Determinants of the adoption of improved varieties of Maize in Cameroon: case of cms 8704

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Abstract

A cereal in full expansion, maize is currently eaten by two out of every three Cameroonians. The NCRE (National Cereals Research and Extension) project introduced and distributed new improved varieties to increase maize output.

The objective of this research is to study determinants guiding the adoption of new varieties of maize following the example of "Cameroon Maize Series (CMS)" 8704. In relation thereto, a Probit model adapted to membership of a smallholders' cooperative was used. The study was conducted on 100 farms in Cameroon's Centre Region. The results show that the zone, the level of education, belonging to a smallholders' cooperative and market orientation positively affect the probability of adopting improved maize varieties. The age, area, gender and risk seem to have no effect on the adoption of such varieties.

Keywords: adoption, CMS 8704, farms, Probit, maize, improved varieties

1. Introduction

About 55%[3] of the Cameroonian population live in the rural environment with agriculture as main activity. Products from this activity serve for on-farm consumption and generating income. This is the case especially for Cameroon's subsistence farming where cereals constitute an important part. Indeed, cereals are the basis of human food, providing 36.2% calorie intake and 40% protein in-take, of which 19.5% and 22% respectively from maize

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3. Cameroon Household Survey (ECAM 3, 2007)

(MINADER, 2006). Produced in the entire country, maize contributes CFAF 5.6 billion to GDP (NEPAD[4], 2004).

Thus, the development of its production[5] should consolidate food crop production to enhance food security and income for the farmers. According to ACDIC (2009), maize is a very strategic crop in Cameroon, in terms of food security and sovereignty. Maize is the major source of income for more than three million smallholders in Cameroon's regions. Maize is the reserve currency of smallholders. In family farms, maize occupies a central place and determines the layout of associated crops. Furthermore, at the socio-economic level, the maize market amounts to about CFAF 25 billion per year and is a source of employment for an increasingly high number of citizens. Maize is the first ingredient in the manufacture of cattle feed. It is indispensable in aviculture and accounts for 65% of the input for manufacturing poultry feed.

The most cultivated cereal in Cameroon, maize is regularly consumed by about 12 million people[6], i.e. two thirds of the population. The price of maize doubled in 2008, reaching about CFAF 230 per kilo. Maize equally constitutes 70 percent of poultry feed. The demand for maize to feed poultry has increased by 40 per cent in less than one year. According to ACDIC[7], maize is the major source of income for more than three million Cameroonian smallholders.

In the past decade, maize[8] cultivation has become more of a cash crop like coffee and cocoa, bringing in non-negligible income to farmers. Maize not only occupies an important place in the different functions of agricultural production in Cameroon, it is also the most consumed cereal in the country, much more than sorghum, rice or wheat. Annual demand in human consumption was estimated at 870 000 tons (consumer survey, 2008) and is projected at nearly 920 000 tons in 2009. The demand in animal feed which was estimated at 320 000 tons in 2008, will be 530 000 tons in 2009 (poultry consumption survey). Consumption by the brewing industry is estimated at 16 500 tons of maize grits in 2009. On their part, export demands and other agro-industries are estimated at 7 000 tons in 2008 (CEMAC Report) which could attain 10 000 tons in 2009.

Having a short production cycle, maize permits farmers to have quick access to the market and maximize their income. The income from the sale of maize during the off-season is higher than during the in-season, the off-season prices doubling.

4. See ftp://ftp.fao.org/docrep/fao/007/ae411f/ae411f00.pdf
5. Hence, increase in production, improved food security and access to food have become the priorities of the Cameroonian Government
6. See www.alecoso.fr/spip.php?article63
7. Association citoyenne de defense des interest collectifs (ACDIC) ("Citizen Association for the Defense of Common Interests")
8. Maize (which means "that which maintains life" in the aboriginal Indian language) is a cereal of American origin.

Therefore, maize offers hope[9] hope for the population since it not only feeds humans from the infant to the adult (cooked in different ways), but also serves as livestock feed and input for the manufacture of beverages.

