LAND USE AND AGRICULTURAL INTENSIFICATION IN MUGANDU WETLAND,
KABALE DISTRICT, UGANDA

By

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Located in SW Uganda, Kabale District has a mountainous landscape and a high population density. The increasing demand for farmland over the past several decades has led to fragmented landholdings on the hillsides and conversion of wetlands into agricultural lands. Converted wetlands are used for subsistence and cash crops, while unconverted wetlands remain a source for raw materials for direct sale or to make into handcrafts for sale.

This study examines how and why smallholder farmers use converted wetlands for farming and identifies factors that influence the intensity of land use on the wetland in Mugandu valley. Research methods include interviews with community leaders and representatives of farmer cooperatives, and comprehensive interviews with 55 smallholder farmers who own fields in Mugandu wetland. Descriptive statistics are used to examine the differences among households by income levels, and the Kruskal-Wallis H test and Mann-Whitney U test are used to analyze the factors influencing land use intensity.
The study found that the wetland is an important source of food and income for farmers. Comparative analyses of the households by income level found differences in farm management, crop yield, income earned, and use of the unconverted wetland. Statistical tests indicate that labor availability has a major influence on intensification.

It is likely that intensification will continue in Mugandu valley. Due to the importance of the wetland to the livelihood of the farmers, I recommend that district and local officials work with the local population to development a management plan for the sustainable use of this and other wetlands.
CHAPTER 1
INTRODUCTION

Wetlands and wetland areas in Uganda constitute about 10% of the country’s total land surface and are significant to local and regional economies and to the livelihoods and food security of people living near them (Republic of Uganda 1995). The British colonial government started large-scale drainage of wetlands throughout Uganda in the 1930s. Conversion continued until Uganda gained independence in 1962 after which drainage continued at a reduced rate. Population growth and increased development for agriculture and industry continue to be reasons for conversion of wetlands. Policies such as the ban on drainage of wetlands (since 1986) have helped to reduce the stress on wetlands (Ecaat and Rutasikwa 1994).

The wetland valleys in Kabale District (Figure 1-1) were traditionally used as a source of reeds and fibers and the outside edges served as a land reserve for agriculture during dry years. This latter function was observed by the British colonial officials, who then ordered that sweet potatoes be planted on wetland edges whenever food shortages were predicted (Carswell 1996). As land shortage became more acute in the 1940s, colonial officials started to see the potential of using wetland valleys for agriculture as a famine prevention measure. Initial government-assisted wetland conversion started in the early 1940s and continued until about 1959 (Carswell 1996).

The landscape of Kabale district contains small, fragmented landholdings on a mountainous terrain. The region has numerous lakes, rivers, and wetlands. The district is densely populated with an estimated density of 281 persons per km$^2$ as of the 2002 census (Uganda Bureau of Statistics 2002). Around 85% of the population are subsistence farmers with an estimated average of 7.4 children per household (Alacho et
al. 2000). Population pressure has led to fragmentation of the farms into small sizes, which range from less than 0.08 ha to 3.2 ha, with an estimated average farm size of 0.72 ha (Tukahirwa et al. 1998).

Figure 1-1. Location of Kabale district and Mugandu valley.

Approximately 6% (111 km²) of the total land area of Kabale district are wetlands, all of which are located in valleys (Uganda National Wetlands Programme 1995). Today, nearly 58% of the total wetland area in Kabale District is used for agriculture while most of the remaining portions are under threat of illicit conversion to agriculture (Uganda National Wetlands Programme 1995). The amount of wetland area used for cultivation continues to increase as farmers see the opportunity to cultivate more land and to grow cash crops (Mohamed 1999).
Historically Kabale District has maintained a high population density. As a result, the pattern of agricultural land use includes intensive farming practices on the upland (hillside) fields and a combination of vegetable production and large and small-scale dairy farming in the wetland valleys. The most important crops are sorghum (*Sorghum vulgare*), sweet potatoes (*Ipomoea batatus*), Irish potatoes (*Solanum tuberosum*), beans (*Phaseolus vulgaris*) and maize (*Zea mays*). Through intensive soil management and intercropping, farmers have been able to grow enough food to prevent large-scale famine. Two rainy seasons, one short and one long, allow farmers to produce up to three crops per year on the upland fields and one crop a year in the wetland fields. Many farmers, especially those with low household incomes, try to plant a second crop of sorghum and maize in their wetland fields. Wetlands are also used for their natural raw materials. As population continues to increase and the upland fields decrease in size, people take on the arduous task of converting wetlands to fields. Land shortage is often believed to be a major factor affecting families’ ability to produce sufficient amounts of food (Olson 1995). Thus the wetlands became the new agricultural frontier.

Much research has been done on agriculture in Kabale District, including soils in the area (e.g., Farley 1996; Lindblade et al. 1996; Olson 1996; Tukahirwa et al. 1998). General land use for each wetland in the district is well documented (Ecaat and Rutasikwa 1994; Uganda National Wetlands Programme 1995; Loy 1999). However, little is known about details of the use of wetlands for agriculture and raw materials and the degree to which farmers depend on wetland fields for food production. The smallholder farmers in the district rely on the crops they grow for subsistence and for income. Factors influencing wetland agricultural field use and intensification need to be
identified and explained to provide a clearer picture of the dynamic nature of wetland use and wetland agriculture in southwestern Uganda. Most farmers in Kabale District rely on their upland fields for the majority of their food. However, the continued use of upland fields for farming has resulted in loss of soil fertility due to erosion and over use (Tukahirwa et al. 1998). In addition, an increase in the urban market demand for food produced in the wetlands, particularly Irish potatoes, has pushed farmers to increase production in their wetland fields (National Environment Management Authority 2004). Regional economic development and food security in Kabale are highly dependent on agriculture and the availability of natural resources.

The site for this research was Mugandu valley (Figure 1-1), located in southern Kabale district near the Rwandan border. Most of the wetland in Mugandu valley is used for growing crops, with a small area used as cattle grazing land and one area left in its natural state for harvesting of wetland grasses. This dissertation examines how and why farmers use converted wetlands for farming in Mugandu valley and attempts to identify which bio-physical and socio-economic variables affect the intensity of land use in the wetland. The objectives of the research are to document and analyze:

- the history of why and how smallholder farmers started using wetlands for agriculture.
- the physical process of wetland conversion.
- differences in how wetlands are used by different income groups.
- the degree of intensity of farming in wetland fields.
- the bio-physical and household socio-economic variables that have the greatest influence on the intensity of farming in wetland fields.

The remainder of this dissertation is organized into seven chapters. Chapter 2 examines the theoretical and empirical background for this study and explores three
relevant topics to this study. The first is land-use decision making, focusing on agriculture; this is followed by a review of the research on farm management decisions by smallholder farmers; the last section examines the literature on population growth, agricultural change, and agricultural intensification. The chapter concludes with discussion of the research design, research questions and hypotheses.

Chapter 3 provides an overview of Kabale District including a description of the population, household types and function, and farming systems. It includes a history of Kabale wetlands from the colonial period to the present and contains a description of the ownership and control of the wetlands. The last section details the ownership of the wetland fields in Mugandu valley through the farmer cooperatives. A detailed explanation of the process of wetland cultivation completes the chapter.

The methods and materials used in this study are discussed in Chapter 4, which is divided into research methods and data analysis sections. Chapter 5 presents the descriptive data and information from the household survey, with an emphasis on cultivation and material use in wetland fields. It also discusses the soil characteristics from the samples taken from farmers’ fields. Chapter 6 analyzes the factors influencing land use intensity. It includes the results of the correlation analysis and of the Mann-Whitney and Kruskal-Wallis non-parametric statistical tests. This chapter also discusses results of statistical tests related to the study research questions. Chapter 7 discusses the conclusions, implications of this research and recommendations for further study.
CHAPTER 2
REVIEW OF LITERATURE, AND RESEARCH QUESTIONS AND HYPOTHESIS

Introduction

Of interest for this dissertation are topics related to land-use decision making, smallholder decision-making processes and agricultural intensification. A review of the relevant literature on land use and agricultural intensification provides theoretical and empirical background to the study questions presented at the end of this chapter. The first section of this chapter discusses perspectives on land use decisions, focusing on agriculture. The second section examines research on farm management decisions by smallholder farmers. The third section reviews the literature on population growth, agricultural change, and agricultural intensification. The final section presents the research design and research questions.

Perspectives on Land Use Decisions

Land use refers to the human manipulation of land for a variety of purposes such as agriculture, industrial complexes, recreation areas, and human settlement (Vink 1975). In definition, land use is straightforward: it is the purpose for which land is used. A more detailed description provided by FAO (1995) states that "land use concerns the function or purpose for which the land is used by the local human population and can be defined as the human activities which are directly related to land, making use of its resources or having an impact on them" (FAO 1995, pp 21). In reality, the choice of how landowners use land is a complex interaction that includes the characteristics of the land, the landowner and economic situation in which the choice is made (Vesterby 2001). Complexity arises in part because land is an economic resource and has many distinguishing characteristics. The location of the land to an important feature such as a
transportation links or a city center, its productivity, erodibility, and topography all
determine its agricultural value and future returns to crop production. In addition, “land
may simultaneously pose characteristics that are favorable to and detract from its value
for a particular use, creating tradeoffs in land-use decisions.” (Vesterby 2001, pp 2).
Management skills, tendencies, preferences, present situation, and economic
expectations of individual landowners affect how these factors are evaluated. Other
factors that also influence land-use choices are likely to include expectations of future
income, level of risk aversion, and age (Daugherty 1997).

Numerous theoretical approaches attempt to explain some of the factors that
influence land use choices. Perhaps the most prevalent approach is the economic
explanation, which is presented via a model or a descriptive analysis. One economic
approach, termed settlement pattern models, explains why towns or villages are set up
with proximity to key resources (e.g., water, agricultural land, roads). Known collectively
as location theory, the most well known theory is that of von Thünen.

In his theory of “The Isolated State,” von Thünen (1966 [1826]) tried to identify the
relationship between agricultural prices, distance to markets and land use. Essentially
he asked, how does location affect potential land uses? In his model, the value and use
of a bed of land are determined by its location and distance relative to a central place
(market). Added into the value of the land are transportation and production costs.
Thus transportation expenses determine the types of crops planted. The value of land
decreases as distance to a central place increases. This location, along with other
related agricultural costs such as labor and market value determine how the land is
used. The patterns of agricultural activities on a landscape can change relative to these
costs. Von Thünen’s theory has been extensively studied for spatial allocation of agricultural activities (e.g., O’Kelly and Bryan 1996), for how spatial factors affect the intensity of agricultural production (e.g., Webber 1973; Visser 1982), and for levels of deforestation (e.g., Moran 1981; Chomitz and Gray 1996). It was introduced into rural geography by Chisholm (1962).

Another theoretical approach explaining land use decisions is the behavioral model, in which researchers focus on a choice criterion (e.g., maximizing profits contingent on a number of constraints) and test the hypothesis that land users make decisions consistent with the outcomes of the model (Liverman 1994). Behavioral models often have well-developed constructions of farming behavior (e.g. market/subsistence-based in less developed countries) that are incorporated into a model (Hayami and Ruttan 1985; Pingali, Bigot and Binswanger 1987; Turner and Brush 1987). Behavioral models have been assessed at household and village levels, often by evaluating the inputs and outputs that follow the logic of the model (Rayner et al. 1994).

Examining agriculture as a form of land use includes consideration of both human and biophysical factors. These can be identified by the researcher or the farmer, or examined more analytically through the use of a model. Variables that may affect a farmer’s decision making include household assets (both human and non-human) plus the qualities and assets of the farm itself. While there are many endogenous and exogenous factors that may influence why farmers cultivate land as way they do, ultimately it is the farmer who makes the final decision on how to use the land. The
following section describes the characteristics of smallholder households and the processes of smallholder decision making.

Smallholder Farmers and Smallholder Decision Making

Many rural households in developing countries are considered smallholder farmers. Smallholder farmers are rural cultivators practicing permanent, diversified agriculture on small farms (Netting 1993). What characterizes farmers as smallholders is that they manage small tracts of land for cultivation for family food supply but they also may use the land for extra income. Smallholder farmers remain the main food producers in many parts of the world, especially sub-Saharan Africa where 470 million people live in rural areas and 65% of whom are employed in agriculture (World Bank 2008). Many African farmers are located in areas of dense population and practice intensive agriculture. Smallholder farmers have limited resources endowments with respect to land, labor, and capital. In the past in many areas of Africa, land was abundant and was not a critical constraint, which allowed farmers to increase production by clearing new land and then rotating the use of fields over time to help maintain soil fertility. As population increased, especially in the 20th century, shifting cultivation could no longer be practiced in many areas. Land became a limiting resource, and often either poor quality, remote, or difficult land was brought into production (Hildebrand 1986). Smallholder farmers depend on family labor, including the extended family for agricultural activities. Although they cultivate small pieces of land, labor shortages can occur at critical periods during the year. Nearly all agricultural processes are completed by hand, thus the need for more labor on the farm during critical times. Capital, especially cash, is limiting on most farms. Access to credit is constrained by the lack of fixed capital to use as collateral, and when loans are obtained, they often carry high
interest rates (Hildebrand 1986). Farm households often supplement their farm income by participating in off-farm activities and non-farm activities. This removes some of the available on-farm labor, which may leave farmers susceptible to labor shortages especially during peak periods (Netting 1993).

Smallholder farmers consider the farm first as a home and then as a business, and priority is given to the welfare of the family and home over profits from the fields (Hildebrand 1986). Households are involved in diverse activities and they tend to have limited time to manage any particular activity intensively (Netting 1993). The quality of management of small farms is hindered by generally low education levels and limited access to appropriate information. Also limited is access to services such marketing, transportation, storage and processing for crops (Hildebrand 1986). This influences the technologies used as well as the overall productivity of smallholder farms.

The family household is the major social unit of the smallholder farm. The household is a social group engaged in a combination of production, distribution, transmission (e.g., transfer of property), biological and social reproduction, and co-residence (Wilk 1991; Netting 1993). Households come in various forms, including monogamous, polygamous, nuclear and extended, with or without servants, etc. Every household has different resource endowments (i.e., labor and land) and different economic constraints (Angelson 1999). Ethnic and cultural traditions also have a significant impact on how a household operates (Boserup 1965). Due to the amount of variability found within and among households, there are differences in household choices on agricultural production, marketing of crops, amount of land to cultivate, access to additional land to cultivate, and use of labor and cash resources. There are
contrasts among households even in areas of uniform or similar cultural and ethnic identities (Netting 1993).

Smallholder farmers manage resources and organize consumption at the household level (Hildebrand 1986; Netting 1993; Ruben, Moll and Kuyvenhoven 1998; de Koeijer et al. 1999). Basic livelihood strategies of households are influenced by the socioeconomic and agro-ecological circumstances around them, and is an important factor as to why farmers are often rational in their behavior. Smallholder farmers use a variety of techniques to maintain their livelihoods, using the resources available to them. A combination may include members of the household, fields and animals to use, neighborhood help via special cooperatives, relatives, local labor markets, and merchandise markets. Schultz (1964) stated the argument for the rationality of smallholder farmers as “There are comparatively few significant inefficiencies in the allocation of the factors of production in traditional agriculture” (Schultz 1964, pp 37).

Schultz (1964) considered economic rationality as the major influence guiding the allocation of resources by smallholders. Prior to Schultz, the literature on smallholder farmers and traditional agriculture usually stereotyped the farmer as lazy, unmotivated, and acting irrationally as farm managers, including crop choices and economic decisions (Ellis 1998). Schultz argued that farmers rationally adjust and optimize the available resources that makeup the smallholder farm. For example, in response to a price increase, farmers may need to decide to adjust labor input and production amounts. His theory of the profit-maximizing peasant emphasized that peasants operate in such a way that no alternative allocation of inputs or adjustments in inputs would give higher monetary or non-monetary net income to the household. Schultz was
adamant that peasants are rational, efficient resource allocators, and that they remain poor because in most poor countries there are only limited technical and economic opportunities to which they can respond. Furthermore, Ellis argues that peasants maximize profits subject to trade-offs with other goals (e.g., household needs), resource constraints, and the working of markets (Ellis 1998).

Peasant rationality in decision-making was also theorized by Scott (1976). He contends that peasant rationality in farm management choices is shaped by economic, political, and social constraints. Scott argued that peasant societies find themselves on the margins of subsistence constrained by society and their physical environment. Thus, they avoid risks that would threaten their basic subsistence. Instead of maximizing income for themselves or their families, they choose to pursue a moral economy based on two principles “firmly embedded in both the social patterns and injunction of peasant life: the norm of reciprocity and the right to subsistence” (Scott 1976, pp 4). Smallholder preoccupation is with ensuring enough food for the household even though minimal return to the amount of labor extended may occur. The strategy is to avoid falling below what Scott calls a “subsistence danger level” by combining risk avoidance behavior. Based on this principle, farmers prefer to minimize the chances of disaster rather than to maximize their average return from inputs and labor.

Another viewpoint on the functioning and decision-making of smallholder farms is that of Sahlins, who introduced the concept of the “domestic mode of production” to describe how households in less developed countries support themselves (Sahlins 1972). According to Sahlins (1972), the variation in the domestic mode of production by smallholder households comes from a number of factors components. The first is that
the mode of production varies based on the household division of labor and the distribution of tasks within the household. The second is influenced by mechanisms at the community level, including amounts and types of reciprocity and redistribution of goods and services, plus the degree of internal differences among households within the community. Lastly, the distribution of factors of production is hampered or enhanced by the quality of the natural environment. In addition, beyond the household and local community, aspects of society, state policies and market intervention also influence smallholder farmers’ decision-making (Porro 1997).

The balance of productivity and risk inherent to the smallholder farms is stated succinctly by Hart (2000) “resource poor farmers have no choice but to consider productivity and risk simultaneously. The risks that influence their decisions are both ecological and economic, including unpredictable market prices.” (Hart 2000, pp 41). The obvious choice for smallholder farmers is to value short-term family survival over potential long-term economic returns. Hart continues: “Resource poor farmers have no choice but to design crop and livestock systems that trade-off higher productivity for reduced risk. And those pushed into fragile environments with poor soil and unpredictable rainfall are particularly vulnerable.” (Hart 2000, pp 41). The socioeconomic status and physical environment for each smallholder household varies. Farmers must continually reevaluate their situation at the beginning and the end of the growing season.

Management and decision-making on smallholder farms is complex. The ‘balancing act’ performed by smallholder farmers is further explained by Collinson (2000) who states that the main purpose of smallholder farmers is maintaining food
security. However, smallholders must manage many external uncertainties such as weather variation, degrading land, pests, diseases, and unreliable markets and prices. There is no safety net available. Farmers are fully exposed to these diverse uncertainties and they use production strategies evolved by their culture for survival. As such, how a smallholder farm is managed and the decisions made within the household vary greatly from farm to farm.

Livelihood diversification is another explanatory perspective about how smallholder farms operate, which includes management decisions, specifically income diversification, seasonality, and labor availability. Livelihood diversification is the process by which rural households conduct a variety of activities and construct different social-support capabilities to survive and to improve their standard of living (Ellis 1998). Livelihood refers to more than just income, but also to social institutions (kin, family village, etc), gender relations, property rights, and access to and the benefits derived from social and public services provided by the state such as education, health services, water supplies (Blackwood and Lynch 1994; Lipton and van der Gaag 1993).

Because of the broad spectrum of factors and benefits, livelihood diversification is not synonymous with income diversification, which refers to the composition of a household's income at a given time (Ellis 1998). Income sources consist of three primary categories: farm, off-farm (wage and exchange labor within agriculture), and non-farm (Saith 1992). Within these, there can be full-time, part-time, seasonal, and casual types of work. Between the categories of income sources and the types of work, there are infinite gradations and variations in the mixture of income sources that a household can use. Income in rural households also varies year to year as it depends
on the outcome of agricultural production, the prices obtained from crop sales and from the sale of any products made from natural raw materials (Lipton and van der Gaag 1993). The current economic situation of a region also affects the amount of income a household can earn. Participating in non-farm activities is a way rural households can generate cash income to purchase inputs for agriculture, to make farm investments, pay school fees, or other cash-based needs. This non-farm income source is also a substitute for the absence or the high cost of credit (Ellis 1998).

Seasonality, the pattern of wet and dry seasons that dictate farming and related household activities, is an intrinsic feature of the livelihoods of rural households (Chambers 1982; Sahn 1989; Agarwal 1990). Seasonality alone explains many of the temporal patterns of income diversity in rural household. It also implies that returns to labor from both on-farm activity and off-farm labor markets vary during the year (Alderman and Sahn 1989). Due to seasonality, regular household consumption needs may be mismatched with inconsistent income flows. This incongruity causes significant problems for households throughout the year and the reduction of income instability associated with seasonality is an important goal for households (Ellis 1998).

Labor availability in the household is another factor that has a strong influence on how much land is cultivated and when. Household demographic composition greatly influences the amount of labor available. Generally the very young and very old are not available to work on or off the farm. Labor is an important aspect of agricultural expansion and intensification, and where labor is in very short supply, both expansion and intensification are likely to be highly constrained (Boserup 1965; Tiffen, Mortimore, and Gichuki 1994). For example, Reardon’s (1997) study of the rural non-farm labor
market in Africa found that labor markets are often poorly distributed over an area, meaning that there are few opportunities for non-farm work in most rural areas. Other factors that cause differences in labor markets, includes seasonality, sustainability, and potential income growth (Reardon 1997).

Sources of labor used in agricultural production for the household include household members, exchange labor, and hired labor. Exchange labor is usually an informal arrangement between farmers who work on each other’s farms on a reciprocal basis (Eramus 1956). Hired laborers work for a wage rate and are hired to work on individual farms usually on an ad hoc basis. During times of labor shortage in a household, either of these two sources may be used. In the rural labor market priority is placed on labor that is available when needed, which closely coincides with changes in the agricultural seasons. Smallholder farmers search in their own village for laborers who are willing to help out, understanding that loyalty to the village is of primary importance for the continued survival and agricultural success of the residents and of the village (Islam 1987). Households that do not have cash available are most likely to participate in exchange labor. Households that do not have labor available for exchange and do not have the cash resources to hire labor are usually not able to increase their agricultural production (Boserup 1965).

The literature suggests that variation in household land use depends on location, assets, income, opportunity, and social relations. Household types vary widely and the different potential access to diverse income sources varies between individuals and families. How each household decides to use its land resources depends on individual choices as well as environmental, economic, social, and cultural influences. A
successful smallholder farm depends on both the resources available and choices made by household members.

**Population Growth, Agricultural Change and Intensification**

Agricultural intensification has been defined as “increased average inputs of labor or capital on a smallholding, either cultivated land, or on cultivated and grazing land, for the purpose of increasing the value of output per hectare” (Tiffen, Mortimore, and Gichuki 1994, pp 29). Others define agricultural intensification based on the outputs rather than the inputs. For example, Brookfield describes it as “in relation to constant land, the substitution of labor, capital or technology for land, in any combination, so as to obtain higher long-term production from the same area (Brookfield 1993, pp 28). Regardless of whether intensification is defined based on input increases or an increase in outputs there must be a demand for output before intensification will occur. An increase in demand may come from an increase in population, market demand for high value crops, or even an increase in migration to an area (Carswell 1997). Many theories examine agricultural intensification and its causes and much research conducted over the last several decades provides insights and different perspectives on the issue. The following starts with broader theoretical ideas concerning agricultural intensification based on the population-environment debate (Turner, Hyden and Kates 1993).

One of the first theories of the effects of population growth on agriculture change is that of Thomas Malthus (1960 [first essay in 1798]). In his model, birth and death rates vary according to changes in the standard of living, and the return to labor ultimately decreases because the amount of land available for agriculture is fixed. As the population grows the rate of food production does not grow proportionally, thus real
wages decrease, and subsequently the birth rate declines and the death rate increases according to Malthus. Hence, food production establishes the limits to population growth. Malthus also proposed that the impact of population growth would be detrimental to the environment by outstripping all natural resources. This would result in severe environmental deterioration and famine, as well as the involution of agricultural intensification and irreversible land degradation. The work of some authors (i.e., Martin 1987; Lele and Stone 1989) supports this idea and they have found that where population densities have been high for a long period, land degradation, involution, and perhaps even stagnation have set in. Conversely, there are similar areas where this has not occurred. Lewis, Clay and Dejaegher (1988) found that in the densely populated country of Rwanda, farmers were managing their resources wisely and have been able to maintain yields over time. Tiffen and Mortimore’s (1994) study of Machakos district in Kenya found that population growth combined with market development and access to capital resulted in new technologies, which brought about increased agricultural productivity and improved land and water conservation.

Boserup’s is another well-known theory concerning agricultural change and population growth (1965). Her theory predicts that agriculture will intensify as a response to increased population pressure. She argues that the pressure on resources resulting from population growth can stimulate change and agricultural innovation. Boserup hypothesized that an increase in population density (or land scarcity) is an independent variable that can initiate agricultural intensification. This is because increased labor is used for agriculture. Intensification of agriculture usually occurs after the expansion of agriculture. The process of intensification starts with a reduction of the
fallow period, followed by the adoption of new technologies, increased use of labor, and eventually by the addition of organic and/or inorganic inputs. Farmers do not intensify agriculture until the demand for food production forces them to since intensification requires increased work (Boserup 1965).

