25 hectare) were experiencing a decline in fertility, only half the fields of the "large" farm households (those with over a hectare of land) were experiencing declining fertility. The question was not whether farmers with more land could increase their soil's fertility, but was simply how were they able to prevent the soil from

deteriorating?

A comparison between farm size groups in their application of manure did not reveal, however, a similar wide differential. Because families with middle-sized farms "borrowed" animals from wealthier farmers, the "manure gap" seemed to have narrowed (see Table 8). The statistics support the conclusion of the older man quoted above. Although the larger farms had more animals, the manure was spread across a wider area. This meant that the actual amount of manure used per hectare varied little

Table 13 Field management and household characteristics by farm size category, Butare and Gikongoro (data source: Olson 1992b).

	TOTAL FARM SIZE (ares)				
	0 to 25	25 to 50	50 to 75	75 to 100	100 and above
USE OF MANURE ON FIELD					
none	70%	50%	54%	52%	50%
a small amount	28%	37%	30%	37%	33%
medium amount	3%	11%	13%	9%	13%
a large amount	0%	2%	3%	2%	4%
TOTAL	100%	100%	100%	100%	100%
DOMINANT CROP SEASON B					
Beans & other annuals	37%	27%	22%	22%	21%
Bananas	20%	16%	18%	17%	10%
Cassava, white potatoes, taro	15%	11%	8%	9%	6%
Sweet potatoes	22%	27%	23%	22%	20%
Coffee, tea	5%	5%	13%	7%	7%
Trees, pasture	2%	6%	13%	14%	25%
Fallow	0%	9%	3%	8%	10%
TOTAL	100%	100%	100%	100%	100%
n (fields)	37	135	79	97	152
TONS OF ANIMAL MANURE PRODUCED ON FARM/YEAR	1.31	4.55	2.18	4.90	9.44
GENDER OF HEAD OF HH					
male	40%	72%	60%	79%	91%
female	60%	28%	40%	21%	9%
TOTAL	100%	100%	100%	100%	100%

between the medium and large sized farms. Approximately half the fields had some manure placed on them in both cases. Only those farms with very little land were significantly different, with only 30 percent of their fields receiving any manure. Nevertheless, those fields were intensely cropped with almost no fields devoted to trees, pasture or fallow.[3] In contrast, the relatively large farm households were able to devote 35 percent of their fields to trees, pasture or fallow. As seen in previous tables, the farms with more than a hectare were able to continue some of the elements of the traditional system of maintaining fertility.

It comes to no surprise that variations in farm size makes a difference in the ability of farmers to spread manure and that changes in soil fertility vary between farm size groups. Sufficient land provides the means to support animals and relieve cultivation pressures. No information comparing the farm size or wealth of ethnic groups is available since farmers were not asked their ethnicity, but farmers and others in informal and group interviews indicated that few differences remained between groups. Differences between households headed by men and women in ability to raise animals, however, are a magnification of the differences between households of varying farm sizes. Many female-headed households experienced severe shortages of productive land, labor, animals and trees. They were representative of a marginal group in society: old, with very small farm sizes, few animal resources, poorly educated and with difficulties in earning off-farm income (Table 14). In cases where women were heads of household due to separation from their husbands, they often

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[3]The "dominant crop in season B" variable was determined from responses listing the 4 to 6 most important crops that had been grown on the field the previous season (season "B", from February to June, 1992). Cluster analysis grouped the crops into 7 meaningful categories. Each represented a common crop mixture. Pasture is often found under trees in woodlots, for example.

had no labor or other assistance from those living nearest to them, their in-laws. The women indicated that 78 percent of their fields had declining soil fertility, a higher rate than the near-landless. The explanation may be that they have access to only one-third the amount of manure of households headed by men. This large difference is probably due to a combination of loosing rights to the family's animals when the marriage dissolves (to the husband or his family), the inability to herd cattle or sheep

Table 14 Perceived soil fertility by gender of head of household, Gikongoro (data source: Olson 1992b).

	GENDER OF HEAD OF HOUSEHOLD	
	male	female
CHANGE IN FERTILITY		
deterioration	57%	79%
no change	30%	20%
improvement	13%	1%
Total %	100%	100%
MANURE APPLICATION		
none	52%	63%
small quantity	33%	30%
medm quantity	12%	5%
large quantity	3%	2%
Total %	100%	100%
N (fields)	402	104
TONS OF MANURE PRODUCED BY ANIMALS PER YEAR	6.04	2.04

(cultural factor), and the initial poverty of many of these households while with husband. These households also are animal poor: widows and other women heading households often raise only a goat.

D. Levels of explanation

The reasons given by the farmers for the decline in their soil reflects their experience with managing the soil. In this study of the Gikongoro farmers' perceptions of their soil, broader scale environmental variables such as elevation, rainfall, parent material and soil capability collected from maps of 1:250,000, did not provide any insights. The environmental characteristics that were useful in understanding patterns of land use and farm soil changes were of micro scale, in particular at the level of the hill. The hill remains the framework of farm management, although the idealized schema of homes being placed on the tops of hillsides and the lower slopes being reserved for pasture or trees has been replaced by houses being scattered across the hillsides and every bit of hillside is being cultivated. Nevertheless, remnants of the old system remain, but often only due to the fact that the steepest slopes are found on the lower hillsides. The valley land remains a special resource, with its own system of management and a different tenure system than of the hill fields. Changes in fertility of the valleys were often expressed with particular dismay because these fields had remained fertile for many years through fallowing during the rainy season and the addition of nutrients washed from the hillsides. Bunds were often placed in patterns to slow the drainage of water coming from the hills and to thus benefit from sediments. In addition, farmers added grasses to the soil as a green manure when preparing their bunds. Farmers indicated that the soil of half the valley fields had declining fertility. Frequently mentioned was the paucity of nutrients now washing down from the hills, a situation blamed on the erosion ditches for trapping the nutrients, and the decline of nutrients left on the hillsides.

An attempt was made to identify which factors from different levels would be most statistically correlated with variations in changing soil fertility on the field. Some household characteristics that affected access to productive resources were examined, including farm size, gender of head of household, household labor and off-farm income. The significance of the age of the head of household may be partially due to labor constraints but may also be due to the manner in which the question was posed: "Has the fertility changed since you have been cultivating this soil?" Older people had a longer time span to view the changes, whereas younger people were unaware of the quality of the soil in the past. A similar difficulty arose with determining the significance of the number of years the field had been cultivated; in many cases an estimation of a rate of change over time is not possible. Nevertheless the statistics do give an indication of the importance of relative wealth and ability to invest in the farm with resources provided by on- and off-farm sources. Variations in two other productive resources available at the farm level, farm sizes and numbers of animals on the farm, also are reflected in the soil. The field variables, on the other hand, relate more to the importance of management techniques used by the farmer: maintenance of grass strips, placement of manure, and use of fallow.

CORRELATION COEFFICIENTS ASSOCIATED WITH PERCEIVED CHANGES IN SOIL FERTILITY
445 FIELDS IN GIKONGORO[1]

(positive coefficients related to increasing fertility, negative with decreasing fertility)

HOUSEHOLD CHARACTERISTICS	
Age of head of household[2]	-.2003**
Female headedness[2]	-.1936**
Total on- and off-farm income[3]	.1875**
Value of agricultural production[3]	.1533*
Number of animals raised by hh (index)[2]	.1285*
Farm size (ha)[3]	.1255*
Income earned off-farm[3]	.1254*
Land in woodlots (ha)[3]	.1152
Number of people in household[3]	.0708
FIELD MANAGEMENT	
Number of years field has been cultivated[1]	-.2589**
Maintenance of grass strip on erosion ditch[1]	.1832**
Amount of manure applied to field[1]	.1299*
Tenure of field (owned, rented)[1]	.0573
Maintenance of erosion ditch[1]	-.0470
PERCEIVED SOIL CHARACTERISTICS	
Decline in organic matter[1]	-.4475**
Quantity of organic matter in soil[1]	-.3048**
Decline in depth of top soil[1]	-.2558**
Assessment of current fertility[1]	-.2036**
Degree of erosion[1]	-.1928**

2-tailed significance: * - .01 ** - .001

Data sources: [1] Olson 1992b; [2] Olson 1992a; [3] DSA 1990.

E. SUMMARY

Farmers have a very clear perspective of the reason behind the deterioration of their soil: their inability to provide manure in sufficient quantities. The cultural significance of cows may explain part of the emphasis placed by farmers on manure, but the vital role manure played in improving and maintaining the soil surrounding the homestead, allowing people to cultivate the same fields for generations, cannot be underestimated.

The worst declines in fertility occurred next to the homestead where the soil had been best due to large inputs of manure. This decline was acutely felt. Elsewhere, however, the soil also deteriorated due to the breakdown of the fallow system as well as to the lack of manure and other inputs. Valley soils, an important source of dry season food and one of the rare sites in Gikongoro where high-value crops such as sorghum would grow well, were also part of the general decline.

The declines in soil fertility were not uniform across households but varied especially according to farm size and gender of head of household. The fields of those households able to invest in animals and other inputs were not experiencing as severe declines in soil fertility as the poorer households who were unable to employ soil fertility maintenance techniques.

Photo 13 "Les rochers qui affleurissent" or growing rocks on an eroding hillside. Muko Commune (photo by author).

Photo 14 Landslides in Nyamagabe Commune (photo by author).

Photo 15 Grevillea robusta and setaria planted on the upper slope to stabilize the terrace. Karama Commune (photo by C. den Biggelaar).

Photo 16 Gully erosion caused by road run-off. Karama Commune (photo by C. den Biggelaar).

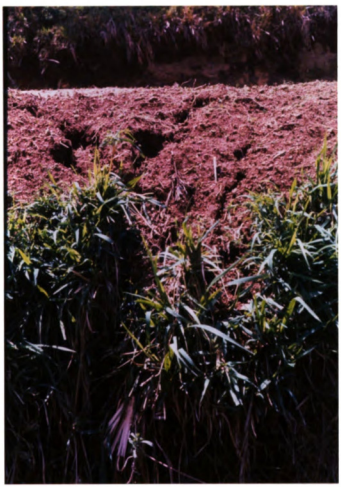

Photo 17 Gully formation following the breakdown of the Setaria grass line (photo by David J. Campbell).

Photo 18 Poorly mulched coffee field. Maraba Commune (photo by C. den Biggelaar).

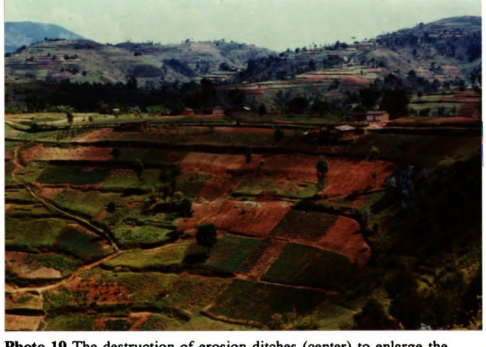

Photo 19 The destruction of erosion ditches (center) to enlarge the fields' surface and as an act of protest against governmental authority (photo by author).

CHAPTER VII

EFFECTS OF AND RESPONSES TO DECLINING SOIL FERTILITY

A. Introduction

The effect of the declining soil fertility has been felt particularly in Gikongoro, especially central and western Gikongoro, more so than Butare or the rest of the country. Indeed, the principal constraint to increased agricultural production in Gikongoro was seen to be a shortage of manure. Small farm sizes, plant diseases, labor constraints and other problems were considered insignificant compared to the decline in soil fertility and lack of manure (Table 15). Butare farmers were also emphatic on the importance of "old" soil and the lack of manure, but many mentioned small farm sizes as being a more important constraint.

The declines in soil fertility most affected those households who could not sustain additional losses. These families had small farms, few animals, low non- and off-farm incomes and were, in sum, very poor. They attributed their increasing poverty to the additional stress of soil degradation. The situation was grim, indeed, for these families. When asked to describe the impact of the changing soil characteristics on their families, they replied with narratives of their children's nutrition and future:

> *"Ils vont mourir c'est tout. Ils n'attendront pas vingt ans puisque dans cinq ans seulement la plupart d'entre eux seront déjà mort. La faim va les décimer. Remarquez qu'on ne peut trouver un travail nulle part. Plusieurs ont déjà quitté l'école parce qu'ils n'ont rien à manger. Certains étaient très intelligent. Ils n'ont pas assez de force pour cultiver; où d'ailleurs cultiver? ils deviennent des délinquants ou des*

Table 15 Perceived principal constraints to increased production, Butare and Gikongoro (data source: Olson 1992a).

	BUTARE	GIKONGORO	TOTAL
PRINCIPAL CONSTRAINTS			
lack of manure	42.5%	81.0%	54.5%
poor or old soil	20.7%	7.6%	16.6%
lack of land	18.4%	10.1%	15.8%
lack of labor	5.7%		4.0%
lack of rain	6.9%		4.7%
other	3.4%	1.3%	2.8%
don't know	2.3%		1.6%
TOTAL	100.0%	100.0%	100.0%
SUFFICIENT LAND TO FEED THE FAMILY?			
yes	37.9%	3.8%	27.3%
no	62.1%	96.2%	72.7%
TOTAL	100.0%	100.0%	100.0%
N (households)	152	95	247

mendiants. D'autres quittent le village et vont en ville à cause de la faim." Group meeting, Muko.

"They will die, that's all. They won't make it to 20 years old because before reaching 5 most will be dead. The hunger will kill them. Notice that you can't find work anywhere. Many have quit school because they had nothing to eat. Some were very intelligent. They don't have enough strength to cultivate, but where to cultivate, anyway? They will become delinquents or thieves. Others leave the village and go to the city because of the hunger."

These intense feelings of hopelessness and poverty was reflected in other questions asked about coping with the effects of the degradation. The soil degradation was mixed in people's minds with their general decline of income and restrictions of new opportunities. Households in Gikongoro linked declining soil fertility directly to

the quantity of food they have to eat. They often eat only once a day, and often only sweet potatoes. Most households interviewed in Butare appeared to be not as badly off and mentioned a switch to buying more food or changing what foods they eat.

B. Government Responses: The Battle Against Erosion, or the Fight Against the Farmer

The response of the government to this situation was a return to policies from the colonial period: enforced digging of erosion ditches. The common perceptions farmers had of their soils— that soil fertility was rapidly declining primarily due to the shortage of manure— was contrary to the view of governmental authorities. Technicians in the government sounded warnings of overpopulation in the steep hills of the country and of the profound gravity of the danger posed by erosion.

Unfortunately for the government, the maintenance of the terraces built during the colonial era had been abandoned after independence because the terraces were seen as a symbol of colonialism (Musema-Uwimana 1979). Indeed, most terraces had been destroyed in anger (Lewis 1992). Nevertheless, the development plans of the Second Republic of President Habyarimana, starting in 1973, placed an accent on "satisfying the food needs of the population, thanks to a strategy based foremost on the protection of the soil" (Musema-Uwimana 1983).

The Battle Against Erosion ("*La Lutte Anti-Erosion*") was re-launched by the new government of President Habyarimana with the establishment of a Soil Protection Service in the Ministry of Agriculture and a massive education program aimed towards the farmers. Staking materials were bought and distributed to the local sectoral governments and nurseries were established to reproduce the grass plants for

the grass lines. Precisely the same erosion control methods introduced by the colonial authorities were adopted, erosion ditches (*fossé isohypse*) with the upper banks planted with Setaria or Pennisetum grass.

Umuganda was again the tool used to implement the program. The farmers were ordered to dig new ditches and plant grass lines. Between 1974 and 1979 in Gikongoro, every year an additional 2,000 to 3,600 hectares were newly protected against erosion. By 1979, 15 percent of the Gikongoro was under protection. The situation in Butare was less impressive with only 7 percent of the land protected by 1979. Seventeen percent of the country as a whole was put under protection in those five years. These immense efforts did require large contributions of labor by farmers, but even the Ministry of Agriculture admitted that other aspects of "rural development" (such as growing food) had suffered (Musema-Uwimana 1979).

A problem recognized by the Ministry of Agriculture was the lack of scientific research that had been conducted in Rwanda on the effect of different erosion-control methods. The agricultural research station (ISAR) was instructed to augment its efforts (Musema-Uwimana 1983). When Nyamulinda wrote a *perspective* on the state of knowledge and research on erosion in Rwanda in 1986, he came to a similar conclusion. Although, as he stated, the degradation of soil in Rwanda was due to hydric erosion, research on erosion in Rwanda was still insufficient in both space and time. It was fragmentary, individualistic and too academic, with almost all research being conducted outside the realities of Rwandan agriculture and with no one able to provide any recommendations to extend to farmers. The methods farmers actually were using to reduce erosion (mulching under banana plants, planting trees and

bushes around the homestead and throughout their fields, leaving crop residues on the field, fallowing and, in the northwest, small terraces) were not considered (Nyamulinda and Ngiruwoneanga 1992).

Despite the concern over a lack of scientific evidence of the utility of the ditches, an order was issued by the president that the entire country must be covered by anti-erosion measures by the 1986-87 agricultural year (Nzindukiyimana 1988, Guichaoua 1991). As in the colonial period, entire weeks or more were spent by farmers digging erosion ditches. Burgomasters, the communal authorities, were obliged to implement this campaign by whatever means necessary since the central authorities updated their reports of communal activities every three months (Guichaoua 1991). Communes who did well were to be rewarded with development activities (Nzindukiyimana 1988).

Even considering probable exaggeration by the authorities, approximately one billion Rwandan francs ($6 million) worth of labor were invested annually in the *umuganda* program by the population (labor being valued at $.60 per person per day) (reported by the Ministry of Plan, cited in Guichaoua 1991). Of that amount, 56 percent was devoted to the Battle Against Erosion campaign, 15 percent to construction of communal buildings, 21 percent to maintenance of communal roads, 3 percent to waterworks and 3 percent to agricultural programs. This distribution reflected, as Professor Guichaoua wrote, a "true fixation" of the authorities on erosion control works (p. 563, Guichaoua 1991).

In January 1988, the president's goal year for the entire country to be covered by erosion control works, the Ministry of Agriculture released a report on the achievements of the Battle Against Erosion program. Already, the area of 38 of 133 rural communes in the country were over 90 percent protected. Gikongoro Prefecture was second only after Gisenyi Prefecture (the president's home) in amount of land protected with 87 percent of the land covered by erosion ditches. Butare was again not quite as impressive with 78 percent of its area was covered. Even Kibungo, a savanna region in the East of gentle rolling hills, was 74 percent covered. It was nevertheless "insufficient and regrettable that the East still harbored illusions that erosion didn't concern them" (p. 2, Nzindukiyimana 1988). It was also regrettable that some of the terraces were being destroyed (Nzindukiyimana 1988).

The response of the farmers to this forced activity was predictable. The old erosion ditches on their farms were still associated with the forced labor activities of the colonial period, and the similarities between that period and the new "*lutte*," battle, were not difficult to perceive.