Unfortunately, the expansion of the maize chain in Cameroon faces several difficulties, namely: rudimentary production methods, low work productivity and poor organization of actors. These difficulties result from production changing at a far slower pace than the population growth. Moreover, the low productivity of the chain, combined with the development of agro-industries[10] and the increasing demand of neighbouring countries, contribute in increasing the deficit between domestic demand and supply. This production gap is all the more preoccupying because maize output from traditional farmers remains small (1.5 to 2.6 tons/ha) and is generally lower by 50% to 80% than optimum yield which is easily accessible with research-driven technology (MINADER, Op cit). Thus, Cameroon moved from being a net maize exporter in 1974, to a net importer[11] since the 1980s. This has increasingly reduced its already trade deficit (Gergely, 2002), especially since the recent upsurge of international food product prices.

Thanks to the NRCE project, the Agricultural Research Institute for Development (IRAD) finalized several improved varieties of high yield maize. The choice of variety depends on several criteria. These criteria are not only linked to characteristics typical of the varieties (cycle, colour, taste and output) but also to factors linked to production constraints (water requirement, resistance to disease, fertilizers…) and marketing (Fagbemissi, 2001). Introduced in 1987, "CMS 8704" is one of the best adapted maize varieties in the entire Southern Cameroon. Even so, the farmers need to adopt it to hope to achieve the desired increase in production.

The aim of this study is to identify factors favouring the adoption of "CMS 8704" and especially, to verify if the inclusion of a farm in a smallholders' cooperative (OP) plays a determining role in the adoption of "CMS 8704".

2. Methodology

The adoption of "CMS 8704" falls mainly within the framework of the success of an agricultural innovation largely contingent on the effectiveness of its dissemination. Therefore, there is need to highlight some theoretical points regarding the mechanism for propagating agricultural innovations and

9. All things that underscore the economic, food, socio-cultural and ecological importance of this crop and would make it – if it is so wished – the main weapon for poverty and food insecurity control in Cameroon.
10. For instance: animal feeds factories, breweries.
11. According to data from the Ministry of Agriculture (Agristat, 2009), national maize production was estimated at 1.102 million tons in 2008 and 1.328 million tons in 2009. ACDIC stresses that Cameroon has recorded a production deficit of 608 194 tons of maize this year, resulting in sharp price increases and creating panic within the poultry farming industry.

their adoption. We will end this section with a format and the method of analysis.

Some theoretical markers of the adoption of agricultural innovation

Admittedly, this innovation can be defined as the deployment or ownership of an invention by growers (Muchnik, 1998). In the agricultural sector, however, innovation is seen as the introduction of a new agricultural practice, sometimes a modification of a traditional practice, rarely the adoption of new socio-economic behaviour (Chantran, 1872). In this study, we will take Adams' definition (1982) which considers innovation as a new idea, a practical or technical method to sustainably increase productivity and agricultural income. This definition fairly matches the perception that farmers have of innovation, trying to understand how novelty is spread.

The notion of distribution has been defined in several ways. For Samatana (1980), distribution is the course of innovation from the feeder system to the receiving system. As for Morvan (1991), he sees it as "the process by which an innovation is propagated". If Tonneau and Sabourin (1999) think that distribution depends mainly on the milieu in which it operates, the actors and the object distributed; Rogers (1995) on his part already saw it as "the process by which an innovation is transmitted to members of a social system through certain transportation corridors for a period of time". This last definition highlights four essential elements namely: the innovation itself, the channels of communication, the period and the social system.

To translate the idea of propagation, Gardner and Rausser (2001) tried to define distribution in terms of penetration of an innovation in its potential market through the definition of a logistic distribution curve in time, as well as the measure of the penetration speed. The graphic representations then had to be refocused on the S curve (Griliches, 1957; Rogers, 1995; Moore, 1991), which distinguishes the growth, maturity and finally, the decline phase of the product. To each of these phases corresponds particular adopters. Different research works on the distribution of technology in the agricultural sector have shown that at the start, only a minority of farmers adopt a particular innovation, before it spreads out.

