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Input Policies and Crop Diversification: Evidence from the Collines Region in Benin

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***Abstract*:** Formulating policy to strengthen rural livelihood in a country like Benin may be very challenging. This paper investigates the effect of input policies on crop diversification in rural Benin. Multistage sampling techniques have been used to collect primary data from 522 households in the Collines Region. Considering access to fertilizer and seed policies, we used a linear regression analysis to find that access to fertilizer and seed negatively affect the extent of crop diversification. Although some factors (household size and access to extension services) have a positive relationship with crop diversification, we maintain that if the government wants to promote crop diversification as a farmer's strategy to manage risk and uncertainty, there is a need to rethink the input policies. Nevertheless, making fertilizer and seed accessible to farmers is a great opportunity in a country where access to inputs is the major agricultural constraint.

1. Introduction

Agriculture in Benin is dominated by smallholder farmers and many communities depend largely on agricultural products for their livelihoods. Still, small-scale farmers in Benin remain vulnerable to many factors that negatively affect their production and incomes. These factors are: climate change, low access to inputs, poor distribution network, high cost of inputs, lack of adequate policy, soil degradation, low use of technologies and poor infrastructures (MAEP, 2011). In subsistence agriculture practiced in Benin, farming households seldom focus their production on one crop. The main food crops cultivated in Benin are maize, cassava, sorghum, millet, rice, yam and cowpea. The main cash crops are cotton and cashew.

In 2006, the Government of Benin through its Ministry of Agriculture launched a strategic plan for the revitalization of the agricultural sector. The aim of this plan, which has been updated in 2016, was to promote agricultural diversification through large participatory approach and institutional support. One of the most important objectives of diversification in crop production is to decrease the overall production risk by selecting a set of crops whose risk profiles are different, uncorrelated and can also be used for consumption in the household. According to Mugendi (2013), this strategy consists of cultivating more than one crop belonging to the same or different species in a given area. Crop diversification is largely justified on the grounds that in rural Benin, household access to food largely depends on what the household grows, either because they consume what they grow, or they purchase food with the income earned from what they grow.

Intensification and diversification are the principal farming practices used, mainly due to the promotion of small-scale agriculture since 1980, population pressure combined with market opportunities. This practice helps farmers to optimize land use and also to meet the needs of the household and spread risk. Crop diversification is also the means for people living in remote rural areas to diversify their diet. Diversification not only increases the number of potential crop types for market, it also improves agro-ecosystem functioning by building redundancy into the agricultural system and allowing for innovation in areas exhibiting impacts of climate variability (Bellon *et al.*, 2016; McCord *et al.*, 2015). It is also a strategy used by rural households to smooth income and consumption (Senadza, 2012).

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Many institutional supports and actions have been taken in order to make agricultural diversification a success. Among these are the development of a new policy to facilitate access to inputs for all agricultural producers and especially small-scale farmers. Analysis of the seed and fertilizer sector reveals that poor availability and accessibility of good quality seed and fertilizer hinders their widespread use by producers (MAEP, 2011). Most farmers have very little use of production inputs (seeds and fertilizers) and techniques. In Benin, the importation and distribution of inputs has been under the responsibility of the private sector since 2000. The role of the government is to ensure good governance, that is, monitoring transparency at all levels through consistent trade-offs based on reliable information systems. According to MAEP (2011), the main challenge of farmers is rather the physical access to the inputs instead of financial access. This is mostly because access to such inputs in Benin depends on the type of crop grown by the farmer. Agricultural inputs are made available exclusively for cotton producers and access to input depends on the capability of the farmer to produce cotton. In order to follow the diversification policy, the government decided to improve the distribution channel of inputs and facilitate the physical accessibility of inputs for all farmers, no matter the crop they grows.

The objective of this paper is to assess the effect of input policies on crop diversification in the Collines Region of Benin.

2. Literature Review

2.1 Policy Context

With an annual per capita income of US$890 in 2011 (World Bank, 2014), Benin is among the poorest countries in the world. According to official data, the rural poverty index estimated from household spending increased from 25.2 percent in 1990 to 33 percent in 1999–2000, while the index of urban poverty has declined from 28.5 percent to 23.3 percent during the same period. Poverty thus appears much more like a rural phenomenon in Benin, in an economic context mainly characterized by the preponderance of agriculture. The agricultural production sector is characterized by the predominance of small farms and vulnerability to climate variability. Most farmers have very little use of inputs and other agricultural technologies.

