African Journal of Food Science Vol. 4(8) pp. 477 - 485, August 2010
Available online http://www.academicjournals.org/ajfs
ISSN 1996-0794 ©2010 Academic Journals

Full Length Research Paper

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

François Joseph Cabral

Faculty of Economic and Management Sciences, University Cheikh Anta DIOP. Senegal.
E-mail: joecabral7@hotmail.com. Tel: (221) 33 864 77 57, (221) 77 567 20 24. Fax (221) 864 77 58.

Accepted 09 August, 2010

During 2008, many of sub-saharan African economies have been obliged to suspend their imports tariffs due 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. An ordered multinomial model based on the Senegalese household data (Esam I) is used to identify the most influential probable causes of food insecurity among farmers. The results showed that the probability of food insecurity among all farmers is significantly diminished for farmers who have access to agricultural and pastoral goods for self-sufficient needs. Access to transfers hardly reduces also the probability of food insecurity for all of them. Income diversification factors like earnings from livestock reduce significantly food insecurity risks among small and larger farmers. Gender for small farmers and age for medium farmers seems also to be significant factors. Household size and its agro-ecological area of residence play a key role in the issue at hand for all farmers. 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 identify which of the key programs to address.

Key words: Food security, poverty, multinomial model.

INTRODUCTION

According to a special report from the United Nations Human Rights Council for Food Prevision, 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 in 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, production for the aim of human consumption 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

JEL classification, C1, I3, O1.

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 turns 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 everyone 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 et 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 and 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.

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 et al. (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.

Food security is estimated according to the foodstuffs baskets of a consumer. 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. Some studies have highlighted the huge contribution of rural households, in particular those operating in groundnut sector to poverty incidence (Direction de la prévision et de la statistique, 2004, 2001; Boccanfuso et al., 2005). But studies on food insecurity among farmers are very scarce. It makes it then difficult for policymakers to overcome this threat as they cannot identify key tools.

The aim of this paper is to identify the factors that have the greatest influence on food insecurity for farmers. By doing so, this paper tries to shed light on food insecurity determinants among farmers by assessing the link between food insecurity and some key explanatory variables that possibly have an influence on farmers household's status.

SOCIO-ECONOMIC CHARACTERISTICS OF FOOD INSECURITY AMONG FARMERS

The socio-economic characteristics of farmers are described based on the Senegalese household data (Direction de la prevision et de la statistique, 2001). Households 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), Casamance (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

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.

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 house-holds. As we are also analyzing the status of farmers 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 as farmers whose farm size comprised between 0 and 2.5 ha, medium farmers as those whose farm size comprised between 2.5 and 7 ha, and large farmers are those whose farm size is above 7 ha. While using the household survey data (ESAM I), we are going to analyze the farmers' 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 farmers between agro-ecological areas and the level of food insecurity according to that area of residence.

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 had 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).

The highest peaks of food insecurity are mainly noticeable among small farmers of the Groundnut belt and medium and large farmers of the Casamance. The lowest ones are noticed among farmers operating in the pasture area (Table 2).

There is a relatively substantial gap between the size of an average Senegalese household (about 10 members) and that of a farmer's household affected by the phenomenon; in rural areas, that size is estimated at 11 for small farmers, 11 for medium farmers, and 15 for large farmers (Table 3).

The agro-ecological zones of the Senegalese river, Casamance 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 Casamance. The majority of large farmer, are based in the groundnut belt (Table 4).

Almost three quarter 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 farmers present in the agro-ecological zone of the eastern part of Senegal (Table 5).

THE DETERMINANTS OF FOOD INSECURITY: AN ANALYSIS BASED ON AN ORDERED MULTINOMIAL MODEL

An analysis of the key food insecurity factors among Senegalese farmers allows us to identify those that can better explain the phenomenon.

The model

While assessing determinants of food insecurity, an ordered multinomial is used. This one is applied to a model for which the endogenous variable is an ordinal one. While assessing the determinants of food insecurity, this variable is supposed to take

Table 2. Level of food insecurity within farmers (by percentage).

Types of farmers	Niayes	Groundnut belt	River area	Casamance	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.

