# Staff Paper

**AGROCLIMATIC SHOCK, INCOME INEQUALITY, AND POVERTY: EVIDENCE FROM BURKINA FASO**

by
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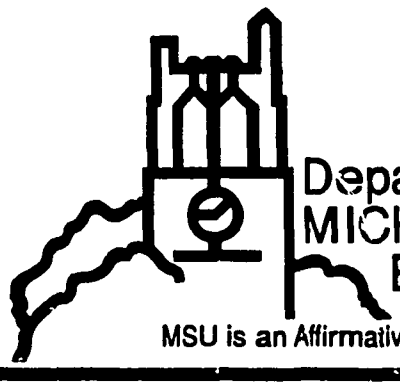

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**Agroclimatic Shock, Income Inequality, and Poverty: Evidence from Burkina Faso**

**Abstract: This paper examines the impacts of agroclimatic shock on income inequality and poverty, using household-farm data from three agro-ecological zones of Burkina Faso together with income-source decompositions of the Gini coefficient and the Foster-Greer- Thorbecke poverty index before and after a severe drought. Our findings reveal that off-farm income increases inequality and fails to shield poor households against agroclimatic risks. The direction of the relationship between changes in inequality and poverty after the drought depends critically on environmental variables and on apparent constraints on income diversification at different points in the income distribution.**

Despite the tremendous human and economic impacts of agroclimatic change in the West African Semi-Arid Tropics (WASAT) and elsewhere, there has been little effort to model theoretically or empirically the impacts of agroclimatic shocks, such as drought, on poverty and income inequality. The relationship between poverty and income inequality is theoretically ambiguous. An agroclimatic shock could reduce income inequality (e.g., by reducing income at the top of the distribution) while increasing poverty (by adversely affecting incomes at or below the poverty line). The distributional and poverty impacts of agroclimatic shocks depend critically upon the distribution of access to social or self insurance against agroclimatic risks. This access is revealed *ex-post* by changes in household income sources.

The present paper tests the distributional and poverty impacts of an agroclimatic shock in three distinct agro-ecological zones of Burkina Faso, by comparing income-source decompositions of the Gini coefficient and of the Foster-Greer-Thorbecke (FGT) poverty index before and after a severe drought. Our findings offer insights into the links between changes in income inequality and poverty in the WASAT, where poor households have limited access to off-farm income. They also reveal differences in the impacts of the drought across agro-ecological zones. These impacts, we argue, are related to inter-zone differences in the risk incentives to diversify incomes prior to the drought, as well as to unequal access to non-crop incomes within zones.

## I. INCOME SOURCES, INEQUALITY, AND POVERTY

Empirical studies of farm households in developing countries typically show a U-shaped relationship between nonfarm income and total income. This implies that relatively poor and relatively rich households diversify their incomes, but the middle stratum's incomes are less diversified. Diversification helps the poor compensate for crop failure and landholding constraints. Shortfalls in farm incomes are partly counter-balanced by nonfarm earnings, and there is a more equal size distribution of income than there would be without income diversification. Most of these findings are from Asian studies, especially in south Asia (Kilby and Liedholm, 1986; Walker and Ryan, 1990; Adams and Alderman, 1992).

The relationship between nonfarm earnings, on the one hand, and inequality in the size distribution of income and poverty, on the other, is theoretically ambiguous. (See Section 2.) The Asian results are not necessarily applicable to other regions with different structural characteristics. African conditions differ substantially from the Asian study sites that have produced the "typical" results. Comparing semi-arid South Asia with semi-arid Africa, Matlon (1987) finds that the latter has less developed rural capital and insurance markets, more extreme climatic variation, more severe environmental degradation, a greater importance of livestock husbandry as an insurance mechanism, less availability of labor-intensive, low capital-input work for the poor, and a more equal land distribution. These considerations can play an important role in shaping both the incentives to diversify and the distribution of access to off-farm incomes.

Despite these differences, very little research on the relationship between rural household income composition and income inequality has been carried out in Africa. The little research that has been done tells an ambiguous story. Matlon (1979) in Northern Nigeria; Collier, Radwan and Wangwe (1986) in rural Tanzania; and Reardon, Matlon and Delgado (1992) in Burkina Faso find

that the poor earn less of their income from nonfarm sources, and the rich more. This would suggest that nonfarm sources increase inequality. Other African studies find the opposite, however. Norman, Simmons and Hays (1982) find that nonfarm incomes are more important in relatively poor Northern Nigerian households.

Few of the past studies examine differences over agro-ecological zones and between normal and drought years. Those that do (e.g., Adams and Alderman) use multi-year data to study sectoral sources of inequality, but they do not examine explicitly the differences between a normal and a drought year. We expect that in Africa, especially in semi-arid Africa where climatic variability is pronounced and irrigation rare, these differences would substantially affect findings on income composition and inequality, perhaps explaining the ambiguity in past empirical work. Comparing income inequality and poverty before and after a drought should provide insights for policy intervention by revealing barriers which the poor face in entering nonfarm activities as a means to overcome environmental constraints and compensate for losses in crop income.