> *"Y-a-t-il une certaine différence entre le deux fossés?"*
> *"Il n'y a pas de différence. Mais il faut remarquer les méthodes de travail de chaque époque. Sous Rugemintwaza, il fallait obligatoirement se présenter même si on avait des malades à la maison. Les vieilles comme nous n'étaient pas dispensées de ces travaux. Maintenant, nous avons compris pourquoi il fallait les creuser. Sous Habyarimana, on obligeait les gens à payer une amende sinon on confisquait tout ce qui leur tombait sous les yeux, y compris les habits. Et puis, c'est toute la famille qui allait dans l'umuganda: les enfants, adultes et les parents."*
> Group meeting, Kinyamakara.

> "Is there a difference between the two types of ditches [those of the colonialists and of the Second Republic]?"
> "There is no difference. But you should note the work methods of each period. Under Chief Rugemintwaza, it was obligatory to be present even if you had sick people at home to care for. The old women like us

> weren't relieved from that work. Now, we understand why they have to be dug. Under Habyarimana, people were obligated to pay fines otherwise everything was confiscated that they saw, including clothes. And, it is the entire family that goes to work at *umuganda*: the children, the adults and the grandparents."

Apparently, the only real difference lay in the methods of enforcement:

> *"Les premiers qui ont été creusé du temps d'Emmanuel nous ont été coûté beaucoup d'effort car c'est sous le fouet qu'on les creusait. Les derniers ont été creusés par les travaux communautaires qui, eux aussi, il faut le dire, étaient forcés. On nous amenait de force a l'umuganda ou confisquerait nos houes quand on s'absentait. Souvent, on devait payer une amende de 100 à 300 francs."* Group meeting, Kinyamakara.
>
> "The first, dug in the time of Chief Emmanuel, cost us much effort because they were dug under the whip. The current ditches were also, it must be said, dug with forced communal labor. They brought us by force to *umuganda* or confiscated our hoes if we were absent. Often we had to pay a fine of 100 to 300 francs."

The feelings of farmers towards the ditches and grass lines on their farms were necessarily mixed. The extension agents, the burgomasters and even the president were constantly teaching farmers about the benefits of the ditches and their importance to prevent famines: the ditches would stop erosion from occurring on their fields and would lead to higher production, while the grasslines along the ditches would provide fodder for their animals. The education campaign was met with skepticism. The utility of the grasses was seen as minimal: "I don't have any animals. Why should I plant grasses that themselves use the nutrients in my manure?" Many of those with animals later, however, realized the benefits of the production of fodder by the grasses (although they require much maintenance and replanting every 2 to 3 years).

Feelings towards the ditches also were mixed. Not only were farmers forced to dig ditches with *umuganda*, they also were forced to maintain the ditches before the

rainy seasons under threat of fines. Some farmers saw the ditches as actually increasing problems of erosion. Because rainwater collected in the ditches, the soil remained saturated for longer periods. In areas of shallow bedrock or steep slopes, this could (and did) lead to slippage and landslides. A more common complaint was that once the ditches were full of water and overflowed, the water caused gullies.[1] Others, however, saw some benefits of the ditches, especially their ability to "trap" the organic matter (and manure) from the fields above. This was then scooped up with hoes or shovels (eventually undermining the terrace and causing slippage [Lewis 1992]) and spread over the lower fields. Rarely, however, was erosion control mentioned as the most important benefit of the ditches.

The result of the forced nature of the ditch digging and maintenance was resentment towards the authorities and denial of the importance of erosion on their fields. Indeed, the word "erosion," "*isuli*," was so associated with *umuganda* and being forced to constantly fight against it that in the formal survey, 94 percent of farmers in Gikongoro and Butare said they had no more erosion on their fields, it had been completely conquered with the ditches and grass lines. In group interviews, as well, people insisted that, at least in their neighborhoods, erosion was simply a problem of the past.

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[1]These problems of the *fossés hydrique cloisonné*, originally designed for much gentler slopes, also were realized by researchers who published articles in the late 1980s and early 1990s comparing different erosion control methods (Nyamulinda 1987, Berding 1991, Réseau Erosion Bulletin numbers 12 and 13, edited by Eric Roose). The erosion ditches did not stop erosion, since the slope of the fields remained important, but simply slowed the transport of nutrients to the valley. The local extension agents and burgomasters, however, saw farmer reluctance as resistance to modernity, and to themselves.

Table 16 Farmer perceptions of erosion on their fields, Gikongoro (data source: Olson 1992b).

	POSITION OF FIELD ON THE HILLSIDE				TOTAL
	summit	hill: shoulder	hill: toe	valley	
DEGREE OF EROSION					
none, no erosion	75%	64%	51%	85%	64%
yes, a bit	11%	18%	20%	8%	16%
yes, a medium amount	3%	6%	7%	2%	5%
yes, much erosion	11%	11%	23%	5%	15%
TOTAL	100%	100%	100%	100%	100%
N (fields)	36	146	221	110	513
IN FIELDS WITH EROSION:					
REASONS FOR EROSION (2 responses possible)					
Steep slope	11%	33%	49%	19%	40%
Water from above forceful	22%	23%	28%	50%	28%
Ditch above overflows	44%	27%	9%	13%	16%
No ditch above		10%	4%		5%
Gully channels through field	33%	10%	16%	6%	14%
Soil erodes easily	22%	6%	12%	13%	11%
River overflows		2%	2%	25%	4%
Strong rains	11%	13%	11%		11%
Don't know		2%	1%		1%
Other		2%	2%		2%
Total	144%	127%	135%	125%	132%
N (fields)	9	52	106	16	183

The field-level results, however, indicate that farmers were very aware of the effects of erosion on their fields. The word erosion was not used by farmers to describe the impacts, but long explanations were given of the effects of water infiltration on the texture of the soil, of rainfall causing soil and manure to fall into the valleys, and of water removing the small nutrients from their soil. A direct question asked while standing on their fields revealed, however, that farmers identified 36 percent of their fields as having erosion (Tables 16 and 17), especially those fields along the hillsides. Steep slopes were the most common reason farmers mentioned as the cause of the erosion, but the overflow from ditches above the fields was also a frequent response.

Table 17 Farmer perceptions of field characteristics by slope category, Gikongoro (data source: Olson 1992b).

	SLOPE IN DEGREES				
	0 to 3	4 to 7	8 to 14	15 to 28	>29
DEGREE OF EROSION					
none	74%	67%	79%	57%	38%
a bit	7%	13%	13%	21%	19%
medm amount	4%	7%	2%	5%	13%
much	15%	13%	6%	17%	31%
TOTAL	100%	100%	100%	100%	100%
CHANGE IN FERTILITY					
improvement	18%	6%	15%	11%	8%
no change	28%	34%	24%	28%	27%
decline	55%	60%	62%	61%	65%
TOTAL	100%	100%	100%	100%	100%
CHANGE IN TOP SOIL DEPTH					
large increase	2%	6%	7%	3%	
small increase	4%	6%	6%	10%	6%
no change	58%	58%	48%	45%	17%
small decline	13%	13%	20%	18%	25%
large decline	22%	16%	18%	20%	50%
don't know		1%	1%	3%	2%
TOTAL	100%	100%	100%	100%	100%
N (fields)	45	104	120	154	48

The tension over the repression used to create and maintain the ditches led to acts of protest by farmers. Once multi-partyism was allowed in 1991, the unquestioned total power of governmental authorities was gone. Farmers began to join opposition political parties and believed that the end of the Second Republic and the rule of President Habyarimana was near. A power struggle developed between the authorities (the burgomasters were all, necessarily, members of the ruling political

party) and the farmers who rebelled in principle against all forced measures of the authorities. Farmers tested their new power by refusing to conform to the rules enforcing erosion ditches, grass lines, compost bins, mulching coffee and interdictions on burning. These techniques were all laden with political meaning and associated with oppression in the farmers' minds.

The techniques also were not correcting what the farmers saw as their most important problem, declining soil fertility. The erosion ditches could, at best, slow the rate of the decline but not augment the fertility. The compost pits were not seen as very useful because the grasses and leaves in the bins did not decompose rapidly without manure, and farmers preferred to place the manure directly on their fields. Interdictions on burning were resented, as well, especially in western Gikongoro where it had been the method used to maintain young Eragrostis grasses for the animals. Many farmers noticed that the unburned grasses (especially the tough Eragrostis) and weeds they placed in the soil did not decompose once the organic matter declined in their soil. Unlike the ashes from burned grasses and weeds, the grasses and weeds did not seem to benefit the crops. In short, the techniques enforced by the extension agents and the burgomasters were unpopular and did not seem to be solving the problem of declining soil fertility as identified by farmers.

This problem was real. Governmental statistics document a decline in total production over time. With increases in population at around 3.2 percent annually, the impact on available production per capita was severe. The two sources of production information, the DSA and the Ministry of Agriculture's agricultural census, both indicated that the prefecture of Gikongoro was producing fewer tons of food crops

over time. The DSA estimated that between 1984 and 1988, the crop most affected was beans. The annual total production steadily declined by 33 percent, from around 12 to 8 thousand tons. Sorghum production declined 20 percent, from around 10 to 8 thousand tons. Butare experienced similar declines of production of beans, from 36 to 22 thousand tons, and sorghum, from 31 to 19 thousand tons (DSA 1991). The Gikongoro agricultural census data, based on estimates by extension agents in the communes, show an even steeper decline in bean production, but no decline in sorghum (CSAG 1991). Both sources indicated that as the production of these nutritious crops declined, the production of sweet and white potatoes increased. For example, sweet potato production increased 36 percent from 92 to 125 thousand tons. These statistics reflect a very rapid change in farmer decisions of what crops to grow and what crops would produce.

Both these sources provide statistics from 1990 a famine year in Gikongoro. The production of all crops was sharply down. The reasons given by authorities for the famine were numerous, from declines in food aid and soil degradation to the start of the war. Analyses by the meteorologist in Gikongoro showed that the explanation given by farmers, of particularly erratic rainfall, heavy hail storms and a late beginning of the rainy season, were probably also important factors. The rainfall in September and October of 1989, the first two months of the 1990 agricultural year, was only 60 percent of normal (Genukwaya 1992).

Although the difficulties Gikongoro farmers were experiencing were recognized, the government did not ask for additional food aid or provide other support (Newbury 1992), perhaps because by this time food shortages were chronic in

Gikongoro and a new decline was seen as simply the usual state of affairs. In a situation of chronic food shortages and steadily declining food production, a famine early warning system or emergency responses to new information of food shortages were difficult to justify. In retrospect, it is now clear that 1990 was the first year of a crisis period for Gikongoro, and for Rwanda.

C. Farmer Responses to Increasing Pressure on Resources

Meanwhile, farmers were being forced by necessity to respond to the declining fertility of their soil and to their reduced ability to support their families. The agricultural system itself began to be reshaped, especially after the mid-1980s, by farmer reactions to the soil degradation. The first responses to the decline of soil fertility, however, were associated with attempts to readapt the old methods that had once maintained the fertility for so many years. New practices also were developed, but usually these practices were very labor intensive (Tables 18 and 19).

Table 18 Perceptions of techniques to improve soil fertility, Butare and Gikongoro (data source: Olson 1992a).

	COMPOST	MANURE	FERTILIZER	FALLOW	DEEP HOEING
PERCENT WHO USE					
Butare	92.5%	74.7%	9.2%	40.2%	88.5%
Gikongoro	87.3%	84.8%	8.9%	32.9%	78.2%
OPINION OF PRODUCTIVITY					
not productive	2.4%		4.0%	1.2%	5.1%
marginally productive	26.1%		4.0%	2.0%	38.3%
moderately productive	56.5%		9.5%	45.8%	39.1%
very productive	15.0%	100.0%	45.1%	51.0%	17.0%
don't knows			37.5%		.4%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%
CHANGE IN USE					
diminished their use	13.8%	34.4%	1.6%	22.5%	9.5%
no change	64.4%	24.5%	95.7%	70.8%	57.3%
increased their use	21.7%	41.1%	2.8%	6.7%	33.2%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%
N (households)					

Table 19 Reasons for change in use of techniques to improve soil fertility, Butare and Gikongoro (data source: Olson 1992a).

	COMPOST	MANURE	FERTILI-ZER	FALLOW	DEEP HOEING
REASONS FOR DIMISHED USE					
lack of materials	85.7%	1.1%			5.3%
lack of animals	2.9%	98.9%			
lack of money			75.0%		
lack of land				60.7%	26.3%
lack of labor	2.9%				5.3%
not productive many crops				25.0%	
many children to feed especially for one crop			25.0%	12.5%	52.6%
other	8.6%			1.8%	10.5%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%
REASONS FOR INCREASED USE					
possess more animals		52.9%			
lack of animals	32.7%			16.7%	
lack of labor				58.3%	7.2%
increased soil fertility	32.7%	23.5%	28.6%	8.3%	9.6%
increased production	25.5%	18.6%	71.4%		9.6%
better root penetration					33.7%
increased soil thickness with manure, some increase in fertility					3.6%
especially for one crop	5.5%			8.3%	33.7%
animal litter		3.9%			
animal fodder				8.3%	
other	3.6%	1.0%			2.4%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%

1. On-farm Responses to Declining Soil Fertility

a. Production of Manure

The first response farmers often gave to questions concerning how they are responding to declining fertility was that they tried to increase the amount of manure available to spread on the fields. This conforms to the historical role of manure and to the contemporary view that the reason behind the decline in soil fertility was the lack of manure. The attempt to increase manure production was constrained by the same reasons behind the original decline of animals: the lack of pasture and other fodder and the inability to invest in buying and maintaining the larger animals. Therefore, several changes in land use occurred. These included:

- planting and maintaining grasses and trees for fodder production. Grasses were planted along the erosion ditches and multi-purpose trees (e.g., ficus) usually were planted along the edges of fields;

- conversion of the most marginal fields (those where cassava would no longer grow) to pasture or, more commonly, trees with pasture underneath;

- attempting to find animals to guard ("borrow") from wealthier farmers in return for the manure. Previously the practice was done only with cattle (in which case the milk of the cow was a further incentive) and sheep; recently the practice was enlarged to include even smaller animals such as goats and pigs;

- raising small animals, especially goats and pigs but even rabbits, instead of focussing solely on cattle that require large amounts of food (Table 20) (Rwamasirabo 1990).

- tethering or placing animals in stables, and cutting grasses and tree leaves to carry as feed to them in order to "capture" the manure that would have been lost. Goats and pigs are the most common animals stabled or tethered.

Table 20 Possession of animals, Butare and Gikongoro (data source: Olson 1992a).

	PREFECTURE	
	Butare	Gikongoro
PERCENT OF HOUSEHOLDS WITH ANIMALS...		
Cows	44%	39%
Goats	45%	40%
Sheep	13%	22%
Pigs	37%	57%
(n)	158	96
MEAN NUMBER OF ANIMALS IN HOUSEHOLDS WITH ANIMALS...		
Cows	1.96	2.03
Goats	1.94	2.61
Sheep	1.70	2.57
Pigs	1.50	1.31

These responses have led to a major change in the agricultural system: the location of fodder production has shifted from communal land to private farms (Table 21). Around half of the households mentioned obtaining some fodder from off the farm (from "neighboring farms"), usually whatever grass is growing along roads, streams or perhaps under the communal government's woodlot. Most responses, however, concern where the fodder was obtained from on the respondents' own farm: pasture, cutting grasses or tree leaves, purchasing fodder (e.g., renting pasture land) or using agricultural residues. The new devotion of precious farmland to the production of fodder is, however, a major concession to the importance of manure and animals in the system.

Table 21 Means of obtaining and change in availability of fodder (households with animals in Rwanda) (data source: DSA 1991b).

	SELECTED PREFECTURES		RWANDA TOTAL
	BUTARE	GIKONGORO	
MEANS OF OBTAINING FODDER (% of 3 possible responses)			
Pasture on own farm	77%	85%	72%
Pasture on neigh. farm	46%	54%	33%
Communal pasture	8%		3%
Cut tree leaves	20%	28%	28%
Cut grasses	33%	66%	42%
Purchase fodder	9%	10%	11%
Agricultural residues	33%	11%	25%
Other	7%	1%	12%
TOTAL	232%	255%	227%
n	90	71	872
CHANGE IN AVAILABILITY OF FODDER (% hh with animals)			
Large increase	11%	27%	24%
Small increase	17%	16%	20%
No change	20%	14%	17%
Small decrease	28%	20%	23%
Large increase	25%	23%	16%
TOTAL	100%	100%	100%
n (households)	65	70	807

Table

Table 22 Application of manure, Gikongoro (data source: Olson 1992b).

	DISTANCE FROM URUGO IN MINUTES					
	urugo	1 to 4	5 to 9	10 to 19	20 to 29	30 to 75
MANURE APPLICATION						
no	23%	46%	61%	73%	74%	79%
yes, small amount	48%	44%	22%	18%	19%	18%
yes, moderate amount	24%	7%	14%	7%	6%	3%
yes, large amount	6%	3%	4%	2%	0%	0%
TOTAL	100%	100%	100%	100%	100%	100%
N (fields)	80	177	86	55	78	33

	TENURE OF BLOC					
	gift of friend/ father in law	inheritance	purchase	granted by authorities	lease (money or in kind)	lease without payment
MANURE APPLICATION						
no	33%	50%	46%	67%	80%	73%
yes, small amount	60%	35%	27%	24%	23%	22%
yes, moderate amount	7%	12%	24%	0%	0%	2%
yes, large amount	0%	3%	3%	9%	0%	2%
TOTAL	100%	100%	100%	100%	100%	100%
N (fields)	15	351	37	33	26	45

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As in the past, placement of manure is very concentrated on the fields surrounding the *urugo* (Table 22). Fields even only five minutes walk from the *urugo* were less likely to receive manure than those adjoining it. The land tenure situation also affected the decision of where manure was to be placed. The land inherited or bought received the most manure, along with land "given" (after the dissolution of a marriage, women heads of household were usually given access to land by their father-in-law). These fields are usually those closest to the home. Land granted by the authorities (after the revolution, for example) was often far from the homestead and in woodlots, they rarely received manure. Rented land receives very little manure for two reasons: it is usually valley land where manure is very rarely placed; and farmers were loath to "give" manure to someone else's soil.

Placement of manure also depended on the crop. Regression analyses indicated that manure was placed most frequently on beans and other seasonal crops (e.g., sorghum), and then bananas. The amount of manure available in the household affected only the quantity placed on the chosen fields, not the percentage of fields receiving manure. Households with larger quantities of manure placed more manure on bananas.

Other techniques that had been in practice for many years were maintained by those farmers who were able to find the necessary resources. These included the gathering of grasses and weeds to incorporate directly into the soil. Female headed households in particular used this practice but complained bitterly about the loss of valley grasses. Eragrostis, a poor substitute, was gathered and placed in compost pits,

used as litter or placed in the soil. Even the future availability of eragrostis, however, was in doubt with the deteriorating level of civil authority.

