



FEWS Working Paper

USAID Famine Early Warning System

PN-ABU 052
93223

VULNERABILITY ANALYSIS in the FEWS PROJECT

FEWS Working Paper 2.9

by
Frank Z. Riely
USAID Famine Early Warning System Project
Washington, D.C.

February, 22 1995

This document was prepared under the FEWS Project (Contract No. AFR-0466-00-9305-00)
through the Tulane-Pragma Group

VULNERABILITY ANALYSIS IN THE FEWS PROJECT

I. INTRODUCTION

1. The USAID Famine Early Warning System (FEWS) is an information system designed and financed by the U.S. Agency for International Development (USAID) to monitor the conditions in developing countries that may threaten food security and ultimately lead to famine. FEWS is currently operating in eleven countries in Africa in the Sahelian and East and Southern Africa regions.¹ The FEWS mandate includes (a) providing an early warning capacity for decision-makers within USAID, (b) providing support to host governments in the development of national early warning systems; and (c) collaboration with the international community on the development of improved early warning methodologies.

2. Since 1987, the FEWS Project has used the systematic analysis of vulnerability to famine in support of its efforts in early warning analysis. The rationale for employing the concept of vulnerability is based on a particular understanding of the complex causes and effects of famine. Under this view, famine is the result, not merely of a decline in food availability, but from a decline in food access, which, in addition to overall food supply, also includes the range of factors that influence the effective demand for food (Sen, 1981). Equally important, this approach recognizes that the effects of famine also vary widely across specific groups of households. According to Downing (1991):

Famine varies in its causal structure and incidence according to the entitlements of specific socioeconomic groups. The specifics of who is affected in a particular famine, however, depend on the causes of famine as they relate to the entitlements of different groups.

3. The concept of vulnerability is used by FEWS to understand which household groups are most likely to be affected by a given crisis, and why. It constitutes the basis of a framework to organize information and analysis in a consistent and comprehensive fashion, according to existing knowledge of the complex determinants and impacts of famine. In practice, that vulnerability framework provides a greater understanding of the linkages between changes in early warning indicators and their potential impacts, ensuring a more accurate and timely signal of impending crisis. In addition, the use of the vulnerability framework also supports efforts to more effectively target relief interventions toward the most seriously affected households as well.

4. The following report is an attempt to update the documentation of the FEWS approach to vulnerability analysis as it has evolved in practice. Section II of the report will describe a conceptual framework for vulnerability analysis based on an explicit understanding of the determinants of household access to food. To do so, it will outline a household income-based model of vulnerability that can be applied for specific socioeconomic groups of interest in FEWS countries.

5. Section III of the report provides a broad overview of the FEWS operational approach to vulnerability analysis. It will identify important indicators used in the analysis of vulnerability, as

¹FEWS Sahelian countries include Mauritania, Mali, Burkina Faso, Niger, Chad, Sudan and Ethiopia. FEWS East and Southern African countries include Kenya, Malawi, Zambia and Zimbabwe.

well as how those indicators are organized in specific analytical tasks. In the course of outlining the basic conceptual framework and structure of empirical analysis, the report will also highlight areas for future emphasis toward improving early warning and vulnerability analysis under the FEWS Project.

II. A CONCEPTUAL FRAMEWORK FOR VULNERABILITY ANALYSIS

A. Definition of Famine Vulnerability

6. Definitions of famine vary widely (Devereux and Hay, 1986). However, most definitions recognize that famine is characterized by the combination of a few key elements. Typically, famine is associated with: (a) a sharp deterioration in economic conditions; (b) extreme social disruption; and (c) some degree of excess mortality (Webb and Richardson, 1993).

7. Rather than being simply a secular decline in food availability, famine is the outcome of a process of impoverishment. For example, chronic problems of resource degradation and poverty typically underlie the more accelerated deterioration in economic conditions that occurs in the case of drought-induced famine. Alternatively, when civil war disrupts household access to their assets, means of production and markets for food, the entire famine process may be quite rapid. In every case, however, the final stages of famine are characterized by drastic reductions in incomes, consumption and, ultimately, starvation and starvation-related mortality.

Vulnerability ≠ Poverty

8. While the households most susceptible to famine are typically among the extremely poor, famine vulnerability is not merely synonymous with poverty. Vulnerability is more complex, including the elements of risk and the variability of incomes and consumption over time, in addition to their levels and trends. According to Chambers (1989):

Vulnerability is distinct from poverty. It represents not lack or want, but defenselessness, insecurity and exposure to risks, shocks and stress ... and difficulty in coping with them.

Therefore, rather than referring simply to the problem of low incomes, the term vulnerability refers broadly to the risk and variability in household incomes which, in turn, has implications for the variability of consumption as well.

9. In the current FEWS framework, the term vulnerability is used to describe the "relative susceptibility of households to various levels of food insecurity" (FEWS, June 1992). Vulnerability is a relative concept such that everyone is considered vulnerable to famine; however, the degree of that vulnerability varies over time and according to the social, economic and political status of various households or groups of households (Downing, 1991).

10. Famine vulnerability can be viewed as a distinct form of vulnerability that refers directly to the implications of variations in consumption levels, as influenced by changes in incomes and access to food supplies. Thus, it can be defined more specifically as the degree of exposure to the risk of starvation or starvation-related mortality from a variety of potential shocks and sources of

stress. This definition more readily includes, at least conceptually, the interactions between incomes and consumption, on the one hand, and health factors, on the other, that ultimately combine to determine the relative risk of starvation.²

B. The Determinants of Starvation

11. Vulnerability and early warning analysis represent, respectively, the assessment of the root causes of famine among specific household groups and the monitoring of the progression of those factors over time. The definition of a conceptual framework to guide those analytical tasks must provide some understanding of the relationships that link the determinants of famine to its ultimate effects – again, the reductions in incomes and consumption that ultimately lead to increased starvation and starvation-related mortality.

12. At the household level, starvation and starvation-related mortality can be viewed as functions of both:

- (a) the composition and level of food consumption, and
- (b) the set of factors that influence health status, such as exposure to disease, access to clean water, proper sanitation and health services.

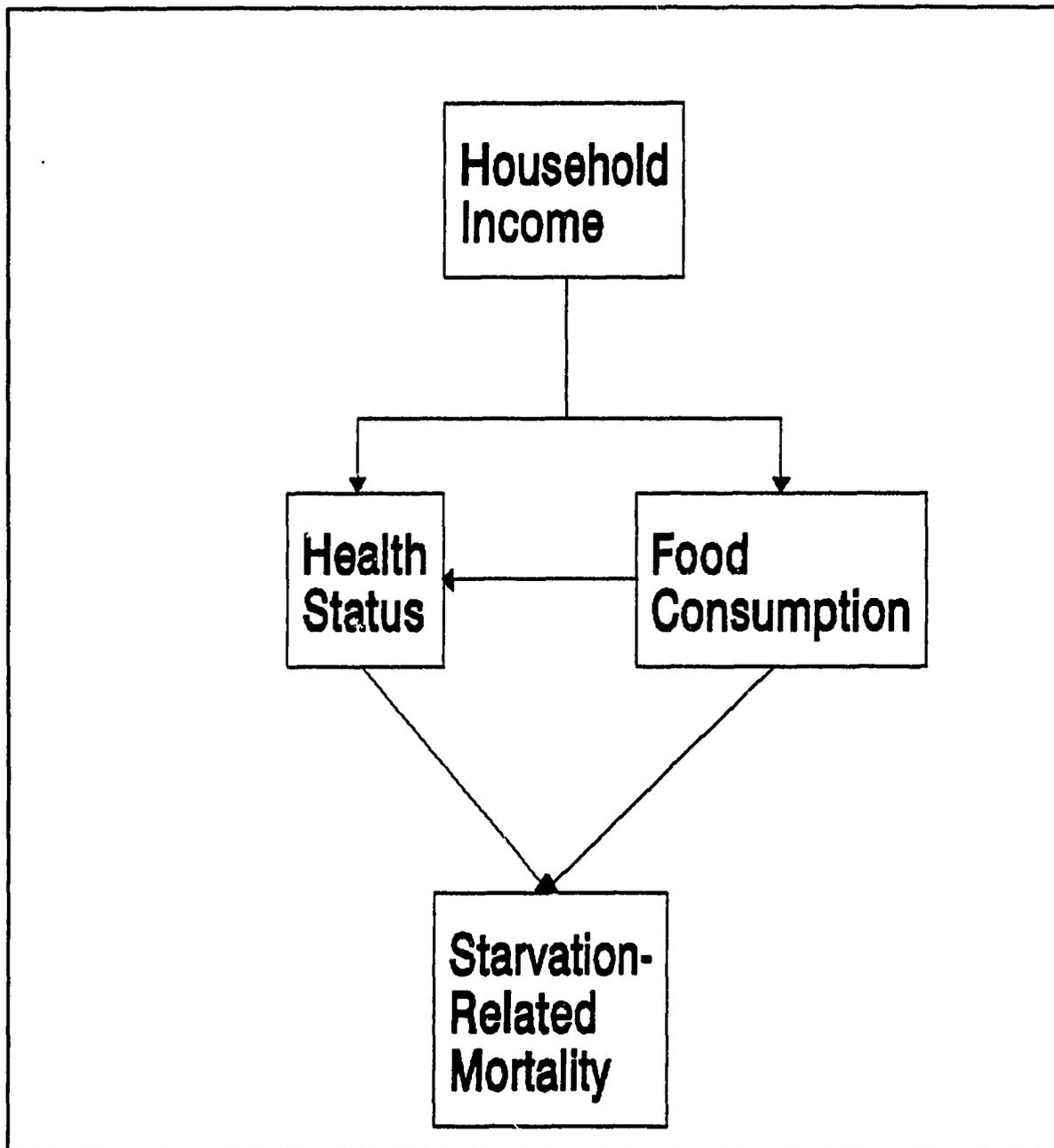
13. The relationship between these factors is summarized in Diagram 1. Note that household income affects both food consumption and health status directly, the latter through its impact on household access to health care and the level of investment in health-related social infrastructure. The composition and level of food consumption itself also has a direct impact on health status, as it influences physiological factors and susceptibility to disease.

