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DECISION MAKING ROLES IN THE RURAL HOUSEHOLD AND THE ADOPTION AND DIFFUSION OF AN IMPROVED MAIZE VARIETY IN NORTHERN SHABA PROVINCE, ZAIRE

Iowa State University

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Decision making roles in the rural household and the adoption and diffusion of an improved maize variety in northern Shaba Province, Zaire

by

Terry Lee Hardt

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of DOCTOR OF PHILOSOPHY

Major: Agricultural Education

Approved: 

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

For the Major Department

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For the Graduate College

Iowa State University
Ames, Iowa

1981

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### TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRODUCTION</strong></td>
<td></td>
</tr>
<tr>
<td>Background of the Problem</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>2</td>
</tr>
<tr>
<td>Purposes and Objectives of the Study</td>
<td>2</td>
</tr>
<tr>
<td>Origin of the Study</td>
<td>3</td>
</tr>
<tr>
<td>Description of the Research Site</td>
<td>4</td>
</tr>
<tr>
<td>Administrative and political structure</td>
<td>4</td>
</tr>
<tr>
<td>History</td>
<td>5</td>
</tr>
<tr>
<td>Physical environment</td>
<td>6</td>
</tr>
<tr>
<td>Cropping systems</td>
<td>7</td>
</tr>
<tr>
<td>Population and Sample</td>
<td>7</td>
</tr>
<tr>
<td>Procedure for Data Collection</td>
<td>8</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>8</td>
</tr>
<tr>
<td>Procedure for Data Transformation and Analysis</td>
<td>9</td>
</tr>
<tr>
<td>Explanation of Dissertation Format</td>
<td>10</td>
</tr>
<tr>
<td><strong>ZAIRE: HISTORICAL PERSPECTIVES ON CURRENT CONDITIONS</strong></td>
<td></td>
</tr>
<tr>
<td>The Congo is &quot;Discovered&quot;</td>
<td>12</td>
</tr>
<tr>
<td>The Congo Free State</td>
<td>14</td>
</tr>
<tr>
<td>The Belgian Congo</td>
<td>15</td>
</tr>
<tr>
<td>Colonial agricultural policy</td>
<td>16</td>
</tr>
<tr>
<td>Transition Period</td>
<td>20</td>
</tr>
<tr>
<td>Independence</td>
<td>22</td>
</tr>
<tr>
<td>Zaire Today</td>
<td>23</td>
</tr>
<tr>
<td>Topic</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Population growth and health services</td>
<td>28</td>
</tr>
<tr>
<td>Education sector</td>
<td>29</td>
</tr>
<tr>
<td>Agricultural sector</td>
<td>30</td>
</tr>
<tr>
<td><strong>SECTION I. SUBSISTENCE AGRICULTURE IN NORTHERN SHABA PROVINCE, ZAIRE: A CASE STUDY</strong></td>
<td>35</td>
</tr>
<tr>
<td>Subsistence Agriculture</td>
<td>35</td>
</tr>
<tr>
<td>Slash and Burn</td>
<td>39</td>
</tr>
<tr>
<td>Agricultural Cycle</td>
<td>41</td>
</tr>
<tr>
<td>Production Practices</td>
<td>43</td>
</tr>
<tr>
<td>Agricultural Labor</td>
<td>46</td>
</tr>
<tr>
<td>Constraints to Increased Agricultural Production</td>
<td>50</td>
</tr>
<tr>
<td>Conclusion</td>
<td>54</td>
</tr>
<tr>
<td>Bibliography</td>
<td>56</td>
</tr>
<tr>
<td><strong>SECTION II. DECISION MAKING ROLES WITHIN THE AFRICAN HOUSEHOLD</strong></td>
<td>58</td>
</tr>
<tr>
<td>Introduction</td>
<td>58</td>
</tr>
<tr>
<td>Purpose of the Study</td>
<td>60</td>
</tr>
<tr>
<td>Methodology</td>
<td>61</td>
</tr>
<tr>
<td>Results and Discussion</td>
<td>62</td>
</tr>
<tr>
<td>Conclusions and Implications</td>
<td>68</td>
</tr>
<tr>
<td>Bibliography</td>
<td>70</td>
</tr>
<tr>
<td><strong>SECTION III. ADOPTION AND DIFFUSION OF AN IMPROVED MAIZE VARIETY IN NORTHERN SHABA PROVINCE, ZAIRE</strong></td>
<td>72</td>
</tr>
<tr>
<td>Introduction</td>
<td>72</td>
</tr>
<tr>
<td>Maize in Zaire</td>
<td>72</td>
</tr>
<tr>
<td>Governmental programs</td>
<td>73</td>
</tr>
<tr>
<td>Project North Shaba</td>
<td>74</td>
</tr>
<tr>
<td>Topic</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Purpose of Research</td>
<td>75</td>
</tr>
<tr>
<td>Methodology</td>
<td>75</td>
</tr>
<tr>
<td>The Adoption Pattern</td>
<td>76</td>
</tr>
<tr>
<td>Discriminant Analysis</td>
<td>78</td>
</tr>
<tr>
<td>Conclusions</td>
<td>83</td>
</tr>
<tr>
<td>Bibliography</td>
<td>87</td>
</tr>
<tr>
<td>SUMMARY AND CONCLUSIONS</td>
<td>88</td>
</tr>
<tr>
<td>Implications of the Research</td>
<td>92</td>
</tr>
<tr>
<td>Recommendations for Further Research</td>
<td>96</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>98</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>104</td>
</tr>
<tr>
<td>APPENDIX A. HOUSEHOLD COMPOSITION AND DEMOGRAPHICS</td>
<td>105</td>
</tr>
<tr>
<td>APPENDIX B. DESCRIPTION OF DISCRIMINANT ANALYSIS</td>
<td>108</td>
</tr>
<tr>
<td>APPENDIX C. DISCRIMINANT ANALYSIS CLASSIFICATION EQUATION APPLIED</td>
<td>111</td>
</tr>
<tr>
<td>APPENDIX D. QUESTIONNAIRE</td>
<td>113</td>
</tr>
</tbody>
</table>
LIST OF TABLES

SECTION I.

Table 1. Consumption chart of a shifting cultivator's family in Kongoy, Zaire 38
Table 2. Annual agricultural calendar 42
Table 3. Farming system: 14-year cycle 43
Table 4. Division of agricultural labor 47
Table 5. Division of labor: household breakdown 49
Table 6. Major agricultural constraints ranked 52

SECTION II.

Table 1. Response to decision making questions by household member categories 63
Table 2. Comparison of responses to questions about agricultural decisions of heads of household with responses of other family members 66
Table 3. Comparison of responses to decision making roles of male heads of household with responses of female heads of household 67

SECTION III.

Table 1. Description and means for selected variables used in discriminant analysis 79
Table 2. Correlation matrix for variables used in discriminant analysis 80
Table 3. Statistics for discriminant function derived for adoption groups 81
Table 4. Classification results of discriminant analysis of adopters 82
Table 5. Standardized discriminant function coefficients 83
LIST OF FIGURES

Figure 1. Map of Africa showing the location of Zaire .......................... 25

Figure 2. Map of Zaire showing agriculture and mineral production and transportation systems ............... 31
INTRODUCTION

Background of the Problem

The economic development of Africa is a major challenge in the modern world (Kamarck, 1976a; Moussa, 1971; Poland, 1980). Food shortages, basic commodity scarcities, and lack of services are common. This has not always been the case. Africa once led the world in the development of technology. African commodities were the basis for extensive trade routes.

Dr. L. S. B. Leakey's research in East Africa has provided evidence that Africa was the birthplace of man. Not only did man originate in Africa, but for some "600,000 years afterward, Africa was the spearhead of man's progress" (Kamarck, 1971, p. 3). It was an African that first made cutting tools from stone and thereby opened new avenues of food sources and began a process that led to the machine-based economy of today. This technological advantage was short lived.

Isolated by deserts in the north and east, sub-Saharan Africa lagged behind the rest of the world in material development. This physical isolation is "largely responsible for Africa's poverty today" (Kamarck, 1971, p. 4).

Economic development in sub-Saharan Africa was limited not only by isolation but also by the fact that the highly weathered soils made settled agriculture impossible in most of the areas. Over the centuries, systems of shifting or semi-nomadic cultivation evolved, adequately supporting small, dispersed, rural populations. Few urban centers emerged.
Today, Africa remains predominantly an agricultural society. Ninety percent of the population live on farms, and almost two-thirds of the exports from Africa are agricultural products (Lele, 1976). Because of the magnitude of the rural population, "the key factor for economic development in most of Africa is still, therefore, agriculture" (Kamarck, 1971, p. 126).

Statement of the Problem

Technological change in agriculture, resulting in increased productivity, is viewed as a principal vehicle for rural development. On the national level, it is seen as a means of increasing food supplies for urban populations and as a means of generating foreign exchange earnings from the export of crops to ease the critical balance of payments situation. On the household level, it is viewed as a means of increasing agricultural output, marketed produce, and income. The worth of increased agricultural productivity is rarely questioned, but the definition of appropriate means to achieve this desired goal provokes considerable controversy.

This research welds two areas of inquiry affecting the design and implementation of agricultural development programs: the differing roles of household members in agronomic decision making, and the adoption patterns of an improved maize variety.

Purposes and Objectives of the Study

The purpose of this research is to contribute to the body of knowledge on program planning for technological change in agricultural
development. Critical appraisal of existing studies and evaluation of common approaches to rural development indicate the need for research on how farm household decisions are made and how the adoption process proceeds (Cleave, 1977; Garfield, 1977).

The planners of programs promoting technological change need detailed information on small farmer agronomic practices. Clarification of the decision making roles for the household unit, the factors affecting acceptance and adoption of improved technology, and the perceived constraints to increased agricultural production is necessary for responsible policy making and effective program design.

The specific objectives of the study are:

1) To describe the system of agricultural production within which small farmer household units live and work in northern Shaba, Zaire.

2) To examine the decision making roles within the small farmer households of northern Shaba, Zaire.

3) To determine the extent of adoption of an improved maize variety in northern Shaba, Zaire, and determine characteristics which allow classification of the sample into adopter and nonadopter groups.

Results of this study may form the basis for modification, refinement, and possible refutation of existing theories and hypotheses regarding rural development.

Origin of the Study

This study was undertaken during the author's two-year tour as a Peace Corps Volunteer assigned as an agricultural extensionist to Projet Nord Shaba (PNS), a U.S. Agency for International Development
integrated rural development project. The study grew from an interest in rural development in general, and an opportunity to examine development philosophy and theory in the context of a local situation. Research efforts were coordinated through the Agricultural Education Department of Iowa State University.

Description of the Research Site

Kongoy, a localité of the town of Kongolo, is situated in nearly the center of the African continent, 250 Kms west of Lake Tanganyika, and 5° south of the equator, in the northern portion of Shaba Province. Kongoy has a total population of approximately 10,000 persons. There are 1,012 households registered with the Agronome de Zone as currently cultivating at least one hectare. These households include 4,706 registered dependents for a total of 5,718 persons in the farming sector. The remaining 50 percent of the Kongoy population are either self-employed (cottage crafts, small merchants, etc.), unemployed, or employed by Projet Nord Shaba (the U.S. AID project), or ONAFITEX (National Office of Fibers and Textiles).

Administrative and political structure

For more than 50 years, a statal administrative structure has been present in the research area. In Shaba region, the national government is represented by the Commissaire de Region in Lubumbashi. The Commissaire de Sous-Region (Tanganyika Sub-Region) is in Kalemie. The Commissaire de Zone is in Kongolo and the Sultani of each collectivité reports to him.
There are Commissaire Assistants de Zone in charge of political, economic, and administrative affairs. There is not an assistant responsible for agriculture, rather, the Department of Agriculture maintains a hierarchy in each zone consisting of an Agronome de Zone, Agronomes de Region, Agronomes de Collectivité, and Moniteurs Agricoles.

History

Beginning in the 1920s northern Shaba was envisioned by the Belgians as the bread basket for the mining populations of southern Shaba. Pronounced agricultural extension efforts and the small farmer Paysannat system (1935-59) emphasized increased food production. The completion of the Kongolo/Kabalo-Lubumbashi railroad in the 1950s provided greater access to markets in the southern mining region. As a result, in 1959, eastern Kongolo Zone alone exported 285,000 MT of manioc, 14,000 MT of maize, 5,000 MT of rice, and 4,600 MT of peanuts (United States Agency for International Development, 1976).

The seven years of post independence civil wars (1960-67) turned the area into a battleground. A succession of armies swept through eastern Zaire during that period, undermining agricultural efforts and substantially reducing agricultural production. After 1967, the government of Mobutu offered little incentive for the production of agricultural commodities in excess of those needed by the farming households themselves. Until the beginning of the U.S. AID development project, there had been no significant attempts at increasing agricultural production in the area.
Physical environment

Climate  The average annual rainfall in Kongoy is 1,200 to 1,400 millimeters. The dry season, June through August, lasts for two and a half months. Temperatures range from 17°C to 32°C, with a mean temperature of approximately 25°C.

Soils  "Kongolo is marked by evidence of substantial historic volcanic activity. Volcanic cinders, lava flows, basalt plains, lateritic soils, and collapsed and extant volcanic domes are evident" (United States Agency for International Development, 1976, p. 26). The dominant soils are oxisols derived from deeply weathered parent materials. The general infertility of the soils dictates the use of a complex system of shifting cultivation because fertilizers are generally not available. Oxisols are characterized by low cation exchange capacity (less than 16 me/100 g), few if any weatherable bases, and a pH of about 5.5 to 5.7. Long periods of fallow are required to restore minimum fertility for crop production after a field has been cultivated for five to seven years.

The major portion of the area is covered by heavy to moderate savanna vegetation. This natural vegetation is stunted on the hill-sides where the topsoil is eroded. The soils are rich in organic matter only in the forested alluvial depressions, valleys, and at the foot of steep hills where vegetable decomposition is evident. These are the preferred areas for cultivation. Most of the farmland lies between 600 and 900 meters elevation. Cultivated areas are allowed to organically rejuvenate during the fallow period of the rotation cycle.
Cropping systems

Maize, rice, oil palms, palm trees, manioc, cotton, and peanuts are intercropped in integrated long-term systems of field rotation, crop rotation, and strip farming.

Two crops of maize per year, or a maize/rice sequence, are planted with adjacent strips and intercrops of beans, or oil palms, bananas, cotton, yams, and other vegetables.

After three to five years of maize, four years of manioc, and seven years of fallowing, the land may be recleared and oil-palm branches cut back, in preparation for another cycle of maize planting. In the savannah, maize often comes after cotton and can be followed by manioc or a peanuts/manioc sequence.

Maize is the favored crop because it heavily predominates over manioc in the staple boiled-flour gruel called Bukari (kiSwahili) and is viewed as a good cash crop.

Population and Sample

Kongoy has a total population of approximately 10,000 persons. The Agronome de Zone records 5,718 persons living in 1,012 households registered as farming at least one hectare. One hundred of these households were randomly selected from the census data to be included in the study. Data were collected from the 255 adult members living in these households. Adults were defined as those individuals either married or at least 18 years of age. Twenty-five of the families were randomly selected from the original sample to be monitored weekly during the agricultural year, August, 1979, through May, 1980.
Procedure for Data Collection

The three interview teams, each composed of one man and one woman from the local area, were selected and trained by the researcher. Personal interviews with the adult household members were made by the teams; the men interviewing the male household members, the women interviewing the female members.

The interview instrument and procedures were pretested in the geographic area, but outside the research site. The data were collected during February and March, 1980, after the second planting season of the agricultural year. The interviews were carried out either in the local vernacular, kiHemba, or kiSwahili. In addition, data for agricultural labor and timing of agronomic practices were recorded from the subsample of 25 households.

