

The Diversification of Agricultural Products in Mono, Benin

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## **1. Introduction**

Since 1980, the population of Benin has more than doubled, and is expected to become three times greater than the level in 1980 by 2015. Its gross domestic product per capita (in purchasing parity power) has grown from 450 to 1,070 US dollars between 1985 and 2002 (Global Virtual University, 2005). It is not difficult to imagine that such rapid growths of both population and market forces have pressured the agricultural sector in Benin to increased intensity and productivity. The pertinent question here, as in many areas of the world, is how to increase food production for rising population and market demand. A number of studies have focused specifically on the role of agricultural production diversification in increasing general agricultural productivity. Netting (1993), Dorsey (1999), and Coelli and Fleming (2004) have all found a tendency for diversification to increase productivity.

In this paper, I test this hypothesis for the department of Mono in Benin by attempting to answer the following questions: (1) how does diversification of agricultural production affect farm productivity, and (2) of the household/farm characteristics each farmer possesses, what are the key determinants of agricultural diversification?

The dataset used in this analysis is the Benin Small Farmer Survey, which was conducted in 1998 and published by the International Food Policy Research Institute (IFPRI). The data are analyzed in the paper via the ordinary least squares (OLS) regression in an effort to better understand which household/farm characteristics increase farm productivity, and also, to identify what characteristics are the primary determinants of agricultural diversification.

This study finds that, though the evidence is not strong, the diversification of agricultural production has a positive effect on the net farm-generated profits per acre in Mono. Also, it is strongly suggested that the household wealth, the proportion of agricultural income in total household income, and family size have the effect of increasing the overall level of farm diversification. It is also found that farm size, in general, decreases the level of diversification.

In the next section, a brief description of Benin and a review of the literature related to Benin's agricultural situation follow. In addition, some of the earlier work around agricultural diversification in other areas of the developing world are detailed and discussed.

Section 3 outlines the data and the methodology used herein. First, the Benin Small Farmer Survey is briefly explained. Then, after exploring several alternate definitions of agricultural diversification, the equations for the OLS analysis are presented and the theories behind them detailed. In Section 4, the results from the analysis discussed in Section 3 are presented and analyzed. First, the results regarding the relationship between diversification and productivity are discussed. Then, an analysis and interpretation of the results concerning the factors of diversifications follows. Section 5 provides a conclusion which summarizes the paper.

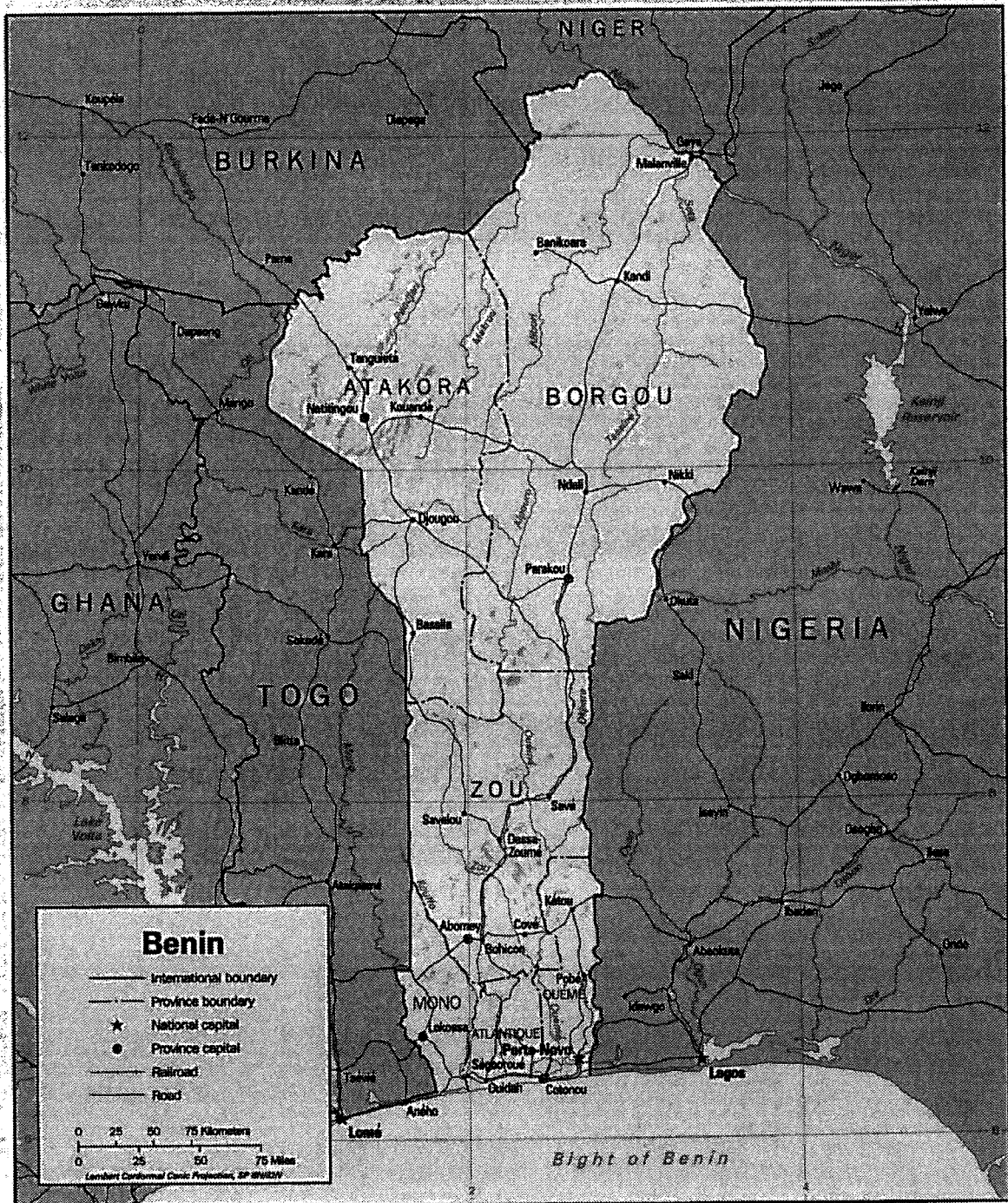
## **2. Overview of Benin and Literature**

### **2.1 Summary of Benin**

Benin, formally the Republic of Benin, covers an area 112 thousand square kilometers. Of this, only 23 thousand km<sup>2</sup> (21 percent) are used for agricultural purposes. It has an estimated 2005 population of 7,460,025 (CIA The World Factbook, 2005), indicating a population density of 67 inhabitants per km<sup>2</sup>. Much of the population of Benin is concentrated in the south, and is inconsistently distributed throughout the rest of the countryside so that the density ranges from over 300 inhabitants per km<sup>2</sup> in the department of Atlantique, to less than 40 per km<sup>2</sup> in the departments of Atacora and Borgou (Kherallah et al, 2001). The GDP per capita is estimated (in 2004) to be \$US 1,200 (CIA The World Factbook, 2005). While this qualifies Benin as a low-income country, its per capita income is higher than those of many its neighbours (Niger, Mali, and Burkina Faso) while still lower than those of Cameroon, Cote d'Ivoire and Togo (CIA The World Factbook, 2005), placing it in the mid-range for wealth in western Africa.

Benin has three distinct agro-climatic zones. The north of Benin is semi-arid and has an annual rainfall of just 800-1000 mm with a rainy season that typically extends, although with considerable variation, from May to September. The southern part of the country has a sub-equatorial climate and two rainy seasons (from March until July and then from September to mid-November) with rainfall averaging 1200 to 1500 mm per year. The central region of Benin, categorized climatically as Sudano-Guinean, has a single rainy season (from April to October) with average rainfall ranging from 1000 to 1200 mm per year.

**Figure. 1**  
 A Map of Benin (before the Administrative Reorganization)



Source: African Studies Center, University of Pennsylvania

The agricultural sector in Benin, the focus of this study, accounts for 36.3 percent of the gross domestic product (CIA The World Factbook, 2005) and employs over half of the economically active population. The main cash crop is cotton which accounts for 44 percent of the value of exports. Much of the population continues to practice subsistence agriculture and the main food crops produced for this as well as for sale are: corn, cassava (tapioca), yams, beans, palm oil, peanuts, and livestock. Other agricultural exports, including oil palm, cashew nut, and pineapple, comprise a much smaller share of the overall agricultural production (Republique du Benin, 1997).