> *"Après épuisement d'urukangaga nous utilisons de l'eragrostis comme compost. Alors comme on a commencé à faire des feux sur les montagnes, l'érosion va être favorisés et nous n'aurons plus de récoltes."* Group meeting, Rwamiko.
>
> "Once *urukangaga* [Rynchaspora corymbosa] was exhausted, we used eragrostis for compost. Now that they have started to burn the mountains [i.e., eragrostis], erosion will increase and we won't have anymore harvests."

b. Reserving Land in Grass and Trees

Associated with these efforts to raise animals is the recent trend of producing what had been available from communal land on private farms. Setaria and other grasses, usually along the erosion ditches, were maintained as an important source of fodder. The increase in the number of trees on farms, however, was the second largest visible change in land use after the expansion of cropped area. The increase in the number of trees did not appear on the aerial photograph interpretations due to the scale of that analysis (only land cover types of over 6.25 hectares were evaluated). Most trees on the hillsides were not grouped but scattered across and on the edges of fields.

Trees growing in the region originated from the enforced tree planting with *umuganda* during the colonial period. Trees were then planted in government woodlots, along roads and on the hilltops. After independence, the government and expatriate agro-forestry projects established tree nurseries and encouraged tree planting. The results include an increase in availability of seedlings and knowledge of tree planting, more trees in government woodlots, and now more trees on private

farms. This coincided with an increase in the demand for tree products (fruit, fodder and wood) as forests have been converted to cropped land.

Trees are beginning to be considered as an important resource in soil fertility maintenance because they slow erosion, produce animal fodder which increases manure availability, and produce leaves to add organic matter to the soil (Table 23). This attitude towards the role of trees is a radical change from previous times when farmers emphasized the competition between trees and crops on the fields. Evolution of farmer knowledge of tree planting and especially of tree maintenance, has led farmers to develop methods to minimize the competition (den Biggelaar 1994).

In addition to the increase of tree planting on the edges of fields and near the homestead is the conversion of former crop land to woodlots. Fields that had particularly degraded soils, so degraded that even cassava would no longer produce, were being planted with trees.

The practice of devoting land to grass and trees is a reversal of the process that had been occurring for 50 years of conversion of pasture and forests to crops. The newest phase in the evolution of the agricultural system appeared to be moving away from heightened intensification of crop production per hectare to a less intense use of the land. The reasons for the shift were related not to declining population densities but out of necessity to maintain the productivity of the cropped land. The productivity was, as farmers realized, dependent upon additions of nutrients from off the fields, and the farmers were consciously attempting to produce those nutrients to

Table 23 Change in number of trees on farm, Butare, Gikongoro and Rwanda (data source: DSA 1991b).

	SELECTED PREFECTURES		RWANDA TOTAL
	BUTARE	GIKONGORO	
CHANGE IN No. OF TREES ON FARM (% of households)			
Increase	76%	65%	62%
No change	10%	16%	20%
Decrease	14%	19%	18%
TOTAL	100%	100%	100%
REASONS FOR PLANTING TREES (% of 3 possible responses)			
Conserve the soil	21%	51%	21%
Wood production	89%	77%	86%
Fruit	54%	35%	48%
Leaves (mulch, org. matter)	13%	16%	4%
Fodder	4%	8%	4%
Bean stakes	5%	2%	19%
Medicines	3%	1%	1%
Fence around the house	9%	29%	26%
Mark field boundary	28%	33%	32%
Shade			1%
Other	10%	8%	6%
TOTAL	235%	260%	248%
N (households)	155	93	1221

add to the cropped land. Production of the sources of those nutrients, grasses, leaves and especially manure, were becoming part of the on-farm agricultural system.

c. Soil Preparation

Farmers also were adapting a practice that had been used less frequently in the past for the conditions they found in their fields, that of deep hoeing (usually two hoe blades deep, around 30 centimeters). Deep hoeing was a tremendous effort, requiring a pick in some soils:

> *"Nous avons tout essayé! Chez moi par exemple j'ai un pie que j'utilise souvent. J'ai constaté que sans fumier, même le labour profond est inutile. Le labour profond se fait surtout dans les champs où il y a des*

pierres ou bien dans les champs de type inombe." Group meeting, Nyamagabe.

"We've tried everything! At my farm for example I have a pick I often use. I've noticed that without manure, even deep hoeing is useless. Deep hoeing is usually done in fields where there are rocks or in *inombe* [a soil type] soils."

Farmers explained that it had become necessary to conduct deep hoeing more frequently than in the past because of the large amount of top soil lost through erosion. In the past, deep hoeing had been confined to fields where tubers were grown, but more recently it had become necessary for other fields of other crops, as well. The increased reliance on tubers also resulted in an expansion of land subject to deep hoeing.

Unfortunately, the B horizon thus exposed and incorporated into the remaining top soil was hard, sterile and very acidic (Angé 1990). Crops more tolerant of the acidity, such as potatoes or cassava, usually were planted immediately following the deep hoeing. Farmers estimated that three seasons of adding manure were required before the soil could produce sorghum or other less tolerant crops.

Other new methods of preparing soil were being tried. Because burning weeds was forbidden, farmers began to hoe all the weeds into the soil to add "humidity" to the soil. Only the noxious weed *chiendent* (quack grass) was pulled out and left to dry.

"Lors du labour, il faut disperser les mauvaises herbes au dessus du sol pour diminuer la chaleur. Et puis encore, il faut faire comme notre ami Samuel. Il labourait sans ramasser aucune herbe. Ceci a l'avantage que les herbes qui vont repousser retiendront les eaux de l'érosion." Group meeting, Musange.

> "During hoeing, you must spread out the weeds below the soil's surface to reduce the heat [so they don't dry out]. And, you must do like Samuel. He hoes without removing any grasses. Those that regrow retain the erosion water [retain the soil]."

Hoeing from bottom to top, and from top to bottom, were also tried to test their effectiveness of reducing soil loss.

Most erosion ditches existing on fields were maintained, even after the governmental authorities could no longer enforce upkeep. Farmers especially in the middle elevation areas (between 1500 to 1800 meters) appreciated the organic matter trapped in the ditches and realized their effectiveness, if limited, in reducing erosion (small terraces eventually formed over time).

d. Expanding and Diversifying Land Cultivated

In response to the decreasing soil fertility, an attempt was made to rent land that was less degraded or to simply increase the acreage cropped even on degraded soils in hopes of having a larger harvest.

> *"Celui qui a beaucoup de terre peut au moins compter sur la culture extensive. Là où il produiraient par exemple 300 kilos il aura 100 kilos. Mais celui qui n'a qu'une petite parcelle aura par exemple cinq kilos ou même deux kilos."* Group meeting, Nyamagabe.

> "The person with lots of land can at least depend on cultivating extensively. In the field where he had been able to produce 300 kilos he could still produce 100 kilograms. But the person with only a small farm harvests only five or even only two kilograms."

Buying and selling land was discouraged by the government to prevent landlessness. Renting crop land, however, was an unexpectedly frequent occurrence although farmers often complained that they could not find land to rent. Most rented

land was in the valleys, sites of better soils. Rented land was often the last land to receive manure from either the owner of the land or the renter, however, because neither was guaranteed a profit from its future effects.

e. Crop Substitution

Another major change has been a substitution of crops, from those vulnerable to degraded soil to those more tolerant.

The crop most mentioned as suffering from soil degradation was traditional bush beans, the primary protein source and a staple of the Rwandan diet. Beans grown on soils of poor fertility were particularly susceptible to root rot, a complex disease always present in the soil that becomes severe when soil fertility is low. Seventy percent of the bean harvest was lost in 1991 due to root rot (Buruchara interview). Although farmers attempted new mixtures and varieties of beans (there are hundreds of bean varieties actively maintained by farmers [Voss 1992]), the disease had grown worse. Ninety-four percent of the farmers in Butare and Gikongoro reported that bean productivity had declined, and many in Gikongoro had abandoned growing beans (Tables 24 and 25).

Soybeans were being encouraged as a replacement by the agricultural services, especially in Butare. Soybeans require special cooking techniques but were nevertheless being adopted. The loss of the standard bean crop has resulted, however, in a severe decline of protein in the diet. Because purchasing beans was difficult (as discussed in Chapter 3), most people simply ate fewer or none at all.

Table 24 Farmer perceptions of changes in crop yields and in land planted under each crop, Butare and Gikongoro (data source: Olson 1992a).

	SORGHUM	BUSH BEAN	CLIMBING BEANS	PEAS	SOYBEANS	CASSAVA	WHITE POTATO	SWEET POTATO	COOKING BANANA	BEER BANANA	COFFEE
CHANGE IN CROP YIELDS											
decrease	66%	94%	18%	19%	16%	22%	29%	13%	50%	54%	59%
no change	13%	3%	23%	37%	19%	23%	24%	14%	19%	19%	15%
increase	21%	3%	60%	44%	65%	55%	47%	73%	31%	26%	27%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
DEGREE OF CHANGE IN YIELD (-1 to +1)											
Butare	-.46	-.85	.18	.12	.26	.17	-.21	.46	-.19	-.26	-.36
Gikongoro	-.40	-.91	.45	.08	.44	.50	.50	.44	-.19	-.38	-.14
CHANGE IN AREA IN CROP											
decrease	29%	67%	24%	9%	13%	12%	20%	10%	4%	9%	5%
no change	47%	20%	12%	72%	18%	15%	43%	27%	76%	72%	72%
increase	24%	14%	64%	19%	69%	73%	37%	63%	20%	19%	23%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
DEGREE OF CHANGE IN AREA (-1 to +1)											
Butare	-.01	-.36	.02	.08	.32	.42	-.18	.35	.05	.05	.08
Gikongoro	-.13	-.65	.28	-.06	.21	.33	.25	.27	.00	-.07	.06
N (households)	245	243	185	172	211	227	10	252	141	243	169

Table 25 Reasons farmers provided for changing the land planted under each crop, Butare and Gikongoro (data source: Olson 1992a).

	SORGHUM	BUSH BEAN	CLIMBING BEANS	PEAS	SOYBEANS	CASSAVA	WHITE POTATO	SWEET POTATO	COOKING BANANA	BEER BANANA	COFFEE
REASONS FOR DECREASE IN AREA UNDER CROP											
does not produce well	31%	67%	23%	31%	32%	14%	15%	4%	17%	19%	75%
low yields on poor soils	10%	6%	5%			4%	10%		33%	37%	
lack of manure/compost	4%	2%	9%				5%	4%	33%	21%	
plant diseases		15%	26%	6%	4%	7%	15%	13%			13%
lack of land	43%	6%	2%	50%	32%	32%	35%	17%			13%
lack of seeds		2%	5%	6%	14%		15%	13%			
lack of labor	11%	3%	5%		7%	32%		30%		21%	
lack of stakes			21%								
other			5%	6%	11%	11%	5%	17%	17%	5%	
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
N (households)	70	159	43	16	28	28	20	23	6	19	8
REASON FOR INCREASE IN AREA UNDER CROP											
adapted to bad soils				13%	16%	20%		1%			16%
low yields, so need to to increase area	11%	10%				4		1%			
more beneficial than other crops	3%	46%	19%	29%	6%	11%	2%		2%		
early harvest		3%		34%	1%	8%		8%			
intercrops well	3%		30%	16%	18%	1%	11%	1%		2%	3%
produces well			20%	3%	1%			1%	4%	4%	
crop/variety trial	9%	13%		3%	1%	3%	49%	2%			5%
have a lot of land	7%	3%	1%		1%	9%	3%	1%	30%	57%	70%
provides money	4%			3%		29%		22%			
combats famine						9%		22%			
many children to feed	28%	29%		3%	18%	6%	24%	32%	15%	20%	
important food	19%	3%			1%	1%			4%		
many ways to prepare	2%	16%		3%		1%	3%	2%	41%	7%	
preferred taste	2%		2%	3%	12%	1%					
plant diseases	18%	19%	2%		2%	8%		5%	11%	9%	5%
other	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
TOTAL	57	31	115	32	143	164	37	158	27	46	37
N (households)											

An improved variety of climbing beans was introduced by the *Centro Internacional de Agricultura Tropical* that were more tolerant of root rot and had high productivity. Farmers were anxious to obtain the project seeds even though in Gikongoro these beans, also, suffered from diseases.

As reflected in the governmental statistics, sorghum production also declined due to declines in soil productivity and its relatively large land requirements. The decline has nutritional implications since the *pâte* (porridge) is an important children's food. Another product, sorghum beer, has also been an important money earner. Beer bananas also suffered declining productivity, reflecting farmers' bleak impressions of the soil in the *urutoke* fields surrounding the homestead. To compensate, some Butare farmers increased the area under beer bananas because they provide so much profit. Minor crops, such as squash and yams, also were mentioned as disappearing due to the decline in soil fertility.

Farmers attempted to compensate for the losses in production of grains and beans by growing larger areas under tubers. Land increased under cassava, the unpopular "famine food" of last resort and under sweet potatoes. Seventy-three percent of farmers increased acreage under cassava. It grows even on the most degraded soils (except in high elevation zones) and provides a resource in times of famine. Land increased under sweet potatoes, on the other hand, because farmers needed large quantities of food to feed their many children.

The declines in production of beans and sorghum and increases in production of cassava and sweet potatoes do not reflect positive strategies being adopted to cope

with the changes in the soil but rather reflect the narrowing of choices available to farmers. The impact of the changes on food quantity and type of food had the largest impact on children:

> *"Nous avons le problème du manque de vivres. On peut souffrir des maux de ventres mais si on a de quoi à manger ce n'est rien. C'est très dommage que les gens meurent de Kwashiorkor suite au manque de vivres."* Group meeting, Kinyamakara.
>
> "We have the problem of a lack of food. We can suffer from stomach aches [a reference to soybeans] but if we have food to eat the aches are nothing. It is a real pity that people die of kwashiorkor because of a shortage of food."

The application of these responses to declining soil fertility is not uniform across households and between fields because the techniques require resources such as land, animals, trees, money, and labor that are distributed unevenly between households. Much as the ability to maintain soil fertility depends upon access to resources, the capability of farmers to respond to soil degradation depends upon their access to the same resources. The concept of "social fertility" introduced above, which describes the reinforcing relationship between wealth and good soil fertility, or poverty and poor soil fertility, seems to have equal relevance for the adoption of these techniques.

2. Nonagricultural Responses[2]

Development and adoption of these on farm techniques to respond to declining soil fertility were clearly not sufficient to offset the declines in agricultural production and food availability. Farming alone was unable to support the rural populations in

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[2] This section on nonagricultural responses to increasing pressure on resources is based on Olson, 1994c.

Gikongoro and Butare. The chronic food shortages and the difficulties farmers were experiencing reflected this reality. The deficiency in the agricultural sector increased the importance of other responses to increasing pressures on resources.

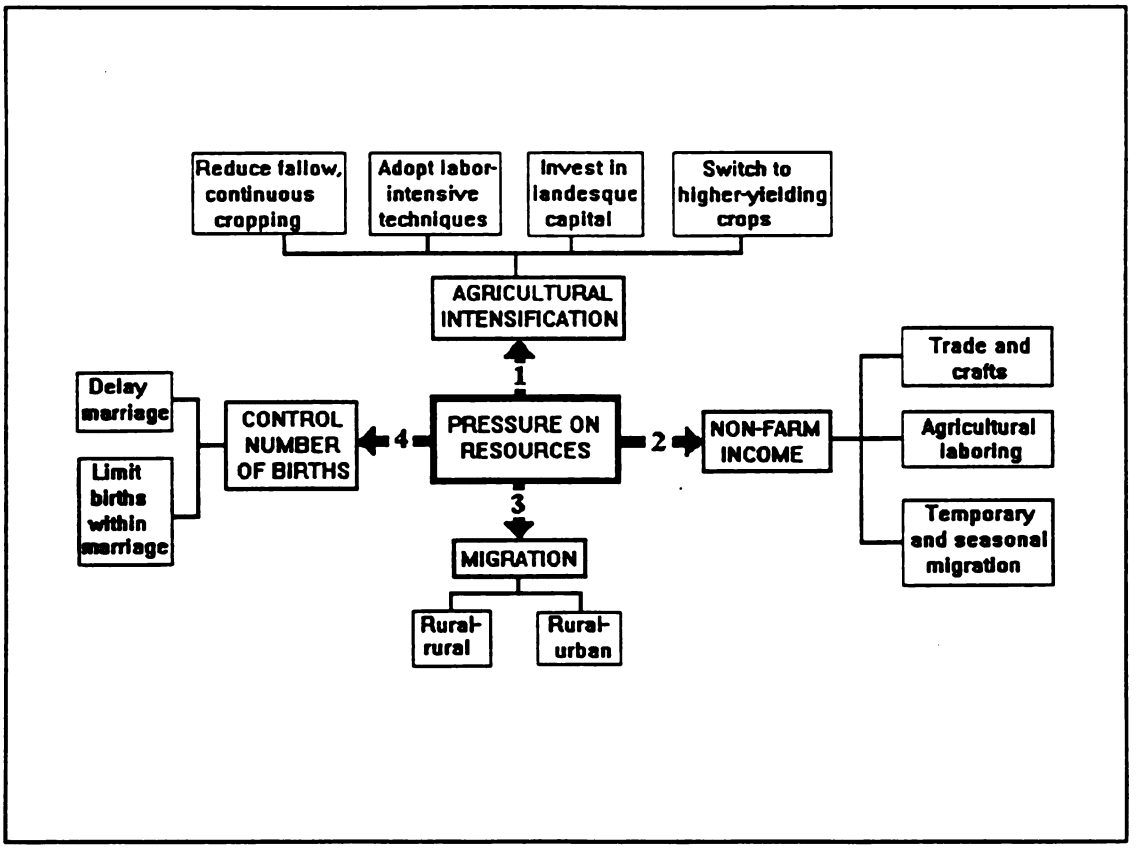

Figure 15 Sequential responses to pressure on land resources (adapted from Grigg 1980).

Grigg's (1980) construct of responses to increasing pressure is useful to understand the broader pattern of changes that occurred in Gikongoro (Figure 15). The first response, agricultural intensification, has been the theme of the study up to this point. The agricultural system has continued to evolve, most recently in new directions in response to declining soil fertility. These changes were in themselves

insufficient to offset the various economic, political and social factors that had contributed to the increased pressures and poverty. At the farm level, a household's ability to invests in "landesque capital" (Blaikie and Brookfield 1987) such as manure, land and labor, was shown to be an important indicator of the ability to maintain soil fertility and a profitable farm. In families without this ability, the other responses become more important.

The second response to increased pressures that Grigg outlined was to engage in non- and off-farm income generation by trading, working as agricultural laborers on nearby farms and performing short-term migration to other rural areas or to the capital city. These non- or off-farm activities were already conducted by more than half of all rural households (Clay et al 1989). The most common form of off-farm employment in Gikongoro was agricultural labor, usually conducted by people from the smaller farms. As described in Chapter IV, opportunities to earn better paying salaries were extremely limited in rural areas of both Butare and Gikongoro.