Instrumentation

The focus of the interviews was on production patterns and included basic information on the individuals and the household unit. Record was made of knowledge and adoption of an improved maize variety, utilization of recommended agricultural practices, communication channels used by the farmer, decision making within the family unit, and labor allocation within the family. Specifically, the following information was gathered:

- sex
- age
- relationship to the head of household
- number of wives in the household
number of children in the household
total fields for the household; number and area
number and area of individual fields
children's school attendance
children's help with agricultural work
literacy of the individual
number of years in school
nonfarm sources of income
nonfamily agricultural labor
crops cultivated
planting methods
agricultural decision making
agricultural labor
knowledge of new varieties
changes since adoption
perceived constraints to agricultural production

Procedure for Data Transformation and Analysis

The data were coded from interview records by the researcher, and key punched with verification by the Iowa State University Computation Center. The following subprograms from the Statistical Package for the Social Sciences, SPSS (Nie et al., 1975; Hull and Nie, 1979), were used for computer analysis:

1A copy of the questionnaire is included in Appendix D.
1) FREQUENCIES
2) CROSSTABS
3) MULT RESPONSE
4) DISCRIMINANT

SPSS subprogram FREQUENCIES was employed to obtain frequency distributions of individuals and household units among various categories of demographic and agronomic factors. CROSSTABS was used to obtain chi-square statistics on household decision making. The MULT RESPONSE subprogram allowed analysis of frequency distribution of perceived constraints to increased agricultural production. Classification of the sample into adopter and nonadopter categories was achieved through the DISCRIMINANT subprogram.

Explanation of Dissertation Format

An introduction and statement of the problem supporting the need for the research was the first portion of this dissertation. Included also was a description of the research site and the methodology. The second portion will briefly describe the history and sequence of events which have led Zaire into its present situation.

The findings of the study are presented in three separate sections. Section I is a case study of small farmers in Kongoy, Shaba, Zaire. The study describes the system of agricultural production within which the household unit lives and works. The fourth part, or Section II, explores the decision making roles within the rural family and explains the relevant findings in terms of rural development application. The fifth portion, or Section III, studies adoption and
diffusion patterns and derives a classification equation through the use of discriminant analysis.

The last part of this study presents a summary of research and its implication for field application in rural development work. This section also outlines suggestions and recommendations for further research in this area.

The Iowa State University Committee on the Use of Human Subjects in Research reviewed this project and concluded that the rights and welfare of the human subjects were adequately protected, that risks were outweighed by the potential benefits and expected value of the knowledge sought, that confidentiality of data was assured and that informed consent was obtained by appropriate procedures.
ZAIRE: HISTORICAL PERSPECTIVES ON CURRENT CONDITIONS

An examination of the successive periods of Zairian history serves as a basis from which to discuss present-day situations. It is possible to place current conditions in Zaire into perspective by tracing the evolution of the political, economic, and production sectors through these historical periods.

The Congo is "Discovered"

In 1482, three Portuguese ships attempting to find a route around Africa discovered the ancient kingdom of the Congo (also seen in the literature as Kongo). The king of the Congo, Mani Congo, welcomed them as potential allies, and the Portuguese saw the opportunity to establish a Christian state and agreed to send technical aid. Priests and skilled craftsmen arrived in 1490. Two German printers were requisitioned in 1492, when the art of printing had been established in England for only 15 years. This is an indication of the level of civilization in the Congo (Nkrumah, 1967).

Mani Congo's hold on the Congo people was not strong. Immigration, internal movement and mixture, and adaptation to a diverse physical environment had resulted in what Kaplan (1979, p. 4) described as "...sharing across boundaries of many aspects of culture, but it also left most of Zaire's many groups organized into small-scale politics, often extending no farther than a village or a small cluster of villages thinly scattered." The isolation of the Congo Basin was such that there were no other significant incursions of
outsiders until the second half of the nineteenth century. Afro-
Arabs (Swahili) from Zanzibar and the east coast of Africa came into
what is now eastern Zaire searching for slaves. Rubber, ivory, and
wax were also found to be profitable trading commodities. These
intrusions were disruptive to local communities, bringing change and
violence to the communities encountered. The introduction of this
extractive system "entailed deep economic and social changes" (Vellut,
1977, p. 229). Agriculture was also profoundly affected.

The traders purchased food (root crops, dried fish, etc.) or
planted their own crops. Vellut (1977, p. 299) noted that "...traders
used to establish their own fields around the temporary villages
where they settled for up to eighteen months when trading.... Such
practices certainly hastened the introduction of new crop varieties
and stimulated agricultural growth." In fact, the two major food
crops in Zaire today, maize and manioc, are not indigenous. A myriad
of vegetables, fruits, cash crops, and domestic animals was introduced
(Miracle, 1967, pp. 269-301).

The nineteenth century is often described as "the age of African
exploration." Many expeditions were made through central Africa and
what is now Zaire. The most famous of these was initiated to locate
Dr. David Livingstone, a missionary who had been missing for several
years. After finding Livingstone in east Africa in 1871, Henry Stanley
traced the Congo River from source to mouth. In 1877, he arrived at
Boma, the mouth of the Congo on the Atlantic Ocean.
Many historians disdain the term "explorers." The term is misleading because the travels of the Europeans followed long-established trade and communication routes which had been used by the Africans for hundreds of years. Nkrumah (1967) wrote that there was a network of well-defined trails from the Katanga (now Shaba Province, Zaire) copper mines along which the copper, mined and smelted by Africans, was distributed throughout the continent.

The Congo Free State

During the 1800s, missionaries and traders began settling in scattered, small communities in the Congo Basin. Rubber, ivory, and slaves were collected for export, often under conditions of duress. In 1878, King Leopold II of Belgium formed a private company for the large scale extraction of mineral and other natural resources. Exports increased; large quantities of trading goods were brought in, and the export of rubber and ivory increased. Vellut (1977, p. 295) pointed out that "...new forms of European capitalist enterprise intervened to deprive African producers of direct access to their market." He explained that large companies were beginning to monopolize trading.

As a result of a compromise, the Berlin Conference in 1885 recognized Leopold II as absolute monarch of the Congo Free State. The name of the new state did not reflect the political attitudes of the Europeans in the least. The Africans were subjected to forced labor and had monthly quotas of agricultural commodities for which they were paid a fraction of the true value. Those individuals who
did not meet the quotas suffered the loss of a limb or their life (Twain, 1961).

Leopold declared that his first objective in the Congo Free State was to suppress the slave trade. Estimates of the number of slaves removed from the Congo Basin range from 15 million (Nkrumah, 1967) to 30 million (Twain, 1961). Nkrumah (1967, p. 6) explained that what King Leopold II actually did was not suppress slavery, but change its nature. "His objective was to make slavery more profitable by employing the slave in the Congo and thus avoid the difficulties caused by the international abolition of the trade in its old-fashioned form." This was accomplished through forcing the population to work in mines, collecting rubber, and producing food stuffs for the Europeans.

Gannon (1978, p. 98) noted, "The Congo has a long record of brutality, rapine, murder and cannibalism; and the Belgians were themselves accused of using severe methods of enforcing order among the natives employed in their mines...." The Belgians justified their actions by arguing that physical discipline was the only form of order which the Congolese native understood. As a result of international concern and national debate on this subject, the Congo Free State was ceded by the Belgian crown to the Belgian state in 1908.

The Belgian Congo

The Belgian Congo was administrated by the Belgians as an adjunct to the Belgian economy. Jewsiewicki (1980, p. 46) stated that "Increasingly, Leopold II saw himself less as the civilizing monarch presiding over a coalition of black African states and more as the
manager of a vast economic enterprise designed to guarantee the viability of his political creation." The goal of the colonial policy was to use resources and labor to expand the economy of Belgium. Little effort was given to programs which promoted the interests of the Congolese themselves. The Belgians refused to recognize that the Congo would someday be independent. Peemans (1975) wrote that the core of the colonial economic policy from 1890 to 1945 was precisely to avoid a situation that would put production into the hands of the African.

A principal concern of the Belgian colonial policy was to attract foreign financial capital and to develop large scale transport and mining enterprises. Major international companies were established to consolidate these interests. "...in 1932 four groups controlled, in association with the state, 75 percent of the capital of the colony" (Peemans, 1975, p. 151). These companies have continued to dominate the economy of Zaire (Nkrumah, 1967).

Colonial agricultural policy

During the time Zaire was under colonial rule, 1895-1960, there were several programs aimed at changing farming practices and farmers' habits to reflect the over-all colonial policy. This policy of favoring the establishment of large industrial and extractive companies rather than encouraging the growth of traders, settlers, and small farmers reached a climax during the depression of the 1930s, when the Africans were restricted from processing or marketing agricultural goods and were limited to the production of raw products to be used
or exported by the Belgians. A combination of global economic and local political and social factors resulted in failure for most of the agricultural programs.

During World War I, farmers were required by the Belgian colonial administration to cultivate certain food crops (particularly rice) to support the 260,000 troops and porters who were garrisoned in the eastern portion of the Congo guarding against a possible attack from the German colonies. The limited success of the policy encouraged the government to continue it after the war was over. The enforced production of rice and other food crops after the war, however, was aimed at feeding the population in the mining and urban areas (Harms, 1974).

The Great Depression led to a "rationalization" of colonial exploitation. "The state decided to extend administrative control over the use of men and arable land by African rural economies" (Jewsiewicki, 1980, p. 53). The introduction of new crops was the major technological change which accompanied the imposed system of obligatory cultivation. New crops such as cotton, often had negative effects on men and on the soil and contributed to African hostility towards the colonial government. Jewsiewicki (1977) wrote that the spread of manioc resulted from the need for subsistence. The forced agricultural work took time from personal farms and manioc with its low labor requirement was viewed as an alternative food source. Manioc was a poor substitute, however. Jewsiewicki further commented that there was no discussion of the subsequent nutritional problems
created by this change which was further aggravated by the concomitant decline in protein consumption.

Because of the inelastic demand for food crops, the emphasis was gradually shifted to export crops, the major one being cotton. Depending on the region and productivity of the land, each farmer was required to plant an area of cotton which was determined by the local agricultural agent. Each year the cultivators were forced to extend their fields. The colonial administration held the theory that eventually the farmers would find cotton-growing advantageous, and would put even larger areas under cultivation on their own initiative. This failed to occur because cotton prices to the cultivators were set by private foreign-owned companies and did not reflect true market prices (Harms, 1974).

The majority of small-holder farmers had little enthusiasm for cotton-growing, and they tended to plant the cotton on poor ground or on fallow fields, reserving their fertile fields for their own food crops. The Belgian answer to this was to mandate a rotation system, which proved unsuccessful (Harms, 1974).

By the early 1930s, the Belgian colonial government had realized that the forced cultivation policy was causing or exacerbating a rural population exodus and exhausting the soils under cultivation. In 1936, government agronomists introduced the Paysannat scheme, a cultivation method they hoped would conserve the soil while providing higher yields per unit of labor.
In a typical Paysannat, each farmer was given a strip of land which was divided into 20 equal plots. The first year he would plant corn on plot 1. The second year he would plant corn on plot 2 and cotton on plot 1. The third year he would move up the corn and cotton and plant peanuts on plot 1. During the fourth year he would move up the corn, cotton, and peanuts, and plant manioc on the first plot. The fifth year he advanced each one plot, leaving plot 1 fallow.

Every year after that he would advance each crop one plot. By the twentieth year, when the farmer reached the last plot, the first one would have regained fertility, so the farmer would be ready to start over (Harms, 1974, p. 16).

However, the Paysannat program had several inherent disadvantages. The first and primary was the failure to recognize the extreme variability of the soils within and among plots. The indigenous system allowed farmers to scatter their fields and thereby make use of only the best soil. The Paysannat program arbitrarily divided the land, giving farmers both good and bad plots. The scheme was also contrary to customary land tenure arrangements, which caused intra-village and tribal disputes. Other problems occurred; the concentration of crops led to proliferation of crop pests and diseases. Occasionaly, production increased much faster than processing, storage, and preservation facilities could handle the agricultural produce (Harms, 1974).

Drachoussolf (1965, pp. 147-48) described the effect of the introduction of European techniques and the resulting effects upon the economy as having been quantitative rather than qualitative "...leading to an extension of the cultivated area without appreciable modification in farming methods." He contended that the imposition
of compulsory cultivation of certain crops did not alter the traditional system, but rather these crops were farmed in separate blocks and considered as "government fields." He stated that the only possible benefits were those resulting from production changes such as timely planting, proper spacing, and the introduction of selected seeds.

Jewsiewicki (1980, p. 58) took a more negative view of the Paysannat program, calling it a simple "agrarian reform replacing direct constraint with a program of crop rotation" and stated it was merely a political ploy designed to improve cotton yields by integrating it into the food crop cycle. He concluded that the Paysannat "...was thus a vast fraud designed to reestablish control over the peasantry." He explained the program was designed to improve the quality and increase the quantity of agricultural exports. This was accomplished by keeping the peasant outside the market and under direct administrative constraint.

In 1959, when the program was suspended for a thorough review, only about half of the expected number of farmers were involved with the plan. The program was not reinstated.

Transition Period

By the 1950s, European plantation agriculture was the only sector still creating jobs for the rapidly growing population. The colonial administration had succeeded in slowly raising urban wages but in general, the first ten-year plan (1949-59) ended in failure. Rural wages and farmer incomes lagged behind urban wages because of worsening
terms of trade in agricultural exports and the absence of real incentives and opportunities for the small landholders (Jewsiewicki, 1980).

The African attitude became increasingly nationalistic and anti-colonial, finally leading to the demand for complete independence. Peemans (1975) documented that "At the end of the 1950s the growing social discontent among the urban and rural masses provided a firm popular support to this movement, which culminated in independence in June 1960" (p. 154).

An examination of the economic situation at the end of the colonial period shows that the structure blocked any further capital accumulation or development in the African sector (Peemans, 1975). It was evident that the colonial government had created a system with the single objective of enriching Belgium. Poland (1980, p. 4) wrote that what was left was an "illogical system." Production was geared towards an artificially maintained foreign export market. Agricultural commodities were produced to feed the Belgians in Zaire, not to be distributed or processed by the local population for their own consumption.

Labor done in the copper and diamond mines had been done under the Belgian technicians' supervision, and the schools had functioned to provide office clerks for the colonial administrative offices. There was no skilled or trained cadre of people in any sector -- agriculture, mining, medicine, or even local government (Kamarck, 1976a; Poland, 1980).
Independence

On June 30, 1960, the Belgian Congo became the Democratic Republic of the Congo. Within a week of independence, the Congolese army had mutinied against its officers. "Leaderless, the troops ran wild, attacking the property of Europeans and Africans alike" (Rooke, 1967, p. 46). The remaining Europeans fled or were subjected to reprisal at the hands of the military or local groups. "The violence continued and by the eleventh of July it was so out of hand that the Congolese government appealed to the United Nations for assistance in restoring order" (Rooke, 1967, p. 47). On the same day, copper-rich Katanga (now Shaba Province), the most valuable of the six provinces which made up the Congo, announced that it was withdrawing from the new republic to become a separate state.

"At independence, ... no single leader or party could command the loyalty of even a substantial minority of Zairians" (Kaplan, 1979, pp. 6-7). The resulting chaos (the revolt of the armed forces, the secession of Katanga, the upheavals and rebellions in the east and the northeast) was as disruptive as colonial rule had been (Peemans, 1975; Poland, 1980; Vellut, 1977). "Given the widespread disorder and the lack of trained personnel, they [the Zairians] were unable even to maintain agricultural production at preindependence levels" (Kaplan, 1979, p. 7).

Remnants of the colonial past were quite evident in every sector of the Zairian society after independence. The colonial policy had established an economic reliance on the mining industry. The agricultural
policy and programs aimed at export crops and European-type commodities had created a system which could not meet demands for food in the rural areas let alone the demands in urban centers. The educational policy and political suppression left few trained or skilled leaders. The political and social chaos that resulted with independence was no surprise to anyone who understood the situation.

Zaire Today

In 1965, when Mobuto Sese Seko took power, he attempted to bring order out of chaos, to end the endemic and sometimes epidemic conflict among various political groups. To these diverse groups, few of which were oriented to the notion of an entity as inclusive as Zaire, he stressed unity. If this then was his objective, he "has had a measure of success" (Kaplan, 1979, p. 7). The only legal political party, the Popular Movement of the Revolution (Movement Populaire de la Revolution - MPR), acting under a highly centralized administration, carefully allocated positions and responsibilities on a regional basis. All independent manifestation of regionalism or ethnicity "were either made illegal or otherwise discouraged" (Kaplan, 1979, p. 7).

