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DETERMINANTS AND EFFECTS OF INCOME DIVERSIFICATION AMONGST FARM HOUSEHOLDS IN BURKINA FASO

By

Thomas Reardon (*),

Christopher Delgado (*)

and

Peter Matlon (**)

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(*) Research Fellows, International Food Policy Research Institute (IFPRI), 1776 Massachusetts Ave., N.W., Washington, D.C. 20036

(**) Director of Research, West African Rice Development Association, Bouake, Côte d'Ivoire

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Determinants and Effects of Income Diversification Amongst Farm Households in Burkina Faso

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Using four years of household data from three agroecological zones in Burkina Faso -- Sahelian, Sudanian, and Guinean -- the paper examines the determinants and effects of household income diversification. Harvest shortfalls and terms of trade are found to drive diversification, but land constraints do not. Income diversification is associated with higher incomes and food consumption, and more stable income and consumption over years.

INTRODUCTION

The Sahel, in the West African Semi-Arid Tropics (WASAT)[1], has captured the attention of the international community since the early 1970's, because of its declining food output per capita, its periodic droughts, and its extremely variable and risky agriculture. Moreover, crop insurance and consumption credit markets are severely underdeveloped in the WASAT (Binswanger, 1986; Christensen, 1989). These agro-economic characteristics, together with the widespread assumption by policymakers and researchers that WASAT farm households depend mainly on own-cropping to assure food security (Kowal and Kassam, 1978; CILSS/Club du Sahel, 1981; Giri, 1983; OECD, 1988), imply the presence of recurrent household food insecurity[2], especially in drought years.

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* At time of manuscript submission, Reardon was Research Fellow, International Food Policy Research Institute (IFPRI), Washington, D.C., and at the time of publication (January 1992) is Associate Professor at Michigan State University; Delgado is Research Fellow at IFPRI; Matlon is Director of Research, West Africa Rice Development Association, Bouake, Cote d'Ivoire.

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Yet, there is a paradox -- despite recurrent crop failures, there is evidence that WASAT households are still able to assure their food security, even in zones where one would have expected famine, such as the Sahelian zone of Burkina (Reardon and Matlon, 1989). Hence, many WASAT households must have effective compensating mechanisms when harvest shortfalls occur. In fact, rural WASAT households secure income not only from cropping, but also from other agricultural income, such as from livestock husbandry, as well as local non-farm income, and income from long-distance sources, such as migration.

This article explores two issues: (1) Does WASAT household income diversification (i.e. earning non-cropping income in addition to, or as a substitute for, cropping income) resolve the paradox -- enabling households to smooth income and consumption over years marked by severe instability in crop output, and in an economy marked by a near-absence of consumption credit and crop insurance markets? (2) What is driving the diversification, and how do these factors differ over rich and poor households, and agroclimatically good and poor agro-ecological zones?

There are examples in the literature concerning the ways in which rural households attempt to compensate for harvest shortfalls and dampen consumption fluctuation. For example, Lucas and Stark (1985) point to evidence of migration for this purpose in Botswana; Rosenzweig and Stark (1987) and Rosenzweig (1988) point to evidence for semi-arid India of consumption-smoothing being effected by migration and inter-village marital links across rainfall zones.

But the determinants and effects of income diversification as a strategy for income and consumption smoothing have been relatively neglected (Robison and Barry, 1987); an exception is the work by Walker and Ryan (1990) in the Indian semi-arid tropics.[3] In particular, the issue has been neglected in the WASAT,

where recent household survey evidence in Burkina Faso and Senegal, for example, suggests that contrary to the conventional image expounded above, rural households have very diversified incomes (Reardon, 1990), and that these erstwhile 'autarkic' households are often net purchasers of grain (Weber et al., 1988).

The paper proceeds as follows: (i) the general analytical framework is outlined; (ii) the hypotheses based on that framework and past empirical work are presented; (iii) the regression models are presented; (iv) the data and study context are described; (v) patterns in the data concerning income composition, variability, and distribution are discussed; (vi) regression results are discussed; (vii) conclusions are presented.

APPROACH

Nakajima (1986) defines the 'farm household' as a complex of the 'farm firm' (producing agricultural outputs with household labour, other variable inputs, and land), the 'labourer's household' (supplying household labour and earning wage income), and the 'consumer's household' (expending money income to achieve utility maximization). The 'farm' can be classified from fully subsistence to fully commercial, and the 'household' can earn income in both the agricultural and the non-agricultural sector, both in-kind and in-cash. The case that interests us here is that of a farm household that has full-time off-farm employment in addition to cropping (hence, its 'income is diversified'). This follows an approach increasingly seen in the farm household literature (e.g. Yotopoulos and Nugent, 1976; Singh, Squire, and Strauss, 1986; Low, 1986). The behavioural principal of the farm household is to maximise utility. With Nakajima (1986), we assume that the utility of the farm household is a positive function

of net income (from all sources -- in-kind and in-cash, and from all sectors), inter alia[4].

With Newbery and Stiglitz (1981) we also assume that the multi-period household utility is a negative function of income instability -- which translates, although not necessarily completely, into consumption instability. This assumption implies the maintained hypothesis of the presence of risk aversion. In the face of substantial cropping sector risk, such as is the case in the WASAT, farm households have four options to redress crop output shortfalls and stabilise income and consumption: (1) participate in the credit or the insurance market; (2) receive transfers from other households; (3) earn non-farm income (diversify income); (4) sell assets.

As for credit and insurance markets, Binswanger (1986) showed that both credit and insurance markets in low income countries are plagued by moral hazard, information problems, and covariance of crop output over households within a given region. The consequence is severely underdeveloped credit and insurance markets, which is certainly the case in the WASAT, and particularly the case in Burkina Faso (Matlon, 1979; Christensen, 1989). As for the possibility of inter-household transfers ('the social safety net') being sufficient to help households that experience severe cropping shortfalls to redress them, Reardon (1990), in a review of survey evidence from Northern Nigeria, Senegal, and Burkina, found that these transfers were only a tiny part of income and consumption and highly insufficient to compensate harvest shortfalls.

Hence, in the failure or near-absence of consumption credit and crop insurance markets, and of an ineffectual 'social safety net', households must turn to income diversification. Portfolio theory predicts that firms/households that are risk averse, and that face returns across sectors that are not perfectly

correlated, will diversify their sectoral incomes to reduce overall risk:

> A less than perfect correlation between the returns of assets allows for gains from diversification by reducing risk costs, although the gains in risk reduction diminish as the number of assets increases. In contrast, economies of scale, which reduce average cost as production increases, favor specialization. (page 142, Robison and Barry, 1987).