Boserup’s original theory ignored other factors such as markets. Pingali, Bigot andBinswanger (1987) state that changes in the landscape are a response to local demands, which includes market demands. Turner and Brush (1987) suggest that agricultural change and intensification are influenced by consumption and commodity demands. Changes in agriculture are a result of constraints and demands placed on farmers by local and national economic conditions (Turner and Brush 1987).

Participation in markets can be an advantage for farmers. Farmers may intensify production for purely monetary reasons such as for producing surplus yields, which they can then sell for cash (Goldman 1993).

Another theory on agricultural intensification is based on the scarcity or expense of resources at hand. The induced-innovation model (Hayami and Ruttan 1985; Pingali, Bigot, and Binswanger 1987) points out that smallholder farmers will work on the part of the system that is the highest cost. If land is scarce or expensive, farmers will attempt to increase the yield per acre, often by increasing the amount of labor used or by adding available organic or inorganic fertilizers. On the other hand, if land is abundant and labor scarce, mechanical and biological technology such as tractors and herbicides may be used.

Intensification in agriculture does not always come under the conditions of population pressure or market forces. A major obstacle to intensification is the
environment. The relationship between population density and agricultural intensity is strongest with modest environmental constraints to land quality (Brookfield 1984). In environments where there are severe environmental constraints, agricultural production is reduced or even inhibited. Lele and Stone (1989) argue that soil conditions and rainfall are constraints to agricultural improvement in Africa. Although the environment, including soil conditions, may not limit intensification, it influences how intensification is pursued (Goldman 1993). Netting (1965, 1993) found that farmers adapt to their environment and are able to support large populations without having optimal environmental conditions. They do this by maintaining crop diversity, using crop residues, and using other small, resourceful farming and household techniques that maximize crop output and household activities.

Population growth may also affect the natural environment. In Honduras, Stonich (1989) found evidence that soil degradation and deforestation are directly associated with fragmentation of landholdings and population pressure. In Kisii District, Western Kenya, decades of population pressure led to numerous adjustments including land fragmentation, agricultural intensification, intercropping, and encroachment into forests, woodlands, and water catchment areas (Okoth-Ogendo and Oucho 1993). This same trend is also occurring in Kabale District, Uganda, with the shift from intensive cultivation of the hillside fields to conversion of wetlands to agricultural fields.

**Research Design**

This study examines how and why people use converted wetlands for farming in SW Uganda. Kabale District in SW Uganda provides a good example of how smallholder farmers use fragile lands to try to increase their agricultural production. Historically, population density in Kabale District has been high and agricultural
production on hill slopes has been intensive (Lindblade et al. 1996). As a result, agriculture has expanded onto wetlands in the valley floor, although the degree to which farmers depend on these fields is not known. This study uses data collected at the household level to examine the extent to which households use their valley fields for agriculture. I examine how and why farmers use valley fields to explain specific land use in the wetlands. Although my conclusions are limited to a single district in Uganda, the results of this study serve as a case study of the more general question of how people use land resources of other types and in other places.

My approach to examining how and why people use converted wetlands for farming in SW Uganda goes beyond land use description alone. It examines how intensively farmers use valley land in this area of high population density. The focus for this study is how much land is used, how it is used, how intensively it is used, and what influences the differences in intensity of land use among households. The research on smallholder farming systems reviewed in this chapter and land use identifies several socio-economic and biophysical variables related to how and why smallholder farmers use their farmland as they do. I will focus on six variables that seem likely to be causal or explanatory factors in the determination of agricultural land use in the wetlands: household income, access to labor, total farm size, sufficiency of food production on upland fields, the quality of soil in the valley fields, and percentage of crops grown on valley land for home consumption.

The financial resources available to farmers influence land use for agriculture. Financial resources include income from on-farm, off-farm and non-farm sources, and capital such as livestock that farmers can sell when they need cash (Ellis 1998). The
amount of cash available in a household is an important variable in determining how many fields the farmer can plant and how much of each crop type he/she can plant. Income varies over time, both seasonally and annually. This is particularly so for households that rely heavily on income from farming because on-farm income depends primarily on the outcome from agricultural production (Lipton and van der Gaag 1993).

Access to labor is perhaps the second most important variable to the smallholder farmer after cash. All work on smallholder farms in SW Uganda is manual. The amount of labor needed varies by crop and task. Therefore, labor for agricultural tasks is a necessary component of the agricultural system and access to labor plays an important role in determining how much land the farmer can plant and what crops he/she can grow (Boserup 1965).

The upland fields are the primary land resources for smallholder farmers in Kabale District. The farmers consider these fields their primary land resource for several reasons:

- Ownership of the fields is generally passed through the family, and the land may be in the family for generations;
- It may be possible to produce three crops per year on a field;
- A wider variety of crops can be grown on upland than in the valley fields;
- Families tend to have more land in upland fields than valley fields;
- The owners hold titles for the land on the hillslopes whereas most valley land is owned by cooperative societies and leased to farmers on a long-term basis.

The crops produced on the upland fields provide a variety of food products for the smallholder family. Producing enough food on these fields, whether for consumption or sale, can influence how a household uses their valley fields. In many cases, the main agricultural priority of small farmers is to meet food needs and then to produce excess
staple crops for sale. The amount of land that is needed in the valley and how it will be used may therefore be strongly influenced by the degree to which the household is able to meet its food requirements for home consumption first, and then for cash sale from the production on their primary fields.

Most farming systems have a few key crops. In this region, rural households rely on beans, maize, or bananas as the staple food. As a result, these crops are nearly always present in traditional farming systems, and farmers will make these crops a priority for planting. Based on the importance of home consumption of major food staples in smallholder farming systems (Hildebrand 1986; Netting 1993; Collinson 2000) this variable can be expected to play a key role in determining how much land, and which land, can be used to produce non-key crops in Kabale District. In addition, farm size may also affect land use decisions. Farmers with more land often farm a smaller proportion of their total land holdings (Ellis 1988; Pichon 1996; Shriar 1999). Farm size also influences the allocation of land among crops, woodland, and other uses (Netting 1993).

Soil quality is a biophysical variable that influences the use of valley land for farming. Overall soil qualities as well as specific soil characteristics determine which crops can be grown and how well different crops will grow (USDA 1998). Irish potatoes, for example, require coarse textured soils with good aeration and drainage. The potato will not tolerate prolonged soil saturation. Since smallholder farmers generally own more than one field, the characteristics of the soil on the different fields may influence how they use their fields and to what extent they cultivate them.
The objectives of the research are to examine and analyze:

- the history of why and how smallholder farmers started using wetlands for agriculture.
- the physical process of wetland conversion.
- the differences in how wetlands are used by different income groups.
- the level of intensity of farming on wetland fields.
- which bio-physical and household socio-economic variables have the strongest influence on the intensity that wetland fields are farmed.

**Purpose of Study**

The key objective of this study is to identify and analyze the variables that influence the intensity of land use in a converted wetland valley. Land-use intensity is defined as the proportion of land planted during the two growing seasons per year for each household. It is expressed on a scale where 1.0 represents planting all valley fields in both seasons, and 0.0 represents no planting on valley fields in either season. This can also be represented as percents ranging from 0% to 100%. Data were collected from households that use the wetland. Data were not collected from households that do not use the wetland.

I use a model that explicitly considers factors or conditions at the household scale and how these interact to influence the need to intensify valley land production. Original hypotheses were developed based on my interpretation of the literature about land use by smallholder farmers, smallholder decision making, agricultural intensification, and study area characteristics. Many other studies focused on a variety of factors regarding smallholder farmers (i.e., Conelly 1994; Reardon 1997; Angelson 1999). Other studies examined wetland development for a large region (Woodhouse, Trench, and Tessougue 2000) or for commoditization of crops by businessmen or the state (Southgate and
Hulme 2000), but none related to identifying factors influencing the use of wetlands for agriculture by smallholder farmers. This study identifies the factors that influence the use of wetlands (located in valley fields) for agriculture by smallholder farmers.

**Research Questions**

The following research questions are addressed in this study:

1) To what extent does household income influence the use of valley fields?
2) To what extent does labor use influence the use of valley fields for agriculture?
3) Does the upland food sufficiency influence how farmers use their valley fields?
4) Does overall farm size affect how much the valley fields are cultivated?
5) How does the amount of valley crops consumed influence how much of the valley fields are cultivated?
6) To what extent does the general soil quality of valley fields influence how fields are farmed?

**Hypotheses**

This study hypothesizes that:

Land use intensity in the valley will depend on household income, access to labor, the food sufficiency from upland fields, farm size, the amount of valley crops consumed, and the soil quality of the valley fields where

- Land Use Intensity is defined as the amount of land planted over the two planting seasons per year as a proportion of the total amount of valley land available to the household
- Household income = estimated total household income for 1999
- Labor use = the total number of people used to cultivate valley fields
- Amount of valley crop consumed = percent of valley crop production for two planting seasons consumed in 1999
- Upland food sufficiency = whether enough food is produced to feed all household members (within the past 5 years)
- Farm size = total area of upland and valley fields
• Soil quality = ranking of soil physical properties (soil depth, texture, structure, aggregates, bulk density, infiltration rate, amount of roots and pH), where the higher the rank for each variable, the better the soil quality

**Research Hypotheses**

Variation in land use intensity will result from differences in the following:

H1: Household income is negatively correlated to valley land use intensity.

H2: Access to labor is positively correlated with valley land use intensity.

H3: Upland food sufficiency is negatively correlated with valley land use intensity.

H4: The amount of valley crops consumed is positively correlated with valley land use intensity.

H5: Total farm size is negatively correlated to valley land use intensity.

H6: The valley soil quality is positively correlated to valley land use.

Statistical tests were conducted on the field data to determine the strength of the relationship between land use intensity and each of the six variables listed above. The following chapter (Chapter 3) discusses the research methods of this study.
The methods and materials used in this study are discussed in this chapter. It is divided into research methods and data analysis sections.

**Research Design**

To meet the key objective of this study, to describe how and why people use converted wetlands for farming, the research compares the importance of the independent variables stated in the previous chapter in explaining land-use intensity in the wetland fields used for agriculture in one wetland valley. This study uses a cross-sectional design on a single population at a single point in time. The strength of the cross-sectional design is that it can be done in a short amount of time and allows for collection of data on many variables and for comparison of individual groups within the sample. However, it is not good for determining cause and effect (Creswell 1994). The approach used in this study was to compare the proportion of wetlands fields cultivated (land-use intensity) to the variables of household annual income, access to labor, upland food sufficiency, the amount of valley crops consumed, total farm size, and valley soil quality. It examines which variables influence the dependent variable. This approach is consistent with that described in the previous chapter: households and their field fields are the main components in the study of land use and land-use intensity.

**Research Procedures**

**Research Site Selection**

Criteria for the selection of the wetland study site was determined prior to the start of fieldwork. The criteria were established to identify the number of wetlands that would be suitable for this study. The first criterion was that much of the local population must
have access to the wetland though individual leases or through a farmer cooperative.
The second criterion was that the majority of the wetland must be used for crop farming,
ot not pasture. The third criterion was that the conversion of the wetland must have been
done by the local population and occurred in the 1980s or as close to that time as
possible so people would remember the event.

Preliminary visits were made to Kabale District in 1997 and 1998 to meet district
officials, familiarize myself with wetland locations, and to collect literature on the Kabale
wetlands. The National Wetland Program’s status report for Kabale District (1998) was
used to develop the initial list of potential sites for this study based on my criteria.
Fourteen wetlands were identified as possible research sites. During the fieldwork
portion of this study in 2000, these wetlands were visited to verify their status and
ownership. Discussions with farmers and local officials at each wetland valley provided
information about the use of the wetland and ownership of the wetland. The visits also
confirmed which wetlands had uncooperative populations and which wetlands were
inaccessible on a frequent basis. The wetland in Mugandu Valley was selected for this
study because it best met the above three criteria. Only one valley was examined for
this study due to time and money limitations.

Twenty villages are in the parishes of Mugandu and Buramba surround Mugandu
Valley and the wetland. Fourteen of these villages were adjacent to the wetland.
Informal interviews were conducted with leaders from each of the fourteen villages to
obtain an estimate of the number of people in each village that owned fields in the
wetland. Additional interviews with the leaders of the two cooperative grower societies1

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1 A majority of the land in Mugandu Valley is owned by two farmer cooperatives. See Chapter 4 for
information on the cooperatives.
were completed to verify this information. I was not able to obtain the list of members for each society. The leaders felt that it would be best if members were not chosen outright for interviews. Furthermore, the societies’ lists are not comprehensive because farmers who own wetland fields that are outside of the grower cooperatives’ land area would not be included in the sample population. Six villages of the fourteen surrounding the wetland were selected. This is because most of the population needed for this study lived in these six villages (Bernard 1994).

The six villages are located on the hill slopes facing the wetland. The villages of Kihira and Rukole are in Mugandu parish and are located on the east side of the valley. On the west side of the valley in Buramba parish are the villages of Karambo, Gwanganiro, Rutooma I, and Rutooma II (Figure 3-1).

It is important to remember that there are still wetland areas available for conversion in Mugandu valley. This is the section of the wetland owned by the Mugandu-Buramba farmers’ cooperative society that has not yet been allocated. In addition, it takes years to convert a wetland to farmland, which I didn’t realize when I started this research. For instance, some families were given fields in an adjacent section around 1986 and they recently started to cultivate their fields. Prior to this, the fields were too wet to farm and canals were dug to drain the excess water. Hence, this study is a snapshot of a process that takes years to complete.

**Field Research**

The fieldwork for this study was completed from January-September, 2000. The data were collected using a variety of methods including unstructured key informant interviews, semi-structured group interviews, a structured group mapping exercise, soil sampling of respondents’ wetland fields, and personal interviews with individual
households (Bernard 1994). The fieldwork was carried out with a field assistant who was from Kabale District, fluent in the local language and university-educated in the social sciences.

Unstructured and informal interviews were conducted throughout the fieldwork period. Interviews with Kabale District officials were conducted to obtain information on wetland history and use in the district. Information about the political and social structures of the Mugandu and Buramba parishes and villages surrounding the valley were obtained by interviews with parish chiefs. Information about the general population characteristics and agricultural and economic systems, including labor and crop markets, was gathered at this time. Meetings with village leaders and the leaders of the two cooperative growers’ groups provided information about the history, ownership and use of the wetland. Semi-structured group interviews were conducted with members of the farmer cooperative societies and with the elders of the area who were familiar with the historical use of wetland raw materials and the history of the first use of the wetland for agriculture. The structured interviews with individual farm families are discussed in detail in the next section, followed by a discussion of the soil sampling methods.

**Sampling**

The theoretical population was households who own fields and farmed in the Mugandu wetland. After meeting with local administrators and the leaders of each of the farming cooperatives that manage the wetland fields, I determined that the accessible population for this study lived in the villages of Kihira, Rukole, Karambo, Gwanganiro,
Rutooma I, and Rutooma II who are owners of one or more fields in the wetland\textsuperscript{2}. For this study, ownership is defined as having control of wetland field property for planting purposes. The sampling frame for this study was households from the above six villages who owned fields in the wetland. The sample was drawn from this sampling frame. No data exist for the number of households or the total population of the villages. Attempts to obtain this information from village chiefs was unsuccessful. A count of the houses in each village completed by the researcher, gave an estimate of 382 households.\textsuperscript{3} The number of households interviewed in each village was determined proportionally because the number of households per village was not uniform (Table 3-1). A mean of 16\% of the households in the sampling frame population were sampled. Sample size was limited by the distance and travel time to the study site from the researcher’s residence.

Village houses are located either alone (without an adjacent neighbor) or in clusters of 3 to 5 houses on the hillside. No houses were located on the hilltops. Houses were counted starting from the left side of each village boundary and going from bottom to the top of the hill (Romesberg 1990; Hessler 1992). Clusters of households were counted toward the left, from the lowest to the highest elevation. Houses were assigned a number during the counting process. After obtaining an estimate of the

\textsuperscript{2} Land tenure was a fixed effect of the study. To examine land use in the wetland, I needed to meet with people who have the authority to use the fields in the wetland. Hence, households were selected by land tenure status

\textsuperscript{3} The estimate could be incorrect because of the counting of abandoned houses or houses in which the owner resides in Kabale town. During the sampling process, many households were not users of the wetland for various reasons (owner lives out of town, house occupied by an elderly person, or young couple).
number of households in each village, households to be interviewed were selected using a random number table.

Table 3-1. Villages in Mugaundo valley with number of households sampled

<table>
<thead>
<tr>
<th>Village</th>
<th>Total number of households</th>
<th>Number of households interviewed</th>
<th>Percent of households interviewed</th>
<th>Percent of the total study population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kihira</td>
<td>81</td>
<td>15</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Rukole</td>
<td>68</td>
<td>11</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Karambo</td>
<td>44</td>
<td>6</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Gwanganiro</td>
<td>22</td>
<td>3</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Rutooma I</td>
<td>64</td>
<td>10</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Rutooma II</td>
<td>101</td>
<td>15</td>
<td>15</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>382</td>
<td>60</td>
<td>16</td>
<td>100</td>
</tr>
</tbody>
</table>

The unit of analysis for this study was the individual farm household. A household was defined as a group of related individuals residing in the same house, sharing food and financial resources. The head of the household and spouse were sought for participation in the survey. One was interviewed if both were not available. During the initial visit with a household, the purpose of the study was given and permission to interview was sought. If the household head did not own a field in the wetland, the household was replaced with another. Once the respondent agreed to the interview, an interview date was set. If the household adults were not home at the time of the initial visit, a message was left with a neighbor saying when the researcher would return. In two instances, the household head refused to participate. In another two households, the owner and spouse were absent for a long period of time and could not be reached during the data collection period. In all cases, a replacement household was identified.

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4 Additional numbers to use as replacements for non-qualified households were selected at the same time the original numbers were obtained from the random number chart.
A total of 60 households were interviewed. Fifty-five of the questionnaires were used in the data analysis. One of the questionnaires was not used because it was determined that the respondent lied about owning fields in the wetland. Another was not used because the respondent did not actually own a field in the wetland, but was dependent on the owner for authorization for use of the field. In both instances, the truth was not known until after the interview was completed. Three other questionnaires were not used because they rented wetland fields, but did not own any.

Instrumentation

A questionnaire was developed specifically for this study and is suited to the research questions. The questionnaire was administered through personal interviews with farmers. A preliminary questionnaire was developed prior to fieldwork. The preliminary instrument was submitted to the University of Florida Institutional Review Board and was approved on December 15, 1999 (approval number 1999-940). The instrument was revised in the field based on information provided in the individual and group interviews. The questionnaire was pilot tested with eight households in the study area. The questionnaire was edited; questions were adjusted and subsequently used in the personal interviews with the respondents (Appendix A).

Specific questions were included in the instrument to elicit information regarding each of the independent variables and the land use intensity variable (the dependent variable) (Bernard 1994). The questionnaire was divided into four units: valley land use; household demographic, labor, and economic information; upland field information; and use of wetland raw materials. Variables used in this study are stated above in the Research Design section. The variables are explained in Chapter 3 in the Research Design and Purpose of study sections.
The first unit contained questions about valley land use intensity had four subsections. The first elicited information about cooperative growers’ society membership, the second about renting additional valley fields, the third covered problems with valley fields, and the fourth part was about frequency and type of cropping patterns for wetland fields. The responses from the last section were used calculate land use intensity.

The second unit of the questionnaire included questions about household demographics and socio-economic characteristics. This unit also provided information about the use of labor on the farm and household income.

The third unit of the survey concerned production in upland fields. The topics for this unit included the number of fields, types of crops grown, and yield from upland fields. This last topic contained three parts: the first about food sufficiency, the second about surplus harvest used for seed, and the third about surplus harvest for sale.

The fourth unit of the questionnaire examined the use of wetland materials. These data provided information about how wetland materials are used for the home and farm. Also, questions about income received from the sale of wetland raw materials and the sale of products made from wetland raw materials were asked.

Many of the variables in the questionnaire are quantitative and include nominal (e.g., gender and marital status), ordinal (e.g., perception of upland food sufficiency), and continuous data (e.g. number of wetland fields, Irish potato harvest, soil quality data). Qualitative data were also collected during interviews with the respondents. During the interviews handwritten notes were made from observations made by the
researcher or from comments from the respondents. These were later examined and used in the description of households and farms (Chapter 5).

Each questionnaire was coded with an identification number corresponding to the village and respondent. Prior to the start of the interview, a verbal introduction to the purpose of the study and the content was given to the respondents. Respondents were assured that their anonymity would be retained and that all data collected would be aggregated. Respondents were also given the opportunity to decline to participate in the study. The researcher was present for each interview; therefore, any problems that arose with the survey process or the questionnaire were corrected during the interview.

A soil sampling data form was developed for recording observations and findings from the examination of wetland field soil quality. It was used for recording soil analysis results, general cropping patterns of the field, and any problems with the field. Due to time limitations, a sample was taken from one wetland field for each farmer. It was not possible to obtain soil quality data from every wetland field the respondent owned. Soil tests were completed after the personal interviews often in the same day.

**Soil Testing**

Soil samples were taken from one wetland field for each respondent interviewed (Appendix B). The sample was selected by the respondents, who were asked to identify their best field. The samples were taken to determine the soil quality and to use in descriptive and statistical analyses. For the purpose of this study, soil quality is defined as the inherent ability of the soil to provide a growth media for food crop plants (Karlen et al. 1997). Soil quality is not one single property but the combination of several soil properties that individually relate to specific soil function (Green and Brye 2008). Soil properties were tested using standard techniques recommended by the
United States Department of Agriculture and the Soil Quality Institute (USDA 1998).

These techniques permit evaluation of soil quality through analyses that can be completed directly in the field. The following properties were used to develop a soil quality index for the soil samples:

- Texture
- Structure
- pH
- Water stable aggregates
- Effective depth
- Bulk density
- Infiltration rate

Soil samples were collected from the first 30 cm of the soil profile and were coded following the criteria for each property using the recommendations from the Soil Quality Institute (USDA 1998).

Data Analysis

Coding of Data

The completed questionnaires contained dichotomous, continuous, and categorical variables for coding into the data set. For the dichotomous variables, 0 was used to indicate a negative response and 1 was used to indicate a positive response. For continuous variables such as number of valley fields owned, the exact number was entered into the data set. There were several open-ended questions for which the exact response was recorded. These responses were then put into similar categories and then coded into the data sheet. For instance, responses to the question about problems farmers are having with valley fields were coded as follows:

1. Pest on Irish potatoes
2. Dry season too long and/or too hot
3. Flooding and/or too much water
4. Irish potato crop leaves dry up
5. Irish potatoes appear to be ready but the tubers aren’t
6. Bean and/or Maize don’t grow well or stunted
7. Low yields

The numbers assigned each response were not ranked and only represent the specific category.

**Soil Quality Index for Valley Soils**

This section describes effective depth, water stable aggregates, bulk density, and infiltration rates. These four variables not usually included with soil physical measurements, but are important part of the Soil Quality Index (SQI) for this study. Overall, the higher the SQI score the better the quality of soil for farming. Two variables account for much of the total score for the SQI: effective depth and water stable aggregates.\(^5\) The raw scores for both of these variables were used. Thus, the higher the effective depth and/or water stable aggregates score, the higher the total soil quality index score. There is no limit to measurement of effective depth except the length of the measuring probe, which was 100 centimeters.\(^6\) Effective depth is important because it determines the depth that plant roots can penetrate without being blocked by bedrock, stone layer, hard pan or water table. Effective depth was coded in centimeters for each sample. The higher ranked soil samples generally have a deep effective depth measurement, which means there is plenty of room for plant root growth. For water stable aggregates, the limit is 100%. That would mean that a soil sample is completely composed of water stable aggregates. In general, a sample needed to have high numbers in both variables to have a high score.

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5 A soil aggregate consists of many soil particles bound together and is a measure of the strength of the soil to resist erosion and of a soil’s water infiltration ability. Thus the more aggregates, the better the soil.

6 For this study, the depth limit was 1 meter, the same as the soil probe.
Bulk density is another variable measured. It is defined as the ratio of dried soil mass to its bulk volume and includes the volume of particles and the pore spaces between the particles. It serves as an indicator of compaction of soil particles and organic material. Ideal bulk density weight is based on the soil texture of the sample and is measured in g/cm$^3$. Bulk density was measured and coded using the recommendations from the Soil Quality Institute (USDA 1998).

The fourth variable is infiltration rate. The rate of infiltration is the maximum velocity at which water enters the soil surface. This variable helps to determine the overall health or quality of a soil. Soil that has a slow infiltration rate can cause increased runoff water and retain less water for plant use while a moderate to moderate rapid infiltration rate usually indicates a healthy soil environment. Very rapid rates can cause nutrient leaching. Infiltration rate is dependent on the soil type, soil structure, and the soil water content. Infiltration classes for the soil samples in this study were coded based on the timed movement of one inch of water through a 10 inch diameter soil column and coded using the recommendations from the Soil Quality Institute (USDA 1998).

