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What are the key factors of food insecurity among Senegalese landowners?

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Food insecurity determinants: the case of Senegalese farmers?

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Abstract

During 2008, many sub-saharan african economies have been obliged to suspended their imports tariffs to the magnitude of the food crisis. Frequent riots experienced in several cities have then raised the deep issue of food security. The purpose of this paper is to identify for the case of Senegal the major causes of food insecurity among rural households which are more affected, in particular farmers. A binomial logit model based on the Senegalese household data (Esam I) is used to identify the most influential probable causes of food insecurity among landowners.

The results showed that the probability of food insecurity among landowners is at its highest for large size farmers operating in the Groundnut Belt and at its lowest for small farmers whose activities are located in agro-ecological river areas. Income and consumption diversification factors like income from livestock and net transfers seem to hardly reduce the probability of food insecurity. The risk is also significantly diminished for landowners who have access to agricultural and pastoral goods for self-sufficient needs. Household size plays a key role in the issue at hand for all landowners.

Policymakers must then set some mechanism which will sustain farmers so that they can receive their part of overall increasing economic growth benefits. In particular, by trying to understand their specific agro-ecological conditions, they can for them identify which of the key programs to address. More generally, creating programs and making policies that are flexible and reflect the needs, conditions, and resources in each rural area is quite a challenge for policy makers.

Key words: Food security; Poverty; Logit model

JEL Classification: C1; I3; O1

Introduction

According to a special report from the United Nations Human Rights Council for Food provision, about 58% of worldwide death cases were due to malnutrition in 2006. About 62 million people die every year for one reason or another. In 2006, the number of death caused by starvation or other diseases linked to the lack of micro-nutriments was estimated at 36 millions (Ziegler, 2005). In Sub-Saharan Africa, more than anywhere else, food insecurity is highly linked to the lack of food provisions. The world system for urgent information on food and agriculture, (FAO/SMIAR, 2003) anticipated that the needs in cereal imports for that part of Africa were going to be rather important, due mainly to the fact that severe droughts dangerously prevailed in the Southern, Eastern and Western parts of the continent in 2002. The food supply deficit has engendered special food assistance needs estimated at 4.6 million tons in comparison to the estimated 2 million tons for 2001 and 2002. Performances in cereal supply are generally much lower in this region of Africa than in other regions of the world.

Besides, it is widely agreed that the needs for food are going to increase in the coming decades due to several reasons. Incidentally, population growth, which undoubtedly results in an increase of the world demand for cereal, will have a tremendous impact on the world market for cereal. Moreover, the increase of the average income in developing countries like Brazil, Russia, India, China, contributes to a bigger demand in global cereal markets, as well as livestock food. In concurrence with a growing demand for biofuels, human consumption production is more and more replaced by a production for energizing use; which in return reduces cereal availability. Climate change is also a big part of this equation. Recurrent droughts in great cereal producer countries like Australia and the United States of America greatly reduce the supply and stocks. All those factors contribute to the growing worldwide demand in cereal supply, which consequently result in a strong price increase (Hazgui, 2008). An increase that might turn structural, causing millions of people around the world to face food insecurity.

Senegal is not immune to these world cereal demands crises. Cereals are far from being sufficiently produced in the country. The low growth of farming supply, partly related to the effects of farming technologies, macro-economic policies and external shocks, have had negative consequences on covering the country's food needs as well as households' income flows. From 1984 to 1993 the contribution of domestic suppliers to the satisfaction of cereal needs was roughly 57.78%, the gap being filled by importations and food assistance. Between 1994 and 2000, that contribution fell to 49.53% (Cabral, 2005).

The concept of food security, which was first introduced in the 70s (seventies) according to the Food and Agriculture Organization (FAO), has been given several definitions. According to the FAO, food security is achieved when all people can permanently have physical and economical access to food that is good and rich enough that their energetic needs and food preferences are satisfied, allowing them to perform their daily activities and have a healthy lifestyle. Some authors would define it as the capacity of ensuring an efficient food provision system for a population to be adequately fed in the long term (Staatz and al., 1990), whereas for others, food security is established as long as a

household, as a unit of production and reproduction, is not threatened by the lack of food (Maxwell & Frankenberg, 1995). Others define food security as the permanent access of a whole population to sufficient food, in order to live decently (Demery and Addison, 1987). Such a definition refers to the consumer's food stuffs basket which is supposed to provide each household with a consumption estimated at 2400 kg/calories per day and per adult. Although food security has been given several definitions, there is a consensus on the concept basis. No matter what the definition is, four key elements are constantly highlighted: availability, stability, access to food and its quality. An appropriate availability means that there is a perfect adequacy between consumer needs and supply. Stability means that food supply is permanently ensured for a long term. The concept of "access to food" refers to the purchasing power, given that, despite the availability of foodstuffs, poor households might be starving to death as a result of their lack of means to produce or buy needed food. Here, Quality is linked to the cleanliness and healthiness of food for consumption.