And Rosenzweig (1988) writes:

> As long as households prefer to smooth their consumption over time and/or are (relatedly) risk averse, resources will be in part be allocated to minimise the riskiness of income and/or to smooth consumption. (page 1150, Rosenzweig, 1988)

But the choice between specialization and diversification, and the decision as to how far to pursue the latter, are constrained from two angles in the WASAT. On the one hand, specialization in cropping by a given household is constrained in the short-run by the following factors: (i) a short, single cropping season per year; (ii) a fixed household size, combined with what appears to be a supply- and demand-constrained market for hired agricultural labour; (iii) low cropping labour productivity; (iv) general lack of irrigation; and (v) low rainfall and poor soils that place strict technical limits to cropping options. These constraints to specialization, combined with aversion to the riskiness of cropping, imply that households will desire to diversify income sources.

On the other hand, however, the desire and capacity to diversify are functions of various factors specific to households, villages, and agroecological zones. Households across agroecological zones would have different incentives to diversify in the case where the riskiness of cropping and the correlation between returns to the cropping and non-cropping sectors differ. This is the case in the WASAT; in the discussion of zone characteristics below, it is shown that the variability in rainfall, output, and prices differs very substantially across agroecological zones in Burkina. Moreover, the greater the level of agricultural development of the zone, the more opportunity for inter-sectoral 'growth

linkages' between cropping and non-cropping. (Mellor, 1976; Hazell and Roell, 1983).

At the village level, the degree of infrastructural development (access to roads etc.) should have an important effect on the opportunities for diversification (Anderson and Leiserson, 1981).

At the household level, the determinants of desire and capacity to diversify are the same that determine factor allocation across sectors in a profit function framework. We assume that relative riskiness of sectoral returns is the same across households within an agroecological zone. Then, labour allocation across two sectors (cropping and non-cropping) is a function of: (i) prices in both sectors; (ii) wages in both sectors (assuming the household is a price and wage-taker, and there is no land market); (iii) asset holdings or wealth (land and non-land assets); (iv) number of workers in the household (household size); (v) other household characteristics. (Nakajima; Yotopoulos and Lau).

HYPOTHESES and ISSUES

Inter-zone Determinants of Diversification

With the near-absence of credit and insurance markets, and with severe cropping instability, households that wish to smooth income and consumption streams over years need to diversify their incomes, supplementing cropping with non-cropping activities. As discussed above, portfolio and risk theory suggests that the riskier the agriculture, and the less correlated the returns of agriculture and non-agriculture, the more diversified will be households incomes. The implication is that the households in the agroclimatically poor and risky Sahelian zone will diversify the most, and those in the agroclimatically favored

and stable Guinean zone will diversify the least.

Yet, on the other hand, the intersectoral growth linkage literature (e.g. Mellor, 1976; Hazell and Roell, 1983) suggests that agricultural development leads to the development of non-farm activities that are linked 'downstream' or 'upstream' to cropping, or the demand for which is spurred by increases in farm incomes. (Liedholm and Kilby, 1989). The implication is that zones with less agricultural development have less non-farm income as well.

Hence, neither theory nor empirical evidence present us with unambiguous hypotheses concerning which zone and which households will diversify the most, but it appears that diversification can arise from two causes -- the struggle to survive in a risky environment, and the desire to build on the base of a dynamic agriculture. Each of these can be pertinent to a given agroecological zone, and their presence will be examined.

Inter-household Determinants of Diversification

Given shared levels of agricultural and non-agricultural risk in a specific agro-ecological zone, again neither theory nor empirical evidence present us with unambiguous hypotheses concerning the determinants of household-level diversification.

First, both land and non-land assets have an empirically and theoretically ambiguous effect on the household's desire and capacity to diversify. On one hand, theory predicts that as the wealth of the household increases (in land and non-land assets), the less risk-averse will be the household, and hence the more willing to undertake investments with uncertain returns (such as in new non-farm activities) (Newbery and Stiglitz, 1981). And, in the presence of a capital or liquidity constraint, or underdeveloped credit markets, wealthier households

could rely on their own liquidity resources (either directly for investment, or as collateral) to enter into non-farm activities.

On the other hand, again drawing on portfolio theory, households with less land or non-land assets (e.g. livestock, food stocks, savings) would be more risk averse and hence more sensitive to the need to diversify to lower overall instability of returns. Moreover, in static terms, a household-level land constraint would translate into limited food output, and the need to undertake off-farm activities to compensate.

Thus, theory does not provide a straightforward hypothesis concerning the relation of either landholdings or non-land wealth to income source diversification behaviour. Empirical evidence is equally ambiguous. Walker and Ryan (1990) found an inverse relation, in the Indian SAT, between non-farm earnings and landholdings (in a situation where cropping specialization is possible). Evidence from five case studies in Asia, Northern Nigeria, and Sierra Leone, reviewed by Liedholm and Kilby (1989), also show this inverse relation.

By contrast, Taylor (1987), for example, found in Mexico that landholdings do not have a significant effect on migration, one component of income diversification. This issue has not been examined empirically in the WASAT. It could be an issue, since Matlon (1991) shows that the traditional view that land is not constrained in the WASAT is now outmoded, and that there are land constraints in the Sahelian and Sudanian zones, examined in the present study. Norman (1973) asserts, for the case of Northern Nigeria, that land constraints drive households into non-farm activities, but does not test this empirically. Hence, the point is still controversial and this we hope to shed some light on it.

Second, theory does not point unequivocally to a single hypothesis for the

effect of cash cropping on income diversification into non-cropping activities. On the one hand, the 'cash income target' literature, starting with Khatkhate (1962), would suggest that cash cropping is a substitute for non-farm activity. On the other hand, the liquidity constraint literature would see cash cropping as providing a source of liquidity for investment in non-farm enterprise where credit markets are underdeveloped or constrained (Collier and Lal, 1980). In practice, cash-oriented and subsistence-food cropping have highly correlated returns, and thus the former does not supplant the cash-generating need for income diversification into activities with returns that are less correlated with cropping outcomes. This, again, is a controversy on which our findings will shed some light.

Third, theory does suggest some non-ambiguous hypotheses concerning diversification determinants. Specifically, non-food sector terms of trade 'pull' households toward diversification. Mundlak (1979) stressed the importance of the relative return between agriculture and non-agriculture for the allocation of labour and capital between sectors -- and one expects this at the household level as well (Nakajima, 1986; Yotopoulos and Nugent, 1976).

Effects of Income Diversification on Income and Consumption Levels and Stability

The above discussion suggests that the assets of a household, plus other household, village, and zone characteristics, determine whether the household is able to supplement or possibly supplant its cropping income with non-farm income. Supplemental income would of course increase overall income, and in the presence of functioning product markets, allow households to purchase food and increase the quantity and quality of consumption.