**Data Analysis**

The data were examined using several different types of analyses. First, the data obtained from key informant interviews and group interviews, and other relevant contextual information from secondary sources were synthesized and used in Chapter 5 to meet study objectives number 1 and 2 as described in Chapter 2.

Next, the data collected from the personal interviews and soil tests were coded into a spreadsheet. The data for the independent variables were put into groups of three for this part of the analysis. The independent variables were broken into groups
representing low, middle, and high scores for each variable. For example, the following groups were used for the income variable: 1 = low income, 2 = middle income and 3 = high income. Natural breaks in the data were used to form the groups; therefore they are not of equal number. The purpose of this was two-fold: to determine if there is a difference between the groups and respective land use intensity, and to define a combination of variables leading to the highest land use intensity. The results will give a better understanding of the influencing factors in this area. For example, hypothetically, the combination of low income, high soil quality, and middle sized farm lead to the highest intensity use of wetland fields.

Further explanation is needed for a few variables. For the labor data, the specific number of people who worked in the cultivation of wetland fields and the number of days that each task took was obtained during the personal interview process. Labor data were calculated as the average number of person-hours per raised bed per year for each respondent. Beds are the standard unit of measurement for the size of a wetland field. The number of person-hours/bed/year assumes that the higher the labor, the more likely a farmer has planted all of his fields.\textsuperscript{7} For the variable, amount of valley crops consumed, only Irish potato was used because there is no standard unit of measurement for the other valley crops. Finally, the additional wetland fields that were rented by the respondents were not included in the analyses of labor data and in the calculation of the dependent variable (land use intensity). Not every farmer interviewed rented additional wetland fields, thus these fields cannot be included in the analyses.

\textsuperscript{7} Only persons age 16 and older were counted for the number of people used in wetland field labor. This is because children younger than 16 do not actively participate in farming. When they do participate, they do not work the entire time.
Once the data were grouped, these data were analyzed in search of trends and patterns. Descriptive statistics were used to meet study Objectives 3 and 4 (Chapter 2). Other relevant contextual information from the researcher’s notes was included in the narrative.

To obtain the dependent variable, land use intensity, the total proportion of the number of wetland beds planted to the actual amount owned during the 1999–2000 growing season was used. This number was calculated for each household. Next, the data were broken into two groups. There were no clear breaks to split the data into 3 groups. One group represented households who farmed 85% or more of their wetland fields (in area) in 1999 and are referred to as “total” users. The second group planted less than 85% of their wetland fields (in area) in 1999 and is referred to as “partial” users. The cut off at 85% was selected by a natural break in the data. I also considered that 85% was very close to planting all of the fields and would be hard to distinguish this amount from 100% visually in the field, given that the crops do not all grow at the same rate. Thus, 85% was chosen as an appropriate cut off point for distinguishing between partial and total users for the land use intensity variable.

To meet study Objective 5 (Chapter 2), Spearman’s rank-order correlation was first used to observe relationships between the variables. Next, I tested for a relationship between the independent variables and land use intensity, and then between the groups of each independent variable and the dependent variable.

Non-parametric statistics were used because the data were not appropriate for other measures of relationship, such as linear regression. The sample size is not large enough for linear regression analysis (Tabachnick and Fidell 2001) and is not normally
distributed, an assumption for most parametric statistical tests (Newton 1999). Non-parametric analysis was initially accomplished by performing Kruskal-Wallace H Test and if results were significant, indicating a difference between groups, then a Mann-Whitney U Test was used to determine which of the groups was most different.

Given the exploratory nature of this research, much of the study involved the assessment of data. There are no previous published studies to provide guidance about which variables should be included or excluded from examining land use intensity on a converted wetland valley. A concern with this research is that the variables obtained during the survey and interview process may be so closely related that they only act to muddy the waters of the results. A correlation between variables means that the variables “explain” each other to some extent. If two or more variables correlate, then there is uncertainty as to which of the variables are important. As Miles and Shevlin state: “when two variables covary (change together) we cannot decide which is important in determining the outcome.” (2001, pp 126) Furthermore, “if the variables are highly correlated, this implies that they are measuring similar constructs and that the information in one of those variables may be, at least partially redundant” (Miles and Shevlin 2001; pp 131).

Chapter 4 discusses the history of wetland conversion in Kabale district and the physical process of converting a wetland into agricultural fields. It also includes a history and description of the farmer cooperatives that control access to wetland fields in Mugandu valley, where this research was conducted.
Figure 3-1. Location of study villages
CHAPTER 4
HISTORY AND PROCESS OF WETLAND CONVERSION IN MUGANDU VALLEY

This chapter describes the relevant history and background of Kabale District, the region for this study, and Mugandu valley, the study site. It is divided into three major sections: a description of Kabale District, the history of wetlands in Kabale District, and a history and a description of the use of the wetland in Mugandu Valley.

Under colonial rule, from the 1860s to 1962, Kabale District was part of an administrative unit called Kigezi District. The Ugandan government divided districts several times since independence from Great Britain. Kabale District was split in 1991 into Kabale District and Kisoro District. The area used in this study is within the current Kabale District. Kabale District's land area is 1,827 km$^2$.

Physical Description of Kabale District

Kabale District is located in southwestern Uganda (1°05' - 1°30'S, 29°45' - 30°15'E). The topography is mountainous with long, smooth ridges spaced apart about three to six kilometers (Ollier, Beckett, and Webster 1969). The geological age of the surface is pre-Cambrian with sandstones, phyllites, shales and quartzites as the dominant rock types (Harrop 1960). Elevations range between 1500 and 2750 m above sea level. Dispersed throughout the hills are abundant small streams, steep slopes (10-30 degrees inclination), and some wetlands. Valleys between the hills are narrow and dry at higher elevations. At lower elevations they are wider and may contain papyrus swamps. Some lower valleys extend over a kilometer in width (Purseglove 1946).

Native vegetation for Kabale District is predominantly grass savanna, although some areas are covered in moist evergreen forest and thickets (Ollier, Beckett, and Webster 1969). However, most of the native vegetation was removed and replaced
with agricultural crops over the previous centuries. The remaining primary forests are national parks or forest reserves located in the north of the district. At present, vegetation cover on the hills is a mixture of crops, pasture grasses, and privately owned woodlots planted with Eucalyptus (*Eucalyptus cinerea*). In valleys with wetlands, the vegetation is a mixture of papyrus (*Cyperus papyrus*) and grasses (e.g. *Miscanthidium voilaceum*) (Hamilton 1969).

The climate in Kabale District is a temperate equatorial mix due to its elevation and location. The mean annual rainfall is 1000 mm, distributed in a bimodal pattern with the most rain occurring between February and May, and September and December. The dry seasons are from June to August and from mid-December through the end of January. The annual temperature varies from 9°–24°C (48°- 75°F) throughout the year.

**Population**

The dominant ethnic group in Kabale District is the Bakiga. Total population in Kabale District from the last census in 2002 was 471,783 people (Uganda Bureau of Statistics 2002). Most of the population is rural with 90% of the people living outside of Kabale town (UBOS 2002). Kabale District is densely populated district with a density of 281 persons per km². The district’s average annual population growth rate from 1980 to 1991 was 2.9% and from 1991-2002 it was 0.9% (GOU 2002). The decline in growth rate over the last two decades is accounted for by out migration, particularly of males. Men leave the district to seek more land for agriculture, employment on tea plantations, or work in the construction industry, mostly around Kampala. Kabale has the highest net out migration in the country (National Environment Management Authority 2001).
The male out migration is apparent in the male to female sex ratio (86.0) in 2002 (GOU 2002).

**Farming Systems**

The majority of the population (86%) in Kabale District is smallholder farmers (NEMA 2004). These families carry out most of the district's agricultural production and rely mainly on the hillslope fields. However, converted wetlands, which comprise some valleys, are used for crops. In addition, the district's few large farms are dairy farms that operate in the wetland valleys. Crop cultivation on hill slopes occurs year round with two planting seasons in September to November and March to May. Harvest times vary dependent on the crop planted. For wetland fields, planting occurs in late May through June and harvesting is in September. The second season for wetland fields starts with planting in October and November and harvesting in February and March.

Table 4-1 presents the district’s main crops by field type. Intercropping is practiced in both upland and wetland locations with beans and peas often grown together on the hill slopes. Other combinations include bean and Irish potato and bean and sorghum. In the valleys bean and maize are grown together. Despite lower yields for each crop in intercropped fields (because less land is devoted to each crop), farmers rely on it to reduce their risk should one crop fail (Farley 1996).

Furthermore, farm households keep small numbers of livestock (goats, cows, sheep, chickens, and rabbits). These animals are mostly kept as a source of reserve capital for purchasing land, making bride payments, or for medical or school expenses rather than as a protein source (Farley 1996). The small amount of animal manure available is placed on fields near the home. Inorganic fertilizers are not readily available in Uganda.
Table 4-1. Crops produced in Kabale district

<table>
<thead>
<tr>
<th>Crops</th>
<th>Hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>10746</td>
</tr>
<tr>
<td>Sweet Potato</td>
<td>16748</td>
</tr>
<tr>
<td>Bean</td>
<td>32975</td>
</tr>
<tr>
<td>Maize</td>
<td>27349</td>
</tr>
<tr>
<td>Wheat</td>
<td>974</td>
</tr>
<tr>
<td>Irish Potato</td>
<td>11332</td>
</tr>
<tr>
<td>Banana</td>
<td>24734</td>
</tr>
<tr>
<td>Total</td>
<td>124858 (1249 km²)</td>
</tr>
</tbody>
</table>

Source: Uganda Ministry of Agriculture 2001

Land Tenure

Traditional land tenure in Kabale District was based on customary user rights. A man could hold as much land as he could cultivate and defend, which included assistance from family and community members when necessary (Purseglove 1950). In 1955, the Uganda Protectorate Government developed a land tenure proposal. It stated that land tenure could be based on individualized freehold titles (Zirahuka 1988). From this proposal, the Public Lands Adjudication Rules developed in 1958. It allowed an occupier of land under the customary tenure to obtain a certificate of ownership if ownership of the land could be established (Zirahuka 1988). Most of the current individual land titles in Kabale were established under this policy. Land tenure for property in wetlands, however, is different from upland fields and is discussed on page 62.

Inheritance of land is usually through the eldest son or through the eldest living brother if no sons exist (Parsons 1960). Fathers give land to their sons when they marry. Sons then pass on their land to their eldest sons and so forth. When there are several sons in a family, each gets a portion of his father’s land. The result of this inheritance pattern (and a continued growth in population) is that increasingly smaller
farms are being inherited (Byagagaire and Lawrence 1957; Kururagire 1969; Kagambirwe 1972).

**Field Location within the District**

Rural Kabale residents tend to live in villages near the valleys, and are spread out along the footslopes of the hills. Fields are located like a patchwork throughout the hillsides, hilltops, and valleys. Most farmers have fields on the hillsides and in valleys. The hillside fields are dispersed on various parts of the hills as well as on several different hills. The distances between fields range from a few meters to kilometers. Average walking distance to fields can range from five minutes to two hours (Puhalla 1998). This land fragmentation is a result of population pressure and the traditional patrilineal land inheritance practice (Farley 1996).

Despite the variation in location of fields and the travel time needed to reach them, land fragmentation has some advantages. Farmers view field location diversity as insurance from natural hazards such as hailstorms, floods, and landslides and an opportunity to have different soil qualities available for a variety of crops. Disadvantages of land fragmentation include a reduced incentive for investment in the land and increased risk of theft or animal damage in fields further from home (Makerere Institute of Social Research 1988). Furthermore, as land becomes more fragmented and farms shrink, farmers expand cultivation into wetlands and marginal uplands with poor soils and steep slopes.

The total number of fields owned by families varies from three to ten with a few families owning more than 30 (Farley 1996). Landholdings are small, with 62% of rural Kabale households having less than one hectare each. Another 23% do not fare much better with holdings of between 1 and 2 ha each (GOU 1995). A more detailed study
found that farm size varies from less than 0.08 ha to 3.2 ha with 0.72 ha, the average farm size (Tukahirwa et al. 1998). As a result of population growth and generations of land partitioning in recent years, the available cultivable area per capita is less than 0.04 ha or 400m² (World Bank 1993; GOU 1995). Thus, Kabale District has one of the lowest amounts of land per capita in Uganda.

Smallholder Farm Households

The typical farm family in Kabale today is composed of two parents and multiple children. Because of the strong extended family structure of the Bakiga tribe in Kabale District, it is not unusual for a household to have relatives such as cousins, grandparents, or grandchildren living with the family. Polygamy is still practiced, although it is not as common as it was a few decades ago due to current economic and land constraints. In polygamous marriages, each wife maintains a separate household with her children, and takes care of her fields provided by her husband. Women in monogamous households have the same arrangement with the exception of the husband having only one residence.

Kabale farm households are fairly typical of other African farm households in that they strive to produce food for their consumption, as well as a surplus to sell (Ellis 1998). Women do the majority of the agricultural work in Kabale. Women have traditionally been responsible for more of the farming tasks than men. Women do a large amount of the field tillage, particularly on hillside fields. They also perform most of the planting, weeding, and crop harvesting of household fields. These tasks are completed with hand tools. Men help with the tillage and sometimes with the harvesting of crops. Some households have fields that are used for family food production and a few that are kept by the husband for his personal use, retaining the harvest and cash
received from sale of crops for himself (Kisakye et al. N.D.). Women usually do not have fields for their exclusive use. Indeed, men usually control the income from crop sales and the overall household income. This is particularly true in younger households where women have less autonomy and decision-making power (Puhalla 1998). In households where the husband works outside of the district, the wife is in charge of the fields and income from crop sales while the husband is away.

If a farm family has the cash available, labor is hired to help with the agricultural work. Hiring labor to help with farm tasks is common. Hired laborers usually work for cash; occasionally laborers will work in exchange for food. In addition, women frequently form groups and hire themselves out for work, particularly during planting and harvesting periods for the upland fields. The money earned is divided and shared among the women. Women also form exchange labor groups and work on each other's upland fields in turn. Cultivation is a labor-demanding task and labor shortages are common because fields are prepared and harvested around the same time, creating a demand for labor. Labor shortages are a concern for farm families as it prevents them from producing as much food as they would like (Mugisha 1992).

Farm families are also involved in other non-agricultural income generating activities such as marketing their cash crops, operating small-scale enterprises, and off the farm wage work. The primary crops sold are Irish potato, bean, sorghum, and cabbage. Both men and women sell their crops at local markets. Crop sales alone usually do not provide enough income for the household and they try other enterprises to meet their cash needs. Brewing and selling sorghum beverages is a common business; women normally make a thin porridge drink while men make an alcoholic
drink to sell. Other cottage industries for women include operating a shop to sell household supplies (salt, soap, matches) and making mats or baskets for sale. Men seek non-farm employment within the district area in agricultural trade, construction, and carpentry. Men also migrate from the district in search of wage work on large tea and sugar cane plantations and in trade industries in other parts of Uganda.

**Kabale Wetlands**

Wetlands cover approximately 111 km² of Kabale District (Figure 1-1) and lie at elevations of 1,525 to 2,135 m above sea level (Uganda National Wetland Programme 1998). Wetlands are classified as papyrus swamp, montane bog, which is dominated by sedges and grasses, forested wetland (in the protected areas only), or seasonally flooded wetland containing a variety of plant species (UNWP 1998). District wetlands drain into one of three drainage basins: Lake Bunyonyi, Lake Edward, or Lake Victoria. Within these three basins are eight wetland systems containing 54 distinct wetlands. The area of the wetlands range from .02 km² to 16.5 km². Many wetlands are small in size; 29 of them cover an area of less than one km². About 58% (64.4 km²) of the total wetland area in the district has been drained and is now used for agriculture (either vegetable production or pasture). Seasonal wetlands are most affected by conversion (83%) compared to 27% of the permanent wetlands (UNWP 1998). Conversion of seasonal wetlands is more frequently undertaken because they are small in size, contain less water and therefore they are less laborious to convert.

Wetlands provide a variety of economic and socio-cultural values to the local people. Papyrus and other sedges are used for roof thatching, although the materials are not as sought after as they were several decades ago because metal sheets have replaced many of the traditional thatched roofs. Where thatching is still used, it is more
difficult to find enough papyrus, as a result sorghum stalks are used instead. Papyrus is also used to make ropes and fencing. Wetland grasses are used for mat making, either for home use or for sale. Wetlands are also important for keeping alive sweet potato vines during the dry season, which ensures vines will be available for transplanting on the upland fields in the next planting season (UNWP 1998). Sweet potatoes are planted from live vines, not with seeds as with most crop plants. Bee keeping is also practiced in wetlands because of the proximity to water and abundance of vegetation during the rainy season.

Wetlands in Kabale District are called swamps. The term “swamp” more accurately describes the types of wetlands in the district. I use these terms interchangeably in the following discussion.

**History of Kabale Wetlands**

Traditional use of swamps in Kabale District was for fishing, hunting, and for collecting grasses and papyrus for mats, baskets, and roof thatching. Early in the 20th century, the outside edges of the swamps were occasionally used for sweet potato cultivation. This cultivation practice became required by the British Colonial government during periods of food shortage or predicted food shortage (Carswell 1996).

The first documented swamp conversion in Kabale District started in 1942, when farmers in the southern and eastern parts of the district began to drain swamps. Between 1946 and 1949 the colonial governors supported a relocation program as an attempt to ease the problem of land shortage in the district. Approximately 15,000 people left the area to establish homesteads in northern Kigezi District¹ (Kagambirwe

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¹ This area is now Rukingiri District.
1972). Despite the number of emigrants, colonial government officials felt that the relocation program did not have a large enough impact to ease the overpopulation and land shortage in central and southern Kigezi District. They decided to start converting some of the wetlands for conversion to food crop production (Kagambirwe 1972).

The swamp conversion project was investigated, developed, and carried out by the Uganda Hydrological Survey Department. The department worked in wetlands of any size. Government-employed engineers used machines to drain large swamps, which are several kilometers in length. Most of the large swamps were converted between 1956 and 1960. The local population was responsible for the conversion of the numerous smaller swamps under the supervision of the government engineers. In these instances, the government hired local laborers and hand tools were used for drainage.

From 1949 to 1960, the government was responsible for maintaining drainage canals in the small converted swamps. However, in 1960 the government ceased payment of laborers for canal maintenance, handing over the job to local communities. As conversion continued within the district, the colonial government also found that maintenance of canals in large converted swamps was a financial burden. They turned over canal maintenance of the three largest swamps, Kiruruma North, Kiruruma South, and Kashambya, to the Kigezi District Administration in 1967. The District government continued canal maintenance until 1969 when they also decided that it was too costly. At that time canal maintenance became the responsibility of the people wanting to use the converted land.
The process of large-scale wetland conversion in Kigezi ended in 1960. Government approved conversion continued at a slower pace and only on small wetlands after this date until 1994. In 1995, the Ugandan government passed a new constitution, which included a section that stated that no one in Uganda can claim ownership of any wetland or part of a wetland (UNWP 1998). Wetlands were to remain public property under the jurisdiction of the local government. Residents who live on or use a wetland converted prior to the 1995 constitution were allowed to remain in the wetland but no further expansion into the wetland is permitted without consent of the government (Loy 1999).

Manpower shortages in the District curtailed enforcement of the ban on new wetland drainage until 1999 when an employee of the Uganda National Wetlands Conservation Program was assigned as the wetland officer in Kabale District. He was responsible for working with communities that live next to the remaining natural (untouched) wetlands in the District. No new swamp conversion occurred in Kabale after the wetland conservation officer started his position.

**Control of Converted Wetlands**

A large demand for converted swampland created an opportunity for unequal claiming of fields. Reports of unequal sharing of fields among farmers were common (Kagambirwe 1972). The colonial government officials intended a fair allocation of fields in the newly created farmlands. In 1962, an ordinance about the control of swamps in Kigezi was drafted. Swamps would remain communal and the process of ownership of fields would be under the guidance of parish\(^2\) chiefs. In the large converted wetlands,

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\(^2\) Municipalities in Uganda are divided into districts, county, sub-county, parish, and cells (villages).
swamp planning committees headed by parish chiefs oversaw field distribution. Unfortunately, policies were not established quickly enough to ensure equal allotment of wetland fields among farmers. As a result, within the three large wetlands, field distribution was highly inequitable. Some people gained ownership of large fields while others obtained only a small piece of land (Carswell 1996). The local population considered most of the individuals who secured large tracts of drained wetland “wealthy,” and as such, they could hire labor to help them clear land. Other farmers were politically influential, thereby enabling them to obtain large pieces of converted wetlands (Kagambirwe 1972).

The success of the plan in the smaller wetlands was likewise limited, as allocations did not proceed as intended because parish chiefs did not follow the guidelines (Carswell 1996). In 1967, another set of by-laws was established to control all of the smaller converted swamps; the intent was to deter land-grabbing by people within the government or with close ties to the government (Zirahuka 1989). The by-laws established Swamp Advisory Committees (SACs) for each wetland undergoing conversion and gave authority to the local committees to allocate land. SACs oversaw the distribution of swampland for cultivation and pasture. The committees also established reserve areas in each swamp for future use (Kagambirwe 1972). The by-laws provided three rules that influenced development within smaller wetlands. First, it established guidelines for allocating land to the head of families. Second, it limited the size of allocated fields to less than five acres for any one head of family (Kigezi District Files 1967). This rule applied to new allocations, not to those established prior to the commencement of the by-laws. The third rule that influenced wetland development in
Kabale District stated “no person shall fence off or clear any public land (swamp or not) without a [sic] written permission from the district commissioner’s office” (Zirahuka 1988, pp 32). Hence, the by-laws of 1967 established criteria from which local committees planned how each wetland was zoned for areas of cultivation, grazing, and natural areas (Carswell 1996).

Ownership of Wetlands

Farmers who received fields of converted swamp were allowed to obtain a lease on the land from the government. Wetlands are public lands and do not fall under the customary tenure rule. Hence, the Kigezi District Administration granted the right to occupancy. Kigezi was one of the few districts that granted land titles to individuals for land in a converted swamp (Faisal 1995).

When a family head was given land in a swamp, he was given the land that he cleared before requesting the allocation from the government. Converted land was given according to the age of a man and/or number of wives. Thus, the older a man was and the more wives a man had, the more land he was likely to receive (Kagambirwe 1972). Farmers then occupied the land and had a right to use it by the authority of the Swamp Allocation Committee. In effect, the head of the family held a leasehold tenure on the land. Under leasehold tenure systems, as long as the land remained productive, the household could continue to claim the land. Applicants for leases had to sign a contract that the land was given on a free lease basis. The lease had restrictions stating that the owner was not allowed to sell his field nor can he plant

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3 Women were not granted land ownership.
trees in it (Kagambirwe 1972). Because of these ownership restrictions, farmers used the traditional family inheritance pattern to dispose of unwanted swamp fields.

In the very large wetlands, a few farmers leased large tracts of land in the smaller wetlands. Leasing of wetlands by a few farmers restricted access to wetland resources by many local people. In some locales with small wetlands, local SACs were ineffective in regulating land allotment. Many of these communities formed cooperatives prior to leasing wetlands. Cooperative goals were twofold: to allow community access to the wetland for raw materials, and to provide a way to equally share the communal work such as constructing new canals and continuing canal maintenance.

Today, ownership of wetland property is a mixture of private, cooperative, and public ownership.\(^4\) Many private and cooperative owners have either a 49- or 99-year lease on the land from the government. Public wetlands are governed by local administration as stated in the Public Lands Act of 1969. Access to public wetlands is usually limited to residents of villages living around the wetland.

**Cultivation in Wetlands**

Once conversion of a swamp was complete, engineers from the Hydrological Survey Department taught farmers how to maintain water supply to the crops. Cultivation of wetland fields began immediately after conversion. Sweet potatoes were always the first crop planted. Sweet potatoes were said to “clean” the soil (Kagambirwe 1972) and were planted on narrow raised beds. “Cleaning” the soil means it loosened the thick and course roots that are part of the papyrus plant and very difficult to remove. Farmers used this technique in lieu of digging out the deep roots. As the soil loosened,

other crops were planted (bean, sorghum, carrot, Irish potato, and tomato). Vegetables were an important segment of the local economy as they were sold at nearby market centers and in the cities of Kampala and Jinja (Kagambirwe 1972). Crops sold in the earlier years included carrots, tomatoes, Irish potatoes, beans, and cabbage. In recent years, Irish potatoes and cabbage are the predominant crops for sale in the market place.

**Physical Process of Wetland Conversion**

To understand land use in the wetlands it is important to understand how the process of change happens (Young 1999). In Mugandu Valley the change from an annually regenerating wetland to an agricultural field is done manually using a machete and a hoe. Wetland vegetation begins to regenerate if the field is not kept clear of grasses and sedges. This is true even for fields that are planted during the second season. By the start of the first planting season (June) numerous grasses and sedges grow to several feet in height. Papyrus will regenerate yearly in some sections of the wetland. The process of conversion and cultivation is uniform among cultivators. The soil in the converted swamp is made into ridged beds as part of a ridge and furrow system. The beds are reconstructed yearly at the beginning of the first growing season.