The third and fourth responses were demographic in nature— out-migration and reducing the number of births. These demographic responses to these pressures in Rwanda are now presented. The change in birth rates that first became apparent in the 1991 population census are presented will be first, followed by the new migration patterns.

a. The Declining Birth Rate

One response to the worsening situation has been a decline in birth rates, first observed in the results of the 1991 census (Figure 16). The degree of the decline was

unexpected by demographers of Rwanda who had continued to write of the extremely high birth rates and population growth rates until the 1991 census results were published (e.g., May et al. 1990, ONAPO 1990). For example, in 1990, one year before the census, the Population Reference Bureau (PRB) had estimated Rwanda's total fertility rate the highest in the world at 8.3 (PRB 1990).[3]

Although the death rate did not change substantially between the two censuses, from 18.4 to 14.1 per thousand, the crude birth rate declined from 54.1 to 45.9 per thousand (MINIPLAN 1992, MINIPLAN 1993). The new total fertility rate was estimated at 6.2 (PRB 1994).

The decline of the birth rate in Kibuye and Gikongoro, where it had not been particularly high in 1978, was attributed to the effects of poor and deteriorating economic circumstances for farm families during that period (Akimabera interview). The ability of young rural people to afford marriage and establish new families had become increasingly difficult due to a worsening land shortage, declining soil fertility and few non- or off-farm jobs.

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[3] The crude fertility rate is not an ideal measure to compare human fertility rates between prefectures and time periods because it is confounded by the effects of age composition. Barrére et al. (1994) calculated a fertility rate index from results of the 1992 *Enquête Démographique et de Santé* (Demographic and Health Survey) not confounded by those effects. The results of the survey are presented with high and low fertility rate prefectures grouped, and with the urban and rural communes within prefectures grouped. This makes inter-regional comparisons of their fertility index difficult.

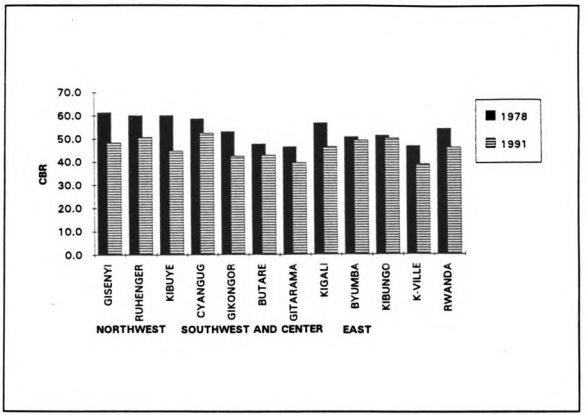

Figure 16 Crude birth rates by prefecture in 1978 and 1991 (per 1000) (data source: MINIPLAN 1982, 1993).

Perhaps the most important reason for the decline in birth rates was a delay in age at first marriage (Barrère 1994). Couples delayed marriage because young men did not inherit sufficient land to support a family. Rwandan custom stipulates that a young man must have a sufficient amount of land upon which to build a house and to grow food to support his family before formally getting married. Many young men found they did not inherit and could not buy that minimal amount of land, much less pay for the necessary brideprice (commonly a cow or its monetary equivalent). This led to a delay of marriages nationwide from age 25 for men and 22 for women in 1978 to 27 for men and 23 for women in 1991 (the Southwest has the highest age of

marriage of the rural areas) (MINIPLAN 1993). The delaying of marriages meant that women had their first child at a later age, reducing the total number of children born.

The inability to afford marriage also led to a decline of formal and an increase in informal unions as young couples started new households without getting married by the law and/or in a church or traditional wedding ceremony. The proportion of households headed by formally married couples was dramatically lower in age groups 35 and younger than among older couples. The majority of the young couples were together in a *"union libre"* relationship (MINIPLAN 1993).

One implication of this is that if a couple separates the woman has very few legal or traditional rights to cultivate her husband's land or to secure support for their children. Usually she must return with her children, empty handed, to her parents' farm. In contrast, if a formally married couple separates, the wife may go to court to claim her right to remain on and cultivate some of her husband's land and to demand support for the children (Bucyedusenge et al 1990). Another consequence of the inability of young people to afford marriage, according to farmers, was the heretofore rare situation of children being born to unmarried young women still living with their parents.

The dissolution of the traditionally strict family structure partially was due to poverty (the inability to afford marriage and/or the out-migration of men) and partially to wider changes in the society. Nevertheless, one consequence was an increase in the percentage of female-headed households in the regions most affected by poverty, the Southwest and the Center. These female-headed households, as seen

earlier, are those most affected by a lack of productive resources and by declining soil fertility.

The birth rates also declined due to a reduction in the number of children born within marriages. The cost of children to parents for food, clothing, school fees etc. had increased somewhat while the benefits of added labor on the farm that children provided became less important as farm sizes declined. The desired number of children in rural families declined and the preferred length of time between births increased between 1983 and 1992 according to demographic and health surveys (Barrère et al 1994). This decline in desired number of children contrasted with the former situation in which families had been able to increase the amount of land they cultivated as their families grew. The recent interest in reducing the number of births within marriages coincided with an increase in availability and use of contraceptives (Barrère et al 1994).

The Rwandan government had established the *Office National de la Population* (ONAPO) in 1981 promoting family planning. By 1990 it disseminated information and contraceptives to most public rural health centers (ONAPO 1990), the most common source of contractive devices for women (Barrère et al. 1994). Access to the public center facilities and the devices were free of charge for all women. The use of modern contraceptive methods by women nationwide increased from 1 percent in 1983 to 13 percent in 1992, the essential element in the boosting of all contraceptive (modern and traditional) use from 11 to 21 percent during the same time period (Barrère et al. 1994). It appears that the governmental efforts to reduce the rate of population growth and to distribute contraceptives coincided with societal processes,

particularly important in the West, that led to a reduction in the desired number of children and a delay in marriages.

This decline in fertility rates was due to a changing of behavior patterns by individuals and couples, new behavior part of an adaptive response to deteriorating economic conditions. Family planning policy and programs were actively promoted also in response to the perceived accentuation of economic and governmental problems linked to rapid population growth. Instead of a decline in fertility rates due to economic development, as postulated by the demographic transition theory, this change in behavior and policy resembles more closely a "crisis-led transition" (Lesthaeghe 1989).

b. Out-migration[4]

The fourth response to increasing pressure on resources, following agricultural intensification, expanding nonfarm income and declining number of births, has been permanent out-migration. Commune-level statistics on migration were calculated from the results of the 1978 and the 1991 censuses (MINIPLAN 1982, 1992). The *residual* method using vital statistics was employed. Net migration rate, therefore, was calculated as the difference, or residual, between the population growth and the population's natural increase (births minus deaths) between 1978 and 1991 (Shyrock and Siegel 1976).

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[4] The author would like to thank to Dr. Nan Johnson for aiding in the adaptation of the method for the available data in the estimations of commune-level migration.

The results indicate that contrary to what is often assumed, internal migration is a common occurrence in Rwanda (Figures 17 and 18). Emigration to neighboring countries, on the other hand, was restricted during this time period due to political and social troubles (Guichaoua 1989).

The extreme concentration of the mass of rural in-migration to a few communes in the far East reflects what many authors have written and what farmers have said: opportunities for finding new land in Rwanda were extremely limited (Uwizeyimana 1991, Guichaoua 1989, Bart 1993). The migration stream to the East is a continuation of the pattern existing since independence in 1962 as farmers have moved from the densely populated Western Highlands farther and farther east searching for unsettled agricultural land (Olson 1990). The far eastern communes experiencing high rates of in-migration do not have very high agricultural potential. The soils are shallow and rocky, and the rainfall is low and often variable. Other communes are marshy and require drainage (CPR 1992).

A few rural communes in the Western Highlands are also experiencing a small degree of net in-migration. These communes are located alongside forests, indicating that incoming farmers are probably clearing lands next to the forests or inside the official forest reserve boundaries. This is visible along the Parc des Volcans in the Northwest, the former Gishwati Forest Reserve just south of this park, and the southwestern edge of the Nyungwe Forest Reserve in the Southwest. The greenbelt that had prevented Gikongoro farmers from moving towards the forest apparently was less successful in Cyangugu. The incoming farmers are probably short-distance migrants, coming from the surrounding communes. These movements were

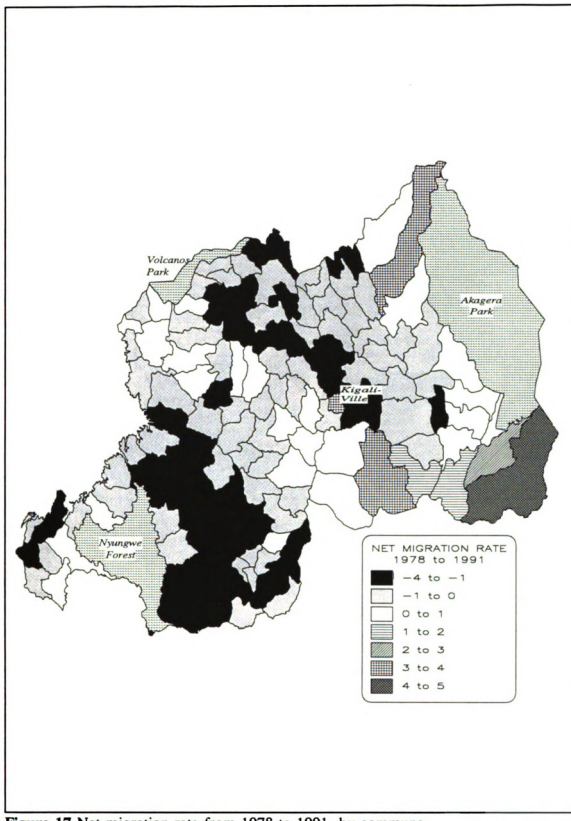

Figure 17 Net migration rate from 1978 to 1991, by commune

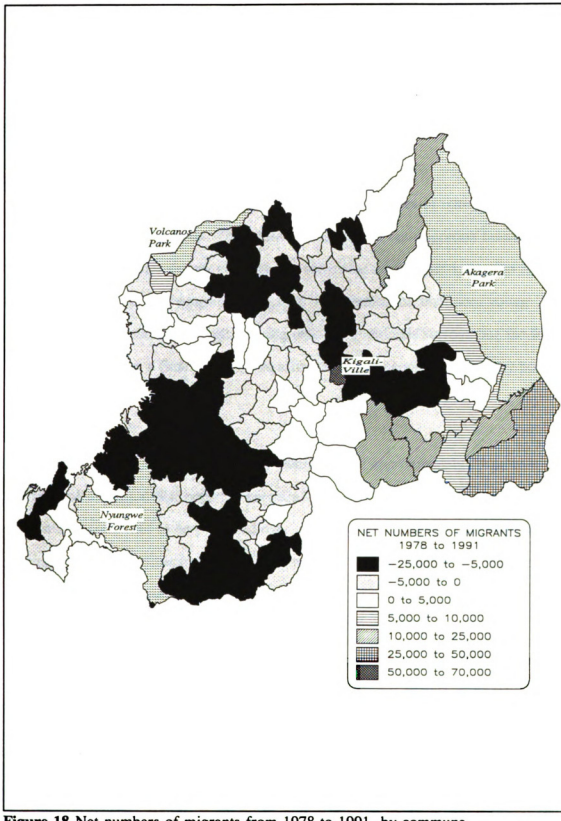

Figure 18 Net numbers of migrants from 1978 to 1991, by commune

undetected in earlier migration studies (Cambrezy 1984; Olson 1990). One indication that their movements may have been a new phenomenon is that the 1978 to 1991 inter-prefectoral movements indicate a stream of migrants moving from Gikongoro to Cyangugu, probably to those communes along the western edge of Nyungwe Forest receiving in-migrants.

Gikongoro and Butare had experienced important rates of out-migration, similar to earlier time periods. The relative difference in out-migration between the communes was not significant, although the somewhat smaller out-migration rate from those communes along Nyungwe Forest may be an indication that more young families there had stayed, perhaps moving onto the grasslands surrounding the forest. The grasslands were a final frontier that afforded young people land, if very poor land.

As a whole, rural areas were the destination of approximately 73 percent of all the internal migration that occurred between 1978 and 1991. This indicated that rural destinations continued to be preferred over urban areas even as the prospect for finding unsettled land became increasingly rare and what available land existed was marginal for agriculture.

Only two cities appear as major targets of in-migration, that of Gisenyi in the Northwest and the capital city, Kigali-Ville. Even with this growth in Kigali-Ville, its population made up only three percent of the population of the country, a very low percentage compared to capital cities of other African countries (MINIPLAN 1992). Other urban communes, such as Butare town, may be attracting in-migrants, but

because the method used to calculate migration somewhat underestimates in-migration in urban areas, and any in-migration was apparently small, the movements were not detected.

Sirven (1984) discussed the "under-urbanization" of Rwanda compared to other countries in Africa and concluded that it is due to a convergence of historical, political, economic and cultural factors. These factors seemed to have persisted, and very little urban growth was detected other than in Kigali-Ville and in Gisenyi and Gitarama. The small market centers existing throughout the country have not evolved into larger towns, perhaps due to the poverty of the countryside upon which they depend. The slow growth of the urban economy has, in its turn, reduced opportunities for rural people.

To detect streams of migration between prefectures of the country during the same 1978 to 1991 time period, a matrix of net migration between prefectures was created based on published results of the 1978 census (MINIPLAN 1982) and an analogous but unpublished table that MINIPLAN had generated for the author from weighted, sampled results of the 1991 census (MINIPLAN 1992b). By first calculating the net movements between prefectures for each time period separately and then comparing the results of the two tables, an estimate of the movements that occurred between the two time periods was determined.

The movements are an extension of the west to east rural-rural migration pattern established after independence (Figure 19). Migrants from throughout the country concentrated their land-seeking efforts in a few areas of the extreme far east,

an area of marginal agricultural lands situated far from the migrants' origins. This land still represented more prospects than what the migrant farmers could expect in their origin prefectures or in the city. The out-migration from Gikongoro was, as had been since independence, the highest of any prefecture.

This extension of the historic west-to-east, rural-rural flows seemed final. The only unsettled land remaining was found in the 15 percent of country designated as parks and forest reserves, land set aside initially because it appeared to have little agronomic potential.

> *"Non, il n'y a plus. Avant on y allait mais aujourd'hui il n'y a plus de parcelle libre, dit-on. Ceux qui s'y rendent reviennent bientôt. C'est le cas de ceux qui étaient en Tanzanie. Nous préférons croupir dans notre pauvreté que de devenir d'éternels voyageurs."* Group meeting, Kinyamakara.
>
> "No, there isn't any more [possibility to move east]. Before we went but today there aren't any more free fields, we hear. Those who go soon return. That's the case for those who went to Tanzania. We prefer to wallow in our poverty than to become endless voyagers."

The proportion of migrants seeking nonagricultural opportunities in the capital city, Kigali-Ville, continued to increase relative to rural-destined migrants. As in earlier periods, the rural-urban migrants originated from throughout the country and were somewhat better-educated than the rural-rural migrants. This selectivity has declined as a broader spectrum of people moved to the city, although limited employment possibilities in Kigali-Ville for those not well-educated is widely known. Many young couples continued to prefer the better known, longer-term solution by searching for sufficient farmland to support themselves and their families.

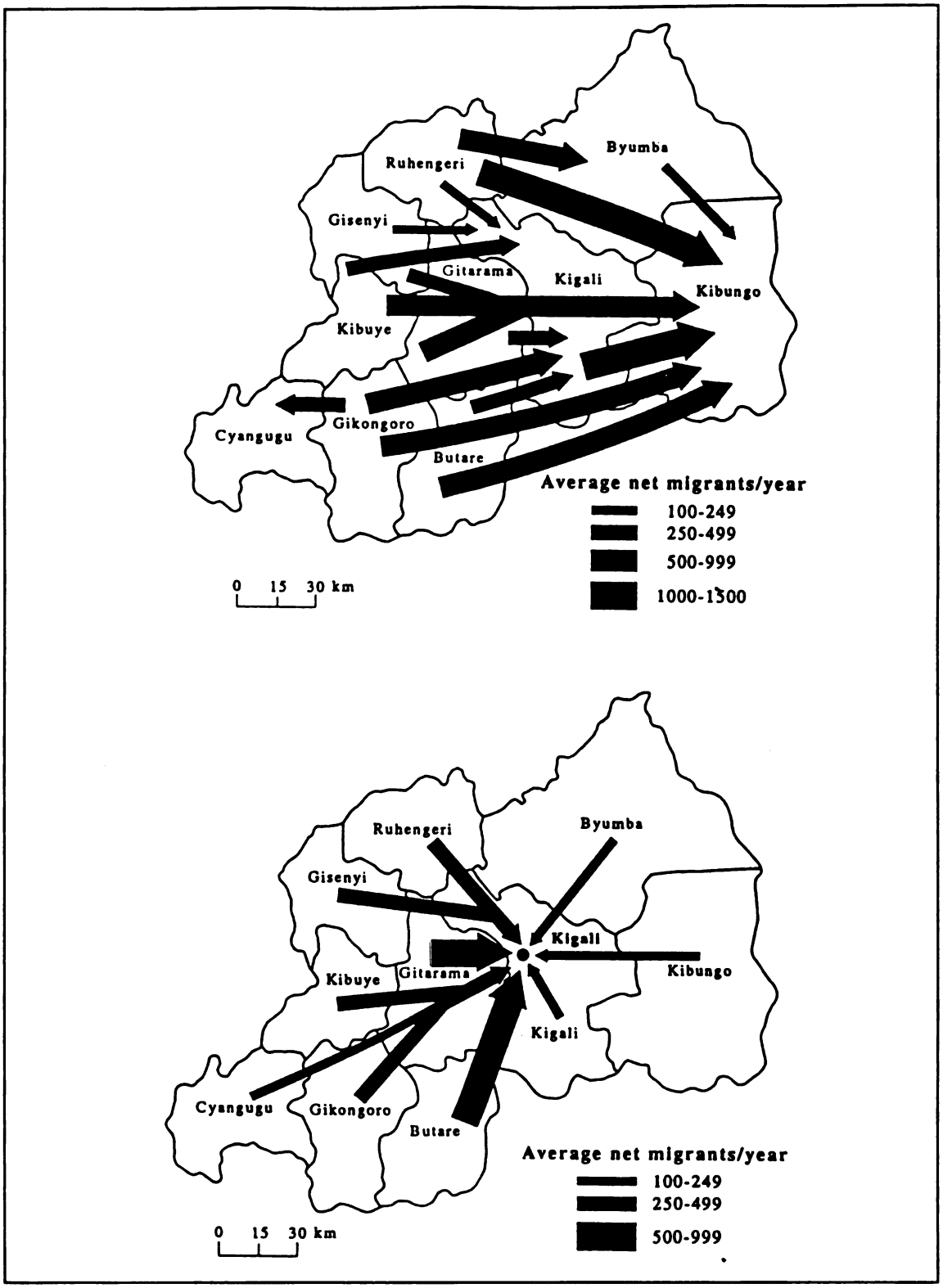

Figure 19 Net inter-prefectoral migration from 1978 to 1991; rural-rural (top), rural-urban (bottom)

The permanent, long distance movements provide only a partial view of the activity occurring throughout the country. Labor migration from Gikongoro to richer farms elsewhere was frequently mentioned by farmers.