Hence, theory presents an unambiguous hypothesis concerning the consumption

effects of diversification, once it is established that diversification indeed is associated with higher incomes. The latter, however, has been debated in the last few decades. At the aggregate (zone) level, there is for example the controversy between Hymer and Resnick (1969), who assert that an increase in average rural income is associated with a decrease in non-farm activity, and Mellor (1976) and Chuta and Liedholm (1990), who champion the contrary. Again, most of the empirical work on this (at the household level) has occurred in Asia, where the data constraint has been less onerous. Indian SAT household survey results either show a U-shaped or a negatively-sloped relationship between diversification and income (Walker and Ryan, 1990). Diversified income is usually associated with rural poverty on the basis of these Asian findings; relatively few studies (e.g. Matlon 1979) in the African setting counterbalance this view.

REGRESSION MODELS

Two sets of equations are presented below to test the hypotheses and explore the issues discussed above. The first are the 'levels regressions', which model yearly levels of diversification, income, and consumption, using panel data. The second are 'variations regressions', which explain inter-year variation in income and consumption, using cross-section data.

Levels Regressions

Given the agroecological zone, the outcomes of factor allocation to crop and non-crop production activities at the household level are: (i) the share of non-cropping income in total income (i.e. diversification), which approximates the unobserved factor allocation between sectors, and is a function of household assets, terms of trade, and other household and village characteristics; (ii)

total net household income, which is a function of the household's sectoral factor allocation, in addition to assets, terms of trade, and other household and village characteristics; (iii) consumption as a function of income and, to the extent that sectoral incomes are not fungible (because of seasonality), the sectoral allocation of factors (proxied by income diversification), as well as terms of trade.

Based on the above, the 'levels model' comprises the structural equations for (i) the share of non-farm income in total income, (ii) total income per AE (adult equivalent unit), and (iii) consumption per AE. These equations and the variable definitions are presented in Table 2.

The two main estimation issues posed by this formulation are (i) the possibility of simultaneity and (ii) how to handle unobserved differences across agroecological zones without losing information concerning the relative importance of those observed variables that vary greatly across zones.

With respect to the first issue, there is considerable reason to believe that the system is recursive. In the decision-making process, households first select a crop/non-crop production diversification strategy for the coming year, based on the elements specified above. This strategy plus other factors determine current incomes. Current incomes plus other factors then determine current consumption.

Since recursivity has major implications for the choice of estimator, the assumption was tested explicitly. Recursive models are characterised by a triangular parameter matrix (by specification) and a diagonal variance-covariance matrix (in fact). The latter was tested in the present case by generating the covariance matrix of the equation system by Zellner's method (SURE). Results are displayed by zone in Table 1. The matrix for each zone was found to be diagonal

at a 10 percent significance level using the Breusch and Pagan Lagrange Multiplier test (Breusch and Pagan, 1980; Judge et al., 1985). Given empirical support for the assumption of recursivity, each equation was estimated separately using OLS, the best linear unbiased estimator in this case (Johnston, 1984).

The issue of pooling by zone was tested using an F-test and the separation by zone was supported at a significance level of 10 percent.

Estimation by agroecological zone eliminates the need to explicitly account for the relative riskiness of sectoral returns, which is theoretically an important household-level determinant of diversification. Our maintained hypothesis is that relative sectoral risk is the same over households within a given agroecological zone.

A further note is necessary regarding one of the components of 'household assets' -- the predetermined variable 'beginning food stocks' (food stocks present at the beginning of harvest-year t that are the fruit of the cropping season in t-1, just before the beginning of t). The inclusion of this variable was inspired by the 'cash target' work of Khatkhate (1962) and the 'subsistence first' work of Hammer (1988) and are included here to test for the 'compensatory' role of non-farm income (that is, farm households with worse harvests should have higher income diversification in the year following the harvest, ceteris paribus).

Variation Regressions

For modeling income and consumption variability, we adapted the approach of Walker et al., (1983), who regressed inter-year income variability against average income level and household resource endowments, and crop yield variability. In a two-stage system, we then used the predicted value of income

variability as a regressor to explain inter-year variation in consumption. The equations and variable definitions of our 'variations model' are presented in Table 3.

DATA and STUDY ZONES

The data used to estimate the models come from the farm household survey in Burkina Faso conducted by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).[5] The survey covered four harvest-years (1981/82 - 1984/85, a period comprising both good and poor harvests). Because of the presence of lagged annual variables in the regressions here, only three years (82/3 - 84/5) are used for 't' (current year) observations.

The sample included 150 households; 25 per village, with three villages per zone, in the following three agroecological zones: the Sahelian, in the northwest; the Sudanian, in the Central Plateau; and the Guinean, in the southwest. Table 4 shows zone characteristics. Note that the average rainfall over the study period was below the long-term average, particularly in the Sudanian and Sahelian zones.

The Sahelian zone is very poor agroclimatically, with the lowest and most variable rainfall of all the zones, and thus extremely variable cropping outcomes -- the variability of which was much higher during the study period as compared to the long-term variation. Coarse grain yields are also very poor. Yet on average the overall sample of the zone was just self-sufficient in foodgrains -- but this disguises extreme inter-year variation. Livestock holdings are highest in this zone.

The Sudanian zone is poor-to-intermediate agroclimatically, with low-medium rainfall that is less variable than the Sahelian zone's. Coarse grain yields are

also poor. On average the overall sample is just short of being self-sufficient in foodgrains, but the deficit was more steady over study years than was the case in the Sahelian zone.

The Guinean zone is moderately-favored agroclimatically, with medium to high rainfall (for the WASAT) that is much less variable than in the other zones -- and hence cropping is much less risky. Like the other zones, the Guinean zone produces coarse grains and pulses, but also produces substantial amounts of cotton as a cash crop.

The scarcity of hard facts concerning the nature of rural household incomes in the WASAT, and particularly how they differ across agroecological zones, argues for an in-depth examination of income patterns shown by the data set, prior to presentation of the regression results.

PATTERNS OF INCOME COMPOSITION, DISTRIBUTION, AND VARIABILITY

Table 5 shows the mean level (per AE or adult equivalent in the zone), the composition (average per zone over households and years), and the inter-year variability (average over households of the household's inter-year coefficient of variation (CV)), and inter-household distribution of household income (Gini coefficient of household income per AE), by agro-ecological zone. Six points are striking.

First, average household income per AE is <u>not</u> closely related to the agroclimatic level of the zone. The agroclimatically-poorest zone, the Sahelian zone, and best zone, the Guinean zone, have the highest average incomes, but the Sudanian zone has the lowest.