Although the soil diversity favors agricultural diversification and allows local production to cover basic food needs, the statistics on poverty and food security in rural areas are not glowing. Food security is a concern because of the existence of pockets of severe food insecurity in some areas like the Collines region, and low-income families in urban areas. According to the second survey on household living conditions, at least 33 percent of households are unable to meet their minimum food needs despite the high level of food expenditure (70 percent) on their budget. On that matter, the government — through the strategic program of recovery of the agricultural sector — has decided since 2006 to revitalize the sector by focusing on agricultural diversification.

The use of fertilizer and quality seeds adapted to the climatic condition for both food crops and industrial crops is an important component for improving agricultural productivity in Benin. Analysis of the seed sector reveals that limited availability and accessibility of good quality seeds hinder their widespread adoption by producers. These problems are found all along the seed sector both in terms of production, distribution and marketing (Ayenan *et al.*, 2017). Before 2005, access to inputs such as seeds and fertilizers were limited to cotton producers because this was the only organized sector. Thus, the importation and distribution of inputs were taken over gradually by national private operators whose numbers have changed over time. The local distribution of these inputs was ensured by cotton farmers' organizations. The consequence of this policy is that inputs access for non-cotton producers has become challenging.

Benin has adopted in December 2005 (updated in 2016) the national input policy whose vision was to make the production of seed industry efficient, secure and sustainable, addressing the need for productivity and competitiveness of Beninese agriculture. The State guarantees the quality of seeds through agricultural research and production of pre-basic and basic seed; and then the private sector and farmers' organizations support the multiplication and marketing of seeds, through specialized operators. On the other hand, through the stakeholder participation approach, fertilizer is imported by the private sector, which benefits from the government subsidy. The certified retailers and mostly the farmer-based organizations are supposed to play a key role in distributing the fertilizer to farmers. The main problem is not farmers' financial access but mostly farmers' physical access to fertilizer.

2.2 Crop Diversification

Crop diversification can be examined from two perspectives. The main form and the commonly understood concept is the addition of more crops to an existing cropping system, which could be referred to as horizontal diversification. However, this type of crop diversification means the broadening of the base of the system, simply by adding more crops to the existing cropping system. The other type of crop diversification is vertical crop diversification, in which various other downstream activities are undertaken. This could be illustrated by using any crop species, which could be processed into manufactured products. Diversification at farm level will involve growing of several crops for achieving self-sufficiency, but it may be a totally different approach at the national level.

They are many factors that may lead a farm household to diversify its cropping portfolio and this may vary depending on the countries or regions. The most common factors include the need to reduce risk, diversify income sources, seasonality, labor markets, credit market failures, responding to changing consumer demands or changes in government policy and more recently as a coping mechanism towards climate change (Gajigo, 2013). Studying the case of Ethiopia, Rehima *et al*. (2013) concluded that agriculture in Ethiopia is highly diversified to meet own consumption, market needs, withstand price fluctuation and to manage income risks. Also, De and Chattopadhyay (2010) viewed the phenomenon of crop diversification in India as the survival needs of the farmers especially of the small and marginal ones.

The theory of the farm household and its application to the agricultural household model is the most appropriate for this research in the sense that the structure of the household mostly determined its decision-making in terms of resource allocation. Farmers' decisions about the extent of cereal crops and varieties to grow can be understood in the context of the theory of the farm household. Households choose the best combinations and quantities of these commodities in the conventional way by maximizing their utility function subject to prices and resources constraints.