Watu and Howe (1979, p. 375) commented that, "Mobutu's rule has been characterized by a constant and increasing concentration of power in his own hands." Incarceration or execution has been the penalty for any who disagreed too loudly. Over the years several prominent Zairians have been jailed and/or executed for allegedly plotting to assassinate Mobutu (Watu and Howe, 1979).
The name of the country was changed from the Congo to Zaire in 1971. Christian names and western dress were discouraged, if not outlawed. Watu and Howe (1979, p. 375) stated that, "From 1971 the ideology of the single ruling party became 'authenticity' -- a sort of refurbished Negritude. In 1974 this official ideology became 'Mobutism'.'"

Adelman (1979, p. 117) wrote that President Mobutu Sese Seko was "eminently suited to consolidate a fractionated, highly volatile political entity and begin molding it into a nation-state." He noted, however, that Mobutu is "just as eminently unsuited to address the economic and social needs of the people, once the political consolidation has begun." Kaplan (1979, p. 8) described Mobutu's economic approach as "...at best haphazard and at worst putting government decision making ... ownership and control into the hands of politico-economic elite concerned with personal enrichment."

Early signs of economic deterioration included a decline in government revenues relative to the gross domestic product, a steady growth in budget deficits, an over-all increase in inflation, a fall in real wages and salaries, and the overvaluation of the currency (International Bank for Reconstruction and Development, 1979).

Zaire, the second largest African state, has great mineral and energy resources. The country supplies two-thirds of the free world's supply of cobalt (a vital mineral needed in steel production), half of its industrial diamonds, and approximately one-third of its tantalum and germanium (Figure 1). The much-valued copper region
Zaire: A country profile

Total area: 2.345 million square kilometers (km) (Gourou, 1979).

Population: 26 million (mid-1979) with an estimated annual growth rate of 2.7 percent. About 75 percent of the population live on about one-third of the land surface (Kaplan, 1979).

Ethnic groups: 250 groups have been distinguished and named (Kaplan, 1979).

Education: General literacy is estimated at 20 percent; literacy in French (the national language) is estimated to be 15 percent (Kaplan, 1979). Forty-five percent of the 5- to 19-year-olds are in school with 83 students per teacher (Newspaper Enterprise, Inc., 1980).


Transportation: 14,000 km of navigable waterways, 5,000 km railway systems, 140,000 km roads (Kaplan, 1979). Usable roads estimated at 12 percent of those available at independence (Adelman, 1979).
supplies about 10 percent of the world's supplies, and the Zaire River could conceivably light up all of central Africa (Adelman, 1978).

In spite of such impressive wealth, Zaire's population does not see the benefits. A per capita income of less than $200 has caused the United Nations to declare it one of the least developed states. For the 18 to 20 million small farmers in Zaire, per capita income is estimated at between $25 and $50 (Gran, 1979a).

In both urban and rural sectors it is becoming increasingly more difficult to maintain a minimal standard of living. Adelman (1978) wrote that Zairians today face greater hardships than they did throughout either the colonial or immediate post-colonial period. Estimates place the average standard of living now at the same level as that of 1910-15. "Domestic food production is down; the transportation system disjointed if at all operative; commercial credit tight; and social and economic discontent high" (Adelman, 1978, pp. 36-37).

Young (1978) reported that real wages have fallen below the 1910 levels, less than 15 percent of the roads available at the time of independence are now usable, agricultural production is less than the level at independence with food imports now exceeding $300 million annually.

This situation has not arisen overnight. The International Bank for Reconstruction and Development (1979) noted that "...the current difficulties of Zaire are in many respects the result of developments which took place in earlier years."
Underlying the current budgetary debt and trade imbalances, officially cited as the major problems of Zaire, are far more complex development problems. Gran (1979a, p. 1) wrote that this is not an accident of geography and history. It is instead the logical result of deliberately designed historical processes that are implemented by and through a system of local, national, and international institutions ... processes which have and will continue to impoverish the majority of its citizens ... a potentially permanent situation.

A short summary of the current situation in several vital sectors outlines the need for increased emphasis on development. Population growth rates and the lack of health services, inadequate education, and the neglect of the agricultural sector all substantiate the need for immediate attention.

Population growth and health services

Zaire is now faced with an unprecedented population explosion. Fertility rates range from 38 to 45 per 1,000, with an average of 43. As a result, the "age pyramid" reveals that more than half the population of Zaire is less than 15 years of age. "There is therefore, good cause to include the fertility component and its demographic repercussions in any development study of Zaire" (Ciparisse, 1978, p. 36).

The infant mortality rate is 160 per 1,000 live births, with life expectancy at less than 45 years (U.S. Embassy, 1980). The population per physician ratio is 27,669 (Newspaper Enterprise Association, Inc., 1980, p. 597).

Malaria, sleeping sickness, filariasis, bilharziasis, and ankylostomiasis flourish (Gourou, 1979). As Kamarck (1976b) noted,
for many of the tropical countries, the incidence of severe sicknesses affects a person's ability for heavy or sustained work or thought, thus ultimately affecting the economic development of the country.

**Education sector**

Zaire has a relatively low literacy rate of 15 percent. Forty-five percent of the five- to nineteen-year-olds are enrolled in schools with a student teacher ratio of 88:1 (Newspaper Enterprise Association, Inc., 1980, p. 597). However, fewer than 1 percent of the children entering primary school graduate from either academic or technical high schools. Agricultural schools were established by the Belgians (Sloan, 1962). There are no current figures available for students enrolled in vocational schools or even current estimates of the number of vocational schools (Haddad, 1980). These technical schools could be compared to agricultural schools elsewhere in Africa, which are noted for ineffectual agricultural programs and an inadequate agricultural knowledge base (Sinclair and Lillis, 1980).

"The unplanned and uncoordinated growth of the education sector both before and after independence has not effectively contributed to the development of the human resources required to exploit Zaire's development potential" (International Bank for Reconstruction and Development, 1977, p. 1). It is difficult to imagine how a government can presume to be providing capable and well-trained leaders by means of such an insufficient education system. Ewert (1977) documented common, yet tragicomic situations arising from the limited agricultural extension training.
Agricultural sector

As a result of the political and economic disorders which have disrupted Zaire since 1960, agricultural production has deteriorated (Figure 2). "Marketed agricultural products fell almost 40 percent between 1959 and 1967, and its share of the gross domestic product of the money economy fell from 21 percent to 13.13 percent in 1968" (Lacroix, 1979, p. 1102). More than 30 percent of the imports are food items (Young, 1978).

Mwamufiya's analysis (1977) of the Zairian situation indicated that the decline in agricultural sector can be partially attributed to: 1) the civil wars and political unrest since independence which have disrupted the agricultural production and marketing infrastructures set up by the colonial administration; 2) the emphasis placed on the mining in the 1960s; and 3) a rapid urban migration. The declining standard of living in rural areas has resulted in much dissatisfaction. The resulting exodus of small farmers and agricultural workers from the rural areas has caused a drop in agricultural output. Their withdrawal from the labor force has not been compensated by an increased labor productivity. The migration to urban centers has increased the demand for staple food for non-farming populations in the larger cities (Mwamufiya, 1977).

In contrast, Watu and Howe (1979, p. 376) cited the basic reason for agricultural recession in the subsistence sector as being the fall in real rural incomes as a result of inflation. "...wretched producer
Figure 2. Map of Zaire showing agricultural and mineral production and transportation systems

Essential facts: Zairian agricultural sector

Population: About 80 percent is rural. Average rural density is about 11 per square kilometer (Gourou, 1979).

Major export crops: Oil palm, rubber, coffee, cocoa, tea (Kaplan, 1979).

Major food crops: Manioc, maize, rice, bananas, peanuts (Kaplan, 1979).

Per capita income: Between $25 and $50 for subsistence farmers (Gran, 1979a).

Importations: More than 30 percent of foreign exchange is spent for importing foodstuffs — exceeding $300 million annually (Young, 1978).

Agricultural production: Since independence marketed produce has fallen almost 40 percent (Lacroix, 1979).
prices and deteriorating transport services have caused farmers to give up producing food for sale."

Agriculture in Zaire "has been almost wholly neglected since independence, despite its official designation as 'the priority of priorities'" (Watu and Howe, 1979, p. 376). In describing an agricultural project and the lack of coordination between national and regional offices in the central portion of Zaire, Ewert (1977, p. 268) wrote, "The Zairian government does not appear to have any coherent development plan." There are no signs that Zaire is making any real strides towards self-sufficiency in food grains (Gran, 1978; Sorenson et al., 1975). Adelman (1978) explained governmental goals aimed at agricultural development and marketing improvements, but did not offer any hope that their carefully drawn plans would succeed. "...remedial programs are now being arranged, and the nation's path towards economic reform and stability has been mapped out; this is at least a crucial first step in a long and difficult journey" (Adelman, 1978, p. 44).

Zaire has declared a goal of agricultural self-sufficiency; yet whether or not the plans can be realized depends on a complex set of conditions. The government, often termed a kleptocracy, is noted for its corruption and ineffectiveness. Schatzberg (1980) explained that when conditions of scarcity and insecurity exist, there are few economic resources to go around and people do not know how long they will be able to retain those they have. He stated that the natural impulse was to accumulate wealth as rapidly as possible.
"In consequence, officials will try to convert small parcels of authority into wealth by using them to extract resources from those who can be coerced" (Schatzberg, 1980, p. 171).

"Some sources estimate that 60 percent of regular State revenues disappear through irregular maneuvers by officials" (Watu and Howe, 1979, p. 376). In a system that is run, if not ruled, by bribes and under the table dealings, it is hard to imagine that any real emphasis on rural development will take place.

Many writers have taken a wait-and-see attitude to the present approach. Results to date have not been promising, yet within the context of the country, any improvement is note-worthy. But, as Gran concluded, "As the 1970s draw to a close, it is painfully clear that involvement in the world system has been singularly unrewarding for most of the people of Zaire" (Gran, 1979b, p. 296).
SECTION I. SUBSISTENCE AGRICULTURE IN NORTHERN SHABA PROVINCE, ZAIRE: A CASE STUDY

Subsistence Agriculture

There are approximately 1,012 farmers in Kongoy, Shaba, Zaire. The economic stability of the area is precarious, but on the whole is better than that of many areas of Zaire. Kongoy's agricultural potential is good, and the area was once seen as the bread basket for the mining populations in southern Shaba (United States Agency for International Development, 1976).

The objective of this study is to describe the system of agricultural production within which small subsistence farmer household units live and work in northern Shaba, Zaire. The presentation of the data is complemented with the researcher's descriptions and observations.¹

"In 1978, an estimated 18 to 20 million people, about 75 percent of all Zairians, lived in rural areas and practiced predominantly subsistence agriculture. Subsistence, however, implies subsisting. Many of these people are slowly starving" (Gran, 1979, pp. 2-3).

Terman and Hart (1977) wrote that a subsistence family in Zaire consumes about 80 percent of its production in the average year. In a

¹Data presented here are a portion of a larger study. Interviews were conducted with all adult members (n = 255) from 100 households randomly selected from government census data. Twenty-five of the households from the original sample were also selected to be monitored weekly during the agricultural year, August, 1979, through May, 1980. Additional demographics for the sample are found in Appendix A.
good year, there is little surplus; in poor years there is little or no surplus, but the family is fed. They regard this as the minimal subsistence level.

The typical Kongoy farmer cultivated 5 hectares (ha) of maize (Zea mays), beans (Phaseolus vulgaris), and manioc (cassava, or Manihot esculenta). Generally, assorted other smaller fields of ground nuts (Arachis hypogaea), rice (Oryza sativa), and oil palm (Elaeis guineensis) were also farmed.¹

All 100 families (100 percent) of the sample indicated they planted some maize, 92 percent said they planted manioc, 77 percent reported planting rice, 47 percent said they planted peanuts, and 13 percent said they planted at least one type of beans. When asked which of the crops was the largest in area, 81 percent replied "maize," 13 percent indicated manioc, 5 percent said rice, and 1 percent reported beans.

Of those families surveyed, total area cultivated per household ranged from 1 to 25 ha. Six families reported farming 1 ha, 63 said they were farming between 5 and 10 ha, while eight families reported farming more than 10 ha. The mean area cultivated per family was 4.85 ha.

Total area cultivated usually represented more than one field. Of the families in the sample, only six reported farming a single field.

¹ Portions of these data were previously published. Hardt, Terry. 1981. Africa's slash and burn agriculture. In Iowa Agriculturalist 82, No. 2:26-28.
Sixty-nine families said their land was broken up into between two and four fields and 25 of the families said they tilled between five and nine fields. The mean number of fields farmed by the households surveyed was 3.72 ha.

The majority of the households in the survey planted tomatoes (*Lycopersicum esculentum*), onions (*Allium cepa*), tobacco (*Nicotiana spp.*), and sweet potatoes (*Ipomoea batatas*) in small plots around their mud huts.

Minor food crops were plantains (*Musa pradisica*), oranges (*Citrus sinensus*), avocados (*Persea gratissima*), papayas (*Carica papaya*), mangoes (*Mangifera indica*), pineapples (*Ananas sativus*), and bananas (*Musa sapientum*). Little effort was spent in their cultivation. Goats, sheep, and poultry were raised, but no cattle.

Starchy foods predominated in the diet of Kongoy families (Table 1). Miracle (1967, p. 40) stated, "For most of the tribes of the Congo Basin ... starchy-staples usually account for from 80-95 percent of the calories consumed." Because of proximity to the Lualaba tributaries, fish were abundant; but other forms of protein were only available on a seasonal basis (termites), scarce (wild game), limited (goats and chickens), or were not commonly eaten because of taboos (eggs). Daily protein intake was below minimum standards set by the United Nations Food and Agricultural Organization or the U.S. Department of Agriculture. The International Bank for Reconstruction and Development (1975, p. 4) reported, "About one-third of the rural population suffer from
Table 1. Consumption chart of a shifting cultivator's family in Kongoy, Zaire

<table>
<thead>
<tr>
<th>Product (Crops produced by the family)</th>
<th>Month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
</tr>
<tr>
<td>1) Staple foods containing starch</td>
<td></td>
</tr>
<tr>
<td>Manioc</td>
<td>X X X X X X X X X X X X X</td>
</tr>
<tr>
<td>Maize</td>
<td>X X X X X X X X X X X X X</td>
</tr>
<tr>
<td>Rice</td>
<td>X X</td>
</tr>
<tr>
<td>Sweet potatoes</td>
<td>X X</td>
</tr>
<tr>
<td>Plaintains/bananas</td>
<td>X X X X X X X X X X X X X</td>
</tr>
<tr>
<td>2) Staple foods containing protein</td>
<td></td>
</tr>
<tr>
<td>Beans</td>
<td>X X</td>
</tr>
<tr>
<td>Manioc leaves</td>
<td>X X X X X X X X X X X X</td>
</tr>
<tr>
<td>Sweet potato leaves</td>
<td>X X X</td>
</tr>
<tr>
<td>Bean and squash leaves</td>
<td>X X X</td>
</tr>
<tr>
<td>Ground nuts</td>
<td>X X X X X X X X X X X X X</td>
</tr>
<tr>
<td>Grain amarathus</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Bambura ground nuts</td>
<td>X X</td>
</tr>
<tr>
<td>(voandzeia sub-terranea)</td>
<td></td>
</tr>
<tr>
<td>Lentils</td>
<td>X X</td>
</tr>
<tr>
<td>3) Fruits and nuts</td>
<td></td>
</tr>
<tr>
<td>Onions</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>X X X X X X</td>
</tr>
<tr>
<td>Eggplant</td>
<td>X X X X</td>
</tr>
<tr>
<td>Okra</td>
<td>X X X</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>X X X</td>
</tr>
<tr>
<td>Pumpkins/squash</td>
<td>X X X X</td>
</tr>
<tr>
<td>Citrus (oranges, tangerines, lemons, grapefruit)</td>
<td>X X</td>
</tr>
<tr>
<td>Oil palm nuts and oil</td>
<td>X X X X X X X X X X X X X</td>
</tr>
<tr>
<td>4) Collected foods</td>
<td></td>
</tr>
<tr>
<td>Termites (white ants)</td>
<td>X X</td>
</tr>
<tr>
<td>Various fruits</td>
<td>X X X X X X X X X X X X X</td>
</tr>
</tbody>
</table>

^Observed by researcher, 1978-80.
deficiencies in caloric intake; and more seriously, a grave shortage of protein is characteristic of most of the population of the country."

