Analysis of Factors Influencing Farm Households' Adoption of Maize Technical Package in Western Cameroon

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Abstract: The low productivity of farms in sub-Saharan Africa including Cameroon is due among other things to the low adoption rates of innovations generated by agricultural research. This paper is a case study of the adoption of the technical package (improved varieties of seeds, fertilizers, pesticides, monocropping) extended for maize in western Cameroon. Data sampled farmers were analyzed using a Logit model. Results showed that the size of maize land areas, market orientation of production, contact with extension services, land tenure are factors that significantly determine the likelihood of a farmer to adopt the technical package. It was concluded that agricultural research and extension should adapt their technological innovations to the various needs of farmers.
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1. Introduction

The Cameroonian agriculture is the mainstay of the economy, providing employment for many rural and urban residents. The centrality of the agricultural sector is well understood from the fact that majority of the population live in rural areas. Over the years, a major concern of policy makers is the low resource productivity of the farmers, thereby warranting investment in research and technology innovations. This is a necessary, though not sufficient condition for ensuring rapid agricultural productivity. However, the hypothesis of agricultural productivity enhancement through agricultural innovations cannot be easily discarded, despite numerous constraints befalling the Cameroonian agricultural sector.

Numerous studies had analyzed the contribution of technological changes to agricultural productivity in developing countries (Feder *et al*. 1985; Feder and Umali, 1993; Datt and Ravallion,1998; Nkamleu, 2004; FARA, 2006; World Bank, 2007; Arega *et al*. 2009; Ali-Olubandwa *et al*. 2010). In these studies, it had been shown that the state of the technology and the efficiency with which the factors of production are used are the main determinants of increased agricultural production. Hence, the overall and sustained interest in the analysis of adoption processes for rapid agricultural transformation can be empirically and humanly justified.

It should be further emphasized that although agriculture is a dominant sector in most of the economies of sub-Saharan Africa (World Bank 2008, Mokwunye on 2010, Enete and Onyekuru on 2011), low farm resource productivity is clearly evident (World Bank, 2008). One of the reasons for low productivity is the low rate of adopting technological innovations (Nkamleu, 2004; World Bank, 2008). This is the case for the maize cultivation in Cameroon, where the low yields - (less than 2 t/ha in peasant culture, approximately 2.5 t/ha in semi-intensive culture, and 4.5 t/ha in large farms (Minader, 2006) - are due to low adoption of the technical package in the form of improved seeds varieties, chemical fertilizers, pesticides etc. that are extended by the country's agricultural departments. Indeed, a good understanding of the reasons for low adoption of this technical package is important for the search for alternatives means of boosting maize production in the process of ensuring rapid agricultural productivity.

Rogers (2003) defined the diffusion of an innovation as the process by which an innovation is passed on over time through some communication channels to the members of a social system. Innovations spread within a group or within a community by imitation, conformity or through a social training (Young, 2007). As for the adoption, it refers to the decision to resort to an innovation and to continue to use it (Van den Ban *et al*. 1994). The diffusion and adoption of innovations (agricultural innovations in particular) depend on several factors. Among these are the socioeconomic characteristics of adopters, the information they received and how were able to use them, the structure and nature of their

interactions with members of their social network, the characteristics of the innovations and how they are perceived by those who want to adopt them (Ryan and Gross, 1943; Ryan, 1948; Gross, 1949; Marsh and Coleman, 1955; Jones, 1963; Fliegel and Kivlin, 1966; Van Den Ban, 1984; Valente and Davis, 1999; Caswell *et al*. 2001; Sunding and Zilberman, 2001; Wejnert, 2002; Rogers, 2003; Young, 2007; Monge *et al*., 2008; Matthews-Njoku *et al*., 2009; Oleas *et al*., 2010).

In general farmers discuss of their activity with their peers within farmers' organizations (PO) and within groups of mutual aid. There they share their experiences and new technologies and techniques of production. Their involvements in these organizations generally have positive impacts on adoption of agricultural innovations, but it also depends on the types of innovations and the kinds of organizations in which they participate (Jagger and Pender, 2003). Therefore, a farmer adopts an innovation only if it meets her production objectives and goals (Griliches, 1957). Therefore, the goal of this paper is to identify by means of primary data factors that determine the decision of a farmer to adopt technical packages for maize cultivation.