The literature suggests that farmers in developing countries tend to be risk averse and crop diversification may be a strategy to insure against production and price risk. The review of literature on agriculture shows that there are a number of studies on estimating farmers' risk preferences that provide a model to understand how farmers decide among a set of random choices. According to Anderson (2000), there is a plethora of unpredictable uncertainties that impinge on the farmers and other business operators who work in rural areas. Some farming systems or crop growing methods give more stable returns than others. That is why farmers often select between relatively less exposure or risky crop (Leathers and Smale, 1991). In the absence of an insurance market and risk sharing institution, the choice of crop that will be grown by household becomes critical. The effect of crop insurance on crop portofolio is well documented in the literature. According to Yu (2015), the agricultural insurance mechanism can change farmers' investment decisions and so affect crops selection due to risk reduction involved. The presence of crop insurance has the potential to sway farmers to choose higher risks and higher return crops (Karlan *et al.*, 2014). Yu (2015) acknowledges that crop diversification is the only self-insurance mechanism available for farmers without crop insurance.

Crop diversification is seen as one of the most ecologically feasible, cost-effective, and rational ways of reducing the effect of uncertainties in agriculture especially among small-scale farmers (Mugendi, 2013). Empirical literature found a number of factors that can influence crop diversification, and classify these factors into four categories, namely: economic factors, institutional factors, environmental factors and social factors. These factors are related and depend on the characteristics of each society. According to Bhattacharyya (2008) most crop diversification came through the individual efforts of small farmers, with little support from government, as government policies mainly emphasized cereal-based production for household food security. Studying the case of West Bengal in India, Bhattacharyya (2008) used the Simpson Diversity Index as a dependent variable in a regression equation so as to determine the separate effects of each individual explanatory variable on crop diversification. He found that demand and knowledge factors have a determining effect on the rate of diversification.

The major determinant of diversification was a demand-side factor that had induced farmers to shift towards production of high value crops. Crop diversification was more prominent in rain-fed areas than in irrigated zones. The rain-fed areas were seen as becoming the hub of non-cereals due to the low water requirements of these crops and the abundant labor supply in rain-fed areas. As the cost of cultivation of fruits, vegetables, and flowers was relatively low, these high value crops were becoming popular among small farmers who could not afford high agricultural-related investment costs. However, the decisions to diversify the crops that farmers produced in West Bengal were affected by a lack of proper institutional support. Farmers required from government the financial resources, guidance, encouragement, and training in new production techniques to attract farmers towards high value crop cultivation. Joshi *et al.* (2003) applied the Generalized Least Square (GLS) technique to study the factors affecting crop diversification in South Asia and found that relative profitability, irrigation, roads, markets, rural

literacy, the proportion of small holders, income from crops, urbanization, rainfall and production year affected crop diversification in South Asia.

Using the Herfindahl index for the Malawi case, Kankwamba *et al*. (2012) found that, although crop diversification had decreased nationally, beneficiaries of the input subsidy program had become more diversified in their cropping practices. Their study concluded that, while various policies in Malawi encourage agricultural diversification in broad terms, there was a lack of strategic thinking around how exactly it was to be achieved, and more importantly, how crop diversification could be promoted among different types of farmers with the aim of contributing to economic growth, risk mitigation, and nutrition security.

Dercon (1996), used a two-stage choice model in the case of Tanzanian farmers and found that in the absence of land and labor markets, households with more labor will tend to specialize in labor-intensive crops. Household with large labor endowments relative to land would be more likely to move toward potatoes, suggesting that this is a more labor-intensive crop than other crops. Using a multinomial logit model of farmer's choice of crops with cross-sectional data, Seo and Mendelsohn (2008) explored how farmers would adapt to exogenous environmental factors such as climate and soils. They found that temperature and precipitation affect the crop that South American farmers choose — they choose fruits and vegetables in warmer locations and wheat and potatoes in cooler locations. Studying the case of Zimbabwe, Zivanomoyo and Mukarati (2010) reported that crop diversification may also be affected by factors like government policies regarding incentives and credit availability. Moreover, most of the crop choice studies found that crop selection is mainly a strategy to mitigate climate risk. Kurukulasuriya and Mendelsohn (2007) found that crop choice is very climate sensitive. Farmers select sorghum and maize-millet in the cooler regions of Africa, maize-beans, maize-groundnut in moderately warm regions, and cowpea and millet-groundnut in hot regions.