Slash and Burn

Miracle (1967, p. 31) defined shifting cultivation as a general term used to describe any agriculture "in which the boundaries of farmers' fields shift from one cultivation cycle to the next. The cultivation cycle is completed when a field has been cultivated, then fallowed." Slash and burn agriculture, as practiced in Kongoy, is only one type of shifting cultivation. There is little permanent field agriculture found in Zaire (Terman and Hart, 1977).

It was observed that fields were cleared by the families in the dry season, from July to September. First, the men cut the underbrush with crude hatchets or machetes. Then, trees were felled, leaving those of especially hard wood which were difficult to cut with the untempered metal implements. These, along with the very large trees and trees that bear products of value (fruits or palm-nuts), were left standing. The debris was collected by the women to be used as firewood or piled and allowed to dry approximately two weeks and then burned in the field, hence the term, slash and burn cultivation. "The incineration, like cutting of the trees, is not complete and affects only the new undergrowth and debris on the ground" (Lacomblez in Miracle, 1967, p. 45). Logs and trees were left in the field, and after the field was hoed, crops were planted around them. Jurion and Henry (1969, p. 29) concluded that this act of clearing the forest "creates a hereditary right of usufruct."
Burning is essential for this type of agriculture. Nye and Greenland (1960) reported that for tropical agriculture, burning the surface vegetation in the clearing operation generally resulted in greater yields of the ensuing crop than in cases of land preparation without burning. Research has shown that the major positive effects include a saving of time and labor required to ready the field for planting and large quantities of nutrients from the vegetation and litter being spread in the ash on the surface of the soil (Nye and Greenland, 1960). The resulting rise in pH from the alkaline ash and the increased nutrient availability are two of the most important effects of burning. Recent agricultural research has shown that land cleared through slash and burn techniques yields 50-60 percent higher than areas cleared mechanically (Moran, 1979).

When the soil surface is heated, the parasite and microbiological population is altered and the chemical properties of the soil colloids are changed. Results may or may not be advantageous to crop production.

On the negative side, nearly all of the nitrogen from the soil is lost to the atmosphere as ammonia, gaseous nitrogen or the oxides of nitrogen, and sulphur is released as sulphur dioxide during the burning process (Nye and Greenland, 1960). "The loss of nitrogen is reckoned at between 60 and 71 lb. per acre per annum in the loams of temperate regions and at between 170 and 270 lb. in hot, wet lands. A rise in temperature favors a loss of nitrogen" (Gourou, 1966, p. 22).

The burning destroys valuable forests which could be exploited for timber, firewood, or wood pulp and leaves the denuded soil
susceptible to erosion and leaching (Gourou, 1966). While slash and burn agriculture has its disadvantages, modern agriculturalists have not yet been able to provide viable alternatives for Kongoy farmers and their estimated 20 million Zairian counterparts.

Agricultural Cycle

The researcher observed that the average Kogoy farmer planted two annual crops of maize during the wet season. The first maize crop was planted in September and harvested in January. The second was planted at the time of harvest of the first and was harvested in May or June. Table 2 shows an annual agricultural calendar for the Kongoy area. If the rains were late, the maize fields might be planted in October, but this delay significantly decreased yields, so most farmers timed their planting accordingly (United States Agency for International Development, 1976).

Manioc harvest began 18 months or so after planting and might continue 10 to 12 months longer, thus several plantings of other crops might be made during the life of one manioc field.

Norman (1979) cited that the major biological and physical advantage in developing a perennial crop component, such as manioc, within an annual cropping system lies in the increased potential for exploiting and conserving the natural resources available to the farming unit. This is done through reducing soil erosion and planting the perennials in odd or less desirable sections of the plot which are not readily cultivatable.
Table 2. Annual agricultural calendar

<table>
<thead>
<tr>
<th>Crop</th>
<th>Plant</th>
<th>Weed</th>
<th>Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize #2</td>
<td>Jan.</td>
<td>Feb./March</td>
<td>April/May</td>
</tr>
<tr>
<td>Rice</td>
<td>Dec.</td>
<td>Jan./Feb.</td>
<td>May/June</td>
</tr>
<tr>
<td>Manioc</td>
<td>Sept.-March</td>
<td>As necessary</td>
<td>After 12-15 mo. for 36 mo.</td>
</tr>
<tr>
<td>Peanuts</td>
<td>Sept./Oct./Nov.</td>
<td>When ≥6&quot; high</td>
<td>Jan./Feb./March</td>
</tr>
<tr>
<td>Beans</td>
<td>Sept., Jan.</td>
<td>When ≥4&quot; high</td>
<td>Nov., March</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Sept.-May</td>
<td>As needed</td>
<td>When ready</td>
</tr>
<tr>
<td>Bananas</td>
<td>Sept., Jan.</td>
<td>As needed</td>
<td>After 12-18 mo. once only</td>
</tr>
</tbody>
</table>

^Observed by researcher, 1978-80.

Manioc, because of its tolerance to poor soils, its low labor requirements, and the fact that it may be left in the field for a year after it is first ready to harvest, tends to be the "terminal crop" in both forest and savanna areas planting sequence (Miracle, 1967, p. 165). Observations in the Kongoy area indicated that manioc is generally the last crop before the land is allowed to fallow.

The greater part of the tropical lands consists of very mediocre soils, mainly sandy, poor in humus (1.8 percent compared to temperate region levels of 10 percent or more), low in clay and in fertile elements, but sufficiently friable for cultivation (Gourou, 1966). The fields around Kongoy were predominantly oxisols derived from...

Because of the poor soils and the lack of chemical fertilizers, the household used a field for only five to seven years, followed by six to seven years of fallow. Table 3 shows a schematic presentation of the rotation patterns. This cycle was usually repeated two to three times, then the plot was abandoned for 60-100 years. Depending on the scarcity of land, the village may be forced to move at this time.

Production Practices

Maize was planted by the women making a hole in the soil with short-handled hoes and dropping in seeds. Ninety percent of those surveyed said they planted between four and six seeds to a "pocket."

Table 3. Farming system: 14-year cycle

<table>
<thead>
<tr>
<th>2-3 years</th>
<th>3-4 years</th>
<th>6-7 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>maize</td>
<td>manioc</td>
<td>fallow</td>
</tr>
<tr>
<td>1-2 years</td>
<td>manioc</td>
<td></td>
</tr>
<tr>
<td>maize + rice</td>
<td>+</td>
<td>beans, bananas, etc.</td>
</tr>
<tr>
<td>1 year maize</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*aGraphic presentation adapted from Miracle, 1967, to represent data observed by researcher, 1978-80.*
Seventy-nine percent of the families surveyed indicated they used a one meter by one meter spacing between "pockets" of seeds.

It was observed that fields were then interplanted with beans, peanuts, or bananas. Rice was sometimes planted with the second maize crop (Table 3). Two crops of maize per year, or a maize/rice sequence were planted. Two or three years of maize were followed by three or four years of manioc.

... Intercropping is more productive per unit land (up to 30 percent higher than monocropped fields)... Intercropping gives higher yields because it intercepts more light per unit of land, soil nutrients and fertilizer are used more effectively, and because nutrient leaching is reduced due to increased soil protection (Moran, 1979, p. 9).

The women of the household, who did 60-80 percent of the agricultural work (United States Agency for International Development, 1976), weeded the maize once or twice before December. The researcher observed that in January after the maize stalks were dry, the women twisted the ears off and pulled the stalks up, leaving them to lie in the field. The unshucked ears were stored by the wives in their kitchens where the heat and smoke from the cooking fire lowered moisture levels and reduced insect infestations.

It was observed that weeds did not grow for several months if the fields were well burned, because the seeds in the soil were killed by the heat; however, as the cropping sequence progressed, weeds became a problem. In 1908 Johnston (in Miracle, 1967, p. 60) noted, "...plants struggle against the weeds which grow afresh without ceasing, and they are with difficulty disentangled from time to time."
Observation indicated that if manioc was to be planted, immediately following the first rain the women in the family made mounds about a meter in diameter at the base and half that at the apex. Using a short-handled hoe the woman stepped one pace from the last mound and began to pull the earth on top of her foot, rotating as she worked so that when finished she had formed a mound around the one leg. She then lifted her leg out, took another pace, and repeated the process. The mounds were made to reduce the depth that must be dug to harvest the mature roots.

After the mounds had been made, three or four manioc cuttings 2-30 cm long were planted around the sides of the mounds. Bananas, plantains, and papayas were usually interplanted with the manioc, with the plants being scattered throughout the fields. The researcher noted that none of these companion crops was placed on mounds, and the ground was generally not hoed before planting bananas; a hole was dug with a small hoe and the rhizome was set in it and covered with soil. The researcher observed that the manioc was harvested by digging a little earth away from the roots, then grasping the stalk and pulling it and all attached roots free. Any roots that had broken off were dug out.

After harvest, the manioc stalks were piled in a shady area on the side of the field, where they remained until they were cut up into cuttings for the next season's crop.

Slash and burn agriculture as described here relies on nature, rather than on human effort or chemical inputs, to restore soil fertility.
"...the principal method of restoring soil fertility lost through cultivation is not only to rest land periodically, but to allow regrowth of natural vegetation during fallow periods" (Miracle, 1967, p. 31). Thus, at any one time, 20-50 percent of a family's fields may be fallowed (Miracle, 1967; Rutenberg, 1976).

Agricultural Labor

Traditional agriculture in Zaire is based almost entirely on family labor (Miracle, 1967). Principally, exceptions occur in regions where a profitable cash crop has been introduced or when some of the cultivators use hired laborers or take on share tenants. Some individual farmers may supplement their family labor with hired workers (Drachoussolf, 1965).

In the sample studied, 14 percent of the families indicated that they had paid workers that either cleared and burned the fields, or helped the family perform these tasks (Table 4). Thirty-nine percent of the families indicated that the men of the family did the cleaning and burning of the fields. Only 3 percent of the households reported that the women did this work, while the husband and wives did it together in 36 percent of the cases. Eight percent of the families said the children helped with this task.

For the job of digging the holes preparatory to planting, 48 percent of the families said the men performed this task, none indicated the women did it alone, but 27 percent said the men and women did it together. Sixteen percent said the children of the family helped, and 9 percent of the families interviewed said
Table 4. Division of agricultural labor

<table>
<thead>
<tr>
<th>Activity</th>
<th>Men</th>
<th>Women</th>
<th>Men and women together</th>
<th>Children assisted by other family member</th>
<th>Hired labor assisted by family members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning and burning fields</td>
<td>39</td>
<td>3</td>
<td>36</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>Digging before planting</td>
<td>48</td>
<td>0</td>
<td>27</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Planting of crops</td>
<td>10</td>
<td>33</td>
<td>29</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>First weeding of fields</td>
<td>11</td>
<td>4</td>
<td>56</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>Second weeding of fields</td>
<td>9</td>
<td>13</td>
<td>50</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>Harvesting crop</td>
<td>9</td>
<td>24</td>
<td>39</td>
<td>19</td>
<td>9</td>
</tr>
<tr>
<td>Corn shelling</td>
<td>9</td>
<td>32</td>
<td>34</td>
<td>23</td>
<td>2</td>
</tr>
</tbody>
</table>
their paid workers helped the family dig planting holes in the fields.

One-third (33 percent) of the households surveyed said the women did the actual planting of the crops, 29 percent said this task was done by the men and the women of the family together, 10 percent said the men did it alone. Twenty percent of the households indicated that the children helped, and 8 percent of the households said they hired labor to help plant the crops.

Among the 100 families surveyed, 56 percent said the men and women together weeded the fields the first time, 4 percent indicated the women did it alone, 11 percent said the men of the family performed this task, and 10 percent said the work was done by the hired labor. Half (50 percent) of the households said the men and women together did the weeding the second time, 13 percent said the women did it alone, 9 percent said the men of the family did it, and 12 percent said they had hired labor do the job. Children assisted other family members do the first weeding in 19 percent of the families and in 16 percent of the households during the second weeding.

For the task of harvesting, 39 percent of the households said the men and women of the family did it together, 24 percent said it was done by the women, 9 percent reported the men did it, and 9 percent said it was done by the hired workers. Nineteen households (19 percent) reported their children helped harvest the crops.

Corn shelling was done by the men and the women in 34 percent of the households, by the women alone in 32 percent of the families, and
by the men in 9 percent of the cases. Twenty-three percent of the households reported their children assisted in shelling the corn. Only 2 percent said the hired labor helped with this task.

Thirty-five percent of the households reported that some or all of their children helped in the fields. Digging, planting, weeding, and harvesting were the tasks the children did most frequently. Twenty-six of the households reported that their children helped with all field work, while nine indicated that the children helped with only a portion of the agricultural work.

Table 5 shows a breakdown of the division of labor by sex. Figures for this table were tabulated from the weekly monitoring of 25 households. The calculations plainly show the burden of work was performed by the female members of the household. Major responsibilities of the women included the majority of the agricultural work,

<table>
<thead>
<tr>
<th>Task</th>
<th>Men (percent)</th>
<th>Women (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree felling</td>
<td>90</td>
<td>10</td>
</tr>
<tr>
<td>Clearing and burning</td>
<td>42</td>
<td>58</td>
</tr>
<tr>
<td>Planting</td>
<td>31</td>
<td>69</td>
</tr>
<tr>
<td>Weeding</td>
<td>26</td>
<td>74</td>
</tr>
<tr>
<td>Harvesting</td>
<td>13</td>
<td>87</td>
</tr>
<tr>
<td>Transporting and selling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>agricultural produce</td>
<td>22</td>
<td>78</td>
</tr>
<tr>
<td>Transporting water and firewood</td>
<td>11</td>
<td>89</td>
</tr>
<tr>
<td>Hunting, fishing, food gathering</td>
<td>67</td>
<td>33</td>
</tr>
<tr>
<td>Food preparation</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>Building construction</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>Child care</td>
<td>3</td>
<td>97</td>
</tr>
<tr>
<td>Cottage crafts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(pottery, mats, carving)</td>
<td>68</td>
<td>32</td>
</tr>
</tbody>
</table>
transportation of water and firewood, food preparation, and child care. Men were responsible primarily for tree felling, hunting and fishing, building and construction, and cottage crafts.

Anthony et al. (1979) reviewed previous labor studies in Zaire and commented that employment in agricultural pursuits showed strong seasonal variation, with women's nonworking hours varying from 13 percent of the day in March, when gathering activities are at their peak, to 40 percent in October, when all activities except housekeeping are at a minimum. Men are busiest from February through June, when leisure accounts for less than a third of their time, and least busy in August and October, when more than half of their time is free. Seasonal variation in the time devoted to manufacturing, building, hunting and gathering, and social activities is much greater.

The time spent by women in housekeeping activities showed an inverse relationship with time spent on the farms.

Constraints to Increased Agricultural Production

A central issue for those trying to improve production or efficiency of African agriculture is the set of constraints which affect production and the acceptance of profitable innovations. Cleave (1977) stated that the major constraints are: 1) the physical and economic environment, 2) the initial conditions from which the farmer must formulate his production strategy, 3) the nature of the household/farm production unit with its competing demands for family labor in both the domestic and economic sectors, and 4) the perceived risk from climatic and market conditions.
Individuals from the 100 sample households were asked to rank a list of perceived constraints to increased agricultural production. The number of individuals who ranked each constraint as being among the three most important are presented in Table 6. Inflation was the only constraint on the list not ranked as one of the top three concerns by any individual.

It is interesting to note that an overwhelming majority, 249 persons from a sample of 255 (97 percent), placed the lack of hand tools as one of the top three reasons they did not produce more agricultural produce. Miracle (1967) cited a Belgian publication from 1920 that singled out the shortage of hoes, axes, and machetes among African farmers as the major obstacle to expansion of production.

Because of the division of agricultural labor between men and women, the constraints were examined for differences between the sexes in perception of constraints. Major differences were found. Women perceived the lack of bicycles and personal illness more constraining.