14. The importance of health status in determining famine mortality is becoming increasingly clear (Ravallion, 1983; de Waal, 1989). Outbreaks of cholera, measles and other diseases are common during famine periods, especially in the camps of displaced that often develop on the outskirts of major urban areas. These camps are typically over-crowded, have poor shelter and sanitation and provide little access to clean water. The interaction between increased malnutrition and increased exposure to unhealthy conditions is perhaps the most important factor in explaining famine mortality.³

²Note that household-level starvation can exist in non-famine conditions. Therefore, the implications of a household-based model of vulnerability are not immediately relevant to a famine situation. However, although based on relationships defined at the household-level, the model of vulnerability is applied in practice to specific groups of fairly homogeneous households in specific regions. Therefore, an observed increase in the probability of starvation-related mortality for a given group is likely to correspond to a similar increase in the probability of famine itself.

³Health status, as it affects human capital and labor productivity, is itself also an important determinant of incomes. A number of studies have shown that, at the individual household level, illness to an important income-earner can be devastating to food security and, in many cases, leads to starvation (IDS, 1990). However, at the aggregate level and during times of famine, the importance

Diagram 1



of health status is mainly in its interaction with malnutrition and the resulting direct risk of mortality. There is little evidence that links even epidemic disease to a widespread loss of income and, through that indirect channel, an increased threat of famine.

15. Rather than assessing consumption levels directly, however, the focus of vulnerability analysis under FEWS is on household incomes. In practice, food consumption is difficult to measure, both at the household level and at broader levels of aggregation. Household consumption surveys are rare and fraught with difficulties in implementation and interpretation. At the national level, the analysis of food consumption is analogous to an assessment of per capita food availability, leading to the use of food balance sheets. That approach, while useful, is difficult to apply at the level of sub-national regions, given the difficulty in estimating local food stocks and inter-regional flows of food. Because it is based on estimates of availability, that approach also fails to incorporate the other factors that influence household access to food through changes in purchasing power and effective demand.

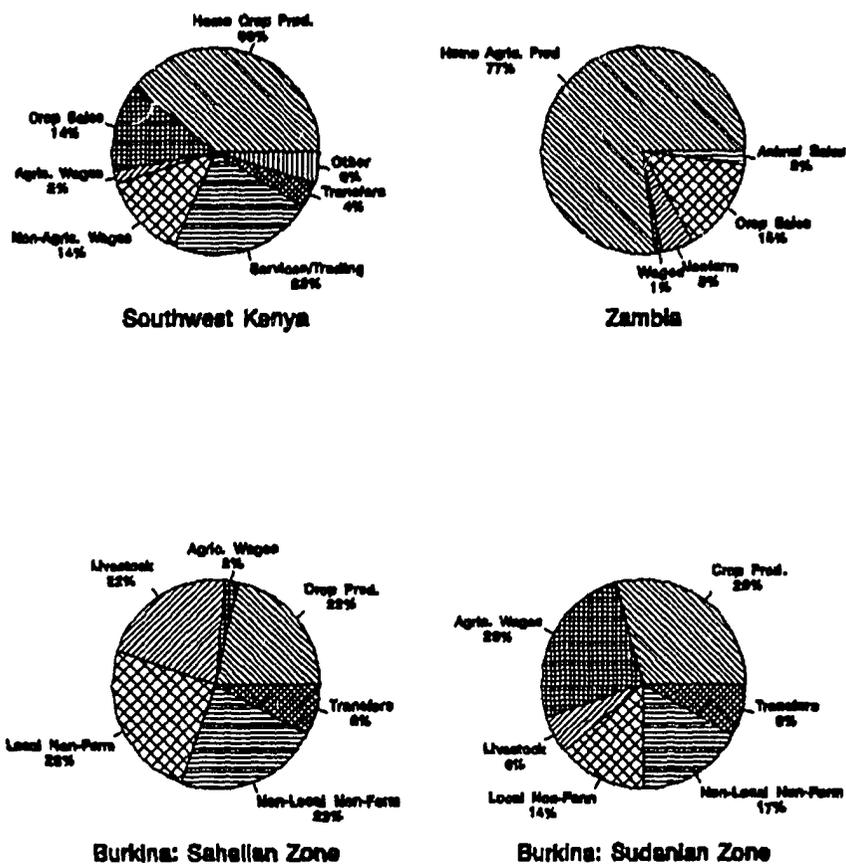
16. A central aspect of vulnerability and early warning analysis in the FEWS Project is to develop some understanding of potential changes in measures of overall income, which can be defined to include the complete range of factors that influence food access for specific groups of households. The FEWS focus on household incomes is, in part, justified by the observed strong relationship between incomes and food consumption. According to a survey of developing countries, poor households spend as much as 60 to 70 percent of their income on food (Alderman, 1986). That proportion typically increases as households become poorer. As practical concern for vulnerability analysis, data related to income levels is available not only from crop production and price statistics, but from information on quantities of output and prices covering a range of productive activities that contribute to household incomes as well.

17. In addition, research throughout Africa has indicated that households attempt to minimize the overall risk exposure of their incomes by diversifying across a range of productive activities with non-correlative risk (Reardon, et al, 1988; Staatz, et al, 1991; von Braun, et al, 1991). In Burkina Faso, for example, the high risk of drought in the relatively low agricultural potential Sahelian region of the country led households there to diversify their incomes toward local, non-agricultural activities, as well as seasonal migration to urban centers and other farms in higher potential, less drought-prone areas. During drought years, those households with more diversified income sources are typically better able to insulate their consumption than those in relatively high potential areas that focus most of their efforts in rainfed agriculture (Reardon, et al, 1988).

18. As indicated in Figure 1, income sources may vary widely across households and location. In Zambia, for example, households in a recent survey obtained nearly 77 percent of their incomes from agricultural production for home use. In southwest Kenya on the other hand, households surveyed received only 39 percent of their incomes from crop production for home use. Even within countries, the importance of individual income components can vary significantly, as already suggested in the case of Burkina Faso described above.

19. Therefore, in addition to an understanding of potential changes in overall income levels, the analysis of vulnerability also requires the explicit identification of specific income sources for each household group of interest. By focussing on the individual components of income, analysts are better able to distinguish and monitor the specific sources of risk that are most likely to lead to declines in total income and consumption levels.

Figure 1. Rural Income Sources in Selected FEWS Countries



BEST AVAILABLE DOCUMENT

C. A Model of Household Incomes

20. Under the FEWS framework, a model of household income provides the foundation for the analysis of famine vulnerability (May, 1990). However, the use of a household model is only to describe important relationships between the factors that influence income and consumption and to act as a guide for empirical analysis. In practice, as will be discussed further below, the household model is applied to relatively homogeneous households, or socioeconomic groups, as defined by similarities in their location within particular regions, their household-level production systems, as well as the characteristics of individuals within those groups (Downing, 1991).

21. In general, per capita food consumption can be represented as a function of both the price of food and per capita incomes:

$$(1) C = f(p, Y)$$

C - per capita consumption

p - price of food

Y - per capita income

22. Because vulnerability refers ultimately to an assessment of the probability of a given event, the relevant measure of income must include all expected or potential income for each group of households. Therefore, income is defined to include:

- (a) cash or in-kind payments derived from the sale of labor for wages and the sale of other goods and services produced in the household;
- (b) the value of goods produced by the household for own consumption, particularly food commodities, which is defined as a form of implicit income; and
- (c) the current value of household assets, food stocks and claims on community or government entitlements, which is seen as a form of potential, or expected income.