Table 3. Average size of a household.

Small farmers	11
Medium farmers	11
large farmers	15
Senegal	10

Sources: Figures from Esam I.

Table 4. Repartition of farmers throughout the agricultural and ecological zones (by percentage).

Type of farmers	Niayes	Groundnut belt	River area	Casamance	Eastern area	Pasture area	Total
Small	6	22	36	29	4	2	100
Medium	4	56	5	24	6	4	100
Large	2	72	5	13	2	7	100

Sources: figures from Esam I.

Table 5. Repartition of farms within the agricultural and ecological zones (by percentage).

Types of farmers	Niayes	Groundnut belt	River area	Casamance	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
Total	100	100	100	100	100	100	100

Sources: Figures from Esam I

three modalities: The status of those not suffering from food insecurity, the status of those suffering from vulnerability to food insecurity and the status of those affected by food insecurity. For those suffering from vulnerability to food insecurity, we consider the group of households for which the level of food consumption is 10% below or above the food insecurity line. Then, we try to see if the household status regarding to food insecurity varies depending to a set of variables (household size, age, transfers, education, agro-ecological area, access to incomes from livestock activity).

The multinomial model can be obtained through two ways: Though a latent variable (error measurement model) or trough odds ratio (proportional odds ratio model).

As the latent variable (food insecurity) is a quantitative one and is well known, we adopt the model of latent variable. This later is specified as followed:

If we supposed that Y is a variable of interest with J modalities ordered and independent, the probability of being under food insecurity is calculated as following:

$$P(y_i = m), \forall m \ni \{1,...,J\}; i \ni \{1,...,n\} \quad (3)$$

This probability is explained by a set of explanatory variables X (X_1, …,X_p) and a vector of parameters $\beta = {}^t(\beta_0,\ldots, \beta_p)$.

Even if we can observe Y, there is an unobservable variable Y* for which the domain of definition is R given by:

$$y_i = m \quad if \quad Y_i^* \ni \{\delta_{m-1}, \delta_m\} \quad (3)$$

where δ_{m-1} and δ_m are thresholds to determine (cutoffs, treshold) with $\delta_0 = -\infty$ and $\delta_J = +\infty$. We suppose that:

$$Y_i^* = {}^t X_i \beta + \varepsilon_i$$

$$Y_i^* = \beta_0 + \sum_{j=1}^{p} \beta_j X_{ij} + \varepsilon_i$$

As the problem is to calculate the probability for the variable of interest to be equal to one of the m modalities, suppose that Y_i^* comes from a known distribution function F. We have then:

$$P(Y_i = 1) = F(\delta_1 - {}^t X_i \beta) \quad for \quad m = 1 \tag{3}$$

$$P(Y_i = m) = F(\delta_m - {}^t X_i \beta) - F(\delta_{m-1} - {}^t X_i \beta) \quad for \ 2 \le m \le J-1 \tag{3}$$

$$P(Y_i = m) = 1 - F(\delta_{m-1} - {}^t X_i \beta) \quad for \quad m = J$$

The ordered multinomial model is given the following expression:

$$F(z) = \Phi(z) = \frac{\exp(z)}{1 + \exp(z)}$$

The X explanatory variables for this model are the following:

1. The household size.
2. The age of the head of household and/or his experience estimated by the square of his age.
3. The gender of the head of household.
4. The level of education of the head of household.
5. The socio-professional class of the head of household.
6. The area of residence.
7. A secondary job.
8. Incomes earned from livestock.
9. The self-sufficiency from agricultural and pastoral goods.
10. Household net transfers.

Before analyzing the key food insecurity factors among Senegalese farmers, a brief discussion on explanatory variables and an approximation of expected results are presented. A discussion on explanatory variables is made and the expected outputs presented as well.

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 potential-lities, 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), Casamance (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.

Farmers are not a homogeneous group. This is confirmed by an LR test which rejects this hypothesis and reflected by the sign and magnitude of coefficients which varies from one group to another. So an ordered multinomial model has been used for the three groups of farmers and the marginal effects of keys factors

Table 6. Characteristics of a mean farmer in each category.

