PN-ABU-049
93186

FEWS Working Paper

A.I.D. Famine Early Warning System

INCOME DIVERSIFICATION in MALI: ANALYSIS and METHODOLOGY for VULNERABILITY ASSESSMENT

FEWS Working Paper 2.6

by
Thomas R. Fattori

June 1992

The U.S. Agency for International Development reserves the royalty-free, nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use, this document for government purposes. This document was prepared under the FEWS Project (Project No. 698-0466, Contract No. AFR-0466-C-00-9035-00).

Income Diversification in Mali:

Analysis and Methodology

for

Vulnerability Assessment

by **Thomas R. Fattori**

The Pragma Corporation
116 East Broad St.
Falls Church, VA 22046

in collaboration with

Paul Bartel, FEWS
Charles A. May, FEWS

June, 1992

Tulane/Pragma Group
1611 N. Kent St., Suite 511
Arlington, VA 22209 USA

Consultancy report for the
Famine Early Warning System (FEWS) project

Table of Contents

I. Introduction **1**

A. Terms of Reference 1

B. Products 1

C. Rationale 1

II. Framework for Vulnerability Assessment **2**

A. Current FEWS Vulnerability Assessment Methodology 2

B. Expanding Current Methodology 2

III. An Approach to Vulnerability Assessment **3**

A. An Approach 3

B. An Illustrative Example 3

IV. The Approach Visualized **5**

A. Production Systems vs Administrative Units 5

B. Integrating Regional and Production Systems 6

C. Diversification and Risk 6

D. Driver and Qualifier Matrices 9

V. Driver Matrices - Quantifiable Indices **9**

A. Agro-Climatic Matrix 9

B. Demographics Matrix 11

C. Production Matrix 12

D. Technical Opportunities Matrix 12

VI. Production Systems - Qualifier Indices **13**

A. Production Systems Analysis 13

B. Production Systems Defined 14

VII. Recommendations for Operationalizing Vulnerability Analysis **15**

A. Administrative Units Stratified by Production Systems 15

B. Production Systems Stratified by Income Components 15

C. Income Components Stratified by Income Activities 19

D. Income Activities Stratified by Subsistence or Exchange 19

VIII. Notes on Household Income Diversification Strategies **21**

IX. Bibliography **22**

X. Acknowledgements **22**

I. Introduction

A. Terms of Reference

The USAID/Mali Disaster Relief Action Group (DRAG) requested the FEWS project to provide technical assistance to the FEWS representative in Mali in order to develop an operational schema (database) of income components for use in household income analysis. This database will be used in the on-going process of monitoring famine vulnerability nationwide.

Specifically, the objectives of this consultancy can be stated as follows.

The consultant will conduct a literature review and synthesis of important information in order to increase the general understanding of vulnerability for various socio-economic groups of people in rural and urban Mali. The consultant's report will characterize these socio-economic groups (production system) in terms of their diversity of income generating activities and define where they are found spatially in Mali. The term production system as used here goes beyond an agricultural production analysis to captures all possible income generating activities by the household.

The consultant will develop a database of the identified production systems which can be used by mapping and analytical software.

The consultant will expand the current set of indicators used by the FEWS analyst (see FEWS for methodology) for measuring vulnerability at the household level based on findings during the literature review.

The consultant will recommend ways to operationalize this knowledge for the purpose of monitoring vulnerability in the form of a word processed document.

The consultant will present preliminary findings to the DRAG before departure from Mali.

B. Products

The consultant provided the FEWS project with the following products derived from this consultancy.

An analytical tool (series of matrices) that define in relative terms household-level income-generating activities that are pursued by specific production systems. The series of matrices, currently in spreadsheet format can be used by the analyst to enhance the specificity of a vulnerability assessment program.

A methodology (approach) for expanding the current conceptual framework for vulnerability assessment by geo-referencing identified production systems, characterizing how the production systems derive income, and linking this information to a set of quantifiable indicators.

A packaged presentation of charts, diagrams, and graphs that can be used in workshop or seminars on vulnerability analysis. The package is presented in both hard copy and digitized format.

An annotated bibliography on food security-related issues (submitted separately) in both hard copy and digitized format. Rural development and food security databases in the Ibiscus, Tropag, Agricola, USAID/Library, and Michigan State University African Library accessed and information compiled into a complete annotated bibliography.

Recommendations on how to operationalize are made on pages 21-28 in this document.

The consultant presented the draft report to the DRAG in Bamako, Mali on June 10, 1992 and to the FEWS Washington office on July 15, 1992.

C. Rationale

Mali is a tremendously diversified country with regards to the environment, geography, people and their culture. To understand how the people have adapted numerous income-generating strategies to the risks imposed by a precarious and harsh environment, it is necessary to dis-aggregate all relative information into specific economic activities. These activities are further stratified into income derived from subsistence and/or exchange activities.

The thesis of this report is the recognition of a need for an approach to vulnerability assessment that can capture how various population groups in Mali, defined at the household level, have adapted to seasonal fluctuations in their ability to produce and access adequate levels of food nutrients. The approach begins with the premise that household's seek opportunistically various income-generating activities, both for subsistence and exchange, in order to optimize their general welfare.

The following approach and analytical tool presented here will enable decision makers to go beyond aggregated reporting and assess at the household level how a crisis or even a development project will impact on the livelihood of specific groups of people.

More specifically, decision makers will be able to:

- determine who is vulnerable;
- defend why they are vulnerable;
- define their normal state of vulnerability; and
- predict (somewhat) how specific production systems will alter their income-generating activities in response to negative or positive change.

The "tool" that will be presented here is essentially a database of agro-physical and socio-economic factors that characterize in relative terms the level of vulnerability for various socio-economic groups of people. The files are presented in Lotus 123, v3.1 format to facilitate data revision and manipulation.

II. Framework for Vulnerability Assessment

A. Current FEWS Vulnerability Assessment Methodology

FEWS vulnerability assessment methodology has evolved considerably in the last two years. A good number of the pieces of a complex multidimensional puzzle have been identified and the interrelationship among most of these pieces defined. However, the puzzle has not yet been assembled into a complete image that accurately reflects regional, household or individual vulnerability to famine.

Current FEWS methodology (1991 and 92 vulnerability assessments reports for Mali) incorporates a set of short- and long-term agro-climatic and socio-economic indicators that are referenced geographically to each of Mali's 46 cercles (admin level 3).

Essentially, the Mali analyst utilizes quantifiable indicators derived from various existing databases. This approach is recognized as being limited in that it does not incorporate household-level information that characterizes human behavior (decision making), nor does it reference the various production systems to their specific administrative location.

Current vulnerability assessment methodology continues to evolve from a two dimensional approach (Figure 1) to include specific socio-economic groups of people.

Spatial Dimension. The spatial aspects of the vulnerability framework refers to specific administrative units in Mali. Current FEWS assessments have been conducted at the cercle level. This report expands this dimension to the next level or the arrondissement (admin level 4). Also, it is recognized that other spatial relationships are considered within the vulnerability assessment framework (e.g., average distance to market), however the discussion of spatial stratification relates here to geo-referenced administrative units. Mali is divided into 8 regions, 46 cercles and 134 arrondissements.

Temporal Dimension. Explicit recognition of the intra-annual (seasonal) and inter-annual variation in almost all factors that contribute to vulnerability to famine is made by current methodology. Current FEWS methodology looks at short-term socio-economic factors that include indicators for production, access, well-being, and economic shocks. Also, long-term indicators related to the physical quality of life, relative livestock wealth, cash crop income, remittances and riskiness of production. However, these indicators are generally aggregated and mask the effects of seasonality.

B. Expanding Current Methodology

The problem faced by the FEWS analyst is a suitable approach that incorporates the third dimension (socio-economic groups) into current methodology without overburdening the analyst with data collection requirements (Figure 2). What is needed therefore, is a database that can be coupled with the current quantitative indicators in order to enhance the quantitative picture of vulnerability with qualitative socio-economic characteristics of various groups of people. This method will enable decision makers to understand how people attempt to secure a stable livelihood, by providing insight into options and mechanisms used by the household to generate income.

The challenge is to develop a series of sets of viable indicators that capture and measure all salient aspects of vulnerability to famine by incorporating the three domains of hunger (regional, household, and individual) into a matrix that is spatially defined (geo-referenced administrative units) and temporally complete (both long- and short-term factors).