23. At the conceptual level, total income should be distinguished from the disposable income, net of any production costs, which is actually available directly for food consumption -- although, in practice, data on production costs are typically quite limited. In addition, even though expenditures on food typically dominate household expenditures, the competing demands of other necessities on household budgets, which may vary widely across groups, must also be taken into consideration in the analysis of famine vulnerability.

24. Diagram 2 illustrates the sectors of productive activities through which households typically obtain their incomes. These various components of income can be broadly categorized to include that derived from:

- (a) home production, which includes the production of goods by the household for own consumption, particularly subsistence food crops, livestock products consumed in the

household, wild foods gathered and other agricultural and non-agricultural goods (and is defined as an implicit form of income);

- (b) marketed output, which provides cash or in-kind income directly from the sale of surplus food crops, other cash crops, livestock products, as well as non-agricultural goods produced and sold by the household;
- (c) wage employment, including cash or in-kind income from both local and migrant wage employment in both the agricultural and non-agricultural sectors;
- (d) asset sales and stock drawdowns, such as the sale of land, livestock, tools and other assets owned by the household, as well as drawdowns of cash savings and food stocks (which can be measured as a form of potential income);
- (e) self-employment, including income obtained directly from petty trading and other income-generating activities; and
- (f) transfer receipts, including government or donor food aid receipts, remittances from absent family members, as well as gifts and loans from the local community (which may also include potential income from claims on government and community support systems).

25. This formulation of income includes the factors analogous to common measures of food availability, represented here primarily by the value of food production, food stocks and the value of food transfer receipts. Diagram 2 also captures the other determinants of household food access derived from the range of other income sources which directly influence households' ability to purchase food in the marketplace.

26. The relationships between the various income components and total income, as illustrated in Diagram 2, can be restated in a simple equation. Given the diversification of household incomes across n possible productive activities, total per capita income can be represented more generally as follows:

$$(2) \quad Y = p_0 * q_0 + p_1 * q_1 + p_2 * q_2 + \dots + p_n * q_n$$

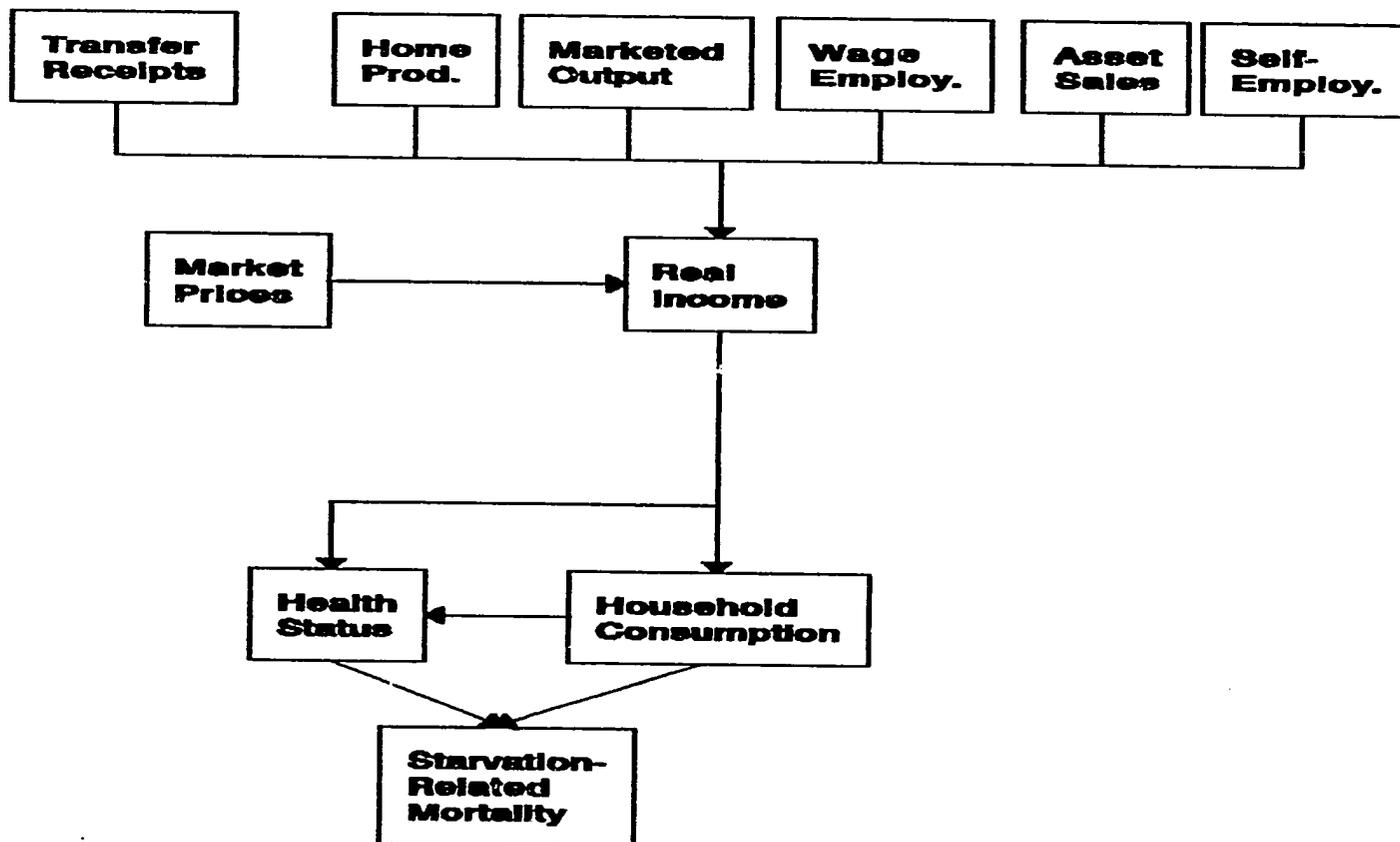
Y - total per capita income

p_i - price of output for activity i

q_i - per capita output for activity i

27. In this equation, p_i equals the price (net of costs) of each good or service provided by the household and q_i represents the quantity of each good or service actually produced for sale. Goods produced for own consumption are valued at the relevant consumer purchase price. Note that this notation includes not only prices and output of goods and services produced, but also the quantity of labor supplied by a household in the labor market and the value of the wages received.

Diagram 2. The Determinants of Household Income



28. As will be discussed further below, the set of prices faced by individual households as both producers and consumers will vary from observed market prices according to households' relative degree of market access. In practice, barriers to market access can vary significantly across population groups. Understanding those factors and their impact on the set of effective prices which households face is an important element of vulnerability analysis.

29. It is useful to characterize total household income in terms of its value relative to the price of food, denoted here as p_0 . This provides a measure of the total food purchasing power of household incomes, as follows:

$$(3) \quad \bar{Y} = \frac{Y}{p_0} = \frac{p_0}{p_0} * q_0 + \frac{p_1}{p_0} * q_1 + \frac{p_2}{p_0} * q_2 + \dots + \frac{p_n}{p_0} * q_n$$

\bar{Y} - per capita income (in food purchasing power equivalents)

p_0 - price of food

30. This particular form of the relationship highlights some important elements in vulnerability and early warning analysis. Dividing each income component by the price of food produces an explicit representation of the terms of trade between food prices and the prices of other goods and services produced by the household. According to Equation (3), purchasing power, or access to food, will be adversely affected by either: (a) an increase in food prices, p_0 ; (b) a decrease in the price of household goods and services produced and sold, p_i ; or a decline in the output of those goods and services, q_i , such as when drought leads to a decline in the quantity of food produced.

31. This focus on the complete range of household productive activities and sources of income provides an important perspective for the interpretation of indicators across different household groups. For example, it is clear that a given change in crop production influences incomes and vulnerability only to the extent that a specific group of households rely on that activity as a major source of income and consumption. As illustrated in Figure 1 above, the degree of reliance on crop production for income can vary widely, both across households and location. Therefore, in vulnerability and early warning analysis, the influence of changes in each indicator must be weighted for specific household groups according to its relative importance to their overall incomes and access to food.

32. Until recently, vulnerability and early warning analysis focused only on a narrow range of goods produced by the household, primarily food commodities, and a narrow range of corresponding prices. Ultimately, however, while observed declines in food production and availability are useful for predicting the onset of a food emergency in general, that information says little about the vulnerability of specific groups of households. Given a loss of crop or livestock incomes, it is what remains from the income that can be obtained from other sources that ultimately determines which households will maintain sufficient access to food to avoid a crisis.

D. The Determinants of Income

33. As illustrated in Equation (3), prices and output in various productive sectors are the primary determinants of household income and, therefore, important variables of interest in FEWS vulnerability assessments. However, these variables do not represent the final level of analysis in the FEWS framework. In addition to looking forward from possible changes in incomes to the likely impact on consumption, health status and starvation, it is also necessary to look back from individual income components to understand the factors that ultimately determine the level of risk associated with prices and output in each sector of household productive activity.