Through an analysis of the different stages of the innovation process and its social dimension, it appears that innovation in its evolution resembles a "snowball" effect. It is through this "snowball" effect that innovation increasingly acquires anchors on the field, generating more acceptance that would not subsequently be called into question. Innovation is therefore progressively becoming stable.

Moore (Op.cit), in particular, throws interesting light on the pace of adoption of new technologies by the different groups. He highlights what he refers to as the "abyss" which he places immediately before the acceptance of the new technology by the early majority. According to him, some innova-

tions cross the abyss and enter the mass market by first winning over the majority of pragmatics then naturally, the rest of the potential users. Others fall into the abyss, for not convincing the early majority; the key to success lying in the delicate passage between the visionaries and the pragmatics.

Overall, the distribution of the innovation is similar to a communication activity during which information on a new idea is disseminated to members who informed in advance and those not informed. The spread of such information is contingent on trust[12] between the different actors of the activity. Correspondingly, if some ideas take into account the purely rational choice of growers in the process of transferring research innovation to growers, others go as far as considering that the choices are mere mimicry. However, the motivation notwithstanding, adoption-friendly[13] and adoption-hostile behaviour are observed. In a "risky future" situation, where the decision maker knows all possible decisions, s/he is capable of evaluating their consequences, comparing them according to the criteria of expected utility and retaining that which maximizes the decision.

In the case of agricultural innovation, Chambers et al (1994) shows that farmers do not think in terms of adoption or rejection as researchers do. The individual tries to understand an new invention, its functioning, its advantages and disadvantages, then forms his/her opinion about the new idea and determines the attitude to chose: either adoption, or rejection. Rogers (Op. cit) identifies two kinds of cessation (or even "discontinuance") namely: the cessation of disillusion: a decision to reject an idea because of discontent as concerns its implementation and the cessation of replacement: a decision to reject an idea in order to adopt a better one. The advantage of novelty and its associated risks are considered among the major factors which influence the decisions of growers. The more an object gives us pleasure and satisfaction, the more we are ready to invest time and money to acquire it.

The farmer who decides to adopt a new method, selects an innovation depending on the technical characteristics and the environment according to its best criteria. An innovation will only be adopted when the people concerned are convinced, depending on the information they have, of the interest or gains they can have because, according to traditional economic theory (Jevons

12. Therefore, trust is a relational asset defined as "the assumption that in a situation of uncertainty, the other party will act, including when faced with unforeseen circumstances, depending on rules of behaviour deemed acceptable" (Bidault and Jarillo, 1995). Similarly, "trust basically means rendering one's person vulnerable to the other to be able to accomplish something good with him or her, although that also does not prevent from doing the utmost to reduce the risk related to that vulnerability" (Usunier, 2000). These definitions underscore the two dimensions of the concept: truth as a sentiment or subjective reality' having trust is "a subjective probability estimated by an individual that another may be worthy of trust" (Usunier, 2000) and trust as a behaviour or objective phenomenon; having trust involves counting on another, releasing resources (taking the risk) and trying to reach a defined goal.

13. Rogers (1983) defines adoption as being the decision to choose an innovation as the best alternative. This process revolves around the mental move of an individual from the first information up to adoption. For Van den Ban et al (1988), adoption of innovations means the decision to apply them and continue to use them.

1875, Menger 1892, Walras 1874), the rationality of the individual is determined by his sole interest through the invisible hand (Smith,1776). Hence, adoption by these individuals is no longer the result of a social process but a consequence of their own intrinsic characteristics: the desire for novelty either as a result of being the targets of a particular marketing strategy or of risk aversion (Steyer and Zimmermann, 2004).

Furthermore, in the study of the adoption of fertilizers in Madagascar, Randrianarisoa and Minten (2003) insist on the appropriateness of innovation on the environment in terms of interdependence of different factors of production. Whether they are markets for products or inputs, they could be bearers of risks and uncertainties which could endanger any process of adoption and distribution of agricultural innovations in their structure, behaviour and performance.