FIGURE 1

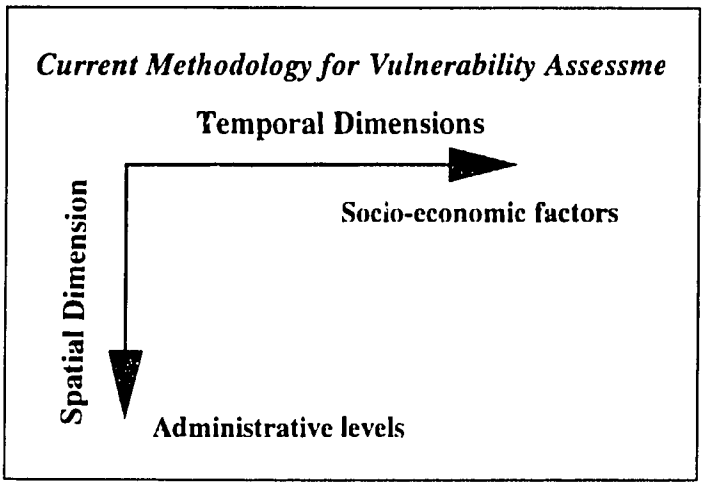
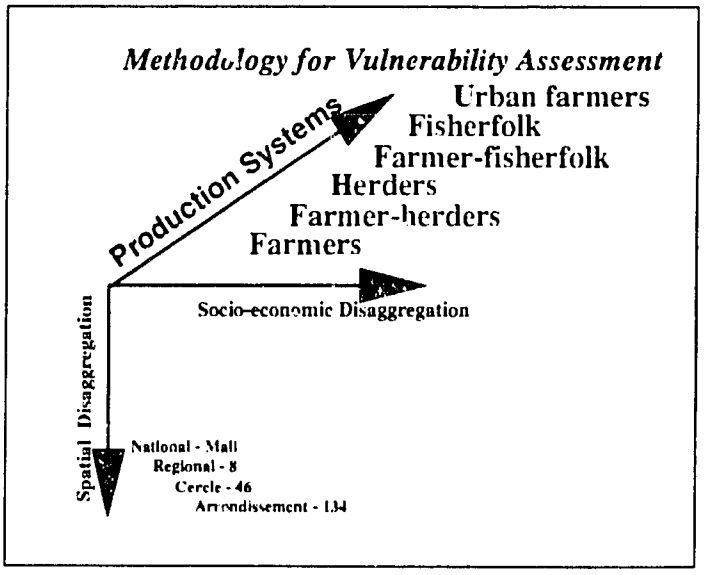


FIGURE 2



Furthermore, this challenge should be met without significantly augmenting data collection requirements on the part of the analyst.

The approach presented here recommends developing a set of four matrices of quantifiable agro-climatic, demographic, technical opportunities, and production indicators (driver sets) that can be used in conjunction with a set of matrices that characterize different socio-economic groups of people (qualifier sets).

III. An Approach to Vulnerability Assessment

A. An Approach

The approach presented here is for the development of an analytical tool within the evolving FEWS framework that can be used for vulnerability assessment without increasing primary data needs.

Expert Opinion. The procedure recommended here for expanding FEWS methodology, without a significant increase in data collection requirements, calls for accessing the relative wealth of information and knowledge already present in Mali. The recommendation is to tap into existing sources of expert information to validate or "ground truth" the qualitative information presented in the qualifier data set.

Various development agencies, governmental, non-governmental and private sector "experts" are intimately aware of local or even regional agro-climatic and socio-economic conditions. Furthermore, they are knowledgeable in their understanding of both the "normal" and "abnormal" state of affairs. Some of these expert sources conduct formal research, other have intuitive feelings based on years of experience, and all of this information is relatively available and requires a minimum of resources to pursue.

The approach is also based on systems analysis and follows a deliberate dis-aggregation (stratification) of information collected at the administrative unit level. The administrative units are dis-aggregated into specific production systems and then the production systems are dis-aggregated into income-generating activities for both subsistence and exchange.

Broadly defined, this approach views a household (rural or urban) as an income-generating unit that derives it livelihood from either subsistence or exchange activities. The household is faced with endogenous limitations on their ability to generate income, while pursuing various income activities "opportunistically" given a particular production system exploited. Furthermore, the household is analyzed in context of a hierarchy of systems where regional systems (higher level) exert exogenous constraints on the lower level household and their associated production systems.

B. An Illustrative Example

The household is in many ways similar to a small business, and it's analysis could follow a business approach. The following illustration is made to draw an analogy between the household and a small business.

In general terms, a cashflow statement is an analytical tool used to gain insight into vulnerable periods of time and sources of income that affect the ability of the business to survive financially (livelihood).

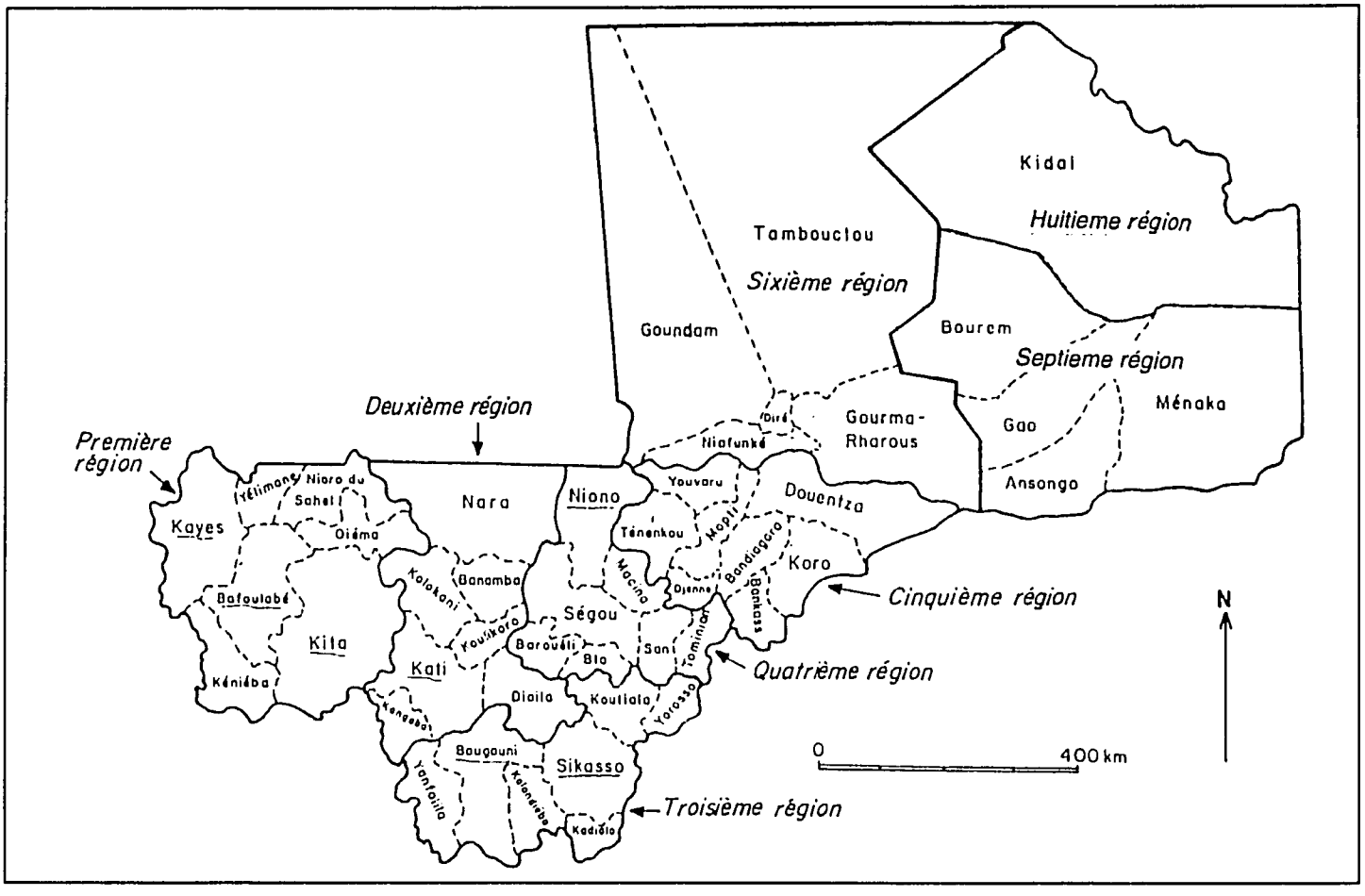
Consider the advantages of a cashflow statement for a small business (household in our case). If the statement was summarized along the temporal dimension into an aggregated annual total, insight into monthly variation in cash flows would be masked. Interpretation of the financial well-being of the business would be restricted and decisions required to respond to needed change in business activities would be made with a lower probability of success. However, this aggregated value can be decomposed by expanding the temporal axis into monthly figures. As information is dis-aggregated, understanding into deficient or problem areas is enhanced.

Similarly, as one looks down the cashflow statement at a hierarchy of categories that constitute total income and expenditures for a particular period of time, sub-totals mask how specific activities affect the flow of money through the business. Again, by dis-aggregating this information into relative shares or sources of income by activity reveals a more refined and complete set of information which characterizes more clearly how the business or household derives it's livelihood. More importantly, it enables the analyst to see more clearly the causalities of good or poor performance.

Current vulnerability assessment methodology needs the flexibility to expand and collapse an income matrix for a particular production system along all dimensions in response to specific questions or objectives set forth by the analyst. Currently indices are static and thus limited in their ability to explain underlying causalities or circumstances leading to changes in specific groups of people's vulnerability to famine.