Since the 1980s, Benin has embarked upon a path of economic reforms intended to inject vitality into its economy. While these reforms were initially limited to the agricultural sector, they have since extended to the national development strategy. Benin's first Structural Adjustment Program (SAP) negotiations with the international financial institutions were initiated in 1989 and served as the starting point for subsequent national development reforms. The central thrust of the SAP reforms, in Benin and beyond, has been a push towards a private sector based free market economy. Subsequent to these reforms, the growth rate of the economy has increased: from -3 percent in 1989 to 5 percent in 2004.

Despite these apparent economic successes, the social impacts of the reforms, again in Benin as well as the surrounding region, have resulted in a backlash of criticism and have served to threaten national and regional political sustainability. There continues to be widespread concern that the reforms and in particular, the SAPs, have adversely impacted Benin's most vulnerable members. One of the significant gaps in the research and evaluation of the reforms in Benin relates to their impacts at the household level,

with a specific view to effects on poor and marginalized groups. Given that agricultural households represent a disproportionate number of Benin's poor, as well as more than half of its overall population, a better understanding of the effects of the past several decades of reform on the agrarian population can be seen as critical to any attempts to analyze their overall success.

## 2.2 Literature Review

### *2.2.1 Agriculture and Rural Development in Benin*

Given the importance of agriculture and market access in Benin, it has been the focus of a number of studies.

#### *i) Agricultural Policy and Reforms*

As in many of its neighboring countries, agricultural reforms in Benin have been extensive. The regulation of food markets has in large part been eliminated and previously nationalized food marketing enterprises have been privatized or disbanded. Earlier agricultural subsidies were eliminated in the 1980s and the importation of fertilizer eventually permitted (Kherallah et al, 2001).

The Benin Small Farmers Study (Kherallah et al, 2001) among others (Senahoun et al, 2000) suggests that the agricultural reforms have had minimal discriminatory impacts on small, remote, or non-commercial farmers. Small farmers appear to show levels of satisfaction with the economic changes comparable to those of large farmers.

Interestingly, the degree to which produce was marketed, versus used for subsistence purposes, appears to have had little impact on levels of satisfaction (Kherallah et al, 2001).

Indeed, that same study (Kherallah et al, 2001) indicates that agricultural reforms have, if anything, reduced poverty and regional imbalances. While it appears that urban households were adversely affected by food price changes due to privatization, the survey suggests that those negative impacts did not extend to rural households, which are argued to have seen an improvement in conditions since 1992. The improvements noted in the study, carried out in 1994-95, were in fact quite significant with levels of poverty in rural areas falling notably (Kherallah et al, 2001).

*ii) Devaluation*

Broader economic reforms, such as those macro level reforms impacting the region, have similarly affected the state of agriculture in Benin. The 1994 devaluation of the CFA had positive impacts on promoting production of cotton and other export crops, as well as crops for domestic consumption such as rice (Kherallah et al, 2001). The result of these macroeconomic reforms, which included a basket of instruments including devaluation, state enterprise reform, and fiscal balance, has been subsequent rates of economic growth averaging 5 percent a year (CIA The World Factbook, 2005). An aspect of this growth has been the recovery of the financial sector following the 1988-89 bank failures, along with accompanying credit availability. A further immediate result of the economic reforms has been increased per capita production of almost all the major crops. As noted above, the 1994 devaluation succeeded in improving incentives for the production of export crops and increasing the real price of domestic produce such as maize and rice.

A work by Senahoun et al (2000) assessed the impact of the 1994 devaluation of the CFA franc on the country. This was done by combining historical price data over 1993-

97 with models of household behavior. The findings of this study confirm other reports that devaluation had a positive impact, particularly cotton farmers in the short run and food crop farmers in the longer run. Its finding as well that the impacts were negative when it came to urban households, was confirmed in the slightly later Benin Small Farm Study.

### *iii) Food Security*

A significant factor with respect to food security in Benin is that crop production, even by small farmers, is largely destined for market sale. The national average for market sale of produce is almost two-thirds of the total value, while even small and poor farms sell over half of their output. The implication of this finding is that agricultural prices are of great importance to the farming households of Benin, not least when ensuring basic food security and nutrition. Market prices and policies surrounding agricultural trade deserve close attention by government and other concerned bodies (Kherallah et al, 2001).

The Benin Small Farm Study makes the important observation that farm size in Benin is only weakly related to household well-being. While this result appears counter-intuitive, there are several explanations. One of these is that small farmers often depend more on off-farm income, with the factor of farm size becoming less significant. The report presents as a second justification the tendency of small farmers in Benin to grow crops with higher potential revenue per hectare. A third point is that there is a greater opportunity for small farmers in Benin to take advantage of two seasons of production, such that differences in area under crop are less than those of farm size. And finally, the

report suggests that household size correlates to farm size, with larger farms having more “mouths to feed” (Kherallah et al, 2001).

The work of Janssen and Perthel (1990) examines the supply responsiveness of maize in the department of Atlantique and has general applicability to food security in Benin. The findings demonstrate that first season maize is used almost entirely for subsistence (thus attempting to ensure food security). Farmers then determine whether the first season harvest of maize is sufficient to supply the household needs, and if so, proceed to plant cash crops for the second season. If, however, the first season harvest is felt to be insufficient, the farmers would proceed to plant maize to supplement the previous season’s subsistence harvest. The authors test this hypothesis using time-series data on prices and production in each season. The results from this study are consistent with hypotheses that farmer decisions are more market oriented in the second season. An additional finding is that the supply of cash crops in the second season is positively and significantly influenced by maize yield in the first season.

In 1998, Alpini argued that Benin was effectively self-sufficient in staple food crops. Despite this, several factors were interacting such that food security in Benin was clearly an issue of concern. The first of these factors was that the regional and annual variations in production could, and often did, result in localized or temporary shortages of food. The second factor involved the dependence of Benin’s agricultural economy upon events and policies in Nigeria (namely, degree to which Nigeria’s markets were liberalized). Finally, separate from the availability of plant-based staples, the consumption of animal products continues to be low (16 grams per person per year) and thus leads to inadequate protein intake.

With respect to poverty and rural development in Benin, the most comprehensive study to date is *Enquête sur les Conditions de Vie des Ménages Ruraux* (ECVR), conducted in 1994. This in-depth study involved a sample of 1040 households in the first two rounds and 1350 in the second two. The authors estimated that a national poverty line of 56,600 FCFA per adult equivalent per year applied and found that 33 percent of the households fell below that line. The highest rates of poverty (at 47 percent) existed in the central zone of Benin, followed by the extreme north and finally by the *terre de barre* zone in the south. Additionally, the study found that 36 percent of children under five were malnourished and illiteracy rates were at 73 percent. Notably, the burden associated with manual agricultural work, declining soil fertility and lack of access to agricultural credit were identified as the top three problems by rural households (United Nations Development Programme and Ministère de Développement Rural, 1996).

A final note on these findings is that while the Benin Small Farm Study suggested that food security and poverty have been, and continue to be, issues, farmers in Benin have reported a decrease in household levels of poverty since 1992. More than half of those farmers surveyed in 1994-5 reported an improvement in living conditions while 28 percent noted deterioration in standard of living. For those who reported improved conditions, an improved economic context was the reason most cited. Those who reported worsened conditions pointed to family health and factors such as weather as determining factors (Kherallah et al, 2001).



#### *iv) Gender*

A final point that deserves mention is that of gender. The United Nations Development Programme in 1998 conducted a review of information from a variety of different sources

relating to the role of women in Benin. The report assessed gender differences in areas such as education, employment, life span, and economic activities. It concluded, perhaps unsurprisingly, that economic contributions of women were undercounted by conventional measures.

The Benin Small Farm Study however argued that female-headed household did not seem to be at a significant disadvantage. They found that while female-headed households did tend to have smaller farms and fewer household assets, their overall poverty rates were no higher than male-headed households. In fact, they were determined to be more market-oriented, with comparable access to inputs and credit. The authors of the study suggest caution in the interpretation of these results given the small number of female-headed households in the sample (5 percent or 39 households) (Kherallah et al, 2001).

### 2.2.2 Diversification of Agricultural Production

This paper intends to incorporate the theme of agricultural diversification into the existing body of work on agriculture in Benin. The summary below represents some of the work that has been done around agricultural diversification in other Southern countries.