3. Methodology

3.1 Data Source and Sampling Technique

The study used the multistage sampling procedure starting with a purposive selection of the Collines Region. We chose this region because the crop diversification level is very high and households are engaged in growing on average more than three crops. At the same time the region is one of the most food insecure in the country. There are six municipalities within the region. Based on the importance of agricultural activities in the municipalities, five municipalities out of six served as the study area: Bante, Dassa-Zoume, Glazoue, Ouessè, and Savalou.

Firstly we computed a sample size using Cochran's (1977) approach:

$$n = z^2 * p(1-p)/m^2 \tag{1}$$

where n is the required sample size, z is the confidence level, p is the estimated prevalence of farm attribute in the area and m is the margin of error.

In our specific case, in order to minimize the error, we will use the confidence level of 95 percent with the standard value of 1.96, the margin of error (m) is 5 percent. Our general population is all the crop farm households in the Collines Region and they represent 65 percent of the total households in the region (INSAE, 2013). Therefore, $p = 0.65$.

$$n = 1.96^2 * 0.65(1-0.65)/0.05^2 = 349$$

In our case, we increase the sample size by 50 percent to account for contingencies such as non-response or recording error.

$$N* = 349 * 1.50$$

$$N* = 524$$

The next stage involved the distribution of the 524 respondents among the five municipalities according to the percentage of farm households in the municipalities. The distribution is shown in Table 1.

Each municipality is divided into districts, and in each district we have a certain number of villages/communities (Municipalities — Districts — Villages/Communities — Households). First, we randomly selected 50 percent of the districts in

Table 1: Sampling distribution of household respondents

Municipalities	Bante	Dassa	Glazoue	Ouesse	Savalou	**Total**
Population*	106,945	112,118	123,542	141,760	144,814	**629,179**
Total household*	13,368	16,016	19,006	20,251	18,101	**86,742**
Crops production households*	9,438	10,132	11,575	14,062	11,175	**56,382**
Percentage	16.74	17.97	20.53	24.94	19.82	**100**
Sample size	88	94	108	130	104	**524**

*Estimation from National Statistical Institute (2014).

each municipality and where the number of districts is odd, we rounded up (for example, if the number of the district is 9, we retained 5). Within the districts, we purposively chose one village/community proportionate to the number of farm households in each village (they are also the main agricultural production villages). The share of the farm households in each municipality and district was obtained from the National Statistical Institute of Benin. In each village, we randomly selected 5 percent of the total farm households and based on the information provided by the agricultural extension officers and the farmers-based organizations. The farm households that were enumerated were randomly selected from the total agricultural household list of the villages. The questionnaire is addressed to the person who is recognized as head of the household at the time of the interview. The person is supposed to have information and knowledge of the household affairs.

3.2 Method of Analysis

There are several ways to measure crop diversification and the most important include the Herfindal Index, Simpson Diversity Index, Ogive Index, Margalef Index, Shannon Index, Berger-Parker Index and Entropy Index. Another common method for measuring crop diversification is to count the number of crops grown by the farmer.

All these indices are computed on the basis of the proportion of gross cropped area under different crops cultivated in a particular geographical area. The Simpson Index is usually known as the Simpson Diversity Index in ecology and as the HHI (Herfindahl-Hirschman Index) in economics and we used it as a diversification index for the present study. One of the advantages of using the Simpson Diversity Index in the present study is that it does not require farmers to produce all types of crops. Another approach is to use the number of crops produced by the household. In our present case we compute the two (Simpson Index and number of crops grown) and see which one will be more consistent.

$$SDI = 1 - \sum_{1}^{n} P_i^2 \tag{2}$$

where *SDI* is the Simpson Diversity Index, P_i is the proportionate area of the *i*th crop in the gross cropped area, and *n* is the total number of crops grow by the household.

The regression model is specified as follows:

$$Y = \beta \mathbf{Z}_i + \mu_i \tag{3}$$

where *Y* is either SDI or number of crops type produced by the household, $\mathbf{Z}_i$ is a vector of explanatory variables presented in Table 2 and μ_i the error term.

• *Gender of the household head:* male- or female-headed household can choose a number of crops to grow based on their preferences and access to resources. In a country like Benin where women's access to resources such as land, labor and fertilizer are limited, the extent of crop diversification can be affected by the gender of the household head. For example, women are less likely to grow tree crops especially because of the traditional land tenure system which give more advantages to men. According to de Brauw (2014), women farmers heading the household tend to grow crops with less complicated production techniques and are less likely to grow the area's main cash crop. Thus the nature of the relationship of this variable may vary.