The analytical tool presented here provides the option of qualifying an assessment through a more focused (dis-aggregated) analysis method, which greatly enhances any derived conclusions established by a purely quantitative vulnerability assessment.

FIGURE 3



IV. The Approach Visualized

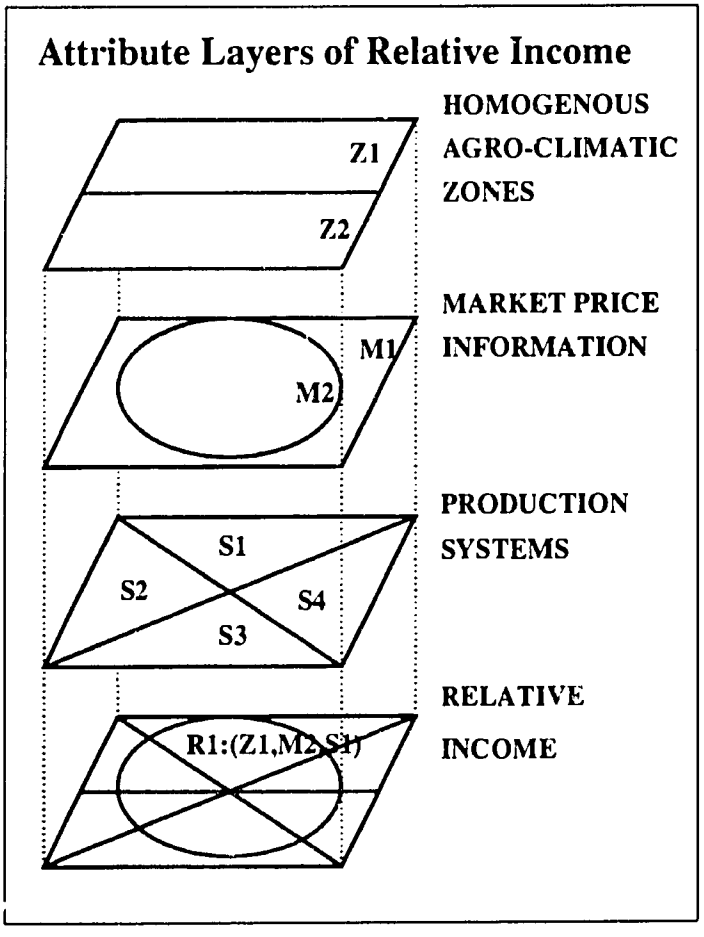
A. Production Systems vs. Administrative Units

Because socio-economic data is collected and stored at a particular administrative unit level (Figure 3), and production systems are delimited by agro-climatic factors and not only administrative boundaries, it is possible that production systems may overlap spatially.

A model of four attribute layers affecting household-level income are presented (Figure 4) to help readers visualize how information reported at the administrative level (boundaries defined by the black lined rectangle) can be: 1) divided into different agro-climatic zones; 2) influenced by the market pull of an urban area; and 3) where a number of different production systems can be operating within the same administrative boundaries.

A stratified administrative zone (Figure 5) would unmask important livelihood activities by defining relative income as influenced by climate, market area, and would be specified for a particular production system.

FIGURE 4



For example, the Mopti Cercle in Mali (Figure 6) is divided by the Niger river and the Dogon plateau from north to south. The market in Mopti has an economic influence on a geographical area that is quite different than another market town east of the Dogon plateau (e.g., Bankass). Furthermore, fisherfolk engage in income-generating activities along the Niger river that are different from the activities pursued by farmer-fisherfolk in the Niger delta; agro-pastoralists east of the Dogon plateau practice a millet-cattle based system where as agro-pastoralists west of the Niger practice a rice-cattle system.

This example serves to illustrate that aggregated information at the cercle level masks the dynamic nature and diversity of socio-economic activity within a given administrative unit. Furthermore, if a decision was to be made to assist the Mopti Cercle because of a drought crisis an appropriate plan of action could be devised. What would be the effect of importing rice versus millet for the Mopti Cercle?

FIGURE 5

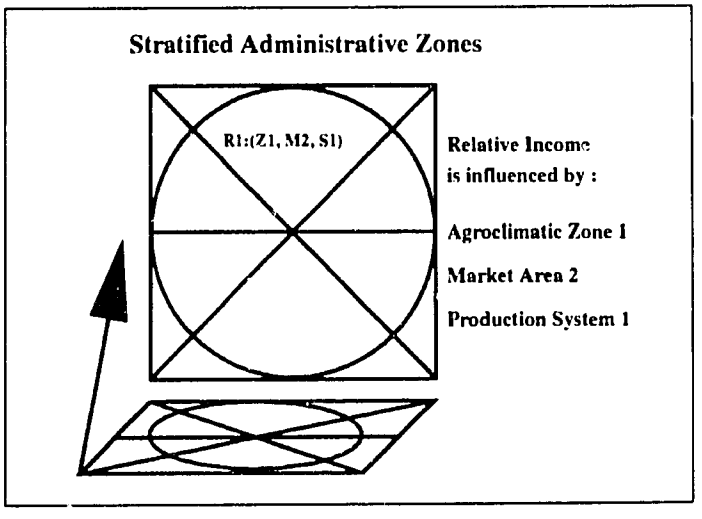
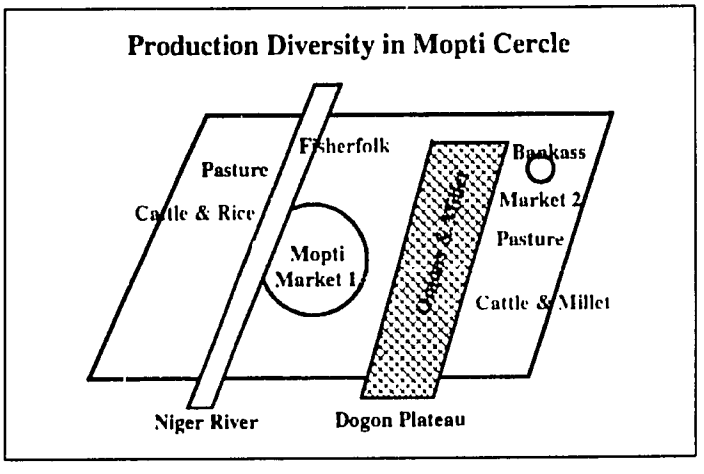


FIGURE 6



B. Integrating Regional and Production Systems

Rationale

Because of extremes in the level of diversity that exist in Mali, dis-aggregation is conducted at two levels.

Regional. Diversity of socio-economic groups (production systems) living within an administrative boundary.

Household. Diversity of income-generating activities within a particular production system.

From a regional systems perspective, agricultural and socic-economic processes are closely linked. For example, the importance of regional level infrastructure and services such as extension programs, market towns, and paved roads have been demonstrated to have a significant effect on the ability of the household to generate income.

Intermediate levels between the production system and the regional system can be villages or geographic units such as the inland Niger Delta. The regional system can be analyzed from the ecological or socio-economic perspective.

Intra-household dynamics are treated as endogenous limitations on the ability of the household unit to generate income. Furthermore, regional analysis was conducted to capture those significant factors at the regional level, exogenous to the household, that actually or potentially constrain the household's income-generating abilities.

The degree of income diversification among production systems is made evident in Figure 7. This bar graph can be used to compare relative shares of total income for the various production systems. The degree of diversity becomes even more apparent when the relative shares graphed here are further dis-aggregated into specific activities pursued by specific socio-economic groups.

C. Diversification and Risk

Subsistence "plus"

In Mali, various production (income-generating) strategies are pursued "opportunistically" with a strong bias towards minimizing adverse nutritional and socio-economic risk. Chronic food insecurity or the persistent lack of real income to assure a nutritionally adequate diet is the crux of the economic development problem. (Sundburg, 1988)

Rural and urban producers exploit their natural environment for two reasons: 1) for their own subsistence and 2) to raise cash to buy necessities and luxuries on the market. The "plus" is the remaining share of total income that is invested in assets (i.e., goats, bicycles or production equipment) that enable the household to minimize risk and potentially advance their productive capacity and ultimately their livelihood.

Income Diversification and Drought

The following data, presented in the form of a series of charts (Figure 8- 11) was taken from Moorehead, 1991 and illustrates how a production system will alter it's income generating strategy in response to a drought.

In the pre-drought year of 1981, farmer-fisherfolk in the Niger river delta derived a majority of their income from subsistence activities (Figure 8). Furthermore, the value of subsistence production of rice (Dec-Feb period) was significantly greater than any other period of the year. This observation illustrates the level of importance of seasonal effects on income-generating activities. This observation is amplified when data on income and expenditures is charted for the same year (Figure 9). In 1981 farmer-fisherfolk experienced an economic deficit in the Sep-Nov and Jun-Aug periods. This resulted in a negative balance for the year.