2. Materials and Methods

Data Collection

The data used are those of a survey that was had in March, 2010. According to the report of the 2009 agricultural campaign made by the departmental delegation of the agricultural studies and statistics, an average of 98 % of the agricultural population of this department cultivated maize that year. The survey was made in collaboration with the services of the regional and district delegations of the Ministry of Agriculture and Rural Development. A sample of 52 farmers was randomly chosen. The data collected from these farmers include socio-economic characteristics, farm characteristics and adoption of the technical packages.

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Specification of Adoption Model

The adoption of an innovation can be modeled as a choice between two alternatives: to adopt or not to adopt the innovation (Caswell *et al*. 2001). The choice of an individual 'i' is then represented by a latent variable y_i^* which is the difference between the utility the adoption provides him/her and the utility the non-adoption brings to him/her. The value (positive or negative) of this difference of utility depends on a set of explanatory variables x_i :

$$y_i^* = x_i\beta + \varepsilon_i \qquad \forall i = 1,\ldots,n \quad .1$$

Where β is a vector of parameters, disturbances ε_i is the independently and identically distributed error term (McFadden, 1984). According to the survey guide on the adoption of agricultural technologies of the CIMMYT (1993), the most used model for the identification of variables that affect adoption of an agricultural innovation is the Logit model, the logistic function of which is most likely to explain the adoption process of these innovations.

A simple Logit model has then been used in order to specify the relationship between the probability of adopting technical package and the determinants of this probability. The choice of each investigated farmer is represented by a discrete variable y_i, the values of which are 1 if the technical package was adopted by the farmer, and 0 if it was not. The relationship between the difference of utility (y^*_i) and the choice of the farmer (y_i) is modeled as follows:

$$y_i = f\left(y_i^*\right) = \begin{cases} 1 \; si \;\; y_i^* > 0 \\ 0 \; si \;\; y_i^* \leq 0 \end{cases} \quad .2$$

Under the hypothesis of rationality (Richefort, 2009), a farmer will choose to adopt the popularized technical package if it brings more benefits. The dependent variable "technical package" takes the value 1 if the investigated farmer resorts jointly to all of the elements of the popularized technical package regardless to the order of adoption or the used quantities. Otherwise its value is 0. The variables that are likely to explain the adoption of agricultural innovations on which our estimations are based are: the gender, the number of years of experience in cultivating corn, the educational attainment, the main orientation of the production, the access mode to the land, the proportion of the surface cultivated with corn, the existence of a source of income that differs from agricultural activities, the enrolment in a farmers' organization (FO) and the interaction with services of agricultural popularization.

Table 1: Description of the Variables Used in the Adoption Model

Variables	Description
Dependent Variable	
Technical Package	Technical Package (1 if the technical package is adopted, 0 otherwise)
Explanatory Variables	
Gender	Gender (1= Male, 0= female)
Maize cultivation Experience	number of years of experience in growing corn (here, between 1 et 43 years)
Educational Attainment	Years of education
Products Orientation	Principal orientation of the production (1= Auto-consumption, 0= Trade)
Land areas	Surface cultivated with corn (measured in hectares)
Estate	Access Mode to land (1= Property, 0= Renting)
Source of Income	Other than agriculture (1= Yes, 0= No)
Membership	Member of a Farmers' Organization (1= Yes, 0= No)
Popularization	Connections with services of de agricultural popularization (1= Yes, 0= No)

The estimation of the unknown parameters of the model was made by means of the software Stata 9.0.

3. Results and Discussion

Characteristics of the Farmers of the Sample and of their Farms

The results show that 58 % of the farmers were male. As the culture is in Cameroon, the males are the ones that are customarily eligible to own lands. Most women received the pieces of land they were cultivating through their husbands. Only 2 women out of the 22 that were sampled inherited their pieces of land. The age range of the farmers was 17 to 68 years, while the average age was 45 years. Those who were 45 years old or above constituted 79% of the sample, and most of them were women. Young men were rather interested in non-agricultural activities (small shops, public transportation etc.). This is why they massively move to cities, abandoning agricultural activities to women and older men. Almost all the sampled farmers (92%) were educated.

Maize has a great importance in the food custom and in the social life of the people of the region. All the farmers had cultivated maize for many years. The average number of years of experience is 14. The results showed that 54% of the farmers had grown maize for at least 10 years, and 92 % allocated at least 50% of their total farm size to grow maize. However, most of the cultivated land areas were between 0.5 and 2 hectares (65%). The agricultural tools are rudimentary, and the techniques are most often inherited from their forefathers.