34. The risk and variability inherent in these secondary income determinants constitute the root causes of famine. An understanding of the functional relationships between the secondary income determinants, on the one hand, and output and price, on the other, provides insight into the underlying structure of famine vulnerability. With that understanding, FEWS analysts are able to trace observed changes in a given secondary determinant, such as a fluctuation in rainfall, through to its probable impact on overall incomes and consumption, thus allowing the prediction of changes in vulnerability over time in early warning analysis.

35. In general, the prices faced by a given household for the goods and services it produces and consumes are influenced by a range of secondary determinants, including: (a) the factors that influence household physical access to the market for particular goods and services produced and consumed, (b) government policies regulating those markets, and (c) the factors that influence the overall supply of and demand for the relevant goods and services. A more detailed description of the set of the secondary determinants that influence prices, for the specific case of food commodities, and the basic structure and temporal ordering of their relationships with each other is presented in Diagram A.1 in the appendix.

36. Similarly, the level of output for goods and services produced by a household depends on each household's resource endowment, which provides the set of inputs used in household productive activities, as well as the factors that determine household access to those resources. The resources a household has at its disposal to employ in its productive activities can be broadly categorized as: (a) natural or environmental resources, (b) human capital and labor resources, as well as (c) physical and financial capital resources. Diagrams A.2 through A.4 in the appendix illustrate the various secondary determinants that influence output in a selected number of productive activities.

37. In the case of crop production (Diagram A.3), a combination of factors determine household access to natural resources and the other inputs necessary to the production process. Household location, for example, influences access to quality soils and water sources, as well as exposure to specific climatic conditions. Similarly, location also determines, in part, household access to government extension services, as well as the cost of transporting purchased inputs from the nearest marketplace. The economic factors of supply and demand influence the market price and, therefore, availability of the necessary inputs in the production process, and thereby determine the supply of credit and the quantity of land, draft power, labor and other factors available to households for their production activities.

38. Physical processes, on the other hand, determine how effectively household resources and inputs, once obtained, may be combined to produce a given output. For example, in a given location and with a given set of resources and inputs, crop yields are determined by the interaction of:

(a) the climate, including local temperatures, rainfall and humidity that influence photosynthesis, evapotranspiration and other biological processes related to crop production; (b) soil factors such as nutrient content, moisture holding capacity and the degree of erosion; (c) the physiology of a specific crop varieties grown and their responsiveness to various combinations of climate, soils and chemical or natural inputs and; (d) the exposure and susceptibility of various crops to diseases and pests. Similar physical relationships also influence the availability of pasture grasses and livestock production (Diagram A.4).

39. The outcome of the physical processes outlined above is the production of an economic good, such as a food crop or livestock product, that has value to the household, either as an input in a related production process, or as a final output that is consumed directly, stored, or sold in the marketplace. The ultimate value of that final good to household incomes is, again, determined by a household's physical access to the relevant market and the factors which influence the aggregate supply and demand for that good and, thereby, its price.

40. While a large number of factors ultimately influence price and output in each productive sector, history suggests that only a few of these are ultimately responsible for both the long-term deterioration in conditions and short-term instability that combine to determine levels of famine vulnerability. Over the long-term, those factors include: (a) increases in population pressure and the resulting deterioration in the natural resource base which limits productivity in the crop and livestock sectors in particular; (b) adverse policies which distort the functioning of the economy in general, with particular biases against the rural poor in many cases; and (c) repeated crisis situations which lead to the erosion of household assets and a deterioration in the long-term productive capacity of affected populations.

41. The most common forms of short-term instability include: (a) adverse changes in the pattern and level of rainfall, which threaten crop and livestock production, agricultural employment and other related productive activities; (b) market failure which leads to sharp rises in food prices or the collapse of prices for livestock and other goods and services households produce for sale; and (c) conflict and civil war which, again, disrupts household productive activities as well as their access to assets and markets for food and employment.

42. As will be evident in Section III below, vulnerability analysis in the FEWS Project places high priority on developing and assessing information on these factors in particular. The continued development of improved methods to analyze the specific functional relationships between these factors and famine vulnerability -- to better identify the relative risk inherent in these secondary income determinants and to better elucidate the temporal dimension of their impact on incomes and consumption -- is an important focus in the FEWS Project.

E. Market Access and Inter-Regional Linkages

43. The model of household incomes defined by Equation (3) above does not explicitly account for the spatial factors that determine the relative vulnerability to famine across households in different locations. As indicated above, however, the location of households is an important determinant of: (a) access to a set of natural resources for use as inputs in productive activities; (b) access to the markets in which households buy and sell goods and services; as well as (c) access to government services, such as agricultural extension, which can serve to improve household

productivity, and access to social security measures which provide a critical safety net in the event of short-term fluctuations in income and consumption.

44. Typically, households are not located directly at the markets in which they must buy and sell goods and where market prices are actually monitored. Their physical access to those markets, and the actual prices which they face, are determined by their distance to the relevant market, the quality of roads and other market infrastructure, the availability of fuel and transport, as well as other possible physical barriers to trade (Diagram A.1). Although difficult to measure directly in some cases, these factors constitute a "friction of distance" that must be accounted for in some way.

45. In terms of Equation (3), the determinants of physical access can be represented in the income-based framework as a form of transaction costs (Elhance, 1991). These transactions costs increase the effective price (observed market price plus costs) of the goods and services which households purchase and consume. Conversely, those costs reduce the effective price (observed market price minus costs) households receive for the goods and services which they produce and sell. In the case of government transfers, differences in location and access are, again, be represented by differences in the set of prices used in determining the expected value of that transfer income for various households, which also declines with more restricted access and higher transaction costs.

46. In addition to the prices which households face, spatial factors also influence household access to specific sources of income. In their attempts to control the risks to their incomes and consumption, households diversify their activities, not only across sectors of productive activity, but also across geographic area. To the extent that goods and services produced and consumed by households are traded across regions, these inter-regional linkages exist through capital markets, labor markets, markets for household output, as well as markets for consumer goods and factor inputs.

47. In a crisis period, these inter-regional linkages may be particularly important in determining the extent to which local food shortages can be made up through trade with distant, surplus-producing regions. The degree of spatial integration influences the relative speed at which adjustments in quantities and prices are made in the local marketplace. Similarly, even in non-crisis years, it is important to be able to understand the implications of any disruption of production in those distant areas for local households as well.

48. Another important representation of these inter-regional linkages is in the determination of income from labor migration. In many FEWS countries, it is common for large numbers of workers to migrate either on a seasonal or permanent basis to distant agricultural schemes, the mining sector or urban areas, and to provide some portion of their earnings to households in their home areas. As with markets for food, to the extent that households migrate to earn their incomes, it is necessary to understand the factors that determine the supply and demand for labor in those distant migrant sectors, as well as the factors that determine access to those employment opportunities for households from any given region.

49. Finally, it is important to note that the determinants of physical access and inter-regional linkages are not synonymous with the factors that influence overall economic access to food supplies, which is the central concern of vulnerability analysis. Economic access represents the full set of factors that influence households' ability to command sufficient food supplies and other goods and services in the marketplace. In addition to the spatial relationships that influence transactions costs, household incomes, the determinants of overall supply and demand which influence observed market

prices, as well as the factors that influence market structure such as government policy, the number of traders, and other factors, all contribute to a household's economic access to specific goods and services.

F. Household Adjustments during the Famine Process

50. Given an understanding of the structure of incomes and the determinants of access and vulnerability, it is important to understand how changes in the determining factors described above actually lead to famine. Again, fundamental to the analysis of famine vulnerability and the prediction of events in early warning analysis is the understanding that famine results from a process of impoverishment, which may be prolonged in the case of drought-induced famine, or quite rapid, as when civil war disrupts household productive activities.