In the post drought year of 1985, farmer-fisherfolk derived by far the greatest share of their income from exchange activities. The degree of seasonal variation was dampened by this behavioral change to market exchange activities (Figure 10). The rationale for such a change is made evident in data presented in Figure 11. There were still deficit periods during the year, however, on balance the change in strategy enabled the household to have a positive economic balance at the end of the year.

Essentially, the farmer-fisherfolk switched from a rice-fish system (subsistence based) to a fish-rice oriented system (market oriented). The point being two fold. First, the seasonal effects on the households ability to derive adequate income to cover a minimum of needs is made evident. Secondly, production systems are driven by human behavior that is flexible and responds to conditions and constraints as needed to survive. The movement between subsistence and exchange activities was in response to negative climatic effects on rice production and opportunities presented for selling fish on the market.

FIGURE 7

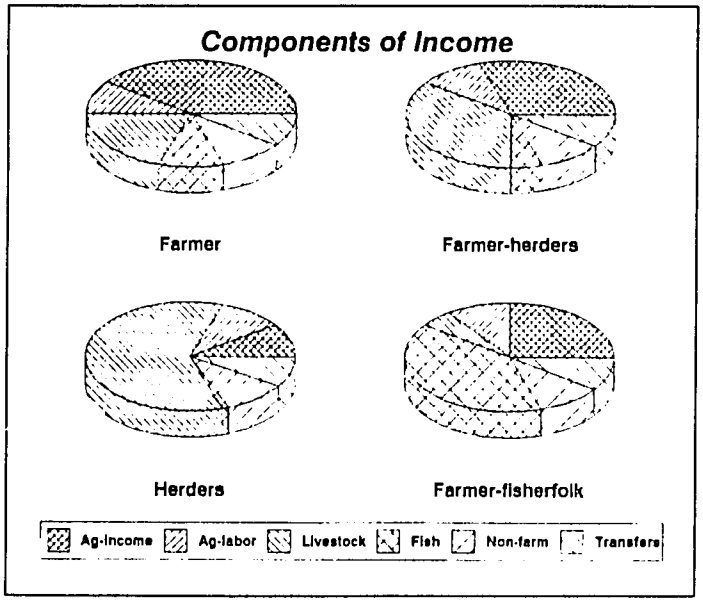
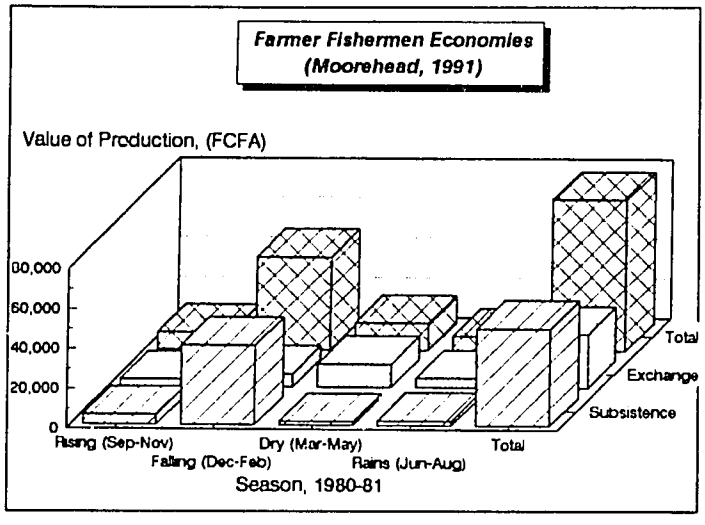


FIGURE 8



Risk Minimization

The farmer-fisherfolk example can also be used to illustrate how household decision makers minimize risk associated with production and other income-generating activities. In this case the risk of poor rice production as a result of consecutive years of drought conditions was too high and thus the decision to pursue a less risky income activity (fishing) was made.

Household decision makers will adjust their income-generating behavior in order to minimize risk to adverse agri-climatic and socio-economic conditions. For example, herders will change their grazing patterns, transhumant routes, and livestock sales strategies in response to risks associated with expected civil unrest. Farmers will change their planting patterns, field size, and shorten the distance they are willing to walk to a more productive field in response to the risk of drought or civil unrest.

FIGURE 9

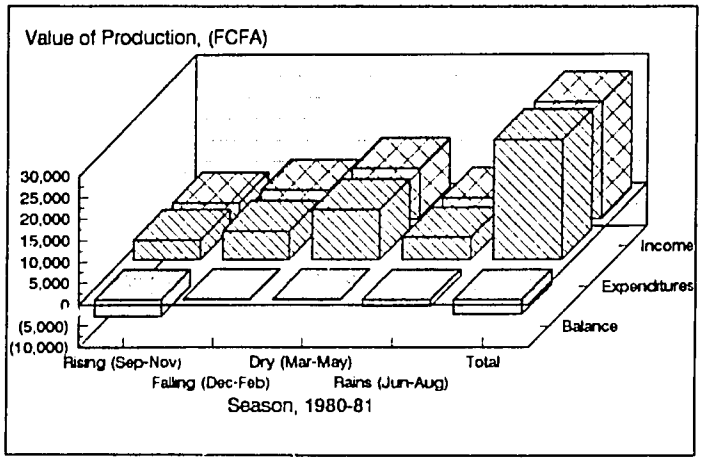


FIGURE 10

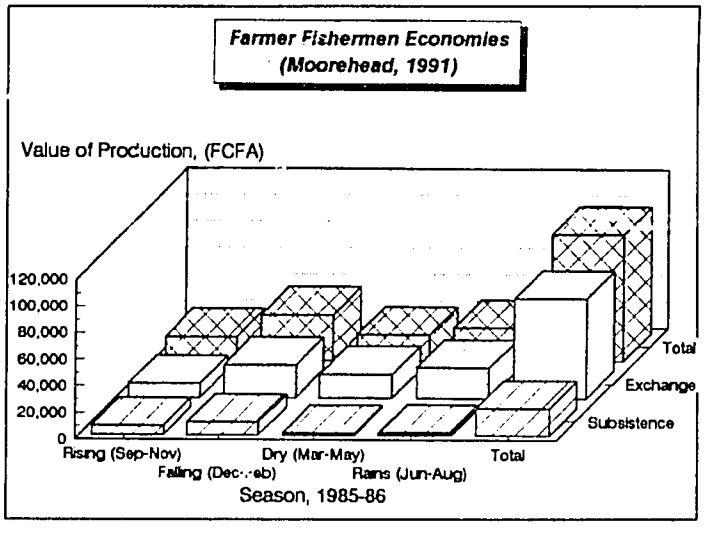


FIGURE 11

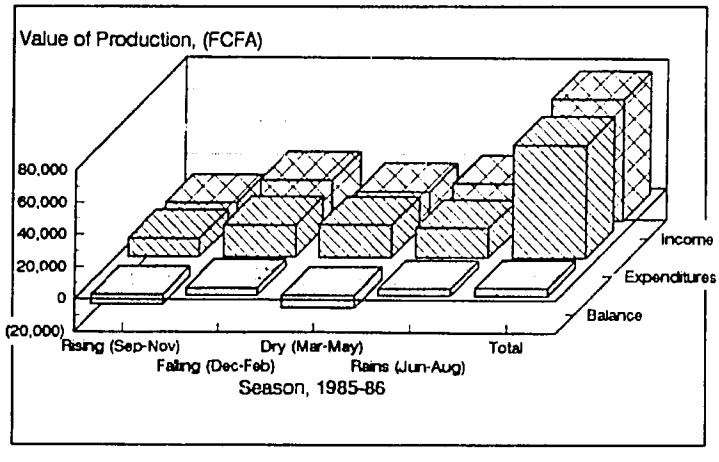


FIGURE 12

VULNERABILITY ASSESSMENT DATABASE

Cercle Arrondissement	AGRO-CLIMATIC	DEMO-GRAPHICS	TECHNICAL OPPORTUN.	PRODUCTION	FARMER SYSTEM				FARMER-FISHERFOLK			
					AGRI-INCOME	LIVESTOCK & FISH	LOCAL NON-FARM	TRANSFERS	AGRI-INCOME	LIVESTOCK & FISH	LOCAL NON-FARM	TRANSFERS
e.g., KOULIKORO												

Set of "Driver" Matrices

Example Set of "Qualifier" Matrices

ANALYSIS METHODS:

SORTING BY FACTOR, e.g., RAIN, TECHNOLOGY, PAVED ROADS, ETC.

INDEXING COLUMNS FOR GIS MAPPING

DIVIDING FACTORS TO DERIVE NEW FACTORS

MULTIPLYING FATORS

The Household Defined.

The farm household consists of a group of people, often related, who, individually or jointly, provide the management, labor, capital, land, and other inputs for the production of crops, livestock, and other income-generating activities, and who consume at least part of the farm produce. The farm household is thus the center of consumption, resource allocation, management and labor, and can consist of more or less autonomous subsystems.

Household-level management regulates the various income-generating components and their interactions within the system. Management implies decisions on objectives (e.g., investment in cash or food crops), on the way these are to be reached, and how deviation from normal due to a crisis have to be corrected during implementation.