Little past work has explored the three-way relationship among income diversification, poverty and the size distribution of income. The few studies that have examined the relation between changes in income inequality and changes in the incidence of poverty have not specifically compared drought and normal periods, and the studies have been in Asia; these findings have produced an ambiguous picture. Malik (1993) found for Pakistan that poverty incidence declined with greater inequality in the overall income distribution; Datt and Ravallion (1993) and Kakwani and Subbarao (1993) found the contrary for India, that increases in inequality are associated with increases in incidence of poverty. Understanding the links between income inequality and poverty is particularly important in Africa, where poverty is widespread and where, given low per-capita incomes, the poverty consequences of changes in the income distribution are likely to be significant.

The present research attempts to fill this void by using income and poverty decomposition techniques and a unique data set from Burkina Faso. We begin by examining sectoral sources of income inequality in three agro-ecological zones for a base year in which there was a harvest from a season with normal rainfall. We compare this to the sectoral sources of inequality for the same zones in the subsequent drought year, and then link changes in sectoral sources of income inequality to changes in the incidence of poverty.

To estimate sectoral contributions to income inequality, we use Gini decomposition techniques developed elsewhere (Lerman and Yitzhaki, 1985), but to date applied only once in Sub-Saharan Africa, in Kenya in Francis and Hodinott (1993); the latter does not examine differences over agroecological zones or between drought and normal years, as we do here. To link income source inequality to the incidence of poverty, we modify the Foster-Greer-Thorbecke (1984) poverty index with an income-source decomposition. We have found no such sectoral poverty decomposition in the literature for Africa. Huppi and Ravallion (1991) do such a decomposition for Indonesia. More commonly one finds in recent literature that sectoral decomposition is proxied by undertaking a standard poverty decomposition for groups defined by primary sectoral source of income, or other characteristics such as household size or group/location. For example, Baliascan (1993) did such a study for the Philippines; Gusstafsson and Makonnen (1993) looked at principal income sources' effects on poverty incidence in Lesotho; Boateng et al. (1992) decomposed by location and group for Ghana; Kanbur (1990) decomposed poverty incidence by degree of income diversification and by region and group, and Kakwani (1993) by regions and household characteristics, for Cote d'Ivoire. This proxy method is difficult to justify where a typical farm household's income is diversified into a variety of activities, such as is the case in the West African semi-arid tropics (Reardon et al., 1992). Moreover, none of these past poverty decomposition studies combined information on sectoral sources of income inequality with sectoral sources of poverty incidence, and compared these over drought and

normal years. This combination is highlighted in the present paper, and is particularly important in the WASAT given the importance of recurrent drought in that region.

## II. THEORETICAL CONSIDERATIONS

Because risk aversion varies with wealth (Newbery and Stiglitz), the risk incentives to diversify income sources generally are not uniform across the income distribution, and income diversification does not have a neutral effect on rural income inequalities. The existence of heterogeneous environments creates incentives for households in poor and unstable agroecological zones to diversify their income sources across zones where the returns to income activities are not highly correlated (for example, through migration) or within zones into activities whose returns do not depend on the harvest. By contrast, in zones with more fertile soils and more stable rainfall, there are more incentives for households to specialize or diversify locally, including into activities that may be linked to crop production through input or output markets. These considerations suggest that, other things being equal, an agroclimatic shock that lowers crop production should have a less unequalizing (or perhaps equalizing) effect on the income distribution in the unstable zone, where ex-ante incentives for poor and middle income households to diversify are large.

Other things are not equal, however. In the absence of perfect credit and insurance markets, wealthy households are better able to self-insure against given income risks and to invest in risk-reducing cropping strategies (e.g., environment-improving technologies like land quality improvements, irrigation, and flood and erosion control). If diversification is costly (i.e., has high entry barriers) and initially risky, wealthy households are also in a more favorable position to diversify into noncrop activities. A theoretically ambiguous relationship between income and income diversification, in turn, means that the implications of diversification for the size distribution of income is ambiguous.

The relationship between the size distribution of income and the incidence of poverty also is theoretically ambiguous. An increase in inequality may be associated with more or less poverty. Where average per-capita income is low, however, changes in income inequality are likely to be associated with changes in poverty. In the extreme case where per-capita income is just above the poverty line, any level of inequality implies some poverty.

The effect of an agroclimatic shock (e.g., drought) on rural income inequalities and poverty within zones depends on the extent to which incomes at different points in the income distribution are diversified away from agroclimatically-vulnerable activities and on the costs of diversifying income in response to the shock. When diversification is costly and there are financial constraints on income diversification for poor households, the poverty impacts of a drought are likely to be severe.

## III. GINI DECOMPOSITION METHODS, DATA, AND AGRO-CLIMATIC ZONES

Following Lerman and Yitzhaki (1985), the contribution of income from source k to total inequality as measured by a Gini coefficient can be derived as the product of three terms: the share of income from source k in total income ($S_k$), the Gini coefficient of income inequality for income from source k ($G_k$), and the (Gini) correlation between source-k income and the distribution of total income ($R_k$). The Gini coefficient for total income inequality is the sum of the individual income source contributions to inequality. The income-source elasticity of inequality, i.e., the percentage effect of a 1-percent change in source-k income on the Gini for total income inequality, is the difference between source k's share in total income inequality and its share in total income.