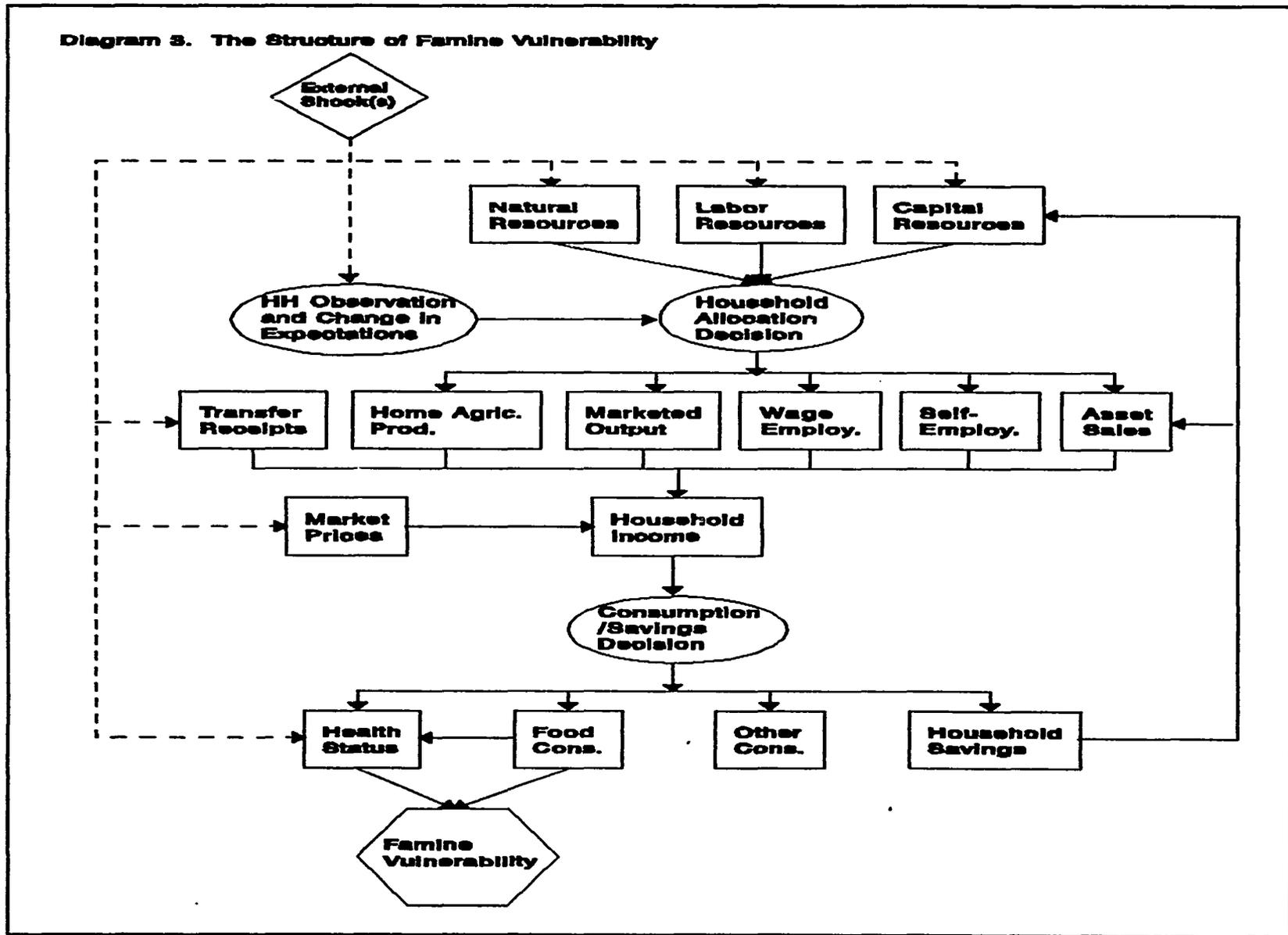
51. In general, the famine process develops over time from an initial shock (or shocks) to household productive activities and moves through a series of resulting changes in physical and market conditions. These changes in conditions represent a re-ordering of the resource constraints households face in their various productive activities. To the extent these changes are observed, they influence household expectations regarding the likely long-term streams of income from their various productive activities and result in significant changes in household behavior as they attempt to cope with that initial shock. An attempt to describe this process in the context of the income model described above is represented in Diagram 3.

52. In response to an external shock, and given observed changes in conditions and adaptations in their expectations of the future, households undertake changes in behavior intended to maximize their long-term incomes and consumption (or minimize losses). Referring again to Diagram 3, these coping responses can be categorized broadly as follows:

- (a) a re-ordering of the timing, composition or location of the factor inputs within a specific productive activity -- such as through variations in the timing of planting or weeding in crop activities, or, for livestock production, migration to other pasture areas less affected by local rainfall conditions;
- (b) a reallocation of factor inputs across different productive activities -- such as the reallocation of family labor from local agricultural production to migrant labor activities; and/or
- (c) a re-ordering of savings and consumption patterns -- such as the sale of assets for the purchase of food or the reduction in consumption levels to conserve resources.

53. As the famine process progresses over time, households undertake a pattern of behavior that eventually escalates from relatively low cost insurance measures to minimize risk, such as through the reduced consumption of non-food items to conserve income; to intermediate cost measures including the use of savings to purchase food; and, finally, to high cost measures, such as the sale of productive assets, that limits their future income-earning capacity (Corbett, 1988). These changes in the production and asset management strategies of households over time, and the extent to which they represent the increasing degree of stress which households face, serves as the basis for determining final levels of vulnerability in the FEWS Project, as outlined in the FEWS Vulnerability

Diagram 3. The Structure of Famine Vulnerability



Matrix in the appendix.

54. In terms of Diagram 3, the famine coping process can be viewed as a series of iterations through the various stages of the model. For example, given an observed shortage of rainfall, households may choose to adjust the timing of their cropping activities. While, initially, there may be no actual impact on crop incomes, households may also choose to reduce their levels of consumption and increase savings as insurance measures under the expectation of future income declines.

55. With prolonged drought, and the expectation of an inevitable failure of crops, the second-round impact might include a reallocation of household labor from crop activities toward migrant wage employment. To the extent that income from wage employment does not compensate for the loss of crop income, households may be forced to draw down on their savings in order to finance their reduced levels of food consumption.

56. A final iteration of this process might represent the failure of diversification efforts by affected households, requiring the liquidation of productive inputs through the sale of assets and ultimately, complete destitution, with an associated drastic reduction in consumption levels. However, it is also important to note that, at any point in this process, mitigating factors such as government or donor intervention, or a favorable change in environmental or market conditions may reverse the trend toward impoverishment and famine, potentially leading to recovery and the resumption of more "normal" productive activities and patterns of consumption.

57. The capacity for households to respond and, therefore, the rate at which the famine process proceeds towards total destitution and starvation, depends on the duration and intensity of a given shock and the constraints households face in their responses. These constraints are defined by the conditions households face in various factor and commodity markets, the composition of their initial natural resource and labor endowments, their level of physical and financial wealth, as well as possible cultural factors that may also govern behavior.

58. In many famine-prone areas, the underlying constraints to effective household response are frequently conditioned by the long-term degradation of the natural resource base, for example, that is typically associated with the process of desertification. Exposure to prior crises and the prior loss of productive assets, without an intervening period of sufficient recovery, may also lead to reduced coping capacity and, therefore, greater vulnerability to more acute fluctuations in other determining factors, such as drought or drastic changes in food prices.

59. Throughout the famine process, however, household objectives are not simply to preserve their means of livelihoods. A more general definition of household objectives is that they order their resources to maximize their well-being over the long-term, according to existing constraints. Holding other factors, such as cultural values and practices, constant, well-being is typically associated with levels of consumption. Therefore, household objectives can be assumed to lead to efforts to maximize consumption levels over the long-term.

60. This broader definition of household objectives allows the application of the vulnerability framework to non-crisis or recovery periods when households look for ways to invest and improve incomes, as well as to the initial stages of a crisis when the preservation of livelihoods, or long-term income and consumption potential, is a more immediate concern. This definition of household objectives also applies in the final stages of the famine crisis when even productive assets are

completely liquidated out of a concern for the long-term preservation of human life.⁴

61. In the FEWS framework, reports on household behavior obtained from key informants and other sources are used as confirming indicators against which changes in incomes predicted by the income-based vulnerability model are assessed. As discussed in greater detail in Section III, FEWS analysts use the convergence of evidence from a variety of information sources to actually determine final level of vulnerability. These behavioral indicators are often among the most important sources of information in signalling the possibility of a crisis and in confirming a crisis actually exists. The use of the formal methodology in no way negates the importance of information on changes in household behavior. The strengthening of local key informant networks to provide improved information on household behavior should continue to be an essential priority in any attempt at improved early warning capacity.

G. Current v. Chronic Vulnerability

62. As discussed above, the concept of vulnerability can reflect both short and long-term changes in households' access to food. Chronic factors such as over-crowding, resource degradation and low incomes lead to chronically low levels of consumption. These long-term problems are typically the necessary conditions through which short-term instability from drought and other factors leads to famine. Thus, while closely related, long-term patterns of vulnerability, defined as **chronic vulnerability**, and the actual food security status of relevant population groups at the present time, defined as **current vulnerability**, may be seen as separate concepts.

63. However, it is the current vulnerability status of a given population group that is of most relevance to policy-makers responding to possible emergency situations. On the one hand, the analysis of current status would seem to necessarily take long-term changes into consideration, in the sense that everything that has happened to a given population in the past from chronic problems should be expressed in the extent of their current level of vulnerability.

64. On the other hand, and in consideration of the practical needs of any empirical analysis, it is important to recognize the usefulness of baseline data on chronic conditions in interpreting current changes in indicators. In fact, those current changes can only be understood in the context of historical patterns of poverty and food access in order to draw accurate implications for current food security and famine vulnerability.