	Small farmer	Medium farmer	Large farmer
Self-consumption(in fcfa)	194865.3	234158	354344.8
Household size	9	10	13
Age	51	51	54
Livestock income (in fcfa)	19638.02	583448.5	71210
Nets transfers (in fcfa)	120942.2	133752.1	136106.3

Sources: Figures from Esam I.

Table 7. Key factors of food insecurity.

Factors	Small farmers		Medium farmers		Large farmers	
Food insecurity	**Coefficient**	**P > z**	**Coefficient**	**P > z**	**Coefficient**	**P > z**
Size	0.290653	0.000	0.283019	0.000	0.223736	0.000
Age	0.015653	0.069	-0.015626	0.052	-0.007756	0.291
Self-consumption	-9.51 e-06	0.000	-6.52e-06	0.000	-5.84e-06	0.000
Sex	0.643776	0.030	-0.458526	0.205	0.205700	0.712
Livestock income	-7.88 e-06	0.111	-2.65e-06	0.172	-3.12e-06	0.008
Net transfers	-1.78e-06	0.009	-6.64e-06	0.024	-2.94e-06	0.000
Primary school	-0.391936	0.504	-0.236440	0.606	0.209987	0.679
Groundnut belt	1.205643	0.050	2.034212	0.004	1.933187	0.010
Casamance	1,058526	0.645	2.517736	0.001	2.232224	0.004
River area	0.273770	0.082	0.884081	0.309	1.419293	0.103
Eastern area	0,838314	0.270	2.281767	0.006	3.206263	0.004
Pasture area	-0,919014	0.461	-0.893811	0.404	0.443086	0.602

Sources: Estimations.

evaluated

RESULTS

For some keys factors, effects are the same for all categories of farmers. But for others, results vary from one category of farmer to another. For each type of farmer, marginal effects are evaluated compared to a farmer's household of reference within this category which is close to the mean household characteristics of that sample. Table 6 gives some characteristics of the farmer's household of reference for each category. Larger amounts of self-sufficiency and net transfers received are recorded for the mean large farmer compared to the other categories. Livestock income is higher for the mean medium farmer category than for the larger one. The mean household size of this later is larger than for the other types of farmer and the mean head of household age also. The variable related to gender ("sex") is supposed to take the value 1 for men and 0 for women. For farmers who have at least primary school level, the value of this variable is set to 1 and 0 if not. For each area of residence, the value is set to 1 if the farmer's household is a resident of the area and 0 if not.

WHAT ARE THE FACTORS OF FOOD INSECURITY AMONG FARMERS?

Tables 7 and 8 provide results of the key factors of food insecurity and their marginal effects. Among factors negatively affecting the status of farmers facing food insecurity, household size exerts a larger negative effect for all groups of farmers. In fact, it is positively and significantly in relation with the probability of being affected as reflected by the p-value.

Hence, within each category of farmer, the analysis of marginal effects shows that an increase of the household size of groups of farmers suffering from food insecurity or groups which are under food insecurity vulnerability raises their probability of being affected by food insecurity compared to the status of the respective farmer's household of reference as reflected by the p-value. Living in rural agro-ecological area of groundnut basin and Casamance also significantly increases for all groups of farmers the risk of being affected by food insecurity. For small farmers under food insecurity vulnerability, the risk

Table 8. Sensitiveness of the probability of food insecurity with respect to factors.