Data for our analysis come from the farm household survey conducted by ICRISAT in rural Burkina Faso. The data used here cover two harvest-years: the "normal" base year, 1983/84, from the beginning of harvest in 1983 (following the normal rainy season in calendar 1983) to just before the harvest of 1984, and a "drought" harvest year following a poor rainy season in calendar 1984

(1984/85). The sample includes 150 households, 25 per village and two villages per zone, in the three main agroecological zones of the West African semi-arid tropics (the Sahelian, Sudanian and Guinean zones).

In all three zones, households practice rainfed agropastoralism. Most northerly is the Sahelian zone, with low but extremely variable rainfall, a fragile environment, and poor agroclimate. These environmental factors create incentives for households to diversify their incomes outside the local crop economy -- that is, for outward-oriented diversification. The middle belt is the Sudanian zone, with poor-to-moderate agroclimatic conditions, rainfall a little higher and more stable than in the north, and severe environmental degradation. About four-fifths of the Sahelian rural population live in these two zones. The Guinean zone, in the south, is moderate to good agroclimatically, has higher and more stable rainfall, and is characterized by a greater use of external inputs in crop production. The more dynamic agriculture in this zone creates incentives to diversify income into activities linked forward and backward with cropping -- that is, inward-oriented diversification. This paper will focus on the Sahelian zone, where the drought was most severe, and the Guinean zone as polar cases, but findings for the Sudanian zone are included in our tables.

## IV. INTER-ZONE COMPARISON OF INEQUALITY SOURCES IN THE NORMAL YEAR

Table 1 presents our Gini decompositions of income by income source for the three zones in harvest year 1983/84, the 'normal' (base) year. The column headings refer to the variable symbols given in Part 2. They include $S_k$, $G_k$, $R_k$, source k's absolute and percentage contributions to the Gini for total income ($S_kG_kR_k$ and $S_kG_kR_k/G$, respectively), and the effects of a small percentage change in income from source k on the total-income Gini.

Gini coefficients often are used to infer the impacts of income sources or assets on inequality. This may be misleading. Changes in an income source can have an equalizing effect on the

distribution of total income if income from the source is equally distributed (i.e., it has a low Gini), or if it is unequally distributed but favors the poor (e.g., welfare payments). The product of the income-source Gini coefficient and the Gini correlation between the income source and the distribution of total income ($G_kR_k$) provides a measure of income-source inequality that reflects both the distribution of the income source and the correlation between the income source and household total-income rankings. This index ranges from -1, in the case where all of the source's income goes to the poorest household ($G_k = 1$, $R_k = 1$), to 1, in the case where all source-k income goes to the richest household ($G_k = 1$, $R_k = -1$). The product $G_kR_k$ appears in Column 4 of Table 1.

The disposable income sources (all in net terms) include: (i) crop income (imputed value of home production plus gross sales less input costs); (ii) livestock income (net sales plus the imputed value of home consumption); (iii) local off-farm income; (iv) income from household seasonal migration in Burkina Faso or abroad; and (v) income transfers (from other households in the village, from external food aid, and from family members permanently residing outside the village).

The findings in Table 1 reveal that the share of crop income in total income is similar in the Sahelian and Guinean zones, around one half. However, they confirm our expectations concerning the inward and outward orientations of income diversification in the Guinean and Sahelian zones, respectively, and they suggest that there are barriers to income diversification into local nonfarm activities for poor households in both zones but particularly in the Sahelian zone, where agriculture is more risky. The poor in the northern zone are constrained to depend on the vagaries of unstable agriculture.

Crop income is more unequally distributed in the Guinean zone than in the Sahelian zone, probably because there is a wider range of crop investments (particularly fertilizer and animal traction) and hence productivity levels, and a wider range of crop mixes over households in this agroclimatically-favored zone. In both zones, increasing crop income reduces inequality, but the

impact is twice as great in the Sahelian and Sudanian zones than in the Guinean zone. Crop income is an equalizing income source.

Despite the traditional image of the Sahelian zone as "pastoralist" and the Guinean zone as "farming," the share of (disposable) livestock income is around 15 percent in both zones. Livestock is an important insurance and savings mechanism, given the dearth of functioning insurance markets and rural banks and a very weak informal credit market (Christensen 1989). In both zones, the Gini for livestock income is very high (around .75), reflecting unequal ownership of herds. Increasing livestock income has a small unequalizing effect on the size distribution of income in the Guinean zone, but a small equalizing effect in the Sahelian zone, however. This is because of a smaller Gini correlation between this income source and total income in the Sahelian zone. That is, poor households initially have more access to livestock income in the northern zone, where agro-climatic conditions are most risky.

The share of local off-farm income in total income is high in the Guinean zone (.38, compared with 0.22 in the Sahelian zone. This finding reflects greater opportunities to invest in activities that have forward and backward production linkages with agriculture in the agroclimatically better, Guinean, zone. Moreover, the Gini and Gini correlation for local off-farm income are lower in the Guinean zone ($G_k$ = .56, $R_k$ = .78 $G_kR_k$ = .44) than in the Sahelian zone (.80, .77 and .62, respectively), suggesting that entry barriers are lower for these activities in the Guinean zone. Many local production activities in the south require little capital and afford local employment to poor households. Increasing off-farm income in either zone has an unequalizing effect on the size distribution of income, although the effect is much stronger in the Sahelian zone.