Second, non-cropping income is a high proportion of income in the Sahelian and Guinean zones -- 52 percent and 57 percent respectively -- versus only 26

percent in the Sudanian zone. This range exceeds that found by Haggblade, Hazell, and Brown (1989) in their review of sub-Saharan African evidence, suggesting that the WASAT is a region of relatively high income diversification.[6]

Third, the type of income diversification differs between the Sahelian and Guinean zones. Non-cropping income in the Guinean zone is almost entirely earned locally in activities closely tied to the processing and trading of agricultural products; 38 percent of income is earned in local non-farm activities, and only 1 percent from migration. By contrast, only 24 percent of Sahelian zone income is earned locally, but 11 percent is earned from migration (and this can climb to 25 percent in poor harvest years).[7]

Hence, diversification is much more outward-looking in the Sahelian zone. Households have to diversify their incomes geographically as well as sectorally to compensate for cropping outcome variation and risk. By contrast, there appears to be much more potential for intersectoral linkages within the zone in the Guinean zone, in view of its strong agricultural base.[8] This finding supports the point in the hypothesis section above that diversification can spring from both a situation of poverty, stagnation, and instability, as well as from a dynamic agricultural base -- but here we find that the diversification will present different characteristics according to its root motivation.

Fourth, there is very little demand for hired agricultural labour in all the zones; hence, the share of agricultural wage income is very small in the incomes of all zones, as one would expect where a 'green revolution' has not yet occurred.

Fifth, inter-year variation in total household income is less than that of cropping income alone. Table 5 presents the average (over households per zone) coefficient of variation over years of cropping income, of other non-cropping

incomes, and of total income. The figures suggest that non-cropping income smoothes the total income stream in the face of fluctuations in cropping outcome. This is similar to the findings of Walker and Ryan (1990) for the Indian SAT.

Sixth, the 'equity' impacts of non-farm income differ by zone. When the Gini coefficient (for income per AE) for own-cropping income is compared with that for overall income, one finds that including non-cropping income with cropping income does not reduce the Gini coefficient in the Sahelian zone, and even increases it in the Sudanian zone.

This runs counter to the Thai, Nigerian, and Sierra Leonean findings cited in Liedholm and Kilby (1989); they found that non-farm income tended to equalise overall income distribution relative to cropping income distribution. But in the rural Burkina context household income and share of non-farm income are strongly positively correlated (shown below in the regression results), as opposed to related in a 'J' or 'U' function, as is found in areas with more plentiful labour-intensive off-farm opportunities for poor households (Matlon, 1979; Liedholm and Kilby, 1989; Walker and Ryan, 1990; Reardon, 1990).

By contrast, the comparison of the two Gini coefficients in the Guinean zone yields results similar to Liedholm and Kilby's; non-farm income flattens the size distribution of income; the 'barriers to entry' are perhaps less constraining to poor households in that zone.

REGRESSION RESULTS

Tables 6 and 7 present regression results for the models of levels and variation, respectively. In view of the double-log specification adopted, coefficients on the continuous variables can be interpreted as elasticities in Table 6 (with the exception of the consumption equation for the Sahelian zone).

Determination of Share of Non-cropping Income

In all zones, an increase in the 'beginning food stocks' causes a decrease in the share of non-cropping income. Hence, income diversification in a given year appears designed to compensate harvest shortfalls. The effect is lowest in the Guinean zone where there is the least fluctuation in output.

Greater landholdings per adult equivalent (AE) means greater diversification in the deficit zones -- the Sahelian and Sudanian. In the surplus zone, the Guinean, more land means less diversification (although the effect is not significant at 10 percent). A negative coefficient implies that a land constraint helps promote income diversification. Hence, the findings come down on the side of either a lack of significant relationship, or that land increases households' investment in non-farm activity either by decreasing risk aversion or providing directly or indirectly the liquidity to invest.

In the Guinean zone, where cotton production is important, cash cropping and diversification are positively related, although not in a statistically significant way. As discussed in the hypotheses section, this suggests the presence of a credit constraint on non-farm activity, forcing households to supply their own liquidity to start and maintain them. The desired liquidity could come from cash crop sales. This coincides with statements by sample farmers in the authors' conversations with them. It is also consistent with the finding of credit market research in the region that the credit market for farm and non-farm activities is severely underdeveloped (Christensen, 1989). Furthermore, it extends to the WASAT Liedholm and Kilby's (1989) finding that there are severe credit constraints on non-farm activity in most LDC's and the usual source of financing is from households own liquidity.

Controlling for the non-food price, an increase in the food price has the

expected negative 'terms of trade' effect on the share of non-cropping activity. This is neither significant nor of the expected sign in the Sahelian zone, however.

Other results are interesting as well. In the Sudanian and Guinean zones, more savings (from the prior year) means more diversification (the sign is the same for the Sahelian equation, but the coefficient is not significant). This appears again to imply a borrowing constraint for households to start non-farm activity.

In all zones, greater livestock holdings mean greater diversification. This could work through various channels: (a) livestock can be used as collateral for loans to start non-farm enterprises; (b) animals and byproducts are sold, and the revenue is included in non-cropping income; (c) wealthier households are less risk averse and thus perhaps more willing to invest in off-farm activity (Newbery and Stiglitz, 1981).

Another asset is the presence of a long-term outmigrant in a coastal country -- reflected in the dummy variable 'outmigrant'. As expected, the sign on this variable is positive in all zones (such a person or channel implies a lower transaction cost for migration (Stark and Taylor, forthcoming), but significant only in the Sudanian zone. Partly this is explained by the Sahelians migrating to a greater variety of places than the coast, and the very low share of migration income in the Guinean zone.

The coefficients of the demographic variables (household size, dependency ratio, age of head) are generally not significant in any zone, nor is number of wives or head's status (head of compound). Yet the <u>structure</u> of the household has an important effect, as expected; in the zones with the most off-farm activity (Sahelian and Guinean), only having a single conjugal unit means less non-farm

activity. There appear to be economies of scale to 'z-good production' when there are more conjugal units, presumably reducing the obligation on any woman, or man, in the compound, thus freeing them to work in off-farm activity; this concurs with casual observation by the authors.

Determination of Income level (per AE)

In every zone, and with highly significant coefficients, a higher share of income from non-cropping activities means a higher household income -- even controlling for the level of the 'beginning food stocks', which underscores the importance of diversification as a strategy, which can also be seen in the 'patterns' section. This contradicts the hypothesis that more diversification is associated with household poverty, but is consistent with a view that the liquidity aspect of diversification is central to income growth in the absence or near-absence of credit markets.

The higher the 'beginning food stocks', the higher the income -- with the effect lowest in the Sahelian zone, where there are the fewest 'growth linkages' between agriculture and non-agriculture (Hazell and Roell, 1983; Reardon, 1990), moderate in the Guinean zone (where it appears that intersectoral linkages are much higher), and highest in the Sudanian zone, where household incomes are least diversified -- and consumers are most vulnerable to swings in cropping outcomes.

Determination of Consumption Level

In general, where product markets are functioning, more income should mean more consumption. This relationship has been debated recently (e.g. Ravallion, 1990). The results here show a strong positive and highly significant coefficient on income in the Sahelian and Guinean zones -- even controlling for 'beginning

food stocks'. This of course concurs with the importance of income diversification for food security in these two zones.