Table 2: Dependent and independent variables

Variable	Description	Measurement
Dependent variables		
SDI	Simpson Diversity Index	Continuous
No of crops	Number of crops cultivated	Continuous
Independent variables		
Gender	Gender of the household head (*SEX*)	1 for Male and 0 for Female
Age	Age of the household head (*AGE*)	Continuous
Family size	Number of person in the household (*FSIZE*)	Continuous
Education	Whether household head attended school (*EDUC*)	1 for none and 0 else 1 for primary and 0 else 1 for secondary and 0 else
Credit	Access to credit (*CREDIT*)	1 for access and 0 else
Non-farm income	Total Non-farm income (*NINCO*)	Continuous (in FCFA)
Association	Membership of farmers association (*ASSOC*)	1 if yes and 0 else
Location	Location of the household head (Dummy variable)	1 if Bante and 0 else 1 if Dassa and 0 else 1 if Glazoue and 0 else 1 if Ouesse and 0 else 1 if Savalou and 0 else
Fertilizer	Access to fertilizer (*FERTI*)	1 if yes and 0 else
Seed	Access to improved seed (*SEED*)	1 if yes and 0 else
Extension	Number of extension visit per year (*EXTEN*)	Continuous
Land size	Total land size (*LSIZE*)	Continuous (in hectares)
Farm plots	Number of farm plots (*PLOT*)	Continuous
Labor	Number of hired labor used (man/day)	Continuous
Distance to market	Distance to local market (*DMAR*)	Continuous (in KM)
Storage	Access to storage facilities (*STOR*)	1 if yes and 0 else
Livestock	Tropical livestock Unit (*TLU*)	Continuous

• *Age of household head*: According to FAO and WFP (2010), elderly farmers look at farming just as a way of life whereas young farmers may be more inclined to look at farming as a business opportunity. It is expected that the extent of diversification will be higher for young headed household. The expected sign will be negative.

• *Family size*: family size is expected to increase diversity through preference heterogeneity and labor capacity (Benin *et al*., 2004). The larger the family size, the more likely that it will be able to diversify so as to increase its food production level.

• *Education*: it is likely that education by contributing to the household head's human capital, enhances the ability to accept and adopt new production techniques more rapidly, to seek new information on technology and to meet more complex management requirements of crop diversification. According to Ashfaq et *al*. (2008) and Ibrahim *et al*. (2009), the importance of knowledge and ability to absorb new information through formal education increased crop diversification.

• *Labor:* This refers to the hired labor man day. Although farm households use both hired and family labor, we simply consider hired labor alone in the man-day calculation since family labor is associated with the household size. The higher household size, the more family labor. Households using hired labor in the region are most of the time also using family labor. The greater use of hired labor is therefore associated with high crop diversification.

• *Membership of farmers' association:* the new agricultural policy in Benin consider FBOs as a key bridge through which information on agricultural diversification policy should flow. Being a member of an association may provide reliable information and opportunity for diversification.

• *Access to fertilizer and seed*: access to fertilizer was measured as a dummy variable instead of a continuous variable in kg/hectare. This is because first we dealt with many crops and it became difficult to estimate the quantity of fertilizer used (kg/hectare) for all the crops and secondly because access to fertilizer and seed in the region is mostly constrained by physical access

rather than the financial capacity of farmers. Although some studies (De and Chattopadhyay, 2010) show that the quantities of fertilizer and the facility of access to seed is positively associated with crop diversification, we think that it can be negative in the case where access to fertilizer and seed can lead to specialization into a specific crop.

• *Access to extension services*: Farm households may diversify because they do not have access to extension services which can provide them with knowledge on a specific crop. On the other hand, extension services can also be associated with dissemination and adoption of new technologies which may be directly relevant to diversification (Rehima *et al*., 2013). The expected sign is positive.

• *Location:* as a dummy variable, the location as a determinant of diversity would capture the difference in culture and environmental condition in which farm households work.