In this study, we sought to determine the effects of these different factors on the adoption of the "CMS 8704" variety by certain Cameroonian farmers, more especially to see whether belonging to a smallholder's cooperative is a factor of adoption.

Identification Model for Determinants of the Adoption

Several empirical studies (Nkamleu and Coulibaly, 2000; Adesina et al, 2000) studied the adoption of agricultural innovations. Various methods of analysis were applied, notably the use of econometric models. The literature summary on adoption studies helps to distinguish three types of models routinely used to analyse the decision to adopt an agricultural technology: linear probability models, Logit and Probit. The first model has disadvantages because the forecast probability can often be defined beyond the [0.1] interval. For its part, the Logit model is often used in most adoption studies. As verified by Morimune et al (1980) in the Monte Carlo studies, estimates of the parameters and their precision obtained by the Probit and Logit models are generally hardly different. This can be explained by the proximity of logistic and normal law. We are retaining the Probit model as a tool for our analysis. A binary Probit model was preferred in specifying the relations between the probability to adopt and its determinants, considering the nature of data collected: the attitude to adoption or not, as opposed to different degrees of adoption.

The choice of the Probit model is justified for at least two reasons. First the logistics law tends to attribute a higher probability than normal distribution to extreme events. Then, as a disadvantage of logistic regression, it is noticed that independent variables should be linearly independent (non co-linearity); considering that they are a numerical approximation, with the result that logistic regression does not always converge in an optimal solution.

On the contrary, the Logit and Probit models directly describe the probability of achievement of an event (in our case, the adoption of the improved

maize variety "CMS 8704" by farmers), *y=1* and in some cases rely on recourse to latent variables.

Our model is expressed thus:

$P(y = 1) = G(x\beta) \equiv p(x)$

Where x is a vector with dimension 1*K of explanatory factors with unity as first term, thus taking into account the original ordinate.

β is the vector K*1 of coefficients (constant term and slope coefficients).

Specifically, let us assume that there is a certain index y* which is in a one-to-one relationship with the probability to adopt the "CMS 8704" improved maize seeds. In that regard, the greater the value of y*, the greater also the probability of adopting. In this case y* will be seen as the much lower gain the farmer will have from adopting the improved variety.

Moreover, the index is imagined to be a combination of characteristics x of an individual and a disruption ε. Assuming that y*, which is the latent variable, is described by a linear regression, we have:

$y^* = x\beta + \varepsilon.$

where ε is the random variable which represents the non-negligible but also non-measurable influences of the environment on the y* variable.

Given that the farmers will opt for y = 1 and not otherwise if $y^* \geq 0$, the individual is sufficiently motivated to adopt the "CMS 8704" improved maize variety and the dichotomous variable takes the value 1. In this case we will have:

$prob(y_i = 1) = prob(y^*_i > 0) = prob(x'_i \beta > -\varepsilon) = F(x'_i \beta)$
$prob(y_i = 0) = 1 - F(x'_i \beta)$

Since, the objective of this study is to identify the determinants of the adoption of improved maize seeds, we will estimate a Probit function in which the decision to adopt a technology is dichotomic[14]. Specifically, the decision[15] to adopt depends on the characteristics of the farmer (age, sex, level of education, etc.), his/her membership in a smallholders' cooperative and farmers' strategies (market orientation, food habits) of the area.

The level of education is important in this study for better understanding[16] of farmers' expectations. An educated farmer will better understand

14. The farmer may decide to adopt a technology or otherwise.
15. If we state that farmers behave as homo economicus, it would be expected that they be less inclined to adopting the high yield variety. For instance, it is quite plausible that farmers not wish to adopt "CMS 8704" for fear of redistributing their income to their entourage. Based on our survey, there is little inequality among farmers. Hence, this assumption is not proven.
16. It is possible that an imitation effect could be generated. The dissemination of innovation is similar to communication activity during which information on a new idea is shared among members informed in advance and those not so informed. As such, where some ideas take into account the purely rational choice of farmers in the process of transmitting research innovation to farmers, other go as far as considering that choice is mere mimicry.