Netting (1993) argued that the Kofyar tribal agriculture in Nigeria demonstrates how diversification can increase productivity, reduce risk, and enhance sustainability. Netting (1993, p.32) wrote: "Maize and the elephant-ear coco yam or taro tubers flourished best with extra moisture, while the savanna cereals of millet and sorghum were adapted to drier, sunnier locations. These conditions could vary within a kilometer, and people

maximized homestead production by matching their crop association to the environmental potential”.

The Kofyar intercrop several species with different characteristics to minimize the damage from irregular rain fall patterns and other environmental adversities, and to prevent pests from spreading over their farm land, which occurs at a greater rate with monocropping (Netting, 1993). Such farming technique can reduce the amount of fertilizers and pesticides required, thus decreasing overall production costs. Moreover, by planting several species together, people’s location-specific farming skills are used simultaneously, which increases labor productivity (Norman, Simmons & Hays, 1982).

In addition to productivity per unit farm size, Dorsey (1999) investigated dynamics within agricultural diversification, specialization of cash cropping and scale of farm size. He argued that growing a variety of crops increases the farmer’s chance to specialize promptly in the most profitable product on the market so that she can increase her on-farm net income per unit farm size (Dorsey, 1999).

In his study on the Kirinyaga District in Central Kenya, which inspired this study, Dorsey tested how agricultural diversification, the proportion of income generated by the most highly valued crop on the market and farm size affect net agricultural income per unit farm size. He also assessed how, in turn, agricultural diversification was affected by the share of the highest valued crop sale, farm size and the net agro-income per area (Dorsey, 1999).

Dorsey found that the proportion of income from the highest market-valued crop in the total farm-generated income was highly correlated with the number of types of crop grown by a farmer (Dorsey, 1999). Dorsey wrote, “The high correlation between

commercial specialization and diversification may seem theoretically contradictory, since diversification implies a wide variation in products, whereas commercial production involves the opposite, a narrowing variation of products. Survey results suggest that through diversification the smallholder is more readily able to select, from a wide variety of farm products, that crop or type of produce to be specialized for a given growing season or seasons” (1999, p.192). However, he recognized that the direction, or even the existence, of causality could not be confirmed by his study (Dorsey, 1999).

In terms of the relationship between diversification and farm size, the number of agricultural products grown by a household tended to be higher among households whose farms sizes ranged from 1.2 to 1.6 hectare than those whose farm sizes were outside of that range (Dorsey, 1999). This is interesting as it suggests that farm size and agricultural diversification may not have a linear relationship, and that there might, in fact, be an ideal size range for diversifying agricultural products.

Coelli and Fleming investigated the diversification of agricultural production among traditional subsistence food cultivation and new cash crop/food systems (2004). Their study, which inspired my methodology in terms of defining diversification, was based on the small-farmer survey data collected by Overfield (1995) in Benabena, Papua New Guinea, and they found that at first agricultural productivity increased as farmers diversified their agro-production by adopting new production of cash crops (mainly coffee in this district) and/or cash foods. But that it started to decline as cash cropping food systems comprised the bulk of total agricultural production (Coelli & Fleming, 2004).

In order to examine how diversification of agricultural production influenced productivity, they estimated levels of efficient use of inputs or technical efficiency (Coelli & Fleming, 2004). They followed Coelli et al. (1998, p.64) in Coelli and Fleming (2004) to define the input distance function by:

$$d(x, y) = \max \{D\}, \quad \text{such that } \frac{x}{D} \in L(y)$$

where  $L(y)$  is the set of all possible input vectors  $x$  that can produce the output vector  $y$ .

The function  $d(x, y)$  takes values greater than or equal to 1. The closer the value of  $d(x, y)$  gets to 1, the greater technical efficiency becomes (Coelli & Fleming, 2004).

Coelli and Fleming (2004) econometrically estimated the function based on Overfield's survey data, and the results of their analysis suggested that specialization of agricultural production increased technical inefficiency, thus decreasing the factor of productivity.

This corresponds to the argument made by Fleming and Hardaker (1994) that productivity tends to increase when diversification is undertaken through combining traditional farming and new cash-crop farming by improving "technologies, management practices and field husbandry methods [that] are simple and mostly inexpensive in cash terms" (1994, pp.44-99). Their study ultimately concludes that moving towards specialization of cash crops/foods is not necessarily the best strategy to increase productivity.

The purpose of this paper is to examine how, in the department of Mono in Benin, diversification of agricultural product affects agricultural productivity and also how characteristics of household influence such diversification. In the following section, the data and methodology used for this analysis are described and explained in detail.

### **3. Data and Methodology**

#### **3.1 Data**

For my analysis, I employed the Benin Small Farmer Survey, which was conducted in 1998<sup>1</sup>. The survey was conducted by the International Food Policy Research Institute (IFPRI), as well as by the Laboratoire d'Analyse Regionale et d'Expertise Sociale (LARES) in Benin, and funded by the Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (BMZ). A total of 899 farm households were interviewed for this survey across the country. The Benin Small Farmer Survey consists of 16 sections, and these focus upon: household characteristics, housing characteristics, land, agricultural production, labor use, input use, changes regarding input use, credit, crop marketing, storage, sources of information, food and non-food consumption, allocation of time, asset ownership, sources of income and perceptions of farmers. The questionnaire of the survey is in the appendix.

In this survey, Benin is divided into six departments, namely, Atacora, Atlantique, Borgou, Mono, Ouémé, and Zou. There was an administrative reorganization after the survey was conducted, and as a result, currently Benin consists of 12 departments (Minot & Daniels, 2002). However, as my analysis is based upon the IFPRI survey, in this paper I use the prior six-department administrative system.

For my study, I focused exclusively on Mono. There are a number of reasons for this. First, as both time and resources were limited, I chose to focus on one of the smallest departments in terms of sample size (Mono and Atlantique). This is because handling the survey data required enormous amounts of time due to the following reasons. In the Benin Small Farmer Survey, 899 households and more than 4000 farms are surveyed, and

there are close to 250 variables associated with those households and their farm plots. The survey data are organized into 32 different spreadsheets according to category, such as, household characteristics and land characteristics. Some of the tables are arranged in terms of household and others in terms of farm plot. Very often, several households/plots appear in one worksheet but not in another. Also, there are quite a few missing values for certain variables and some inconsistency from department to department and from village to village.<sup>2</sup> These facts made me go through each observation on an individual basis in order to minimize errors and to rearrange the data into a convenient format for my study. Therefore, it was simply not feasible to handle all six of the departments.

Second, farmers in Mono are generally more educated than the average farmer nationally in Benin. The literacy rates are highest in Ouémé and Mono, and correspondingly, the average levels of education (in terms of number of years of schooling) in these departments are higher than those of other departments (Kherallah et al, 2001). Finally, Mono is densely populated, and its average farm size is the smallest among the six departments (Kherallah et al, 2001). Since the last two points, education and farm size, are discussed among much of the existing literature on agricultural diversification, it seemed a more useful contribution to investigate Mono for insights on how these factors affect the diversification of agricultural products.

## 3.2 Methodology

### *3.2.1 Defining and Measuring Diversification*

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<sup>1</sup> The description of the Benin Small Farmers Survey in this section is based on Kherallah et al, 2001.

<sup>2</sup> In fact, I first conducted research on Atlantique, but judged that the problems around missing values and inconsistency were less strong in Mono.

Before investigating the relationship between the agricultural diversification of smaller farmers in Mono and their productivity, it is necessary to define diversification of agricultural production for the purposes of this analysis. Dorsey defines agricultural diversification as, “the number of food and cash crops currently under production on a farm (1999, p.179).” For the sake of brevity, I will denote the number of types of agricultural produce grown by each household as  $D_N$ . The rationale behind Dorsey’s definition is that smallholder farmers in his target area of Central Kenya diversify their agricultural products; i.e. increase  $D_N$ , and thereby provide themselves with a variety of options from which they can choose the most profitable crop seasonally (Dorsey 1999). In this formula, the actual amounts grown of each crop are not significant. The critical factor is the number of choices for diversification that farmers possess.