By contrast, the effect is not significant in the Sudanian zone, but the 'beginning food stocks' effect is highly significant and positive -- supporting that food entitlement in the least diversified zone is driven mainly by 'beginning food stocks', while in the other two zones it is driven both by 'beginning food stocks' and by overall purchasing power.

Determination of Income and Consumption Variation

Table 7 shows the determination of income variation by zone. Significant results are discussed below.

The level of household income diversification (average percentage over study years of non-cropping income in overall household income) has a negative coefficient in all zones, but a significant coefficient only in the Sahelian and Guinean zones, the zones with greatest diversification. This is evidence of the 'income smoothing' effect of income diversification. The effect is not significant in the Sudanian zone, where households are much more dependent on the vicissitudes of the local cropping economy.

Because of the importance of income diversification in the Sahelian zone, instability in coarse grain yields does not significantly drive instability in income; however, it does drive this instability in the Sudanian zone, again, where incomes are dependent mainly on local cropping. Moreover, the variable is not significant in the Guinean zone -- probably because yields are much more stable.

Wealth (proxied by livestock holdings) is not significant in any zone, and hence does not appear to play a role separate from increasing the ability to

diversify income. Interestingly, landholdings do not significantly affect income instability in the Sahelian and Sudanian zones, although the signs are negative, but they do decrease income instability in the Guinean zone, perhaps through the cash cropping channel.

The consumption variation regressions in the Sahelian and Sudanian zones show that more income instability translates into more consumption instability, as expected. The income level of the household does not appreciably affect consumption variation. Hence, in the Sahelian zone, more income diversification means less income instability and less consumption variation -- i.e. both income and food consumption smoothing, as hypothesised. This concurs with Walker and Ryan's results for the Indian semi-arid tropics, but as mentioned above, the types of non-cropping used to effect the smoothing differ between the two regions. The same holds for the Sudanian zone, but the first link is weaker, as would be expected where households are much more dependent on own-cropping, and hence vulnerable to its vicissitudes. By contrast, the results are not significant in the Guinean zone.

CONCLUSIONS

The results concerning the determinants of diversification are as follows. **First**, a land constraint does not appear to be driving income diversification in any zone, despite evidence found by Matlon (1991) of land constraints in the Sahelian and Sudanian zone. This is one of the strong differences with the Asian findings. **Second**, shortfalls in cropping income do drive income diversification; non-farm income is used to 'compensate' these shortfalls. Yet access to this income appears to be unequal, and in two of the three zones non-farm income did not improve inter-household income distribution. **Third**, terms of trade 'pull'

households toward diversification. **Fourth**, and perhaps most importantly for policy purposes, cash cropping does not appear to be a substitute for non-farm activity, and may be strong complements, given a constraint on credit for non-farm activities.

Diversification was found to be associated with <u>higher incomes</u> -- contrary to the hypothesis derived from Asian findings. As it appears that product markets -- if not factor markets -- are functioning, diversification is then associated with higher food consumption via the income link -- even after controlling for 'beginning food stocks'.

Finally, in two of the three zones (those of lower agricultural potential and greater cropping instability), income diversification was found to smooth income over years, which in turn smoothed consumption.

These results suggest the following **policy implications. First**, the results here should encourage the growing policy interest in promoting non-farm activities in developing countries, particularly in the WASAT. Income diversification is a valuable mechanism, especially in the lower potential Sahelian zone, and to a much lesser extent in the Sudanian zone, to compensate for lack of credit markets and poor harvests, and thus smooth income and food consumption over years. Yet, it should be kept in mind that most of these activities depend directly or indirectly on agriculture -- either locally or on the 'humid coastal' countries of West Africa -- or on a few other sources of income growth (e.g. foreign assistance). Hence, development of non-farm activities should complement the effort to develop agriculture, at least in the higher potential zones, and to conserve soil in the lower potential zones (Reardon, 1990).

Second, the role and root of income diversification differs widely by

agroecological zone. In the Sahelian zone, for example, it serves to counterbalance the local cropping economy, which is beset by stagnation and extreme fluctuation; it does so by being based as much as possible in sources not dependent on local cropping, such as migration remittances. By contrast, in the Guinean zone, diversification appears to be born of local 'growth linkages' with agriculture. Hence, developing agriculture in the southern zone will spur non-farm activity growth, with its attendant increase in incomes. But, as the prospects are poor for developing coarse grain cropping in the Sahelian and Sudanian zones (Matlon, 1990), the promotion of non-farm activities will serve to moderate the impact of food crises.

Third, contrary to the situation in countries where intensified agriculture affords abundant demand for hired farm labour, the poorer rural households in the Burkina Faso have fewer opportunities for wage labour and self-employment off-farm, and hence less diversified incomes. This appears to reflect their relative lack of capital and access to credit, which makes it harder to diversify away from subsistence agriculture. Policies that enable the poorest rural tercile in the WASAT to gain access to off-farm opportunities are likely to be good for equity -- correcting the imbalance of opportunity that exists now. The latter can be facilitated by four sets of measures:

(a) development and intensification of agriculture in the high potential zone would create more farm labour demand and lower grain prices, which would provide off-farm employment to the poor, promote the growth of non-agricultural activity, and benefit net purchasers of grain in the lower potential zones (Mellor, 1976; Lele and Stone, 1989; Reardon, Delgado, and Matlon, 1987; Weber et al., 1988, Reardon, 1990; Delgado, 1991);

(b) promotion of non-cropping enterprise in low potential zones through

project assistance would provide both greater stability of income and consumption, and access to the capital/liquidity needed for growth at the household level;

(c) improvement of credit and insurance markets, with special provision for the poorest (Liedholm and Kilby, 1989). It could be that improvement of credit markets over time will lead to increased specialization of activity in zones where product markets function well.

(d) targeting of food aid, social security, and food-for-work schemes to those identified as having the lowest purchasing power, not just the poorest cropping outcomes, which will not be coincident (Reardon, Matlon, and Delgado, 1988).