FIGURE 13

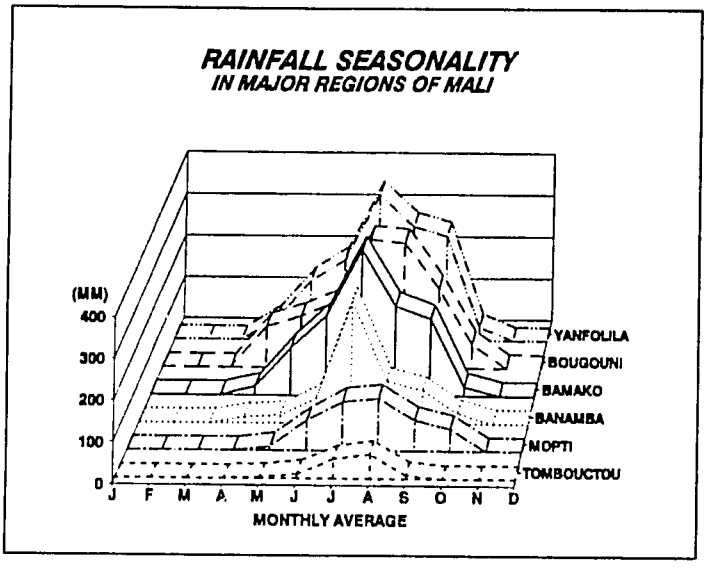
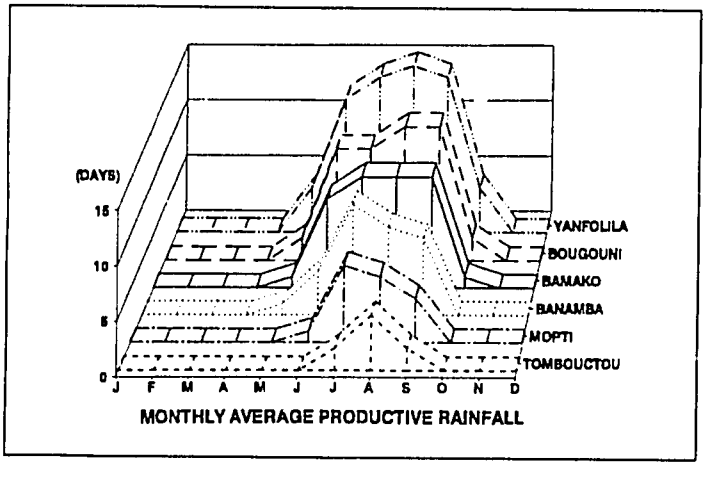


FIGURE 14



D. Driver and Qualifier Matrices

The database that is being constructed for household-level vulnerability assessment is composed of two sets of matrices (Figure 12). The first set or "driver set" is a series of matrices that incorporate numerous agro-climatic, demographic, technical and production indicators that are employed to "drive" the vulnerability assessment from a quantitative perspective. The second set or "qualifier set" is a series of individual matrices (production systems) that incorporate the major sources of income for the household exploiting a particular production system.

Driver Set - is a set of four matrices (agro-climatic, demographic, technical, and production) that are composed of numerous quantifiable indicators. Each matrix and the chosen indicators will be detailed below. Generally, the indicators are readily accessible from institutions for updating.

Qualifier Set- is a set of six production system matrices (farmer, farmer-herder, herder, fisherfolk, farmer-fisherfolk, and urban farmer) that are composed of household-level income, sub-divided into income components (shares), specific activities and stratified by subsistence or exchange. This qualitative information will be validated by expert opinion.

Note. A diversity index or commodity vulnerability index can be developed based on the commodity mix or commodity vulnerability for a specific production system. This could be expressed as a level of alternative opportunity, however this concept is not pursued in this paper. Perhaps the ratio of subsistence to exchange activities would be a useful index.

V. Driver Matrices - Quantifiable Indices

A. Agro-Climatic Matrix

Rainfall

The length of the growing period (based on adequate soil moisture) varies widely in Mali from zero weeks at Tombouctou to 33 weeks at Sikasso (ICRISAT, 1985). Variation in the length of the growing season in Mali can be characterized (generally) as progressively shorter periods are found at points moving from south to north (Figure 13 and 14). This means that certain areas in the south have a long

enough growing period for cotton, or maize. Intermediate periods for sorghum and short rainfall periods in the north where only fast growing varieties of millet are possible. Tombouctou with only 192 mm rainfall is very risky for cropping.

Rainfall Variability and the Planting Schedule

Yearly variation in the timing and quantity of rainfall received during certain stages of the growing season have two sorts of important effects (agronomic and behavior):

1) They result in different yields for crops each year, as a response of crops to water availability at critical periods in their growth cycles, and

2) They force farmers to adopt their work schedules to their perceptions of the most likely distribution of the rains, based on past years.

The coefficient of variation of rainfall from previous years in different climates indicates that annual rainfall variability is inversely related to the average quantity of rainfall received (high variability implies low rainfall).

Farmers (all production systems) in drier regions, who are perhaps the least able to endure long interruptions in rainfall, are the most likely to experience them. In many parts of northern Mali, livestock are the only means of subsistence, since the extreme variability of the rainfall makes cropping very risky. Combining crop with animal production improves food security. In some areas of the Sahel, cropping could not be done if it were not for the presence of livestock which provide an alternative source of food for the human population when the periodic grain deficits caused by poor rainfall occur.

Agro-climatic zones (delineated by rainfall and vegetation):

- Saharan, (200 mm);
- Northern Sahelian, (200 - 400 mm);
- Southern Sahelian, (400 - 600 mm);
- Northern Soudanian, (600 - 900 mm);
- Southern Soudanian, (900 - 1,200 mm);
- Northern Soudano-Guinean, (1,200 - 1,500 mm);
- Inundation Zone of the Niger River.

Ecological Zones

The Arid Zone

This zone includes all land receiving less than 600 mm annual rainfall (400 mm with 80% probability), but excluding the inundated zone of the Niger River.

The arid zone includes two major belts.

- The first consists of those areas receiving less than 200 mm where cropping is not possible and where, north of the 100 mm rainfall isohyet, the vegetation becomes typically Saharan. Less than 100 mm is the Sahara and between 100 to 200 mm is the Northern Sahel.
- The second belt (Northern Sahel, NSH) usually experiences between 200 and 400 mm (C.V. 25-35%), some rainfed agriculture is practiced but is extremely risky.

The arid zone accounts for well over half the land area of Mali.

The Semi-Arid Zone

This zone is located approximately between the 600 and 1,000 mm isohyets and includes the Southern Sahel and the North Sudanian vegetation zones. Rainfall coefficient of variation is 20-25%.

The Subhumid Zone

This zone lies south of the 1,000 mm isohyet and includes the Southern Sudanian vegetation belt. The higher and more reliable rainfall permits rainfed cultivation of cereal and cash crops.

The Inundation Zone of the Niger River

Associated with floodplain grasslands and farming.

North delta (Lake area)

Administrative boundaries extend over the cercle of Youvarou, the north of Mopti cercle (Arrondissements of Korientza and Sendegue), and the west of Douentza cercle (arrondissement of NGouma and Bore). The land area is 14,000 km2, and represents 39% of delta.

The local population is estimated at 148,400 with a population density 11/km2. The population is composed of Peul (herders), Touareg, Tamachek, and some Sonrai herders, some Bambara and Rimaibe agro-pastoralists and some Sorko (Somono) fisherfolk.

The lakeside zone is characterized by the presence of lakes and ponds which the population is engaged in a range of economic activities, particularly flood recession agriculture, herding and fishing. The north delta bourgoutieres provide excellent dry season pasture.

West delta (Mema)
Administrative boundaries include the west and north western parts of Tenenkou cercle, specifically the arrondissement of Dioura and the western part of the arrondissement of Toguer Kumbe. The land area is 4,246 km2, and represents 12% of the delta.

Mema is primarily a dry season pasture and cattle waiting zone, complementary to the Farimake (northern part of Nampala in the fourth region) and the Mauritanian sahel.

Central delta
Administrative boundaries include the Mopti cercle (Apart from the arrondissement of Sandogue, Korientza and Soye) and the Tenenkou (apart from the arrondissement of Dioura, and the western part of the arrondissement of Toguere Kumbe). The land area is 11,348 km2, or 31% of the delta.

The population is mainly composed of Rimaibe, Bambara, Peuhl, and Bozo.

South delta
Administrative boundaries, include Djenne cercle, southern part of Mopti cercle (Arrondissement of Soye), and the southern part of the cercle of Tenenkou (arrondissement of Diafarabe). The lane area is 6,286 km2, or 18% of the delta.

Population composed of Bambara, Bozo, Peuhl, and some Dogon who come from the Seno and the plateau.

The south delta is inundated by flooding from the Niger and the Beni. Sofara station, reported a max height of the flood at 422 cm for 1981-86 as opposed to 672 cm for 1968-71.

The bourgoutieres such as the Pondari (Flooded by the Bani), Yougari and Mangari (flooded by the Niger and its tributaries), are currently only flooded to a minor extent.