65. The analysis of long-term patterns of vulnerability can be broken down into two distinct activities: the analysis of historical vulnerability and the analysis of structural vulnerability.

66. Historical vulnerability implies the analysis of the trends and variations of income and its determinants over some extended time period. This form of analysis produces a simple baseline

⁴In this formulation of responses, starvation is not the result of a conscious trade-off by households between "low-valued" family members and productive assets, as the focus of livelihood preservation might imply. On the contrary, starvation may be seen to result from the fact that households are forced to make decisions with imperfect information regarding future economic and health conditions.

measure of vulnerability to serve as a point of reference in the analysis of current vulnerability for a particular socioeconomic group. As stated, current vulnerability analysis is an updating of that baseline estimate at a particular point in time, given additional, recently observed data. It is possible to define early warning analysis as a continual process of current vulnerability analysis to establish changes in the estimates of risk faced by various groups at any given time.

67. Given historical patterns of vulnerability, structural vulnerability analysis is intended to identify the most important underlying cause and effect relationships between various secondary determinants and for each household group's range of income components. Structural analysis is used to assess the possible impact of a change in some observed, secondary variables on the final measure of interest: changes in incomes and access to food. For example, in the case of crop income, structural analysis would be used to establish the basic parameters to assess the relative influence of various soil types, rainfall patterns, changes in area planted and other factors on the historical variability of crop production.

68. Although they appear similar, historical analysis and structural analysis are quite distinct conceptually: the former produces some understanding of the relative magnitude of incomes and their variability for a particular group, while the latter describes why those income sources are more or less variable. Identification of the structure of vulnerability allows analysts to focus on a particular set of variables of greatest importance in determining a given population's vulnerability. For example, it is possible to define socioeconomic groups according to the specific nature of their vulnerability -- such as those especially vulnerable to drought, or to fluctuations in demand for labor in migrant sectors, or to fluctuations in food prices -- and then monitor those factors more intensively.

69. Understanding the nature of the cause and effect relationships identified also allows prediction of the eventual impact of a given change on the future vulnerability level. While important for early warning purposes, this type of structural analysis could also ultimately inform decisions regarding the design of famine prevention and mitigation interventions, enabling policy-makers to identify and prioritize actions to address the most important root causes of vulnerability for specific populations.

70. Over the course of the growing season, FEWS analysts continually update their assessments of short-term changes in current vulnerability, a process which is synonymous with early warning analysis. Longer-term changes that may reflect more chronic vulnerability are updated once a year in an annual Vulnerability Assessment. This annual assessment of long-term (multi-year) changes in conditions produces a baseline from which to interpret on-going, short-term changes in current vulnerability through the following year (May, 1990).

71. The final level of vulnerability is defined by the degree of fluctuation in income, relative to historical patterns, and, as described in Section II.F. above, where those fluctuations place affected households within the famine process. Again, referring to the FEWS Vulnerability Matrix in the appendix, vulnerability levels are defined specifically by the extent to which changes in incomes result in drastic changes in the production and asset management strategies of households over time. Groups are categorized according to whether they face (a) slight, (b) moderate, (c) high, or (d) extreme risk of declines in food access or (e) to the extent that famine conditions actually exist, the imminent threat of starvation and starvation-related mortality.

III. THE EMPIRICAL ANALYSIS OF FAMINE VULNERABILITY

A. Units of Analysis

72. As stated, the use of a household income model in FEWS vulnerability assessments is to describe important cause and effect relationships between various factors and to act as a guide for empirical analysis. In practice, however, the focus of FEWS vulnerability assessments is not on individual households, but relatively homogeneous socioeconomic groups. These socioeconomic groups are defined according to: (a) their location within particular regions, (b) their household production systems, as well as (c) the characteristics of individuals within each region-specific household groups.⁵ The application of an income-based model at each level of analysis provides FEWS analysts a means to differentiate the relative importance of the resources and income streams relevant to each group and to assess more specifically the variations in those factors that might signal changes in each group's vulnerability (Downing, 1991).

73. In its analysis of vulnerability, the FEWS Project uses available secondary data on prices, output and the other determinants of income, which is referenced to a particular (sub-national) region or location. However, the definition of a region for analysis is not constrained to pre-defined administrative boundaries within a country. Spatial data, such as that from satellite imagery, is typically available at a fairly high degree of resolution and can be easily interpreted at a very local level. Socioeconomic data, on the other hand, especially that collected on a representative sample of a given population, may be more difficult to disaggregate below the administrative level used to define the relevant sample frame.

74. In the end, the nature of the specific data set will determine the basic unit of analysis for that particular data. Relationships between data sets, as determined by the application of the income-based model for each relevant socioeconomic group, are assessed at a level of regional disaggregation that ensures both the statistical integrity of the data and the highest possible homogeneity within the regional level selected for analysis. For reporting purposes, on the other hand, in order to ensure ready use by decision-makers, regions are defined by existing administrative boundaries, at some degree of disaggregation from the national level.

75. Information on the occupation structure of households within particular regions, derived both from census data as well as other information on local production systems, allows a more detailed interpretation of fluctuations in data on specific income components -- according to the characteristics of the specific household groups within a given region. Typically, these separate groups have access to fairly distinct sets of resources and may have fairly distinct patterns of income, consumption and, therefore, vulnerability. For example, a change in regional livestock income may be interpreted differently for farming populations within a region than for local pastoralist groups. A number of well-defined groups have been identified for analysis in the FEWS countries, including pastoralist, agro-pastoralist and sedentary farming groups, landless laborers, fishermen, craftsmen, urban poor and refugees (FEWS, 1992).

⁵The analysis of vulnerability at the level of the household and individual does not imply the identification of specific households and persons within a village or region. It simply represents an analysis of the likely implications of a given change in regional incomes on specific groups of households and types of individuals within a region.

76. At the final level of analysis, information on the characteristics of individuals within a defined region, such as the age/sex structure of households from census or demographic surveys, the proportion of female-headed households, and age/sex-specific health and nutritional information allows an even more detailed understanding of the implications of changes in regional incomes at the individual, intra-household level. Typically the analysis of vulnerability at the individual level focuses on the implications of a given change in regional incomes on access to food for the most vulnerable types of individuals, especially including children, pregnant and lactating women, and the elderly.

B. The Selection of Indicators

77. The framework for vulnerability analysis presented above is highly complex, presenting a wide range of potential income components for various households groups and an even larger number of possible determining factors. From an operational perspective, while there are limits to the amount and type of data actually available from secondary sources, it is still necessary to set priorities in the collection and use of information in vulnerability analysis.

78. To establish those priorities, FEWS analysts first attempt to identify the most important individual income components in both the agricultural and non-agricultural sectors and then possible sources of information on the relevant prices and quantities of output in each of those sectors. As a second step, FEWS analysts attempt to identify the most important secondary determinants for each relevant income component, as well as information that would allow them to monitor possible fluctuations in those factors.

79. In rural areas, which are typically most vulnerable to the effects of famine, crop and livestock production dominate household activities and incomes and, therefore, are a central focus for the selection, monitoring and evaluation of empirical indicators. However, as stated previously, the importance of income diversification in minimizing the overall risk exposure of households implies that other income components must also be monitored to develop an understanding of on-going changes in vulnerability.

80. As a result, and while the relative importance of each may vary widely across socioeconomic groups and across countries, FEWS analysts also monitor information on prices and output in the following sectors, as they directly reflect possible changes in income from: cash crop production; wage employment in various agricultural and non-agricultural activities, such as migrant labor in gold mines or on commercial farms; food aid transfers and remittances; as well as petty trading and handcrafts activities.

81. Given that list of priority income components, FEWS analysts are then able to establish priorities in the collection of secondary income determinants to monitor as well, as a means to predict and/or confirm fluctuations in individual sources of income. Typically, the most common indicators used in early warning and vulnerability analysis across all FEWS countries include the following:

- (a) Crop production, area and yield estimates for both food and non-food crops, as well as information on pest infestations, typically available from government or donor estimates on the basis of pre-defined administrative units;
- (b) NDVI (Normalized Difference Vegetation Index) satellite information on photosynthetic

activity as it relates to vegetative vigor, or the "greenness" of vegetation, currently available at a 7 sq km resolution;

- (c) **Meteosat satellite imagery of cold cloud duration, which provides estimates of the possibility of rainfall in a given area, currently available at a 7 sq km resolution;**
- (d) **Point rainfall estimates from individual weather stations scattered throughout FEWS countries;**
- (e) **Prices and, in some cases, quantities of throughput of food and cash crops, livestock and other commodities, typically from a limited number of markets in FEWS countries; and**
- (f) **Data on the outbreak of civil conflict in specific areas, including the number of incidents and populations affected.**

82. Other data on food transfers from government relief distributions and some measure of cash transfers from remittances may also be available in some FEWS countries. It may also be possible in some cases to obtain fairly direct measures of income generated from wage employment in particular sectors. Secondary data on the incidence of malnutrition and other confirming indicators may also be available on a limited basis. A complete list of indicators, and some sense of their use in the FEWS Project, is presented in Table 1 below.