TABLE 1: VARIANCE COVARIANCE MATRIX OF DISTURBANCES OF LEVELS MODEL (Logs)

Sahelian Zone

	INCDIV	INC	FOODCONS
INCDIV	.33		
INC/AE	7.4E-14	.11	
FOODCONS/AE	1.0E-11	9.0E-12	.07

Sudanian Zone

	INCDIV	INC	FOODCONS
INCDIV	.32		
INC/AE	2.2E-13	.07	
FOODCONS/AE	-3.2E-13	5.7E-13	.09

Guinean Zone

	INCDIV	INC	FOODCONS
INCDIV	.10		
INC/AE	-1.2E-13	.16	
FOODCONS/AE	-2.0E-14	-3.5E-14	.06

All significant at 10 percent by the Breusch Pagan Lagrange Multiplier test

TABLE 2: 'LEVELS' REGRESSION MODEL

Equations:

(1) $INCDIV_{h,t} = b0 + b_1 ASSETS_h + HHSIZE_{h,t} + HHSTRUC_{h,t} + PRICES_t + VILLAGE + ETHNIC + e_{h,t}$

(2) $INC/AE_{h,t} = b_0 + INCDIV_{h,t} + a_1 ASSETS_{h,t} + HHSIZE_{h,t} + HHSTRUC_{h,t} + PRICES_t + VILLAGE + ETHNIC + e_{h,t}$

(3) $FOODCONS/AE_{h,t} = b_0 + INCDIV_{h,t} + INC/AE_{h,t} + b_1 ASSETS_{h,t} + HHSIZE_{h,t} + HHSTRUC_{h,t} + PRICES_t + VILLAGE + ETHNIC + e_{h,t}$

Definition of variables:

$INCDIV_{h,t}$: the share of non-cropping net income in total net household income (endogenous)

$INC/AE_{h,t}$: the total net household income in FCFA per AE. (endogenous)

$FOODCONS/AE_{h,t}$: household average daily kilocalorie intake (computed by disappearance method) in kcals. during harvest year t, per AE. (endogenous)

$ASSETS_h$: vector, composed of:

$AVGLVST/AE_h$: The average over two harvest-years (83/84 and 84/85) of the imputed value of livestock holdings, per AE (data were only available for these two years). (predetermined)

$LAND/AE_{h,t-1}$: The total land area in has. per AE cultivated (data are not available on non-cultivated landholdings) by the household in the cropping season just prior to the harvest-year t (upon which the 'beginning food stocks from harvest' were produced); this is a predetermined variable in t. (predetermined)

$FOODSTOCK_{h,t-1}$: 'Beginning Food stocks' on hand at the beginning of harvest-year t, produced during the cropping season in t-1; this is expressed as a ratio, the 'production sufficiency ratio', which is the proportion of the harvest year for which the household could feed itself at a calorically-adequate level (2280 kcals./day/AE) from its own production of food (grains and pulses). t begins. (predetermined)

$SAVING/AE_{h,t-1}$: savings (in FCFA/AE) generated in harvest year t-1; this excludes food stocks generated in the cropping season in t-1. (predetermined)

$OUTMIGRANT_h$: dummy variable: household has long-term outmigrant in a coastal country (dummy). (predetermined)

$CASHCROP_{h,t-1}$: the percentage of cultivated land under cotton during the cropping season in t-1. (predetermined)

$HHSIZE_{h,t}$: household size in unweighted persons in harvest-year t. (predetermined)

$HHSTRUC_{h,t}$: vector (predetermined variables), composed of:

$DEPENRATIO_{h,t}$: share of children in total household size.

$AGEHEAD_{h,t}$: age of household head

$NUMWIVES_{h,t}$: number of wives in household

$LEADER_{h,t}$: dummy variable for household head = head of compound

$SINGCONJ_{h,t}$: dummy variable for single conjugal unit =1 (multiple = 0)

$PRICES_t$: vector (exogenous variables), composed of:

$PNONFOOD_t$: zone-specific non-food price in harvest-year t

$PFOOD_t$: zone-specific food price in harvest-year t

$VILL_h$: dummy variable: household is in village near main road, dummy = 1 (exogenous)
$ETHN_h$: ethnic dummy (1= bwa in Guinean zone, 0 otherwise in Guinean zone; not present in other zone regressions) (exogenous)

TABLE 3: 'VARIATIONS' REGRESSION MODEL

Equations:

(4) $CVINCOME/AE_h = b_0 + CVYIELD/HA_h + AVGINCDIV_h + AVGINC/AE_h + (AVGINC/AE)^2_h + a_1 AVGLVST/AE_h + b_2 AVGLAND/AE_h + b_2 AVGHHSZ_h + HHSTRUC_h + VILL_h + ETHN_h + e_h$

(5) $CVFOODCONS_h = b_0 + PREDCVINC_h + AVGINC/AE_h + (AVGINC/AE)^2_h + b_2 AVGHHSZ_h + e_h$

Definition of variables:

Regressands:

$CVINCOME/AE_h$: Coefficient of variation over four harvest-years of net household income in FCFA per AE (adult equivalent) from all sources

$CVFOODCONS_h$: Coefficient of variation over four harvest-years of household average daily kilocalorie intake (computed by disappearance method) in kcals. during harvest year t, per AE.

Regressors

$PREDCVINC_h$: Predicted value (from (4) of $CVINC_h$

$CVYIELD/HA_h$: Coefficient of variation over four production seasons (immediately prior to each of the four harvest years) of the average millet/sorghum yield per hectare (ha.)

$AVGINCDIV_h$: The average over four harvest-years of the share of non-cropping income in total net household income

$AVGINC/AE_h$: The average over four harvest-years of the total net household income in FCFA per AE.

$AVGLVST/AE_h$: The average over <u>two</u> harvest-years (83/84 and 84/85) of the imputed value of livestock holdings, per AE (data were only available for these two years).

$AVGLAND/AE_h$: The average over four harvest-years of total land area in has. per AE <u>cultivated</u> by the household (data are not available on non-cultivated landholdings).

$AVGHHSZ_h$: The average over four harvest-years of the household size in unweighted persons.

$HHSTRUC_h$: A vector of the following variables, all measured as averages over the four harvest-years:

DEPENRATIO: share of children in total household size.

AGEHEAD: age of household head

NUMWIVES: number of wives in household

LEADER: dummy variable for household head = head of compound

SINGCONJ: dummy variable for single conjugal unit =1 (multiple = 0)

$VILL_h$: infrastructure/village dummy (t): 1 = in village near main road
$ETHN_h$: ethnic dummy (1= bwa in Guinean zone, 0 otherwise in Guinean zone; not present in other zone regressions)

TABLE 4. ZONE CHARACTERISTICS

	Sahelian	Sudanian	Guinean
1. Cropping Technology			
Hired Labour (%total)	4%	10%	24%
Animal Trac. (%hh's)	9%	14%	19%
Chem. Fert. (kg/ha)	*	11	31
Fallow Time (years)	5	9	13
2. Rainfall			
Rainfall-long term (mm)	480	724	952
CV long-term rain	.34	.25	.21
Study Period Rainfall	410	563	779
CV Study Period Rain	.60	.36	.14
3. Crop Output			
Millet/sorg. yield/ha.	307	317	490
CV yield/ha.	.74	.51	.47
Prod. Suff. (PSR,%)	119	82	105
CV of Prod. Suff.	.75	.42	.46
4. Assets/Demography			
Land per AE* (hecs.)	.92	.58	.65
CV land/AE	.19	.21	.20
Gini land/AE	.28	.33	.30
Livestock per AE (CFA)**	16824	11503	9015
Gini livestock/AE	.70	.95	.75
Household size	8.0	10.3	10.3
CV household size	.14	.08	.14
5. Price Variability			
CV of Producer Millet Price	.24	.34	.20
CV of CPI	.17	.23	.17

Table 4 Notes:

* AE = Adult equivalent (calculated by weighting household members by coefficients reflecting age/sex composition).
** average over two harvest-years (83/84 and 84/85) of the imputed value of livestock holdings, per AE (data were only available for these two years).
*** the 'production sufficiency ratio', which is the proportion of the harvest year for which the household could feed itself at a calorically-adequate level (2280 kcals./day/AE) from its own production of food (grains and pulses).