Various authors have tried to assess the determinants of food insecurity. A group of authors did it by using the 2006 Core Welfare Indicator survey (CWIQ) and found out that beans were the food item that is the most consumed in rural as well as in urban areas (Zoyem, Diang'a, Wodon, 2008). However, food consumption is mostly concentrated in rural areas where the main three products (beans, cassava and corn) account for 40% of its total. Even if we take into account the food insecurity threshold of 1400Kcal, which is extremely low, the incidence of food insecurity is 34% and its depth 7.9%. An estimate of food insecurity determinants suggests that a number of factors can expose a household to food insecurity. For Zoyem, Diang'a, Wodon (2008), the main factors are: the area of residence (urban/rural), the physical aspects (land, animals) and human capital (education, professional occupation, mental or physical disability, household size).

For Che and Chen (2003), food insecurity is significantly related to weak or bad health status, the existence of chronic health problems, obesity, distress and depression. These authors found that during the period of 1998 to 1999, approximately three million Canadians lived under the food insecurity line. The incidence of food insecurity was higher for households with low incomes, those relying on social aid, single parent families headed by women, tenants, children and aboriginal people. Comparing the determinants of food security and nutritional status in rural and urban areas of Mozambique, Garrett and Ruel (2009) found that they were nearly the same. The difference in the observed outcomes appears primarily in the levels of critical determinants rather than in their nature.

We devise our approach of the procedure in two stages. We first evaluate the status of a household by measuring its distance from the food insecurity line, and then link it to some key explanatory variables that possibly have an influence on the household's status. Food security is estimated according to the foodstuffs baskets of a consumer, at the contrary of poverty. The threshold of food insecurity is consequently related to the threshold of food poverty. When a household consumption is inferior to 2400 calories per day and per equivalent adult, it means that such a household lives below the average in terms of food insecurity. In the poorest areas, some consumers who cannot have access to the minimum basket of food are therefore condemned to food insecurity. In the case of Senegal, while

dealing with poverty, that particular category of consumers living in a situation of food shortage is not really taken into account. We must recognize that food insecurity is caused by various factors. What are the factors causing food insecurity for Senegalese landowners in rural areas?

The aim of this paper is to identify the factors that have the greatest influence on food insecurity for landowners. In its first part, we will identify the specific characteristics of landowners facing food insecurity and draw an evaluation of its extent in Senegal. The methodology is described in the second part and the results highlighted in the last part.

1. Socio-economic characteristics of food insecurity among farmers

Households¹ can be affected by food insecurity in different ways depending on their area of residence and on their socio-economic characteristics. In rural areas, differences can be noticed among consumers according to the agro-ecological area where they live. We distinguish five rural agro-ecological areas: Niayes zone, *Groundnut belt* (Zba), Southern area (Zs), River area (Zf) and pasture area (Zsp). Agricultural sectors have an impact on households depending on their type of productive activity and area of residence. The groundnut belt is the main area of groundnut production in Senegal. Household's earnings in the rural Niayes area depend on vegetables production and fishing activities. The cultivation of cotton and forestry are, in turn, the dominant activities for rural households in the eastern part of Senegal and in upper Casamance. Rural households in lower Casamance depend mainly on their production of paddy rice and forestry activities.

Livestock is the main activity in the sylvo - pastoral area. The main activity for farming households in the area of the Senegalese river is the production of paddy rice. In most of the agro-ecological area, livestock and millet production is complementary to the main production activity. Fruit cultivation, and to a lesser extent tubers production, tend to become alternative sources of income for some farming households. The aim of distinguishing the main agro-ecological districts is to highlight the activities of agricultural production in rural areas of Senegal and the geographic location of households.