The MULTI RESPONSE subprogram of the Statistical Package for the Social Sciences (Hull, C. Lalair, and Norman H. Nie, eds. SPSS Update. 1979. McGraw-Hill Book Company, New York. pp. 99-109) was used to analyze those constraints named by the sample as being one of the three most important. The original list of constraints the sample was asked to rank included: no good agricultural market, personal illness, lack of hand tools, not having a tractor, overall price inflation, unfair prices and practices by the agricultural produce merchants, the lack of agricultural chemicals, and "other." This list of constraints was compiled by the researcher through discussion with the farmers. "Other" was recoded to reflect those named by the sample, namely: not having a bicycle, no large motorized transportation, no credit available, and the combination of no motorized transportation and the lack of credit.
Table 6. Major agricultural constraints ranked

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Male (n=113)</th>
<th>Female (n=142)</th>
<th>Total (n=255)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand tools</td>
<td>108 (95.6%)</td>
<td>139 (97.9%)</td>
<td>249 (96.9%)</td>
</tr>
<tr>
<td>Illness</td>
<td>71 (62.8%)</td>
<td>123 (86.6%)</td>
<td>194 (76.1%)</td>
</tr>
<tr>
<td>Bicycle</td>
<td>47 (41.6%)</td>
<td>91 (64.1%)</td>
<td>138 (54.1%)</td>
</tr>
<tr>
<td>Large transport</td>
<td>45 (39.8%)</td>
<td>27 (19.0%)</td>
<td>72 (28.2%)</td>
</tr>
<tr>
<td>Agricultural chemicals</td>
<td>32 (28.3%)</td>
<td>28 (19.7%)</td>
<td>60 (23.5%)</td>
</tr>
<tr>
<td>Tractor</td>
<td>30 (26.5%)</td>
<td>14 (9.9%)</td>
<td>44 (17.3%)</td>
</tr>
<tr>
<td>Credit</td>
<td>4 (3.5%)</td>
<td>1 (0.7%)</td>
<td>5 (2.0%)</td>
</tr>
<tr>
<td>No market</td>
<td>1 (0.9%)</td>
<td>0 (0.0%)</td>
<td>1 (0.4%)</td>
</tr>
<tr>
<td>Transportation and credit</td>
<td>1 (0.9%)</td>
<td>0 (0.0%)</td>
<td>1 (0.4%)</td>
</tr>
<tr>
<td>Unfair merchants</td>
<td>0 (0.0%)</td>
<td>1 (0.7%)</td>
<td>1 (0.4%)</td>
</tr>
</tbody>
</table>
than the men did, while men ranked the lack of large transport and tractors higher than women did.

Tuthill (1975) surveyed samples of high, medium, and low income farmers in eastern Zambia to determine perceived constraints to increased agricultural production. His findings were slightly different than those found for Kongoy, with the lack of money, lack of seeds, and fertilizer being named by the Zambian farmers as the major constraints.

Agricultural land is generally considered to be one of the major agricultural production constraints in many developing countries. Only 1 percent of the total land mass of Zaire is currently being used for agricultural production, although 26 percent of the country is arable land. Kamarck (1976) calculated that the population-to-cropland ratio for area actually under cultivation is comparable to India and Pakistan, both noted for their high population to land ratios. Availability of land, however, was not perceived by the sample households as a constraint to increasing agricultural production.

Small farmer perception of constraints may be viewed in another way. Terman and Hart (1977, p. 220) divide them into categories of physical and political constraints.

In Zaire, the physical restraints include almost complete dependence on hand labor and poor facilities for transporting the farmer's excess produce to market. Political restraints include high cost/price ratios for fertilizers and other agricultural inputs in relation to comparatively low prices for maize and other products set by the government of Zaire.

This study bears out the first portion of this statement, but does not prove that the sample considered policy issues as constraints to
agricultural production. Ewert's (1977) study found similar results; the population appeared reluctant to name the government as a hindrance to their agricultural pursuits. This could be because of fear of governmental reprisal, or it could reflect a desire to minimize risk with the subsistence agriculture initially, and participate in a market economy as a second priority.

Conclusion

Methods of slash and burn agriculture which include a cropping sequence followed by a fallow period such as the type used in Kongoy are found in a broad, continuous belt running across the middle of the African continent. This encompasses all of the Congo Basin and most of tropical Africa covering some 36 million square kilometers (Miracle, 1967).

Pierre Gourou (1966, p. 338) indicated that agricultural systems of this type are fairly similar throughout the world.

In Africa, America, and New Guinea shifting cultivation is the primary source of vegetable foods; agriculturalists clear a portion of forest or savanna, burn the dried vegetation, make holes with a stick and put in various grains, weed or do not weed, protect the cultivated plants from wild animals, and reap. The cleared field may be abandoned after a single harvest or after two or three.

However, Miracle (1967, p. 170) was more reluctant to generalize, and emphasized that:

...diversity appears to be the outstanding characteristic of shifting cultivation in the Congo Basin. In addition to variation in methods of working the soil in main fields, there is extreme diversity in the combination of agricultural enterprises found; in the number, types,
The African cultivator seems quite adaptable. The system of agriculture used by the small farmer is complex and reflects a favorable adaptation to indigenous constraints. This farming system is a reflection of a set of decisions made. Schlippe (1956, p. 240) concluded from his extensive study of the Zande tribe in Sudan and Zaire that "a system of agriculture of a human group is an important although interdependent part of the whole culture of the group and that as such it is endowed with all the features of a culture."

Consistent with this line of reasoning, Webster and Wilson (1980, p. 99) noted that "both the current state of agriculture and the possibilities for its development are influenced by social, economic and political circumstances as well as the environmental and technical factors...." The method of farming in Kongoy is a rational response to the environment, both the physical and agronomic conditions, and the social factors.

Legum et al. (1979, p. 14) concluded that the core of recommendations for African development approaches should be concerned with "righting imbalances" among sectors, regions, and individuals. To achieve this would require a shift in the allocation of resources in favor of agriculture and the rural poor. It would also entail adopting measures explicitly designed and tailored to the small farmers.
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SECTION II. DECISION MAKING ROLES
WITHIN THE AFRICAN HOUSEHOLD

Introduction

The nature of decision making within the household has important implications for the introduction of technologies and program planning for African development. Veiga-Pinto (1976, p. 4) defines decision making as a "complex process made up of several component parts such as the determinations of an objective to be attained, information, etc., in which a varying number of persons can participate at various levels." Knowing which family member makes agricultural decisions is necessary in order to plan for the adoption of a new agricultural technology.

Current literature reviewed below assumes that agricultural decisions are made for the production unit by a single individual. The African household is generally described as a production and consumption unit comprised of a man, his wife or wives, and their unmarried children. As a production and consumption unit, the family, the household, and the farm are synonymous although the "male head of the family is typically the decisionmaker" (Cleave, 1977, p. 158). The basic family unit may be extended to include married children and their families and/or other relatives (Garfield, 1977; Norman, 1967).

\[1\] See Appendix A for a description of the household composition for this study.
The key factors cited in the literature that affect the nature of the household decision making roles are: the presence or absence of the husband; the stage of the domestic cycle; and the social-economic status (Abbott, 1974; Kershaw, 1975).

For the small farmer the major portion of the labor force, management, and the capital come from the same household. Farm business decisions are intermixed with family considerations (Mellor, 1966, pp. 133-134). Cleaves states, "...a division of labor and of decision making both between domestic and farm activities and within farm production is common in Africa. ...the major decisions on levels of resources used and techniques of production may be divided between communal activity and private activity" (1977, p. 158).

Anthropological studies (Fischer, 1956; Oboler, 1977) indicate that men and women within one farm household may make separate farm management decisions for their respective plots and crops. However, these studies also indicate that there is a single decision maker who manages the farm as a single production unit; in fact most definitions of the sampling unit for farm management surveys rest on this assumption.

Moock (1973) in his study of maize production in Vihiga, Kenya, has elaborated on the single production unit concept to include two levels of farm decision making. He draws a distinction between the farm head (basically the same concept as the household head) and the farm manager, who are generally assumed to be the same person in most studies. The farm head makes decisions about what enterprises and
investments will be undertaken and what resources will be employed as well as what produce will be sold; thus he or she makes virtually all decisions regarding the use of cash resources. The farm manager makes the technical decisions about how and when to use a given set of resources which the farm head has decided upon; he or she makes decisions about such matters as when to plant and how to allocate family labor. There is uncertainty in the literature about who makes decisions concerning such matters as whether to grow more or less maize and over sales of small quantities of produce.

Purpose of the Study

Even though some consideration of the production unit question has been made, information about farmer decision making still has little effect on resource allocation decisions in agricultural development projects. Hoben (1980, p. 337) stated, "There is a gap between the rhetoric and policy guidelines of development agencies, the allocation of their resources, and the outcomes of their projects. Although in recent years academics and policy planners have come to recognize the farmers' decisions are rational responses to local conditions, this change in perspective is not carried through in the selection of projects." Helleiner (1975, p. 45) concurred with the conclusion, "Farm ... studies that shed light upon smallholder decision making are few and far between in Africa."

Berry (1980, p. 321) said, "Since the literature on agricultural decision making is itself inconclusive concerning the particular content and method of poor farmers' decisions, it can be used to justify
conflicting approaches to effective rural development, and may therefore be said to have contributed little to the cumulative improvements of rural development strategies."

Clearly, there is need for additional information on agricultural decision making within the rural African household. Rural development strategies based on inconclusive or incomplete concepts concerning decision making roles within the household unit cannot hope to achieve the desired goals.

The purpose of this study is to describe the nature of the agricultural decision making process of farming households in northern Shaba Province, Zaire.

Methodology

The data were collected from 100 farming households randomly selected from the Agronome de Zone census data for the localité of Kongoy, Shaba, Zaire. Personal interviews with the household members were made by trained interview teams composed of one man and one woman each; the men interviewing the male household members, the women interviewing the female household members.

The interview questionnaire and procedures were prepared and pretested in the geographic area, but outside the sampling area. The interview focused on production patterns and included basic information on the individuals and the household unit. Knowledge and adoption of an improved maize variety, utilization of recommended agricultural practices, communication channels used by the farmer,
decision making roles within the family unit, and labor allocation within the family were recorded.

The interviews were carried out either in the local vernacular, kiHemba, or kiSwahili, and took place during February and March of 1980.

Results and Discussion

The data were first analyzed to determine decision making by household members. Nearly 90 percent of the household members said that the head of the household was responsible for all agronomically related decisions with the exception of the issue of disposition of agricultural produce. Disposition is defined as the allocation of the produce to either marketing or consumption (Table 1). Household members were in agreement (90 percent or better) that the family decisions are made by the head of the household on the issues of what to plant, where to plant, when to plant new fields, method of planting corn, the date of planting, the date of weeding, date of harvest, what produce is sold, and the location in which it is sold. The family members (89.8 percent) concurred that the head of household made the decisions about the amount of corn planted and the type of corn seeds used.

However, not all household heads made harvest disposition decisions. Table 1 shows the household member response to disposition of harvest decision making roles. Nearly 30 percent of the sample reported the head of the household traditionally made this decision, more than 60 percent of the sample said it was a decision made by the
Table 1. Response to decision making questions by household member categories

<table>
<thead>
<tr>
<th>Who in the household makes the decision</th>
<th>What to plant</th>
<th>Where to plant</th>
<th>When to plant new fields</th>
<th>Amount of corn</th>
<th>Type of corn seeds</th>
<th>Method of planting corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household head</td>
<td>244</td>
<td>245</td>
<td>243</td>
<td>229</td>
<td>229</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>(95.7%)</td>
<td>(96.1%)</td>
<td>(95.3%)</td>
<td>(89.8%)</td>
<td>(89.8%)</td>
<td>(94.1%)</td>
</tr>
<tr>
<td>Wife</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>15</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(1.6%)</td>
<td>(1.6%)</td>
<td>(2.4%)</td>
<td>(5.9%)</td>
<td>(6.3%)</td>
<td>(3.1%)</td>
</tr>
<tr>
<td>Household head and wife</td>
<td>1</td>
<td></td>
<td>5</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.4%)</td>
<td></td>
<td>(2.0%)</td>
<td>(1.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(1.2%)</td>
<td>(1.2%)</td>
<td>(1.2%)</td>
<td>(1.6%)</td>
<td></td>
<td>(1.6%)</td>
</tr>
<tr>
<td>Household head, wife and child</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wife and child</td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.2%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household head and child</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does not apply</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(1.2%)</td>
<td>(1.2%)</td>
<td>(1.2%)</td>
<td>(1.2%)</td>
<td>(1.2%)</td>
<td>(1.2%)</td>
</tr>
<tr>
<td>n = 255</td>
<td>255</td>
<td>255</td>
<td>255</td>
<td>255</td>
<td>255</td>
<td>255</td>
</tr>
<tr>
<td></td>
<td>(100%)</td>
<td>(100%)</td>
<td>(100%)</td>
<td>(100%)</td>
<td>(100%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>
Table 1. Continued

<table>
<thead>
<tr>
<th>Who in the household makes the decision</th>
<th>Date of planting</th>
<th>Date of weeding</th>
<th>Date of harvest</th>
<th>Disposition of harvest</th>
<th>What produce is sold</th>
<th>What amount is sold</th>
<th>Where produce is sold</th>
<th>Composite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household head</td>
<td>242 (94.9%)</td>
<td>239 (93.7%)</td>
<td>231 (90.6%)</td>
<td>66 (25.9%)</td>
<td>241 (94.5%)</td>
<td>234 (91.8%)</td>
<td>239 (93.7%)</td>
<td>88.5%</td>
</tr>
<tr>
<td>Wife</td>
<td>7 (2.7%)</td>
<td>10 (3.9%)</td>
<td>13 (5.1%)</td>
<td>155 (60.8%)</td>
<td>6 (2.4%)</td>
<td>11 (4.3%)</td>
<td>7 (2.7%)</td>
<td>7.9%</td>
</tr>
<tr>
<td>Household head and wife</td>
<td>3 (1.2%)</td>
<td>20 (7.8%)</td>
<td>2 (0.8%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.1%</td>
</tr>
<tr>
<td>Child</td>
<td>3 (1.2%)</td>
<td>3 (1.2%)</td>
<td>3 (1.2%)</td>
<td>2 (0.8%)</td>
<td>5 (2.0%)</td>
<td>5 (2.0%)</td>
<td>5 (2.0%)</td>
<td>1.2%</td>
</tr>
<tr>
<td>Household head, wife and child</td>
<td>2 (0.8%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.09%</td>
</tr>
<tr>
<td>Wife and child</td>
<td>2 (0.8%)</td>
<td>5 (2.0%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.3%</td>
</tr>
<tr>
<td>Household head and child</td>
<td>2 (0.8%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.06%</td>
</tr>
<tr>
<td>Does not apply</td>
<td>3 (1.2%)</td>
<td>3 (1.2%)</td>
<td>3 (1.2%)</td>
<td>3 (1.2%)</td>
<td>3 (1.2%)</td>
<td>3 (1.2%)</td>
<td>3 (1.2%)</td>
<td>0.7%</td>
</tr>
<tr>
<td>n = 255</td>
<td>255 (100%)</td>
<td>255 (100%)</td>
<td>255 (100%)</td>
<td>255 (100%)</td>
<td>255 (100%)</td>
<td>255 (100%)</td>
<td>255 (100%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>
wife, and nearly 8 percent answered that the decision was made jointly by the household head and the wife. With respect to decision making, the results indicate that farming families in Kongoy all operate in a similar fashion.

Table 2 compares responses of head of the household with responses of other household members to analyze intra-household consensus as suggested by literature (Cleave, 1977, p. 158). Again, there appears to be high agreement among all household members that the agronomic decisions are made by the head of the household with the same exception of those decisions dealing with the disposition of agricultural harvest. Thirty-three percent of the heads of the household said this was a decision made themselves, 67 reported that another household member made the decision.

Thirty-three of the other household members (21.7 percent) indicated the household head made decisions on the disposition of harvest while 119 (78.3 percent) said these decisions were made by other family members living in the household. Chi square analysis of the data in Table 2 showed no significant differences between responses of household heads and other household members.