TABLE 5. INCOME COMPOSITION, VARIATION, AND DISTRIBUTION

(1981/2-84/5 AVERAGES)

(In percent of total income)

Zones	Own-Cropping Income (net)	Ag Wages	Livestock Income	Local Off-farm	Migration	Transfers Received	Total Income	Total Income (FCFA/AE)
SAHELIAN	.49	.01	.14	.23	.10	.03	1.00	38,500
Inter-year CV	(.67)							(.41)
Gini (per AE)	.33							.34
(Gini inter-year CV)	(.23)							(.09)
SUDANIAN	.60	.01	.06	.28	.02	.02	1.00	23,600
Inter-year CV	(.52)							(.40)
Gini (per AE)	.25							.30
(Gini inter-year CV)	(.19)							(.25)
GUINEAN	.37	.02	.20	.39	.01	.01	1.00	45,800
Inter-year CV	(.45)							(.31)
Gini (per AE)	.34							.30
(Gini inter-year CV)	(.23)							(.30)

Table 5 Notes:

(a) Real income calculated by standardizing to 1981-5 average CFA.
(b) Total income is the imputed net value of crop production, plus livestock sales and home consumption, plus transfers received, plus net cash receipts from all non-farm sectors.
(c) Average over household CV's -- each household CV is over years.
(d) The figures are all mutually distinct at probability of 10 percent or less.

TABLE 6. RESULTS OF LEVELS OLS REGRESSIONS ON PANEL DATA: LOG-LOG FORM (##)

Variables	Income Diversification			Income/AE			Calories/AE ##		
	Sahelian Zone	Sudanian Zone	Guinean Zone	Sahelian Zone	Sudanian Zone	Guinean Zone	Sahelian Zone	Sudanian Zone	Guinean Zone
Endogenous									
$INCDIV_t$	1	1	1	41 ** (.00)	.45 ** (.00)	.45 ** (.00)	-396.07 (.45)	.07 (.38)	-.15 ** (.03)
INC/AE_t	--	--	--	1	1	1	.03 ** (.03)	.02 (.85)	.20 ** (.00)
$FOODCONS/AE_t$	--	--	--	--	--	--	1	1	1
$(INC/AE)^2$	--	--	--	--	--	--	-.15e-06 ** (.02)	--	--
Predetermined/Exogenous									
$FOODSTOCK_{t-1}$ (output from cropping season in t-1)	-.35 ** (.00)	-.56 ** (.00)	-.24** (.00)	.39 ** (.00)	.75 ** (.00)	.50 ** (.00)	11.35 ** (.00)	.83 ** (.00)	.63 ** (.00)
SAVING/Aet-1	.02 (.46)	.03 * (.09)	.06 ** (.00)	.04 ** (.01)	.02 ** (.03)	.15 ** (.00)	.00 (.40)	-.01 (.54)	-.03 ** (.05)
$AVGLVST/AE_h$	.05 * (.06)	.11 ** (.00)	.03 ** (.01)	.03 * (.09)	-.02 (.13)	.03 (.12)	.00 (.16)	-.01 (.24)	.02 * (.08)
$LAND/AE_{t-1}$ (cropped in t-1)	.65 ** (.00)	.59 ** (.01)	-.18 (.13)	.06 (.68)	.15 (.18)	-.01 (.96)	290.1 (.27)	-.33 ** (.01)	-.33 ** (.00)
$CASHCROP_{t-1}$ (cotton in t-1)	.02 (.89)	.01 (.90)	.01 (.73)	-.03 (.77)	-.01 (.67)	-.00 (.89)	-254.02 (.76)	-.08 ** (.00)	-.02 * (.08)
OUTMIGRANT	.04 (.86)	.25 * (.07)	.04 (.53)	-.28 * (.06)	-.13 ** (.05)	.03 (.71)	296.98 (.29)	.07 (.33)	.05 (.38)
$HHSZ_t$	.25 (.31)	-.31 (.16)	.02 (.82)	-.08 (.59)	-.07 (.49)	-.00 (.99)	-42.34 ** (.04)	-.14 (.25)	-.23 ** (.00)
$DEPENRATIO_t$	.24 * (.09)	.48 (.13)	-.72 (.11)	-.14 * (.10)	.02 (.87)	-.05 (.37)	929.1 * (.10)	-.17 (.32)	.02 (.51)
$AGEHEAD_t$	-.28 (.37)	-.16 (.55)	-.13 (.37)	.04 (.85)	-.06 (.63)	-.13 (.49)	12.39 * (.09)	.13 (.37)	-.02 (.83)
$NUMWIVES_t$	.05 (.73)	.10 (.21)	.01 (.68)	.09 (.26)	-.01 (.89)	.01 (.79)	122.0 (.36)	-.01 (.78)	.04 * (.08)

Table 6 continued

Variables	Income Diversification: Sahelian Zone	Income Diversification: Sudanian Zone	Income Diversification: Guinean Zone	Income/AE: Sahelian Zone	Income/AE: Sudanian Zone	Income/AE: Guinean Zone	Calories/AE ## : Sahelian Zone	Calories/AE ## : Sudanian Zone	Calories/AE ## : Guinean Zone
$LEADER_t$	.27 (.20)	.18 (.26)	.05 (.57)	.02 (.84)	.13 * (.08)	-.12 (.26)	324.0 (.17)	.11 (.22)	-.09 (.14)
SINGCONJt	-.40 * (.09)	.24 (.25)	-.20** (.04)	-.08 (.57)	.11 (.28)	.01 (.92)	94.82 (.65)	.02 (.83)	.08 (.31)
$PNONFOOD_t$	-.38 (.81)	-.17 (.85)	-.19 (.53)	.65 (.48)	-1.16 ** (.01)	-.17 (.66)	4.35 (.74)	2.11 ** (.00)	-.11 (.64)
$PFOOD_t$	.49 (.58)	-.98 * (.08)	-.69** (.01)	-.15 (.77)	1.58 ** (.00)	-.51 (.14)	6.92 (.52)	-.17 (.63)	-.39 * (.07)
VILL	.25 (.18)	.23 * (.09)	-.13 (.17)	.01 (.91)	.11 * (.08)	.30 ** (.01)	52.77 (.76)	.20 ** (.01)	.29 ** (.00)
ETHN	--	--	-.50** (.00)	--	--	.05 (.73)	--	--	.11 (.21)
Intercept	.26 (.96)	6.85 * (.09)	4.47** (.02)	5.88 * (.09)	5.86 ** (.00)	10.91** (.00)	-1947.87 * (.08)	-6.82 ** (.00)	5.33 ** (.00)
Adjusted R squared	.40	.43	.55	.65	.77	.58	.74	.55	.74
Durbin Watson	2.23	1.82	2.09	2.13	1.97	1.83	2.52	1.92	2.10
Number of Observations	90	113	143	90	113	143	90	113	143