As we are also analyzing the status of landowners in regards to food insecurity, we make the distinction between small, medium and larger farmers by referring to the number of hectares owned. We define small farmers landowners whose farm size is comprised between 0 and 2.5 hectares, medium farmers those whose farm size is comprised between 2.5 and 7 hectares, and large farmers are those whose farm size is above 7 hectares. While using the household survey data (ESAM I), we are going to analyze the landowners' distribution between agro-ecological areas and their level of food insecurity according to the households' location. In the following section, while using data from the household survey (ESAM I), we are going to analyze the distribution of landowners between agro-ecological areas and the level of food insecurity according to that area of residence.

¹ A household is defined as the whole members of a house, even if they are or not parents.

- Socio-economic areas and characteristics of consumers suffering from food insecurity

The foodstuffs basket is supposed to provide consumers with 2400 kilos calories per day and per equivalent adult. It has been developed from the 26 items that are most often used by consumers and whose total amount represent 80% of the household total expenses belonging to five deciles of consumption per equivalent adult: deciles 2, 3, 4, 5 and 6. In the case of Dakar, the other urban areas, and rural areas, the basket is respectively estimated at 251.5 FCFA a day, 238.2 FCFA a day and 236.7 FCFA a day, that is to say 91797.5 FCFA a year, 86943 FCFA a year and 86395.5 FCFA a year respectively (Direction de la prevision et de la statistique, 2004). According to the Senegalese household data (Esam I), the expenditure per person or per equivalent adult is estimated at 237903 FCFA a year for a middle class Senegalese household whereas for a household affected by food insecurity, it is around 73 064 FCFA a year in urban areas and 63 328 FCFA a year in rural areas. In rural areas, large farmers' households experiencing food insecurity, spend on average 64 150 FCFA a year whereas medium and small farmers, affected by it spend less than the required average.

Table 1: Expense per person; per equivalent adult a year in CFA (by average)

Senegal	237 903
Urban area	73 064
Rural area	63 328
Smallholders	59 884
Medium farmers	61 411
Large farmers	64 150

Sources: figures from Esam I.

There is a relatively substantial gap between the size of an average Senegalese household (about 9.92 members) and that of a farmer's household affected by the phenomenon; in rural areas, that size is estimated at 10.83 for small farmers, 11.13 for medium farmers, and 14.85 for large farmers.

Table 2: Average size of a household

Small farmers	10.83
Medium farmers	11.13
large farmers	14.85
Senegal	9.92

Sources: figures from Esam I.

The agro-ecological zones of the Senegalese river, the Southern area and of the *groundnut belt* are essentially the favourite areas of small farm holders. Medium farmers are mainly located around the *groundnut belt* and in the Southern area. The majority of large farmers, are based in the groundnut belt.

Table 3: Repartition of landowners throughout the agricultural and ecological zones (by percentage)

Type of farmers	Niayes	Groundnut belt	River area	Southern area	Eastern area	Pasture area
Small	6	22	36	29	4	2
medium	4	56	5	24	6	4
large	2	72	5	13	2	7

Sources: figures from Esam I.

Almost $\frac{3}{4}$ of the farms implanted in the River area, are small sized. It is likewise in the Niayes area where more than 4 farms out of 10 are small sized, to the opposite of the *groundnut belt* and the livestock area where the great majority of farms are large sized. Medium farmers represent nearly half of the landowners present in the agro-ecological zone of the eastern part of Senegal.

Table 4: Repartition of farms within the agricultural and ecological zones (by percentage)

Types of farmers	Niayes	Groundnut belt	River area	Southern area	Eastern area	Pasture area	Senegal
Small	44	11	74	39	31	14	43
medium	35	32	12	35	46	26	46
Large	21	57	14	26	23	59	45

Sources: figures from Esam I.

The highest peaks of food insecurity are mainly noticeable among small farmers of the Groundnut belt and medium and large farmers of the southern area. The lowest ones are noticed among farmers operating in the pasture area.

Table 5: Level of food insecurity within landowners (by percentage)

Types of farmers	Niayes	Groundnut belt	River area	Southern area	Eastern area	Pasture area
Small	36,84	56,16	32,79	49,49	40,00	12,50
Medium	20,00	48,54	35,00	53,33	40,91	6,25
large	22,22	47,80	30,43	53,03	36,36	14,71

Sources: Figures from Esam I.