• *Non-farm income*: income from remittances, gifts or aid may have ambiguous effects, serving either to cope with production risk *ex post* or to intensify production and engage in multiple activities (Benin *et al*., 2004). The increase in non-farm activities may prevent the household from allocating sufficient time to many crops. According to Harris *et al.* (2010), they may be conflicting labor allocation between farm and non-farm activities and, therefore, the increase in non-farm work may reduce the time allocated to farm work (the number of crops grown). The expected sign is negative.

• *Number of farm plots*: this refers to the total number of fields or farm plots that the household has. This variable is expected to influence positively the extent of crop diversification. According to (Benin *et al*., 2004), the more farm plots a household has, the more it is able to diversify.

• *Total land size*: the amount of land a household has plays an important role in determining how many crops they can produce. Previous findings shows that crop diversification is associated with larger farms (Weiss and Briglauer, 2002; Benin *et al*., 2004). The expected sign is positive.

• *Distance to local market*: distance to the market is an indicator of physical access to markets, as well as proximity to economic resources. Difficulties in physical access to market may push farmers to diversify in order to have a wide range of product (Sassi, 2015). Studies on diversification highlight the importance of proximity to main roads and markets for development of other farm enterprises (Benin *et al*., 2004). However, in some instances, households located farther away from markets or main roads, are found to diversify their crops in order to meet their broad subsistence and nutritional needs (Kankwamba et al., 2012).

• *Access to formal credit:* Credit constraints may be a reason for a household to grow a specific crop. It is expected that access to credit negatively affects the extent of diversification since credit institutions in the Collines region usually target specific crops.

• *Livestock unit*: Livestock, as a measure of wealth, may have ambiguous affects, similar to exogenous income (Rana *et al*., 2000; Van Dusen, 2000).

• *Access to storage facilities*: households may choose not to grow a specific crop because of the lack of access to storage facilities. Therefore, storage facilities may increase the diversity in the sense that the households have more access to technologies.

4. Results and Discussions

4.1 Socio-economics and Demographics Characteristics

Table 3 presents the summary descriptive statistics of the socio-economic and demographic characteristics of the respondents. As stated in the methodology, data was collected from 522 farm households. Most of the household heads are male (77 percent, against 23 percent female). Most of the female-headed households have been interviewed in the absence of their husband, who had generally migrated to Nigeria.

On average, the households headed by men are 45 years of age against 38 years for female-headed households. The level of standard deviation also shows that there is a wide variation within the age groups. Regarding the household size, Table 3 shows that on average the household size is 7 persons, although some households have up to 16 members. The average land size is 7 hectares for male-headed households and 3 hectares for female-headed households. There is a high dispersion among the land size regarding their standard deviation. Table 3 also shows that households in the Collines Region seldom grow one crop. Each household is involved in at least two crops and up to a maximum of six different crops. The crops produced vary from staple to industrial crops. Figure 1 presents the different combination of the crops grown by households. It appear that 56 percent of the households interviewed grow, at the same time, cereals, roots and tubers and others legumes and oilseeds; 14 percent of the households concentrate on growing during a single season, cereals, and other legumes and oilseeds. The combination of roots and tubers and other legumes and oilseeds is practiced by 13

Table 3: Socio-economics and demographics characteristics

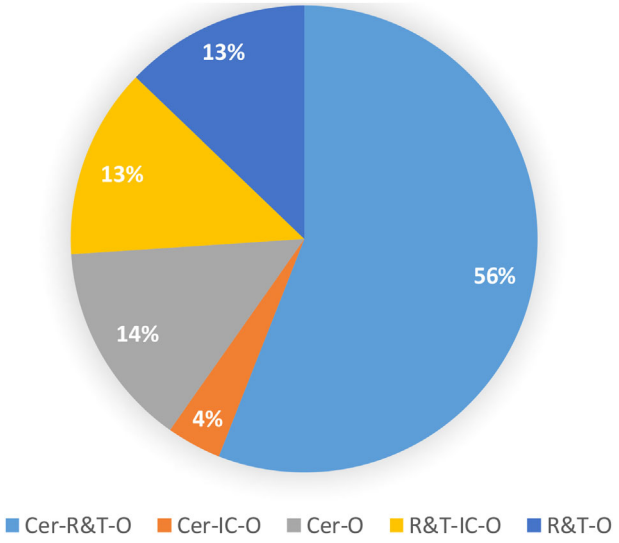
Variables	Mean	Std Dev.	Minimum	Maximum
Male ($n = 393$)				
Age	45.55	10.66	26	70
Household size	6.67	2.86	2	16
Land size	6.77	10.39	3	50
Number of crops	4.06	1.18	2	6
Female ($n = 129$)				
Age	38.33	7.98	23	62
Household size	6.89	2.40	2	14
Land size	2.86	7.80	2	35
Number of crops	3.86	1.19	2	6