> *"Vu la baisse de la fertilité, comment se débrouillent ceux qui n'ont pas d'autres moyens pour trouver des champs?"*
> *"Ils vont chercher du travail pour gagner un peu d'argent. On va par exemple à Kaduha et au Mayaga. La plupart des hommes sont maintenant à Mayaga où ils travaillent pour les haricots."*
> *"Certains dont mon fils qui est là se sont rendus en Tanzanie mais ils ont été chassés et sont revenus. Maintenant ils vivent de la petite ration que leur offrent ceux pour qui ils travaillent."* Group meeting, Musange.
>
> "Considering the decline in soil fertility, how do those people who have no means of finding more land cope?"
> "They go to look for work to earn a bit of money, for example, to Kaduha and Mayaga [in Butare] where they are paid in beans. Some, like my son, left for Tanzania but were chased out and have returned. Now they live from the tiny amount people for whom they work give them."

D. Summary of Responses to Increasing Pressures on Resources

Some farmer responses to the increasing pressures on resources are adaptations of old well-known methods, and others are leading the farmer towards the development of a new system. The chapter began at the level of the field, examining how farmers are attempting to regain the lost fertility to their soils. The changes in the system, in some senses, are a continuation of the intensification process, of increasing crop production per hectare. Examples of this approach would be the labor intensive techniques of deep hoeing, incorporating grasses into the soil and raising tethered animals and bringing them cut fodder. The switch to tubers, high-yielding crops, was partly due to intensification pressures but also to the impact of the declining soil fertility on the other crops. On the other hand, farmer responses seem to be leading away from intensification, returning to aspects of the old, extensive

system. A conversion of land from crops to trees, and to a lesser degree from crops to grasses, had begun as part of a new effort on the farmers' part to reproduce on-farm a miniature version of the old system of transferring nutrients from the out-fields to the cropped land. A similar contradiction has developed in their efforts to reduce erosion. Although erosion ditches and grass lines are maintained, deep hoeing and weeding the fields occur more frequently, practices which disturb the soil and increase erosion potential.

The responses went beyond changing agricultural techniques and soil preparation. The family structure also was being altered, with delays in marriage, more informal unions, and fewer children born within marriages. The crisis of increasing poverty and limited nonfarm opportunities had changed the economic and social structure for young people. Even the final response of out-migration, which had been adopted widely following independence and redistributed the population of the country, had become less of an option because the zones of possible destination were rare.

Meanwhile, the government was also responding to the problem which it defined as erosion; the solution was the forced digging of erosion-control ditches. For the farmers, however, the government's imposition of these and other mandates was placing additional pressure on their labor demands. The enforced aspect of the mandates also were rapidly leading to a growing rift between the farmers and the authorities.

The multi-faceted responses by the farmers to the pressures were not sufficient to regain the lost soil fertility or provide sufficient alternative, nonfarm sources of livelihood. Aspects beyond the level of the farm were constraining the positive if desperate efforts by the farmers. The situation was grim and getting worse. Beyond the economic and social responses outlined in this chapter, farmers also began to respond politically. These responses reverberated back to the level of the nation.

Photo 20 Tethered goat browsing on *igitovu* (Acanthus pubescens). Karama Commune (photo by C. den Biggelaar).

Photo 21 Milking the family cow. Maraba Commune (photo by C. den Biggelaar).

Photo 22 Pig raised in pigsty and fed with agricultural residues. Nyamagabe Commune (photo by the author).

Photo 23 Attempting to grow cassava in badly eroded soil, Maraba Commune (photo by C. den Biggelaar).

Photo 24 Burning piles of grasses and weeds. The ashes will be spread over and incorporated into the soil, Nyamagabe Commune (photo by author).

CHAPTER VIII

DISCUSSION OF THE CASE STUDY IN TERMS OF THE HUMAN/ENVIRONMENT LITERATURE

A. Introduction

This chapter reflects on the findings presented from the case study of land degradation in Gikongoro, Rwanda in light of the human/environment literature discussed in Chapter II. The Rwanda case is presented as an investigation of changing human/environment interactions over time. Gikongoro provides a unique view of this relationship due to the long time span of intense settlement of the region. This chapter starts with a more traditional approach in describing the loop of human/environment interaction over time in Gikongoro. The interactions are reflected in the changing proportion of crops, animals and trees on the land, a change explained by intensification and extensification processes. The regional political ecology approach is then reviewed, which provides important elements, such as the exercise of power, that help in the understanding of the case study. Finally several findings from the dissertation that are counter-intuitive to the prevailing discourse on Rwanda and on human/environment themes are reported.

B. Human/Environment Interaction

For hundreds of years, the impact of humans on the environment was based on the manure cycle in which nutrients were brought from the extensive, anthropogenic pasture lands of the valleys and lower hillsides to the cropped land on the upper hillsides. The upper hillsides grew fertile in this process, creating pockets of highly productive soil amidst large areas of unproductive, eroded grasslands. The grasslands

had been established from cleared forest around 1,500 to 2,000 years ago and had since been maintained by fire for domestic animal grazing. Deforestation, therefore, was not a recent event, occurring after the twentieth century population increases. The landscape of grass-covered hills with small pockets of homesteads and their surrounding fields and the soil itself were the results of hundreds of years of human activity and maintenance.

The conversion of pasture to cultivation that occurred during the twentieth century was then examined. Following colonial mandates to extend cultivation, the revolution of 1962 in which the Tutsi lost power, and finally a rapid increase in population densities, pasture became open for conversion to cultivation. It was cleared, hoed, spread with manure and other inputs and then planted. These activities increased the productivity of the former grasslands and their soil. The inner fields, however, received less manure or other inputs since the density of cattle per hectare of cropped land had diminished. Initially farmers were able to compensate by practicing more extensive techniques of fallow and expansion of cropped land. Eventually pasture land was no longer available, the manure cycle was broken, fallows were reduced and even steep slopes and other marginal lands were cleared and cropped. Mandated erosion control ditches may have slowed but did not halt erosion and the loss of soil nutrients. The sum result was another change in the soil— soil fertility declined and erosion increased.

In response to the impact of declining soil fertility on their economic and food security, farmers altered their land use to attempt to reduce soil degradation by growing fodder (grasses and trees) on-farm and planting trees on extremely degraded

slopes. Other changes included more frequent deep hoeing and a switch in crops grown. Thus a loop was formed, of humans affecting the environment, the environment affecting humans, and again humans affecting the environment.

1. Animal/Crop/Tree Triad

In this historical synopsis of relatively recent events, the socio-cultural, political and economic value of crops, animals and trees have changed significantly. This evolution has been reflected in the proportion of land devoted to each.

Initially animals dominated, with crops occupying a small area due to the highly controlled political and cultural system. With the revolution and ascension of Hutu to power in 1962, the political and cultural system was transformed and animal raising gave way to cultivation. This is an ongoing process; the lack of non- and off-farm employment, slow growth of the urban based economy and limited options for rural destined out-migration have left most rural areas with increased population densities dependent upon crop production for their livelihood. In many areas, only remnants of pasture land are left in valleys, along roadsides and on the most marginal lands.

Tree planting in government woodlots and along roads had began under colonial policy and was continued under the independent government. Government-planted eucalypti, pines, cypress and black wattle have become an important part of the landscape. Meanwhile tree products gained in economic value and wild off-farm sources of wood became less available. Tree planting by farmers has become common, and the amount of land in trees scattered or in small lines on-farm has

increased greatly.[1] In sum, the land under grass has declined enormously, that under trees has increased somewhat, and land under crops has increased.

The latest trend in Gikongoro is a revaluation of animals due to the importance farmers place on manure for combatting declining soil fertility. Farmers are attempting to recreate the manure cycle within the new limitations posed by the loss of communal pasture land. Growing fodder (grass and tree leaves) on-farm has become a necessary part of the agricultural system. Grasses had been in communal or private pasture lands away from the intensely cropped fields near the *urugo* and the rare trees had been in valleys or hilltops on communal lands. Now they are planted on private land on-farm as part of the cropping system. A second emerging trend is that farmers with extremely degraded fields are converting the land to pasture and woodlots. This reversal may lead to somewhat less land under crops and more under grass and trees.

2. Intensification/Extensification Processes

The increase in land under crops and decrease of land in fallow and pasture are examples of a Boserupian (1965) intensification of the agricultural system. Boserup framed her intensification process as a response to increasing population densities and availability of labor. The most recent intensification process in Rwanda reflects momentous socio-cultural, political and economic shifts as well as demographic pressures.

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[1]The increased number of trees on-farm was not illustrated on the aerial photography interpretation analysis because the trees were scattered. They did not form a homogenous polygon sufficiently large to be included as separate from cultivation.

The farmers of Rwanda had developed a very intensive cropping system before and during the colonial period due to politically induced population pressure. Farmers were confined to extremely small areas and developed a highly productive, permanent cropping system dependent upon inputs of manure. Despite their productivity, the small areas allotted to cropping were inadequate to produce sufficient food to prevent periodic famines among the farmers.

Beginning with the implementation of famine-prevention programs during the colonial period and especially following the reversal of political power at independence, the intensification process was temporarily replaced in importance by rapid extensification. This period, from around 1957 to 1985, was one of initially short and then long distance movements from densely settled areas to former pasture zones. The extensification of cultivation was sufficiently rapid and important that famines were reduced and food production increased at the same rate as the population. This period also witnessed extremely high population growth rates.

The extensification process slowed when local and distant rural destination areas within Rwanda were completely settled and cultivated. Urban destinations did not provide a major outlet either. Non- and off-farm employment in rural areas was very limited. Intensification of agriculture then returned to become the most important means of increasing production to meet the needs of the growing population.

In sum, during the period of low population densities, the land had been kept relatively unproductive as pasture. Increased population densities resulted in pasture

giving way to crops and adoption of labor-intensive land management techniques that raised soil productivity significantly.

The contraction and expansion of the Rwandan agricultural system over time have thus been closely related to political, socio-cultural and economic conditions that have changed abruptly or slowly over time. They have not only shaped the direction and timing of the intensification or extensification processes but also, to some degree, the rate of population growth. The Boserupian theory of agricultural intensification requires inclusion of these non-demographic factors that affect agriculture. The effect of the intensification process on the soil also needs to be considered explicitly.

The recent intensification process in Gikongoro has been accompanied by adoption of land use practices that have led to land degradation. These practices include cultivating steep slopes, reducing the use of manure and the practice of fallow, and frequent hoeing. The steep slopes, acidic soils, and humid climate make Gikongoro particularly susceptible to soil erosion and degradation. Land degradation and declining production have been significant, as have increasing hunger and poverty.

Considering these circumstances, is Malthus correct in predicting dismal results from the continued increase in population densities? The poverty and hunger in Gikongoro are due to not only reduced farm sizes and soil degradation, however, but also to wider national and international factors, such as low government investment, governmental appropriation of land, inefficient agricultural and development programs, declining purchasing power and the slow growth of nonfarm economic

opportunities that placed additional pressures on resources. An apparently Malthusian outcome has occurred from more than merely Malthusian processes.

Farmers responded to soil degradation by adopting new practices to reduce declines in soil fertility and maintain productivity. They were deliberately re-directing the intensification process. The new direction included, ironically, recreating aspects of the old extensive communal system on their private farms. Crops were giving way to grasses and trees for animal raising and soil conservation. These re-directed intensification practices, however, required large inputs of labor to plant and maintain the grasses and trees and to raise the animals. Other farmer responses to degradation such as deep hoeing and gathering grasses to add to the soil similarly demanded high labor inputs. Although the landscape may have appeared less intensely cultivated than it had been, in reality the new alterations were furthering the process of intensification— farmers were responding to the degradation with development and adoption of new labor-intensive practices to increase productivity of the land. They also responded with increased adoption of non-agricultural activities, including off-farm employment, reducing the number of children born, and temporary and permanent out-migration. These responses, much as the initial factors placing increasing pressure on resources, were closely associated with the national and international context.

The Boserupian intensification process appears to have been relatively successful, therefore, in areas of relatively better soils and in farm households with sufficient resources to invest in the soil. In ecologically marginal areas and in poorer households, the intensification process has not provided a sufficient increase in

production to support the added number of people, and the process has also resulted in a decline in soil fertility.

C. Regional Political Ecology

1. Introduction

In the simple attempt to describe the changing proportion of land devoted to crops, animals and trees in the previous paragraphs, it was necessary to mention the political revolution, the slow growth of urban centers and the cultural role of animals. The interpretation of the changing triad in terms of intensification and extensification processes similarly led to the explanation of political, economic and socio-cultural factors that forced the discussion beyond the local agricultural into the wider non-agricultural spheres. Understanding of farmer activities on the land requires, in short, an approach such as Regional Political Ecology (RPE) (Blaikie and Brookfield 1987; Campbell and Olson 1991; Peet and Watts 1993). Critical elements of RPE include:

- the *integration* of economic, socio-cultural, political and environmental factors;
- the interaction of these processes through *time;*
- interactions at and between different *scales*, from the household to the international; and
- patterns of interaction determined by the structure and application of *power.*

2. Power, Access to Resources and Revolutions: a Condensed Political Ecology of Causes of and Responses to Land Degradation

Political power continues to determine who has access to resources and how the resources are allocated and used. Historically, economic and political power were associated with ownership of cattle and control over the pasture land necessary to

maintain cattle. More recently, national political power has not been agriculturally but urban-based, and political and economic power associated with monetary wealth and jobs. In rural areas, however, economic wealth and political power remain associated with ownership of cattle and land. Differential access to these resources also has affected who has the capability to maintain soil fertility and respond to declining soil fertility.

Following is a recapitulation of the impact the application of power had on shifting access to resources and the consequences for soil fertility maintenance and the social system itself. Political, socio-cultural and economic changes over time are emphasized, along with their scaler elements from the local to the international.

The dissertation began with an idealized schema of a hill and farm of perhaps 80 to 100 years ago to understand the current agricultural system, although the contemporary political, cultural or economic situation hardly resembles the context from which that schema had evolved. Nevertheless, the farmers perceptions and behaviors, and the soil itself, are creations of this old schema.

The high, almost mystical value farmers of today place on cattle and cattle manure originate from the old political and cultural tradition of the Rwandan monarchy in which power was symbolically and literally tied to cattle ownership.

The politico-cultural system was based upon on a highly structured, authoritative state in which power over land management and access to land was concentrated in the hands of cattle owners, the Tutsi. The cattle owners thus ensured

the reservation of large expanses of land in pasture, even in the face of pockets of high population densities and small farms of the Hutu. The Hutu raised the cattle in return for milk, the male offspring and manure. It was this manure from the Tutsi cattle that was spread on the cultivated fields and maintained soil fertility.

The German and then Belgian colonial structure maintained and ruled through the Tutsi power structure, thus initially ensuring the continued presence of large expanses of grasslands and the manure cycle. In response to their own religious/cultural beliefs, colonial administrators implemented programs to reduce famines. The programs established minimum acreages Hutu had to cultivate, acreages much larger than previously cropped. Farmers were no longer able to spread manure over the acreage at the same high rate as they had previously on their smaller fields, and erosion became manifest on the newly cultivated, steeply sloped hillsides. In response, the colonial service mandated the digging of erosion control ditches with *umuganda*, forced labor.[2] Meanwhile population densities mounted due to the introduction of new crops and improved health services but the acreage yielded by the Tutsi for farming did not increase at the same rate, leading to further politically induced population pressure.

Resentment built up among the Hutu due to the continued and even increased concentration of wealth and power in the Tutsi and the heavy and demeaning demands on labor made by the Belgians. After several years of protests, the social revolution of 1959-1962 led to the overthrow of the Tutsi, the departure of the Belgians, and the

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[2]These large demands on labor may have led to an increase in desired family size and abandonment of traditional birth spacing practices (ONAPO 1990; Cordell and Gregory 1987).

assumption of political power by the Hutu. Thus, the political, cultural and economic system was reversed and the landscape transformed. Large expanses of pasture land were converted to crops as people moved short distances to cultivate the lower hillsides and the valleys and then longer distances to cultivate the marginal high altitude regions in the west, including western Gikongoro, and the eastern savanna.

Despite the momentous events and transformation of the agricultural system, echoes of the old system continue to shape farmer values and practices and government values and practices. The prerevolution period provided a baseline of what levels of soil fertility are expected on fields and what soil fertility maintenance techniques are preferred. In this country, where soils are an anthropogenic phenomenon, farmers interpret all recent changes in the soil as related to alterations of soil management, especially shortages of manure. The high value placed on cows and on manure, and the reliance on the system of transfer of nutrients, date from long ago. Farmers linked the shortage of manure and other resources to broader questions of loss of access to communal pasture land due to government appropriation and the increase in population.

The government, meanwhile, returned to the pre-independence definition of the problem as one of erosion and to the old solution of *umuganda* to dig erosion control ditches. On the ground, the *Lutte Contre Erosion* (Battle Against Erosion) was more of a fight against farmers than against erosion. The erosion control program, of course, did not address the farmers' concerns about the decline in availability of manure and cost the farmer much time and labor for an activity that showed them few benefits.

This clash of explanations of and solutions to soil degradation between farmers and the government led at first to passive then active resistance by farmers starting in 1991. The protests were directed more against the authorities and enforced labor than against the ditches, but many ditches were destroyed. The highly authoritative governmental system had implemented numerous other mandates concerning farming with such coercion that it tended towards exploitation and oppression. Meanwhile, appropriation of land by the government for woodlots, valley development programs or for development projects accentuated the pressure felt on the land and, more importantly, the bitterness of the farmers.

New divisions of wealth within the rural society also developed, represented not by ethnicity (there were no longer large differences in wealth between Hutu and Tutsi farmers) but still by ownership of cattle. The differences in numbers of animals, and other forms of wealth, also affected the ability of households to combat declining soil fertility. "Social fertility" is a term describing the correlation between economic well-being and soil fertility, in which a households's social standing reflects its soil fertility and vice-versa. Richer families have more resources to invest in their soil to maintain the soil 's fertility which lead to better harvests and increases the household's wealth. Poorer families, frequently headed by women, have less to invest in their soil; their fields often have declining soil fertility and low harvests, further increasing the household's poverty.