Factors	Households no suffering from food insecurity		Households under food insecurity vulnerability		Households suffering from food insecurity	
Food insecurity	**Coefficient**	**P > z**	**Coefficient**	**P > z**	**Coefficient**	**P > z**
			Small farmers			
Size	-.0721866	0.000	.0128951	0.002	.0592915	0.000
Age	-.0038876	0.069	.0006945	0.110	.0031931	0.068
Self-consumption	2.36e-06	0.000	-4.22e-07	0.009	-1.94e-06	0.000
Sex	-.1598884	0.030	.0285619	0.062	.1313266	0.032
Livestock income	1.96e-06	0.109	-3.50e-07	0.173	-1.61e-06	0.103
Net transfers	4.43e-07	0.009	-7.91e-08	0.035	-3.64e-07	0.009
Primary school	.09503	0.488	-.0212318	0.566	-.0737982	0.462
Groundnut belt	-.2905549	0.032	.0193645	0.224	.2711904	0.060
Casamance	-.2584638	0.645	.0276242	0.001	.2308395	0.095
River area	-.0680769	0.644	.0113539	0.622	.056723	0.649
Eastern area	-.204211	0.237	.0112378	0.526	.1929732	0.303
Pasture area	.207548	0.386	-.0576352	0.513	-.1499128	0.324
			Medium farmers			
Size	-.0520906	0.078	.0242518	0.001	.0278388	0.239
Age	.0028761	0.171	-.001339	0.075	-.0015371	0.296
Self-consumption	1.20e-06	0.108	-5.59e-07	0.009	-6.41e-07	0.267
Sex	.0843932	0.313	-.0392909	0.236	-.0451023	0.400
Livestock income	4.88e-07	0.000	-2.27e-07	0.055	-2.61e-07	0.000
Net transfers	1.22e-07	0.145	-5.69e-08	0.045	-6.53e-08	0.280
Primary school	.0411992	0.602	-.0197283	0.599	-.0214709	0.613
Groundnut belt	-.3473386	0.088	.1519742	0.002	.1953643	0.242
Casamance	-.5344355	0.002	.1438868	0.180	.3905487	0.117
River area	-.1912655	0.383	.0743182	0.255	.1169474	0.486
Eastern area	-.5140409	0.002	.0969296	0.522	.4171113	0.107
Pasture area	.13021	0.402	-.0659462	0.374	-.0642639	0.444
			Larger farmers			
Size	-.0555118	0.000	.0113238	0.000	.044188	0.000
Age	.0019244	0.292	-.0003925	0.296	-.0015318	0.295
Self-consumption	1.45e-06	0.000	-2.96e-07	0.002	-1.15e-06	0.000
Sex	-.0510369	0.712	.010411	0.713	.0406259	0.712
Livestock income	7.73e-07	0.008	-1.58e-07	0.023	-6.16e-07	0.008
Net transfers	7.29e-07	0.000	-1.49e-07	0.009	-5.81e-07	0.000
Primary school	-.0523707	0.680	.0091137	0.619	.0432571	0.691
Groundnut belt	-.4184672	0.001	.1126006	0.004	.3058665	0.001
Casamance	-.4683149	0.000	-.0356702	0.467	.5039851	0.001
River area	-.3243214	0.041	-.007603	0.883	.3319245	0.111
Eastern area	-.5117219	0.000	-.1263738	0.017	.6380957	0.000
Pasture area	.0157112	0.599	.0157112	0.344	.0946015	0.626

Sources: Estimations.

is just higher for those living in Casamance, due certainly to the guerilla warfare in this part of the country which is supposed to have an effect on local rural activities whereas the farmers of the groundnut belt are facing decreasing profitability of the groundnut activity and its impact on local rural economy.

Living in rural eastern area also tends to specifically increase the risk for medium and large farmers. Age has also an adverse effect on food insecurity status but just for the category of small farmers. Inside this group, it

seems to increase the probability of food insecurity for the farmers under food insecurity as reflected by the marginal effects. Those results are closed to the one of Zoyem et al. (2008) who found that the main factors of food insecurity are: The area of residence, the physical aspects (land, animals) and socio-economic variables within which household size, professional occupation, education, mental or physical disability.

REDUCING FACTORS OF FOOD INSECURITY RISKS

The risk of food insecurity is significantly reduced 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 farmers' households. Consequently, self-sufficiency and transfers significantly reduce the threat of food insecurity among all groups of farmers compared to the respective farmer's household of reference. This is reflected by the marginal effects which show a significant effect of those two keys factors on reducing the probability of being affected by food insecurity. For the category of larger and small farmers, revenues collected from livestock are also considerable reducers of food insecurity risk for those two groups. But inside the small farmer category, the later result is just obvious for the group of those suffering from food insecurity and is submitted to a significant level of 15% of the p-value.