83. In fact, few countries have sufficient data on prices and output on all important income components. Therefore, some proxy indicators for particularly important income components may have to be developed. For example, in the absence of data on changes in livestock production year-to-year, some FEWS countries use NDVI-based estimates of pasture biomass production as a proxy for production estimates to provide at least a qualitative assessment for prospects in the livestock sector. Similarly, in the case of wage employment in the commercial agricultural sector, a proxy indicator might be constructed from data on area planted to various crops and estimates of the units of labor employed per unit of land (or per unit of output) by crop and cropping activity.

84. Finally, other background, or baseline, information on the structure of the population and natural resource base is also used by FEWS analysts to assist in the interpretation of fluctuations in the primary and secondary determinants of income. Information on land use patterns, soil profiles, cropping intensity, land/labor coefficients in the production of various crops, demographic information such as population, occupational structure of households, age/sex structure of populations within a defined region all constitute important data for FEWS vulnerability assessments. Again, these indicators are listed in Table 1.

C. The Structure of Vulnerability Analysis

85. The analysis of vulnerability indicators in the FEWS Project is undertaken in a sequential process corresponding to the seasonal pattern of household productive activities in each country and is designed to provide specific information to the USAID decision-making process on a timely basis for programming food aid commitments. In each FEWS country, the annual analytical cycle begins just prior to the beginning of the growing season with an intensive Vulnerability Assessment. That assessment, which is based on the analysis of historical vulnerability to that point,

with particular emphasis on events in the preceding year, establishes a baseline from which to assess changes in incomes and food access through the season.

86. It is important to note that, as illustrated in Table 1 above, the availability and quality of various data sets and indicators varies widely across FEWS countries. Therefore, it is only possible to discuss a broad conceptual framework and the general steps in the empirical analysis of vulnerability, which are consistently applied across all FEWS countries. Specific methodologies for the analysis of some indicators, as well as methods to combine indicators into an overall assessment of vulnerability, may vary slightly across countries.

87. Following the initial FEWS Vulnerability Assessment, conditions that influence crop, livestock and other income components are monitored continuously throughout the growing season, with reporting at regular intervals.⁶ While some FEWS reports, such as the Pre-Harvest and Harvest Assessments, highlight a specific set of narrowly-defined issues and indicators, changes in current vulnerability are evaluated regularly, at each step in the analytical process, and are made more explicit in reporting as the season progresses, or as major changes in conditions are observed.

88. Diagram 4 outlines the broad structure of FEWS vulnerability analysis, which explicitly reflects the conceptual framework described above in Diagram 3. As illustrated in Diagram 4, information from the analysis of regional crop production, livestock production and other income sources is combined into an index of total incomes. To the extent that direct measures of the primary determinants of income (prices and quantities produced) are available for each income component, the total income index represents the sum across each income source. In countries where proxy measures are used to identify changes in one or more income sources and are, therefore, not directly comparable to one another, other methods are used to weight income components and synthesize them into a final income index.

89. In many cases, information on actual changes in output, such as crop production data, are available only at certain times during the year. Using information on changes in relevant secondary income determinants, however, predictions of potential changes in incomes can be developed at any point in the year. For example, changes in greenness through the growing season, as indicated by NDVI data, may be used to draw implications for future production and, as a result, the future vulnerability of specific populations.

90. At this point, though, formal predictive models that might link changes in important determining factors to future changes in production and incomes are only at the planning stage. Instead, the well-informed, albeit somewhat subjective, predictions of FEWS analysts are currently used at various stages of the year in informal sensitivity analyses which evaluate the likely direction and broad magnitude of possible changes in future vulnerability.

91. Examples of the analysis of changes in income components, for the cases of crop and livestock production are presented in Diagrams 5 and 6. These diagrams describe a temporal

⁶Reporting requirements for FEWS Sahelian countries include the Vulnerability Assessments, Pre-Harvest and Harvest Assessments trimestral reports, regular 10-day early warning bulletins and, in most cases, regular monthly food security cables. FEWS East and Southern African countries have less regular reporting requirements.

Diagram 5. The Organization of Indicator for the Analysis of Crop Production and Food Availability

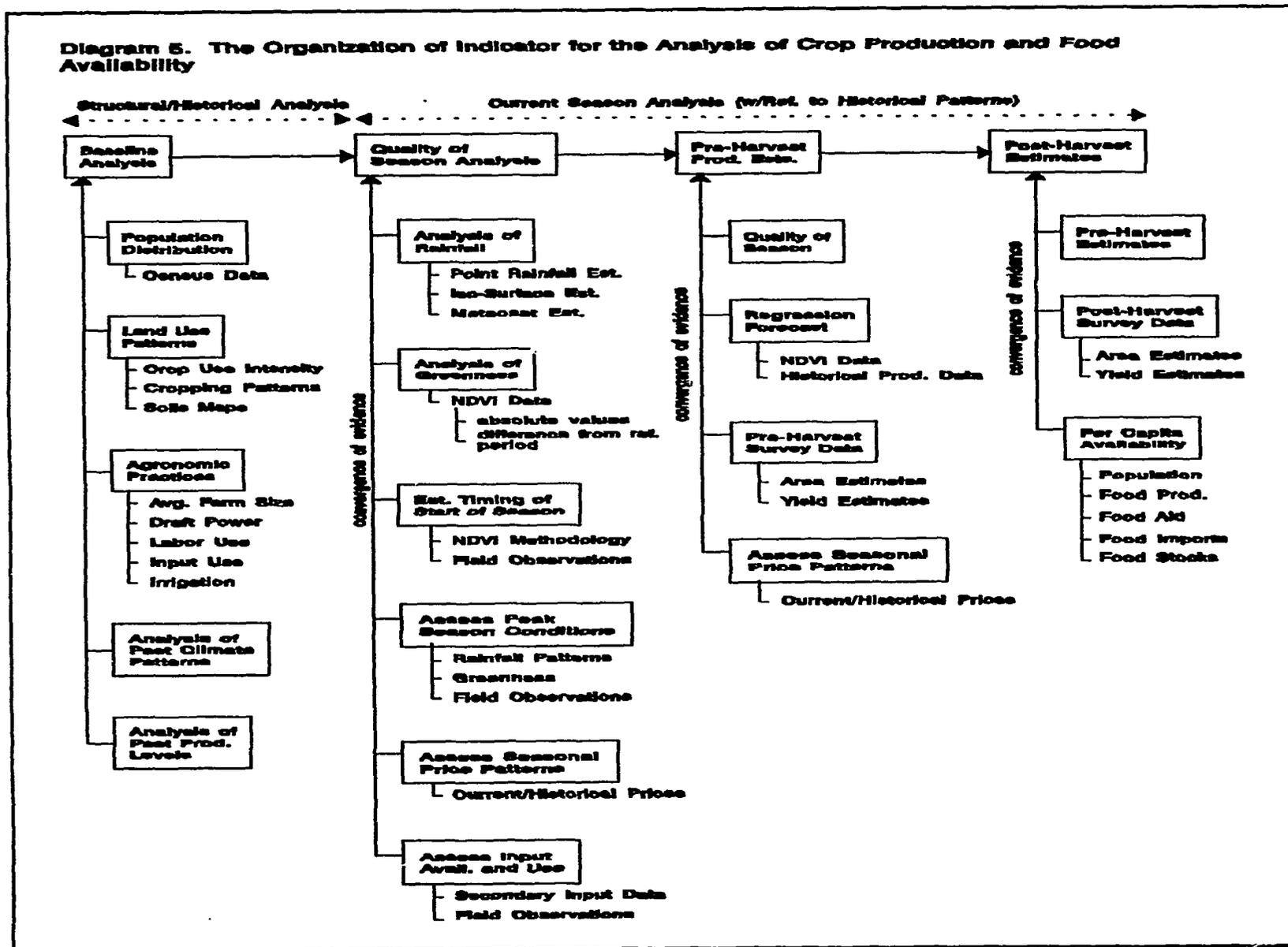
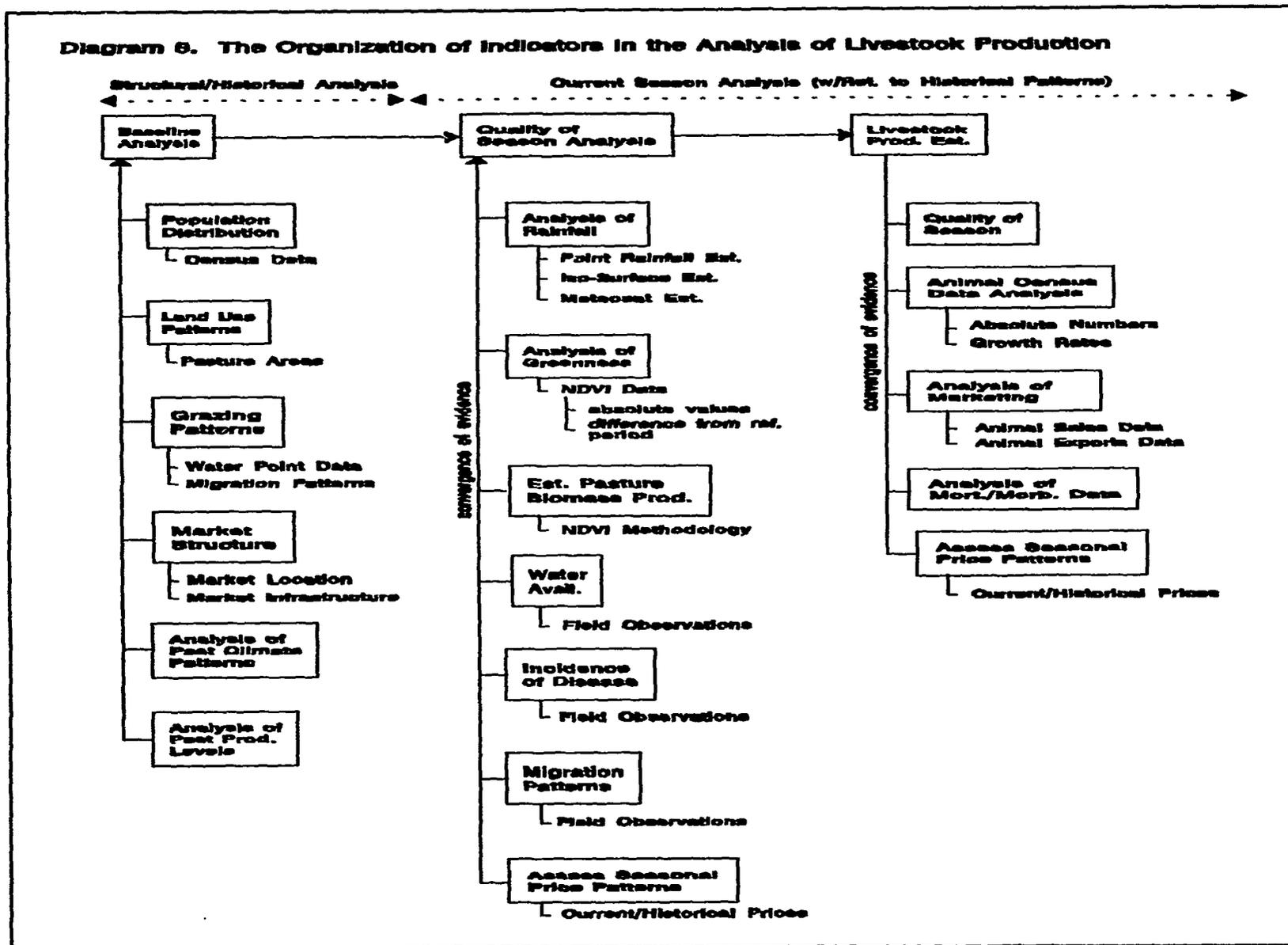