Converting to agricultural fields involved five steps: cutting, land preparation, planting, weeding, and harvesting. Cutting vegetation is done with a long stick and a machete and is usually done by men (Figure 4-1). The stick is used to push back the grasses, which are then cut with the machete. Land preparation starts when the soil is dry enough to work and the water table is low enough to allow construction of ridged beds (locally called “parcels”). It may take several days for the soil to dry. Bed construction is done with a hoe and is both time consuming and physically demanding.
The amount of earth displaced during land preparation is about three times of what is needed for preparation of hill slope fields (van de Giesen 1994). The beds are approximately 1-1.5 m wide and 6-8 m long. The whole bed is tilled and the soil turned. The top 50 to 70 centimeters of the old bed is placed in a new one next to the original. The purpose of this is to bury the layer that contains roots and seeds of the weeds so the new weeds cannot grow. The second layer, which often contains muck, is placed
on top of the new bottom layer. Dry soil is placed on top if available. The bed structure also keeps most of the soil in which the crops are planted above the water table. Both men and women help with the land preparation.

The next step is planting, which is done shortly after land preparation when the land has settled and dried slightly. After planting, crops are weeded as needed throughout the growing season. Women do most of the planting and all of the weeding of the fields. All potato fields are harvested within a few weeks of each other in September because trucks arrive (from cities) and buy the harvest directly from the fields for only a short time. Thus, men, women, and children participate in harvesting. Women dig up the potatoes and men carry the sacks and baskets to the road for sale or home for storage.

Maize and beans are the most commonly planted in the second season. No land preparation is needed because the existing beds are used. Weeds are cleared and then seeds are spread by broadcast method. Maize is harvested a little at a time and is
used immediately for consumption. Beans are harvested once and then dried. Women are generally responsible for the cultivation of beans and maize.

Preparing land for planting in the far northern end of the wetland (next to the lake) is different. This land was converted in the last several years. Sweet potatoes are planted for the first three years as part of the process of “cleaning the soil”. The soil is very wet, contains clumps, and is clogged with roots from papyrus and grasses during the first few years after conversion. Sweet potatoes grow easily among them. Each year as the sweet potatoes are harvested, the remnants of papyrus roots are removed by hand until the soil is clear of the root masses. Once cleared, Irish potatoes can be planted.

**Mugandu Valley**

**Physical Description**

Mugandu wetland (3.67 km²) is a permanent wetland located within southwest Uganda (1°25′S and 29°56′E). The wetland’s northern end is adjacent to Lake
Bunyonyi and the narrow southern end continues into Rwanda. It is a papyrus swamp and roughly one half its total area has been converted for agriculture.

Figure 4-5. Mugandu valley showing the wetland planted in potatoes

Land cover in the valley is divided into three types: pasture (3%), farmland (45%), and natural wetland grasses and reeds (52%) (UNWP 1998). The area receives a mean annual rainfall of 1140 mm. The annual temperature range is from 10°C to 25°C. Elevations range from 2000 m in the wetland to 2394 m along the highest mountain ridge. The wetland is flanked by Mugandu parish on the east and Buramba Parish on the west. The dominant vegetation is papyrus and sedges. Sitatunga (*Tragelaphus spekii*), an amphibious antelope, is occasionally seen in the area. Mudfish (*Protopterus annectens*) are available in the wetlands. Access to Mugandu wetland is from a road that descends along the hill on the east side of the valley from the Rubaya sub-county headquarters (3-1).

**Soils**

Soils in Mugandu wetland are alluvial peat derived from humified residues of the swamp vegetation. They are mixed with fine clay sediments from the hill slopes.
bordering the valley. The hillside soils originate from sedimentary rock. The dominant parent rock is Karagwe-Ankolean phyllite and quartzite. Two dominant soil series on the hillsides are known as Mafuga and Kabale. Mafuga soils are loams located on the mid- to upper-slopes and have a low productivity (Uganda Land and Surveys Department 1960). Kabale soils are found in the mid- to lower-slopes and are clay-loams and loams with a medium-to-high productivity (ULSD 1960).

**Agriculture in the Mugandu Valley**

Converted wetlands in Mugandu Valley are used for two seasonal growing seasons. The first is during the dry season (May-September), and the second extends from October-March. Irish potato, cabbage and sweet potato are planted in the first season. Maize, bean, sweet potato and cabbage are cultivated in the second season. Due to the cooperative grower societies’ rules, the entire converted area of the wetland is planted in the first season. Planting in the second season is not mandatory. Hence, a smaller number of fields are cultivated for the second season. This corresponds with the period of short rains and many fields are too wet to produce well.

**History of Mugandu Wetland**

Mugandu wetland was first used for agriculture around 1957 when several people started to clear vegetation and drain the wetland. Almost all were unable to obtain a land title. Reasons for this are unknown. Only one person, a local businessman and politician, received a land title (for a large section of the wetland) in late 1950s. The

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5 The dates stated here might not be in line with the dates mentioned in the previous section on wetland history in the District because the information recounted came from oral history as told by several elderly men. What is significant is the historical process of the conversion of Mugandu wetland.

6 Peasants will sometimes say that only wealthy or politically important people are able to work with the government processes beyond the village level.
area included portions that he did not clear himself but he was able to receive a title because he had influence with local and regional politicians. Kagambirwe (1972) states that similar situations occurred in other parts of Kabale during this same time period. The family of this man now owns a number of acres in Mugandu Valley and uses them for pasture and vegetable production. Several other men were able to obtain titles for large tracts of land during this period. This handful of farmers owns the far southern end of Mugandu Valley, which is entirely converted to agriculture use.

As more farmers learned that it was possible to get land titles from the government for converted wetland, they began draining and clearing larger areas of the swamp. Many saw this as an opportunity to obtain more land and to produce additional crops. Following the pattern of conversion across the district, wetland conversion continued until the first cooperative farmer society was formed in 1972, the Kihira-Buramba Growers Cooperative Society. The idea for the group started when several farmers cleared land adjacent to each other. Forming a cooperative before securing a lease ensured that many people rather than a few individuals would own the swamp. It also guaranteed that canal maintenance would be a group task. The new fields allocated to the cooperative were divided into equal sizes after the lease was obtained. Farmers who cleared more land prior to the formation of the society received more fields. The group finished clearing all of their land in the late 1970s.

After the formation of the Kihira-Buramba Society more farmers started encroaching further into the wetland for cultivation. In the early 1970s, two of the wealthy and politically influential farmers went to the government in the early 1970s to obtain a lease in yet another part of the wetland valley to augment their landholdings.
When the government surveyors arrived they were chased away by the community. Government officials intervened and gave the land to the local community in 1973, as was decreed in the 1967 Kigezi District bylaws. The community gave part of the wetland to the Protestant and Catholic churches, and set aside land for the primary school. Government surveyors demarcated the areas, which remain in effect today.

In 1980, conversion of the area that eventually became the Mugandu-Buramba Growers Cooperative Society began (Figure 4-1). The Mugandu-Buramba Society formed similarly to the Kihira-Buramba Society. While the lease officially started in 1983, the group leaders reported receiving the land title from the government ten years earlier. It is a 49-year lease covering 102 ha of wetland. The first conversion phase was from 1980 to 1983. During this time only sweet potatoes could be planted until the soils were loosened enough for other crops. The second conversion phase began in 1985 after a prolonged dry season when people demanded more wetland fields because of small harvest on upland fields. Fields were measured to ensure that everyone who cleared land would get fields of equal size. Conversion occurred only as demand required. The interest in converting new wetland fields waned if farmers were satisfied with the yields from their hill slope fields.
Figure 4-6. Mugandu wetland ownership pattern
In 1987, a severe hailstorm destroyed crops in the area. Dozens of families decided to emigrate to seek more fertile and abundant land elsewhere. The Mugandu-Buramba Society gave the abandoned wetland fields to current members. All fields were re-allocated by the end of 1987. A portion of the Mugandu-Buramba Society land remains in natural wetland because the conversion process became slower in areas closer to the lake. This is due to the greater volume of water present in the soil, which makes the wetland more difficult to drain. The area is open for anyone to gather raw materials for handicrafts and/or roof thatching.

**Operation of the Grower’s Cooperative Societies**

As of 2000, the Kihira-Buramba Growers Cooperative Society had 84 members. All but two of the members live in Mugandu or Buramba parishes. The group is led by four men in the positions of president, vice-president, treasurer, and secretary. Membership is capped; hence, others cannot join unless a member leaves the group or migrates out of the area. When a member dies, the family may inherit the field.

The Society is both individual and communal. Each member has individual rights when it comes to planting his/her field. They may plant any crop they want, or rent out a field if they are not going to use it. Communal responsibilities include weekly work meetings on Saturday to maintain the canal system and the cultivation of the group fields. Canal maintenance is performed when needed. Members can pay an annual fee in lieu of attending weekly work meetings. The society charges a fine if a member misses a scheduled workday. If a member cannot make a workday, a family member

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7 The two men live in neighboring parishes.

8 The meetings for both societies are from around 9 a.m. to 1 p.m. on their respective workdays.
can go in his place. Members who want to sell a field must present the potential buyer to the society leaders for approval before making the sale. This is to ensure that the new buyer lives is in the area and will adhere to the Society rules.

The Kihira-Buramba society requires members to plant their fields during the first planting season, which is also the dry season (June-September). Irish potatoes are a cash crop and are planted in late May and June. If a member cannot use a field, the society will find someone to rent it from him. The rationale behind having all fields cultivated during the dry season is to reduce canal maintenance and predator problems. Canals that are covered with weeds will not drain well and can cause flooding problems in the rainy season. Additionally, animals use the tall, thick weeds in uncultivated fields as habitat and can destroy nearby potato plants. Thus, the rules requiring cultivation during the dry season are set for practical reasons.

Mugandu-Buramba Society is governed and operates in a similar fashion, with a few exceptions. Most of the members live in Mugandu or Buramba parish, while some live in the neighboring Kaluga parish. New members may join when a field becomes available or if the society decides to clear more wetland in the remaining unconverted section of their property. The weekly workday is Monday. The society charges a fee per member for the harvest of Irish potato crops in the first planting season. This money will be used to purchase milk cows to graze on a portion of the wetland that they are trying to drain for pasture use (Table 4-2).

Several spots in the Mugandu-Buramba society land are still undergoing conversion. The fields were allocated several years ago, but until farmers can drain enough water from the fields and prevent the wetland vegetation from growing back,
farmers will not plant in them. A few reported slowly increasing the number of beds they are able to plant each year as they clear the papyrus roots and other vegetation from their fields and create more canals for drainage. The Mugandu-Buramba society clears more drainage canals and creates new ones each year on this section of their land. The goal, as reported by the society members, is to clear enough water away from this section so that farmers can plant crops without problems of frequent flooding or flooding easily during the first growing season.

<table>
<thead>
<tr>
<th>Table 4-2. Grower cooperative society information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Society</strong></td>
</tr>
<tr>
<td>Year established</td>
</tr>
<tr>
<td>Number of members</td>
</tr>
<tr>
<td>Joining fee (USH)</td>
</tr>
<tr>
<td>Annual fee in lieu of attending weekly workdays (USH)</td>
</tr>
<tr>
<td>Fine for missing weekly workday (USH)</td>
</tr>
<tr>
<td>Harvest fee for Irish potato (USH)</td>
</tr>
<tr>
<td>Area in hectares</td>
</tr>
</tbody>
</table>

Note: USH represents Uganda Shillings. $1 U.S. = 1500 Ugandan Shillings in 2000.

**Non-Society Land**

Several parts of Mugandu Valley are deemed “non-society land” because the land does not lie within the boundaries of either growers’ society. This land lies between the societal boundaries and the toeslope of the hills on both sides of the valley (Figure 4-1). Non-society land was converted during the same time periods as the cooperative societies developed. Eleven families interviewed own non-society fields. Because of the autonomy of non-society land, owners are not subject to the regulations and fees established by the grower societies. Canals are maintained by consensus among growers. Local councilmen settle any maintenance disputes that arise.
Church and School Land

The primary school and the local Catholic and Protestant churches have separate mechanisms for renting out wetland fields. Each teacher at the school is given a field to use. Pastors also receive a field from their respective churches. Any parent of a child, who is enrolled at the school is eligible for the drawing that determines who can rent fields. The school sets the rental price and the rental period is for one year. Churches rent out land by taking bids from church members on rental price per bed. Highest bids are offered fields for the one year rental period.

Conclusions

A review of the physical, social, and historical information for Kabale District, affords a better understanding of the area and the people. Colonial powers influenced how wetlands were developed for agriculture and who obtained the newly created farmland. This influence is seen today in how the converted land is managed and used. The intervention of local communities at the time of land distribution prevented loss of a communal natural resource to private owners. This allowed the converted wetland to be shared by many people and parts of it to be preserved for future use. However, not all residents had the opportunity to gain access and control over a wetland field. An exclusionary pattern of access to valley land is clear. Residents of villages overlooking the valley were eligible to join the cooperatives. Membership is capped for the two societies so no new members can join unless additional areas of the wetland are drained. In addition, access to school or church land in the valley is restricted to access by affiliation.

The history of Mugandu wetland provides the background for how the cooperative growers’ societies were established. Their present role in the management of the
wetland ensures that community members continue to equitably use the wetland. The diversification of livelihoods of the farm families, and the differences in how fields are used given the small landholdings and fragmented fields, were touched upon in this chapter.

The following, Chapter 5 presents the results from the descriptive statistics, addressing research Objective 3, to explore the difference in wetlands use by income groups and 4, to examine the level of intensity of farming in wetland fields.
CHAPTER 5
HOUSEHOLDS AND FARMS

This chapter presents information about the demographic and agricultural characteristics of the households interviewed for this study. It also discusses the soil characteristics of the samples taken for this study. The intent of the chapter is to provide a human and social context for the statistical analyses that are reported in Chapter 6.¹ The chapter is divided into six major sections: General Household Characteristics, Wetland Field Characteristics, Use of Wetland Raw Materials, Wetland Products Sales, Upland Fields and Food Production, and Valley Soil Characteristics.

**General Household Characteristics**

Fifty-five households within Mugandu Valley were interviewed for this study. All of them were smallholder farmers. Married couples represented the majority of the interviewed households (Table 5-1). In these cases, both the husband and wife were interviewed together for this study. Widowed women and unmarried women headed a small number of the households. This area of Kabale has an unusually high number of polygamous marriages, according to local government officials. Although the majority of household males had one wife, 27% of the married households surveyed were part of a polygamous marriage (Table 5-2.). No data on the number of polygamous household in Kabale District are available. However, for several other districts, the polygamy rate for rural areas was similar at 28% (Kiragu et al. 1996). Each wife in a polygenous marriage maintains her own household and fields. Wives usually do not live in the same village.

¹ There are many details here than in the next chapter because it deviates from the original hypotheses for contextual reasons. As a precursor to the results of the statistical analyses, this chapter provides a better understanding of the households surveyed and their use of wetland fields and materials.
Table 5-1. Marital status of households in the study

<table>
<thead>
<tr>
<th>Marital Status</th>
<th>No. Households</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Married</td>
<td>48</td>
<td>87%</td>
</tr>
<tr>
<td>Widowed</td>
<td>5</td>
<td>9%</td>
</tr>
<tr>
<td>Single</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 5-2. Number of wives for married households

<table>
<thead>
<tr>
<th>Number of wives</th>
<th>No. Households</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>35</td>
<td>73%</td>
</tr>
<tr>
<td>Two</td>
<td>8</td>
<td>17%</td>
</tr>
<tr>
<td>Three</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>100%</td>
</tr>
</tbody>
</table>

The mean age of the male farmers was 40 (n = 45) with an age range of from 19 to 76 (Table 5-3). For women in the households (n = 54) the mean age was 37, with an age range from 18 to 65. Most of the farmers are still young enough to be active in agriculture. Few people over 60 years participate actively in agriculture. They rely on younger family members or hire labor to help on the farms. However, they also often aid the household by helping with food preparation or watching the young children. The average number of children living in the household (n = 54) was 4.1 and the average household size for the respondents is six persons. The average household size for rural Kabale is 5.1 people (Government of Uganda 1992).

Of the female-headed households interviewed for this study, one farmer (19 years) was in charge of all of her younger siblings, another farmer (30 years) was a single mother of three. Widows headed the remaining female-headed households. One of the widows had only 29 years. It is unusual to find many female-headed household headed by younger women. In many parts of Uganda, women who head households on their own tend to be much older (50+ years).
Men had an average of 4 years of education and women had 1.5 years. Twenty-six men had completed some primary school and another eight men attended some secondary school. One man completed the full secondary school education. Fifteen women had varying years of primary schooling, with three of them completing all seven years. One woman interviewed completed secondary school. She was the only woman of the households surveyed who had any secondary schooling. The low educational level is common in rural Uganda. In a rural family, educating boys is favored over educating girls. With the start of universal primary education in Uganda in 1996, girls are attending school at higher rate than previously. Universal Primary Education (UPE) began in 1996. It allows free education at the primary school level for the first four children in each family. Families must still purchase uniforms and school supplies. The gender inequality in years of education may decline in the next decade since the start of UPE.

Table 5-3. Characteristics of the households

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Age (n=45)</td>
<td>39.84</td>
<td>40.00</td>
<td>13.01</td>
</tr>
<tr>
<td>Female Age (n=54)*</td>
<td>36.65</td>
<td>35.00</td>
<td>11.94</td>
</tr>
<tr>
<td>Male Years Education (n=46)</td>
<td>4.13</td>
<td>4.00</td>
<td>3.53</td>
</tr>
<tr>
<td>Female Years Education (n=54)</td>
<td>1.46</td>
<td>0.00</td>
<td>2.58</td>
</tr>
<tr>
<td>No. of children in household (n=54)</td>
<td>4.06</td>
<td>4.00</td>
<td>2.13</td>
</tr>
<tr>
<td>Age of Female-headed households</td>
<td>44.14</td>
<td>50.00</td>
<td>17.90</td>
</tr>
</tbody>
</table>

* One woman did not know her age.

Ninety-one percent (n=55) of the respondents were subsistence farmers without income from outside of the farm. There is little excess time, labor, food, money, or other amenities to be enjoyed. Five men had paid employment positions in addition to their role as farmers. Two men were Catholic pastors, the third man was the parish’s truck
driver, the fourth man was a night guard for the local secondary school, and the fifth man was a primary school teacher. All men farmed occasionally and their wives farmed full-time. The teacher and the pastors were given land in the valley to farm as part of their positions, as their employers own fields in the wetland. The other two men have their own fields in the wetland.

**Household Income Groups**

Dividing farmers by demographic characteristics is one way to examine the households interviewed for this study. Another way is to group the households by annual income. The households surveyed are grouped by annual income because income is a variable that relates to many other household and farm variables, such as land ownership and hiring labor (Netting 1993).

Farmers from Buramba Parish, part of the study area adjacent to Mugandu Valley, identified three wealth groups for themselves (Tukahirwa et al. 1998). Categorizing households by income is different than by wealth because wealth categories include variables such as meals per day, number of livestock, and trips to hospitals instead of rural clinics, in addition to other household tasks and activities that involve income. These specific wealth data were not collected for this study. Therefore, using the same number of categories, three, as the Tukahirwa study (1998), the households for this study (n=55) were divided into three income groups: low income, middle income, and high income. Most of the households (30) are in the middle income group.

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2 It was suggested that the household also be compared by female and male headed households. However, there are only seven female headed households in the sample, which is not enough to justify a comparison.

3 I use income groups to compare households in this descriptive chapter to see if anything particularly interesting or unusual comes out of it. I view this chapter as exploration of the households surveyed and data collected.
Table 5-4. Comparisons of study participants to Buramba parish households

<table>
<thead>
<tr>
<th>Income Group</th>
<th>% of Buramba Parish Study</th>
<th>% of Respondents in Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>19%</td>
<td>27%</td>
</tr>
<tr>
<td>Middle</td>
<td>45%</td>
<td>55%</td>
</tr>
<tr>
<td>High</td>
<td>36%</td>
<td>18%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The income groups used for comparative purposes are similarly grouped to the self-defined income groups by the farmers in the study at Buramba (Table 5-4). This was done by sorting the annual income data from lowest to highest values and then creating a histogram. Large gaps (or natural breaks) in the data were identified thus breaking the sample into low, medium, and high income groups. Details on the division of income groups are found in Appendix C.

The income range for each of the groups varies with the highest income group having the widest range of income (Table 5-5). The average income for all of the farmers surveyed was 471,028 Ugandan Shillings (USH). There is a wide range in the annual incomes of the respondents. There are 4 farmers who have the highest annual incomes are outliers compared to the other 51 households. Two of the four earn income outside of farming. One man earned much of his income from brewing and selling sugar cane alcohol. This form of alcohol is much more lucrative than selling alcoholic beverages made from sorghum. It also requires more effort to maintain a side business like this because the ingredients, sugar cane by-products (molasses), must come from Jinja, a town that is a 10-hour drive from the Mugandu area. Another man had a salaried position as a driver for Mugandu parish that provided a higher than normal annual salary for a farmer. The last two men in this group are especially successful. They also had employment that brought in additional income. One was a
pastor for the Catholic Church, which provides a small monthly salary. The other farmer loaned money to people using their land as collateral. For the other six farmers in the high income group, two had salaries while the other were full time farmers who earned income only from sale of crops and animals.

Table 5-5. Annual income

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (n=15)</td>
<td>12,500</td>
<td>108,500</td>
<td>66,547</td>
<td>74,600</td>
<td>30,527</td>
</tr>
<tr>
<td>Middle (n=30)</td>
<td>148,000</td>
<td>628,000</td>
<td>321,753</td>
<td>254,000</td>
<td>156,097</td>
</tr>
<tr>
<td>High (n=10)</td>
<td>805,000</td>
<td>2,765,000</td>
<td>1,525,575</td>
<td>1,149,800</td>
<td>764,454</td>
</tr>
</tbody>
</table>

Note: all figures in Uganda Shillings. $1 U.S. = 1500 Ugandan Shillings in 2000.

The farmers in this group are those farmers who obtain their income from a variety of sources, including temporary work, day labor work, selling animals and crops, etc. The exception to this is the farmer who owned the only local shop on the Buramba side of the valley. The income from his shop was not reported because he claims that he did not keep records. Four of the respondents in the middle income group received a regular salary during the time period this survey was conducted. Farmers will take part-time or short-term work, such as guarding a construction site. Some farmers, particularly the young men, will migrate to other districts in Uganda for work. Several other of the farmers in the middle income group sold animals, usually goats, for income.

### Income Sources

Most farmers in all three groups rely greatly on crop sales for their income (Tables 5-6 and 5-7). This is particularly true for the low and middle income groups. The mean total income from crop sales accounts for 70% or more of their annual income. In contrast, crop sales account for less than 50% of total income for the wealthier farmers. As mentioned above, several of the respondents in this group receive a monthly salary.
Table 5-6. Income sources

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Valley income (USH)</th>
<th>Crop income (USH)</th>
<th>Annual income (USH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>20,000</td>
<td>43,000</td>
<td>74,600</td>
</tr>
<tr>
<td>Mean</td>
<td>22,433</td>
<td>50,420</td>
<td>66,546</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>21,301</td>
<td>34,010</td>
<td>30,527</td>
</tr>
<tr>
<td>Middle</td>
<td>89,500</td>
<td>193,000</td>
<td>254,000</td>
</tr>
<tr>
<td>Mean</td>
<td>117,167</td>
<td>241,380</td>
<td>321,253</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>102,216</td>
<td>68,433</td>
<td>156,097</td>
</tr>
<tr>
<td>High</td>
<td>183,000</td>
<td>651,000</td>
<td>1,149,800</td>
</tr>
<tr>
<td>Mean</td>
<td>336,100</td>
<td>776,325</td>
<td>1,525,575</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>379,366</td>
<td>661,582</td>
<td>764,454</td>
</tr>
</tbody>
</table>

Note: all figures in Uganda Shillings. $1 U.S. = 1500 Ugandan Shillings in 2000.