The Seno Plain
North Seno Plain
Covers the eastern part of the arrondissement of Diankabou and the Dinangourou and Dioungani arrondissements of Koro cercle.

Central Seno and the Bandiagara Plateau
These two zones cover the arrondissement of Madougou, Koporo Kendie, Na and the north of central Koro arrondissement in Koro cercle and the arrondissement of Goundaka and part of the arrondissement of Wo in the Bandiagara cercle.

South Seno
South Seno covers the arrondissement of Toroli and the south of the central Koro arrondissement in the Koro cercle, the central Bankass arrondissement, the eastern parts of the arrondissement of Kani Bonzon, Diallassagou and Sokoura and the central part of Ouenkoro arrondissement in Bankass cercle.

B. Demographics Matrix

The 1987, national population general census is an excellent source of demographic information that is essential to an accurate vulnerability assessment.

Recensement General de la Population et de L'Habitat de la Republique du Mali, (April, 1987).

The general population of Mali in April, 1987 was 7,696,348 people, 51% female and 49% male. This population lives in 1,364,079 households within 787,783 compounds. Seventy eight percent of the population or 6,006,059 people live in rural areas.

Urban population is defined as those towns or cities where the population is more than 20,000 inhabitants. Twenty- two percent of the population or 1,690,289 people live in urban areas.

Mali has 13 towns or cities classified as urban.

- Bamako.....(658,275)
- Segou.....(88,135)
- Mopti .....(74,771)
- Sikasso.....(73,859)
- Gao .....(55,266)
- Kayes.....(50,993)
- Koutiala .....(48,698)
- Kati .....(34,315)
- Tombouctou.....(31,962)
- San .....(30,772)
- Kita .....(22,914)

- Bougouni .....(22,374)
- Koulikoro.....(20,795)

Population profile

Age distributions

- 46% of total population (3.5 million children) are under 15 years of age.
- 48% are between 15 and 54 years
- 6% are older than 54 years

Population density defined

- Rural and urban

Sedentary population

- 96% of population is sedentary

Nomadic population

- 4% of the population (317,361) is nomadic
- 71% of all nomads live in either Tombouctou or Gao.

Population growth rates

The difference between the total gross birth and death rate gives the Natural Growth Rate of 3.7%. However, this rate is not adjusted for international migration.

The adjusted or total net growth rate of the population for Mali was 1.8%.

- Rural .....4.5 % growth rate
- Urban .....1.2 % growth rate
- Average 1.8 % growth rate in Mali

C. Production Matrix

Reference on land use indicators.

The French development agency (Ministere de la Cooperation et du Development) financed a comprehensive study involving a complete inventory of vegetative resources and agricultural land use in Mali. This study produced detailed maps from satellite images in 1990 as well as specific reports on land use, climatic conditions, vegetation, and agriculture land potentials at the Cercle level for most of Mali. The project was entitled "Projet Inventaire des Ressources Ligneuses et Occupation Agricole des Terres au Mali".

Land area indicator.

The total land area expressed in kilometers squared for a particular cercle or arrondissement can be used to derive population densities (human or livestock).

Agricultural land area indicator.

This indicator is a measure of occupied land (both fallow and planted land) expressed in hectares. The values were determined from the satellite images in the above mentioned study. This report uses a value of aggregated agricultural land and not the dozen or so divisions of agricultural land use given in the study. This information is available and future work towards refinement could expand this agricultural land indicator into more specific components (e.g., irrigated land, valley bottom land, etc.).

Potential agricultural land area indicator.

This indicator is also an aggregated value that can be decomposed into more specific land use types. The indicator can be used to establish a relative weight in the estimation of the agricultural crop potential of a geographical area. Areas with low quantities of land potential would be considered more vulnerable to long term disruptions in their livelihood than regions in Mali with large areas of agricultural land. Again, this indicator could be used with the demographic matrix to derive population densities.

Reference on production indicators.

The Conjuncture Agricole, is an annual bulletin published by the government on production throughout mali.

Livestock population indicators.

Cattle, sheep and goat populations were reported for each administrative unit and the herd profiles derived fom herd ILCA estimates.

Agricultural production indicators.

Cereal crops (millet, sorghum, maize, peanut, upland rice, irrigated rice, miscellaneous crops).
Cash crops (Cotton, Tobacco)

D. Technical Opportunities Matrix

This set of indicators is important because not all socio-economic groups of people (production systems) have the same set of opportunities available to them. It was stated above that family members of a household will seek out "opportunistically" varied income-generating activities in order to secure an adequate livelihood. For example, there is a greater opportunity to market charcoal or trade handicrafts along a paved road linking urban centers than there is along a poor dirt road (grade #4) in rural areas. The point being that as a crisis such as drought or even civil turmoil impacts the household, there is a logical shifting from a set of income-generating activities to a new set depending upon the opportunities available to the household.

Level of technology indicator.
The literature adequately demonstrates the significance of the level of technology on the households ability to generate income and thus indicates a relative degree of vulnerability among similar production systems. The relative technical capability (equipment opportunity) of a household, exploiting a particular production system can be classified into three groups. Obviously, the types of technology utilized by a particular category of production system will vary.

Traditional or non-equipped households are (usually young and old) can not afford any production equipment other than traditional tools such as the machete, hoe, and woven baskets.

Semi-equipped households are those that utilize a minimum of equipment, desire to use more, but do not yet have the resources to obtain them or have had them and have lost them. For example, these producers are aware of the value of fertilizer and pesticides and purchase small amounts, or perhaps they rent animal traction equipment from other families.

Equipped households that have acquired productive equipment (ploughs, weeders, boats, outboard motors, feed mills, etc.) and utilize this equipment to achieve a higher degree of production and thus security for the household.

Technical assistance indicator.
A technical assistance opportunity has been reviewed in the literature and shows that those areas of Mali where the government has invested and supported an active extension service, households have benefitted from increased productive capacity, income and thus a lower degree of vulnerability.

Market access indicators.
The ability of household members to access a market will determine to a large extent the ratio of subsistence to exchange activities within a production system. The indicators used to derive market access are:

The number and relative size of rural and urban markets is used as an indicator of market access. This indicator has spatial implications as distance to market as well as size and type of markets will represent different opportunities to different production systems. For example, large livestock markets will draw herders from great distances for the opportunity to sell their products. This market would not represent the same opportunity to a rice based production system.

The total length in kilometers of five different classes of road per arrondissement are used as a road access indicator.

Length of international borders per arrondissement. The opportunity to trade with neighboring countries could be important economically because of proximity, exchange rates, tradition (same ethnic groups), trade opportunities and others.

Length of river per arrondissement. Considerable fishing is practiced by household women on a seasonal basis and for subsistence purposes. Rivers also provide a greater opportunity to manage a garden plot (counter seasonal garden) because of the need for hand irrigation.

VI. Production Systems - Qualifier Indices

A. Production Systems Analysis

The term "Production System" is used here to capture the broader sense of a farming system to include all income-generating activities.

Production systems are limited by endogenous factors, such as household-level demographics, wealth, kinship networks and lifecycle stage of the household.

Exogenous factors or constraints occur at levels higher than that of the system being analyzed. For example, production systems in Mali are constrained by regional systems.

Higher level constraints will affect all lower level systems, because the hierarchy is comprehensive (each system is included in the next higher level). Climate, prices and infrastructure are examples of regional factors that constrain output on lower level production systems.

Endogenous factors or limitations are set by subsystems within the system or below the system.

For example, production system output may be limited by labor inputs at the household level (sub-system) as well as the genetic potential of the crop.

The distinction between exogenous and endogenous factors is essential in understanding system performance. What production system prevails depends on household resources, access to inputs, the division of labor and cultural factors.

B. Production Systems Defined

Two main criteria will be used to deliniate the production systems of Mali. This method follows Wilson, 1986.

1) The degree of dependence on pastoral products for the gross revenue (exchange) or food supply (subsistence) of the household or production unit, and

2) The particular type of agriculture associated with the livestock system.

Cattle constitute the most important species in all the systems, economically if not culturally, and irrespective of whether their role is primarily milk production (pastoral), draught power (agro-pastoral), or meat production, or a combination of these roles where system boundaries are not clear cut. Sheep are extremely important in the pastoral system, especially in the northern and floodplain areas. In the agro-pastoral system, goats are the most important livestock.

Agriculturalists, Farmers.

Ten percent (10%) or less of gross revenue is derived from livestock.

Rainfed crop sub-system

- Cereal crops, and cash crops.
- Livestock (Draught oxen, donkeys, and goats and sheep in a 5.4:1 ratio

Irrigated crop sub-system

- Rice crops
- Livestock (Draught oxen, donkeys, and goats and sheep in a 1.4:1 ratio)

Floodwater crop sub-system

- Rice crops
- Fishing

Agro-Pastoralists, Farmer-herders.

A production system in which between 10 and 50% of gross revenue is from livestock or livestock products.