Source: Data collected in 2015.

percent of the household. The industrial crops (cashew and cotton) is combined with roots and tubers and other legumes and oilseeds by 13 percent of the households.

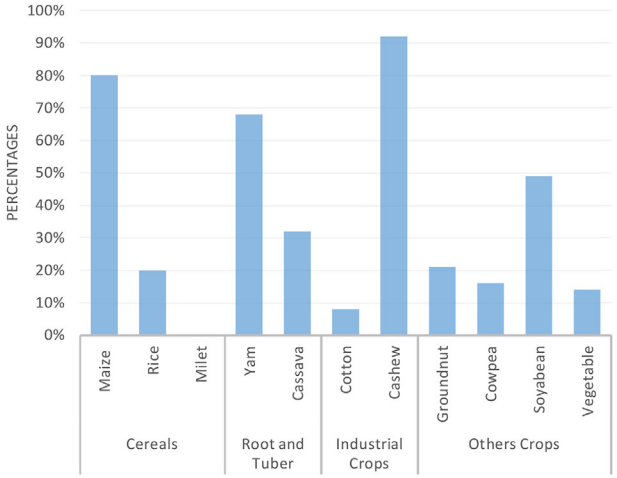
Figure 2 provides details on the different crops grown by households and only two cereal crops (maize and rice) grown by households. It appear that maize is the first cereal produced by households — up to 80 percent of them grow maize while only 20 percent are engaged in rice farming. Concerning roots and tubers, the figure shows that yam is the most produced — up to 68 percent of the household surveyed produce yam and 32 percent are engaged in cassava production. Cashews represent the first industrial crop in the region, in fact the region is the first cashew producer in the country and as the figure shows, 92 percent of the respondents are engaged in cashew production. Cotton production is low in the region and this is the case since 2001 where the sector faced price crises. Many other crops are also cultivated by households in the region such as soybeans, groundnuts and cowpea and these are mostly cultivated as intercropping. Among them, soybeans is the most cultivated by households interviewed.

Figure 1: Crops combinations



Note: Cer = Cereal, R&T = Roots and tubers; O = Oilseeds; IC = Industrial crops
Source: Data collected in 2015.

Figure 2: Crops produced by households



Source: Data collected in 2015.

4.2 Estimation Results

The regression results of the determinants of crops diversification are given in Table 4. We can see that apart from the nonfarm income and the access to storage facilities, which are significant for Simpson diversity index and number of crops grown respectively, we have the same variables significant for either the Simpson diversity index or the number of crops grows simulation.

The sign of the coefficient of the variable sex implied that female-headed households are more likely to diversify than male-headed households. Most of the female-headed households interviewed have their husband out of the village, mostly migrants in Nigeria, Ghana, and Côte D'Ivoire; they are more likely to be concerned about securing food for the family and income diversification than male-headed households (Ozughalu and Ogwumike, 2013).

We also found that the extent of crops diversification increases with the size of the household. In a country like Benin, where family labor constitutes most of the agricultural labor force, households are more likely to diversify their crops as their size is increasing in order to fulfill the household food demand.

Access to extension services is positively associated with the extent of diversification. This implies that extension officers play an important role in creating awareness among farmers about the importance of diversification, especially in the context of changing environment and as a risk management tool. This can also be explained by the fact that the extension officer's role is to support agricultural policy such as crop diversification. Our result also shows that high land holding is associated with low diversification, which is contrary to our expectation. This may be explained by the fact that large farm size holders tend to specialize on a specific crop. For example, large farm size identified during the survey are mostly those under cashew cultivation. According to Eneyew (2012), large farm size households tend to move their objectives towards commercialization and this leads to specialization. Another explanation may be that households with small land size are more likely to have a subsistence objective than households with large land size. However, some studies (Weiss and Briglauer, 2000; Benin *et al*., 2004) found that larger farms are associated with high diversification.