Table 5-7. Valley and crop income proportions

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Valley income as proportion of crop income (%)</th>
<th>Valley income as proportion of annual income (%)</th>
<th>Crop income as proportion of annual income (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Mean 39.57</td>
<td>31.74</td>
<td>69.79</td>
</tr>
<tr>
<td></td>
<td>Median 46.75</td>
<td>30.26</td>
<td>78.52</td>
</tr>
<tr>
<td></td>
<td>Std. Dev 32.82</td>
<td>30.55</td>
<td>30.43</td>
</tr>
<tr>
<td>Middle</td>
<td>Mean 47.91</td>
<td>34.93</td>
<td>71.10</td>
</tr>
<tr>
<td></td>
<td>Median 43.49</td>
<td>33.14</td>
<td>84.00</td>
</tr>
<tr>
<td></td>
<td>Std. Dev 27.40</td>
<td>22.24</td>
<td>25.96</td>
</tr>
<tr>
<td>High</td>
<td>Mean 38.31</td>
<td>16.92</td>
<td>47.38</td>
</tr>
<tr>
<td></td>
<td>Median 38.71</td>
<td>10.55</td>
<td>40.26</td>
</tr>
<tr>
<td></td>
<td>Std. Dev 23.85</td>
<td>15.84</td>
<td>32.49</td>
</tr>
</tbody>
</table>

In addition to crop sales, farmers reported trying to earn additional income throughout the year to supplement their agricultural income. Several opportunities for earning income were mentioned. Some of these sources include:

- Working as hired labor on other's farms (26)
- Non-agricultural income (20)
- Remittances from relatives (10)
- Selling animals (7 farmers)

Working as hired labor is the most common method to earn money because work is available and it does not require special skills or any startup capital. Non-agricultural
income is any income not related to crop fields, such as making mats or sorghum drinks for women or the construction of furniture for men. Ten households reported receiving money from relatives. These relatives are usually grown children or siblings working in salaried positions outside the area. Remittances are not a large portion of the annual income for the households surveyed. No farmers interviewed were dependent on this income for their livelihood.

Selling animals is common. Goats, sheep, and chickens are usually sold when extra cash is needed. However, the farmers did say that it was hard to find the adequate animal feeds during the long dry season.

**Farm Labor**

Having enough labor for cultivation of fields is of utmost importance for the farmers. The hiring and exchange of labor is common. Eighty percent of those surveyed (n=55) hired laborers to help with cultivation of valley fields (Table 5-8). There is usually plenty of labor available for hire in Mugandu Valley area, including Rwandans who cross the border to seek day work in the fields.

Two types of labor are used for cultivation: family and hired. There is much variation in the use of both labor types by each income group (Table 5-8). Farmers in the low income group use the same average labor as the other groups. However, they rely more on family labor than the other two income groups. The middle income group uses about equal amounts of family and hired labor during the growing season. Hired labor is a large part of the total labor used by farmers in the highest income group.

The amount of hired labor used on the farm is determined by the amount of work to be done, the number of fields, and the amount of money a farmer has available to pay for laborers. Most of those who hired labor are in the middle and high income
Table 5-8. Respondents' labor issues for valley fields

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Reported having a labor shortage</th>
<th>Uses hired labor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (n = 15)</td>
<td>80%</td>
<td>53%</td>
</tr>
<tr>
<td>Middle (n = 30)</td>
<td>83%</td>
<td>87%</td>
</tr>
<tr>
<td>High (n =10)</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

groups (Table 5-9). All of the farmers in the high income group (n = 10) used hired labor on their valley fields. Wealthy farmers also tend to have more fields; hence the need for hired help is more pressing.

Table 5-9. Amount and type of labor used in valley field cultivation.

<table>
<thead>
<tr>
<th>Income Group</th>
<th>No. of family laborers used</th>
<th>No. of hired laborer used</th>
<th>Total amount of laborers used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Mean</td>
<td>22.70</td>
<td>10.80</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>17.00</td>
<td>8.00</td>
</tr>
<tr>
<td></td>
<td>Std. Dev.</td>
<td>14.97</td>
<td>13.26</td>
</tr>
<tr>
<td>Middle</td>
<td>Mean</td>
<td>35.47</td>
<td>35.47</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>27.00</td>
<td>27.00</td>
</tr>
<tr>
<td></td>
<td>Std. Dev.</td>
<td>28.95</td>
<td>28.95</td>
</tr>
<tr>
<td>High</td>
<td>Mean</td>
<td>27.10</td>
<td>53.60</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>21.00</td>
<td>29.50</td>
</tr>
<tr>
<td></td>
<td>Std. Dev</td>
<td>16.47</td>
<td>54.64</td>
</tr>
</tbody>
</table>

The low use of hired labor in the valley fields by the poorest farmers is a stark contrast to that of the highest income group. Just over half of the farmers (53%) in the lowest income group use hired labor. There are a few reasons for the gap between the low and high income groups. A low percentage of hired labor indicates that not much labor is needed, or that more family than hired labor is used. Family labor includes the immediate family living in the household interviewed, and the extended family living nearby. Also, these farmers are experiencing a shortage of labor because of the lack of income to hire help.
Hired laborers for valley fieldwork are usually paid a daily wage (Table 5-10). A few farmers paid laborers by the bed as an incentive to get the work done faster. It is uncommon to hire group labor for valley fields. For instance, twenty-one farmers (n=55) hire individuals, while one farmer reported hiring group labor. When a group is hired, it is usually by contract for the task instead of a daily wage. Hired laborers also help with upland fields.

Farmers reported labor shortages in May and June, which corresponds to high labor needs for wetland cultivation. Labor is also somewhat limiting in September when Irish potatoes are harvested. The workday for the farmers surveyed is six hours on average (Table 5-10). However, hired laborers averaged seven hours per workday. Each farmer wants to get as much work out of the laborers as possible. A set number of hours is established for the worker. Nine of the farmers interviewed did not have a set workday length for themselves and worked varying hours (3 to 8) in their fields each day. The average wage for hired labor in valley fields is slightly higher than for upland fields in those cases where there is a difference in the median cost of labor for the two types of fields.\(^4\) Farmers state that the reason wages for labor in the wetland are generally higher is because the work is more strenuous and labor is harder to come by. The competition for hired help is exacerbated because everyone plants and harvests their fields around the same time. The availability of labor on the smallholder farm for all fields (wetland and upland) was a problem for 89% of the responding households.

\(^4\) The dollar exchange rate at the time of data collection was 1500 USH to $1. The equivalent wages per day for hired labor are .67 dollars for valley fields and .47 dollars for the upland fields.
The shortage was more acute for the wetland fields with 94% of the respondents indicating that they do not have enough labor for cultivating wetland fields (Table 5-8).

Adults and young adults (16 and older) work in valley fields. Children do not actively participate in wetland agriculture. They sometimes “help” with potato harvesting by collecting the small potatoes overlooked by the harvesters. On occasion children will harvest maize for the family’s evening meal.

Table 5-10. Labor information

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average length of workday for families</td>
<td>6.26</td>
<td>6.00</td>
<td>1.66</td>
</tr>
<tr>
<td>Average length of workday for hired labor</td>
<td>7.35</td>
<td>8.00</td>
<td>1.42</td>
</tr>
<tr>
<td>Average wage for hired labor in valley</td>
<td>958 USH</td>
<td>1000</td>
<td>141.81</td>
</tr>
<tr>
<td>Average wage for hired labor upland fields</td>
<td>765 USH</td>
<td>700</td>
<td>104.46</td>
</tr>
</tbody>
</table>

Note: USH represents Uganda Shillings. $1 U.S. = 1500 Ugandan Shillings in 2000.

**Wetland Field Characteristics**

This section discusses the findings on cooperative society membership for the farmers interviewed and the characteristics of the fields and beds used for farming in Mugandu Valley (Figures 5-1 and 5-2). It also presents information on the rental of wetland fields, the crops cultivated and their use, and valley flooding.

**Wetland Field Ownership**

Most of the farmers are members of either the Kihira-Buramba or Mugandu-Buramba cooperative growers’ societies that operate in the wetland. A few belong to both societies. There are no rules of exclusive society membership for wetland field ownership. Farmers can belong to one or both societies and they may still have wetland fields outside of the society. The only limit to society membership is that the membership numbers are capped.
Figure 5-1. Wetland fields (plots) are divided into beds.

Figure 5-2. Photograph of valley fields.
Eleven farmers do not belong to either society and maintain fields outside society land (Table 5-11). Farmers who own fields that are not under the jurisdiction of either society actually have some advantages. They do not have to attend weekly workdays and there are no fines or fees assessed for not following society rules. One disadvantage is that there is no organized control over the maintenance of the canal system or over cutting wetland grasses next to cultivated fields. Village officials can intervene when these issues arise and cannot be settled between field owners.

Table 5-11. Cooperative grower’s society membership

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Kihira-Buramba (KB) members</th>
<th>Mugandu-Buramba (MB) members</th>
<th>Member of both societies</th>
<th>Non-Society farmers</th>
<th>Mean years Kihira-Buramba membership</th>
<th>Mean years Mugandu-Buramba membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>2</td>
<td>11</td>
<td>1</td>
<td>3</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>Middle</td>
<td>10</td>
<td>18</td>
<td>3</td>
<td>5</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>High</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>3</td>
<td>22</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>35</td>
<td>5</td>
<td>11</td>
<td>22</td>
<td>14</td>
</tr>
</tbody>
</table>

The farmer cooperative societies allow anyone to become a member as long as they abide by the rules and pay any fees or fines that are assessed. This includes women and teenagers, some of whom inherited the field from their husband or father. Married women can also hold their own fields separate from their husband’s, although only one woman of the households surveyed did so.

When a married woman owns her own field, it gives her autonomy from her husband. She can farm the fields and do what she wants with the harvest. If a woman has her own field, the field is hers and she decides how to use it. Her husband usually does not intervene in matters concerning the field. For women to own valley fields is a step forward in gaining land tenure rights and control over fields. Historically in Uganda, women do not usually inherit land and cannot truly hold a title for it.
The average length of time of membership in the Kihira-Buramba society was 21 years (Table 5-11). For the Mugandu-Buramba Society it was 14 years. The numbers are close to the number of years that the societies have been operating, which is 27 years for the Kihira-Buramba group and 14 years for the Mugandu-Buramba group. Most of the farmers surveyed have owned their fields since they first joined their society. A few farmers obtained additional fields since receiving their initial wetland field.

Ownership of valley fields by location of the fields does not vary much across income groups. The exception to this is the average years that the low income group and the high income group joined the Mugandu-Buramba society. There is a five year difference between the average years of membership for the two groups. The high income group has the highest average length of membership and the low income group has the fewest average years of membership. It is hard to say why this may be so. The reason farmers joined the society are most likely vast. Perhaps some farmers saw the advantage of having a valley field before others came to the same conclusion. In terms of income earning potential, farmers who have been cultivating wetland fields the longest have been able to profit from the sale of potatoes much longer therefore earning more income for a longer period of time.

Without interviewing farmers in the Mugandu Valley area that do not have access to valley fields, it is difficult to document the significance of wetland fields to the household/farm family beyond allowing for an additional growing period (or two if wetland fields are cultivated in the second season). The wetland fields are of a different soil type by nature than upland fields and this provides an opportunity for farmers to grow Irish potatoes, a crop that does not produce well on upland fields.
Opportunities arise to obtain additional wetland fields because maintaining society membership is not easy for every family. Sixteen farmers have obtained additional valley fields since acquiring their first field. Valley land does not come available very often.

Conversely, a household may lose rights to valley fields on society land for several reasons. One household interviewed lost their society field when they could not make the weekly workday. The fines for these absences charged by the society for missing these days accumulated to a large sum. The society leadership committee will give a family’s field to another farmer if the family does not pay the fine by a mutually agreed upon date. This particular family could not pay the fines on time and they lost possession of their valley field.

During the collection of the data for this study, a few farmers volunteered their opinion of the cooperative societies. One farmer, who had lost his field, felt obligated to tell me his story. He had fines assessed and could not pay the fines. He believed that the society fees and additional fines were meant to eliminate poor people from becoming members and maintaining membership. He felt that he had been discriminated against because he did not have as much money as other farmers did.

Ninety-one percent of the farmers (n=44) said that they, or someone in their household, goes to their society’s weekly workday. Any family member may attend the workday meeting in lieu of the field owner. Frequently spouses and older children attend rather than the male head of household, although the field owner is normally listed as the male head of the household. Five farmers paid the yearly fee charged by the cooperative societies instead of attending the weekly meetings. Four of these
farmers are in the middle income group and one in the low income group. They pay the fee because it allows more time for them to work on their farm.

Field Characteristics

The average number of fields per farmer is 2.8 (Table 5-12). However, the range was from 1 to 14 fields per household. The average number of fields per farmer is 2.6 is the outlier of 14 is discarded. The high income group owns the most fields. They had the highest mean and median for field ownership. There were no outliers.

It is unusual for a farmer to have 14 fields given that the competition for valley fields is strong. This farmer owned the only small general store that serves the four villages surveyed in Buramba parish. Children owned titles for wetland fields in four of the households interviewed. One father purchased a field and registered it under his daughter’s name when she was an infant. Another family obtained the fields that were given up or repossessed and then registered the fields in their sons’ names. All three are young men who still live at home. For children to own fields, parents must be active in the search for new fields as they become available. The limited amount of land in the valley makes it difficult for young adults to have fields. They must rely on family inheritance or pursue the availability of fields being sold.

The average number of fields owned by the farmers varies among the income groups. As usual for areas of subsistence agriculture such as Mugandu Valley area, the households that earn more income also have the highest average number of fields in the valley. Although this group does not include the farmer who owns the highest number of fields, 14, it contains several farmers who own more than the overall average number of fields. This means that they have the most land to be used for cultivation.
This affords the household a chance to produce enough food for the family and perhaps even a surplus to sell.

Table 5-12. Valley field ownership

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Average</th>
<th>Median</th>
<th>Range</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (n=15)</td>
<td>2.40</td>
<td>2.00</td>
<td>1-7</td>
<td>1.64</td>
</tr>
<tr>
<td>Middle (n=30)</td>
<td>2.90</td>
<td>2.00</td>
<td>1-14</td>
<td>2.41</td>
</tr>
<tr>
<td>High (n=10)</td>
<td>3.20</td>
<td>2.50</td>
<td>1-8</td>
<td>2.30</td>
</tr>
<tr>
<td>Total (n=55)</td>
<td>2.80</td>
<td>2.00</td>
<td>1-14</td>
<td>2.19</td>
</tr>
</tbody>
</table>

**Bed Traits**

The rectangular wetland fields are divided into raised beds. Farmers distinguish among the fields they own by the number of beds in each field (Figure 5-1). The average number of beds owned for all farmers surveyed was 65. The range was from 9 to 339. Bed quantity per field varies by the field’s location. The average number of beds in a field is 25. As described in Chapter 4, fields were of equal size in the Kihira-Buramba society land when the society first obtained the land. Each Kihira-Buramba society field has about the same number of beds. Fields also have similar numbers of beds in the Mugandu-Buramba society land because of the measurements that were made when the fields were distributed.

In contrast, non-society fields vary greatly in size. Few are as large as the fields on Kihira-Buramba and Mugandu-Buramba societies’ land and some are only a few beds in size. Additionally, these fields are located in areas, such as next to the curve of a hill, that are not easily divided into rectangular shapes. Overall, the size of the non-society fields is smaller than society fields. Households that were society members had an average field size of 25 beds compared to the non-society members who had an
average of 21 beds. A farmer may have several non-society fields but the overall size is not equal to one of the standard size fields on society land.

The annual process of field preparation was described in Chapter 4. Although the beds are recreated at the start of each annual planting season (long dry season), the number of beds created remains fairly consistent. The re-creation allows farmers to plant as many beds as they want or as their resources allow. If a farmer has problems with getting enough seed to plant, or does not have enough labor to cultivate the fields, he can limit the number of beds built and put under cultivation. This cultivation system allows for an accurate measurement of the number of beds planted. With this information, the percentage of the total field cultivated for each field can be calculated.

In addition, because of the general uniformity of the bed size, an estimate of the bed size can be made. The average bed size is 1–1.5 m wide and 6-8 m long.\textsuperscript{5} The average width of ditches between beds is 0.5 m to 1 m. Calculating a rough estimate of the land area using a mean of 25 beds in a field gives a measure of between 225 m\textsuperscript{2} and 500 m\textsuperscript{2} per field. Using this figure and the median number of two fields per household for the sample, an estimate of median area of valley land for each household is 450 m\textsuperscript{2} to 1000 m\textsuperscript{2} (0.045 to 0.1 ha).

**Amount of Valley Land Cultivated/Land use Intensity**

The number of beds owned by the farmer is the true indication of the amount of valley land they own. Field sizes vary and are distinguished by the number of beds in them. Although the number of fields a farmer owns is a fair representation of how much

\textsuperscript{5} Measurement of beds was done sporadically to get an estimate of size.
valley land they can farm, the number of beds provides a more insightful look into the differences in land ownership between income groups.

The farmers in the middle income level have the highest average number (76.2) of beds (Table 5-13). This result is skewed because of an outlier (339 beds). When this number is removed, the average number of beds is 67 and the group has fewer beds on average than the high income group. The difference between the three groups is evident in comparison of the medians. Again the low income group has the least amount of land.

Table 5-13. Bed ownership and proportion of valley fields planted

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Total beds owned</th>
<th>Proportion of beds planted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Low (n = 15)</td>
<td>40.40</td>
<td>33.00</td>
</tr>
<tr>
<td>Middle (n = 30)</td>
<td>76.20</td>
<td>66.00</td>
</tr>
<tr>
<td>High (n = 10)</td>
<td>70.10</td>
<td>54.50</td>
</tr>
</tbody>
</table>

Note: All data are per household for each group

The dependent variable for this study is the percent of valley land planted, which is a measure of land-use intensity. This number was determined for each of the income groups and the average does not indicate that there is much difference between the income groups (Table 5-13). More revealing is the median amount planted for each group because there is no influence from the outlier variable. The low income group plants more of their fields than the other two groups. A potential reason is that the low income farmers are more reliant on their valley fields for food than the richer farmers. Income from outside the farm is not as common among these farmers. With less cash available, they have fewer opportunities to purchase food or seed when needed. Another reason is that they have fewer fields and therefore can plant them all more
easily than a farmer who has many fields. The more fields a farmer has the more labor it takes to cultivate, and the more seed is required to plant.

**Rented Fields**

Renting additional wetland fields for farming is common. Farmers who do not plant all beds of their wetland fields may rent out all or some of the beds to another farmer to use. The rent for the field is charged per bed. This allows a farmer to cultivate part of his field and rent out the rest if he chooses. In the 1999\(^6\) planting season, 40% of the farmers rented one or more fields for their own use in the wetland (Table 5-14). A total of twenty-eight fields were rented during 1999. Fields were rented in all locations except for on Kihira-Buramba society land. Farmers who rented land rented an average of 34 beds. One farmer rented 90 beds, which he shared with his two wives.

<table>
<thead>
<tr>
<th>Table 5-14. Wetland field rental</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers who rented additional valley land (n=55)</td>
<td>22</td>
</tr>
<tr>
<td>Total fields rented</td>
<td>28.00</td>
</tr>
<tr>
<td>Mean beds rented</td>
<td>40.36</td>
</tr>
<tr>
<td>Median beds rented</td>
<td>35.00</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>31.59</td>
</tr>
</tbody>
</table>

Renting additional valley land for planting is done by farmers at all income levels (Table 5-15). However, the percentage of farmers renting land varies among the groups. The farmers with the higher income levels are more likely to rent land, because land rental is dependent on the availability of cash. According to the farmers surveyed valley land rental is only paid in cash, and not by payment in crop harvest after the growing season as is sometimes done on upland fields.

\(^6\) Data were collected for the calendar year from June 1999 to June 2000.
Income also appears to influence the number beds rented by the farmers. Not only did most of the farmers in the high income group rent land (80%), they also rented the highest number of beds on average. One of the farmers in this group rented a total of 135 beds for the year the data was collected. He said he normally rents valley land every year and the amount he rents varies.

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Rented valley fields</th>
<th>Number of beds rented</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
</tr>
<tr>
<td>Low (n=15)</td>
<td>3</td>
<td>20%</td>
</tr>
<tr>
<td>Middle (n=30)</td>
<td>11</td>
<td>37%</td>
</tr>
<tr>
<td>High (n=10)</td>
<td>8</td>
<td>80%</td>
</tr>
</tbody>
</table>

The majority of farmers do not rent out their wetland fields to other farmers. Only five of those surveyed said they rented out one field or a portion of their fields during Irish potato season. They rented out or gave the land to their relatives to use for the season. Two of these farmers were in the low income group, another two in the middle income group, and the last in the high income group. The reasons why farmers give or rent land depend on the individual. For instance, one farmer gave his son a field to use every year and the son would pay rent on it some years and not pay rent on other years. Another farmer had a debt to pay from a rental of an upland field and decided to pay that off with the money he received from renting out one of his wetland fields.

Given that there are fields available for rent indicates that not every household who has valley land uses it. It is possible that those who rented out their fields are Mugandu-Buramba society members who live in neighboring Kibuga parish. The hill between Kibuga and Mugandu parishes is long. Traveling by road the six kilometers
from Kibuga parish\textsuperscript{7} to the Mugandu wetland is challenging and time consuming. The long distance to and from the wetland may be a reason for farmers to rent out their valley fields rather than farm them.

Respondents stated that there are farmers who live overlooking Mugandu Valley, who also rented valley fields for farming and do not have wetland fields of their own. Renting fields is viewed as an opportunity to supplement upland field harvests. Four categories of farmers tend to rent land: young married couples, farmers who live in the far southern end of the valley (near the border with Rwanda), young men just starting out as farmers, and farmers who migrated into the area in the past decade. Farmers in the latter two categories were either too young to obtain membership fields or did not live in the area at the time when societies formed. Others simply missed out on the opportunity or did not want a field at that time the fields were distributed.

**Valley Crops and Problems**

Crops grown in the valley are Irish potato, bean, maize, sweet potato and cabbage. Farmers plant what they want in their fields because there are no cooperative society rules for crops grown in the wetland fields. The combination of Irish potato in the first season and an intercrop of beans and maize in the second season was most commonly practiced (by 85% of the farmers and on 75 fields). A pattern of Irish potato in the first season followed by not planting (fallow) in the season was found on 47 of the fields and used by 44% (24) of the farmers. Many other cropping patterns are used in the wetlands including Irish potato followed by cabbage and an intercrop of Irish potato and sweet potato followed by a fallow (Table 5-16).

\textsuperscript{7} Kibuga parish was not included in this study.
Table 5-16. Cropping patterns practiced in wetland fields

<table>
<thead>
<tr>
<th>Cropping pattern</th>
<th>Number of fields</th>
<th>Number of Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irish-potato then bean/maize</td>
<td>75</td>
<td>47</td>
</tr>
<tr>
<td>Irish potato then fallow</td>
<td>47</td>
<td>24</td>
</tr>
<tr>
<td>Sweet potato then fallow</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Other patterns</td>
<td>40</td>
<td>27</td>
</tr>
</tbody>
</table>

Harvesting and Selling of Valley Crops

The average number of sacks of Irish potato harvested per household was 5.2. On average, 52% of these sacks were sold for cash. However, some households relied more on the harvest from valley fields for food than for cash. Five families sold none of their Irish potato harvest and only one sold all of it. Three of these families are in the low income group and the other two are in the middle income group. Cabbage is also grown in the second season as a cash crop, and was cultivated by five farmers in 1999. Farmers alternate years of planting cabbage and a bean and maize intercrop in the second season. Bean and maize are grown for home consumption. Maize is sometimes sold if buyers come to the valley looking for maize for their roadside food stand. The maize is roasted and sold as a convenience food on the main roads and near rural shopping centers.

Another trend in the amount of Irish potato harvested and income level is evident in the data (Table 5-17). The lowest income group of farmers harvested the least amount of potatoes, an average of 4.1 sacks compared to 13.2 and 29.8 sacks for the middle and high income groups, respectively. More interesting is the percent of total harvest that is sold on average by each of the groups. The middle income group sold

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8 Sack sizes are 50 kg and 100 kg. The latter is commonly used for with Irish potatoes.

9 Only information on Irish potato harvest was available. Farmers do not track harvest of other crops as closely as they do Irish potato.
the most (55%) of their total harvest of Irish potatoes. The low income level group sold
the least amount of their harvest (30%). It may be possible that the low percentage
reflects more of a reliance on the potato harvest for food than for income. The middle
income and high income group sell about half of what they produce while the low and
middle income groups included farmers who did not sell any of the Irish potato harvest.
In contrast, all of the farmers in the highest income group sold Irish potatoes; the
minimum percent of total harvest sold was 22%.

Table 5-17. Irish potato harvested and use of the harvest

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Sacks Harvested</th>
<th>Sacks Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Low (n=15)</td>
<td>4.13</td>
<td>4.00</td>
</tr>
<tr>
<td>Middle (n=30)</td>
<td>13.12</td>
<td>10.00</td>
</tr>
<tr>
<td>High (n=10)</td>
<td>29.75</td>
<td>18.50</td>
</tr>
</tbody>
</table>

Note: Size of sack used is 100 kg.

Table 5-18. Irish potato harvest as proportion of total harvest

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Sold as proportion of total harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Low (n=15)</td>
<td>.304</td>
</tr>
<tr>
<td>Middle (n=30)</td>
<td>.551</td>
</tr>
<tr>
<td>High (n=10)</td>
<td>.503</td>
</tr>
</tbody>
</table>

A different perspective is provided by examining the amount of income received
from the sale of Irish potato harvested by the farmers in the three income groups.
Several outliers influence the average for households as a whole and for the income
groups. For this reason, the median is discussed instead. For all households, the
median income received by all households from the sale of valley field crop harvests
was 54,000 USH ($36) (Table 5-18). The amount of income obtained aligns with the
separate income groups: the low income group received the least amount of their
income from sale of Irish potato while the high income group received the most. The difference between the two groups is a large sum (163,000 UGS). Further, the high income group earned more than twice the amount of income from these sales than did the middle income group.