2. Food insecurity key factors

An analysis of the key food insecurity factors among Senegalese landowners allows us to identify those that can better explain the phenomenon. In this next section, we are going to describe the methodology used and analyze the results.

2.1 The model

While assessing the determinant of food insecurity, many studies were done using different approaches. For instance, Che and Chen (2003) have estimated the proportion of people living under food insecurity by cross-tabulations. That method has also been used to measure the prevalence of five specific health characteristics in people affected by food insecurity and those that are not affected. Multiple logistical functions were used to estimate the regression equation that links food insecurity with several demographical and economical factors, on one hand and various health problems on another hand. Zoyem, Diang'a, Wodon (2008) used a multivariate procedure to estimate the regression equation linking the gap of calorie intake quantities to the food insecurity line and a set of explanatory variables, while Garrett and Ruel (2009) used the two-stage least squares (2SLS) procedures to estimate the regression equations.

In this paper, to assess the determinants of rural and urban food insecurity, we use a binomial Logit model that helps estimate the probability for a household to be more or less exposed to the phenomenon. The choice of this model over the others is justified by the fact that the sample size is not really big, consequently giving a higher significance to extreme values versus the significance of the *normal law* described by the Probit Model (Hosmer and Lemshow, 2000). The process consists in explaining the dichotomous variable y from a set of p variables (x_1, x_2, \dots, x_p). The dichotomous variable y represents food insecurity, and has a value of 1 if the household is suffering from food insecurity, and 0 in all other cases.

The sample is thus subdivided into two groups: households suffering from food insecurity ($y=1$) and those not suffering from it ($y=0$). Theoretically, we suppose that the probability for a household to be part of the first group ($y=1$) depends on certain socio-economic characteristics.

An estimation of the probability that a household belongs to class 1, if it is characterized by the vector $X = (x_1, x_2, \dots, x_p)$, is given by the following logistic function:

$$P_i = P(y_i = 1) = P(y_i^* > 0) = P(\beta_0 + \beta_1 x_i + \varepsilon_i > 0) = P(\varepsilon_i > -(\beta_0 + \beta_1 x_i)) = \Phi(\beta_0 + \beta_1 x_i) \quad (1)$$

With $\Phi(\cdot)$ the function of repartition of the logistic rule.

$$P_i = P(y_i = 1) = \Phi(\beta_0 + \beta_1 x_i) = \frac{\exp(\beta_0 + \beta_1 x_i)}{1 + \exp(\beta_0 + \beta_1 x_i)} = \frac{1}{1 + \exp(-(\beta_0 + \beta_1 x_i))} \quad (2)$$

By generalizing we can set this operation

$$P_i = P(y_i = 1) = \frac{1}{1 + \exp(-\eta_{ij})} \quad (3)$$

The log-odds ratio is a transformation of the equation (3):

$$\eta_{ij} = \log\left(\frac{P_{ij}}{1 - P_{ij}}\right) \quad (4)$$

While, P_{ij} can't take any other value than 0 and 1, η_{ij} can take any value. The probability of suffering from food insecurity predicted by the equation (3) is therefore a result of log-odds ratio (η_{ij}) transformation. The logit model is, then, a model in which the log-odds ratio, η_{ij} is obtained through a linear combination of explanatory variables:

$$\eta_{ij} = \beta_{0j} + \beta_{1j}X_{1ij} + \beta_{2j}X_{2ij} + \dots + \beta_{qj}X_{qij} \quad (5)$$

Where X_{qij} represent the explanatory variables and β_{qj} the parameters to be estimated.

The X_{qij} variables are components of the vector X and β_{qj} the unknown coefficients of the model with j varying from 1 to q .

The p explanatory variables for this model are the following:

- The household size;
- The age of the head of household and/or his experience estimated by the square of his age;
- The gender of the head of household;
- The level of education of the head of household;
- The socio-professional class of the head of household;
- The area of residence;
- A secondary job;
- Incomes earned from livestock;
- The self-sufficiency from agricultural and pastoral goods;
- Household net transfers.

Before analyzing the key food insecurity factors among Senegalese landowners, a brief discussion on explanatory variables and an approximation of expected results are presented in the following sub-section. A discussion on explanatory variables is made and the expected outputs presented in the following sub-section before the results' analyses.