Agro-Pastoral Farming System (Farmer Herders) can be subdivided into three sub-systems, where mobility is low, cropping is the major component, and the main species raised are cattle, for draught.

Rainfed cropping sub-system

Floodfed cropping sub-system

Irrigated rice cropping sub-system

Pastoralists, Herders.

A production system in which more than 50% of gross revenue (the value of subsistence plus marketed production) or more than 20% of household food energy was directly derived from livestock or livestock-related activities.

Livestock capital is the major resource of the pastoral production system. Livestock represent reproductive and investment capital as well as a source of daily food (Hesse, 1987). Herders balance animal sales, to meet their short term needs (food, cloths, taxes), against longer term objectives of animal conservation, to guarantee a rate of reproduction equal to, or greater than, the rate of disposal.

The conservation of minimal herd size is crucial to herders' short and long term well-being.

Pastoral System (Herders) three sub-systems

<u>Pure Pastoral sub-system.</u>
Mainly a camel-based system in the Northern arid zone, characterized by high mobility and having almost no direct links with agriculture.

<u>Transhumant and Nomadism sub-systems</u>
Animal production is associated with dryland cropping, with some cultivation and the exchange of manure for grazing land and water. Located in the northern central and northwestern semi-arid areas. Cattle, goat and sheep are the main stock kept.

Animal production is linked with floodplain grazing and farming; cropping is more important here and cattle are the main species raised. Located in the inundated area of the Niger River and its hinterlands.

<u>Transhumance</u>
System of management, in which herders or fisherfolk migrate seasonally but return to a fixed spot. Practiced by the agro-pastoral Fulani of the Gourma, the Moors and some

Tuareg who live close to the Niger River, and the Bozo fisherfolk.

Agro-fishing System, Farmer-fisherfolk

Agro-fishing production systems in which between 20 and 50% of gross revenue is from fish and fish products.

Farmer fisherfolk cultivate specific varieties of rice that mature late in the season, they fish throughout the year and move along the floodplains in order to fish the pools, channels, and main river area as the seasons change.

Farmer fisherfolk of the delta will differ in their production systems than farmer fisherfolk that inhabit other regions (ecological areas) of Mali.

Fishing System, Fisherfolk

Fisherfolk households derive 50% or more of their gross revenue from fish and fish products.

Fishing systems exploiting the Niger Delta will differ from fishing systems that exploit other major and minor rivers in Mali. Differences will evolve due to ecology of the area.

Many transhumant fisherfolk in the Delta farm as well as fish. However, they differ from farmer fisherfolk by the distance they travel, the time they spend away from their communities and the areas they come from (Moorehead, 1991).

They follow the falling water levels down through the delta, living in fishing camps. With the approach of the rains they return home and cultivate and fish in their own areas in the rising and high water seasons.

Urban Farming Systems

An urban household that derives 50% or more of its gross income from agriculture or agriculture related activities.

Major activities include:

- Fruit, vegetable, and condiment gardening
- Marketing of agricultural products
- Smallstock production, and
- Transport with livestock.
- Donkeys replace cattle as the main revenue earning livestock, followed closely by goats.

VII. Recommendations for Operationalizing Vulnerability Analysis

A. Administrative Units Stratified by Production Systems

The first step towards stratifying each administrative unit in Mali into more homogenous groups of production systems was completed in such a way that one or more production system could be assigned to a particular administrative unit if need be. An estimate, based on expert opinion, of the relative proportion of the population characterized as being actively engaged in a particular production system was made for each administrative unit.

The standardized administrative matrix (all cercles and some arrondissements) was completed with column headings identifying the six production systems (farmers, farmer-herders, herders, farmer-fisherfolk, fisherfolk, and urban farmers) and two production sub-systems (transhumance, and nomadic). See Figure 15.

For example, the cercle of Kayes (100% of the ag-sector) was stratified into farmers (50%), farmer-herders (15%), herders (10%), farmer-fisherfolk (5%), fisherfolk (0%), and urban farmers (20%). See Figure 16.

This preliminary stratification of all administrative units into relative proportions of the population active in specific production systems enables the assignment of one or more production system to a particular administrative unit.

B. Production Systems Stratified by Income Components

The second step, was to sub-divided each production system into the following income components (relative shares of income sources): See Figure 17.

- Ag-income and income from ag-labor
- Livestock and fish income
- Local Non-farm income
- Transfers

Transfers were divided into categories based on degrees of reciprocity. Generally, gifts and alms imply lower levels of reciprocity than exchange or credit arrangements.

FIGURE 15

		FARMING SYSTEMS								
		AGSYS	AGPAST	PAST	AGFISH	FISH	URBAN	TRANS	NOMAD	
1	KAYES									
	KAYES									
	AMBIDEDI									
	AOUROU									
	DIADIOUMBERA									
	DIAMOU									
	KOUSSANE									
	LONTOU									
	SADIOALA									
	SAME									
	SEGALA									
2	BAFOULABE									
	BAFOULABE									
	BAMAFALE									
	DIAKON									
	DIALLAN									
	KOUNDIA									
	MAHINA									
	OUALIA									
	OUSSOUBIDIAGNA									
3	DIEMA									
4	KENIEBA									
5	KITA									
	KITA									
	DJIDIAN									
	KOKOFATA									
	SAGABARI									
	SEBEKORO									
	SEFETA									
	SIRAKORO									
	TOUKOTO									
6	NIORO									
7	YELIMANE									
8	KOULIKORO									
9	BANAMBA									
10	DIOILO									
11	KANGABA									
12	KATI									
	BAGUINEDA									
	KALABAN KORO									
	KATI									
	KOUROUBA									
	NEGELA									
	OUELESSEBOUGOU									
	SANANKOROBA									
	SIBY									
13	KOLOKANI									
14	NARA									

(Partial Listing)

FIGURE 16

		FARMING SYSTEMS									
			AGSYS	AGPAST	PAST	AGFISH	FISH	URBAN	TRANS	NOMAD
1	KAYES									
	KAYES	100%	50%	15%	10%	5%	++	20%		
	AMBIDEDI	100%	70%	20%	5%	5%	++	++		
	AOUROU	100%	40%	35%	25%	++	++	++		
	DIADIOUMBERA	100%	65%	30%	5%	++	++	++		
	DIAMOU	100%	80%	10%	5%	5%	++	++		
	KOUSSANE	100%	40%	35%	25%	++	++	++		
	LONTOU	100%	85%	10%	++	5%	++	++		
	SADIOALA	100%	90%	10%	++	++	++	++		
	SAME	100%	80%	10%	5%	5%	++	++		
	SEGALA	100%	80%	10%	5%	5%	++	++		
2	BAFOULABE									
	BAFOULABE	100%	80%	10%	5%	5%	++	++		
	BAMAFALE	100%	80%	5%	++	5%	10%	++		
	DIAKON	100%	95%	5%	++	++	++	++		
	DIALLAN	100%	95%	5%	++	++	++	++		
	KOUNDIA	100%	85%	10%	++	5%	++	++		
	MAHINA	100%	70%	15%	5%	5%	5%	++		
	OUALIA	100%	80%	10%	5%	5%	++	++		
	OUSSOUBIDIAGNA	100%	80%	15%	5%	++	++	++		
3	DIEMA	100%	60%	30%	10%	++	++	++		
4	KENIEBA	100%	80%	++	++	++	++	20%	GLD	
5	KITA									
	KITA	100%	70%	10%	++	++	++	20%		
	DJIDIAN	100%	95%	5%	++	++	++	++		
	KOKOFATA	100%	95%	5%	++	++	++	++		
	SAGABARI	100%	95%	5%	++	++	++	++		
	SEBEKORO	100%	95%	5%	++	++	++	++		
	SEFETA	100%	90%	10%	++	++	++	++		
	SIRAKORO	100%	95%	5%	++	++	++	++		
	TOUKOTO	100%	90%	10%	++	++	++	++		
6	NIORO	100%	30%	30%	20%	++	++	20%		
7	YELIMANE	100%	50%	30%	20%	++	++	++		
8	KOULIKORO	100%	75%	5%	++	5%	5%	10%		
9	BANAMBA	100%	75%	20%	5%	++	++	++		
10	DIOILO	100%	95%	5%	++	++	++	++		
11	KANGABA	100%	85%	++	++	++	++	15%	GLD	
12	KATI									
	BAGUINEDA	100%	100%	++	++	++	++	++		
	KALABAN KORO	100%	40%	++	++	++	++	60%		
	KATI	100%	30%	++	++	++	++	70%		
	KOUROUBA	100%	100%	++	++	++	++	++		
	NEGELA	100%	100%	++	++	++	++	++		
	OUELESSEBOUGOU	100%	100%	++	++	++	++	++		
	SANANKOROBA	100%	100%	++	++	++	++	++		
	SIBY	100%	100%	++	++	++	++	++		
13	KOLOKANI	100%	80%	15%	5%	++	++	++		
14	NARA	100%	50%	30%	20%	++	++	++		