Table 6 Notes:

(a) Source: data from ICRISAT baseline survey, Burkina Faso, 1981-5.
(b) Coefficients are rounded to second decimal.
(c) Numbers in parentheses are probabilities associated with t values, given degrees of freedom.
(d) Coefficients followed by * and ** indicate significance at the 5% and 10% level, respectively.
(e) "--" indicates that this variable was excluded from the equation (column).
(f) Sample size is total number of year/household observations in the panel.
(g) t is current harvest year (September of calendar year t through August of calendar year t+1).
(h) ## This equation is in non-log form (while the other equations are in log-log form).
(i) The coefficients are elasticities with the exception of the constant, the dummies on the constant, and the coefficients in the equation marked ##.

TABLE 7: RESULTS OF VARIATION 2SLS REGRESSIONS ON CROSS-SECTION DATA: LOG-LOG FORM

	Income Variation			Consumption Variation		
Variables	Sahelian Zone	Sudanian Zone	Guinean Zone	Sahelian Zone	Sudanian Zone	Guinean Zone
Endogenous						
CVINCOME/AE	1	1	1	--	--	--
CVFOODCONS	--	--	--	1	1	1
Predetermined/Exogenous						
PREDCVINC	--	--	--	.66 ** (.00)	1.13 ** (.00)	.34 (.17)
AVGINCDIV	-.62 ** (.05)	-.09 (.57)	-.85** (.02)	--	--	--
CVYIELD/HA	.57 (.22)	.47 ** (.02)	.25 (.29)	--	--	--
AVGINC/AE	-6.25 (.38)	-.91 (.86)	-10.13** (.02)	1.39 (.71)	-3.86 (.50)	-6.78 (.13)
$(AVGINC/AE)^2$	.31 (.35)	.04 (.87)	.48 ** (.02)	-.07 (.70)	.18 (.51)	.31 (.13)
AVGLVST/AE	.01 (.87)	.03 (.30)	.07 (.15)	--	--	--
AVGLAND/AE	-.17 (.71)	.16 (.65)	-1.15** (.01)	--	--	--
AVGHHSZ	-.13 (.73)	-.09 (.76)	-.45 (.18)	.03 (.77)	.28 (.19)	-.14 (.34)
DEPENRATIO	-.05 (.83)	.12 (.80)	.13 (.48)	--	--	--
AGEHEAD	-.24 (.62)	.05 (.89)	-.04 (.93)	--	--	--
NUMWIVES	.08 (.63)	.05 (.65)	-.10 (.49)	--	--	--
HEADER	-.10 (.74)	.11 (.61)	-.45 (.10)	--	--	--
MARINGCONJ	-.01 (.98)	-.22 (.46)	.04 (.80)	--	--	--

Table 7, continued

Variables	Income Variation: Sahelian Zone	Income Variation: Sudanian Zone	Income Variation: Guinean Zone	Consumption Variation: Sahelian Zone	Consumption Variation: Sudanian Zone	Consumption Variation: Guinean Zone
VILL (1=near main road)	.26 (.34)	.48 * (.07)	.31 (.45)	--	--	--
ETHN (1=bwa)	--	--	.18 (.64)	--	--	.30 * (.10)
Intercept	33.30 (.39)	4.21 (.87)	55.15** (.03)	-7.48 (.70)	19.31 (.51)	36.05 (.13)
Number of Observations	36	49	49	36	49	49
Adjusted R^2	.01	.31	.17	.22	.25	.15

Table 7 Notes:

(a) Source: data from ICRISAT baseline survey, Burkina Faso, 1981-5.
(b) Coefficients are rounded to second decimal.
(c) Numbers in parentheses are probabilities associated with t values, given degrees of freedom.
(d) Coefficients followed by * and ** indicate significance at the 5% and 10% level, respectively.
(e) "--" indicates that this variable was excluded from the equation (column).
(f) Sample size is total number of year/household observations in the cross section.

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NOTES

1. The "Sahel" here is considered as the West African political grouping of countries in the CILSS (Burkina Faso, Cape Verde, Chad, the Gambia, Guinea Bissau, Mali, Mauritania, Niger, and Senegal. The West African Semi-Arid Tropics (WASAT) is the agroecological term that covers the Sahel, plus semi-arid areas of coastal countries, such as northern Nigeria. The SAT are areas where rainfall exceeds potential evapotranspiration 2-7 months of the year. About 2/3 of the land area of West African countries is in the WASAT. About 1/4 of the semi-arid population of the world is in the WASAT. (Norman, Newman, and Ouedraogo, 1981).

2. This view has only recently begun to crumble in developing countries in general (Liedholm and Kilby 1989) but is wearing away with particular slowness in the WASAT (Hill 1982) partly because of the lack of household data and relative inattention to non-farm issues there (Eicher and Baker 1982).

3. The ISAT and the WASAT differ radically, however, in terms of characteristics of labor and land markets, rainfall variability, and policy and economic environment (Oram, 1977; Hill, 1982; Matlon and Spencer, 1984). Hence, the outcomes of research on income in ISAT cannot be applied with confidence to the WASAT. Hypotheses from prior African work and ISAT research are useful, however, as reference hypotheses in the current work.

4. Throughout the text we abstract from 'in-kind' versus 'cash' income, and in the empirical work, we always use the 'net income' measure (having netted out variable input costs, including hired labor), with in-kind income evaluated at producer prices.

5. IFPRI (International Food Policy Research Institute) provided technical support during its last year of the survey, and IFPRI subsequently undertook a two-year cleaning and aggregating process for a good part of the data used in the analysis here. See Matlon (1988) for details of survey methods.

6. For inter-country comparisons and a review of recent West African results, see Reardon (1990).

7. For a detailed examination of these income sources by income tercile, see Reardon (1990).

8. Given its relatively poor agriculture, why is the income of the Sudanian zone not more diversified? The share of livestock income is less than half that in other zones. There has been a steady process of disaccumulation of herds over the last three decades, driven by increases in population density and by successive droughts.

Moreover, fluctuating cropping outcomes have been a fact of life for a long time in the Sahelian zone, and diversification a traditional response. By contrast, in the Sudanian zone, degradation has been rapid and relatively recent, and household strategies appear to adapt only with a lag. The consequence is that Sudanian households are more dependent on cereal agriculture, hence more vulnerable to its vicissitudes. (Reardon, Matlon, and Delgado, 1988)