The impact of the household size on the probability of being affected by food insecurity is a priori ambiguous. On one hand, income from labor increases with a higher number of working persons in the household, on the other hand, a higher household size means a

higher ratio of dependence. The latter is obtained from the difference between the number of workers and non-workers within the same household.

The age of the head of household has an incidence on the level of food insecurity in the sense that expected incomes get lower as he gets older. His position in the life cycle determines at the same time his household's standard of living. The probability of being affected by food insecurity is supposed to increase with the age of the head of household.

The head of household's gender is supposed to have an influence on the household assets. It can therefore have an influence on the economic choices and the factor return flows. Its effect is supposed to be undetermined.

The status of the household in relation to food insecurity can also be influenced by its human capital which determines its investment decision and inter-temporal consumption. The human capital is measured by the level of education of the head of household and his professional experience which is estimated by his age. Qualifications are supposed to reduce a household's probability of being affected by food insecurity.

The head of family affiliation with certain socio-professional classes may also lead the household to be confronted with food insecurity or not be confronted to it. The unemployed and socio-professional groups with small or contingent incomes are generally the most exposed to food insecurity, contrarily to the groups of qualified workers. Food security is also dependent on the household's area of residence. The fact of living in rural areas, particularly in ecological zones with a relatively important income, can also significantly reduce such a risk. From one region to another, rural areas are affected by evident inequalities in terms of agro-climatic potentialities, implementation of farming activities and uses of production factors. Those inequalities generate wide gaps in trade surplus, revenues, and eventually in food insecurity. Thanks to livestock activity, great opportunities of higher revenues exist in the pasture area, whereas the *groundnut belt* area is confronted with problems as soon as the groundnut sector collapses. We distinguish five rural agro-ecological areas: the Niayes zone, the *Groundnut belt* (Zba), the Southern area (Zs), the River area (Zf), and the pasture area (Zsp).

A strategy diversifying sources of revenue and /or of consumption can influence the food security/insecurity status of a household. This method is known as the *portfolio theory* according to which the household or the consumer is supposed to diversify his portfolio so as to protect itself against any risk. This attitude of diversification is estimated with proxies such as a secondary job for the head of household, net transfers, access to livestock activity income, and self-sufficiency in agricultural and pastoral products. The explanatory variable "head of household secondary job" is supposed to be negatively correlated with the probability of suffering from food insecurity. Taking into account net transfers attest of the importance this category of income could have in the probability of food insecurity. When these are positive, they contribute to a variation in sources of income, but they can also negatively impact some households, especially when the amounts transferred are superior to the amounts received. The link between net transfers and the probability of food insecurity are a priori, undetermined. The variable "livestock income" is supposed to be negatively linked to the probability of food insecurity. This activity contributes mostly to

the primary GDP sector. Self-sufficiency also allows households to keep their consumption safe from markets disturbances.

The methodology recommended by Bendel and Afifi (1977), as well as Mickey and Greenland (1989), is used to select variables relevant to the model. Indeed, many exogenous variables are likely to also be included in the model. The selection criterion of a variable, in the model, varies from one context to another and from one field to another. The most traditional statistical approach to build up a model consists of finding the *best model*. The objective is to minimize the number of variables included in the model so as to obtain the steadiest numerical model, and one that can easily be generalized. Such an approach is based on a strategy of variable selection which results in a model of the “best” type for the issue in context. Most authors agree that it is better to select the variables of a model by using a “clinic” that relies on their significance.

The process that is generally accepted and is adopted in this paper is the one suggested by Bendel and Afifi (1977) and Mickey and Greenland (1989). It is made of a preliminary econometric analysis which links each specific exogenous variable to the endogenous one. Each variable with a p-value inferior to 0.25 is selected for the multivariable analysis as variable which have been certified to have “clinic ” importance. Therefore, variables with a p-value superior or equal to 0.25 are not selected. The age of the head of household and his level of education are not selected for small and large farmers. In the case of medium farmers, household net transfers are excluded.

We use the method defined by Hosmer, D. and Lemshow, S. (2000) to evaluate the marginal effects of discrete variables². The following logistical function is used:

$$P(X) = P(Y = 1 / X) = P(Y = 1 / x_1, x_2, \dots, x_k) \quad (6)$$

The marginal effect of x_i is given for continuous variables by this expression:

$$\frac{\partial P(Y = 1 / X)}{\partial x_i} = \frac{\partial P(X)}{\partial x_i} \quad (7)$$

If we replace the operator ∂ by the operator Δ , the equation (7) gives us the approximate variation of $P(Y = 1 / X)$ when x_i increases by Δx_i , all the other variables remain constant.