Another formula for categorizing agricultural diversification involves output or land shares of different crop types. I use the definition of diversification as a measure of how equally output/land is shared by the various types of agricultural product or production under consideration. Coelli and Fleming (2004) use a related measure of specialisation in agriculture via the ogive index. Their formula for diversification analysis comes from Ali et al. (1991), and is calculated as:

$$Ogive\ index = \sum_{n=1}^N \frac{[X_n - (1/N)]^2}{1/N}$$

where  $N$  is the total number of possible different production enterprises, and  $X_n$  is the output share of the  $n$ th enterprise (Coelli & Fleming, 2004). When diversification is defined by the degree of equal distribution, such as described above, then the ogive index can be used as a measure of diversification. A small value for the ogive index implies a

higher degree of equal distribution, and therefore, a greater degree of diversification, and vice versa. For example, suppose there are three production enterprises under consideration so that  $N = 3$ . If the output shares of the enterprises are equal, then  $X_1 = X_2 = X_3 = \frac{1}{3}$ , and the ogive index takes the value 0. If the first enterprise dominates the whole output, then  $X_1 = 1$  and  $X_2 = X_3 = 0$  for which the value of the index is 2.

In Mono, the average number of crop types per household is 3.42 with a standard deviation of 1.307. The minimum value is 1 crop type per household, and the maximum 7. The actual figures might be slightly higher as out of 536 plots surveyed, there are 28 plots for which the category “other vegetables” or “other crops” was chosen, and it is unclear as to how many different types of produce were grown in those plots. However, it is hard to imagine that the actual figure is greater than or even anywhere near 8 that is the mean value for  $D_N$  in Kirinyaga District, Kenya (Dorsey, 1999). When the majority of farmers have only 3 or 4 kinds of crops from which they can select for a given season’s commercial specialization, Dorsey’s theory becomes less relevant. Another important point is that the dataset for this study does not have a time-dimension. Suppose a farmer decides to grow new types of crops as an investment. Even if it is guaranteed that it will increase her agricultural income in the future, the increase does not occur in the same year. This time lag may distort the accuracy of the analysis. Therefore, for the analysis in this paper, I employ the second definition of diversification, i.e. similar to that of Coelli and Fleming (2004). Thus, in the rest of the paper, diversification is taken to mean how equally output or land is shared by the types of agricultural product or production under consideration unless otherwise mentioned.

Even though the second definition for diversification is adopted, there remain different ways of measuring it. As discussed above, the ogive index is one such measurement. Here, I propose another index to quantify diversification which I developed. It is denoted by  $D$  and defined by:

$$D = \prod_{n=1}^N (1 + X_n) \quad (1)$$

where  $N$  is the number of types of crop under consideration, and  $X_n$  is the share of the  $n$ th type of crop.

In order to have a sense of how this index measures diversification, here are some examples. Suppose there are three possible crop types A, B, and C that can be grown in a studied area so that  $N = 3$ . If Farmer 1 uses his entire farm for just Type A, then  $X_A = 1$  and  $X_B = X_C = 0$ . In this case, the value for the index  $D$  is 2, which is the minimum value  $D$  can attain; i.e. the least diversified. If Farmer 2 diversifies “the most” in a sense that her farm is equally shared by the three crop types, then  $X_A = X_B = X_C = \frac{1}{3}$ , and  $D$  takes the maximum value 2.37.

This index  $D$  and the ogive index behave similarly except that they move in opposite directions. In fact, when the degree of diversification is computed with respect to the land shares of agricultural produce types, the correlation between these two indices, calculated based on the survey data for Mono, is -.990 (significant at the 0.01 level). The reason for why the index  $D$  is used in this analysis is that it “appreciates” an increase in  $D_N$  to a greater degree than the ogive index. For example, suppose that there are three types of crop A, B and C. One farmer X uses 89.9% of her land for A and 10.1% for B. Another farmer Y allocates 90% of his land for A, 9.5% for B and 0.5% for C. As their land use

patterns are very similar, both the index D and the ogive index give similar values for X and Y; 2.0908 and 16.17 for X and 2.0909 and 16.20 for Y, respectively. While the ogive index suggests that X diversifies more than Y does, the index D indicates that the farm of Y is more diversified than that of X.

### 3.2.2 Diversification and Agricultural Productivity

In order to investigate how diversification of agricultural production affects agricultural productivity, the following equation, inspired by Dorsey (1999), is used:

$$AP = \alpha_0 + \alpha_1 D + \alpha_2 CL + \alpha_3 CF + \alpha_4 AA + \alpha_5 P + \alpha_6 CA + \varepsilon_1 \quad (2)$$

where AP is the net agricultural profit per acre of cultivated land, D is the diversification defined by the equation (1), adjusted so that it lies between 0 and 100, CL is the costs of labor in 1,000 FCFA, CF is the costs of fertilizers in 1,000 FCFA, AA is the amount of agricultural assets in 1,000 FCFA, P is the number of people in each household, and CA is the area of cultivated land.

As mentioned above, the diversification is computed by the equation (1) based on the Benin Small Farmer Survey conducted in 1998. The survey provides, for each farm plot, how much area was cultivated for every type of crop planted in the plot. This allows for the calculation of cultivated land share per each crop type as well as total size of cultivated land per household. In the survey, twenty one kinds of crops are listed. These are: maize, sorghum/millet, small grains, rice, finger millet, cow peas/beans, ground nuts, bambara nuts, soy beans, cassava, yams, sweet potatoes, taro, fruits, tomatoes, onions, okra, chili, other vegetables, cotton, and other crops. Therefore, the number of types of crop under consideration, N, is set to 21. With this value, the highest possible value for

the index D is 2.656, and the lowest possible value is 2. The index D is adjusted so that it lies between 0 and 100 as follows:

$$D_{adjusted} = \frac{D_{original} - 2}{2.656 - 2}.$$

The cost of labor is calculated based on figures from the survey. It provides, per activity, the amount of non-family labor each farmer employed (persons times days) according to plot. Activities are divided into six different categories, namely: land preparation, planting /disseminating, weeding/hoeing, chemical application, and beating/trashing/cleaning. The amount of payment for labor (per person per day) is also given so that the costs of labor for each plot can be computed.

The costs of fertilizers are calculated in a similar manner. The dataset provides, according to type of fertilizer, the amount in kg each farmer used per plot. Also, the price of each type of fertilizer is provided in the Benin Small Farmer Survey.

After computing the costs of labor and fertilizer, the net agricultural profit is calculated in order to establish the net agricultural profit per acre of cultivated land according to household. Farmers are asked the amount of total income both in cash and in-kind for each source of income. The listed sources of income are; agricultural labor, other labor, micro-enterprise, crop sales, animal product sales, family help, retired, social assistance and others. The net agricultural profit is simply the crop sales income minus the costs of labor and fertilizers. The costs of pesticides are omitted because (1) pesticides are applied to very few plots, and (2) the amounts paid for the pesticides are almost negligible in comparison to the total amounts of agricultural income. The costs of seeds are not included as the vast majority of farmers use retained seeds from past years, and their values are extremely difficult to estimate. The net agricultural profit per acre is

determined by dividing the net agricultural profit obtained above by the total cultivated land.

In terms of agricultural assets, each household was asked to list assets according to category, amount and value. The agricultural assets range include such property as; carts, plows, harrows, tractors, cattle, work cattle and goats/mutton. Of course, answers to the second question can be very subjective and their accuracy is difficult to assess. However, since it seems reasonable to assume that these agricultural assets enhance output per acre, their possession should not be neglected. Thus, the value of agricultural assets owned by households has been calculated based on these answers and incorporated into the above equation.

### *3.2.3 Factors of Agricultural Diversification*

What motivates smallholder farmers to diversify their agricultural production is an important question. If the key factors behind such diversification are identified, policy makers are armed to develop more effective strategies. To this end, the following equation, also inspired by Dorsey (1999), is estimated by the OLS analysis:

$$D = \beta_0 + \beta_1 HW + \beta_2 AC + \beta_3 AR + \beta_4 S + \beta_5 P + \beta_6 Edu + \beta_7 Age + \varepsilon_2 \quad (3)$$

where D is the diversification defined by the equation (1), adjusted so that it lies between 0 and 100, HW is the amount of household wealth in 1,000 FCFA, AC is access to credit (1 if they received a loan, 0 if not), AR is the proportion of on-farm income in total income, S is the cultivated land size, P is the number of people living in each household, Edu is the number of years of education per household head, and Age denotes that again of household head.