Within this rural, local setting, several national and international processes placed increased pressure on the farmers and their land. These processes came to a juncture in the early 1990s. They included few non- or off-farm employment

possibilities, limited or ineffectual government investment in Gikongoro, few opportunities for out-migration and declining purchasing power. Each was tied to wider national and international factors. For example, the decline in purchasing power was partially due to the implementation of a World Bank structural adjustment program. The limited investment and few off-farm opportunities were aggravated by a concentration of government investment in the northwest, home region of the former president.

The manifestations of the processes, and their links to the national government, were realized by farmers on their land. An outcome of these pressures was the increased level of difficulty farmers had in maintaining their soil fertility. Another outcome, discussed further in the final chapter, was the buildup of local opposition to the national government, expressed in protests and in support of opposition political parties. This local reaction evolved into a political revolution, which elements of the national government were willing to do anything to halt. The past 30 years of relative stability were to end for many of the same reasons behind the social revolution of 1959 to 1962.

3. Essential Points of RPE

To conclude, the political ecology narrative has emphasized the essential elements of power and access to resources in the interaction over time between social, economic, political and environmental factors from the local to the international level. The impact of the exercise of power on these interactions was illustrated by changing group and individual access to land, patterns of land use and soil fertility maintenance practices. The recent rapid decline in soil fertility, as perceived by the farmers, is

directly tied to these changes in regional and local land use and access to resources that have resulted in the inability of farmers to practice their soil fertility maintenance techniques. The responses of farmers to the soil fertility decline and to the linked increase in poverty included changing land use practices on their farms, searching for off-farm sources of income, reducing family sizes and out-migration. The responses of the farmers expanded beyond the local area to the region and nation, reflecting again the close ties between scales.

Essential points from this political ecology view of the complex and evolving situation include the following:

1. Variations between households in terms of resource endowments, off-farm activities, the gender of the head of household and other household characteristics have a direct impact on land use and soil maintenance.

2. Consideration of the State's role is necessary to understand land use changes for both its direct effects (e.g., policies regarding the distribution of land, soil conservation techniques, tree planting) and less direct effects (e.g., investment, siting of development projects, stability).

3. A long time horizon is necessary to understand the forces behind changes in land use and soil fertility maintenance although the environmental impacts of the changes may have been perceived only recently.

4. The local agricultural sector is closely tied to national and international economic, social and political elements.

5. The agricultural system is very dynamic.

D. Counter-Intuitive Findings

During the preparation of the dissertation, several results were found to be counter-intuitive to the prevailing discourse on Rwanda and on human/environment themes. These are presented below. Those related to the environment are presented first, followed by those relating to the social system.

1. The landscape of Rwanda was not a "pristine natural forest" despoiled this century by a rapidly growing population. Instead, the landscape and soils are anthropogenic, created for and maintained as pasture through controlled burning for grazing domestic livestock for thousands of years. The "manure cycle," in which nutrients were brought from the pasture to the cropped land on the upper hillsides, led to the soil of the upper hillsides having very high organic matter and being highly fertile.

2. The number of trees on the landscape has not decreased with increasing population densities but has increased. The former pasture land had very few trees other than remnants in marshy valleys. The multitude of trees planted on-farm have become an integral part of the intensification process. This is similar to processes occurring in Kenya (Scherr 1993, Tiffen et al. 1994).

3. The productivity of the soil did not decrease initially with the increase in population densities. Instead, the conversion of pasture land involved clearing, hoeing, spreading manure and other inputs and then planting crops. The soil fertility improved and total productivity increased.

4. With the increase in population densities and expansion of cultivated land onto pasture, the biodiversity of the area increased. On-farm biodiversity is extremely high with, for example, several hundred varieties of beans are grown. In fact, Rwanda was a secondary gene source for beans and bananas.

5. Farmers view the declining soil fertility as due to human actions, i.e., their inability to manure and otherwise maintain their fields sufficiently due to wider socio-political changes, and they want to address it by replacing the organic matter and nutrients. The government, on the other hand, views the problem as due to accelerated natural causes, i.e., erosion, that must be tackled with physical measures.

6. The intensification process did not reach a plateau or start to involute when soil degradation became severe, but degradation became a

stimulus for farmers to redirect the intensification process. New labor-intensive techniques have been adopted. As part of the intensification process, trees and grasses, often associated with extensive agriculture, have been planted on farms to increase animal numbers, manure production, and soil productivity.

7. The regions of highest population density are not the regions of highest soil degradation in Rwanda. Although Gikongoro and Kibuye have the worst soil degradation, the highest population densities are in the northwest, also an area of high elevation and steep slopes, and the center. In addition to population density, other factors have played significant roles in placing additional pressures on the land in Gikongoro, including physical characteristics of the soil, limited non- and off-farm opportunities, low levels of government investment, declining purchasing power and the lack of access to productive resources.

8. Most farmers of Gikongoro are net buyers of food, not net sellers. They often buy imported beans, making them particularly vulnerable to devaluations of the Rwandan franc. They earn income to buy food mostly through agricultural laboring.

9. The declines in soil fertility were not uniform across households but varied according to economic well-being. Richer families have more resources to invest in their soil to maintain the soil's fertility, whereas poorer families, frequently headed by women, have less to invest in their soil and their fields have a more critical decline in soil fertility.

10. The poorest regions of Rwanda, such as Gikongoro, are the areas with the lowest human fertility rates and the steepest declines in fertility rates. Increasing poverty, the cost of raising children and the lack of foreseeable opportunities elsewhere for young people led to delayed marriages, fewer formal unions and a decline of desired family size. Instead of an economic development-led fertility transition, it was a "crisis-led" transition (Lesthaeghe 1989). Thus the decline in soil fertility was mirrored by a decline in human fertility.

EPILOGUE

IMPLICATIONS OF THE FINDINGS FOR UNDERSTANDING THE RECENT CONFLICT

A. Introduction

The processes that led to increasing poverty in Gikongoro have implications for understanding the causes behind the horrendous events in Rwanda following the plane crash killing President Habyarimana on April 6, 1994. The regional political ecology approach adopted in the study of soil degradation has provided insights into the building up of pressures that eventually led to the outbreak of the conflict. The examination of the societal processes leading to declining soil fertility and the attempts by farmers to respond to the declines revealed economic, socio-cultural, political, and power factors that are important in understanding the causes of the conflict. These various factors are briefly reviewed and then interwoven with the rapidly occurring events to help explain the causes behind the tragedy.

B. Rural Political Pressures and Economic Factors

The local political processes mentioned in this study that have led to elevated tensions between farmers and authorities include: 1) the common application of oppressive power by the government on farmers, 2) unequal access to governmental resources regionally and locally, 3) farmer resentment over *umuganda*, forced communal labor, and other mandated measures, and 4) the appropriation of land that the farmers felt had been theirs. These processes led to increased bitterness and resentment among farmers against the national government and especially towards their local government authorities.

Meanwhile, poverty was increasing. It was linked to a variety of events and processes that placed increasing pressure on land resources in Gikongoro and other rural regions of the country. Although Gikongoro was the among the poorest prefectures and was particularly suffering from declining agricultural production, the entire country was experiencing economic difficulties. These proximate causes to increased pressures on the agricultural system included rapid population growth, declining purchasing power, ineffective agricultural development programs and soil degradation. The result was a decline in agricultural production and per capita food availability, especially in the west. Indeed, prefectures in the southwest were in a state of chronic food deficit and were highly susceptible to minor climatic or other perturbations, as in the 1990 Gikongoro famine.

The deficiency in the agricultural sector increased the importance of non- and off-farm sources of income in rural areas. They remained extremely limited, however, outside of the low-paying agricultural labor market. Governmental and private investment also was extremely limited in almost all rural areas. An exception was the Northwest, which had received much development investment since the early 1980s, a fact that embittered the other regions. Meanwhile, opportunities outside the local rural areas were also dwindling. Migration to urban areas was limited since the urban-based economy had grown very slowly and the government had enforced restrictions on in-migration to cities to those formally employed. Former rural destination sites in the east also offered few hopes since all land was said to be completely settled. In short, the situation for farmers at home was worsening and the possibilities in other areas diminished. The net effect of the decline in the agricultural and non-agricultural sectors was a decline in income, an increase in the number and proportion of

extremely poor households, and many young people being unable to afford marriage and foreseeing a bleak future for themselves.

C. National and International Political Changes[1]

Meanwhile, against this bleak economic backdrop, momentous political changes were occurring. President Habyarimana was forced to institute political reforms due to pressure from within and support from without. A multitude of political parties were formed, and by 1992, seemingly every village had a row of flags declaring the villagers' membership in various parties. The new political parties were opposed universally to the ruling party of the president. For many farmers, *"démocratie"* meant they no longer had to obey administrators. Displays of violent and nonviolent protest became common.[2]. Nevertheless, a mechanism to incorporate opposition parties into the government began to emerge through power-sharing negotiations.

The strongly felt opposition, the appearance of increasing chaos and the weakening of President Habyarimana's position were all heightened by activities of the Rwandan Patriotic Front (RPF). In October 1990, the RPF invaded the country from Uganda after having spent many unsuccessful years attempting to convince

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[1]The following sections are based on Olson 1994d and 1995.

[2]In 1992, farmers began to refuse to participate in enforced communal labor until it was abandoned by the government. Some farmers destroyed the erosion ditches they had dug with communal labor. Woodlots, planted with communal labor on local governmental land and often considered the personal property of the burgomaster, were burned. A few of the most-hated burgomasters were physically threatened.

President Habyarimana to grant the refugees citizenship and allow them to return to Rwanda. The RPF was composed of descendants of mostly Tutsi refugees who had been forced to leave during the Social Revolution in 1959-1962 and other Hutu and Tutsi who later had been forced out due to their opposition to the government. The RPF was halted in disarray by the Rwandan governmental army a few kilometers into Byumba (Onyango-Obbo 1993), but the invasion caused extreme panic in Kigali. Habyarimana's presidential guard immediately began a large-scale campaign to arrest thousands of people, anyone suspected of opposing the president and most top-level Tutsi (Africa Watch 1993). This action was the first major act of violence against local Rwandans by the Habyarimana regime. Future acts of violence in the country would thereafter be attributed to the regime by the population.

President Habyarimana apparently felt he was losing his strong grip on the country due to the increasingly vocal and widespread opposition movement and the intermittent war with the RPF. On the one hand, he instituted political reforms and spoke of peace and power sharing. The government of Tanzania resolutely maintained peace talks between opposition party representatives, RPF political representatives and Habyarimana's government. The talks culminated in the signing of the August 1993 Arusha Accords detailing power sharing amongst the parties: which party was to get what government post and how many parliamentary seats, when elections would be held, etc.

On the other hand, Habyarimana used violence and propaganda to incite fear and to arouse hatred of his enemies. In 1991, the radio station Mille Collines began its broadcasting of fear and hate messages against opposition party leaders, local Tutsi

and the RPF. This departure from his former national unity discourse was an attempt to mobilize the population behind the original cause of the Hutu revolution, of fighting Tutsi domination, and to reunite all Hutu around Habyarimana (Chrétien 1992). Habyarimana, and France, also strengthened the presidential guard, and the guard in turn organized, trained and armed a civilian militia, the *Interahamwe*. Between 1990 and 1994, the presidential guard, the *Comité pour la Défense de la République* (the extremist wing of the ruling party) and/or the militias periodically massacred opposition party members and Tutsi and planted land mines on rural roads and bombs in mini-buses, urban markets, bars and taxi stations to generate a climate of fear (Smyth 1994, Africa Watch 1993). While this created a climate of fear throughout the country, the population associated the acts of violence with the regime and, at least in the South, did not rally around the president.

The situation of March 1994 was one of strained optimism by opposition party members and the RPF who were hopeful the Arusha Accords would soon be implemented, of increasing chaos in the countryside and sporadic violence in Kigali, and of apparent fear of losing power by the president and his supporters. Two possibilities for the future were discussed widely— either the Arusha Accords would be implemented, or the widely-rumored assault by extremist elements of the regime on opposition party members and on Tutsi would begin.

D. The Death of the President

The violence that followed the death of President Habyarimana in the plane crash of April 6, 1994 cannot be explained without recognizing the importance of these antecedent political and economic conditions. The murder of Hutu opponents of

the government and of Tutsi was conducted by those affiliated with the extremist wing of the ruling elite. The fact that those people were Hutu and that Tutsi opponents were particularly targeted has given rise to an explanation for the violence based on long standing ethnic hatreds. Others have suggested that the violence stemmed from desperation due to the effects of overpopulation and poverty. Ethnicity, regional identity and political affiliation had coalesced in complex ways in the period of liberalization since 1990.

E. Ethnicity

The ethnic murders after April 6 were the result of an "encouraged" ethnicity. Habyarimana had cultivated ethnic tensions in the 1990 to 1994 period to mobilize the population behind the original cause of the Hutu revolution, of fighting Tutsi domination and to thus reunite Hutu around himself (Chrétien 1992). This was reinforced by the broadcasts of the radio station Mille Collines. The ethnic threats posed by the Tutsi were believed by his own extremists who felt that all Tutsi were their mortal enemies. The creation of fear was less successful, however, between farmers in rural areas and in towns among the middle class.

After April 6, ethnic tension was no longer a promoted concept but became reality, a matter of life and death. Local Tutsi were targeted by the militia and government troops. Their only hope for survival was an RPF military victory. On the other hand, Hutu were caught in the RPF/government war and looked to the army of the former government to protect them against what they believed was death at the hands of the RPF. The polarization was acted out at the local level where Hutu were fearful their Tutsi neighbors would "collaborate" and point out to invading RPF

soldiers which families were Hutu and would be killed. Inversely, Tutsi feared that their Hutu neighbors would divulge to roaming Interahamwe that they were Tutsi and that they would be killed.

What has often been overlooked in the horror of the post-April 6 events is what did *not* occur between Hutu and Tutsi. There was no immediate spate of killing between people after the president was killed. The mass killings were conducted by outsiders trucked or flown in for that purpose. Butare, for example, stayed quiet for a few weeks with the prefect and the prefectoral head of the army jointly urging people to remain calm. The calm was broken one dawn when presidential guards flew in from Kigali and started their mass killings of Tutsi and opposition party members (UN 1994). The same pattern occurred elsewhere. Many Tutsi and opposition party members, who knew they were targeted because of hit lists that had been circulated, were hidden by friends and neighbors who put themselves at extreme risk.

F. Population Pressure?

Other observers have placed the conflict in a population pressure context. Are the war and ensuing famine and diseases examples of Malthusian "positive checks" on a country ruined by rapid population growth? Are the war, famine and diseases restoring a balance to the population/environment relationship? The answer is no; the massacres, the war and the refugee movements were political in nature. High rural population densities and rapid population growth combined with limited nonfarm sources of income, slow growth of the economy and other factors contributed to worsening poverty. Was poverty a factor in the political events? To the extent that it affected national politics, yes. Rural poverty, combined with resentments built up

through years of repression, *umuganda* and inequitable distribution of governmental resources, led to widespread opposition to the former regime. In a country with a long history of a highly authoritative central government, people tended to expect solutions from and place blame on the central authority when economic problems arise. This condemnation, combined with new freedoms of expressions legislated in 1990, resulted in an outpouring of anti-regime protests by Hutu and Tutsi alike. The protests were organized by elites, many of whom had been members previously of the ruling party, into opposition political parties.

The massacres and the war were planned, led and conducted not by poverty-stricken subsistence farmers but by political and military elites anxious to gain political power. For elites, government rather than land represented the ultimate resource. The government in Rwanda, almost to the exclusion of any other source, was the paramount source of jobs, wealth and power. In Rwanda, the apportionment primarily was regional. The Northwest, home of the former President Habyarimana, had been the leading recipient of government investments since the 1980s, and political opposition formed in the rest of the country around this inequity.

When the President's plane was shot down, the leaders of extremist elements of the old regime dominated and acted in a planned, organized manner to retain political power. The massacres were conducted by the militia and members of the armed forces, primarily from the Northwest, whose purpose was to wipe out political opposition. They first targeted political opponents, both Hutu and Tutsi, and then concentrated on all Tutsi as probable political enemies and potential collaborators with the RPF (des Forges 1994, Newbury and Newbury 1994). How much of the killing in

rural areas was spontaneous between neighbors, and how much was done by or because of fear of the militia and the army, will probably never be known. What is known is that the vast majority of those killed were unresisting civilians. The invasion of the RPF was an effort to halt the massacres (but it was too late) and prevent the rump group from gaining power. The mass exodus into Goma, Zaire was by former regime members and by northwesterners fearful of potential focussed retribution following years of oppression and the massacres.

The massacres, war and refugee movements were tied to political aspirations and fears. Combined with perceived injustices, poverty produced a volatile mix and undoubtedly contributed to the unhappiness with the old regime. It was the efforts of elements in that regime to stay in power, however, that led to the massacres and subsequent war.

ENQUETE DES PERCEPTIONS PAYSANNES SUR LA DEGRADATION DU SOL
Division des Statistiques Agricoles, MINAGRI

AVIS: Vos réponses sont confidentielles. Elles ne sont accessibles qu'à certains fonctionnaires et ne seront utilisées qu'à des fins statistiques

IDENTIFICATION	ENTREVUE
Identification (ID) _____code	Nom de l'enquêteur _____
Ménage_____ _____code	Date de l'entrevue _____
	Heure commencée _____
	Heure terminée _____

OBSERVATIONS:_____

_____

_____

_____

_____

LES OBJECTIFS: Les objectifs de cette enquête sont multiples et ils représentent une extension des efforts du MINAGRI à servir la population rurale du Rwanda. Spécifiquement nos soucis dans ce travail sont les suivants:

- Fournir des renseignements aux planificateurs du Gouvernement Rwandais aussi bien qu'aux techniciens et vulgarisateurs agricoles sur les perceptions paysannes sur l'érosion et sur la diminution de la fertilité du sol.
- Identifier les barrières qui empêchent l'adoption des techniques anti-érosives et d'amélioration de la fertilité.
- Identifier les activités actuellement entreprises par les ménages ruraux ayant les mêmes objectifs que ceux escomptés des techniques anti-érosives et d'amélioration de la fertilité.
- Identifier les stratégies paysannes face à la dégradation du sol.

Le questionnaire: Ce questionnaire est composé de trois parties. La première partie est consacrée à la collecte des renseignements sur l'histoire du ménage et sur la terre qu'il cultive actuellement. La deuxième partie s'adresse aux changements des caractéristiques du sol et ses effets sur le ménage. La troisième partie fournit des renseignements sur l'adoption et sur les opinions des techniques anti-érosives et d'amélioration de la fertilité du sol.