The interest variables, access to fertilizer and seed are also significant and the sign of the coefficients are negative. Access to fertilizer and improved seed are the main challenges of farmers in the Collines Region especially when the household is not engaged in cotton production. The result implies that households prefer to diversify their crop production when they do not have access to fertilizer and seed. This is partially because good access to input may lead to specialization in a specific crop and this is in line with the results of Bowman and Zilberman (2013) and Ayanwale *et al.* (2013) who found that agricultural modernization and good access to input can lead to specialization in a specific crop. According to Dorjee *et al*. (2007), crop diversification helps farmers to respond to input-related risks such as fertilizers and water and therefore any policy helping farmers to reduce these risks will move them from diversification to specialization.

Table 4: Regression result, determinants of crops diversification

	Simpson Diversity Index		Number of crops grown	
Variables	Coefficient	*p* value	Coefficient	*p* value
Sex	–0.054***	0.000	–0.201*	0.082
Age	–0.001	0.678	–0.001	0.879
Education				
- Primary	0.026	0.138	–0.006	0.957
- Secondary	–0.024	0.322	–0.031	0.881
Household size	0.010***	0.000	0.148***	0.000
Membership FBOs	0.004	0.751	–0.059	0.622
Extension services	0.058**	0.015	0.464***	0.007
Distance to market	–0.002	0.798	–0.012	0.798
Land size	–0.004***	0.000	–0.014***	0.009
Location				
- Glazoue	0.015	0.405	0.250	0.186
- Dassa	–0.001	0.936	0.067	0.664
- Ouesse	0.028	0.109	0.011	0.941
- Savalou	–0.004	0.812	0.029	0.847
Fertilizer	–0.105***	0.010	–0.059***	0.008
Seed	–0.059**	0.034	–0.240**	0.020
Number of plot	0.003	0.632	–0.010	0.806
Non-farm income	–0.001***	0.006	0.001	0.797
Labor	0.084	0.267	0.143	0.418
Credit	0.070	0.200	–0.019	0.621
Livestock unit	–0.003	0.141	0.018	0.466
Storage	0.054	0.500	–0.250	0.024
_cons	0.736	0.000	2.801	0.000
	Number of obs. = 520		Number of obs. = 520	
	$F(21, 498) = 9.91$		$F(21, 498) = 7.21$	
	Prob > $F = 0.0000$		Prob > $F = 0.0000$	
	R-squared = 0.2947		R-squared = 0.2331	
	Adj. R-squared = 0.2649		Adj. R-squared = 0.2007	
	Root MSE = 0.12586		Root MSE = 1.0587	

*Significant 10%, ** Significant 5%, *** Significant 1%.
Source: Data collected in 2015.

The results also revealed that nonfarm income significantly affects crop diversification but only for the Simpson diversity index scenario. In addition, an increase in nonfarm income is associated with low diversification (Table 4). This could be explained by the fact that nonfarm activities are also a form of livelihood diversification and so the increase of time dedicated to nonfarm income would result in the reduction of crop diversification.

5. Conclusion

Agricultural policy decisions often failed due to the lack of necessary empirical evidence. Access to fertilizer and others inputs have always been a challenge for a country like Benin. This paper investigated the effect of input (fertilizer and seed) policies on crop diversification in rural Benin. The study found that access to fertilizer and seed have a negative effect on the extent of crop diversification. This can be explained by the fact that fertilizer and seed accessibility by farmers leads to specialization in a specific crop production. Although there are some factors which have a positive effect on crop diversification (household size and access to extension services), we realize that those factors are not necessary under government control. Many farmers grow

more than two crops just because they do not have access to some inputs and this strategy is used to manage the risk of crop failure. There is a need to revise the input policy for the promotion of crop diversification as farmer's strategy to manage risks and uncertainty. Beyond this, there is a need to develop a comprehensive and clear land policy since crop diversification may lead to the reallocation of some of the productive resources.

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