The first three explanatory variables are related to risk. Risk is seen as a cause of diversification in much of the literature (Ellis, 1998). If reducing risk of income losses due to crop failure or diminished crop prices is a main motivation for farmers to diversify their on-farm produce, one's financial security potentially influences degree of diversification significantly. For example, if he is poor, unable to access credit, or heavily dependent on farm-generated income, then he is likely to be inclined to increase agricultural diversification. Another way to view household wealth and access to credit is as indicators of the relationship between diversification and capital constraints. Household wealth and good access to credit should allow farmers to cultivate new agricultural products that are expensive to grow, involving for example, intense capital requirements and high fixed costs. If diversification is undertaken through the adoption of new and at least initially, expensive, farming technology, a greater amount of household wealth and better access to credit could be expected to enhance agricultural diversification. Thus, examining how small farmers' household wealth, access to credit, and proportion of on-farm income affect diversification of agricultural produce can be seen as a key consideration in any diversification analysis.

The amount of household wealth is generated by adding each family's household assets (these would include such possessions as; furniture, electronics and vehicles) to the agricultural assets already calculated in the previous subsection. The value of household assets is computed based on the survey data. Each household provided, for every household item they possess, the item's original value and the length of time for which it has been owned. Then, the value of each asset is calculated based on depreciation rates of

3% per annum. Access to credit is a dummy variable which takes a variable of 1 if the household was able to receive a loan, and 0 if not.

The number of people included in each household is incorporated in the equation as diversification often requires intensive family labour (Coelli & Fleming, 2004). In Ghana, one obstacle to adopt pineapple cultivation was the amount of labour available per household (Goldstein & Udry, 1999). If one desires to diversify her agricultural production by growing such labour intense crops, large family size serves as a positive consideration.

Although the role of gender in farmers' diversification is often discussed (Ellis, 1998), the dataset used for this analysis is not sufficient to test such influence. In Mono, among the 90 household surveyed, there were only two households that were headed by women. This is not sufficient a sample size to conduct analysis. Therefore, the gender of household head is omitted from the equation and from this study.

#### 4. Results of the Analysis

While this study has produced results that are largely in keeping with those found in previous work, several notable and unexpected findings did surface. These are detailed and explained throughout this section. In the first subsection, the results regarding agricultural diversification and productivity, and in the other subsection, the findings about determinants of diversification follow.

##### 4.1 Diversification and Agricultural Productivity

Table 1 shows the results from the Ordinary Least Squares (OLS) analysis using the equation (2). The most interesting result we can observe from this table is that the diversification of agricultural produce seems to have a positive effect on the agricultural profit per acre. Even though the null hypothesis that the coefficient of D is equal to zero cannot be rejected at 10% significance, this result is consistent with previous studies such as the works of Netting (1993), Dorsey (1999), Coelli and Fleming (2004). In order to see the relationship between the theories provided in these studies on why diversification increases agricultural productivity, I will look at the results related to variables other than that for diversification.

Based on the above OLS analysis, there is strong evidence that the value of household agricultural assets has great influence on its agricultural productivity (t-value = 2.459, and  $P = .016$ ). As these assets are generally acquired in order to lessen the burden of agricultural work and/or improve its efficiency, this result is expected.

There was no noticeable evidence of impacts on agricultural productivity due to associated costs of labour, costs of fertilizers, the number of people living in each

household or the size of cultivated area. Of these four variables, the number of people in each family is most likely to have an impact on farm-generated profit per acre given its relatively small P-value (.140). Coelli and Fleming (2004) suggest that diversified agricultural production by efficient use of family labour improves technological efficiency. Interestingly, here the coefficient for this variable is deemed to be negative. This seems to contradict the results of Coelli and Fleming. However, family members' contribution to household labour might not correspond well to household size. There seems to be several possibilities that might cause such distortion.

**Table 1**  
Results from the OLS Analysis with Equation (2)

R	R Square	Adjusted R Square	Std. Error of the Estimate
.397	.157	.096	265.59302

	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	85.973	90.858	.946	.347
D	2.856	1.882	1.518	.133
CL	-.302	1.031	-.293	.770
CF	-1.030	.917	-1.124	.264
AA	.001	.000	2.459	.016
P	-11.927	8.003	-1.490	.140
CA	-4.244	3.436	-1.235	.220

Dependent Variable: AP

First, as an example, if the majority of the family members are small children or elderly people, not only do they not contribute to family labour, but their presence lowers other members' farming productivity as they spend some portion of their time to look after them. Those hours could otherwise be used farming to increase the household's

productivity as a whole. Secondly, if women are socially proscribed from working in the fields or from participating in certain types of agricultural activities, the household size does not simply translate to the amount of family labour. Finally, as Kherallah et al. (2001) suggest in the case of Benin nationally, there is the possibility that, when the family size is great, most of produce is consumed at home and not sold to generate extra agricultural income. If this is true, then household size can negatively affect agricultural productivity. In this analysis, this results from the productivity of agricultural production being net agricultural profit per acre.

#### 4.2 Factors of Diversification

Recall that, in this analysis, potential factors of diversification are tested by the OLS regression using the equation (3). The results are summarized in the Table 2. It indicates that household wealth and the proportion of agricultural income in the total household income significantly contribute to explaining the differing degrees of agricultural diversification among households (t-value = 2.987 and 2.870, P = .004 and .005, respectively). However, there is no real evidence of access to credit contributing to agricultural diversification.

That the coefficient for household wealth is positive indicates that diversifying agricultural production tends to involve capital constraints. In another words, larger household wealth allows for greater diversification. Whether risk reduction is a key motivation for diversification is not clear from this result. However, the positive effect of the agricultural income ratio can be seen as evidence supporting the risk-reduction motivation theory. If a household is dependent on farm-generated income for a large

portion of its total income, reducing risk of income loss due to price drops and crop failure should be a major interest. This at least does not contradict the first result regarding household wealth. If one heavily relies on her farm income as major source of income, and therefore, has an interest in seeing it stabilized, she will use her household wealth to diversify her agricultural production. It is therefore quite interesting that the results for access to credit are not statistically significant. According to the survey data, it is calculated that the median value of the loans the household borrowed was 4,000 FCFA. It is roughly 10% of the median value of the total income. This simply might not be enough to expand diversification, and hence, access to credit does not seem to contribute to the diversification of agricultural production.

**Table 2**  
Results from the OLS Analysis with the Equation (3)

R	R Square	Adjusted R Square	Std. Error of the Estimate
.534	.285	.224	14.99443

	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	31.595	7.189	4.395	.000
HW	.030	.010	2.987	.004
AC	1.565	3.460	.452	.652
AR	.160	.056	2.870	.005
S	-1.395	.380	-3.674	.000
P	1.168	.460	2.537	.013
Edu	-.570	.495	-1.152	.253
Age	-.026	.100	-.263	.793

Dependent Variable: D

The OLS analysis above suggests that the farm size negatively influences the level of diversification of agricultural produce. This result is statistically significant (t-value = -

3.674, and  $P = .000$ ). This might be because, as suggested by Livingstone (1986), Bradshaw (1990) and Dyer (1991), smaller farmers have a greater tendency to increase their agricultural productivity. Since there is evidence, as seen in the previous subsection, that diversification increases crop-sale income per acre in Mono, it makes sense that smaller farmers diversify more. Kherallah et al (2001) indeed found that smaller farmers in Benin tend to grow crops with higher revenue per hectare. Thus, it seems that their production is diversified by adding cash crops into traditional subsistence crops in order to increase productivity and thereby compensate for their small farm sizes.

The figures in Table 2 strongly suggest that household size has a positive impact on diversification ( $t$ -value = 2.537, and  $P = .013$ ). There are a number of cases in which this might happen. First, a household with a large family size may have greater need to increase output to feed family members. Thus, for a household with a large family, it makes sense to diversify agricultural products if the diversification creates more output. Second, if growing various types of crops requires more labour, large household size might be able to provide greater amounts of labour. As indicated in the previous subsection, it would be simplistic to assume that large family size automatically implies more labour. However, it remains a possibility. Finally, there might be an aspect of human capital; knowledge or learning-by-doing that positively impacts a household's tendency to diversify. Growing a variety of crops requires substantial knowledge. For one person to be knowledgeable about the cultivation of a variety of crops might be less common than individual family members 'specializing' their knowledge around particular crops. If this is the case, a large family size may support increasing levels of diversification.