L'HISTOIRE DE L'OCCUPATION DE LA COLLINE

1. **Quel est votre relation de parenté avec le chef de ménage?**
   1-Chef; 2-Epoux (se); 3-Enfant; 4-Soeur, frère; 5-Mère, père; 6-autre parenté; 7-pas de parenté

2. **Sexe de répondant:**
   1 - Masculin 2 - Féminin

3. **Quel age avez-vous?**

   _____ans 99 - ne sait pas

4. **a.Etes-vous né dans ce secteur? Wavukiye muri iyi segiteri?**
   1 - oui (passer à Q. 5) 2 - non

   b.*Si non* Où est-ce que vous êtes né?
   1 - ailleurs dans cette commune
   2 - autre commune, même préfecture
   S'il est né dans un autre préfecture:
   3 - Butare; 4 - Byumba; 5 - Cyangugu; 6 - Gikongoro; 7 - Gisenyi; 8 - Gitarama; 9 - Kibungo; 10 - Kibuye; 11 - Kigali; 12 - Ruhengeri; 13 - autre pays

   c.Pourquoi vous avez quitté le lieu où vous êtes né?
   Ni iyihe mpamvu yatumye wimuka aho wavukiye?
   S'il a migré avec ses parents, demandez et notez le motif de la migration de ses parents
   1 - recherche de la terre; 2 - recherche de l'emploi/raisons de travail; 3 - malentendu avec parents ou avec famille élargie; 4 - pour étudier à l'école; 5 - mariage; 6 - raisons politiques; 7 - autre, à préciser: _____

5. **Quelle contrainte principale vous empêche de produire plus?**
   Ni iyihe nzitizi ituma uteza byinshi kurushaho?
   1 - manque de terre; 2 - manque de main d'oeuvre; 3 - pauvreté de sol; 4 - manque de fumier; 5 - manque d'autre intrant; 6 - manque de pluie; 7 - érosion; 8 - autre, à préciser_____; 9 - ne sait pas

6. **Avez-vous de la terre suffisante pour produire assez de denrées pour votre famille?**
   Mufite ubutaka buhagije kuburyo musarura ibiribwa bihagije urugo rwanyu?
   1 - oui 2 - non

7. **Qu'est-ce que vous faites en dehors de l'agriculture pour vous subventionner?**
   Uretse ubuninzi mukora iki kindi kibunganira kugirango mubone ibibatunga?
   Identifier à droite 2 activités par ordre d'importance
   1-rien; 2-reçoit de l'aide des parentés; 3-reçoit de l'aide du gouvernement; 4-reçoit de l'aide des voisins; 5-vend des produits agricoles; 6-vend des articles d'artisanat; 7-travail comme ouvrier agricole; 8-fait autre travail; 9-autre, à préciser:_____
   a._____
   b._____

8. **Avec votre production et les autres activités, avez-vous suffisamment de nourriture pour la famille?**
   Umusaruro wanyu n'ibyo bindi, bibunganira mubona bihagiye mu gutunga urugo rwanyu?
   1 - oui 2 - non

9. **Combien d'enfants avez-vous?**

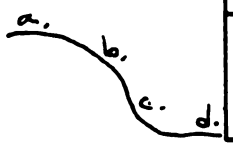
   _____enfants.

10. **Avez-vous de la terre suffisante pour les besoins en héritage de vos enfants?**
    Ufite ubutaka buhagije bwo guhamo abana bawe iminani?
    1 - oui; 2 - non; 3 - ne sait pas; 4 - pas applicable

CHANGEMENTS DU SOL

11. Tableau sur les changements de fertilité du sol depuis qu'il a cultivé ce sol. *Code 9 = ne sait pas*

Localisation du champ	1. Il cultive à cet endroit? 1 = oui 2 = non(pas sur au prochain)	2. *Si oui* Quel est le type de sol le plus fréquent? *Mettre le nom ou la couleur du sol en Kinyarwanda*	3. Fertilité du sol? 1 = très fertile 2 = moyen 3 = peu fertile	4. Kuva igihe utangiriye guhinga aho, wabonye hari igihinduka ku burumbuke? 0 = pas de changement Diminution: 1 = légère 2 = moyen 3 = forte Amélioration: 4 = légère 5 = moyen 6 = forte	5. *Si changement* Comment expliquez-vous cette diminution ou amélioration de la fertilité? *Voir codes en bas. Si autre, écrire la réponse au tableau*
a. En haut de la colline					
b. Le haut du versant					
c. Le bas du versant					
d. Dans la vallée					



Codes pour colonne 5

Diminution du à...		Amélioration due à...	
1-l'érosion	5-présence d'arbres	10-aménagement anti-érosif	13-compost
2-cultivé sans repos	6-l'épaisseur de sol diminué		14-engrais chimique
3-manque de fumier	7-autre,préciser en haut	11-jachère	15-autre, à préciser en haut
4-manque de compost	9-ne sait pas	12-fumier	19-ne sait pas

12. Est-ce qu'il y a un indice qui signale un changement de fertilité de votre sol?
Hari ikimenyetso cyerekana ko hari icyahindutse mu burumbuke bw'ubutaka bwawe?
Identifier à droite 2 indices par ordre d'importance

1 - changement de couleur du sol
2 - maladie des plantes
3 - présence de *musoli/mugabuduunitwa*
4 - présence de l'eragrostis, *ishinge/inyovu*
5 - présence de gravier dans le sol
6 - baisse des rendements
7 - autre, à préciser:_____
8 - autre, à préciser:_____
9 - ne sait pas

a._____
b._____

13. Si la fertilité a baissé, quelles sont les conséquences sur votre alimentation?
Niba uburumbuke bw'ubutaka bwaragabanutse, byagize ngaruka ki ku byerekeye ibabatunga?
Identifier à droite 2 conséquences par ordre d'importance

1 - mange moins de haricots, petit pois
2 - mange moins de légumes
3 - mange plus de patate douce
4 - mange plus de manioc
5 - fait l'achat d'autre nourriture
6 - diminution de repas ou quantité de nourriture
7 - rien, aucun effet
8 - autre, à préciser:_____
9 - ne sait pas

a._____
b._____

14. Si la fertilité a baissé, qu'est-ce que vous faites d'autre dans vos activités agricoles?
Niba uburumbuke bw'ubutaka bwaragabanutse, warakoze iki nyuma mu buhinzi bwawe?
Identifier à droite 2 activités par ordre d'importance

1 - fait de labour profond
2 - met la terre en jachère/pâturage
3 - ne produit plus pour vendre
4 - loue d'autre terre d'ailleurs
5 - fait de travail agricole chez autrui
6 - change de cultures ou variétés
7 - rien, ne change pas méthodes
8 - autre, à préciser:_____
9 - ne sait pas

a._____
b._____

15. a. Si la fertilité a baissé, avez-vous changé des cultures ou de variétés à cause de cette baisse?
Niba uburumbuke bw'ubutaka bwaragabanutse, byaba byaratumye muhindura ubwoko bw'ibihingwa cyangwa bw'imbuto mwahingaga?
1 - oui 2 - non (passer à Q. 16)

Si la culture a changé, écrire les codes seulement.
Si la variété a changé, écrire le code de la culture et le nom de la nouvelle et l'ancienne variété.

b. *Si oui* Anciennes cultures ou cultures/variétés?

a. | _____ | _____ b. | _____ | _____

c. Nouvelles cultures ou cultures/variétés?

a. | _____ | _____ b. | _____ | _____

Codes des Cultures

1-Haricots naine	6-Sorgho	11-Manoic	21-Banane à Cuire	41-Jachère/Pâturage
2-Haricots volubiles	7-Maïs	12-Pomme de Terre	22-Banane à Bière	42-Boisement
3-Petit pois	8-Blé	13-Patate Douce	23-Banane à Fruit	50-Autre,préciser en haut
4-Soja	9-Eleusine	14-Colocase	30-Café	99-ne sait pas
5-Arachides	10-Riz	15-Igname	31-Thé	

16. a.Que faites-vous pour améliorer la fertilité du sol?
Noter à droite 3 activités par ordre d'importance

1-application du compost
2-application du fumier
3-jachère
4-fossé anti-érosive
5-lignes A-E (herbes fixatrices)
6-haie A-E (arbres sur courbe)
7-rotation régulière
8-labour profond
9-application d'engrais vert
10-application d'engrais chimique
11-application de la chaux
12-paillage
13-rien
14-autre, à préciser:_____ 1._____
15-autre, à préciser:_____ 2._____
3._____

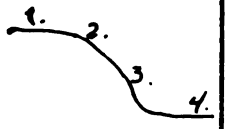
b.Que faites-vous contre l'érosion?
Noter à droite 2 activités par ordre d'importance

1-fossé anti-érosive
2-lignes A-E (herbes fixatrices)
3-haie A-E (arbres sur courbe)
4-application du fumier
5-jachère
6-rotation régulière
7-paillage
8-rien
9-autre, à préciser:_____ 1._____
2._____

17. *Tableau sur la présence des animaux sur l'exploitation*

Animaux	1. Combien d'animaux sur l'exploitation appartiennent à vous? Amatungo yawe bwite ni angahe?	2. Combien d'animaux élevez-vous qui appartiennent à quelqu'un d'autre? Amatungo uregiriye abandi ni angahe?	3. Méthode d'élevage Uyorora ute? (worora ute) *1=stab.permanente 2=semi-perm 3=pas de stabulation*
a.Bovins			
b.Chèvres			
c.Moutons			
d.Porcs			

18. Tableau sur les caractéristiques du sol. *Code 9 = ne sait pas*

Caractéristique du sol	1. Le voyez-vous comme problème dans votre sol? 0 = non 1 = oui,légère 2 = oui,moyen 3 = oui,sévère	2. Depuis que vous cultivez ici, avez-vous constaté une détérioration ou une amélioration de... Kuva aho utangiriye guhinga hano, hahindutse iki ku... 0 = pas de changement *(passer au prochain)* Détérioration: 1 = faible, 2 = moyen, 3 = forte Amélioration: 5 = faible, 6 = moyen, 7 = forte	3. *Si oui* Détérioration ou amélioration surtout à quel niveau de la colline?  	4. Pourquoi il y a eu une détérioration ou une amélioration? *Voir codes en bas de la page. Mettre les 2 codes les plus importants. Si c'est autre, écrire la réponse au tableau.*
a.Matière organique Ifumbire isanzwe mu buteka	(la quantité est un problème?)			a. |_____| b. |_____|
b.Couleur	N/A	amélioré = plus foncé; détérioré = plus claire		a. |_____| b. |_____|
c.Epaisseur de couche arable Uburebure bw'ubutaka buhingwa (isi ihingwa)				a. |_____| b. |_____|
d.Capacité de retenir d'eau Uko ubutaka bubika amazi				a. |_____| b. |_____|
e.Graveleux				a. |_____| b. |_____|
f.Erosion Isuli				a. |_____| b. |_____|

Codes pour colonne 4

La caractéristique a augmenté du à...		La caractéristique a diminué du à...	
1-élevage des animaux	7-cultivation sans arrêt	21-diminuation de bétail	28-érosion
2-stabulation des animaux	8-labour du sol fréquent	22-manque de fumier	29-fossé anti-érosif
3-application de compost	10-labour profond	23-manque de compost	30-manque de fossé
4-application de fumier	11-érosion	24-cultivation de la terre sans arrêt	31-non-pratique de jachère
5-jachère	12-forte pluie	25-mauvaise terre	32-peu de pluie
6-non-pratique de jachère	13-pente forte	26-labour superficiel	33-autre,préciser au tableau
	14-autre,préciser au tableau		

19. Tableau sur les techniques anti-érosives et d'amélioration de fertilité. *Code 9 = ne sait pas*

Technique	1. Pensez-vous que cette technique est productive? 0 = non, pas productive 1 = oui,un peu 2 = oui,moyen 3 = oui,beaucoup 9 = nsp	2. Utilisez-vous...? 1 = oui 2 = non(*passer à la prochaine technique*)	3. *Si oui* Depuis que vous cultivez ici, avez-vous augmenté ou diminué l'utilisation de ... 0 = pas de changement(*passer à la prochaine*) Diminué: 1 = un peu 2 = moyen 3 = beaucoup Augmenté: 5 = un peu 6 = moyen 7 = beaucoup	4. *Si oui* Pourquoi avez-vous augmenté ou diminué son utilisation? *Voir codes à la page 7. Mettre les 2 codes les plus importants. Si c'est autre, écrire la réponse au tableau.*
a.Compost Ifumbira yo mu kimporeri				a. |_____| b. |_____|
b.Fumier Ifumbire y'amatungo				a. |_____| b. |_____|
c.Engrais chimique Ifumbire mvarugenda				a. |_____| b. |_____|
d.Jachère kureza umurima				a. |_____| b. |_____|
e.Labour profond gutabira				a. |_____| b. |_____|

	1.Pensez-vous que cette technique est productive? 0 = non, pas productive 1 = oui,un peu 2 = oui,moyen 3 = oui,beaucoup 9 = nsp	2.Faites-vous? 1 = oui 2 = non(*passer à la prochaine technique*)	3.*Si oui*, Vous l'entretenez, même s'il n'y a pas de suivi des autorités? Muranabikora, niyo ubutegetsi businziliye? 1 = oui 2 = non	4.*Si oui* Pourquoi vous continuez à l'entretenir? *Si non* Pourquoi vous ne l'entretenez plus? *Voir codes à la page 7. Mettre les 2 codes les plus importants. Si c'est autre, écrire la réponse au tableau.*
f.Paillage iseso				a. |_____| b. |_____|
g.Fossé anti-érosif Umuringoti				a. |_____| b. |_____|
h.Ligne anti-érosive (herbes)				a. |_____| b. |_____|
i.Haie anti-érosive (arbres sur courbe)				a. |_____| b. |_____|
j.Terrasse				a. |_____| b. |_____

20. Tableau sur les changements de cultures dans les dernières 5 années. *Code 9 = ne sait pas*

Culture	1. Dans ces 5 dernières années, avez-vous cultivé...? Waba warahinze... mu myaka 5 iyi? 1 = oui 2 = non*(passer à la prochaine culture)*	2. Dans ces dernières 5 années, avez-vous augmenté ou diminué la superficie? 0 = pas de changement Diminué: 1 = un peu, 2 = moyen, 3 = beaucoup — Augmenté: 4 = un peu, 5 = moyen, 6 = beaucoup	3. *Si oui* Pourquoi avez-vous augmenté ou diminué la superficie? *Voir codes en bas de cette page. Mettre les 2 codes les plus importants. Si c'est autre, écrire la réponse au tableau.*	4.*Pour tout le monde* La productivité a-t-elle augmenté ou diminué? 0 = pas de changement Diminué: 1 = un peu, 2 = moyen, 3 = beaucoup — Augmenté: 4 = un peu, 5 = moyen, 6 = beaucoup
a.Sorgho			a. | _____ | b. | _____ |	
b.Haricots			a. | _____ | b. | _____ |	
c.Petit pois			a. | _____ | b. | _____ |	
d.Soja			a. | _____ | b. | _____ |	
e.Manioc			a. | _____ | b. | _____ |	
f.Pomme de terre			a. | _____ | b. | _____ |	
g.Patate douce			a. | _____ | b. | _____ |	
h.Banane à cuire			a. | _____ | b. | _____ |	
i.Banane à bière			a. | _____ | b. | _____ |	
j.Café			a. | _____ | b. | _____ |	

Codes pour colonne 3

Augmentation parce que la culture...		Diminution parce que la culture...	
1-s'adapte mieux au mauvais sol	7-appui du gouvernement	21-ne produit pas bien	26-récolte après longtemps
2-peu productive donc faut augmenter superficie	8-aliment de réserve	22-rendements faibles dans les sols appauvris	27-manque de semences, cordes...
3-plus rentable que les autre cultures	10-contre la famine	23-manque de fumier/compost	28-ne se conserve pas bien
4-minimise les risques	11-beaucoup d'enfants à nourrir	24-maladie de plante	29-prix n'est pas intéressant/pas de marché
5-se conserve dans le champs	12-c'est un aliment très important	25-contrainte de terre	30-transformation demande beaucoup de travail
6-donne de l'argent, marché	13-vente et consommation directe		31-autre,préciser au tableau
	14-autre,préciser au tableau		

Codes pour tableau 19, colonne 4 Pourquoi augmenté ou diminué

Diminué/n'entretient plus du à...		Augmenté/continue entretient dues à...	*L'effet sur le sol...*	*La production de...*
1-ce n'est plus recommandé par les autorités	7-manque de terrain	21-c'est recommandé par les autorités	26-retient l'eau	33-aliment de bétail
2-manque de matière nécessaire (compost, paille, fumier, etc.)	8-ça demande trop d'espace	22-possède la matière nécessaire	27-retient la terre	34-compost,fumure
3-manque d'animaux	10-c'est trop de travail	23-possède plus d'animaux	28-attrape la fumure	35-bois de chauffe
4-manque d'argent pour l'acheter	11-prend longtemps avant voir résultats	24-augmente la fertilité du sol	29-empêche l'érosion	36-tuteurs pour suspendre les cultures
5-manque de crédit pour l'acheter	12-n'est pas productif	25-profitable surtout pour une culture	30-facilite l'infiltration d'eau	37-matériau de construction
6-coûte cher	13-ça dépend de la culture		31-profite du bon sol en bas	38-donne de l'argent
	14-terre emportée par l'érosion		32-facilite le travail cultural	
	15-autre,préciser au tableau	39-autre, à préciser au tableau		

FICHE DE MENAGE
ENQUETE GIKONGORO SUR LA DEGRADATION DU SOL
Jennifer Olson, Michigan State University

ID:_____ _____Nom du Chef:_____Date:_____

Commune:_____Secteur:_____

L'enquêteur:_____H. commencé:_____H. terminée:_____

---

1. Quel est votre relation de parenté avec le chef de ménage?
   Upfana iki na nyir'urugo?
   1-Mari 4-Mari et épouse 7-Autre parenté masculin
   2-Chef féminin 5-Enfant masculin 8-Autre parenté féminin
   3-Epouse 6-Enfant féminin 9-Non-parenté

2. Quel age avez-vous?
   Ufite imyaka ingahe? *L'ENQUÊTE PRINCIPAL* _____ans

3. Combien d'enfants avez-vous?
   Ufite abana bangahe? *COMBIEN A LE CHEF DU MENAGE*

   _____filles _____garçons

4. a.Avez-vous des fils qui habitent en dehors de cette commune? Combien?
   Ufite abahungu batuye muyindi komini? Bangahe?
   0-nul (passer à Q. 5)

   _____fils dehors de la commune

   b.Ou habitent-ils? Batuye he? *NOTER POUR CHAQUE FILS MIGRANT A GAUCHE*
   1 - dans une autre commune de Gikongoro, la commune: _____
   Fils 1:_____ *S'ils habitent dans une autre préfecture:*
   3 - Butare-Ville 6 - Cyangugu 9 - Kibungo 12 - Kigali-Préf.
   Fils 2:_____ 4 - Butare Préf. 7 - Gisenyi 10 - Kibuye 13 - Ruhengeri
   5 - Byumba 8 - Gitarama 11 - Kigali-Ville 14 - autre pays

   c.Pourquoi ont-t-ils quitté la commune?
   Hi iyihe mpamvu yatumye bava muri iyi komini? *NOTER POUR CHAQUE FILS A GAUCHE*
   1 - recherche de la terre 5 - autre, préciser:_____
   Fils 1:_____ 2 - recherche de l'emploi agricole 6 - autre, préciser:
   3 - recherche de l'emploi non-agricole _____
   Fils 2:_____ 4 - étudier à l'école 7 - ne sait pas

5. Si la fertilité de votre sol a baissé depuis que vous cultivez cette terre, quelles sont les raisons principales de cette baisse?
   Niba uburumbuke bw'ubutaka bwaragabanutse kuva muhinga uyu murima, byatewe n'izihe mpamvu z'ingenzi?
   DEMANDEZ DES DETAILS DAVANTAGE, "LE POURQUOI DERRIERE LE POURQUOI"

   _____

   _____

   _____

   _____

   _____

6. Quelles sont les conséquences de la baisse de fertilité sur votre famille?
Ni izihe ngaruka z'igabanuka ry'uburumbuke bw'ubutaka hano iwanyu?