Table 3 shows comparison of responses of male heads of household with responses of female heads of household in those areas dealing with agricultural decision making roles. Again, inter-household similarities and differences were analyzed.

As found previously, with the exception of the issue of disposition of harvest, a clear majority of all decisions was made by the
Table 2. Comparison of responses to questions about agricultural decisions of heads of household with responses of other family members

<table>
<thead>
<tr>
<th>Question</th>
<th>Head of household</th>
<th></th>
<th>Other family members</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>n=100</td>
<td>n=152</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n/%</td>
<td>n/%</td>
<td>n/%</td>
<td>n/%</td>
</tr>
<tr>
<td>Does head of household decide:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What to plant</td>
<td>98</td>
<td>2</td>
<td>146</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>98.0</td>
<td>2.0</td>
<td>96.1</td>
<td>3.9</td>
</tr>
<tr>
<td>Where to plant</td>
<td>98</td>
<td>2</td>
<td>147</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>98.0</td>
<td>2.0</td>
<td>96.7</td>
<td>3.3</td>
</tr>
<tr>
<td>When to plant new fields</td>
<td>98</td>
<td>2</td>
<td>145</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>98.0</td>
<td>2.0</td>
<td>95.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Amount of corn</td>
<td>93</td>
<td>7</td>
<td>136</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>93.0</td>
<td>7.0</td>
<td>89.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Type of corn seeds</td>
<td>94</td>
<td>6</td>
<td>135</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>94.0</td>
<td>6.0</td>
<td>88.8</td>
<td>11.2</td>
</tr>
<tr>
<td>Method of planting corn</td>
<td>97</td>
<td>3</td>
<td>143</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>97.0</td>
<td>3.0</td>
<td>94.1</td>
<td>5.9</td>
</tr>
<tr>
<td>Date of planting</td>
<td>97</td>
<td>3</td>
<td>145</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>97.0</td>
<td>3.0</td>
<td>95.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Date of weeding</td>
<td>96</td>
<td>4</td>
<td>143</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>96.0</td>
<td>4.0</td>
<td>94.1</td>
<td>5.9</td>
</tr>
<tr>
<td>Date of harvest</td>
<td>93</td>
<td>7</td>
<td>138</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>93.0</td>
<td>7.0</td>
<td>90.8</td>
<td>9.2</td>
</tr>
<tr>
<td>Disposition of harvest</td>
<td>33</td>
<td>67</td>
<td>33</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>33.0</td>
<td>67.0</td>
<td>21.7</td>
<td>78.3</td>
</tr>
<tr>
<td>What produce is sold</td>
<td>97</td>
<td>3</td>
<td>144</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>97.0</td>
<td>3.0</td>
<td>94.7</td>
<td>5.3</td>
</tr>
<tr>
<td>What amount is sold</td>
<td>95</td>
<td>5</td>
<td>139</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>95.0</td>
<td>5.0</td>
<td>91.4</td>
<td>8.6</td>
</tr>
<tr>
<td>Where produce is sold</td>
<td>97</td>
<td>3</td>
<td>142</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>97.0</td>
<td>3.0</td>
<td>93.4</td>
<td>6.6</td>
</tr>
</tbody>
</table>

*aA chi square test was done on each question by household position. No statistically significant relationship was observed.*
Table 3. Comparison of responses to decision making roles of male heads of household with responses of female heads of household

<table>
<thead>
<tr>
<th>Activity</th>
<th>Male household heads n=88</th>
<th></th>
<th>Female household heads n=12</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes n/%</td>
<td>No n/%</td>
<td>Yes n/%</td>
<td>No n/%</td>
</tr>
<tr>
<td>Does head of household decide:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What to plant</td>
<td>88</td>
<td>0</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Where to plant</td>
<td>88</td>
<td>0</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>When to plant new fields</td>
<td>88</td>
<td>0</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Amount of corn</td>
<td>83</td>
<td>5</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Type of corn seeds</td>
<td>84</td>
<td>4</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Method of planting corn</td>
<td>87</td>
<td>1</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Date of planting</td>
<td>87</td>
<td>1</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Date of weeding</td>
<td>86</td>
<td>2</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Date of harvest</td>
<td>83</td>
<td>5</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Disposition of harvest</td>
<td>25</td>
<td>63</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>What produce is sold</td>
<td>87</td>
<td>1</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>What amount is sold</td>
<td>85</td>
<td>3</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Where produce is sold</td>
<td>87</td>
<td>1</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

A chi square test was done on each activity by male and female household heads. No statistically significant relationship was observed between the male heads of household and the female heads of household.
head of the household, regardless of sex. Male heads of household responded that in 71.6 percent of the cases decisions dealing with the disposition of harvest were made by another individual. Only 33.3 percent of female headed households indicated that this decision was made by someone else. As in the previous table, chi square analysis showed no significant differences between the responses of the male heads of household and the female heads of household.

Conclusions and Implications

In this study, with the exception of disposition of agricultural harvest, agriculturally related decisions were made by the head of the household. There was no significant difference between decision making roles in those households headed by males and those headed by females. All family members agreed that the decision making roles were the responsibility and traditionally carried out by the head of the household. African labor data show a division of labor in the household with female family members being responsible for a large portion of agricultural work even though decisions affecting this work are predominantly made by the male members of the household. The agreement found among household members indicated these decision making roles and the distribution of ensuing work were with the approval of all household members.

The decisions made regarding agricultural harvest were clearly indicative of the wives' role in decision making, with a high degree of household agreement in this area. Barnum and Squire found "... household decisions about the level of production and labor use can
be made independently of household decisions about consumption" (1979, p. 6). In this study, not only did wives of the household make the decisions in this matter, but the male heads of household agreed that this role was traditionally a function performed by their wives.

Analysis of data collected from the sample indicated that agriculturally related decision making roles were defined along heads of household and household member lines rather than the often-cited male/female lines.

Household unity as shown here provides a basis for directing projects toward decision makers, but also illustrates the obvious need to consider and treat the entire household as a unit, not as a fragmented group of separate audiences.

Implications from these findings are mainly of concern to development planners attempting to induce change or develop programs aimed at adoption of agricultural innovations. A clear understanding of decision making roles and decision implementing roles within the rural household is a prerequisite to planning effective strategies for promoting change.


SECTION III. ADOPTION AND DIFFUSION OF AN IMPROVED MAIZE VARIETY IN NORTHERN SHABA PROVINCE, ZAIRE

Introduction

Maize in Zaire

Historically, the food crops of Africa were mainly the banana (*Musa spp.*), the Asian yam (*Discorea*), and the Coco-yam (*Colocasia*), until the sixteenth and seventeenth centuries A.D. At that time both maize (*Zea mays*) and manioc (*Manihot esculenta*) were introduced, probably as a result of Portuguese trading (Oliver and Fage, 1966; Kaplan, 1979). Although evidence cited by Miracle (1967) supports the hypothesis that maize gives considerably higher yields in calories per acre than other cereals in many of the humid areas of the Congo Basin, Gerhart (1975, p. 35) found that maize introduction in Zaire, as in many African colonies "...often involved coercion, forced labor on demonstration plots, low prices, and conflicting recommendations."

Maize is now produced throughout Zaire on small farms by traditional hand-cultivated methods. Sorenson et al. (1975) found the main production area to be in the south. Kaplan (1979) stated that in much of Shaba, particularly the copperbelt, maize is the preferred staple.

Sorenson et al. (1975, p. 9) observed that, "Average yields are low, ranging from 325 to 1,000 Kg/ha. ¹ Data on yield and production

¹As a reference point, the U.S. and Western Europe average slightly more than four times this amount.
are fragmented and, in some cases contradictory." Yet, the maize yield possible in Zaire is equal to the best in the world (CIMMYT, 1978).

In Zaire, the primary uses of maize are for human food in the form of maize flour for cooking, for seed, and for beer production as brewing grits (Sorenson et al., 1975).

Governmental programs

Since 1960, the quantity of maize consumed in Zaire has exceeded the quantity produced. Imports from African countries south of Zaire (Zimbabwe, South Africa, Zambia, and others) have made up the deficit. The level of imports has increased over the past decade (Sorenson et al., 1975). With the rising cost of imported maize, the government of Zaire has elected to pursue objectives of self-sufficiency in basic food production and to develop the production of maize (Mwamufiya, 1977).

In 1972, the government of Zaire asked CIMMYT (International Maize and Wheat Improvement Center, Mexico City) to cooperate in establishing a maize improvement and production program similar to the one in Kenya (Streeter, 1975). Researchers of the CIMMYT team in Zaire organize and conduct the research work of Programme National Mais (PNM), a governmental agency. PNM's objectives are to develop and to adapt maize varieties which are insect resistant, produce high yields under Zairian ecological conditions and which meet consumers' taste. Specific goals include training Zairians for the continuation of the research work in maize agronomy, protection and
breeding, and to develop technological packages for introduction of new maize varieties to the farmer.

**Project North Shaba**

PNM developed a variety and a set of farming practices to be introduced by the North Shaba Project (PNS), an integrated rural development scheme financed by the government of Zaire and the U.S. Agency for International Development.

Kasai I, the improved maize variety developed by PNM, was first planted near the research area during the fall of 1977 at the PNS research center. The first seeds were available for general distribution in the fall of 1978.

No PNS extensionist was assigned to the localité (Kongoy) where the research was conducted. Preliminary results indicated that in villages having PNS extensionists, adoption rates of the improved variety range between 15 and 80 percent. The acceptance rate in the Kongoy sample was 19 percent.

Kasai I seed is for sale in Kongoy and is accompanied by verbal instructions on improved practices. One recommended practice was to plant in rows which would increase the number of plants per area. Because Kasai I has a higher germination rate than local varieties, it was also recommended that fewer seeds be placed in each hole.

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1Because only 2 percent of the sample households were using the recommended farming practices at the time of the survey, no statistical analysis was done of their adoption or utilization diffusion.
Purpose of Research

The purpose of this research is to determine the extent of adoption of an improved maize variety, Kasai I, in northern Shaba, Zaire, and to determine characteristics which allow classification of the sample into adopter and nonadopter groups.

Methodology

The data were collected from 100 farming households randomly selected from the Agronome de Zone census data for the localité of Kongoy. Personal interviews with the household members were made by trained interview teams composed of one man and one woman each; the men interviewing the male household members, the women interviewing the female household members.

The interview questionnaire and procedures were prepared and pretested in the geographic area, but outside the sampling area. The interview focused on production patterns and included basic information on the individuals and the household unit. Knowledge and adoption of an improved maize variety, utilization of recommended agricultural practices, communication channels used by the farmer, decision making roles within the family unit, and labor allocation within the family were recorded.

The interviews were carried out either in the local vernacular, kiHemba, or in kiSwahili and took place during February and March of 1980.
The Adoption Pattern

Of the 100 households surveyed, 22 male household heads indicated that they were aware of the new variety. None of the 12 female heads of household said they had any knowledge of the new variety. Among the 22 indicating knowledge, seven said they knew only a little about the new variety, ten said they knew a moderate amount, four said they knew fairly much, and only one said he knew a great deal.

Thirteen of these said they had received their information from a PNS employee, eight said they found out from a friend, and one said a relative had told him.

Eight of this group said they had heard of the new variety in 1978, nine said they first learned of it in 1979, four said they had heard of it during the first planting season of 1980, and one said that he had learned of it during the second planting season of 1980. Nineteen said that at least one person in their household was now using the improved variety.¹

Eighteen of the 19 that had adopted the new variety seeds said that they were the first in their household to obtain them, and one said his first wife had been the first in the household to receive the new variety. Sixteen members of the sample said they received the seeds from PNS and two household heads said their seeds had come

¹One wife indicated she had obtained knowledge of the new variety from a relative and was now planting it in portions of her field, although she was the only member of her family to indicate any knowledge of the new variety. For ease in statistical analysis, hereafter she will be considered as a household head in the adopter category.
from either a friend or relative. The one woman in this category said her seeds were obtained from a friend.

Fifteen of the 19 households now planting the new variety said that the household head had first planted the seeds. In four households the seeds had first been planted jointly by the head and other family members.

Fourteen of the households responded that the decision to plant the new variety had been made by the male household head, while four households said the decision had been made jointly by the male head and his wife or wives. The one wife responding in this category said she made the decision herself to plant the new variety.

At the time of the study, three of the households said they were then planting the new variety in all of their maize fields, four households said they were planting about half or more of their area in new variety maize but in combination with the old variety, and twelve indicated that they had only planted a small amount of the new variety.

Five of those households now planting Kasai I said they planted more maize fields than before they had adopted the new variety, and eight of the adopters said they planted larger maize fields since they had begun planting the improved variety. Twelve of the 19 households planting at least some of the new variety said they now planted more maize, and six reported selling more maize than before they adopted.
Discriminant Analysis

Discriminant analysis was used to identify characteristics which aid the classification of households into adopter and nonadopter categories (for further description of analytical procedures, see Appendix B).

All heads of household were treated as the sample to be analyzed and were divided into adopter, those now planting the improved maize variety, and nonadopter categories. The variables used in the analysis, their sample means, and their group means are presented in Table 1. While this table shows similarities and differences between the groups, further analysis is necessary to discover those variables which can be used to discriminate between the groups.

Before discriminating functions can be validly interpreted, investigation of interrelationships between variables is desirable. Closely related variables may distort discriminating powers of one another. Two highly correlated variables may act as "replacements" within the equation, thereby obscuring true discrimination by acting interchangeably within the equation.

The correlation matrix (Table 2) indicates both the magnitude and direction of relationship between variables. None of the coefficients was judged strong enough (>0.50) to warrant further investigation. This analysis confirms that there is little chance for interchangeability of variables used in the discriminant analysis.

Because there were only two groups, adopters and nonadopters, only one function was derived. As reported in Table 3, the eigenvalue
<table>
<thead>
<tr>
<th>Designation</th>
<th>Description of variable</th>
<th>Means of variable for groups</th>
<th>Means for all observations total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Adopt n=19</td>
<td>Nonadopt n=81</td>
</tr>
<tr>
<td>$X_1$</td>
<td>Sex $^a$</td>
<td>1.05</td>
<td>1.14</td>
</tr>
<tr>
<td>$X_2$</td>
<td>Number of wives in household</td>
<td>1.57</td>
<td>1.22</td>
</tr>
<tr>
<td>$X_3$</td>
<td>Number of children in household</td>
<td>8.63</td>
<td>5.11</td>
</tr>
<tr>
<td>$X_4$</td>
<td>Number of years in school</td>
<td>4.94</td>
<td>4.02</td>
</tr>
<tr>
<td>$X_5$</td>
<td>Attend agriculture school $^b$</td>
<td>0.26</td>
<td>0.01</td>
</tr>
<tr>
<td>$X_6$</td>
<td>Nonfarm income $^b$</td>
<td>0.26</td>
<td>0.24</td>
</tr>
<tr>
<td>$X_7$</td>
<td>Nonfamily agricultural laborers $^b$</td>
<td>0.42</td>
<td>0.34</td>
</tr>
<tr>
<td>$X_8$</td>
<td>Total size of household fields $^c$</td>
<td>6.78</td>
<td>4.39</td>
</tr>
<tr>
<td>$X_9$</td>
<td>Number of fields cultivated by head of household</td>
<td>3.10</td>
<td>2.69</td>
</tr>
<tr>
<td>$X_{10}$</td>
<td>Rice cultivated $^b$</td>
<td>0.21</td>
<td>0.23</td>
</tr>
<tr>
<td>$X_{11}$</td>
<td>Disposition of agricultural produce decisions $^d$</td>
<td>1.78</td>
<td>1.53</td>
</tr>
<tr>
<td>$X_{12}$</td>
<td>Age</td>
<td>49.36</td>
<td>43.17</td>
</tr>
</tbody>
</table>

$^a_1$ = male, 2 = female.

$^b_0$ = no, 1 = yes.

$^c$ Reported in hectares.