Reliance on wetland crop sales varies greatly among householders. For five farmers, these crops provide none of their household income. At the other extreme, three households earn >80% of their cash income from valley crops. All valley crops sold account for an average of 40% of total crop income and for 31% of annual household income for the farmers.

There is a disparity in comparison of the groups in the percent of total annual income earned from valley crops. The gap between the low and middle groups is not very wide, showing similar reliance on valley crop sales for household income. However, the gap between these two groups and the richest group is much greater. This group is not as dependent on valley crop harvest, although they still earn a larger sum income from Irish potato sales.

Table 5-19. Income from sales of Irish potato harvests

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Income from sale of Irish Potato (USH)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Low (n=15)</td>
<td>19,700</td>
</tr>
<tr>
<td>Middle (n=30)</td>
<td>107,100</td>
</tr>
<tr>
<td>High (n=10)</td>
<td>318,600</td>
</tr>
<tr>
<td>Total</td>
<td>121,718</td>
</tr>
</tbody>
</table>

Note: Income from fields rented is also included.

Separating the rental fields shows the influence of rented valley fields on household income (Table 5-19). In general, fields rented by the farmers bring in a sizeable income. The median income obtained from rented fields compared to owned fields (Tables 5-20 and 5-21) is similar for the low and middle groups. The high income
group benefits the most because they earned the greatest amount from their rented fields.

Table 5-20. Valley crop sales

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Irish Potato as % of annual income</th>
<th>All Valley Crop Sales as % of annual income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Low (n=15)</td>
<td>29%</td>
<td>21%</td>
</tr>
<tr>
<td>Middle (n=30)</td>
<td>32%</td>
<td>29%</td>
</tr>
<tr>
<td>High (n=10)</td>
<td>16%</td>
<td>11%</td>
</tr>
<tr>
<td>Total</td>
<td>28%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Note: Income from fields rented is also included.

Table 5-21. Income from rented wetland fields\(^{10}\)

<table>
<thead>
<tr>
<th>Income group:</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (n = 2)</td>
<td>16,500</td>
<td>16,500</td>
<td>19,092</td>
</tr>
<tr>
<td>Middle (n = 6)</td>
<td>76,833</td>
<td>63,000</td>
<td>65,203</td>
</tr>
<tr>
<td>High (n = 8)</td>
<td>109,125</td>
<td>76,000</td>
<td>106,387</td>
</tr>
<tr>
<td>Total (n = 16)</td>
<td>85,438</td>
<td>54,000</td>
<td>87,668</td>
</tr>
</tbody>
</table>

Valley Flooding

Flooding of the valley often occurs when crops are still in the field. The frequency and extent of flooding varies. It does not happen yearly. Farmers are concerned about flooding only during the first planting season. Farmers who plant in the second season understand that they risk low yields or crop losses. Nearly every farmer (91%) has experienced a valley field flood since ownership.

Respondents had difficulties in recalling when a flood occurred and if crops were damaged or lost. Within the last five years,\(^{11}\) floods affected almost all farmers (82%; n=45), and 54% lost crops (Table 5-22). Irish potatoes are most likely to be subject to

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\(^{10}\) Rented fields were used for Irish potato cultivation only

\(^{11}\) Five years was used as a time frame reference for recollection purposes.
flooding because they are not yet harvested when the rains begin in September. The runoff from the slopes surrounding the wetland causes much of the flooding. Rainfall produces runoff resulting in deposition of sediments from the hillsides in the valley. If the wetland canals are not kept clear, which allows water to pass and sediment to settle, flooding occurs. However, even good canal maintenance cannot compensate for heavy rainfall. Flooding also occurs even when there is no local precipitation. The headwaters and branches of the main stream running through the wetland originate in Rwanda. Heavy rains on Rwanda's higher elevations can cause downstream flooding in Mugandu Valley.

Table 5-22. Valley flooding problems

<table>
<thead>
<tr>
<th></th>
<th>Flooding (N = 45)</th>
<th>Crop Damage (N = 41)</th>
<th>Crop Lost (N = 35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>45</td>
<td>38</td>
<td>19</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>No Data</td>
<td>10</td>
<td>14</td>
<td>20</td>
</tr>
</tbody>
</table>

Use of Wetland Raw Materials

Wetland raw materials are collected, prepared and used by 91% of the households. The materials are collected from the northern end of the wetland. Part of this area is owned by the Mugandu-Buramba Society and is not converted, and the remainder is government-owned public land. Wetland raw materials are used in a variety of ways (Table 5-23).

Grass Products

As described in Chapter 4, grasses and papyrus are often used for mats, baskets and ropes. A clear division of labor by gender is present in how wetland raw materials are used. Mat making is done by 75% of the women in the households. Two sizes of mats are produced, large and small. Large mats are most common and are made from
omubimbiri grass.\textsuperscript{12} The mats are standard in each household as they are used for sitting, sleeping and drying crops. Small mats are not as prevalent in the homes and are made out of ekyikangaga grasses. A decorative pattern is made using banana trunk woven into the mat. Small mats are used as gifts for weddings and other special occasions. Baskets are also woven from wetland grasses, but only a few of the women interviewed know how to make them.

Most women make mats for their own home use. Two women surveyed frequently produced mats for sale, which accounted for over 20\% of their respective household’s annual income. One woman was a widow and the other was the second wife in a polygamous marriage. Both households fall into the low income group. Mats are produced during the dry season months (June, July, and August) when there are fewer farm tasks to complete and when the natural wetland is not flooded. Extra mats are sold at the local market. Older girls in the family also make mats and keep any money earned from sales for their own personal use.

Papyrus Products

Farmers derive other products from wetland vegetation. Papyrus is used to make ropes for home use and sale. Ropes are made by removing the three outer layers of the stalk and twisting them together. Rope-making is a strictly a male task. The ropes are sold at the market. The collection of papyrus bundles for sale at local markets is another task done by men. Buyers purchase these bundles rather than sacrifice hours collecting it themselves. Papyrus is also cut and used as fencing. Smallholder farms have fences made of papyrus, tree branches, or bushes for privacy. One farmer even

\textsuperscript{12} The scientific name for the grasses could not be obtained.
reported using papyrus for roof thatching. Most households use sorghum stalks instead as they are easier to obtain en masse after sorghum is harvested. Thatched roofs are more commonly found on kitchens and outhouses than on the main house. Papyrus is commonly used to make ceilings in the houses under the metal roofs. Dried papyrus is also used as firewood.

Table 5-23. How wetland resources are used

<table>
<thead>
<tr>
<th>Wetland Resource</th>
<th>Grasses (N = 22)</th>
<th>Papyrus (N = 20)</th>
<th>Mudfish (N = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mats</td>
<td>21</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ropes</td>
<td>0</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Food</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Bundles</td>
<td>0</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Baskets</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Mudfish**

Mudfish is the only animal harvested from the wetland. Mudfish habitat is the muddy bottoms of the canals and streams. The fish are collected by boys and young men in 16% of the households. The fish are gutted, dried and then are either eaten or sold. Money received from the sale of mudfish is kept for personal use.

**Wetland Product Sales**

Twenty-four farmers sold wetland products or products made from wetland materials. Sixty percent of the farmers in the low income group (n=15) sold products made from wetland materials. For the middle and high income groups, the number was 37% and 40%, respectively. Sixteen of the twenty four households selling wetland products live on the Buramba side of the valley. For most of these households, access to the wetland vegetation is a relatively short walk along a road.
Despite more of the poorer households selling wetland products, they earned the lowest average income from these sales (Table 5-24). The majority of the products they sold were mats and ropes. The high income group earned the most money on average, although this number is slightly distorted because only four respondents in this group sold products. Of the four, two farmers sold mudfish, which sells for more money than grass or papyrus. Another two mostly sold bundles of papyrus. Selling a bundle of papyrus involves cutting the stalks and then taking them to market. It proved to be an easy and lucrative effort for these farmers.

There is a difference between the rich and the poor group in use of wetland resources. The rich use a diversity of wetland products to earn money while the poorer households produce mats. Mats take more time to produce and can be made over time at home. However, mats are not as profitable as some other products. Therefore, families are better off putting their labor into papyrus and mudfish harvesting is they can do so.

Table 5-24. Wetland material income

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Wetland Products Sold (USH)</th>
<th>As part of annual income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Low (n = 9)</td>
<td>6,600</td>
<td>5,500</td>
</tr>
<tr>
<td>Middle (n = 11)</td>
<td>7,936</td>
<td>4,200</td>
</tr>
<tr>
<td>High (n = 4)</td>
<td>24,250</td>
<td>29,050</td>
</tr>
</tbody>
</table>

Note: USH represents Uganda Shillings. $1 U.S. = 1500 Ugandan Shillings in 2000.

Selling wetland products to supplement traditional crop income has more influence on the income of the poorer households than is does on the income of the richer households (Table 5-24). There are two reasons for this. First, they have lower incomes overall. Therefore the sale of wetland products makes a larger impact on the
annual income. Second, they purposely make and sell wetland products to augment their income.

**Wetland Products vs. Wetland Crops**

An interesting comparison is to examine the difference in income earned from the sale of wetland products versus the sale of crops grown on the wetland fields. Grasses and papyrus are collected in bundles and crops are collected in sacks. However, there is no consistent bundle size (such as 6 kg), nor is there a standard size of sack for crop harvests. Twenty-four households sold wetland products, which brought in an average of 6.0% of their total income (Table 5-25). However, the *monetary value* of wetland raw materials compared to agricultural crops is low. The average amount of cash earned from selling *wetland products* was an average of 10,154 USH. The average amount of cash received for *wetland crops* was 82,604 USH.

<table>
<thead>
<tr>
<th>Table 5-25. Income from wetland products and crops (n=24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household revenue (USH)</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>Papyrus</td>
</tr>
<tr>
<td>Grasses</td>
</tr>
<tr>
<td>Mudfish</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>All Valley Crops</td>
</tr>
</tbody>
</table>

Note: USH represents Uganda Shillings. $1 U.S. = 1500 Ugandan Shillings in 2000.

This finding supports what most farmers say, that the wetland is more valuable for crop production than for natural wetland materials. As a result, farm families do not put much emphasis on wetland products. The general feeling among farmers is that the wetland natural materials do not hold the same importance as they did a couple of generations ago. Although a majority of the farmers use wetland materials, farmers feel that they have moved beyond a heavy reliance on wetland materials. One man
commented “We have more crops now and the wetland is feeding us. We have
developed. We have tin sheets for roofing so we don’t need the wetland as much.”

**Upland Fields and Food Production**

The farm families interviewed have fields on both the upland slopes and in the valley. Upland fields are the primary fields for cultivation for the smallholder farmers. One reason of this is that more crops can be grown on upland fields than in the valley. For instance, sorghum and bean, two staple foods, are grown on the hill slope fields. The farmers interviewed have an average of eight upland fields. Five farmers owned the largest number of fields. Two farmers own 16 fields each. Three others own 17, 18, and 19 fields, respectively. All five of the farmers are classified in the middle income group.

On average, the farmers surveyed own more upland fields than they do valley fields (Table 5-26). Land is more abundant on the hill slopes and farmers may own land near or far from their house. As such they can have fields on many different hills. The biggest difference between the income groups in land ownership is between the low income group and the other two groups. Overall the low income group owns the least amount of land. The middle and high income groups have about the same amount of land split between the valley and the upland. A few farmers commented that they did not have enough upland fields to meet the needs of their family. They felt that as their family grew, the number of fields that they owned were not enough to keep up with the food demand of their growing children. Some farmers said they had purchased additional upland fields since starting a family. For instance, one farmer said that he was trying to save money to buy more fields because he only had the two that his father gave him.
Table 5-26. Average number of valley and upland fields

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Valley Fields</th>
<th>Upland Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Low (n=15)</td>
<td>2.40</td>
<td>2.00</td>
</tr>
<tr>
<td>Middle (n=30)</td>
<td>2.90</td>
<td>2.00</td>
</tr>
<tr>
<td>High (n=10)</td>
<td>3.20</td>
<td>2.50</td>
</tr>
</tbody>
</table>

On average, the valley fields make up one-third of the typical farm family’s fields. Farmers acknowledged that valley fields are particularly important if a family has a small number of upland fields. In these cases, valley fields help ease the shortage of land on the hill slopes for farming. Farmers who own valley land have an advantage over farmers who do not because valley land is planted in the long dry season, which allows an additional growing season each year.

Every household has a different number of fields, each of a different quality, and a different set of agricultural crops in the fields at any one time. The combination of the three creates a range of cropping system possibilities for each family. Farmers reported that the quality of their fields for agriculture varies. Some fields are considered better overall than others for specific crops. Farmers plant their fields based on their knowledge of their fields.

Hypotheses 3, as stated in Chapter 2, concerns upland field production and the reliance of households on upland fields for food sufficiency. Farmers were asked questions about their upland fields and the food production on those fields.

The first question farmers were asked was if their upland fields produced enough for them to feed their family during the past five years.\(^{13}\) Twenty-nine of the farmers

\(^{13}\) A time frame was set to have farmers refer to the most recent years.
(N=55) answered “yes” to this question (Table 5-27). Overall, a few farmers were quite happy with the harvest from their upland fields. Several stated that the harvest varies each year, but overall their fields have produced enough food. One farmer commented that seven years ago, when he just married, his fields produced enough food. Now that he has children, his fields do not produce enough food. Another reported that the quality of his fields was fine; he just didn’t have enough of them to support his family. Others felt that they had more to eat in the past, 10 to 15 years ago, than today. For the three income groups, the number of positive responses to this question for each group was similar (Table 5-27).

Each household determines how their crop harvests are used. Some of the harvest is consumed by the household, some might be kept for seed, and some may be sold. Farmers were asked if their upland fields produce enough for them to eat while setting aside some of the harvest as seed (Table 5-27). Thirty-six of the farmers (N=55) stated that they do produce enough to keep seed. The number from the low and middle income groups who responded yes to this question are 9 (60%) and 21 (70%), respectively. While for the high income groups the number was 6 (60%). The number of farmers in all groups who keep seed is higher than the number of farmers who stated that their fields produced enough to eat.

Keeping seed is an important issue. Families may keep some of the harvest for seed, even if they feel that there is not enough to eat, because they need to assure that they will be able to plant every year. Purchasing seed can be expensive at planting time because demand is high. Again, the perception of whether the harvest provides enough to eat and enough for seed varies greatly among the respondents. Farmers
may state that their fields do not produce enough to eat, but will say that it is enough for seed.

The third question the farmers were asked was whether the upland fields produce enough harvest to have a salable surplus. A smaller number overall 22 (42%), reported that their upland fields produce enough to have a salable surplus (Table 5-27). For the low income group, only a small percent responded yes to this question. They are more likely to keep more of their harvests than the farmers in the other two groups. Less than half 15 (43%), of the farmers in the middle income group said they have enough from the harvest to sell. Half (5) of the farmers in the high income category said that their upland fields produce enough to sell. Farmers in the high income group have several upland fields and they may plant crops targeted only for sale, such as sorghum. The high income group is also the group that sells the most of their Irish potato harvest from their valley fields.

Detailed data about upland harvests were not collected. A few farmers volunteered that they sell some of the harvest from upland fields. Many do not sell crops produced on the upland fields at all. There are exceptions to this because households will sell stored food when they have for emergency expenses (as explained in Chapter 4).

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Fields produce enough to feed family</th>
<th>Fields produce enough to feed family and have seed to replant</th>
<th>Fields produce enough to feed family, have seed to replant plus surplus seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (n=15)</td>
<td>7</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Middle (n=30)</td>
<td>17</td>
<td>21</td>
<td>13</td>
</tr>
<tr>
<td>High (n=10)</td>
<td>5</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Total (N=55)</td>
<td>29</td>
<td>36</td>
<td>22</td>
</tr>
</tbody>
</table>
Valley Soil Characteristics

Soil samples were taken from 55 valley fields owned by the farmers surveyed. This section presents the general findings of the analyses and the results from the soil quality index.

Valley Soils

Soil samples for the wetland fields came from all three locations: Kihira-Buramba, Mugandu-Buramba, and non-society land. Each farmer was asked to select a field that they consider above average or of good productivity for agriculture. Samples were taken from one of the beds in the field. Each field was under cultivation at the time of sampling. In general, the Mugandu Valley floor has little slope, but enough for water to drain from the ditches to the main canal and into the lake. The slope is 1% to 2%. The average pH of the samples was 4.6 and the ranged from 3.7 to 6.2. Fields in the Mugandu-Buramba society tended to have the lower pH values. This is the area that often contains water year round. The soil is usually moist or even wet for several months of the year until the vegetation is cut and new ridges are formed. Farmers did not report any problems with rocks or trees that prevented cultivation in the wetland. Some farmers said that they had fields that still contained papyrus roots, which sometimes inhibited cultivation of an entire bed.

Valley soil textures ranged from sandy loam to clay loam. Loam was the most prevalent soil texture type (53%). For some samples, there was little sand or clay present and the soil was mostly organic matter originating from the decayed wetland vegetation. The absence of clay or sand is not unusual given that the beds are recreated each year by building up ridges from the muck underneath the surface and at the bottom of the old beds.
The colors of the valley soil fell into three groups: black (49%), dark brown (16%), and dark reddish brown (35%). The loam soils were black in color and composed of almost all organic matter mixed with small amounts of clay and sand. Most of the loam soil samples came from the Mugandu-Buramba society fields. This is the area that was converted in the mid-1980s and still contains a lot of organic matter and wetland vegetation. In some of the fields sampled, the top layer of the soil (4 to 10 inches) was loam followed by a layer of vegetative debris, which was the wetland grass that was turned under during field preparation. In fields located closest to the natural wetland vegetation near the lake, the soils tend to have more water in them, even during the dry season. In this area, farmers often plant sweet potatoes or sometimes only plant later in the dry season in hopes that the next rainy season will start late, thus allowing the crops to be harvested.

**Soil Quality Index**

A soil quality index (SQI)\(^{14}\) derived from the measurements of certain soil properties was used to determine the soil quality of the valley soils. This section is divided into two subsections: general descriptions of the soil quality index results for the valley soil samples, comparison of SQI by location in the valley, and comparison of SQI numbers to the household income groups.

**Comparison of SQI Scores by Valley Location**

The average score for all of the valley field samples was 112, ranging from 51 to 189. In the SQI for this study, the higher the score the better the quality of soil is for farming.

\(^{14}\) See Chapter 4 for explanation of Soil Quality Index
Farmers who own fields in the Mugandu-Buramba society said that their fields are fair to good for cultivation. Some farmers complained that the soil is not yet fully set for cultivation as are soils in the Kihira-Buramba society land. This means that the Mugandu-Buramba soils are often high in organic material content, one effect of which is the desiccation of the upper most few inches of the profile within a few days during the long dry season. They also refer to the higher water table and higher risk of flooding when the rainy season starts, particularly in parts of the Mugandu-Buramba land. In contrast, farmers who have fields in the Kihira-Buramba society land reported that their fields are good for crop plants and they did not have complaints about soil desiccation. Indeed, the soils sampled from fields in the Kihira-Buramba society land received the highest SQI scores for the three valley locations with the median value being higher than maximum value with the exclusion of outliers (Figure 5-3).

Valley soil samples that were loam soils and contained a high amount of organic material had the lowest percent of water stable aggregates. These soils with low mineral content do not form water stable aggregates well. In general, the greater the clay component in the soil, the greater the ability to form aggregates. Many of the fields in Mugandu-Buramba society land were converted during the mid to late 1980s. During the long rainy season, the wetland vegetation grows back in thick patches. Papyrus also regenerates in a few fields. As a result, the fields located in the area with young wetland vegetation contained the most organic matter. The lower average SQI score for the fields located in Mugandu-Buramba society land may be influenced by the annual vegetation regrowth.
Figure 5-3. Soil quality index score by location in valley.

**Household Income and SQI**

Comparing the valley SQI scores to that of the annual income of the farmers interviewed produces no identifiable trends between the two variables (Figure 5-4). Some respondents are farmers who have a large income from what they produce in their fields. Others earn much of their annual income from the sale of Irish potatoes grown in the wetland (Figure 5-5). The quality of the valley soil does not make a difference in the amount of annual income a farmer can earn from potato sales. Some of the poorest respondents have soils in the wetland fields that are considered of a better quality for crop production than some of the valley fields owned by wealthier farmers. In sum, the wealthier farmers do not hold all of the best fields for cultivation in the wetland. This contradicts what some farmers often believe: that the wealthier people have the best fields and soil.
Comparing soil quality scores by income group reveals little difference between the groups and the average soil quality index score (Figures 5-6). No one group has a hold on the best valley soils for farming. The general homogeneity of the valley soils, the identical process of converting the wetland to raised ridges each year, and the same types of crops planted in the valley leaves little variation in the farming process. Therefore, no single field is better than another. Improvement of the soil, such as the addition of fertilizers, is not done.
Comparison of SQI Scores to Land Use Intensity

Comparison of the soil quality index scores to the land use intensity value for each household shows no clear relationship. The intensity that farmers plant valley fields is not directly dependent on the quality of the soil. Several farmers planted more of their fields that had a low soil quality score while others planted less on fields that had a higher soil quality scores (Figure 5-7).

For the farmers, soil quality is a personal perception factor. Whether or not it influences how a farmer uses a field depends on the individual farmer. In comparison of the soil quality index scores to the land use intensity, it is not possible to discern any trends between soil quality and amount of the valley fields farmed.

Figure 5-5. Valley soil quality index score and income from valley crops.
Figure 5-6. Valley soil quality Index score by income group.

Figure 5-7. Soil quality index score compared to land use intensity value.
Conclusions

The descriptive data provide a detailed look at the respondents. The families surveyed represent a variety of households. Most households are married couples with children and are subsistence farmers. The majority of those interviewed are of childbearing age, thus the population of the valley will likely increase. A low level of education is common in Mugandu valley as it is in other rural parts of Kabale District. Likewise, men tend to have a few more years of education than the women.

Analysis of the households by income level breaks away from the usual aggregation of data to reveal some interesting trends, contrasts, and similarities between households. It is clear that household income level makes a difference in how families cultivate their wetland fields and use wetland materials. Of the three income groups, the rich have more of almost everything: cash earned from sale of Irish potatoes, rented valley fields, hired labor, total fields, and even income earned from sale of wetland products. They plant the least amount of their valley fields and therefore have the lowest land use intensity value. A few factors are equal among all three income groups. These are soil quality, valley crop problems, and flooding of fields.

Chapter 6 presents the results of the statistical analyses for this study.
CHAPTER 6
TESTING LAND USE INTENSITY

Chapter 5 examined the household and farm characteristics of the farmers interviewed as well as the level of intensity of farming on wetland fields. This chapter presents the results of the statistical analysis used to test the variables that most influence land use intensity (study Objective 5). The chapter is divided into five sections: introduction, results of the correlation of the independent and dependent variables, the results of the analyses between grouped independent variables and the dependent variable, a summary of the test results for each of the variables and conclusions.

Introduction

At least since Theodore Schultz wrote his major work on smallholder farmers (Schultz 1964), it has been an accepted view than smallholders adjust and optimize the available resources that comprise the farm, and filling the basic needs of the family is given priority over sales of output. There are differences of interpretation in how a household makes decisions about how to use its land, labor, cash, and other resources, marketing its crops and other products, etc (Netting 1993; Angelson 1999). Based on the research and literature about agricultural change, and agricultural intensification in smallholder farming systems, which was discussed in detail in Chapter 2, six variables have been hypothesized as most relevant to this study. The variables are household income, access to labor, percentage of crops grown on valley land used for home consumption, sufficiency of food security (production) on upland fields, total farm size, and the quality of soil in the valley fields. This chapter focuses on the fifth and final objective of this study, which is to examine which bio-physical and household socio-
economic variables have the strongest influence on the intensity of agriculture on wetland fields. The research questions (Chapter 2) for each of these factors ask, in general, how much influence each variable has on the amount of valley fields cultivated.

**Correlation Data**

Prior to testing each of the six independent variables against land use intensity, a one-tailed Spearman’s rank-order correlation coefficient test was run to observe relationships between them. Five of the six independent variables were used: annual income (ANNLINC); total labor used on valley fields (TOTLABR); amount of Irish potato harvested from valley fields that was consumed by the household (PERIPATE); total farm size including upland and valley fields (TOTLFLDS); and valley soil quality (VALSOIL), to the dependent variable, land use intensity. The sixth variable, upland food security (FOODLAND) is dichotomous and could not be used in this analysis. Spearman’s rank-order correlation coefficient was selected because the data for the independent variables are continuous and do not have a normal distribution.

Results of the Spearman’s test revealed a positive correlation between TOTLABR and ANNLINC (Table 6-1), which was statistically significant (p<.001). The higher a farmer’s annual income, the more labor is used on the valley fields. This trend was seen in Chapter 5 during exploration of the data via income groups, where the richest farmers used more labor on their valley fields than the other two income groups. Having a higher annual income makes it easier to pay cash for hired labor.