The impacts of the education and age of household heads on agricultural diversification are not statistically significant. Gockowski and Ndoumbé (2004) have found that in southern Cameroon, a monocropping system, which is not a traditional intercropping system in the area, is better adopted among people who are younger and better educated than other farmers. In their study area, age and education affect the way farmers operate. However, in my analysis, no such evidence was observed. The following section will reiterate and distil the findings detailed throughout this subsection.

## 5. Conclusion

In this paper, I have investigated how, in the department of Mono in Benin, diversification of agricultural product influences overall agricultural productivity and also how characteristics of household influence such diversification. The data for this analysis were taken from the Benin Small Farmer Survey conducted in 1998. Although Benin currently consists of 12 different departments (and notably Mono department no longer exists in the same form as it did during the Benin Small Farmer Survey), it was divided into 6 departments when the survey was conducted. Thus, in this analysis, all departments were based on the old definition.

In the preceding analysis, diversification of agricultural production was defined on the basis of the *degree of equality of each crop type on a farm*, rather than the total number of crop types grown by each household. The rationale for this is the small value for the average number of crop types under production, and the lack of time-series data from the original surveys.

The regression analysis using the data from the Benin Small Farmer Survey indicated that greater levels of agricultural diversification allow higher farm-generated profit per acre. Though this result was not strong (t-value = 1.518, and P = .133), it is consistent with earlier studies on farming diversification, such as studies by Netting (1993), Dorsey (1999), Coelli and Fleming (2004). It seems that diversification enhances agricultural production by incorporating new cash crop species and systems into traditional subsistence crop farming patterns.

The results of this analysis show that the major determinants of diversification are: the value of household wealth, the proportion of agricultural income in total household

income, farm size and the number of people in a household. Except for farm size, all of the above variables had positive impacts on diversification. On the other hand, access to credit, and the education and age of a household head did not seem to impact or offer explanations for diversification differences among households.

The positive effect of household wealth on diversification suggests that diversification involves (at least in Mono, Benin) certain levels of capital constraints, meaning that poor farmers diversify less. Therefore, even if risk reduction is a major part of the motivation for diversifying agricultural production, lack of funds may prevent households from doing so. This seems to contradict the absence of explanatory power of access to credit, as loans should reduce the capital constraints which diversification apparently entails. However, the amount of loans farmers receive (about 10% of total income in median terms) may not be enough to mitigate such burdens. The positive relationship with the proportion of agricultural income in total household income suggests that diversification is motivated by risk reduction.

The fact that small farms are more diversified seems explainable by a combination of theories, namely those presented by Livingstone (1986), Bradshaw (1990) and Dyer (1991). Their theories suggest that smaller farmers have higher agricultural productivity and this is supported throughout this study by evidence that diversification increases agricultural profits per acre in Mono. Smaller farmers have more diversified agricultural production because they can increase productivity by doing so.

The size of households has a positive impact on the degree to which it diversifies. This may be explained by several reasons. First, larger families may have greater needs to increase farm output for household consumption. This can be done by diversifying

agricultural products. Second, if diversification requires more labour, large household size can be advantageous. Finally, a large number of household members may contribute to human capital which diversification may require.

Other findings from this analysis are that (1) the total value of agricultural assets possessed by a household positively affects the agricultural profit per acre, and (2), though the evidence is not strong, a larger family size may act to decrease agricultural productivity. The first result is straightforward. The second result seems counter-intuitive as larger families seem to be able to provide greater family labour, leading to greater productivity per acre. There are however, several reasons for this assumption to prove incorrect. First, if most of the family members are small children or elderly people, it lowers the entire family's productivity. Secondly, if there are social prohibitions against female family members working in the fields or from participating in certain types of agricultural activities, a larger family size does not simply translate into a greater productivity. Finally, Kherallah et al. (2001) suggest that larger families sell less of farm output simply because they have more people to feed.

This study leads to the conclusion that patterns of agricultural diversification in Benin are neither simple nor predictable. Given the significance of agriculture as the dominant form of national employment, as well as its impacts on national food security, it behoves both government and researchers on this subject to further unravel the complexities of agricultural diversification.

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**Appendix**

Benin Small Farmer Survey 1998

Source: International Food Policy Research Institute (IFPRI),  
available at <http://www.ifpri.org/data/benin01.htm>

## QUESTIONNAIRE ON SMALL FARMER IN BENIN 1998

	NAME or DESCRIPTION
Interviewer	
Department	
Sub-prefecture	
Village	
Household head	
Respondent	
Address	

	ACCOMPLISHED TASKS			PERSON IN CHARGE
	Date	Month	Year	Signature
Interview				
Supervision				
Control				
Data Collection				

DPT    SP    V    M  
-----

**DPT** = code for department  
**SP** = code for sub-prefecture  
**V** = code for village  
**M** = Household number

### A. Characteristics of the Household members

A1 What is your relationship with the head of household?

1. Household head	4. Spouse
2. Son/daughter	5. Other family relationship
3. No family ties	

A2 How many people live in your house?   
(please see the definition)

A3 What is the relationship between the head of the household with the informal leader of the village?

1. Village chief	5. Spouse
2. Brother/sister	6. Child
3. Parent	7. Other family member
4. No family ties	

A4 What is the religion of the head of household?

1. Animist	4. Protestant
2. Muslim	5. Other (please specify) _____
3. Catholic	

A5 What is the ethnic group of the head of the household?

1. Fon	7. Otamari
2. Adja	8. Holli
3. Nago	9. Yom
4. Bariba	10. Lopka
5. Mahi	11. Other
6. Dendi	

A6 Do you or members of your household belong to a cooperative or any village group?

1. Yes, a village group(s) (GV)	
2. Yes, agriculture cooperative	
3. Yes, a village group and a cooperative	
4. Not a member.	

A7 Is there any member of the household subscribing to a rotating credit society?

1. Yes      2. No

**DEFINITION of "Household":** Household defines as a group of people (related or not) who eat and live together in the same home for at least six months in a year. This includes the employees and visitors provided that they eat and live with one family most of the time. However, the household excludes the family members who live elsewhere most of the time, whether more 6 months in a year or 4 days in a week.

TABLE A8-A15 CHARACTERISTICS OF THE HOUSEHOLD MEMBERS

A8 First names of household members starting from the head of the household.  (Register all the names before moving to column A9)  (first names)	A9 The relationship to head of the household  1. Household head 2. Spouse 3. First wife 4. Other wife 5. Son/daughter 6. Son/daughter in law 7. Father/mother 8. Grand child 9. Other relatives 10. No family ties	A10 Gender  1. Male 2. Female	A11 Age  (actual year)  (write down 0 for the baby less than 1 year old)	A12 Level of education achieved by member of household  (year)	A13 Can s/he read or write?  1. Can read 2. Can write 3. Can read and write 4. None	A14 What was your main occupation in terms of most time spending on?  1. Crop production 2. Agriculture trade 3. Food processing 4. Livestock production 5. Fishing 6. Construction 7. Manufacturing 8. Other trade and services 9. Unemployed 10. Student 11. Retired/not working 12. Housework	A15 What was your second occupation in terms of most time spending on?  1. Crop production 2. Agriculture trade 3. Food processing 4. Livestock production 5. Fishing 6. Construction 7. Manufacturing 8. Other trade and services 9. Unemployed 10. Student 11. Retired/not working 12. Housework 99. No second occupation
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							

**B. Household Characteristics**

Direction: questions B1 through B4 concern only the house of the head of the household

B1 Main construction material of walls?   
 1. Brick/stone      4. Cement  
 2. Mud brick/mud    5. Bamboo  
 3. Metal sheet      6. Straw

B2 Flooring material?   
 1. Dirt              3. Wood  
 2. Brick/stone      4. Cement/tiles

B3 Material roof is made of?   
 1. Tiles              4. Dirt/mud  
 2. Metal sheet      5. Straw  
 3. Wood              6. Cement

B4 What is the status of your house?   
 1. Own                2. Rent  
 3. Borrowed        4. Used without pay

B5 How much money do you or household members pay for dwelling per month (FCFA)?  FCFA

B6 What is your household's main source of water?   
 1. Private tap                      6. Public tap  
 2. Purchased                      7. River/lake  
 3. Covered private well            8. Rain/water tank  
 4. Opened private well  
 5. Covered public well

B7 How far is the source from your dwelling (In meters)? [if B6 = 1, write "0"]  m

B8 What is the main source of lighting for your dwelling?