Table 1. *Characteristics of both survey sites*[18]

Zone	Ayos	Obala
Rainfall (in mm/y)	1800	1617
Vegetation	Dense forest	Transition forest
Population density	300 inh./km2	About 30 inh./km2
Place of maize in farms	Marginal (some for on-farm consumption and some sold locally)	Central (on-farm consumption and significant sales)
Maize cultivation practice	Generally planted as an associated crop	Single and combined crop

Source: Based on *SPPESA Centre (*2003) and information gathered during interviews with resource persons of the Ministry of Agriculture and Rural Development

the market structure and the product that will significantly increase his/her income. Farmers whose products are market oriented are more interested in yield than those who consume their entire produce (the yield from "CMS 8704" is approximately three times higher than that from older varieties of seeds). As concerns the effect of belonging to a smallholder's cooperation on the adoption, we expect it to be positive given that farmers receive different kinds of training through the cooperatives and have contacts with extension workers[17]. This actually has an effect on the proper understanding of agricultural innovation and related issues. In all, the adoption of the new high-yield variety of maize, like any economic choice, clearly results from the interaction of several technical and socio-economic variables whose adverse, complementary, or ambiguous effects can be clarified through the use of the econometric model of adoption as defined by the binary Probit model.

Required data for the estimation of the model was collected from a sample of 100 farms from two distinct areas of Cameroon.

The data

The study was carried out in two localities of the Centre Region with distinct characteristics, especially concerning the place of maize in family farms (see table 1).

On each of the two sites, sampling of family farms (EFA) was done by reasoned choice, seeking to choose farms with different situations from the point of view of gender, age of main farmer and his/her membership in a smallholders' cooperative or otherwise. A sub-assembly of 100 farms was studied. The sample at the start comprised 100 farms but considering the

17. It is worth noting that the extension workers do not work with individuals; most work with farmers' cooperatives.
18. Table drawn using data from surveys and bibliographic research from agricultural officers in the areas concerned.

difficulty of some people to answer questions, 13 were eliminated. Data was collected using questionnaires.

3. Results and Discussions

The "CMS 8704" adoption trend was presented, followed by the discussion of the descriptive characteristics of the farmers, then by the discussion on determinants for adopting "CMS 8704".

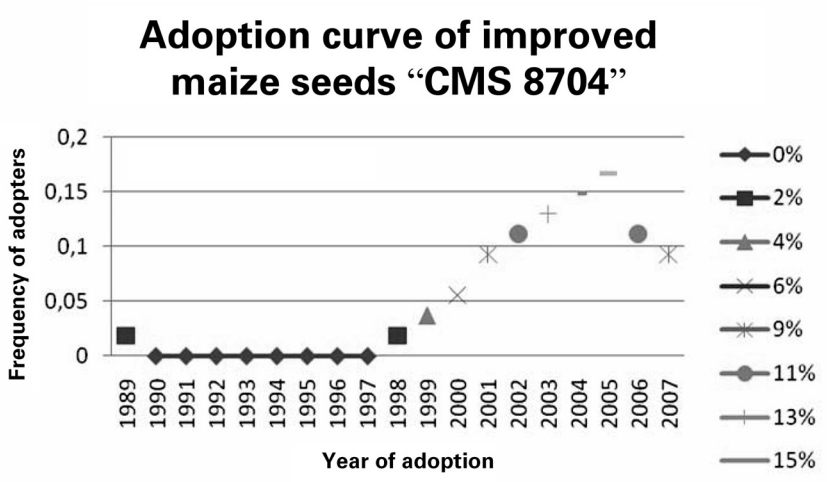
The "CMS 8704" Variety Adoption Trend

The "CMS 8704" adoption curve in the zone under study is represented by Figure 1. It is actually an "S" curve, as prescribed by the model established by Rogers (OP. cit) or Moore (Op. cit).