The explanations for the following two correlations are similar. First, a negative correlation was found between TOTLABR and PERIPATE (potato production for household consumption), which was also statistically significant (p=.001). The more labor (including hired labor) used on valley fields, the smaller the amount of the potato
harvest consumed by the household. Second, a statistically significant negative correlation exists between PERIPATE and ANNLINC (p=.001). Wealthier households generally consume less of their potato harvest. Farmers who use the most labor are using hired labor in lieu of reciprocal or exchange labor. When they invest in hired labor, they usually intend to recoup these expenditures by selling much of their potato harvest to buyers from the larger towns rather than keep it for household consumption or even for sale at local markets. These results are also supported by the data discussed in Chapter 5.

Finally, there is a positive correlation between ANNLINC and TOTLFLDS, which is also statistically significant (p=.004). This indicates that richer households tend to own more fields. This trend was seen in Chapter 5 when examining number of fields owned by the three income groups. While in general, as income increases the total number of fields increases, it levels off between the middle and high income groups. Both groups have nearly the same average number of fields.

There is a strong positive significant (p<.001) correlation between TOTLFLDS and TOTLABR. Farmers who have more fields overall, use more labor. It is important to remember, however, that the TOTLFLDS variable includes all fields (upland and valley) owned by a farmer while the TOTLABR variable only includes the valley fields. It is possible that some farmers own more valley fields than upland fields and vice versa. Thus, it is only possible in this analysis to determine that the relationship is between the combined number of fields and the amount of labor used on valley fields. The association may still be due to chance rather than another reason despite the strong correlation and high significance level.
A couple associations can be generalized here. The wealthier the household, the higher the amount of labor used and the less of the potato harvest consumed by family members. In contrast, households with lower annual income use less labor on valley fields, own fewer fields, and consume a higher percent of their potato harvest.

The results indicate that several moderate and one strong correlation between the predictor variables. The independent variables could be working in combination and may account for the variation in land use intensity, which is tested in the next section. For example, the $r^2$ value of the correlation between TOTFLDS and TOTLABR accounts for 25% of the variance in land use intensity. Although it may appear obvious that these two would be related, recall that the data used for the total fields owned included both upland and valley fields. Therefore, it cannot be assumed that the amount of labor used in the valley fields positively correlates with the number of fields.

Given the limited sample size for these correlations, it is difficult to correctly identify all of the separate relationships. For example, what might be considered a weak relationship between two variables in a large sample (e.g. >300) is considered moderate here (Cohen 1988). It is also possible that these variables have a stronger relationship to each other than indicated by the results. As stated in Chapter 3, some of these variables may be very closely interrelated, and this muddle the results.

In the next set of correlation tests, a Spearman's rank-order correlation coefficient test was run to observe relationships between the independent variables and land use intensity. The dependent variable, land use intensity, like the independent variables is not normally distributed. Therefore a non-parametric correlation test was best suited for
this analysis. All tests were run as one-tailed to test the research hypotheses as stated in Chapter 2. An alpha level of 0.05 was used on each correlation (Table 6-2).

Table 6-1. Spearman’s Rank–Order Correlation Coefficient among the independent variables influencing land use intensity.

<table>
<thead>
<tr>
<th>Variables</th>
<th>ANNLINC</th>
<th>TOTLABR</th>
<th>PERIPATE</th>
<th>TOTLFLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANNLINC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTLABR</td>
<td>.426** (p&lt;.001, 18.1%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERIPATE</td>
<td>-.450** (p&lt;.001, 20.1%)</td>
<td>-.448** (p&lt;.001, 20.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTLFLD</td>
<td>.382** (p&lt;.004, 14.6%)</td>
<td>.504** (p&lt;.001, 25.4%)</td>
<td>-.129 (p&lt;.348, 1.7%)</td>
<td></td>
</tr>
<tr>
<td>VALSOIL</td>
<td>.018 (p&lt;.895)</td>
<td>-.033 (p&lt;.810)</td>
<td>.001 (p&lt;.996)</td>
<td>-.120 (p&lt;.381)</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed)

In general the correlation test reveals little relationship among the variables and land use intensity (Table 6-2). Of the five variables, only one weak positive relationship was found and that was between intensification and the amount of Irish potato harvested from valley fields that was consumed by the household (PERIPATE). Based on the correlation test results, the more intensively a household uses its valley fields, the greater the proportion of the harvest it consumes. This is not surprising since the farmers in Mugandu valley tend use their valley fields to supplement the amount of food harvested from their upland fields, to increase food quantity in the household, and for variety in their diet. Also, more than half of the farmers in the sample hold on to their Irish potato harvest rather than sell it. Most of the farmers who held on to the potato harvest have low and middle annual incomes while all of the richest farmers sold a part of their harvest.
Only one of the four negative correlation results had a significant relationship to
land use intensity. There is a moderate, but significant, negative relationship between
total farm size (TOTLFLDS) and land use intensity (p < .016). Based on the correlation,
the more fields a farmer owns in total, the less intensely the valley fields are planted,
which means that farmers are not planting all of the available land in their valley fields.
The significance level of the correlation indicates that the relationship is more than just a
result of chance and may suggest that valley fields are not as important for cultivation
for farmers who have many fields overall. On average, about one-third of the fields
owned by each farmer are valley fields. As discussed in Chapter 5, farmers with lowest
incomes tend to plant on average more of their valley fields than do farmers with
moderate and high incomes. This correlation explains 8.3% of the variation in the
intensity of use of valley fields, the highest of all of the variables.

The other variables have negative relationships to land use intensity, indicating
that as the variables increase in amount, the valley fields are farmed less intensively.
Two of these, annual income (ANNLINC) and total labor used on valley fields
(TOTLABR) have very weak negative correlations with intensification. In particular,
based on the correlation, annual income has almost no relationship to land use
intensity. This is unexpected because cash is an important variable and is used to buy
seeds to plant and to hire farm laborers. Essentially, the correlation indicates that both
rich and poor farmers are likely to continue to intensify the use of their valley fields.
This finding may also be related to the size (e.g., number of beds) of the valley field. As
discussed in Chapter 5 there is little difference between the size of the valley fields for
the farmers in the medium income and high incomes groups on average, but the low
income group has smaller sized fields overall. Having smaller fields may make it easier to plant all of them without the need to hire labor. About half of the farmers in the low income group did use hired labor for the most difficult tasks of cutting the wetland grasses and field preparation.

The correlation for the last independent variable (VALSOIL) indicates a negative relationship to land use intensity, indicating that farmers intensify farming in their wetland fields regardless of difference in soil quality. This result is not surprising for several reasons. Soil quality in the wetland valley is fairly homogenous with only minor differences based on the location of the field in the wetland valley. They also rely on wetland fields as an important source of food for home consumption and as a reliable source of income from the sale of Irish potatoes.

Table 6-2. Results of Spearman’s Rank-Order Correlation Coefficient between the independent variables and land use Intensity.

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>r</th>
<th>p</th>
<th>r²</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANNLINC</td>
<td>55</td>
<td>-.005</td>
<td>.485</td>
<td>.000025 (.0025%)</td>
</tr>
<tr>
<td>TOTLABR</td>
<td>55</td>
<td>-.099</td>
<td>.236</td>
<td>.0098 (.981%)</td>
</tr>
<tr>
<td>PERIPATE</td>
<td>55</td>
<td>.126</td>
<td>.18</td>
<td>.0158 (1.59%)</td>
</tr>
<tr>
<td>TOTLFLDS</td>
<td>55</td>
<td>-.288</td>
<td>.016*</td>
<td>.0829 (8.3%)</td>
</tr>
<tr>
<td>VALSOIL</td>
<td>55</td>
<td>-.137</td>
<td>.159</td>
<td>.0187 (1.87%)</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (1-tailed)

Spearman’s rank-order correlation coefficient is sensitive to outliers, particularly with a small sample size such as this. As such, three correlations were run again with the outliers removed from the analysis for the variables total labor used (TOTLABR), total fields owned (TOTLFLDS), and annual income (ANNLINC). For total labor used, two outlier cases were removed, for total fields, one case, and for annual income, four outlying cases were removed. The correlation test on TOTLFLDS continued to produce
a moderate negative correlation to land use intensity (Table 6-3). This association was also revealed in the correlation test between the independent variables, as mentioned earlier. Removal of the one outlying variable had a slight influence on the result from the previous correlation using all 55 cases. The result was significant (p = .032). It also accounts now for 6.5% of the variation in land use intensity on valley fields. No large differences were found for the other two variables.

Table 6-3. Results of Spearman’s Rank-Order Correlation Coefficient between the independent variables and land use intensity after removal of outlier cases.

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>r</th>
<th>p</th>
<th>r²</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANNLINC</td>
<td>51</td>
<td>.088</td>
<td>.270</td>
<td>.0077 (.77%)</td>
</tr>
<tr>
<td>TOTLABR</td>
<td>53</td>
<td>-.026</td>
<td>.426</td>
<td>.0006 (.067%)</td>
</tr>
<tr>
<td>TOTLFLDS</td>
<td>54</td>
<td>-.254</td>
<td>.032*</td>
<td>.0645 (6.45%)</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (1-tailed)

**Analysis of Predictor Variables**

Non-parametric statistics were used to test for relationships between the independent variables and land use intensity. Five of the six independent variables were used in the Kruskal-Wallis H Test: annual income (ANNLINC); total labor used on valley fields (TOTLABR); amount of Irish Potato harvested from valley fields that was consumed by the household (PERIPATE); total farm size including upland and valley fields (TOTLFLDS); and valley soil quality (VALSOIL). Each variable was divided into groups of low, medium, and high scores. This was done to determine if there were differences among the groups for a particular variable and the associated land use intensity value. The division of the groups was determined by natural breaks in the data and the number of respondents in each group is not consistent among the variables. A Kruskal-Wallis H test was used. The sixth variable, upland food security (FOODLAND)
is dichotomous and could not be used in this analysis. It is discussed later in the chapter.

Table 6-4. Kruskal-Wallis H Test between the predictor variables and the land use intensity variable.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\chi^2$</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANNLINC</td>
<td>.154</td>
<td>2</td>
<td>.926</td>
</tr>
<tr>
<td>TOTLABR</td>
<td>6.640</td>
<td>2</td>
<td>.036*</td>
</tr>
<tr>
<td>PERIPATE</td>
<td>1.590</td>
<td>2</td>
<td>.452</td>
</tr>
<tr>
<td>TOTLFLD</td>
<td>2.41</td>
<td>2</td>
<td>.299</td>
</tr>
<tr>
<td>VALSOIL</td>
<td>1.27</td>
<td>2</td>
<td>.531</td>
</tr>
</tbody>
</table>

* Result is significant at the 0.05 level (2-tailed)

The individual characteristics of the households of Mugandu Valley differ as described in Chapter 5. Overall, however, the similarities based on five of the independent variables for these households are greater than their differences when it comes to the factors influencing land use intensity on their valley fields. The Kruskal-Wallis H test ($\alpha = 0.05$) indicates no significant differences between land use intensity and annual income, amount of potato harvest consumed, and valley field soil quality (Table 6-4). The result for annual income (ANNLINC) was not a surprise since the Chapter 5 explored the differences between the three levels of income (low, middle and high) and land use intensity, and found that there was only a 5% difference in the average amount of valley land cultivated. Indeed, even the Spearman's rank order test did not indicate any association between annual income and land use intensity. The results from the Kruskal-Wallis H test for the variable PERIPATE showed no significant differences found between the farmers that hold onto most of their harvested potato sacks and those that sell the most. Whether or not a farmer intends to sell most of their harvest or keep most of it has no influence on intensification. Finally, the quality of the valley soil (VALSOIL) is also not an influencing factor on land use intensity as seen in
the results of the Kruskal-Wallis H test. The results indicate that the farmers of Mugandu Valley plant their wetland fields regardless of whatever differences there are in soil quality. This finding is consistent with the results described in Chapter 5, where a comparison of soil quality scores and land use intensity found no clear relationship. Other pressures may account for the fact that soil quality does not influence intensification. The need for additional farmland, food for home use and the possibility of selling the Irish potato crop trumps the quality of the soil of individual valley fields. Farmers also perceive the valley fields as better than the upland fields, so they are more inclined to cultivate them.

The Kruskal-Wallis H test results indicated a relationship between the total amount of labor used (TOTLABR) and intensification. It showed that there is significant difference between the three groups ($\chi^2=6.641$, $p = .036$). Thus, there is a difference in land use intensity between the low, medium, and high amount of labor used. An inspection of the mean ranks of the groups suggest that the middle (medium) group had the highest land use intensity values and the high labor group have the lowest land use intensity values (Table 6-5 and Figure 6-1). Before discussing this result, additional analysis will help verify this finding.

<table>
<thead>
<tr>
<th>Variable/Group</th>
<th>N</th>
<th>Low</th>
<th>N</th>
<th>Medium</th>
<th>N</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANNLINC</td>
<td>15</td>
<td>28.73</td>
<td>30</td>
<td>27.27</td>
<td>10</td>
<td>29.10</td>
</tr>
<tr>
<td>TOTLABR</td>
<td>20</td>
<td>27.35</td>
<td>25</td>
<td>32.58</td>
<td>10</td>
<td>17.85</td>
</tr>
<tr>
<td>PERIPATE</td>
<td>18</td>
<td>24.47</td>
<td>20</td>
<td>28.75</td>
<td>17</td>
<td>30.85</td>
</tr>
<tr>
<td>TOTLFLDS</td>
<td>12</td>
<td>32.46</td>
<td>30</td>
<td>28.38</td>
<td>13</td>
<td>23.00</td>
</tr>
<tr>
<td>VALSOIL</td>
<td>21</td>
<td>29.83</td>
<td>11</td>
<td>30.23</td>
<td>23</td>
<td>25.26</td>
</tr>
</tbody>
</table>

Further analysis using a Mann-Whitney U Test was done to determine which of the three groups for TOTLABR was different from the other two groups (Table 6-6). The
results of the comparison of TOTLABR for groups 2 & 3 show that there is a statistically significant difference in land use intensity between these two groups (p < .007). No other statistically significant differences were found for the TOTLABR grouped variables. However, in comparing TOTLABR groups 1 & 2 and then groups 1 & 3, the probability value is lower when group 3 is in the analysis. In this last instance, the p-value approaches closer to .05 as seen in the comparisons of groups 1 & 3, and 2 & 3, rather than in the comparison of groups 1 & 2. Thus, there is a difference between the middle and high labor group and their respective land use intensity. In other words, the farmers who used a moderate amount of labor on their wetland fields had the highest amount of intensification, and farmers who used the highest amount of labor of their wetland fields had the lowest amount of intensification. This is also supported by results of the Spearman’s rank-order correlation coefficient where labor had a weak negative association with land use intensity.

Table 6-6. Mann-Whitney U Test on total labor used and total amount of fields owned by group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>U</th>
<th>Z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTLABR 1 &amp; 2</td>
<td>207.0</td>
<td>-1.055</td>
<td>.291</td>
</tr>
<tr>
<td>TOTLABR 1 &amp; 3</td>
<td>70.0</td>
<td>-1.353</td>
<td>.176</td>
</tr>
<tr>
<td>TOTLABR 2 &amp; 3</td>
<td>53.5</td>
<td>-2.698</td>
<td>.007*</td>
</tr>
<tr>
<td>TOTLFLD 1 &amp; 2</td>
<td>155.5</td>
<td>-.737</td>
<td>.461</td>
</tr>
<tr>
<td>TOTLFLD 1 &amp; 3</td>
<td>49.0</td>
<td>-1.615</td>
<td>.106</td>
</tr>
<tr>
<td>TOTLFLD 2 &amp; 3</td>
<td>159.0</td>
<td>-.983</td>
<td>.326</td>
</tr>
</tbody>
</table>

* Result is significant at the 0.05 level (2-tailed)

This is an interesting finding since much of the literature on agricultural intensification (e.g., Boserup 1965, Tiffen, Mortimore, and Gichuki 1994) considers labor as crucial to intensification and without it, intensification will likely not happen. Based on the results of the Mann-Whitney U Test, we find a contrast to this theory. It is not necessary to use the most labor to cultivate all of a valley field. Another interesting
aspect to this result is that the farmers who used the highest amount of labor also had the lowest amount of intensification, even lower than the group who used the least amount of labor on their valley fields (based on the mean ranks observed).

Furthermore, based on outcomes of exploring the data via income groups in Chapter 5, the richest farmers use the most labor on their valley fields, and they also plant the least amount of these fields, thus giving them the lowest value for land use intensity. The use of hired labor is common among the farmers and the hours that hired labor work is longer than what the farmers say they work in the field per day. The result of the Kruskal-Wallis H Test contradicts the trend that more labor use is associated with greater intensification.

A second analysis using a Mann-Whitney U Test was done to determine which of the three groups for TOTFLDS was different from the other two groups. The variable also had a significant correlation to the land use intensity variable discussed earlier (Table 6-2). Therefore, it was used in the Mann-Whitney U Test to determine if there is any significant difference between the three groups (Table 6-6). The results for total farm size (TOTFLDS) did not show any effect ($\chi^2=2.413$, $p=.299$) in the first analysis (Table 6-4), although there is a 9.5 point difference in the rank between the low and high groups as shown in Table 6-5. There were no statistically significant differences between the three groups for the TOTLFLDS variable. It is possible to see that the comparisons in which group 3 was used, the probability value is lower than in the analysis without group 3 as a variable. As discussed previously in Chapter 5, the farmers who own more fields in total also have the least amount of intensification of their wetland fields. This could have an influence on the probability value. The result
supports previous studies where farm size was a factor, finding that farmers with more land often plant a smaller proportion of their total fields (Ellis 1988; Pichon 1996; Shriar 1999).

The last and sixth variable, upland food sufficiency is dichotomous, with respondents answering yes or no to the question about whether or not their upland fields produced enough for them to feed their family. Thus, a Mann-Whitney U Test was used to compare food sufficiency (FOODLAND) and land use intensity. The results of the test show that there is no statistically significant difference between the two groups of food sufficiency and land use intensity of valley fields (Table 6-7). This result is not very surprising. The respondents were split 53% “yes” to 47% “no” for the answer to the question as explained in Chapter 5. The perception of food sufficiency may vary from farmer to farmer. One farmer may feel that having enough to feed his family means just that and not having much in storage or reserves, while another may feel that having enough to feed his family means always keeping a reserve amount in storage. In addition, the benefits of more food for the family and cash from the sale of Irish potato may be incentives for farmers to cultivate wetlands regardless of the productivity of their upland fields.

Table 6-7. Mann-Whitney U Test for upland food sufficiency and land use intensity

<table>
<thead>
<tr>
<th>Variable</th>
<th>U</th>
<th>Z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOODLAND</td>
<td>280.5</td>
<td>-1.699</td>
<td>.089</td>
</tr>
</tbody>
</table>

Summary of the statistical results for each of the independent variables

For this study, I hypothesized that the variation in land use intensity will result from differences found in the six independent variables as stated in Chapter 2. This section summarizes the results for each of the six independent variables. The intent is to provide
a clearer picture of the influence they have individually on intensification of the Mugandu Valley wetland fields.

From the results of the statistical tests it appears that annual income (ANNLINC) has little, if any influence on land use intensity. I predicted that household income would be negatively correlated to land use intensity, which it was albeit weakly. Furthermore, discussion in Chapter 5 revealed individual differences between farmers’ income sources and how they earned money. Although it is apparent that these farmers are not similar by examining the households, the rate at which they intensity cultivation on their valley fields cannot be explained by annual income.

The total amount of labor used to cultivate valley fields (TOTLABR) showed a weak negative correlation to land use intensity. This was further explained by the Kruskal-Wallis H test, which indicated that the amount of labor used accounts for differences in land use intensity with the highest amount of intensification being associated with moderate amount of labor while the lowest amount of intensification is associated with a high amount of labor used. Hypothesis 2, which predicted that this variable would be positively correlated with valley land use intensity, is rejected. Hypothesis 2 was based on the previous research in the literature on labor and intensification, which made a reasonable prediction.

I predicted that total farm size (TOTLFLDS) would be negatively correlated to land use intensity, which was the case as described earlier in the chapter. Beyond just being associated, further analysis via the Kruskal-Wallis H Test and the Mann-Whitney U Test did not show any additional support to the relationship between farm size and land use intensity of the wetland fields.
The fourth variable was the amount of the Irish potato harvest that was consumed (i.e., not sold) by the household (PERIPATE). I hypothesized that this would be positively correlated with land use intensity, and a weak positive relationship was found. However, little was revealed about this variable and its influence on intensification in the statistical analyses.

The valley soil quality variable (VALSOIL) did not correlate significantly with the other independent variables. In the Spearman’s correlation test it was negatively correlated to intensification, although weakly. No other relationship to intensification appeared in the Kruskal-Wallis analysis. I expected that it would be positively correlated to valley land use based on my knowledge of wetland soils for agriculture. Wetland soils are highly sought after for cultivation and I assumed that the farmers would try to optimize the use of them. However, the task of clearing the wetland and preparing the soil for cultivation is very difficult, and I underestimated the impact of this factor.

The last variable concerns upland food production, named upland food security (FOODLAND) for this study. As the only dichotomous variable it could not be run through the correlation test with the other independent variable or through correlation with the dependent variable, land use intensity. I hypothesized that this variable would be negatively associated with intensification. The results of the Mann-Whitney U Test show that upland food production has no statistically significant influence on land use intensity. Despite what farmers believe about food production on their upland fields, it does not influence how much of their valley fields they plant.
Conclusions

This chapter presented the results of the statistical analysis testing Objective 5 of this study. Most of the analysis did not bring to light significant findings as to which of the independent variables best predicted land use intensity. Many of the results were supported previously found trends during the exploration of the data in Chapter 5.

Only one variable, total labor (TOTLABR), stood out strongly when tested using the Kruskal-Wallis H Test. The variable also had moderate correlations with three other predictor variables (annual income, consumption of potato harvest, and total number of fields owned), none of which came out as significant in influencing intensification. I feel one of the most important factors here is the relationships found between the predictor variables. As the correlations indicate, several of the independent variables influence each other. The result of this is that they may suppress each other so that no clear results stand out. Chapter 7 discusses the implications and conclusions of this study.
Figure 6-1. Land use intensity values for the predictor variable groups.
CHAPTER 7
CONCLUSIONS AND IMPLICATIONS

This study examined how and why smallholder farmers use converted wetlands for farming and attempted to identify which biophysical and socio-economic variables influence the intensity of land use on the wetland. The model used to examine land use intensity considered factors at the household and field scale and examined how these interact to influence the need to intensify farming in their wetland fields. This chapter presents the conclusions and implications of the study, followed by the application implications and finally recommendations for further research.

Most of the farmers in the Mugandu Valley rely on the wetland for income and subsistence as described in Chapter 5. The area has maintained a high population density for several decades. The initial clearing and draining of the wetland began several decades ago, a response to the population pressure creating a pattern of extensification and subsequent intensification as first described by Boserup (1965). This process created much needed additional farmland. At the time of this research, the population pressure and fragmentation of upland fields had put more pressure on the use of the wetland valley for its raw materials and for continued clearing and drainage of additional wetland area for crop production.

The households interviewed for this study are very similar in characteristics to the peasant households described the literature (e.g., Netting 1993; Angelson 1999; Collinson 2000; Gray 2005). They are subsistence farmers with low education levels and limited socio-economic and environmental resources. The households vary to some extent in resource endowments and economic constraints. Farmers grow agricultural products for home consumption and for income generation. They allocate
their resources so that they can make the most out of their circumstances (Shultz 1964). For example, a farmer who has cash available may choose to rent additional farm land in the valley and then sell the harvest to earn more income. Another farmer may need to decide how much of a potato harvest to keep and how much to sell based on the needs of his family at the time or in the near future. Most farmers use their wetland fields to supplement harvests from their upland fields and to earn income, mainly from the sale of Irish potatoes, which grow better on wetland fields than the upland fields. They also rely on the unconverted wetland for raw materials for handicrafts.

The first objective of this study was to examine the history of how and why smallholders started using wetlands for agriculture (Chapter 4). The review showed that the changes in how wetlands were used, from just a source for raw materials to fields for crop production, were influenced by the need for additional farmland to meet the food needs of an increasing population. First initiated by the local farmers, and then mandated by the British colonial authorities, the use of the edges of wetlands for farming and then complete wetland conversion was a response to increasing land scarcity in the area. This finding is consistent with Boserup’s theory (1965) that population density and land scarcity will stimulate change and agricultural innovation. The desire for more food for the household especially in years when yields from upland fields were small, and the demand for potatoes in the city markets, were reasons for continued cultivation in the wetland. This supports Turner and Brush’s (1987) view that agricultural change and intensification are influenced by consumption and commodity demands.
The second objective for this study was to examine physical process of wetland conversion. The steps in the annual process of preparing and cultivating a field in a wetland valley were described in Chapter 4. An interesting finding about this process is important. The annual method of conversion of wetland into fields is uniform for all farmers; fields are prepared for planting in only one way. Field preparation is very labor intensive since the farmers will move about three times as much soil by weight as they would for upland field preparation because of the amount of moisture present in the wetland soils (van de Giesen 1994). For some farmers, particularly those with fields in the newly converted and much wetter section of the wetland, the labor requirement could be a constraint to intensification. However, based on the high land use intensity amounts seen in this study (between 80% to 100% of the total area of wetland fields cultivated) this is an unlikely conclusion, supporting what Netting (1993) found, that farmers are able to pursue intensification by finding ways to adjust to present conditions.