The Sahelian zone findings contradict the findings from Asia that adding non-crop income to crop income reduces the Gini coefficient for total income inequality. Instead, it increases inequality. The case of the richer, Guinean zone is more typical. There, adding non-crop income to crop income

reduces inequality. In all zones, however, local off-farm income contributes the most by far to overall income inequality, in contrast to recent findings for Asia. (E.g. Adams and Alderman found that crop income was by far the most important source of inequality in rural Pakistan).

Our finding makes sense when one considers that land is more equally distributed in the WASAT than in south Asia, credit markets are much less developed (formally or informally), and lower levels of technological change make labor-intensive activities connected directly or indirectly with local agriculture less abundant and hence less available to the poor. Other evidence from this region (e.g., Matlon, 1979 and Reardon *et al.*, 1993) supports our view that the poor face capital entry barriers in starting more-remunerative, capital intensive nonfarm enterprises and are limited to working in labor-intensive activities. An inability to overcome these barriers reflects the underdevelopment of local capital markets in this region.

The Sahelian zone is diversified externally relative to the other zones. The share of migrant remittances in total income is much higher in the Sahelian zone (.09, compared to .01 in the Guinean zone). The Gini coefficient for migration income is also higher in the Sahelian zone, however, and increasing migration income weakly increases overall income inequality there. (The Gini elasticity of migration income is .01). The most remunerative migration is to the coast or abroad and has substantial capital requirements; the poor are left with the less remunerative and scantier work opportunities closer to home.

The Gini coefficients for total household income per AE (adult equivalent) are similar in the two zones (.34 in the Sahelian zone and .32 in the Guinean zone) in 1983/84, despite very different agroclimatic levels. This degree of inequality is similar to other WASAT study sites, but it is at the low end of the African and South Asian inequality spectrum (Ghai and Radwan 1983; Matlon 1979; Walker and Ryan 1990).

## V. INTER-ZONE COMPARISON OF CHANGES INDUCED BY DROUGHT

The distributional consequences of the 1984/5 drought depend on the initial role of income sources in inequality shown in Table 1 and the responses to the drought by households at different points in the income distributions of the three zones. By decreasing crop incomes, the drought reduces the weight on the largest income-equalizing component of income portfolios in both zones, although more so in the Sahelian zone where the drought is most severe. Incomes in the Sahelian zone, however, are more diversified externally into activities that are likely to have a low correlation with local activities vulnerable to the drought. In both zones, differences in the ability of households to shield themselves from the drought are critical in shaping the drought's effect on inequality.

Table 2 summarizes income changes, by source, between the base and drought year in the three zones. The total income decline is greatest in the Sahelian zone (25 percent); total income actually increases in the Guinean zone (6.5 percent). The changes in income are uneven across income sources, especially in the Sahelian zone where the largest adjustments occur. While crop income declines 64 percent in the Sahelian zone, livestock income more than doubles (154 percent), reflecting a substantial sell-off of animals. Migration income and transfers increase between the two years in all three zones, reflecting a social and self-insurance response to the drought.

Table 3 has the same categories and definitions as Table 1, but treats harvest-year 1984/85 (following the drought of the rainy season in calendar 1984). Three major sets of findings emerge from a comparison of Tables 1 and 3.

First, there is a marked shift in income sources away from crops towards livestock and migration in the hardest hit but diversified Sahelian zone, but there are much smaller income-source changes in the Guinean zone. The share of crop income in the Sahelian zone in the drought year is now half that in the Guinean zone (with the latter staying close to the share in the normal year). Non-crop income is important in the Sahelian zone to compensate for the harvest shortfall, and it is

less important in this regard in the Guinean zone, where the harvest shortfall was smaller. Meanwhile, the share of livestock income in total income doubles in the Sahelian zone, but is nearly the same as in normal year in the Guinean zone. The share of migrant remittances in total income doubles (.09 to .18) in the Sahelian zone. By contrast, it only rises slightly, from .01 to .03, in the Guinean zone.

Second, the equalizing role of crop income decreases in the Sahelian zone (from a Gini elasticity of -.23 to -.10), while the opposite occurs in the Guinean zone (from -.11 to -.18). It appears that the poor's crops suffer disproportionately from the drought, due perhaps to poorer quality land and a limited ability among the poor to invest in reducing crop production risk. Although the inequality of crop income as measured by the Gini coefficient almost doubles in the Sahelian zone when the drought occurs, the drastic drop in the share of crop income in total income reduces its contribution to overall inequality (from 31 to 14 percent). Despite this, the Gini coefficient for total household income per AE decreases in the Sahelian zone (from .34 to .31), while it does not change in the Guinean zone. This is due primarily to distress sales of livestock by the poor.

Livestock sales by the poor are much smaller in absolute terms than livestock sales by rich households in the Sahelian zone. But the share of these sales in the poor's income rises relative to that of rich households. The latter are not under the same pressure given their greater ability to self-insure against the harvest shortfall through other means. The Gini coefficient for livestock income falls in the Sahelian zone (from .73 to .67), as does the marginal effect of changes in livestock income on total income inequality (from .05 to .02).