$^d_1$ = decisions made by household head or by household head with other family members, 2 = decisions made by wife or wives.
Table 2. Correlation matrix for variables used in discriminant analysis

<table>
<thead>
<tr>
<th></th>
<th>$X_1$</th>
<th>$X_2$</th>
<th>$X_3$</th>
<th>$X_4$</th>
<th>$X_5$</th>
<th>$X_6$</th>
<th>$X_7$</th>
<th>$X_8$</th>
<th>$X_9$</th>
<th>$X_{10}$</th>
<th>$X_{11}$</th>
<th>$X_{12}$</th>
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<tr>
<td>$X_1$</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_2$</td>
<td>-0.43</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$X_3$</td>
<td>-0.22</td>
<td>0.32</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_4$</td>
<td>-0.33</td>
<td>0.08</td>
<td>0.11</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_5$</td>
<td>-0.05</td>
<td>-0.07</td>
<td>0.19</td>
<td>0.23</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$X_6$</td>
<td>-0.15</td>
<td>0.08</td>
<td>0.11</td>
<td>0.26</td>
<td>0.15</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$X_7$</td>
<td>-0.16</td>
<td>0.03</td>
<td>0.05</td>
<td>0.05</td>
<td>-0.04</td>
<td>-0.00</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_8$</td>
<td>-0.11</td>
<td>0.31</td>
<td>0.23</td>
<td>-0.23</td>
<td>-0.17</td>
<td>-0.06</td>
<td>0.29</td>
<td>1.00</td>
<td></td>
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<td>$X_9$</td>
<td>-0.04</td>
<td>-0.03</td>
<td>0.16</td>
<td>-0.13</td>
<td>-0.07</td>
<td>0.04</td>
<td>0.28</td>
<td>0.43</td>
<td>1.00</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$X_{10}$</td>
<td>0.06</td>
<td>-0.01</td>
<td>0.02</td>
<td>0.10</td>
<td>0.07</td>
<td>-0.15</td>
<td>-0.21</td>
<td>-0.18</td>
<td>-0.22</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_{11}$</td>
<td>-0.13</td>
<td>0.23</td>
<td>-0.02</td>
<td>0.16</td>
<td>-0.04</td>
<td>0.06</td>
<td>0.07</td>
<td>0.05</td>
<td>-0.03</td>
<td>-0.01</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>$X_{12}$</td>
<td>0.01</td>
<td>-0.05</td>
<td>0.32</td>
<td>-0.26</td>
<td>-0.11</td>
<td>0.23</td>
<td>0.06</td>
<td>0.27</td>
<td>0.20</td>
<td>-0.11</td>
<td>-0.25</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Table 3. Statistics for discriminant function derived for adoption groups

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Eigenvalue (^a)</td>
<td>0.45</td>
</tr>
<tr>
<td>Canonical correlation (^b)</td>
<td>0.55</td>
</tr>
<tr>
<td>Wilks' lambda (^c)</td>
<td>0.68</td>
</tr>
<tr>
<td>Chi square</td>
<td>35.71*</td>
</tr>
<tr>
<td>Degrees of freedom</td>
<td>5</td>
</tr>
</tbody>
</table>

\(^a\) A test of significance for the importance of functions is the relative percentage of the eigenvalue associated with the function. An eigenvalue is a special measure of the relative importance of the function.

\(^b\) The value squared can be interpreted as the proportion of the variance in the discriminant function explained by the groups.

\(^c\) Represents an inverse measure of the discriminating power in the original variables not removed by the discriminant functions.

*Significant at the .01 level.

associated with the discriminant function is 0.45. The canonical correlation coefficient is 0.55. This value squared can be interpreted as the proportion of the variance in the discriminant function explained by the groups. The chi square statistic and Wilks' lambda statistic show that this function was significant at the .01 level.

One method of testing the equation's ability to predict is to classify cases in the original sample and compare their predicted groups with their actual groups (Table 4). If all members of groups are correctly classified, then the equation could be said to have 100 percent accuracy. \(P^2\) as developed below can be used to measure the degree of accuracy.
The results of the classification presented in Table 4 show a high degree of success with 85 percent of the cases in the original groups being correctly classified by means of the derived function. This suggests that adopters and nonadopters can indeed be considered as separate groups with distinct characteristics.

To further examine the results of the discriminant analysis, Table 5 presents the standardized function coefficients for the classification of the original group. Variables $X_5$ (attending agricultural school) and $X_{12}$ (age) have the largest coefficients and are therefore the most important variables in this function in discriminating between the adopter and nonadopter categories. Variables $X_{11}$ (decisions made regarding disposition of agricultural produce) and $X_2$ (number of wives in the household) prove to be of moderate importance in discriminating between the two groups. Variable $X_6$ (nonfarm income)

Table 4. Classification results of discriminant analysis of adopters

<table>
<thead>
<tr>
<th>Original group</th>
<th>Number of cases</th>
<th>Classification group</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Adopter</td>
<td>Nonadopter</td>
<td></td>
</tr>
<tr>
<td>Adopter</td>
<td>19</td>
<td>13</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>68.4%</td>
<td>31.6%</td>
<td></td>
</tr>
<tr>
<td>Nonadopter</td>
<td>81</td>
<td>9</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.1%</td>
<td>88.9%</td>
<td></td>
</tr>
</tbody>
</table>

$P^2 = 85.00\%$
Table 5. Standardized discriminant function coefficients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Coefficient</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_2$</td>
<td>Number of wives in household</td>
<td>0.31</td>
<td>4</td>
</tr>
<tr>
<td>$X_5$</td>
<td>Attend agricultural school</td>
<td>0.84</td>
<td>1</td>
</tr>
<tr>
<td>$X_6$</td>
<td>Nonfarm income</td>
<td>-0.31</td>
<td>5</td>
</tr>
<tr>
<td>$X_{11}$</td>
<td>Disposition of agricultural produce decisions</td>
<td>0.45</td>
<td>3</td>
</tr>
<tr>
<td>$X_{12}$</td>
<td>Age</td>
<td>0.62</td>
<td>2</td>
</tr>
</tbody>
</table>

showed a negative coefficient value in the classification equation. This indicates an inverse relationship exists between adoption of the maize and nonfarm income. None of the other variables tested was identified by the discriminant analysis as relevant to the classification of adopter and nonadopter groups. (See Appendix C for unstandardized function coefficients and an example of the classification equation.)

Conclusions

Maize is an important crop in Zaire. Although the yield potential of maize in Zaire is comparable to the best yields obtained in the world (CIMMYT, 1978), the Zairian farmers harvest only a fraction of this potential. As a consequence, there are frequent maize shortages and the country is forced to import expensive maize and other food grains in order to even minimally satisfy the demand. Increasing the yield of maize produced by small farmers could alleviate shortages
and reduce the need for food imports. The introduction of improved adopted varieties offers a relatively simple means to increase yields.

One objective of this study was to determine the extent of adoption of an improved variety, Kasai I, in northern Shaba, Zaire. The introduction of Kasai I is a component of the jointly sponsored PNS project aimed at self-sufficiency in maize. The new variety has been available since 1978. Although there was no formal extension program in Kongoy, by the end of the second planting season of 1980, 22 percent of the 100 households sampled indicated that they had knowledge of the new variety. About 60 percent (13 of 22) had received their information from a PNS employee. The others had heard from friends and relatives. It is not within the province of this study to assess whether or not reaching 22 out of 100 households in a two-year period is an acceptable rate of information diffusion. However, both informal (PNS employees) and nonformal (friends and relatives) channels have been identified and both should be capitalized upon to further the spread of information on improved varieties.

This study was concerned with analyzing the extent of adoption. Nineteen of the 22 households (86 percent) who had knowledge of the new variety included it in their production schemes. This indicates that merely informing more farmers about the availability of the improved variety might considerably increase its use in the area and consequently increase yields of maize for that area.
Knowledge of the existence of the new variety was then a crucial factor in distinguishing between those who adopted and those who did not. Identification of other characteristics which distinguished the adopters from the nonadopters could facilitate the planning of programs for effectively communicating the information on the new variety by allowing extension agents to concentrate their efforts on farmers who would be most likely to adopt if they knew of the variety.

Attendance in an agricultural school and age were the most important variables discriminating between adopter and nonadopter groups. Agricultural school in Zaire is organized in the European fashion and is an option for the last three years of secondary school, roughly equivalent to our high school. It combines classroom study with practical experience. The average age for the heads of household in the adopter categories was 49 years. The mean age of the nonadopter group was 43. Having attended agricultural school and being of older age both were characteristics of the adopter group. Both of the characteristics probably indicate financial security and perhaps less aversion to risk.

Decision making within the household and the number of wives were also variables used in the classification of the groups. Those families where the adult female member(s) of the household either made the decision dealing with the issue of disposition of agricultural produce (i.e., allocation to either marketing or home consumption) herself or in conjunction with other family members
were more likely to fall into the adopter category. The number of
wives in the household was also a discriminating variable, meaning
the polygamous household was also more likely to fall into the
adopter category.

Nonfarm income was observed as a negative coefficient in the
discriminant analysis indicating those farmers with an income other
than from agricultural pursuits were likely to be placed into the
nonadopter category.

With these five variables, 85 percent of the household heads
were accurately classified into either the adopter or nonadopter
groups, showing that these two groups are separate and contain
individuals with characteristics distinct for each group. The
discriminant function and classification equation show promise for
further application in the Kongoy area, but care should be taken in
their application to other geographic areas.

The main implication of this research is that a concentrated
effort at informing farmers in the Kongoy area is necessary to
increase adoption rates and thus increase yields of maize. If the
goal of extension program is to reach those farmers most likely to
adopt, efforts should first be aimed at farmers who have attended
agricultural school, have more than one wife (hence are probably
older), and have no income other than from farming.
Bibliography


SUMMARY AND CONCLUSIONS

The economic development of Africa is a major challenge in the modern world (Kamarck, 1976a; Moussa, 1971; Poland, 1980). The predominantly agricultural society suffers from food shortages, basic commodity scarcities, and the lack of services. Ninety percent of the population live on farms (Lele, 1976). "The key factor for economic development in most of Africa is still, therefore, agriculture" (Kamarck, 1971, p. 126).

Technological change in agriculture, resulting in increased productivity, is viewed as a principal vehicle for rural development. The worth of increased agricultural productivity is rarely questioned, but the definition of appropriate means to achieve this desired goal provokes considerable controversy. This research welds two areas of inquiry affecting the design and implementation of agricultural development programs; the differing roles of household members in agronomic decision making, and the adoption patterns of a specific agronomic innovation. The planners of programs promoting technological change need detailed information on small landholder agricultural production patterns. Clarification of the decision making roles for the household unit, the factors affecting acceptance and adoption of improved technology, and the perceived constraints to increased agricultural production is necessary for responsible policy making and effective program design.

Specifically, objectives of the study were:
1) To describe the system of agricultural production within which small farmer household units live and work in northern Shaba, Zaire.

2) To examine the decision making roles within the small farmer households of northern Shaba, Zaire.

3) To determine the extent of adoption of an improved maize variety in northern Shaba, Zaire, and determine characteristics which allow classification of the sample into adopter and nonadopter groups.

The research was conducted in Kongoy, Shaba, Zaire. The Agronome de Zone recorded 5,718 persons living in 1,012 households registered as farming at least one hectare. One hundred of these households were randomly selected from the census data to be included in the study. Data were collected from the 255 adult members living in these households. Adults were defined as those individuals either married or at least 18 years of age. Twenty-five of the families were randomly selected from the original sample to be monitored weekly during the agricultural year, August, 1979, through May, 1980.

The interview instrument and procedures were pretested in the geographic area, but outside the research site. The data were collected during February and March, 1980. The interviews were carried out either in the local vernacular, kiHemba, or kiSwahili.

The focus of the interviews was on production patterns and included basic information on the individuals and the household unit. Record was made of knowledge and adoption of an improved maize variety, utilization of recommended agricultural practices, communication
channels used by the farmer, decision making within the family unit, and labor allocation within the family. Subprograms from the Statistical Package for the Social Sciences (SPSS) were used for computer analysis.

The history of the political, economic, and production sectors of Zaire provided a base for understanding the current state of affairs. The "discovery" of the Congo and subsequent opening of trade in slaves, ivory, and rubber precipitated many social and economic changes in rural communities. During the exploitative reign of King Leopold II, brutal policies of enforced rubber and cotton production led to a decline in subsistence production. The colonial government's single objective was to create a system to enrich Belgium. A policy favoring the establishment of large extractive companies profoundly affected agricultural production during this time. The policy resulted in a deterioration of the quality of diet and a reduction in production of locally consumed foods.

Remnants of this colonial past were quite evident in every sector of the Zairian society at the time of independence. The political and social chaos that resulted at that time came as no surprise to astute observers of the situation.

Mobutu Sese Seko took power in 1965 and managed to restore civil order. The present government, often labeled a kleptocracy, has been characterized by an increasing concentration of power in Mobutu's hands. A deterioration of services, lack of planning and coordination, and omnipresent system of graft cannot help but make one
wonder if it is indeed "...a potentially permanent situation" (Gran, 1979a, p. 1).

The first section of the research findings presented a case study of small farmers in the northern portion of Shaba province. Shifting cultivation in the tropics, with an emphasis on the slash and burn method, was described in a social and cultural context. Examination of the subsistence farming system and production patterns revealed the complex physical and biological conditions the Kongoy farmer deals with. Division of labor and perception of major constraints to production were investigated.

Traditionally, agriculture in Zaire is based almost entirely on family labor; however, some individual farmers in the sample supplemented their family labor with hired workers. Only 14 of the families in the survey reported they had hired labor sometime during the agricultural season. The men are primarily responsible for the clearing and burning of the fields and the digging of the fields preparatory to planting. Women are primarily responsible for the tasks of planting the crops and the harvesting. The study revealed that for many tasks, the men and women performed the agricultural work together.

The major constraints to increased agricultural production were ranked by the sample. Those constraints dealing with labor (lack of hand tool and personal health) were ranked as being more constraining than those items dealing with policy issues (inflation, unfair merchants, no markets, or availability of credit).
The second section of data examined the decision making roles within the rural African household. Agronomic decisions were, for the most part, made by the head of the household. However, decisions dealing with how agricultural produce was disposed of were made by the women of the household. Other family members showed a high level of agreement that these decisions were made by the head of the household and that the women of the household made decisions dealing with the disposition of agricultural produce. There was no difference in these roles between those families headed by females and those with male heads. There is little evidence that decision making was delegated along male/female lines, but rather was the responsibility of the household head — be it male or female.

The adoption of an agricultural innovation was analyzed in the third section. The decision to adopt an improved variety maize was generally made by the head of the household. Discriminant analysis was used to identify the characteristics used to classify the sample into adopter and nonadopter categories. The cases in the sample were classified into adopter and nonadopter groups with an 85 percent accuracy by using the unstandardized function coefficients in the equation derived through discriminant analysis.

Implications of the Research

There are many implications that can be drawn from the conclusions of this study. They should be noted for the development of policy plans and program designs. The once sufficient and profitable agricultural sector in Zaire has deteriorated to a point where the country
is being forced to use scarce foreign exchange to maintain a basic food supply for the population. The failure of the present system of production to meet even subsistence needs is not entirely an agronomic problem. The legacy of colonial management, compounded by the current agricultural policy, has failed to provide incentives to small farmers. In fact, the policies have discouraged the production of market commodities by placing ceiling prices on raw agricultural products, allowing the market infrastructure to deteriorate, and establishing a system that almost requires graft and under-the-table dealings. The unfair terms of trade for the farmer definitely discourage the incentive for production beyond what the household unit can consume itself.

A knowledge of the history and those events which have led to the present situation, a familiarity with agricultural adaptations to the physical environment, and an awareness of the total social system are necessary before even beginning to design programs. Because of the complex structure of traditional or shifting agriculture, encompassing responses to numerous stimuli of varied origin (e.g., climate, market place, kinship) which are integrated into the environmental setting and cultural surroundings, any attempts to modify or "develop" this process should be approached carefully. Although a myriad of "solutions" seem to present themselves to the quite obvious discomforts and problems evident in the subsistence household, consideration of these must be made in view of the total structure. If there truly were easy single-factor solutions for the
small farmers, would they, experts in dealing with their own environment, not have already discovered these within the context of their present situation?

Agriculture is a key factor for economic development in Zaire. Before agricultural production can be increased, appropriate strategies must be defined. One factor affecting program planning for technical change in agriculture is the decision making roles within the household. A farming system can be viewed as a series of decisions. In order to change any aspect of the system, it is necessary to influence the decision maker.