Diagram 8. The Organization of Indicators in the Analysis of Livestock Production



sequence of analytical tasks through the year, as well as the use of indicators in particular analytical methodologies. The analysis of crop production, for example, begins with an evaluation of historical land use patterns as well as current general conditions prior to the harvest, such as the availability of inputs and the status of land preparation. At the onset of the rainy season, FEWS analysts focus on indicators of the quality of the season, as defined primarily by:

- (a) the timing of the start of season, compared to previous years, as indicated by the rate of initial green-up from NDVI analysis as well as field reports from key informants;
- (b) general rainfall conditions from the analysis of rain gauge and Meteosat data, as well as an assessment of vegetative vigor, as represented by various NDVI measures);
- (c) the availability and use of important inputs, such as seeds and fertilizers, using reports from key informants such as government extension agents;
- (d) growing conditions at critical peak of season periods, as well as an evaluation of the overall length of the growing season (as defined by rainfall and greenness); and
- (e) patterns of seasonal market price fluctuations compared to previous years, which reflect market expectations regarding the up-coming harvest.

92. Once the growing season reaches a certain point, it is possible to develop pre-harvest estimates of likely production. Data from pre-harvest surveys, where available, are evaluated against historical figures and a summary analysis of the quality of the season, to develop a pre-harvest estimate of production. Currently, a number of more formal methods to predict crop production are also under development and could also be used in a type of convergence of evidence analysis of pre-harvest forecasts. Again, an assessment of seasonal price patterns is made to ensure that market expectations are consistent with the various estimates.

93. At the final stage of the crop analysis, once post-harvest surveys have been completed, that information is again compared with historical data, pre-harvest forecasts, the quality of the season, and seasonal price patterns, before a final production estimate is obtained. That final estimate, along with similarly produced estimates of livestock production and output in other sectors, is then used as an input in the calculation of the final income index for FEWS vulnerability analysis. Again, Diagram 6 illustrates the similar analytical process used in determining livestock production. The final crop production estimate is also used in conjunction with estimates of food stocks, imports and food aid receipts to produce a regional estimate of food availability.

94. As the next step in the analysis of vulnerability, regional information on demographic factors is then used as a type of filter to interpret implications of observed (or predicted) changes in incomes and, therefore, food access for specific socioeconomic groups. Subsequently, information on health status, particularly the outbreak of epidemic diseases, is used in combination with the index on incomes to produce a final vulnerability index which reflects the relative probability of starvation and starvation-related mortality across socioeconomic groups.

95. At each stage of the analytical process, confirming indicators, such as information on household behavior and nutritional status, are also used to evaluate the evidence provided by the secondary data sources used in the formal vulnerability model. These confirming indicators are used

to support the conclusions of the formal analysis or, where conflicting information appears, to direct further data gathering and analysis.

96. The use of multiple data sources to assess specific issues within the analysis of vulnerability is important to assure accuracy. First, the secondary data that serves as an input in any vulnerability analysis is notorious for its poor quality. Second, data from one source often conflicts with data from other sources and with what is known from the field. Therefore, FEWS analysts confirm the results of their analysis by using a convergence of evidence on the nature of existing conditions obtained from a variety of information sources. This convergence of evidence approach requires a "dialogue" between different sources of information -- for example, in the way information on livestock prices, rainfall levels, NDVI images of the greenness of pastures, and information from the field are all used together to assess livestock and pastoralist prospects.

97. Using the convergence of evidence from both the formal model and other confirming indicators, FEWS analysts are then able to identify groups according to their relative degree of current vulnerability. The criteria for assigning relative degrees of vulnerability to various groups are defined by the likely implications of an observed change in some measure of their overall income, as it places them at some stage in the famine process. As stated above, groups are categorized according to whether they face (a) slight, (b) moderate, (c) high, or (d) extreme risk of declines in food access or (e) actual famine conditions. Again, these criteria are highlighted in the FEWS Vulnerability Matrix in the appendix to this document.

IV. CONCLUSIONS

98. The goal FEWS vulnerability analysis is not to achieve absolute precision, but to minimize the orders of magnitude of error in estimates of the relative severity of food insecurity across regions and population groups. The approach to vulnerability analysis outlined above is intended to help organize existing data and the analysis of that data in a consistent and comprehensive fashion, according to current knowledge of the determinants of starvation. By doing so, analysts should be able to make the best possible use of the information available and, therefore, reduce the magnitude of error in the analysis.

99. The development of a framework of analysis, through the income-based model of vulnerability described above, also points to important steps to be taken in the future to improve both vulnerability and early warning analysis. These include:

- (a) obtaining a more complete representation of overall household incomes beyond current information on crop production and prices, including data on the most important additional income components and their relevant prices;
- (b) obtaining a greater understanding of the relative importance, or weight, of each of the determinants of income for each relevant socioeconomic group;
- (c) developing better tools to assess the relationships between secondary factors and their influence on incomes and consumption, perhaps in the form of predictive models linking, for example, changes in rainfall or NDVI values, to eventual changes in crop production;

- (d) developing improved methods to capture the spatial relationships that influence market access and inter-regional linkages that influence prices as well as output in various markets;
- (e) developing methods to construct adequate proxy indicators for important income components, as well as for overall levels of vulnerability; and
- (f) strengthening of local key informant networks to provide improved information on the confirming indicators based on observations of changes in household behavior.

100. By minimizing to the best extent possible the degree of error in FEWS analysts' predictions of vulnerability, the use of the framework presented above should also help in lowering the expected costs of relief operations. To the extent that the methods employed in that analysis allow for a more disaggregated view of vulnerability, the application of the model also allows for more efficient targeting of interventions and, therefore, should ultimately lead to reduced costs for both relief and mitigation efforts.