Yet, if x_k is a discrete variable, the marginal effect of x_k on the probability is given by the difference between probabilities when $x_k = 1$ and $x_k = 0$:

$$P(x_1, x_2, \dots, x_{k-1}, 1) - P(x_1, x_2, \dots, x_{k-1}, 0)$$

Whether the explanatory variable is continuous or discrete, the marginal effect of x_j on the probability $P(X)$ depends on all the variables x_i (Hosmer, D. and Lemshow, S (2000)).

² The marginal effects associated with the continuous variables are computed using the Stata software.

2.2. Results

Tables 9 and 10 provide results of the key factors of food insecurity and their marginal effects.

What are the factors of food insecurity among landowners?

Among factors negatively affecting the status of landowners facing food insecurity, household size exerts a larger negative effect. In fact, it is significantly in relation with the probability of being affected as reflected by the p-value. The analysis of marginal effects shows that an increase of 10% of small landowner's household size brings up to 5.59% their probability of being affected by food insecurity. That probability is respectively increased to 5.37% and 5.36% whenever the household size of medium and greater landowners grows by 10%.

Table 9: Key factors of food insecurity

Factors	Small farmers		Medium farmers		Large farmers	
	Coef.	P>z	Coef.	P>z	Coef.	P>z
Food insecurity						
Size	0.2418284	0.000	0.3046118	0.000	0.2091242	0.000
Age			0.1857222	0.675		
Self-consumption	-7.23e-06	0.000	-7.95e-06	0.000	-5.14e-06	0.000
Livestock income	0.0000103	0.046	-1.32e-06	0.464	-3.00e-06	0.012
Net transfers	-1.32e-06	0.057			-2.86e-06	0.000
Primary school			0.0172636	0.052		
Niayes			-2.326663	0.012		
Groundnut belt	0.453693	0.147			0.0842571	0.735
Southern area			.349571	0.220		
River area	0.6338466	0.035				
Pasture area			-3.466955	0.004	-1.741432	0.006
Constant	0.9016624	0.006	-.3710124	0.457	-.9990225	0.003

Sources: Estimations.

Reducing factors of food insecurity risks

The risk of food insecurity is negatively and significantly reinforced by other factors. Diversification of income and/or consumption is estimated by many variables proxies.

However, determining factors of such attitude are revealed to be reducing food insecurity factors' threat in the landowners' households. Consequently, self-sufficiency has the effect of significantly reducing the threat of food insecurity. Amounts collected from livestock and the accuracy of transfers are also considerable reducers of food insecurity probability.

Education level has the greatest positive influence on medium farmers' food security. For those among them who achieve primary school, the risk of being affected by food insecurity is significantly reduced. It is also evident that the status of small landowners present in the agro-ecological river zone significantly reduces the probability of food insecurity. The examination of marginal effects certifies that the risk comes down to 0.16% in comparison to a similar farmer type outside of that agro-ecological zone. It is also the case for medium and large farmer operating in pasture area. Their risk of food insecurity is reduced by respectively 1.72% and 0.43% compared to similar type of farmers operating in other agro-ecological areas.

Table 10: Sensitiveness of the probability of food insecurity with respect to factors

Factors	Small farmers		Medium farmers		Large farmers	
	Coef.	P>z	Coef.	P>z	Coef.	P>z
Food insecurity						
Size	0.0558715	0.000	0.0568763	0.048	.0463368	0.000
Age			-0.0032234	0.141		
Self-consumption	-1.67e-06	0.000	-1.48e-06	0.066	-1.14e-06	0.000
Livestock income	-2.38e-06	0.042	-2.47e-07	0.254	-6.65e-07	0.013
Net transfers	-3.06e-07	0.060			-6.33e-07	0.000
Primary school			0.00572132	0.000		
Niayes			0.00766834	0.000		
Groundnut belt						
Southern area						
River area	0.00160497	0.000				
Pasture area			0.01725156	0.000	0.00431143	0.000

Sources: Estimations.