The analysis of the data in Figure 1 thus presents many kinds of innovators: the first adopters show up in1987 during the creation of the variety. In spite of the efforts of NCRE, we notice that less than 10% EFAs of our sample adopted the "CMS" between 1987 and 1998. These are those Moore qualifies as innovative farmers.

From the end of the 1990s, the number of people adopting the improved grains is clearly on the increase. Arguably, this change is due to the adoption[19] of this variety by the "early majority" (Moore, Op. cit). This majority comprising retired persons, civil servants laid off by the drastic reduction of

Figure 1. ***The "CMS 8704" Variety Adoption Curve***



Source: Survey data, 2007

the work force of the Cameroon Public Service (implementation of structural adjustment programmes) and youths returning to the villages to farm the land because of inability to find jobs in town. Therefore, adopters of the seeds are within the 31 to 60 years age bracket (85.45%) as shown on Table 2 below:

Table 2. ***Age of Adopters and Non-adopters***

Age Group	Adopters		Non-adopters	
	Total number	Percentage	Total number	Percentage
15-30	5	9.09	3	9.37
31- 45	15	27.27	15	46.87
46- 60	32	58.18	13	40.62
60 et +	3	5.45	1	3.12
Total	**55**	**100**	**32**	**100**

Source: Survey data, 2007

A drop in the number of adopters is noticed from the year 2005, either, as Moore explains, because most potential adopters had already adopted the variety or because the youths had left the rural areas to look for jobs or to study in the cities, or because the farmers had started having problems marketing their produce[19]. . Marketing will thus be a bottleneck to the adoption of improved crop seeds.

Indeed, an analysis of the penetration of innovation with relation to the market establishes adoption as an economic process. Actually, the market contributes significantly to economic growth and any form of obstacle to its access constitutes a denial of freedom which deprives the smallholder of outlets for his/her product. A lingering feeling of loss is evident among populations excluded from the advantages of the market (de Janvry and Sadoulet, 1996). Lack of access to the market is correspondingly a "non-economic freedom" which is expressed in the form of extreme poverty that renders people vulnerable by also weakening the other freedoms and choices (Sen, 2003).

The low prices of commodities is one of the major drivers of rural exodus; poor farmers, on the fringes of survival, unable to sell their produce because their country imports foodstuff like maize at low cost, unable to improve their production tools because inputs are too expensive, have abandoned their villages in search of a fictitious better fortune in the overpopulated and dirty shanty towns of the big cities.

Consequently, for farmers to respond to market incentives by adopting better technologies, they need to have better access to market outlets. The unreliability of markets in rural zones, partially due to deficient infrastructure especially in marketing systems (IFPRI, 2003; Wortmann et al, 2004) is not likely to encourage such change. The non-adopters interviewed (80%) name

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the marketing problem as one of the determinants of their denial, especially those interviewed in Ayos, which explains the smallness of the adoption of the variety in this area. It should however be noted that the surveys in the Obala area (100% farmers) faced the same problems of access to markets. However, unlike in Ayos, the people did not abandon the growing of maize since maize is their staple food unlike Ayos. Sixty per cent (60%) of the interviewees put maize in the 4th position in terms of consumption after groundnuts and cassava; in Ayos, maize does not figure among the first five products in terms of consumption.

Economic risks and uncertainties linked to prices and product outlets are important in poor agricultural economies where access to markets remains fictitious. With the product markets risky, the attitude of farmers is characterized by the reduced use of inputs. They opt for strategies that minimize the negative consequences of the risks: the multiplication of activities and sources of income, a greater part of activities devoted to products for on-farm consumption so as to free themselves from the risks on prices, at least partially.

Descriptive Characteristics of Farm Operators

Many factors can influence the adoption of "CMS 8704" by farmers. The variables retained for our model are described in Table 3.