Gender for small farmers and age for medium farmers also seems to play a key role regarding to the status of food insecurity of those two categories. For small farmers, as shown by the marginal effects, food insecurity risks are smaller when the head of the farm is a man than when the head is a woman. Hence, in small farms, women seem to be more exposed to food insecurity than men. For medium farmers, age tends to reduce the probability of food insecurity but just among the group of those close to the line of food insecurity that is those under vulnerability. Those results are not too far from the one of Garrett and Ruel (2009) who found, while comparing the determinants of food security and nutritional status in rural and urban areas of Mozambique that the incidence of food insecurity was higher for households relying on social aid, single parent families headed by women, tenants and children.

Discussion and Conclusion

The household survey data analysis shows that food insecurity is typically a rural phenomenon in Senegal. 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 farmers, using an ordered multinomial model.

The results show that household size is a key determining factor for all farmers, no matter what the size of their property is. It became evident that income and consumption diversification proxies like net transfers for all categories of farmers and livestock income for small and larger farmers also reduce the probability of food insecurity. That risk is also significantly and hardly diminished by self-sufficiency in agricultural and pastoral goods for all farmers. 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 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 its lack of regularity. Then, diversified income seems to be a key strategy against adverse effects of uncertainty 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 is so sensitive to livestock earnings, especially for the small and large farmers for whom the amounts are less than the one collected by medium farmers. 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. Regional factors are also influencing the food insecurity probability. Farmers from the agro-ecological areas depending on rain and where producers generally cannot have agricultural activities no more than three month a year are those more exposed to food insecurity and vulnerability. This raises for policy-makers the need to give the opportunity to farmers to accede to irrigation water all year long which will induced several harvests per year and hence more cash-flows opportunities. This study highlighted that the most important factors of food insecurity among farmers relies mainly on income and/or consumption (proxied by self-consumption, earnings from livestock and net transfers), demographics such as household size and agro-ecological determinants reflected by regional disparities.

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 farmers. Support of social assistance programs in rural areas in Senegal, such as food assistance and social labour intensive programs, will also be useful in a short term for those who cannot participate in the labour market. Increases in income will 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. Trying also to understand specific agro-ecological conditions of farmers can help policymakers 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.

REFERENCES

Bendel RB, Afifi AA (1977). Comparison of stopping rules in forward regression. J. Am. Stat. Assoc., 72: 46-53.

Boccanfuso DFJ, Cabral L, Savard (2005). The analysis of the impacts and the liberalization de of small farms in Sénégal : a module general multi-ménages, Africa Perspective http://www.perspaf.org/, 1(1): 32-58.

Cabral FJ (2005). Accord agricole et redistribution des revenus en milieu rural au Sénégal : essai de simulation à l'aide d'un modèle d'équilibre général calculable, Thèse de Doctorat d'Etat, FASEG/UCAD, Dakar.

Demery IT, Adison T (1987). Food insecurity and adjustement policies in Sub-saharan Africa : A review of the evidence", Development policy review (SAGE, London, Newbury Park, Beverly Hills and New Delhi), 5: 177-196.

Diagne A (2007). Investor in human capital: African Development Rev.

Direction de la prévision et de la statistique (2004). La pauvreté au Sénégal : de la dévaluation de 1994 à 2001-2002, Ministère de l'économie et des finances / Banque mondiale.

Direction de la prévision et de la statistique (2001). Enquête sénégalaise auprès des ménages (ESAM I) , Ministère de l'économie et des finances, Dakar.

FAO/SMIAR (2003). Rapport sur l'Afrique, no. 3.

Hazgui I (2008). Un doublement des prix des céréales en 8 mois », www.easybourse.com.

Maxwell S, Frankenberger TR (1995). Household Food Security: Concepts, Indicators, Measurements. A Technical review. UNICEF, IFAD.

Mickey J, Green land S (1989). A study of the impact of confounder-selection criteria on effect estimation". Am. J. Epidemiol. 129: 125-137.

Staatz JM, D'Agostino VC, Sundberg S (1990). Measuring food security in Africa : conceptual, empirical and policy issues. Am. J. Agric. Econ., 12: 1311-1317.

Ziegler J (2005). L'Empire de la honte, Fayard.