- 1. Electricity                      4. Generator
- 2. Oil/kerosene lamp            5. Fuel wood
- 3. Candles

B9 What is the distance of the closest telephone services from your dwelling?  km

B10 What is the distance to a passable road from your dwelling?  km

B11 What is the distance to pave road from your dwelling?  km

B12 What is the distance to a "sub-prefecture" from your dwelling?  km







**G. Changes regarding intensity of utilization of labor and inputs**

		Use of fertilizers		Use of purchased seeds		Hired labor		Female labor	
		G1 Has the quantity per hectare of fertilizer applied on your crops changed since 1992? 1.Yes, increased 2.Yes, reduced 3.No 4.Not applicable	G2 [if G1 = yes] Why did the quantity of fertilizer applied change? 1. Price of fertilizer 2. Availability 3. Revenue to purchase fertilizers 4. Soil degradation	G3 Has the quantity per hectare of seeds purchased changed since 1992? 1.Yes, increased 2.Yes, reduced 3.No 4.Not applicable	G4 [if G3 =yes] Why did the quantity of seeds purchased change? 1. Seed price 2. Availability 3. Crop price 4. Credit availability 5. Revenue to purchase seeds 6. Previous experience	G5 Has the use of hired labor in crops production changed since 1992? 1.Yes, increased 2.Yes, reduced 3.No 4.Not applicable	G6 [if G5 = yes] Why did the utilization of hired labor change? 1. Yield changed 2. Labor availability/cost 3. Family labor availability 4. Confidence to be paid 5. Recommended 6. Others	G7 Has the number of female labor work in crops production changed since 1992? 1.Yes, increased 2.Yes, reduced 3.No 4.Not applicable	G8 [if G7 = yes] Why did the use of female labor change? 1. Non-agricultural work demands on women 2. Non-agricultural work demand on men 3. Change in household composition 4. Change in division of responsibility
1	Maize								
2	Sorghum /Millet								
3	Small grains								
4	Rice								
6	Cow peas								
7	Ground nuts								
10	Cassava								
11	Yams								
20	Cotton								

Crops Codes: 1. Maize 2. Sorghum/millet 3.Small grains 4. Rice 5.Finger millet 6. Cow peas/beans 7. Ground nuts 8. Ba,mbara nut 9. Soya 10. Cassava 11.Yams 12. Sweet potato 13. Taro 14. Fruit 15. Tomato 16. Onion 17. Okra 18. Chili 19. Other vegetables 20. Cotton 21. Other crops

**H. Source of credit**

H1. Has this household applied for credit during the campaign in 1997-1998 ?   
 1. Yes (continue) 2. No (continue to H10)

TABLE H2-H9 LOANS [INTERVIEWER: Register each loan on one line]

H2 Who has applied for credit ? 1. Head 2. Spouse(s) 3. Son/daughter 4. Son/daughter in law 5. Father/mother 6. Grand children 7. Other member 8. Other	H3 Where did they ask for the loan ? 1. Friends 2. Family 3. Money lender 4. Trader 5. CLCAM 6. CARDER 7. USPP 8. GV 9. NGO 10. Mutual Con.	H4 What was the purpose of the credit? 1. Personal spending 2. Fertilizer purchase 3. Seeds purchase 4. Hired labor 5. Agri equipment investment 6. Non-agri investment	H5 Did you receive the whole amount or just a part? 1. Yes 2. No [if No -> H11]	H6 How much did you borrow? (FCFA)	H7 After how long, the debt must be paid back? (months of granting of this credit until the last installment) (months)	H8 In what form do you have to pay it back? 1. Cash 2. In-kind 3. Combination	[if H8 = 1] H9 How much you have to repay? (FCFA)

H10. If no, what was the reason for not obtaining credit?   
 1. Insufficient funds 6. Too risky  
 2. Insufficient savings 7. Previous problems  
 3. Interest rate 8. No local credit institution  
 4. Complicated Formalities 9. Unlikely to be approved  
 5. No need for credit

H11. Has the credit your household obtained since 1992 change d?   
 1. Yes 2. No (go to I1) 3. Has not cultivated since 1992

H12. How was the change?   
 1. Increased 2. Decreased

H13. What was the reason for the change?   
 1. Credit source disappeared  
 2. New credit source appeared  
 3. More credit sources are available  
 4. Interest rates increased  
 5. Change in the number of credit sources  
 6. Change in interest rates  
 7. Change in inputs use  
 8. Change in cultivated areas





**J Storage**

**TABLE J1-J6 INFORMATION ON STORAGE STRUCTURE**

J1 Access to this type of storage?		J2 Ownership of storage		J3 What is the storage capacity?		UNIT CODES 1. gram (do not apply for storage) 2. kg/liter 3. 25 kg bag 4. 50 kg bag 5. 100 kg bag 6. Ton 7. Sweet potato bag 8. Beans bag 9. Onion bag 10. Piece (do not apply for storage) 11. Total (do not apply for storage)
Structure	1. Yes 2. No	1. Own 2. Rent	Quantity	Unit code		
1	Attic/shed					
2	Store / Warehouse					
3	Inside house					

**TABLE J4-J8 STORAGE FOR EACH CROP [INTERVIEWER: Register the information of each crop on one line]**

Crop code	J4 How much was the total quantity of [crop] stored after 1 month of harvest?	J5 How many months after the harvest does your stock run out? [Put '0' for less than 1 month] (month)	J6 After the harvest, how much do you expect to lose in post harvest?		J7 What caused of the losses?	J8 What was the main reason for storing [crop] after the harvest?
			Quantity	Unit code		
1	Maize					
2	Sorghum					
3	Millet					
4	Rice					
6	Cow peas					
7	Ground nuts					
10	Cassava					
11	Yams					
20	Cotton					

**K Sources of information**

K1 Indicate the principal source of information for each of the below categories (INTERVIEWER: let the person express himself - do not provide any choice)		1. Extension service 2. Friend/family 3. Traders 4. Newspaper/magazines 5. Radio 6. TV 7. Research center 8. Cooperative/GV 9. Ministry of Rural Dev 10. SONAPRA 11. Other
1	Different variety of crops different varieties of seeds	
2	Fertilizer price	
3	Control the vermins and bed herbs	
4	Techniques of crop production	
5	Price and market of different crops	
6	Agriculture reform	

K2 Is there any extension agent assigned to your sub-sector?  
1. Yes  2. No

K3 [If K2 = Yes] how many times did you contact or consult them in the past 12 months (if 0, go to K5)

K4 What kind of assistance did you receive?	1. Yes 2. No	
1	Utilization of agricultural inputs	
2	Method of crop production	
3	Achievement of credit for crop production	
4	Price of the inputs and/or crops	
5	Commercialization of crops	
6	Other assistance	

K5 What kind of information on crop production you think more useful?

1. How to raise yield
2. How to reduce insect problems
3. Use and application rates of fertilizer
4. How to reduce crop disease
5. How to reduce post-harvest losses
6. What seed type/variety to use
7. Other

K6 How has the access of extension service changed since 1992?

1. Better
2. Worse
3. No change
4. Not applicable

K7 How has the access of information changed since 1992?

1. Better
2. Worse
3. No change
4. Not applicable

K8 Who among the household consult the technical agent or participate in the training of service of popularisation?

1. Household head
2. Spouse (s)
3. Head and spouse (s) jointly
4. Son
5. Daughter
6. Household jointly
7. Other family member
8. Other

K9 Is the person (s) who receives all the information from the technical agent is the one (those) directly concerned by this?