Table 3. ***Definition of Variables of the Model***

Variable	Characteristics	Average	Min.	Max.
SEED	Qualitative variable 0=rejection 1=adoption	0.6322	0	**1**
AGE	Quantitative variable in years	45.0575	17	**67**
AGE GROUP		2140.437	289	**4489**
GENDER	Qualitative variable 0= woman, 1 = man	0.4368	0	**1**
PRIMARY	Qualitative variable 1 = primary level, 0= otherwise	.6091954	0	**1**
SECONDARY	Qualitative variable 1 = secondary level, 0= otherwise	.0804598	0	**1**
MARKET ORIENTATION	Qualitative variable 0= on-farm consumption 1= market production	.6436782	0	**1**
SMALLHOLDER COOPERATIVE	Qualitative variable 1= op 0= non op	.70115	0	**1**
ZONE	Qualitative variable 0= Ayos 1= Obala	.2183908	0	**1**
RISK	Qualitative variable (production of maize is risky=1; 0= not)	.5057471	0	**1**
AREA	Quantitative variable in ha	.6867816	.25	1.5

Source: Survey data, 2007

Table 4. *Results of the Probit Model Estimate*

Probit Regression	Number of obs	= 87		
	Wald chi2(10)	= 47.60		
	Prob > chi2	= 0.0000		
Log pseudolikelihood = -17.761901		**Pseudo R2**	= 0.6896	
Marginal Effects after Probity = Pr (seed) (predict)			**= 0.72457973**	
Seed	Coef	Robust Std. Err.	P > |z|	dy/dx
Age	-.2892711	.1172309	0.014**	-.0965942
Age group	.0035941	.0014918	0.016 **	.0012002
Area	-1.01144	.5205906	0.052***	-.337743
Op	-.6013044	.5043765	0.233	-.2117653
Gender	-.7512971	.8121404	0.355	-.2402673
Zone	-3.244276	1.09127	0.003**	-.877822
Primary	-.1174245	.3673014	0.749	-.0388947
Secondary	-1.407674	.7520854	0.061***	-.5184581
Risk	.501245	.4128785	0.225	.1665332
Market Orientation	2.775346	.569189	0.000 *	.826527
Cons	6.088252	2.554953	0.017**	

Source: Survey data, 2007

Determinants of the Probability of Adoption

Several factors are highlighted through the Probit model which gives the results shown in Table 4.

The results on Table 4 show that age, age group, area, zone, secondary level of education and market orientation are the factors of adoption of "CMS 8704".

Finally, for variables like gender, primary level of education, risk, membership in a smallholders' cooperative and the estimated coefficients are not important.

The quasi-elasticity obtained shows that the probability to invest in maize growing diminishes by 9% *ceteris paribus*, when the farmer is 45 years. However, the introduction of this variable in a quadratic form highlights a bell-shaped relation with a reversal of the curve around 45 years. Early adopters of "CMS 8704" are mostly adults. In fact, the highest adoption rate is that of farmers aged between 46 and 60 years (58.18%).

Having secondary school level education is important and has a negative effect. This shows that having been to secondary school diminishes the probability of adopting the improved maize seeds "CMS 8704"; this looks quite contradictory concerning the adoption of improved varieties. It would have been expected that education would help to better understand issues of improved maize varieties. In this situation instead, most farmers have not reached secondary school and those who have opt for non-agricultural activities. However, having a primary level of education has a positive though not significant effect on the adoption of "CMS 8704" improved maize seeds.

The destination of the output appears to be the major determinant in the adoption of the variety. In fact, market policy results in a positive effect on the adoption of "CMS 8704". Moving from the consumption to the marketing of maize, we notice an increase in the number of adopters. The significance of market policy shows the importance of smallholder strategies and the consideration of their needs in the marketing of agricultural innovations through research. Indeed, the fact that the farmers can sell their produce favours the adoption of improved maize seeds.

Belonging to a high maize consumption area increases the probability of adopting the improved variety "CMS 8704". There is much more adoption in the Obala zone than in Ayos. This difference may be due to the fact that in Obala, maize is a staple food and is an important cash crop while Ayos instead produces tubers (cassava, cocoyam, etc.) and plantain. The zone has a negative and significant impact on the probability of adopting the improved maize seeds "CMS 8704". Actually, the adoption rate falls as one moves from Obala to Ayos.