A change in the role of local off-farm income also contributes to lower inequality in the Sahelian zone. The share of local off-farm income in total income is nearly unchanged in both zones, but the share in income inequality decreases in the Sahelian zone while increasing in the Guinean

zone. The Gini for this income source drops considerably in the Sahelian zone (.80 to .68), as does this source's marginal effect on inequality. (The Gini elasticity falls from .18 to .13).

Although Sahelian-zone households diversify externally through migration, access to migration income becomes more unequal. The Gini of migration income falls slightly in the Sahelian zone (from .79 to .73), but a small increase in the Gini correlation between this income source and total income rankings (from .48 to .51) and the rising share of migration in total income double migration's contribution to overall income inequality (from .11 to .22), and it increases the Gini elasticity with respect to migrant remittances (from .02 to .04). Part of this is because the drought coincided with a policy-induced moratorium on construction in Ouagadougou, which reduced internal migration opportunities for low-skilled workers.

Third, what is sometimes referred to as the "social safety net" plays a minimal role in helping households adjust to the drought. This probably is due to high correlations of income loss within the three zones. The share of transfers received in total income is very low in a normal year in all but the Sahelian zone. The share jumps from .01 in normal year to .08 in the drought year in the Sahelian zone, but this is mainly because of food aid, with at least *de facto* targeting apparent from the increase in this source's equalizing effect on the income distribution evident in the last column of the tables (from -.01 to -.08). That is, the international (food-aid) safety net takes the place of the social safety net in playing a major insurance role in the Sahel. It did not, however, reach poor households in the Guinean zone.

The most salient and disconcerting finding that emerges from Tables 1 and 3, we believe, is the important role played by distress sales of animals by the poor during the drought. If proceeds from these sales were invested heavily in assets outside of crop and livestock production, livestock sales may have helped support a transition to a more diversified risk strategy in response to the drought. This would be consistent with the finding that the unequalizing effect of local non-farm

income decreased during this period. In absolute terms, however, local non-crop income decreased substantially in the Sahelian zone (Table 2). It is more likely that livestock sales represented an effort by the poor to protect their food security in the short run by trading off long-run insurance assets. This disaccumulation means that the poor will be more vulnerable to drought the next time around.

## VI. AGROCLIMATIC SHOCK AND POVERTY

Section 5 explored the impacts of agroclimatic shock on household income inequality in different agroecological zones. In the West African semi-arid tropics, where per-capita incomes are low, the impacts of income changes on poverty assume special importance. We now explore the poverty implications of the income changes that occurred during the drought year in the three zones. Because the effects of the drought are uneven across income sources, we also examine the income-source specific effects of income changes, using an income-source decomposition of the Foster-Greer-Thorbecke poverty index.

Following the notation of Foster, Greer, and Thorbecke (FGT) (1984), let $y = (y_1, y_2, \ldots, y_l)$ represent household incomes in increasing order and let $z > 0$ denote the predetermined poverty line. The FGT poverty measure is defined by:

$$P(y;z) = \frac{1}{nz^2}\sum_{i=1}^{q} g_i^2 \qquad (1)$$

where n is the total number of households, $q = q(y; z)$ is the number of poor households, and $g_i = z - y_i$ is the income shortfall (the gap between the household's income and the poverty line; Sundrum) of the ith (poor) household. This index satisfies the two axioms formulated by Sen (1976, 1979) for

poverty measures to satisfy: (1) that a reduction in the income of a poor household, *ceteris paribus*, increases the poverty measure (monotonicity); and (2) that a pure transfer of income away from a poor household increases the poverty measure (the transfer axiom).

FGT present a decomposition of this poverty measure by population subgroup. Alternatively, P(y; z) can be decomposed by income source, by representing $y_i$ as the sum of household i's incomes from K sources:

$$y_i = \sum_{k=1}^{K} x_{ik}$$

and then substituting for $y_i$ in equation (2). This yields

$$P(y; z) = 1/nz^2 \sum_{i=1}^{q} (z - \sum_{k=1}^{K} x_{ik})^2 \qquad (3)$$

Let $\epsilon_{ij}$ denote a percentage change in household i's income from source j, such that

$$x_{ij}' = (1+\epsilon_{ij})x_{ij}$$

The resulting impact of this source-j change on poverty, $\Delta P(x,\epsilon; z)$, is given by

$$\Delta P(x,\epsilon;z) = \frac{1}{nz^2}\left[\sum_{i=1}^{q-\Delta q}\epsilon_{ij}x_{ij}\left(2\sum_{k=1}^{K}x_{ik}+\epsilon_{ij}x_{ij}-2z\right)\right.$$
$$\left.-\sum_{\Delta q}^{q}\left(z-\sum_{k=1}^{K}x_{ik}\right)^2\right] \qquad (4)$$

where $\Delta q$ denotes the group of households at the margin which enter into (escape from) poverty as a result of the decrease (increase) in source-j income. It is evident from Equation (4) that the poverty effect of the source-j income change has two components: (1) an impact on the income shortfalls of households whose poverty status does not change (the first term in the square brackets), and (2) a change in the poverty status of households at the margin whose income shortfall now enters into or is removed from the poverty measure, as depicted by the second term in the square brackets. If $x_{ij} = 0$ for (already) poor households, the first of these two terms is zero, but the second term may be nonzero if households at the margin become poor as a result of the income-source change. If, on the other hand, source j constitutes an important part of poor households' incomes and $\epsilon_{ij}$ is large in absolute-value terms, the source-specific income change can have an important effect on both terms.