The third objective of this study was to explore variation in wetland use by different income groups. Consistent with the findings of various authors (Shultz 1964; Sahlins 1972; Scott 1976; Saith 1992; Ellis 1998), economic resources influence variation in farm management, ownership of property, and use of wetland fields. Farmers with more cash available tend to use their wetland fields differently than households with lower annual income. Research on smallholder farmers indicates that cash is often a limiting factor (Hildebrand 1986). The availability of cash accounts for many differences in how farmers use their fields.

The findings in this study suggest that wealthier farmers manage their farms, including the wetland fields differently than farmers of middle and low income. For
example, farmers in the highest income group own the most wetland fields. They also rent additional wetland fields for Irish potato farming, thus increasing the total area that they can plant. Having sufficient cash means they can hire labor to work on valley fields, allowing them to intensify cultivation. As a result they harvest the largest amount of potatoes and have the highest total earnings from their potatoes. They intensify agricultural production to increase the available surplus to sell for cash. These activities are consistent with research on agricultural intensification by Goldman (1993) and support the induced-innovation model by Pingali, Bigot, and Binswanger (1987).

Examining the level of intensity of farming on wetland fields was the fourth objective of this study and was explored in Chapter 5. Land use intensity was examined for each of the income groups, and on average, it was similar for each group. However, differences in intensification were found by examining median values for land use intensity. The findings suggest that low income farmers are more reliant on their valley fields for food and income than are middle or higher income groups. Non-agricultural income is not common among poor farmers, making their fields more important for food security and for any cash earned through the sale of surplus crop production. They also sell the smallest amounts of Irish potato for cash. This group of farmers avoids risk and gives higher priority to ensuring enough food for the family than to making profits, which supports Scott’s (1976) view that smallholders prefer to minimize risks that threaten food security rather than to maximize average return from inputs and labor.

The fifth, and final objective of this study was to determine the bio-physical and household-level socio-economic variables that have the strongest influence on the intensity of agriculture in wetland fields. I hypothesized in Chapter 2 that land use
intensity in the valley will depend on household income, access to labor, the food
sufficiency from upland fields, farm size, the amount of valley crops consumed, and the
soil quality of the valley fields. The statistical analyses undertaken in the study revealed
that access to labor had any influence on intensification. In this section I will discuss
what the study results suggest about the importance of the six variables related to
intensification.

**Income**

The study shows that higher annual income does not stimulate intensification. Wealthier farmers are not cultivating all of their wetland fields. In contrast, poorer households have the highest percentage of intensification. The selling of Irish potato crops is an important source of cash for poorer households. On average they earn nearly about one-third of their annual income from the sale of Irish potatoes.

**Labor**

The study found that abundant labor is available in Mugandu valley to help with cultivation of wetland fields and many of the farmers take advantage of this. Poorer households tend to use help from their extended families on their fields, while use of hired labor increases with the cash resources available to a household. Farmers without the means to hire labor may state that they experience a shortage of labor during peak periods. Contrary to Boserupian theory the results from the statistical analyses revealed that using the highest amount of labor does not lead to the highest amount of intensification as measured by the value for land use intensity used in this study.

Seasonality of the farming systems in Mugandu valley influences labor and cash availability. The demand for labor is greatest in late May and early June as valley field
preparation begins. This is the period when most households have little cash on hand because it is the time between the first harvest of crops from upland fields in January and the second harvest in July, typically times when surplus crops are sold. It is also a period of low food stores in the household, meaning farmers do not have spare provisions to sell for cash to pay hired labor. Furthermore, less hired labor is available and the price of the hired labor is higher than other times of the year. Consistent with the findings of other authors (Chambers 1982; Agarwal 1990; Ellis 1998), seasonality is an explanation for the incongruity between income flows and labor availability in Mugandu.

**Upland Food Production**

The results of this study indicate that the quantity of crops harvested from upland fields does not influence the amount of intensification on the valley fields contrary to findings by Wood et al. (2002) in Ethiopia and Mohamed’s study of the Saiwa wetlands in Kenya (2002). The data for this variable came from a yes/no question asking respondents if they felt their upland fields produced enough to feed their family. Whether or not farmers felt their upland field produced enough, the study findings indicate that farmers planted 80% or more of their valley fields. The series of questions for this variable yielded conflicting answers to the topic of upland food production. In addition to upland food production to feed the family, farmers were asked if their upland fields produce enough to keep as seed and for sale. The responses to this question conflicted with the response to the first question about food sufficiency. Many farmers felt their upland fields do not produce enough to feed their family but do produce enough to keep some as seed or even to sell a surplus. Purchasing seed can be expensive, especially if bought at planting time when the demand for seed is the
highest. Therefore they may be emphasizing the importance of having seed to plant than having enough to feed their families on a regular basis. Farmers are likely purchasing food if they felt their upland fields do not produce enough to feed their family. They also may be keeping some in reserve to sell for emergency expenses.

**Farm Size**

Results of the study indicate that the total number of fields owned by a household varies from just a few to many, and the more fields owned by a farmer, the less intensively he or she will cultivate their valley fields. This finding is consistent with the work of various authors (Ellis 1988; Netting 1993; Pichon 1996) in the sense that the more land a farmer has, the less of it is planted. It also suggests that farmers view their upland fields as their principal fields. There are three possible reasons for this. First, farmers hold land titles for upland fields unlike the wetland fields where the title is held by the farmer cooperatives as explained in Chapter 4. However, farmers note that valley fields are particularly important if a family has a small number of upland fields. Second, upland fields remain important to smallholder households because of the possibility of producing up to three crops per year on one field and because the location of each field varies on the hill slopes allowing several different types of crops to be cultivated. Finally, by having more land available to cultivate, a farmer has the potential to grow more food and earn more income by selling surplus harvest. In addition, surplus land can also be rented out thus bringing additional income to the household, or it can be fallowed allowing the soil to rest.

**Consumption of Valley Crops**

The statistical analysis revealed that the more reliant farmers are on the harvests from their valley fields to provide food for the household, the more intensively these
fields are cultivated. The finding is consistent with the research on how smallholder farmers prioritize the planting of key subsistence crops (e.g., Scott 1976; Hildebrand 1986; Collinson 2000). The result is closely tied to income level and to the number of fields in the wetland owned by the household. Nearly every farmer sold some of their potato harvest, with the lowest income farmers selling the least and the middle income farmers selling on average slightly more sacks than the richest farmers.

Soil Quality

The study found little difference in soil quality by field location within Mugandu valley, which is related to the length of time since the wetland was converted. Fields that were converted the earliest, specifically those located in Kihira-Buramba Cooperative’s land, have higher average soil quality scores. The statistical analyses also indicates that there is no clear relationship between the level of intensification and soil quality. As such, land use intensity scores are not dependant on soil quality. Farmers understand the value of valley fields and know that the overall quality of wetland soil for cultivation is better than the soil quality on upland fields. If they can farm their wetland fields, they will. This is particularly so because of the importance of Irish potato as cash crop.

Application Implications

It is likely that intensification will continue in Mugandu valley, particularly since the Mugandu-Buramba cooperative society holds the lease for the land for many years to come and some of sections of the wetland that it controls have yet to be allocated. In addition, most of the farmers interviewed are married couples with children, and the majority are of childbearing age. The average number of children in the household for the respondents is 4.1 and the average growth rate for western Uganda is 2.9% (UBOS
(2002), which means the population of the area will approximately double in about 24 years. Along with this, the demand for farmland will increase. The findings of this study indicate that production from wetland fields is an important source of food and income to the smallholder farmers that have them.

The results of this study reveal that the wetland in its natural state provides raw materials for the local population. The far northern end of Mugandu valley is floating papyrus swamp that cannot be drained without the aid of machinery and construction of dikes. The section also cannot be converted due the ban on wetland drainage policy instituted nationwide in 1995. The section is communal land and its continued preservation is important because all households in the valley have access to the raw materials. Use of these materials preserves traditional handicraft skills and helps bring in cash to the households from the sale of these products.

The Kihira-Buramba and Mugandu-Buramba cooperative farmers societies could make changes that would help their members and hopefully increase profits from crop sales. First, due to the high demand of wetland fields for the first planting season, the number of beds that one farmer can rent should also be capped to allow more farmers access to the wetlands. Second, developing a plan for planting and harvesting of fields based on location within the wetland may reduce the risk of crop damage due to flooding. The farmers know which sections of the wetland tend to flood and when. This would also stagger the availability of potatoes at harvest time so that the market is not overwhelmed, theoretically it could result in higher prices received per sack.
Other Considerations and Implications

It is likely that intensification will continue in Mugandu valley, particularly since the Mugandu-Buramba cooperative society holds the lease for the land for many years to come and some of sections of the wetland that it controls have yet to be allocated. In addition, most of the farmers interviewed are married couples with children, and the majority are of childbearing age. The average number of children in the household for the respondents is 4.1 and the average growth rate for western Uganda is 2.9% (UBOS 2002), which means the population of the area will approximately double in about 24 years. Thus, the demand for farmland will increase. The findings of this study indicate that production from wetland fields is an important source of food and income to the smallholder farmers that have them.

The Mugandu wetland in its natural state provides raw materials for the local population. The far northern end of the wetland is floating papyrus swamp that cannot be drained without the aid of machinery and construction of dikes. It also cannot be converted due the ban on wetland drainage policy instituted nationwide in 1995. This section is communal land and its continued preservation is important because it only remaining unconverted wetland in the valley. All households in the valley have access to it for harvesting of raw materials. The use of these materials preserves traditional handicraft skills, which helps bring in cash to the households from the sale of products.

The Kihira-Buramba and Mugandu-Buramba cooperative farmers societies could make changes that would help their members and hopefully increase profits from crop sales. First, due to the high demand of wetland fields for the first planting season, the number of beds that one farmer can rent should also be capped to allow more farmers
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This study reveals that the farmers of Mugandu valley are living just above the subsistence level. This is despite having fields on the uplands and in the wetland, where they produce a market-oriented crop. The amount of food harvested is not always sufficient to feed their families throughout the year. In addition, wages for daily labor are less than a dollar a day for over 7 hours of physical work. This wage is too low to maintain a living at subsistence level and certainly not a productive way to earn income.

There are other factors that contribute to the low level of subsistence in Mugandu valley. The location of Mugandu valley is far from the towns and the cities where the potatoes are purchased. Farmers negotiate the price of potatoes with the truck drivers who arrive in the valley near harvest time. They do not know if they are receiving a fair price for their harvest due to the lack of information on the current market prices. By knowing the market value for potatoes, farmers may be able to negotiate better prices.

Another issue that comes out of this research is the tradeoffs between continuing to convert the wetland for agricultural use and the use of the remaining unconverted wetland for raw materials. The unconverted section provides many economic, social and environmental benefits to the local population. In addition to using papyrus and wetland grasses for home use or for sale, having an intact wetland provides ecological
services (e.g., flood control, increased biodiversity). A disadvantage to the use of unconverted wetland as an income source is that less money is earned from sale of the materials, including “value added” items, such as mats and baskets than from the sale of crops.

The converted section of the wetland provides economic advantages for the smallholders. Cultivation of potatoes increases income and provides food. However, it is important to remember that not all farmers have access to wetland fields unless they are able to find fields to rent. On the other hand, the environmental impacts can be great given that once a wetland is converted the raw materials are likely gone forever.

To help the farmers of Mugandu valley in the long-term, a broader more integrated development agenda is needed. To achieve improvements in the management of the wetland and to help the farmers increase their income and provide greater food security, the following is suggested:

- Women’s handicraft groups. Specifically, this would be the formation of groups to make and market mats, baskets and other wetland grass products to sell in Kabale town and neighboring parishes. A thorough management plan for the sustainable harvesting of wetland materials (e.g., a harvest rotation pattern similar to that used in forest management) accompanied by a market plan could help improve income levels.

- Mugandu wetland management plan. Wetlands are considered public property in Uganda. Greater oversight on the use and maintenance of the wetland by Mugandu and Buramba parishes would help ensure that the entire wetland has a single comprehensive management plan, and not several different ones for each group of
farmers. The plan should be developed in consultation with district level environment managers.

- Greater role for the farmer cooperatives. The officers leading the Kihira-Buramba and the Mugandu-Buramba cooperatives could help their members with the sale of potato harvest. By working together as a group, price per sack and harvest dates could be coordinated with buyers. This would assure the traders that they are receiving potatoes harvested at their peak and it would provide the farmers with the best prices.

- Technical assistance and agricultural programs. Access to agricultural information via extension agents would help farmers manage problems such as pests on potato crops. Along with this, agricultural education programs would help farmers better manage their fields and provide them with information on potato seed varieties as well as information on other crops that may be successfully cultivated in wetland fields.

- Micro-credit programs. Small loans with low interest rate and reasonable repayment terms could help create cottage industries for use of the wetland raw materials, for purchase of better seed potatoes, or even to increase crop diversification. The market in Kabale relies on agricultural products brought in from as far away as Kampala. Access to credit would allow farmers to try to produce a wider variety of crops than currently grown or to improve production of potatoes.

Research Recommendations

The two farmer cooperatives are a good example of an indigenous institution created to manage a natural resource. The farmer cooperatives were set up to guarantee access to the wetland for the local residents, especially for agricultural use.
They now manage the wetlands by ensuring that the fields are cultivated during the potato season, that the canals were maintained, and that members came to the work days. While this has worked thus far, their role could be strengthened. The cooperatives are a form of social capital, and are in a unique position to be able to help their members. I suggest research on the details of how the cooperatives work, asking thorough questions about membership rules and regulations, budgets (e.g., How are the fines collected from the members used?), field rentals coordinated by the cooperative, etc. In addition, comparative research on farmers who belong to a cooperative and those who do not, would elicit valuable information as to whether or not membership in a cooperative has its benefits.

A second recommendation is to research the viability of continued cultivation in Mugandu valley. The cooperatives hold long-term leases for use of the wetland. What will happen when the leases held by the cooperatives end? This study shows that the wetland is important for the local population. Investigating these questions would provide a bigger picture of just how important the wetland is, how it is currently managed, and how it can be managed sustainability so that it can be used by future generations.
Appendix A
Interview Questionnaire

Wetland land use and household information interview Questionnaire

Date: ______
Respondent code number: ________ Which HH member? ________
Village _______________ HH# ________

Section I. Valley fields information
Are you a member of Kihira-Buramba or Mugandu-Buremba society? Y N (circle which society)
If not, why not? _____________
(probe) and then go on to*

If Y, how long have you been a member? (years) ________
Is anyone else in your household a member? Y N Who? ________________
How many plots do you have? _____
How many parcels in each plot? Plot 1: _____ Plot 2: _____ Plot 3: _____ Plot 4: _____

*Is the same amount of land that you had when you first joined the society? Y N
If it is more land, when did you purchase addition land? __
   How much did you purchase at this time? __
If it is less land, when did you sell valley land? __________
   How much did you purchase at this time? __

Do you go to the society workdays yourself? Y N
Does someone go in your place? Y N
Who is this person? ________________
If N, did you pay the fee instead of going? Y N

Do you rent additional land in the valley? Y N
   Which season do you rent land? ________
   When did you last rent valley land? ________
   How many parcels did you rent last time? ________
   How much was the rent per parcel? ________
   Who did you rent from? ________________
   How long was the rental period? __________
Do you rent out any of your valley land?  Y  N
  When do you rent out land? _______
  How many parcels did you rent out last time? _______________
  How much was the rent per parcel? ___________

Specific land use and cropping information about the wetland valley fields:

<table>
<thead>
<tr>
<th>Field # Rented?</th>
<th>Dist. by foot (in min)</th>
<th>Cropping pattern for a seasonal year</th>
<th>How many parcels are planted each season?</th>
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<table>
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<tr>
<th>Field # Rented?</th>
<th>How much is sold as a cash crop - get # of sacks harvest, # sold, and price</th>
<th>Home use</th>
<th>Seed</th>
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Have you always planted all of your parcels since you have owned your valley plots?  Y  N
  When was the last time you did not plant the entire plot? _______
  How many parcels did you plant at that time? ___________
  Why did you not plant the entire plot?
Do you normally plant these crops in your valley fields? Y N (eg, cabbage, maize, beans)
When do you plant something different? ___________ (eg, yearly rotation)
   How often do you plant this crop? _______
   Do you sell this crop? Y N

Do you buy seed for planting in your valley fields? Y N
Do you buy seed every year? Y N
When did you last buy seed? ___________
What seeds do you buy? ___________
From whom do you buy them? ___________
How much do you pay for the seed? ___________

Problems with valley fields
Have your valley fields ever flooded? Y N
When was this? (month & year) ___________
How many times have they been flooded in the last 10 years or since ownership? _______
What caused the fields to flood? -- Unusually heavy rain - hail storm - normal rain - other
Did it damage the crop? Y N
Did you lose the crop? Y N
   Which crop(s) did you lose? ___________

Are you having any problems with your valley fields? Y N
   If yes, please describe this problem:

   How long has this problem occurred? (probe for seasonality)

Section VII. Demographic information
Are you married? Y N        Number of wives? _______
Have you ever been married? Y N        Widowed? Y N
Are you the head of HH? Y N        If not, then who is the head of the household? _______
How many years of education do you have? _______        Age: _______
How many years of education does your spouse have? _______        Age: _______

Number of children:        Grade level of children in school:
Ages:        Sex:
Other HH members:        Sex:        Age:
   Relationship:        Sex:        Age:
Section IV. Labor
Do you have enough labor in your household to cultivate your fields? Y N
When do you have a shortage of labor? (months) ________________
When does this affect cultivation in the valley fields? ________________
Which months are the peak periods of labor demand for cultivation in your valley fields? ________

Labor data for last growing season for each valley field (from 5/1999 to current season):

<table>
<thead>
<tr>
<th>Field #:</th>
<th># parcels</th>
<th>Total number of people working</th>
<th>Number of family members</th>
<th>Number of hired or other laborers</th>
<th>No. of days to complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting veget’n</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preparing land</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weeding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvesting</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

What is the length of the workday for this crop?
Are these hours the same for all crops? Y N
Are the laborers used in the above information hired laborers? Y N
Who do you hire? ________________________
Who pays for the labor? ________________________
How much do you pay per day for laborers? ________________
Do you hire labor for contract work in your valley fields? ________________
Is exchange labor used? Y N If yes, for which tasks? ________________

Section III. Land and crops
How many total fields do you have, including those in fallow? ________________
What is the location of these fields? Distance to fields (min):
Footslope - ________
Midslope - ________
Hilltop - ________

Does this include fields that you use for only yourself? Y N
How many of the above fields do you use yourself? ________
How many fields are currently under fallow? ________

How many woodlots do you have? ______
If none, then where do you do get wood for cooking?

How long have you had your land? (years) ______
Did you have this amount of land from the start?  Y  N
Have you acquired additional parcels over time?  Y  N
    If Y, when did acquire these parcels? ______
    How many parcels did you acquire at this time? ______

Do you rent additional upland fields?  Y  N
    Which season do you rent land? ________
    When did you last rent upland fields? ______
    How many plots did you rent last time? ________
    How much was the rent per plot? ________
    Who did you rent from? _________________
    How long was the rental period? ________

What crops do you plant?
Are you having any problems with your upland fields?  Y  N
If yes, please describe the problem:

How long has this problem occurred?

Since 1995, have your upland fields produce enough food for you and your family to eat?  Y  N
Did this problem start before 1995?  Y  N
When did this problem first start? ______
Which fields are most affected by this problem? ________________________________

Since 1995, have your upland fields yield enough for you to keep as seed?  Y  N
Did this problem start before 1995?  Y  N
When did this problem first start? ______
Which fields are most affected by this problem? ________________________________

Since 1995, have your upland fields yield enough for you to sell?  Y  N
Did this problem start before 1995?  Y  N
When did this problem first start? ______
Which fields are most affected by this problem? ________________________________
How have the yields been on your upland fields over the past 5 years, since 1995? Circle one: little; enough to feed family; surplus for seed; surplus to sell; surplus to sell and for seed

Do have enough cash to plant your fields every season?  Y   N

What do you do when you don’t have enough cash to plant? (e.g., plant less, not plant, rent out land)

Do you ever not plant because you don’t have enough money?  Y   N

**Hill Crop Use**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Last harvest date</th>
<th>Home use</th>
<th>Sold?</th>
<th>Amount of cash received</th>
<th>Stored as seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweet potato</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irish potato</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peas</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cabbage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tobacco</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Do you sell crops at the local market?  Y   N

How long does it take you to get to this market? _________

Do you walk?  Y   N

If yes, do you go by road or footpath?

If no, do you go with transport?  Y   N

**Section V. Use of wetland raw material**

Do you use any raw materials (reeds, papyrus) from the wetland?  Y   N

<table>
<thead>
<tr>
<th>Material</th>
<th>Use and frequency (in home)</th>
<th># produced in last 12 m</th>
<th>Amount of material used</th>
<th># people used to collect material</th>
<th># products sold</th>
<th>Ush earned from product or sale of raw material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Papyrus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mudfish</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Other</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Section VI. Cash and income
Do you (or someone in your household) work in a group on others' farms for pay? Y  N
If yes, how often do you do this (per week)? ______
During which months? ________________
How many members in your group? ____

Do you work individually (or someone in your household) on others farms for pay? Y  N
If yes, how often do you do that? (per week)
During which months? ________________

Does anyone in your household work in a non-farming activity (carpentry, brick making, thatching, brewing beer, salary position, etc)? Y  N
Who is this? ________________
What do they do? __________________
Do they contribute the money they earn to the household? Y  N

What do you spend your money on?

What does your spouse spend her/his money on?

Where does your money come from? (crop sales, work off-farm, non-agricultural products)

How much money (in Ugandan shillings) do you make annually? __________

Breakdown of income sources and amounts:

<table>
<thead>
<tr>
<th>Source</th>
<th>Frequency</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-agr products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-farm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-farm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sell animals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remittances</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local share</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renting out land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other source:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B
SOIL TESTING FIELD SHEET

Soil testing field sheet

Sample number:

Respondent code number: __________ Village: __________

Field location: __________

Slope (estimate):

Erosion amount:

Rockiness:

Drainage:

Field History – length of ownership, cropping pattern, and conversion date.

Soil Profile:

<table>
<thead>
<tr>
<th>Profile depth</th>
<th>Structure (type, grain size, strength &amp; grade)</th>
<th>Color</th>
<th>Mottle present?</th>
<th>Clay bands present?</th>
<th>Amount of plant roots</th>
</tr>
</thead>
<tbody>
<tr>
<td>0” – 4”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4” – 8”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8” – 12”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Effective Depth (inches):

Texture (first 6 inches):

Bulk density sample – full tube or less? Circle. Weight: ____________ grams

Infiltration rate:

<table>
<thead>
<tr>
<th>Start time</th>
<th>End time</th>
<th>Time - min</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

pH: ____________ Amount of water stable aggregates

A ____________ B ____________

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APPENDIX C
FREQUENCY DISTRIBUTION FOR INCOME GROUPS

The income groups were determined by sorting and graphing the annual income of the households surveyed. The range of annual income for was 12,500 to 2,765,000 USH.
Frequency distribution of respondents’ income using 15,000 USH increments.

<table>
<thead>
<tr>
<th>Bin</th>
<th>Frequency</th>
<th>Minimum</th>
<th>Maximum</th>
<th>More</th>
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<tbody>
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<td>15000</td>
<td>152500</td>
<td>6</td>
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<tr>
<td>30000</td>
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<td>30000</td>
<td>305000</td>
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</tr>
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<td>213000</td>
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<tr>
<td>510000</td>
<td>0</td>
<td>510000</td>
<td>513500</td>
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</tr>
</tbody>
</table>

Maximum amount for low income: 630000

Maximum amount for middle income: 665000

More: 6
LIST OF REFERENCES


BIOGRAPHICAL SKETCH

Janet Puhalla was born and raised in Ohio. She started her bachelor’s degree at Youngstown State University and then completed her bachelor’s degree at Ohio State University. She then joined the Peace Corps and worked in Burundi as a fisheries extension agent for two-and-a-half years. Following this, she worked for two years in international development in Washington, DC. Starting in 1994, Janet enrolled in a master’s program in Farming Systems Research and Extension at the University of Florida. She received her M.Sc. in 1996. Through the University of Florida’s Center for African Studies, she received a Foreign Language and Area Studies fellowship sponsored by the Fulbright Program to study Swahili, which supported three years of her graduate study. Janet received a David L. Boren Fellowship (through the National Security Education Program) to conduct research for this dissertation. During completion of her Ph.D., Janet worked at Rollins College and at Missouri State University. She received her Ph.D. from the University of Florida in the fall of 2009.