Conclusion

The household survey data analysis shows that food insecurity as well as poverty, is typically a rural phenomenon. The greatest majority of Senegalese households suffering from food insecurity are mostly encountered in rural areas. We must then put the emphasis on the facet of poverty as a matter of food provision for rural farmers. The purpose of this research was to identify the key food insecurity factors among landowners, using the logit model.

This study highlighted that the most important factors of food insecurity among Senegalese landowners are income and/or consumption (proxied by self-consumption, earnings from livestock and net transfers), demographics such as household size and regional disparities. The results show that household size is a key determining factor for all landowners, no matter what the size of their property is. It became evident that for small landowners, operating in the agro-ecological river region greatly reduces their risk of food insecurity. This is also the case for medium and large size farmers operating in the pasture area. Primary school achievement also reduces the risk of food insecurity among medium size farmers. Income and consumption diversification proxies like livestock income and net transfers also help reduce the probability of food insecurity. That risk is also significantly diminished by self-sufficiency in agricultural and pastoral goods. It is also safe to conclude that certain agro-ecological areas of residence play a key determining role in regards to farmer's food insecurity status, depending on the size of their farms.

What explains those results? On one hand, the Senegalese agricultural sector is more labour intensive thus enlarging the size of the household which is one of the strategies developed by farmers to face the labour constraint. This has in turn an adverse effect on the status of the whole household in regards to food security. On the other hand, as the Senegalese agricultural sector is mainly depending on rainfall, farmers are very affected by risks due to rainfall deficit and lack of regularity. Diversified income seem to be a key strategy against adverse effects of rainfall on Senegalese farmers income and, hence, expenditure. Livestock is one of the most important activities in the agricultural sector as it mainly contributes to deliver the core added value of that sector. So farmers dealing with livestock activity are more willing to diversify and enhance their incomes.

This also explains why the risk of food insecurity of medium and large farmers operating in the pasture area where livestock is the main rural activity is significantly reduced. Large farmers do seem to be more sensitive to changes in net transfers than other types of farmers. This may reflect more needs of resources from large farms which are agriculture oriented. Self-sufficiency is a current behaviour of rural households in Senegal. It gives the opportunity for households to take away a part of their basket consumption from the adverse effects of price volatility. Education is supposed to raise agricultural productivity by enhancing farmer's skills. Regional factors are also influencing the food insecurity probability. As for pasture area, the status of small farmers in river area and the one of medium farmers in the Niayes area tend to reduce the risk of food insecurity. While farmers from other agro-ecological areas cannot have agricultural activities no more than three

month a year, Niayes and river areas give the opportunity to farmers to have access to irrigation water all year long. This induces several harvests per year and more cash-flows opportunities than in other areas.

What are the major policy lessons? Our analysis demonstrates that diversified sources of income are an essential determinant of food insecurity. Though, income-generation is undoubtedly important for achieving food security among Senegalese landowners. Support of social assistance programs in rural areas in Senegal, such as food assistance and social labour intensive programs, will also be necessary to help those who cannot participate in the labour market and receive the benefits of overall increasing economic growth. Education is also important in improving farmer's food security status. In the long term, improving formal education and literacy will raise household incomes as education acts largely through greater knowledge and improved care giving practices. In the long-run, increases in both income and education could have large pay-offs in terms of reducing food insecurity in Senegal.

Our results indicate that large household size has a negative effect on food insecurity. So attention should also be directed at attenuating these conditions. Higher levels of education will over time probably lead to reductions in fertility and birth planning, resulting in smaller household sizes as highlighted by some findings in the case of Senegal (Diagne, 2007). So government can involve direct actions that can in the shorter term, also assist families in exercising their preferences in this area. In the meantime, social assistance programs should be sure to take into account the additional needs of larger households. The agro-ecological conditions emerge as a key element of food insecurity status for farmers. The Niayes, pasture and river areas seem to exert a greater impact on improving farmers' food security status.

In conclusion, our analysis indicates that food insecurity among farmers relies mainly on income and/or consumption, demographics and agro-ecological determinants. Policymakers must then set some mechanism which will help farmers participate more in the labour market and receive their part of overall increasing economic growth benefits. They also must understand specific agro-ecological conditions so that they can identify which of the key programs to address. In particular, water irrigation programs will be very useful for farmers not located in the Niayes area to boost their production. Creating programs and making policies that are flexible and appropriate reflect the needs, conditions, and resources in each rural area is quite a challenge for policy makers.

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