Previous studies and related literature dealing with decision making in rural African households merely point to the general ambiguity surrounding the subject. Recent efforts to create a women's component in development projects have only distorted the issue. While it is true women do perform much of the agricultural labor, they seldom act as an entity separate from the household unit. This study indicates that the decision making power is concentrated in one person. The family showed great internal consistency in accepting the household head as the major agricultural decision maker. If, as found in this survey, the household head does make the majority of the agronomic decisions, the message should be tailored to meet this audience, male or female.

This is not to say that development activities should ignore women who are not heads of households. These findings should especially be noted in extension programs. Even though the male head
of the household may receive the information about and decide to adopt an agricultural innovation, it is often his wife who performs the related agricultural work and who must be familiar with any particular requirements or nuances of the innovation.

The willingness to adopt agricultural technologies is an important factor affecting development program planning. Statistical analysis of adoption characteristics was done to derive a classification equation for adopter and nonadopter groups. An equation accurately classifying 85 percent of the sample was derived. However, additional trials and field tests are necessary before the application of this equation can be recommended for use without reservations. The potential application for such an instrument is obvious. Program developers and implementers at the grass-roots level could easily classify the populations and readily discern those individuals most likely to adopt. An equation would give them the information required for focusing dissemination information and efforts. Further refinement of this or a similar equation would be an immense contribution to development-related literature and practical knowledge.

To summarize, program planners should have a thorough understanding of the existing system of production and the context in which it operates, design their programs to influence decision makers, and recognize characteristics which promote a willingness to adopt agricultural innovations. Hopefully, this study will aid in defining means to achieve the goal of increased agricultural productivity in Zaire and other developing countries.
Recommendations for Further Research

Research addressing the issues preventing maximum agricultural production in the tropical areas has long been neglected. This deficiency has only recently begun to be corrected. Much more needs to be done. Questions arising from this study are listed below.

1) More basic data are required for better understanding of subsistence farmers.
   a) Further research is required into the nature of tropical soils.
   b) Production patterns should be further examined.
   c) The indigenous knowledge systems dealing with soil classification and crop rotation patterns should be explored.
   d) Attitudinal research dealing with perceived constraints to increased agricultural production should be conducted.

2) Decision making roles within the African household need additional study.
   a) Ramifications of the female household members making decisions dealing with agricultural produce disposition should be examined.
   b) Examination of the interrelationships between decisions made about production and those decisions made for consumption should be made.
   c) Investigation of inter-household information systems concerning decisions made by the head of the household
involving changes in the production pattern should be undertaken.

3) Adoption and diffusion patterns require further examination.
   a) A time study should be conducted in the research area to determine if the present adoption trends continue.
   b) The failure to adopt recommended agricultural practices at the same rate as the improved variety needs exploration.
   c) Further refinement of the classification equation for field application should be done.

This list is by no means inclusive. The economic development of Agrica is a major challenge in the modern world. Much research needs to be done on agricultural production in developing countries.
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ACKNOWLEDGMENTS

This study marks the culmination of several years' effort. Many have aided along the way: Dr. David Williams, who served as major professor; and committee members Drs. Harold Crawford, Richard Carter, J. K. Hvistendahl, and Robert Thomas, who accepted a desire to do research in Africa as not too bizarre; and the Agricultural Education Department who provided support for two years of on-campus study.

Staff and members of Peace Corps-Zaire, and US AID Project North Shaba provided both material and moral support during some trying moments in the duration of the field-work.

Literally hundred of Zairians cooperated without question, and in the process brought many things into perspective, both about another culture and the United States.

Many others contributed in various and assorted ways; hand carrying data sheets across the Atlantic, using precious home-leave time to make phone calls and purchase items, hunting down and mailing obscure publications, six months' rent-free use of a typewriter, and encouragement and understanding during the tedious process of writing.

In a special category; Sarah Harper, who invested 27 years of faith and love; Suzanne Poland, who endured sleepless nights to discuss Africa and who moved out of her apartment for several weeks to provide a conducive environment for writing; and the late L. H. Menn, who tried to embody in all of his students his own love of learning.
APPENDIX A.
HOUSEHOLD COMPOSITION AND DEMOGRAPHICS

The data for this study were collected from 100 farming households randomly selected from the Agronome de Zone census data for the localité of Kongoy. Personal interviews were conducted with all adult household members. Adults were defined as those individuals living in the family unit that were either married or 18 years of age.

The sample included 113 males and 142 females. Eighty-eight of the males and 12 of the females were heads of households. There were 84 first wives, 37 second wives, and seven third wives in the sample. Twenty-two sons and two daughters lived in the households at the time of the survey. Three grandparents were living in the households studied.

Household head ages ranged from 20 years to 68 years, with a mean of 44.5 years and a mode of 48 years. This contrasts with all family members surveyed who had an age range of 13 years to 68 years, with a mean of 37 and a mode of 20.0. The median age for all adult household members was 35.8.

Male household heads ranged in age from 20-68 with a mean of 44.5 and a mode of 31.0. Female household heads ranged from 30 years to 62 years in age. The mean for female household heads was 44.4 and the mode was 48.0.

Among the 12 female headed households in the sample, nine reported that they were the only adult in the household, one reported that there was another adult woman living in the household, and two
female household heads reported that they had two other adult women in their household. Among the male headed households sampled, two reported that they did not have a wife, 52 reported that they had one wife living in the household at the time of the survey, 30 reported that they had two wives in the household at the time, and four reported three wives.

The 578 children recorded by the study were children of all ages claimed by the respective heads of households. Eleven households reported they had no children, with the remaining 89 reporting a range of one to 17 children. Seventeen households reported having between 10 and 17 children. The mean number of children was 5.7 with a mode of 5.

Eighty-four of the household heads reported that they could read and write. Fifty percent of the female household heads said they were able to read, while 78 percent of the male household heads reported being literate. Fifty-six and nine-tenths percent of the total sample surveyed indicated they could read and write. All individuals in the survey that could read said they were able to write.

One hundred ten (43.1 percent) of the total sample said they had never attended any school. The remaining 145 reported between 2-11 years, with 66 (or 25 percent) indicating they had attended six or more years.

When broken down by household heads, 83 percent reported having attended some school and 31 percent said they had received six or more years of instruction. Seventy-seven (87.5 percent) of the male
household heads reported some school, contrasted to six (50.0 percent) of the female household heads.

Eight individuals (3.1 percent) said they had attended agricultural school. Two reported one year, four reported two years, and two reported three years. All of these were male, and six of them were heads of households.

Seventy-eight of the households reported that they had at least one child in school. The number of children attending school from the family ranged from one to ten for a total of 256 children enrolled at the time of the survey.

Twenty-eight individuals (10.5 percent) reported sources of income in addition to farming. All but one of these individuals were male, and all but three were heads of households. The types of jobs named were merchant (one individual), hunter or fisherman (two), church or government employee (12), paid laborer (five), skilled craftsman (four), retired on a pension (four), or school teacher (one).

One female household head indicated she was retired on a pension, one male dependent worked as a paid laborer, and two were skilled craftsmen. Eight of these 28 reported that their other sources of revenue provided a larger income than their farming did. All of these eight were male household heads.
APPENDIX B.
DESCRIPTION OF DISCRIMINANT ANALYSIS

Discriminant analysis was used to identify characteristics which would aid in the classification of individuals into adopter and non-adopter groups. The Statistical Package for the Social Sciences (SPSS Update, 1979) has developed a program of discriminant analysis to be used in psychological and educational research in an attempt to determine characteristics of individuals in different groups.

Discriminant analysis may be compared to regression analysis. In regression analysis known values of a dependent variable are used to derive a function which can predict future values of the dependent variable. Discriminant analysis uses a classification of the data into various groups to determine a linear function which is used to predict group membership.

The objective of discriminant analysis is to find the combination of variables (from \( X_1, X_2, \ldots, X_k \)) which "best" discriminates between the groups. "Best" is defined as the function that maximizes the ratio of the between-groups sum of squares to the within groups sum of squares.

If \( k \) explanatory variables have been hypothesized a priori to discriminate between the groups, the problem remains to choose the subset of these variables which possess the most discriminating power. The forward selection stepwise method used in the computation procedure can be used to find these variables. In this method, each variable is added into the equation until a satisfactory level of explanation
has been achieved by the combination of the variables. The selection of a variable into the equation is done based on statistical tests.

At each step in the procedure, the variables are divided into two different categories, one which has variables included in the discriminant function, the other which includes those not in the functions. The within groups sums of squares and cross products matrix is then computed. The total sums of squares and cross products matrix is also calculated. Then, using the within groups sums of squares and cross products, the within groups covariance matrix, and the within groups correlation matrix, are calculated.

The correlation matrix (Table 2) indicates both the magnitude and direction of relationship between variables. If the value is closer to 0, this signifies little correlation, while a value closer to 1 signifies a high level of correlation. A positive coefficient indicates a positive relationship between the two variables while a negative coefficient indicates a negative relationship.

The significance of each function is evaluated using the Wilks' lambda statistic. This represents an inverse measure of the discriminating power in the original variables not removed by the discriminant functions. If the value of lambda is large, less information is in the remaining variables. The significance of the function is tested by transforming lambda into a chi-square statistic.

Coefficients are calculated for each variable in the function during the computation of the discriminant functions. By using these
coefficients, it is possible to rank the variables according to their level of importance.

Another portion of the discriminant analysis procedure is the classification process. This is a test of the power of prediction of the function in which cases are classified into predetermined groups, based on measurements of the discriminating function.
APPENDIX C.
DISCRIMINANT ANALYSIS CLASSIFICATION EQUATION APPLIED

Using the SPSS Update program (1979), an equation was derived to classify individuals from the sample into groups (adopter and non-adopter) that had application for "field" work. Rather than using all data gathered in the survey, only that information that would be readily available or observable was used to develop an equation application for rapid assessment of areas by development project personnel. This was done to minimize the need for hard to obtain or hard to verify data. The following variables were tested through discriminant analysis:

- $X_1$ = number of wives in the household (actual number recorded)
- $X_2$ = years in school (actual number recorded)
- $X_3$ = attendance in agricultural school ($0 = \text{no}, 1 = \text{yes}$)
- $X_4$ = age (recorded in number of years).

It was found that using only three of the variables listed above, an equation accurately classifying 85 percent of the sample could be derived. Using the unstandardized canonical discriminant function constant (-2.94) and the unstandardized discriminant function coefficients for the three variables, the following equation is written:

$$\hat{y} = -2.94 + .61(X_1) + 3.96(X_3) + .04(X_4).$$

Using data from an actual case, the equation becomes:
\[ \hat{y} = -2.94 + 0.61(1) + 3.96(1) + 0.04(31) \]
\[ \hat{y} = -2.94 + 5.81 \]
\[ \hat{y} = 2.87. \]

This equation summarizes the results of the stepwise procedure. The three variables produced a high degree of classification, or separation, between the two groups, as indicated by the final Wilks' lambda statistic (.74) and the canonical correlation (.50) for the discriminant function.

Because there were only two groups, only one discriminant function was possible. The unstandardized coefficients are used to obtain a discriminant score for the function by multiplying each coefficient by the respective variable value and summing the products plus the constant. The value is then compared to the group means or group centroids. These were 1.20 for the adopter group, and -0.28 for the nonadopter group. The computed value of \( \hat{y} \) is compared to these scores, with the case being classified as falling into the adopter or nonadopter group depending on which group centroid it is closest to.

This classification equation yielded an 85 percent accuracy of correct assignment of cases into adopter and nonadopter groups for the sample data. There is no reason to suspect that the accuracy of this equation would be much different when used in the field.

The 15 cases incorrectly classified are "marginal" and located in what may be defined as a zone of ambiguity around the dividing point between the two group means. Separate analysis of these cases failed to uncover any similarities among them.
APPENDIX D. QUESTIONNAIRE
1. Mwanamuke ao Mwanamuke?
2. Mwaka wa kuzaliwa?
3. Hesabu ya wabibi?
4. Kama waye ni bibi, uko bihi ya ngapi?
5. Umri ya watoto yako?
6. Wangapi wana kusaidia ku kazi ya shamba?
7. Ginsi gani munasaidiana ku kazi ghamba? AU, Kushamba, Banatumika kazigan?
8. Wangapi wana fuata masomo?
9. Unajua kusoma na kuandika?
10. Miaka ya masomo?
11. Masomo ya mulimo (kilimo)?
12. Muna tumika kazi ingine isipokuwa shamba?
13. Kazi yako ni nini? Au kama una tumika kunyumba, unafuanya nini?
14. Zaidi ya makuta yako inatoka kukazi gani? Kazi ya kunyumba aushamba?
15. Watu ngapi ni wakulipwa?
16. Kushamba, wanatumika kazi gani?
17. Munawalipa namna gani?
18. Kujamaa yenu mukona mashamba? Enec goni?
19. Weye, ukona mashamba? Eneo gani?
20. Unapanda mimea gani?
22. Kushamba yenu munatumikambegu ya mihindi ya aina gani?
23. Namuna ao ginsi munapanda mbegu ya mihindi?
24. Hesabu ya mbego kwa shimu moja?
25. Mtengano wa mashimo ao distance kati ya mashimu mbili?

Nani ni mkubwa kati yenu:
26. Mimeo gani? Nani ni mukubwa kati yenu?
27. Wapi munapanda nani alichagua nafasi ya kulima?
28. Kamo mpanda shamba mpya (mbichi)? Nani alichagua nafasi mupya?
29. Ngapi ya mihindi munapanda? Nani alichagua aina ya mulfindi mupya?
30. Mihindi mupya ao mihindi traditionel? Nani alichagua mupya ao wazam?
31. Namna ya kupanda mupya? Nani alichagua namna ya kupanda mupya?
32. Mwezi wa kupanda nani alikuambia mwezi wa kupanda mupya?
33. Mwezi wa kupalilia? Nani alikuonesha mwezi wa kupalilia?
34. Mwezi wa mavuno? Nani alikuonesha mwezi wa kuvuna?
35. Nani kati yenu anatafuta musoko? Nani kati yenu anauzisha musoko?

36. Ni mazao gani munapeleka kusoko?
37. Mazao yenye kupelekwa kusoko ina kilo ngapi?
38. Soko iko fasi gani?

Nani anafanya? Mara ngapi?
39. Ni nani analima mashamba? ....................................................
40. Ni nani anaechima shimo ya kupanda? .................................
41. Nani anapanda? ..............................................................
42. Nani anakupalilia? ...........................................................
43. Nani anapalilia mara ya pil? .............................................
44. Nani anaefanya mavuno ya skamba? ........................
45. Nani ana tosha maganda ya muhindì? ........................

Kuvuna mazoa

46. Katika mazoa yenu, zaidì munauza ao munakula? Nani anauza?
   47. Makuta mingì.
   48. Makuta kidogo.

49. Kama munauza mazoa yenu, makuta (faida) ni ya nani?
   50. Makuta unayopata, munaitumia namna gani?

51. Ulisikia habari ya muhindì i mupya?
52. Unajua ngapi?
53. Namna ulisikia?
   54. Wakati ngani?
55. Nani, alipata mbego ya muhindì wakwanza? 
   56. Namna gani?
57. Nani, alifanya kazi ya kupanda muhindì mupya?
58. Nani alipanda wakwanza?
   59. Mwaka wakwanza, munapanda kushamba yote?
   60. Sasa, unapanda shamba yote?

Munafanya habadiliko kwa mulimo mbele ya kupanda muhindì mupya?

Umbali-mpali gani katika miaka ya mashamba

61. Shamba zaidì shamba ya zaidì (ya pili ao ingine)?
62. Shamba kubwa?
63. Muhindi zaidì/mimea ingine ndogo?
64. Munauza kwa wingi?
65. Nani anapata benefice kwa hii?

66. Vivu ingine - nini?

Tengenaza (panda)

67. Hakuna bei muziri kwa mazoa bei ya mazoa si nziri?

68. Unagonjwa unasikiaka magonjwa?

69. Unachelewa chombo?

70. Unataka tractor?

71. Bei yote inapanda?

72. Bei ya commerçant si sawa?

73. Kuchelewa dawa ya shamba Unapenda dawa ya mashamba?

74. Ingine nini?