The overall effect of a sectoral income change on poverty depends both on the distribution of the income-source change (the $\epsilon_{ij}$s) and on the initial distribution of these income sources across households. The Gini decompositions suggest that both these effects may be important in determining the impacts of the drought on poverty. Not only are some income sources unequally distributed to begin with (e.g., off-farm and migration income in the Sahelian zone), but the distribution of some income sources changes during the drought year (e.g., crop income). Inter-year changes in the distribution of income sources suggest that, for a given income source j, $\epsilon$ is not constant across households, especially in the Sahelian zone where adjustments are greatest. Some households are

better able than others to protect themselves against losses in drought-sensitive incomes and/or to secure alternatives to these incomes during the drought year.

Table 4 reports overall poverty levels as measured by the FGT index in the three zones during the base year and the impact of the income loss on poverty in the drought year. Poverty lines are inherently arbitrary. We assume a poverty line such that one-third of all household incomes fall below this line in the base year (similar to e.g. Kakwani (1993) for poverty line in Cote d'Ivoire). The top panel of Table 4 applies this criterion to each of the three zones to obtain zone-specific poverty lines. The bottom panel assumes a uniform poverty line across zones. Experiments with alternative assumptions about the poverty line do not qualitatively alter our findings with regard to the effect of the drought on poverty or on differences in this effect across zones.

The initial poverty level is highest in the middle (Sudanian) zone (0.10 for zone-specific z; 0.15 for uniform z). Because one-third of all households, by assumption, have incomes below our poverty line in the base year, this means that the income shortfalls of poor households initially are greatest in the Sudanian zone. Not surprisingly, poverty increases in all three zones during the drought year. Both the increase and the absolute level of poverty in the drought year are highest in the Sahelian zone, where P=15 and just under 50 percent of households are in poverty in 1984. This zone experiences a more than 50 percent increase in the number of households in poverty and a five-fold increase in the poverty level as measured by the FGT index.

Tables 5 and 6 offer some insight into the reasons for the disproportionate effect of the drought on poverty in the Sahelian zone. Table 5 reports estimated percentage effects of a 1-percent change in each income source on the FGT poverty measure, other things (i.e., the poverty elasticities with respect to income sources) being equal. Table 6 compares observed percentage changes in each income source for rich and poor households. The largest average income-source decline for all households in the drought year occurred in crop incomes in the Sahelian zone; while migration and

transfer incomes increased in all zones. (See Table 2.) Table 5 reports that the poverty elasticity with respect to crop income is positive and highest in the Sahelian zone (2.56), and that changes in other income sources in this zone, other things being equal, have little effect on poverty (the poverty elasticity is 0 for transfers and only 0.63 for local nonfarm income). That is, the income of the poor is tied closely to crop production, and the poor have few alternatives to compensate for crop income shortfalls.

The increase in poverty caused by the decline in crop income is reinforced by apparent obstacles to protecting against crop-income losses in poor compared to rich households. While the drop in crop income for all households in the Sahelian zone is 64 percent, the poorest one-third of households suffer a 69-percent loss, while the loss for the richest one-third is 58 percent (Table 6). By contrast, the poverty impact is lessened by a sell-off of livestock by the poor. While livestock income for all households increases by 154 percent, for the poorest households it increases nine-fold. The overall poverty impact of income changes reflects the inequality in these income-source changes across households.

## VII. CONCLUSIONS

Our Gini decomposition analysis of farm household incomes in the year before and the year after the severe drought of the 1984 rainy season focused on sectoral sources of income inequality and poverty in two zones, the agroclimatically-poor Sahelian zone and the agroclimatically-favored Guinean zone of Burkina Faso. Below are the three key findings, followed by policy implications.

First, given the current economic structure of the rural nonfarm sector (inequality of access due to capital and risk constraints), increasing nonfarm income in either the Sahelian or the Guinean zone has a unequalizing effect on the size distribution of income. This effect is strongest in the Sahelian zone, where the weaker agricultural base makes for fewer labor-intensive opportunities for

poorer households. In all zones, local off-farm income contributes the most by far to overall income inequality, unlike recent findings for Asia (e.g. Adams and Alderman).

Second, in both the Sahelian and the Guinean zones, increasing crop income reduces income inequality, an important finding for beleaguered agricultural research in the semi-arid tropics. In addition to direct income effects studied here, higher crop output would encourage downstream investment in nonfarm activities requiring little capital (e.g., crop processing) and would lead to lower grain prices which would benefit the large numbers of net buyers of grain in this region.

Third, the counterpart to inequality of nonfarm income (with low access for the poor) and equality of crop income is that the poor mainly rely on the latter: Their welfare closely follows the harvest. The 1984 drought thus struck the poor the hardest and increased the incidence of poverty the most in the Sahelian zone, where the drought's impact on crop incomes was highest. The impoverishing and unequalizing effect of the drought was counterbalanced to some extent by a sell-off of long-run insurance assets (livestock) by the poor. This disaccumulation means that the poor will be more vulnerable to drought in the next round.