7. Quelles sont les conséquences de la baisse de fertilité sur vos cultures?
Ni izihe ngaruka z'igabanuka ry'uburumbuke bw'ububutaka ku bihingwa byanyu?

8. Quelles sont les conséquences de la baisse de fertilité ou de l'érosion sur vos méthodes culturales?
Ukugabanuka ki uburumbuke bw'ubutaka cyangwa isuri bigira izihe ngaruka kumihingire yanyu?
DEMANDEZ DES DETAILS DAVANTAGE, 'LE POURQUOI DERRIERE LE POURQUOI'

9. Quelles sont les conséquences de la baisse de fertilité sur vos autres activités agricoles?
Niba uburumbuke bw'ubutaka bwaragabanutse, byahinduye iki ku myifatire yawe irebana n'ubuhinzi?
ENCERCLEZ LES ACTIVITES MENTIONNEES OU SI C'EST 'AUTRE', ECRIVEZ L'ACTIVITE EN BAS

1 - met de terre en jachère/pâturage
2 - ne produit plus pour vendre
3 - loue d'autre terre ailleurs
4 - fait de travail agricole chez autrui
6 - élève plus de chèvres
7 - élève plus de boeuf
8 - élève des porcs
9 - ne sait pas

10. Qu'est-ce que vous faites actuellement pour maintenir la fertilité du sol?
Ni iki mukora uru kugira ngo uburumbuke bw'ubutaka bwo kugaruka?

11. Si vous auriez tous les moyens, quelle serait la meilleure méthode pour maintenir la fertilité du sol?
Muramutse mufite ubushobozi bwose, ni uburhe buryo bwiza bwatuma uburumbuke bw'ubuta ga baruka?

12. Quelle est la contrainte qui empêche l'emploi davantage de cette méthode?
Ni iyihe mbogamizi y'ingenzi ituma ubwo buryo budakoreshwa kurushaho?

13. a.Pensez-vous que la baisse de fertilité du sol va s'arrêter ou s'aggraver dans l'avenir?
Murabona uburumbuke bw'ubutaka bushobora kwiyongera cyangwa kugabanuka mu minsi iri imbere?
0-la baisse va s'arrêter
1-le taux de la baisse va rester le même
la baisse va s'aggraver:
2-un peu
3-moyen
4-beaucoup

b. Pourquoi? Vuga impamvu?

14. Quelles seront les conséquences de la baisse de fertilité sur l'avenir de vos enfants?
Uburumbuke bw'ubutaka buzagira izihe ngaruka kubana banyu?

_____

_____

_____

_____

_____

15. a. Depuis que vous cultivé ici, la disponibilité de fumier a-t-elle augmenté ou diminué chez vous?
Kuva mwatangira guhinga hano uburyo bwo kubona ifumbire y'amatungo bwariyongereye cyangwa bwaragabanutse?
0=rester le même (passer à Q. 16)
Augmenté: 1=un peu 2=moyen 3=beaucoup
Diminué: 4=un peu 5=moyen 6=beaucoup 9=ne sait pas

b. *SI AUGMENTE OU DIMINUE* Pourquoi a-t-elle augmenté ou diminué?
Kuki bwiyongereye cyangwa bwagabanutse?

_____

_____

_____

16. a. Depuis que vous cultivé ici, mettez-vous la terre en jachère moins ou plus fréquemment?
Kuva ninatangira guhinga hano, kuraza ubutaka byaba byiyongera cyangwa bigabanuka?
0=le même (passer à Q. 17)
Plus fréquemment: 1=un peu 2=moyen 3=beaucoup
Moins fréquemment: 4=un peu 5=moyen 6=beaucoup 9=ne sait pas

b.*SI MOINS OU PLUS FREQUEMMENT* Pourquoi? Vuga impamvu?

_____

_____

_____

17. Enquêteur: quelle est l'incidence de eragrostis, ishinge/inyovu?
0=rien 1=un peu 2=moyen 3=beaucoup

18. *AUTRE COMMENTAIRE PAR L'ENQUETEUR*

_____

_____

_____

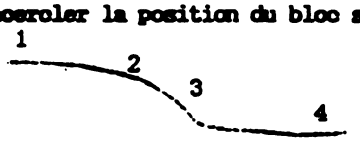
FICHE DU BLOC: ENQUETE SUR LA DEGRADATION DU SOL
Jennifer Olson, Michigan State University

ID:____ _____ **Nom du Chef:**_____ **Enquêteur:**_____

N° du Bloc_____ *Vérifier que c'est le même que sur la fiche superficie*

---

1. Encercler la position du bloc sur la pente de la colline:



2. Distance d'urugo en minutes de marche: _____ **minutes.**

3. Êtes-vous propriétaire ou locataire de ce bloc?
Ni wowe nyir'umurima cyangwa urakodesha?

Si propriétaire, comment l'avez-vous acquis?
Niba ari wowe nyirubwite ute?
1 - Par héritage
2 - Par achat
3 - Par cession de l'autorité
4 - Autre, préciser: _____

Si locataire, quel est le mode de paiement?
Niba ukodesha wishyura ute?
5 - En espèce ou en nature
6 - Sans paiement (gratuitement)
7 - Autre (à préciser) _____

4. Depuis combien d'années exploitez-vous ce bloc?
Hashize imyaka ingahe uhinga uyu murima? _____ **années**

5. Quelles cultures avez-vous cultivé dans ce bloc en...
Ni ibihe bihingwa wahinze muri uyu murima
NOTER LES CULTURES LES PLUS IMPORTANTES. INCLURE LE PÂTURAGE, LA JACHERE ET LE BOISEMENT

a.Saison A (sept-déc) 1991:_____

b.Saison B (fév-mai) 1992:_____

c.Saison C (mai-août) 1992:_____

6. *SI LE BLOC N'ETAIT PAS CULTIVE PENDANT 5a,b OU c* **Pourquoi vous ne cultivez pas ce bloc?**
Kuki udahinga uyu murima?

1-le sol est inproductif
2-manque de main d'oeuvre pour le cultiver
3-c'est trop loin
4-laisser en repos, jachère
5-réserver pour le pâturage
6-c'est un boisement
7-autre, à préciser:_____

7. Quel est le type du sol de ce bloc?
Ni ubuhe bwoko bw'ubutaka bw'uyu murima?

1 - Rugugu
2 - Urunombe
3 - Ibumba
4 - Igishanyi
5 - Urubuye
6 - Urusenyi
7 - Umusenga
8 - Autre (à préciser)_____
9 - ne sait pas

8. Par rapport aux autres blocs de l'exploitation, la fertilité de ce bloc est
Ugereranyije n'indi mirima y'imumbu yawe, uburumbuke bw'uyu murima ubuhoma ute

Supérieur	Le Même	Inférieur
1-un peu	4-le même	5-un peu
2-moyen		6-moyen
3-beaucoup		7-beaucoup

9. a. Depuis que vous cultivez ce bloc, la fertilité de sol a-t-elle changé?
Kuva igihe utangiriye guhinga aha, wabonye hari igihinduka ku burumbuke?

0 - non, pas de changement (passer à Q. 10)

Diminution...	Amélioration...
1 - légère	4 - légère
2 - moyenne	5 - moyenne
3 - forte	6 - forte

b. Comment expliquez-vous ce changement de fertilité du sol?
Wasobanura ute iryo hinduka ry'uburumbuke bw'uyu murima?
DéCRIRE BIEN LES CAUSES PRINCIPALES

_____

_____

_____

_____

10. Avez-vous constaté d'autres changements dans le sol? Lesquels?
Hari ibindi bintu waba warabonye byahindutse muri ubu butaka? Ni ibihe?
P.E. LA COULEUR, LA TEXTURE, DES PLANTES INDICATRICES... IBARA, ININGERI, IBYATSI...

_____

_____

_____

11. a. Depuis que vous cultivé ce bloc, avez-vous changé de culture ou de variété à cause de changements du sol? **Kuva muhinga uyu murima, mwigeze muhindura ibihingwa cyangwa amoko yabyo bitewe n'ihinduka ry'ubutaka?**
INCLURE LE PÂTURAGE, LA JACHÈRE, LE BOISEMENT
1 - oui 2 - non (passez à Q. 12)

b. *SI OUI* Anciennes cultures ou variétés/cultures:
Ni ibihe bihingwa cyangwa amoko yabyo mwahingaga mbere?

_____

_____

c. Nouvelles cultures ou variétés/cultures:
Ibihingwa bishya changwa amoko yabyo mushya?

_____

_____

12. Depuis que vous cultivez ce bloc, avez-vous changé votre méthode de travailler la terre? Si oui, comment et pourquoi?
Kuva mwatangira guhinga uyu murima, mwigeze muhindura uburyo bwo guhinga, gute, kuki?

_____

_____

_____

_____

_____

13. Que faites-vous pour amélioré la fertilité du sol dans ce bloc?
Mukora iki kugirango mwongere uburumbuke bw'uyu murima?

_____

_____

_____

14. Qu'est-ce que vous entendez dire par le mot "érosion"? POSER AU 1er BLOC UNIQUEMENT
Ku bwawe isuri uyumva ute?

_____

_____

_____

15. a.Y a-t-il de l'érosion dans ce bloc?
0-non, pas d'érosion (passer à Q. 15)
1-oui, un peu
2-oui, moyen
3-oui, beaucoup

b.Pourquoi y a-t-il de l'érosion dans ce bloc?
Kuki haba isuri muri uyu murima?

_____

_____

_____

c.Y a-t-il des conséquences de l'érosion dans ce bloc? Lesquels?
Hari ingaruka ziterwa n'isuri muri uyu murima?
SI OUI, IDENTIFIER 3 CONSEQUENCES A GAUCHE PAR ORDRE D'IMPORTANCE. SI "AUTRE", ECRIVEZ SUR LES LIGNES

	0-non, pas de problème	4-baisse de fertilité
1._____	1-des canivaux, rigoles	5-épaisseur du sol a diminué
	2-les plantes tombent	6-ne sait pas
2._____	3-la bonne terre/l'ifumbire part	7-le fossé se remplit

_____

_____

d.Voyez-vous des conséquences de l'érosion sur la fertilité dans ce bloc?
Mubona ingaruka z'isuri ku burumbuke bw'uyu murima?
0-non, pas de conséquence
1-oui, un peu
2-oui, moyen
3-oui, beaucoup

16. Faites-vous quelque chose dans ce bloc contre l'érosion? Que faites-vous?
Hari igikorwa cyo kurwanya isuri mukora muri uyu murima? Ni ikihe?
0-non, rien
oui,_____

_____

_____

17. Tableau sur les caractéristiques du sol

Caractéristique	1.Que pensez-vous de...dans ce sol? 1-beaucoup 2-moyen 3-un peu	2.Y a-t-il eu un changement de...? 0-pas de changement Augmenté: 1-un peu 2-beaucoup Diminué: 3-un peu 4-beaucoup	3.SI CHANGEMENT Pourquoi a-t-il augmenté ou diminué? Kuki byiyongereye cangwa byagabanutse?
a.matière organique ifumbire isanzwe mu butaka			
b.rétention d'eau uko ubutaka bunywa amazi			
c.épaisseur de couche arable Uburebure bw'-ubutaka buhingwa			

18. Utilisez-vous... sur ce bloc?
Mukoresha iyihe... ? *ENCERCLEZ LE CODE APPROPRIÉ POUR CHAQUE INTRANT*

a.le crepost ifumbire yo mu kiraro 0-non 1-oui,un peu 2-oui,moyen 3-oui,beaucoup
b.le fumier ifumbire y'amatungo 0-non 1-oui,un peu 2-oui,moyen 3-oui,beaucoup
c.le paillage isaso 0-non 1-oui,un peu 2-oui,moyen 3-oui,beaucoup

d.l'engrais chimique ifumbire mvaruganda 0-non 1-oui
e.la chaux 0-non 1-oui

REGARDEZ VOUS-MÊME ET ENCERCLEZ LE CODE APPROPRIÉ
f.fossé anti-érosif 0-non 1-oui,pas bien entretenu 2-oui, moyen 3-oui,bien entretenu
g.ligne anti-érosive (herbes) 0-non 1-oui,pas bien entretenu 2-oui, moyen 3-oui,bien entretenu
h.haie anti-érosive (arbres) 0-non 1-oui,pas bien entretenu 2-oui, moyen 3-oui,bien entretenu

19. *Les impressions de l'enquêteur sur ce bloc (l'érosion, les cultures...)*

_____

_____

_____

_____

PROJET RWA/AID/696-0126
ENQUETES AGRICOLES ET ANALYSE
DES POLITIQUES ECONOMIQUES DU
SECTEUR RURAL (MINAGRI)
B.P. 621 - KIGALI.

Kigali, le 6 juin 1991

N/Réf.:243/91/04/AM/IMB

Au Professeur
David J. Cambell
Professeur de Géographie
MSU/USA

Objet:Accord de la DSA
pour votre Recherche

A Madame Jennifer M.Olson
Ph.D Candidate
MSU/USA

Madame,

Monsieur,

En référence à votre lettre du 24 Mai 1991, j'ai le plaisir de porter à votre connaissance que la Division des Statistiques Agricoles est d'accord que vous fassiez vos travaux de recherche à son sein et je vous promets tout l'appui dont vous aurez besoin durant votre séjour au Rwanda.

Je commence par vous remercier, Monsieur le Professeur, pour les publications que vous avez bien voulu nous envoyer. Je profite de la même occasion pour vous demander de faire tout ce qui est possible afin de réactiver la coopération entre Michigan State University, la Division des Statistiques Agricoles et le Département de Géographie de l'Université Nationale du Rwanda, ammorcée lors de votre passage au Rwanda.

Enfin, je vous demanderais de bien vouloir nous envoyer dans les meilleurs délais le calendrier d'activités et les besoins en ressources humaines et matérielles afin de faciliter le démarrage de l'étude envisagée en l'insérant dans notre plan de travail 1992.

Veuillez agréer , Madame, Monsieur, l'expression de ma considération distinguée.

Le Chef de Division
des Statistiques Agricoles
et Coordinateur du Projet ASPAP

Anastase MUREKEZI

C.P.I.à:

- Monsieur le Ministre de l'Agriculture, de l'Elevage et des Forêts à Kigali.
- ASPAP Project Officer USAID - KIGALI
- Daniel Clay, professeur de sociologie à Michigan State University USA

REPUBLIQUE RWANDAISE
MINISTERE DES TRAVAUX
PUBLICS ET DE L'ENERGIE
B.P. 24 KIGALI

Kigali, le 1 [illegible]
N°18.11.02/11340

Monsieur le Directeur Général de
l'Institut Géographique National
136 bis, Rue de Grenelle
75700 PARIS
FRANCE

Objet:
Demande d'autorisation
d'achat des photographies
aériennes du Rwanda

Monsieur le Directeur Général,

J'ai l'honneur de porter à votre connaissance que Madame JENNIFER Olson est autorisé d'acheter les photographies aériennes du Rwanda dont la liste est la suivante:

1974: Bande 8: 500-505
Bande 9: 516-528
Bande 10:532-545
Bande 11:550-563
Bande 12:575-580

1980: S329
Bande 22: 33-37
Bande 23: 27,29,31,33
Bande 24: 28,30,32,34
Bande 25: 27,29,31,33
Bande 26: 15,17,29,31,33,35
Bande 27: 13,15,17,19,23,25,33,35,37
Bande 28: 13,15,16,18,20,22
Bande 29: 15,16,18,20,22,24
Bande 30:23

Veuillez agréer, Monsieur le Directeur Général, l'assurance de ma considération distinguée.

Copie pour information à:
Madame JENNIFER Olson
B.P. 679
BUTARE

LE MINISTRE DES TRAVAUX
PUBLICS ET DE L'ENERGIE
GATABAZI Félicien

REPUBLIQUE RWANDAISE
MINISTERE DES TRAVAUX
PUBLICS ET DE L'ENERGIE
B.P 24 KIGALI.

Kigali, le

Monsieur le Directeur Général
de l'Institut Géographique
National
136 bis, Rue de Grenelle
75.700. PARIS
FRANCE.

Monsieur le Directeur Général,

J'ai l'honneur de porter à votre connaissance que Madame Jennifer OLSON de Michigan State University, est autorisée à acheter les photos aériennes, à 1/50.000, de la campagne 1990, RWA/ 20/ 500

Il s'agit des photos suivantes

Bande:	n° Photos
08	85 à 87
09	115 à 117
10	335 à 338
10	380 à 346
11	361 à 369
12	428 à4 31

Veuilles agréer, Monsieur le Directeur Général l'assurance de ma considération distinguée.

Copie pour information à:
Madame Jennifer OLSON.

Le Ministre des Travaux Publics
et de l'Energie.
GATABAZI Félicien.

REPUBLIQUE RWANDAISE
MINISTERE DE L'AGRICULTURE,
DE L'ELEVAGE ET DES FORETS
B.P. 621. KIGALI

Kigali, le 09 SEP. 1991

N° 3868 /09.30

Au Professeur
David J. Cambell
Professeur de Géographie
MSU/USA

Objet : Accord pour votre travail de recherche

Monsieur,

J'ai l'honneur de porter à votre connaissance que le Ministère de l'Agriculture, de l'Elevage et des Forêts marque accord à votre demande d'effectuer un travail de recherche sur les stratégies de l'agriculteur de GIKONGORO face à la problématique de l'érosion du sol, en collaboration avec votre étudiante Madame Jennifer M. Olson.

Ainsi je vous demanderais de prendre vos dispositions pour toutes les formalités administratives nécessaires auprès de votre représentation diplomatique à Washington.

Veuillez agréer, Monsieur, l'expression de ma franche collaboration.

Le Ministre de l'Agriculture,
de l'Elevage et des Forêts

Dr. James GASANA

Dr HAKIZAMUNGU Ignace
SECRETAIRE GENERAL

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APPENDICES

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