1. Yes
2. No

L. Consumption (food products)

TABLE L1-L8 FOOD CONSUMPTION (FIRST PARTY)

Consumption		Food purchase of the household consumption						Self consumption		
L1 In the past 12 months, have you consumed [...]?		L2 Within a year, how many months did you buy [crop] ?	L3 How frequently does your household purchase in a month ?		L4 For each transaction, what is the average value of [...] purchased?	L5 For each transaction, how much was the average quantity of [...] purchased?		L6 Who was responsible for the purchase of [...]?	L7 In the past 12 months, has your household consumed [...] coming from your own production?	L8 In the past 12 months, how much was the quantity of [...] consumed coming from your own production?
	1. Yes 2. No	(Number of months)	Number of times	Unit of number of times	FCFA	Quantity	Unit 1. gram 2. kg/liter 11. piece	1. Head 2. Spouse (s) 3. Head and spouse (s) jointly 4. Son 5. Daughter 6. Other household member 7. Other	1. Yes 2. No	Quantity Unit 1. gram 2. kg/liter 6. ton
1	Maize									
2	Sorghum/ millet									
3	Rice									
4	Beans									
5	Ground nuts									
6	Garf									
7	Cassava									
8	Yams									
9	Potato									
10	Other tuber									
11	Tomato									
12	Onion									
13	Other vegetables									
14	Fruit									

Code of time unit: 1. Daily 2. Weekly 3. Monthly 4. Annually

TABLE L1-L8 FOOD CONSUMPTION (CONTINUED)

Consumption		Food purchase of the household consumption						Self-consumption		
L1 In the past 12 months, have you consumed [...]?		L2 Within a year, how many months did you buy [crop] ?	L3 How frequently does your household purchase in a month ?		L4 For each transaction, what is the average value of [...] purchased?	L5 For each transaction, how much was the average quantity of [...] purchased?		L6 Who was responsible for the purchase of [...]?	L7 In the past 12 months, has your household consumed [...] coming from your own production?	L8 In the past 12 months, how much was the quantity of [...] consumed coming from your own production?
	1. Yes 2. No	(Number of months)	Number of times	Unit of number of times	FCFA	Quantity	Unit 1. gram 2. kg/liter 11. piece	1. Head 2. Spouse (s) 3. Head and spouse (s) jointly 4. Son 5. Daughter 6. Other household member 7. Other	1. Yes 2. No	Quantity Unit 1. gram 2. kg/liter 6. ton
15	Meat									
16	Fish									
17	Eggs									
18	Dairy products									
19	Salt, condiments									
20	Sugar									
21	Honey									
22	Cooking oil									
23	Meals outside the house									
24	Other food products									
25	Non-alcohol beverages									
26	Alcohol									

Code of period unit: 1. Daily 2. Weekly 3. Monthly 4. Annually

**L. Consumption (Purchase on non-food products)**

**TABLE L9-L14 CONSUMPTION ON NON-FOOD**

	L9 In the past two weeks, did you buy any of the following products?  1. Yes 2. No	L10 How much was the value of [...] purchased in the past two weeks? (FCFA)	L11 Who was responsible for purchasing [...]? 1. Head 2. Spouse (s) 3. Head and spouse (s) jointly 4. Son 5. Daughter 6. Other family member 7. Other
1	Soap, detergents, cleaning products		
2	Toilet paper, razor, cosmetics		
3	Bucket, stamp mark, other small household products		
4	Fuels, kerosene, etc.		
5	Transport fares (bus, train, taxi, etc.)		
6	Other transportation cost		
7	Cigarettes, tobacco, etc.		
8	Reparation, tailor, barber, other services		
9	Sports, other leisure		
10	Domestic workers (exclude agriculture workers)		
11	Other expenses (< 5000 FCFA)		

	L12 In the past 12 months, has your household purchased any of the following products?  1. Yes 2. No	L13 What was the value of the products in the past 12 months? (FCFA)	L14 Who was usually in charge of purchasing [...] in your household? 1. Head 2. Spouse (s) 3. Head and spouse (s) jointly 4. Son 5. Daughter 6. Other family member 7. Other
21	Fabrics		
22	Male clothes		
23	Female clothes		
24	Child clothes (<15 years)		
25	Shoes, hats, umbrella		
26	Kitchen utensils		
27	Bedding		
28	House maintenance		
29	House improvement		
30	School tuition		
31	Books etc.		
32	Medicine, pharmacy		
33	Hospital, clinics, etc.		
34	Social celebrations		
35	Trips		
36	Other expenses (>5000 FCFA)		

**M. Time Allocation**

**TABLE M1-M9. TIME ALLOCATION**

Household member	Season	How many hours per day in average do you spend for the following activities? [Round to 15 minutes. The sum of M1 to M8 has to be equal to 24 hours]								M9 In general, how have your occupations changed since 1992?  Activity taking more time: 1. Agricultural production 2. Post-harvest activity 3. Non-agriculture works 4. Leisure 5. Personal time 6. Household works 7. Fuel wood collection 8. Water collection 9. No change 10. Not applicable
		M1 Agriculture Production	M2 Post-harvest activities (sorting out, processing, selling)	M3 Other work or non- agriculture production (trade, manufacture , wage earning)	M4 Leisure (with friends, etc.)	M5 Personal time (eat, sleep, etc)	M6 Household works (cleaning, taking care children, prepare meal)	M7 Fuel wood collection	M8 Water collection	
1. Male* 20 to 60 years  (code A6)	1. Rainy season									
	2. Dry season									
2. Female* 20 to 60 years  (code A6)	1. Rainy season									
	2. Dry season									

INTERVIEWER: Male is the first man on the list of the question A8 who is from 20 to 60 years of age and who has agriculture as main activity.  
Female is the first woman on the list of the question A8 who is from 20 to 60 years of age and who has agriculture as main activity

**N. Active Asset**

**TABLE N1-N5 HOUSEHOLD ASSETS**

N1 Ownership of the following asset [Finish N1 before continue continuing to N2-N5]  1. Yes 2. No		N2 How many do you own?  (number)	N3 How many years have you owned it?  [average age if there are several]  (year)	N4 What was the value when you purchased it?  (FCFA)	N5 How did you get this equipment? 1. Purchased by husband 2. Purchased by wife 3. Purchased jointly 4. Home-made 5. Gift
1	Chairs				
2	Tables				
3	Beds				
4	Other furniture				
5	Heater, oven				
6	Electric fan				
7	Radio, cassettes, CD				
8	TV, VCR				
9	Sewing machine				
10	Bicycle				
11	Motorcycle				
12	Car, truck				
13	Refrigerator				
N6 What other product that you have that has value at least 25000 FCFA?					
14					
15					

**TABLE N7-N12 AGRICULTURAL ASSET**

N7 Ownership of the following asset [Finish N6 before continuing to N7-N10]  1. Yes 2. No	N8 How many do you have?  (number)	N9 How much is the current value? (FCFA)	N10 How many years you owned it? (year)	N11 What was the original value? (FCFA)
1	Cart			
2	Plow			
3	Harrow			
4	Tractor			
5	Cattle			
6	Work cattle			
7	Goats/mutton			
8	Donkey/horses			
9	Pigs			
10	Poultry			
11	Other animals			
N12 What other farm equipment that u possess that values at least 25000 FCFA?				
12				
13				
14				
15				
16				

**O. Sources of income**

**TABLE O1-O6 SOURCES OF INCOME**

O1 Does your household expect an income in cash from [...]? [complete O.1 for all sources before continuing to O.2]		O2 What is the amount of total income in cash and in-kind that you receive from each of these sources?  (FCFA)	O3 How much the percentage from the reported total revenue?  [ 0 Yes O1=No]	[ if O1=Yes] O.4 Which household member earns the revenue [source]?	[ if O1=Yes] O.5 Who decides on spending?	O.6 Has any important change in the source of revenue since 1992?
SOURCE OF INCOME						
1	Agriculture labor		F	%		
2	Other labor		F	%		
3	Micro-enterprise		F	%		
4	Crop sales		F	%		
5	Animal/animal products sales		F	%		
6	Family help		F	%		
7	Retired, social assistance		F	%		
8	Other		F	%		
[calculate the total of O.3 to verify it is equal to 100%]			F	%		

**P. Farmer Perceptions**

P.1 Change in profitability of [...] since 1992?	1. More profitable 2. Little change 3. Less profitable 4. No opinion 5. Not applicable
Maize	
Cassava	
Sweet potato	
Cotton	

P.2 Change in the following thing [...] since 1992?	1. Better 2. No change 3. Worse 4. No opinion 5. Not applicable
Availability of modern seed	
Availability of hired labor	
Availability of fertilizer	
Availability of pesticides	
Number of trader to buy crops	
Volatility of prices	
Availability of price information	
Road conditions	

[If P3 = 1 or 3]

P.4 Reason for change in living standard?

1. Change in crop prices
2. Change in weather
3. Change seeds and inputs
4. Change in prices or food availability
5. Change in cash crop production
6. Change in off-farm income
7. Change in household health
8. Change in safety
9. Change in soil fertility
10. Change in access to land
11. Change in access to credit
12. Other (describe) \_\_\_\_\_

P.3 How is your overall household living standard compare to 1992?

1. Better
2. No change
3. Worse
4. No opinions