Fourth, Asian studies that examine the relationship between income inequality and poverty incidence show ambiguous results -- some finding a negative relationship, most finding a positive one. Our results show that in the Sahelian zone of Burkina, which has the poorest agroclimate and the most diversified incomes, inequality decreases but poverty increases after the drought. By contrast, in the Guinean zone, where the agroclimate is superior, poverty and inequality are positively related. Our findings suggest that the direction of the relationship between inequality and poverty depends on agroecological variables and on the constraints on income diversification at different points in the income distribution.

Policymakers in developing areas with risky agricultures generally have as a policy goal long-term food security in rural areas. This implies reducing the incidence of rural poverty while

promoting growth and improving the size distribution of income. In the West African semi-arid tropics, participation in nonfarm activities is poorly distributed, but is a key means for relatively high-income households to redress crop shortfalls. Policies and programs that change the structure of the nonfarm sector by easing access by the poor to the credit and knowledge needed to start nonfarm businesses offer promise to alleviate the vulnerability of the poor to agro-climatic shocks. Moreover, continued support for agricultural research in this area is called for, given the dependence of the poor on the cropping base.

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**Table 1. Composition of 1983/84 Income Inequality, Rural Burkina Faso**

| Zone and Sector | Share in total HH income (S) | Gini coeff for income source (G) | Gini corr w/total income rankings (R) | G*R | % share in gini of total income (%) | % change in gini coeff |
|---|---|---|---|---|---|---|
| SAHELIAN | | | | | | |
| Crop Income | 0.53 | 0.27 | 0.72 | 0.19 | 30.6 | -.23 |
| Livestock Income | 0.14 | 0.73 | 0.63 | 0.46 | 19.1 | 0.05 |
| Off-farm Income | 0.22 | 0.80 | 0.77 | 0.62 | 39.9 | 0.18 |
| Migratory | 0.09 | 0.79 | 0.48 | 0.38 | 10.6 | 0.01 |
| Transfers Received | 0.01 | 0.81 | -0.08 | -0.06 | -0.1 | -0.01 |
| Total Inflow Income/AE | 1.00 | 0.34 | 1.00 | 0.34 | 100.00 | |
| SUDANIAN | | | | | | |
| Crop Income | 0.59 | 0.23 | 0.83 | 0.19 | 31.8 | -0.27 |
| Livestock Income | 0.06 | 0.63 | 0.54 | 0.34 | 6.2 | -0.00 |
| Off-farm Income | 0.26 | 0.73 | 0.87 | 0.64 | 48.0 | 0.22 |
| Migratory | 0.05 | 0.95 | 0.91 | 0.86 | 11.9 | 0.07 |
| Transfers Received | 0.04 | 0.79 | 0.23 | 0.18 | 2.2 | -.02 |
| Total Inflow Income/AE | 1.00 | 0.35 | 1.00 | 0.35 | 100.00 | |
| GUINEAN | | | | | | |
| Crop Income | 0.47 | 0.36 | 0.69 | 0.25 | 36.4 | -0.11 |
| Livestock Income | 0.12 | 0.76 | 0.37 | 0.28 | 10.1 | -.02 |
| Off-farm Income | 0.38 | 0.56 | 0.78 | 0.44 | 51.4 | 0.13 |
| Migratory | 0.01 | 0.92 | 0.52 | 0.48 | 2.1 | 0.01 |
| Transfers Received | 0.02 | 0.82 | 0.01 | 0.01 | 0.1 | -.02 |
| Total Inflow Income/AE | 1.00 | 0.32 | 1.00 | 0.32 | 100.00 | |

**Table 2. Household-farm Nominal Incomes, by Income Source 1983/4 and 1984/5 (thousands)**

| Zone | year | crop | live-stock | local nonfarm | migra-tion | trans-fers | total income |
|---|---|---|---|---|---|---|---|
| Sahelian | 83/4 | 176.37 | 27.16 | 121.19 | 14.70 | 10.11 | 349.53 |
| | 84/5 | 64.28 | 69.05 | 89.78 | 22.62 | 15.95 | 261.73 |
| % change over years | | -63.55 | 154.34 | 25.91 | 53.87 | 57.70 | -25.12 |
| | | | | | | | |
| Sudanian | 83/4 | 172.80 | 14.99 | 80.65 | 22.33 | 7.43 | 296.40 |
| | 84/5 | 137.99 | 14.39 | 81.00 | 27.23 | 11.41 | 272.02 |
| % change over years | | -20.15 | -3.99 | 1.18 | 21.95 | 53.69 | -8.84 |
| | | | | | | | |
| Guinean | 83/4 | 307.62 | 52.63 | 339.85 | 8.95 | 5.74 | 714.79 |
| | 84/5 | 313.92 | 92.62 | 320.70 | 16.71 | 9.39 | 761.34 |
| % change over years | | 2.05 | 75.98 | 3.28 | 88.81 | 83.89 | 8.51 |