The area also has an influence on the adoption of the new improved maize variety "CMS 8704". However, increasing the area diminishes the probability of adopting the new seeds. This is particularly true since a big sown area with maize requires much manpower and huge resources. Since subsistence farming is essentially the prerogative of women as compared to cash crop farming in production systems, it is difficult for a woman early adopter without external or family labour to work on a large area: difficult work like the felling of trees and clearing of farms is reserved for men while ploughing, hoeing, sowing, harvesting and selling are reserved for women. Thus, the average size of a farm evaluated at 0.73 hectares in the sample confirms one of the characteristics of the Region's production system: an aggregate of small family holdings.

The inclusion of a family holding in a farmers' cooperative does not on its own confirm our starting hypothesis which is: to check and see if this inclusion of farmers influences the decision to innovate. Although the practice of farmers' organizations is essentially an institutional arrangement to reduce transaction costs is an efficient tool for improving the prospects of adoption by agricultural workers, belonging to a farmers' organization is not a factor of adoption for improved maize seeds. It is worth noting that most producers are also more inclined to go to their relatives and neighbours and less to the extension workers (e.g. head of the agricultural agencies) for advice. Moreover, some farmers do not join the smallholders' cooperatives because they want to grow maize. They do so more because of such fringe benefits as gifts from NGOs and mutual farm assistance.

Admittedly, the effect of risk perception by farmers is not significant with respect to the decision to adopt agricultural innovation ("CMS 8704"). However, risk perception positively influences adoption decisions, revealing the rational attitude of farmers. Instead of the difficulty in having seeds reducing the propensity to adopt, it increases that propensity and makes

farmers use the same seeds several times or request them from their neighbours. Unfortunately, market access difficulties constrain certain farmers to abandon the seeds, others limit their production to on-farm consumption levels and the surplus is sold. Our results here show that the risky nature of the environment does not encourage people to innovate.

The decision to adopt improved varieties of maize like "CMS 8704" does not also seem to depend on the gender of the adopter. In fact we have an atypical relationship with gender while adoption (like any subsistence agricultural activity) is monopolized by women. Men are increasingly interested in subsistence crops, having realized that they can also improve their local environment through growing these crops without neglecting cash crops (cocoa and coffee) which are their priorities and for which nowadays they have mostly adopted the improved varieties.

4. Conclusion and Recommendations

Agricultural innovations as economic investments lose their appeal following difficult market prospects which are often inaccessible and unstable. With uncertain and inaccessible markets, the behaviour of farmers is characterized by reduced use of inputs and insufficient effort in maintaining crops and infrastructures. Farmers opt for "safety first" (Rapoport, 1993) type of strategy which minimizes the negative effects of risks: extensive agriculture by clearing where land is not a limiting factor, multiplication of activities and sources of income, a greater part of activities devoted to on-farm consumption products to at least partially overcome pricing risks, etc. Farmers are penalized because the prices paid to them do not always cover their production costs. This limits their capacity to make productive investments. The lack of motivation of farmers has led to a reduction of agricultural production. Besides, special attention should be paid to smallholdings because they supply the towns with food.

To increase the probability of adopting improved maize seeds, it is necessary that agricultural researchers should think of improving the dissemination of new maize technologies by lifting bottlenecks to the adoption of improved seeds. These marketing bottlenecks hamper the effectiveness of any agricultural policy aimed directly and solely at agricultural production, even as it also underscores the need to organize and support markets in any agricultural policy strategy aimed at increasing food supply, accessibility as well as the stability of supply.

To conclude, for farmers to become real actors of rural development and the agricultural sector, they should be well represented in decision-making bodies concerning them. Their organizations should not only be well represented, but they must also have a solid well recognized structure as their representative vis-à-vis their social partners. By themselves, farmers have a real capacity and an appropriate language in defending their rights

and core interests. Rural poverty is a result of a wait-and-see policy and large-scale social exclusion to the detriment of the farmers. This social exclusion often takes the form of disinformation aimed at curbing rural development.

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