FIGURE 17

	AG–INCOME	AG–LABOR	Livestock	Fish	Non–farm	Trans–fers	Totals
Farmer	40	10	20	10	10	10	100
Farmer–herder	30	10	35	5	10	10	100
Herder	10	10	60	0	10	10	100
Farmer–fisher	25	10	5	40	10	10	100
Fishermen	10	10	5	50	15	10	100
Urban farmers	20	10	10	0	50	10	100

FIGURE 18

	AG–INCOME			AG–LABOR	Livestock			Fish			Non–farm			Trans–fers	Totals		
	Subs	Exch	TTL		Subs	Exch	TTL	Subs	Exch	TTL	Subs	Exch	TTL		Subs	Exch	TOTAL
Farmer	30	10	40	10	10	10	20	10	0	10	5	5	10	10	55	45	100
Farmer–herder	20	10	30	10	10	25	35	5	0	5	5	5	10	10	40	60	100
Herder	5	5	10	10	10	50	60	0	0	0	5	5	10	10	20	80	100
Farmer–fisher	15	10	25	10	5	0	5	10	30	40	5	5	10	10	35	65	100
Fishermen	5	5	10	10	5	0	5	10	40	50	5	10	15	10	25	75	100
Urban farmers	10	10	20	10	5	5	10	0	0	0	10	40	50	10	25	75	100

The relative importance of a category in enhancing the subsistence security of a household depends on location, ethnic group, tradition and culture, household lifecycle, season and the severity of food shortage.

The relative proportion of total household income was partitioned into four major income components.

For example, total household income (100%) for a farmer production system and is partitioned into ag-income (40%), livestock (20%) and fish (10%), local non-farm income (10%), transfers (10%), and agricultural labor (10%).

However, this level of aggregation does not lend itself to facilitate the task of assessing vulnerability, and further disaggregation is required.

C. Income Activities Stratified by Subsistence or Exchange

The third step was to sub-divide each income-generating activity under the ag-income, livestock and fish, and local non-farm income components according to the activity being principally for subsistence or exchange purposes (Figure 18).

For example, if the Agriculture-Income related activities totaled 40%, they could be stratified into 30 % for subsistence and 10 % for exchange. Likewise, income from livestock is stratified into 10% subsistence and 10% for exchange.

This information gives the relative dependence of a production system on the market, as well as insight into the relative level of vulnerability of a household to negative environmental factors such as drought. That is, if a household is more dependent on subsistence activities for their livelihood, then they will be more vulnerable to climatic shocks.

D. Income Components Stratified by Income Activities

Income-generating activities

The fourth step was to sub-divide each income component (both subsistence and exchange) into the following income-generating activities (Figure 19).

Ag-income (subsistence and exchange) was divided into income derived from:

- Crops;
- Cash crops;
- Wild foods;
- Garden crops;
- Fruit crops; and
- Ag-labor.

Livestock and fish component was divided into:

- Cattle, (sales, meat, hides, milk);
- Goat, (sales, meat, hides, milk);
- Sheep, (sales, meat, hides, milk);
- Other livestock and their products; and
- Fish.

Local non-farm income was divided into:

- Wood;
- Charcoal;
- Handicrafts;
- Trade;
- Sewing; and
- Transport (camel, horse, boat, etc.).

Transfers (social networks) were divided into:

- Gifts;
- Remittances from migration inside Mali;
- Remittances from migration outside Mali;
- Exchanges; and
- Credit.

Each income component was sub-divided into activities and a relative proportion of total income was assigned to each activity depending upon the estimated proportion assigned to the particular income component.

For example, if the income component livestock was estimated to be 20% for the farmer production system, then this 20% could be stratified into subsistence income-generating activities such as goat meat (6%), chicken (3%), and eggs (1%). All other activities under this component would be fixed at zero percent. Exchange activities would be goat sales (2%), cattle (2%), and sheep sales (4%).

FIGURE 19

	AG–INCOME							AG–LABOR	Livestock							
	Subsistence				Exchange		TTL		Subsistence			Exchange				TTL
	CRPS	WLDFD	GRDN	FRUIT	CRPS	WLDFD			GTMT	CHKN	EGGS	GTSL	CTSL	CMLK	SHSL	
Farmer	10	10	5	5	5	5	40	10	6	3	1	2	2	2	4	20
Farmer–herder	7	7	6	2	6	2	30	10	8	5	2	5	5	5	5	35
Herder	3	2	1	1	2	1	10	10	10	5	0	10	15	10	10	60
Farmer–fisher	10	6	2	2	3	2	25	10	2	2	0	1	0	0	0	5
Fishermen	5	0	1	0	2	2	10	10	3	2	0	0	0	0	0	5
Urban farmers	10	0	5	5	0	0	20	10	4	1	1	2	0	0	2	10

	Fish				Non–farm									TRANSFERS						Totals		
	Subs	Exchange		TTL	Subsistence		Exchange						TTL						TTL	Subs	Exch	TOTAL
	FRSH	SMKD	FRSH		WOOD	BRCK	WOOD	CHRK	CRFT	TRADE	TRNS	BRCK		GIFT	MIG1	MIG2	EXCH	CRDT				
	2	4	4	10	1	1	2	2	1	1	1	1	10	2	2	2	2	2	10	44	56	100
	2	2	1	5	2	0	1	1	2	1	2	1	10	2	2	2	2	2	10	41	59	100
	0	0	0	0	5	0	1	1	1	1	1	0	10	2	2	2	2	2	10	27	73	100
	10	10	20	40	5	0	1	2	1	1	0	0	10	2	2	2	2	2	10	39	61	100
	10	10	30	50	5	0	2	4	2	2	0	0	15	2	2	2	2	2	10	26	74	100
	0	0	0	0	0	0	5	10	5	15	10	5	50	2	2	2	2	2	10	26	74	100

VIII. Notes on Household Income Diversification Strategies

Sundberg (1988) notes that the characteristics of the household which allow families to survive poor production years without suffering large decreases in their food consumption levels are the following:

- Relatively higher levels of staple grain production;
- Ownership of agricultural equipment;
- Participation in non-agricultural activities; and
- Diversification of cultivated crops.

Wealth, asset base development through small-stock and petty trade.

Pastoral production systems are subject to greater food insecurity than agricultural systems in general, for several reasons (Hesse, 1987):

Herders acquire most of their staple food through exchange (barter) or market transactions, and the market value of their exchange commodity (livestock and livestock products) relative to the cost of food often is determined by both local and exterior economic, political and environmental factors.

Herder food security is dependent upon livestock which represents subsistence as well as investment and reproductive capital (dual demands on commodity).

Livestock and their products are vulnerable to drought conditions.

Livestock care represents full-time demands on labor, which limit access to other income generating activities.

Herders are susceptible to longer-term food insecurity due to difficulties associated with post-drought reconstitution of their productive resource base.

IX. Bibliography

Cohen, Stan, An Economic Analysis of Millet Production in Two Dogon Villages in Mali. Masters Thesis, Purdue University, 1981.

D'Agostino, Victoire, Coarse Grain Production and Transactions in Mali: Farm Household Strategies and Government Policy, Masters Thesis, Michigan State University, 1988.

de Frahan, Bruno, The Effects of Interactions Between Technology, Institutions, and Policy on the Potential Returns to Farming Systems Research in Semi-Arid Northeastern Mali. Doctoral Dissertation, Michigan State University, 1990.

Dione, Josue, Informing Food Security Policy in Mali: Interactions Between Institutions and Market Reforms, Doctoral Dissertation, Michigan State University, 1989.

Flemming, Allen, Agricultural Production and the use of Labor in Alternative Enterprises in the Cercle of Kita, Mali. Masters Thesis, Purdue University, 1981.

Hesse, Ced, Livestock Market Data as an Early Warning Indicator of Stress in the Pastoral Economy, OXFAM, Bamako, Mali, 1987.

Moorehead, Richard, Structural Chaos: Community and State Management of Common Property in Mali, Doctoral Dissertation, University of Sussex, 1991.

Resource Inventory and Management Limited, Refuge in the Sahel: Livestock Populations and Production Systems in Mali Fifth Region, 1987.

Sundburg, Shelly, An Overview of the Food Consumption and Nutrition Situation in Mali. Report submitted to USAID/Mali, March, 1988.

Wilson, Trevor, Livestock Production in Central Mali: Long-term Studies on Cattle and Small Ruminants in the Agropastoral System, International Livestock Center for Africa (ILCA), 1986.

X. Acknowledgments

I thank Chuck May and Paul Bartel for designing what I considered to be an interesting and rewarding consultancy. From the beginning, Chuck was able to organize an itinerary that was efficient in terms of timing and productive in terms of obtaining the information required to complete this consultancy. Paul, with the help of Salif Sow, arranged that my time in Mali be concentrated on the development of a set of working matrices that could be evaluated and used before my departure.

I am grateful to Dick Meyer and his staff at the Washington FEWS office and USAID for affording me the opportunity to conduct this consultancy.

Finally, since this consultancy was about information collection, every effort was made to acknowledge the numerous authors and contacts that contributed to this endeavor throughout the document.