Table 3. Composition of 1984/85 Income Inequality, Rural Burkina Faso

| Zone and Sector | Share in total HH income (S) | Gini coeff for income source (G) | Gini corr w/total income rankings (R) | G*R | % share in gini of total income | Gini Elasti-city |
|---|---|---|---|---|---|---|
| SAHELIAN | | | | | | |
| Crop Income | 0.24 | 0.48 | 0.37 | 0.18 | 14.0 | -.10 |
| Livestock Income | 0.26 | 0.67 | 0.49 | 0.33 | 28.3 | 0.02 |
| Off-farm Income | 0.23 | 0.68 | 0.70 | 0.48 | 36.0 | 0.13 |
| Migratory | 0.18 | 0.73 | 0.51 | 0.37 | 21.9 | 0.04 |
| Transfers Received | 0.08 | 0.38 | -.02 | -.01 | -0.2 | -.08 |
| Total Inflow Income/AE | 1.00 | 0.31 | 1.00 | 0.31 | 100.00 | |
| SUDANIAN | | | | | | |
| Crop Income | 0.51 | 0.34 | 0.63 | 0.21 | 35.5 | -.16 |
| Livestock Income | 0.07 | 0.54 | 0.37 | 0.20 | 4.3 | -.02 |
| Off-farm Income | 0.27 | 0.66 | 0.72 | 0.48 | 40.7 | 0.14 |
| Migratory | 0.08 | 0.93 | 0.59 | 0.55 | 14.8 | 0.06 |
| Transfers Received | 0.07 | 0.71 | 0.29 | 0.21 | 4.8 | -.02 |
| Total Inflow Income/AE | 1.00 | 0.31 | 1.00 | 0.31 | 100.00 | |
| GUINEAN | | | | | | |
| Crop Income | 0.43 | 0.36 | 0.53 | 0.19 | 25.4 | -.18 |
| Livestock Income | 0.14 | 0.73 | 0.49 | 0.36 | 16.0 | 0.02 |
| Off-farm Income | 0.37 | 0.59 | 0.82 | 0.48 | 56.0 | 0.19 |
| Migratory | 0.03 | 0.90 | 0.22 | 0.20 | 2.1 | -0.01 |
| Transfers Received | 0.02 | 0.68 | 0.10 | 0.07 | 0.5 | -0.02 |
| Total Inflow Income/AE | 1.00 | 0.32 | 1.00 | 0.32 | 100.00 | |

Table 4. Poverty Impacts of Agroclimatic Shock, Using Foster-Greer-Thorbecke Poverty Measure

| Zone | Year | Poverty Line (thousands) | N | Q | Poverty Level |
|---|---|---|---|---|---|
| | | | | | |
| Measure 1 * | | | | | |
| Sahelian | 83/4 | 189.52 | 49 | 15 | 0.030 |
| | 84/5 | | 49 | 24 | 0.145 |
| Sudanian | 83/4 | 136.54 | 48 | 17 | 0.100 |
| | 84/5 | | 44 | 20 | 0.125 |
| Guinean | 83/4 | 296.86 | 54 | 17 | 0.054 |
| | 84/5 | | 53 | 17 | 0.075 |
| | | | | | |
| Measure 2 * | | | | | |
| Sahelian | 83/4 | 190.26 | 49 | 16 | 0.030 |
| | 84/5 | | 45 | 24 | 0.146 |
| Sudanian | 83/4 | 190.26 | 48 | 27 | 0.147 |
| | 84/5 | | 44 | 25 | 0.181 |
| Guinean | 83/4 | 190.26 | 54 | 7 | 0.019 |
| | 84/5 | | 53 | 12 | 0.026 |

Notes:

* Zone-specific poverty lines, at which one-third of households in the zone are in poverty in the base year

** Poverty lines not specific to the zones, in which one-third of all households in the sample are in poverty in the base year

Table 5. Percentage Effect of a 1 % decline in Income Sources on Base-Year Poverty by Zone

| Zone | crop | livestock | local nonfarm | migration | transfers | total income |
|---|---|---|---|---|---|---|
| Sahelian | 2.56 | 0.01 | 0.63 | 0.17 | 0.00 | 3.40 |
| Sudanian | 0.80 | 0.00 | 0.14 | 0.00 | 0.06 | 1.01 |
| Guinean | 1.28 | 0.10 | 0.79 | 0.00 | 0.04 | 2.22 |

Table 6. Income Changes, 1983/4 to 1984/5, by Income Source and Tercile in Three Zones

| Zone | crop | livestock | local nonfarm | migration | transfers | total income |
|---|---|---|---|---|---|---|
| Sahelian | | | | | | |
| overall | -63.55 | 154.34 | -25.91 | 53.87 | 57.70 | -25.12 |
| lowest 1/3 | -69.28 | 920.35 | -34.58 | -46.14 | n.a. | -50.31 |
| highest 1/3 | -57.81 | 217.67 | -40.79 | 33.81 | 42.92 | -19.84 |
| Sudanian | | | | | | |
| overall | -20.15 | -3.99 | 0.18 | 21.95 | 53.69 | -8.84 |
| lowest 1/3 | -14.18 | -213.11 | 32.17 | n.a. | -11.42 | -6.90 |
| highest 1/3 | -20.73 | -8.96 | -7.79 | -2.71 | 54.33 | -12.81 |
| Guinean | | | | | | |
| overall | 2.05 | 75.98 | -3.28 | 86.81 | 63.69 | 6.51 |
| lowest 1/3 | -16.84 | -33.75 | -21.15 | 2459.22 | 68.92 | -12.32 |
| highest 1/3 | -1.46 | 97.67 | 1.71 | -4.59 | 42.47 | 8.75 |

N.A. Indicates near-zero income from income source in base year.