Maize is mainly cultivated for home consumption, but a part of the production is sold in order to provide for occasional needs (healthcare, social events, needs that rise at the beginning of an agricultural season, the beginning of a school year). For 46 % of the surveyed, the major part of their production was intended for sale.

The land tenure is apprehended by the access mode to the land. About 90 % of the farmers owned their land through inheritance, donation or purchase. Others, especially foreigners, rented the lands. The surveyed farmers get their means of subsistence from farming, but also from livestock, from small-scale trade, from a paid work or from other activities that generate incomes. However, the trade of agricultural products is the main source of income for 81% of them.

All farmers in the sample noted that they discussed with their friends and family circles on their constraints of production, the solutions experimented, the effects of new technologies and techniques of production. Furthermore, approximately 48% were in touch with services of agricultural extension and they were participating in some organized trainings. However, only 9 of them (a rate of adoption of 17 %) adopted the full technical package. The others used it only partially.

Explanatory Factors of the Adoption of the Popularized Technical Package

Four variables explain in a significant way the adoption of the technical package by the surveyed farmers, namely the proportion of surface cultivated with maize, the main orientation of the production, the contact with extension officers, and the access to the land.

Table 2: Results of the Estimation of the Logit Model

Variables	Coef	Std. Err	z	P>|z|
Gender	.9299048	1.884804	0.49	0.622
Corn exp.	-.0539945	.074784	-0.72	0.470
Educ. level	-.1045823	.7033214	-0.15	0.882
Pro. Orient.	-4.728085	1.477564	-3.20	0.001*
Corn surface	1.382693	.3657958	3.78	0.000*
Land	-3.406163	2.008765	-1.70	0.090***
Income source	3.17621	2.452951	1.29	0.195
Organizations	.0979133	1.71419	0.06	0.954
popularisation	5.208021	2.127657	2.45	0.014**
_cons	-7.183604	3.757451	-1.91	0.056

Legend: * significance at 1 %, ** significance at 5 %, *** significance at 10 %.

The model produced a good fit as shown by the statistical significance of the Wald Chi Square ($p<0.01$). Since the numerical value of the coefficients of the Logit model as shown in table 2 have no direct interpretation, the effect of the explanatory variables on the probability to adopt the technical package is appreciated through calculation of the marginal effects that are presented in table 3.

Table 3: Marginal Effects of the logistic parameters

Y = Pr (technicpack) (predict)	.00164234
Variable	dy/dx
Gender*	.001471
Corn experience	-.0000885
Educational attainment	-.0001715
Product orientation*	-.0203651
Corn Surface	.0022671
Land*	-.0333272
Source of income*	.0177932
Organizations*	.000157
Popularization*	.0238557

(*) dy/dx is for discrete change of dummy variable from 0 to 1

The results in table 3 shows that although the probability to adopt technical package increased with increase in land area cultivated to maize, other things held constant, the increase of this surface by one hectare adds only 0.2% to the probability to adopt the technical package. The market orientation of the production has on the other hand a greater influence on the probability to adopt the technical package; it increases it by 2 %. So, if a farmer from the sample switches from auto-consumption as the main orientation of his/her production to a more market orientated production, the probability to adopt the technical package comes closer to 1.However, when the cultivated lands are rented, the probability of adopting the technical package increases up to about 3.3%. Indeed, farmers who rent the lands have to pay a financial counterpart or cede a part of their products to the owners. This makes them very anxious and willing to make a good harvest. Therefore, they are more inclined to adopt technologies and techniques of high performance production. The calculation of the marginal effects also shows that for a farmer who is in touch with agents of popularization or who participates in demonstrations organized by them, the probability to adopt the popularized technical package is closer to1than for his peers. Indeed, the fact that a farmer is in touch with agents of popularization is shown by an increase of about 2,4 % of the probability to adopt the technical package.

4. Conclusion

From the results, it is evident that both home-consumption as the main reason for production and the fact that the farmer own the cultivated lands have a negative effect on adoption of maize technical package, whereas the maize land areas and the contact with extension agents increased it. Although it is necessary to make a survey with a more representative sample before generalizing the results obtained above, this preliminary study can already lead us to the following conclusions: The popularized technical package is adopted by less than 20 % of the farmers of the sample, and this may be the sign of its inadequacy to the local context of production and/or to the needs of the farmers. However, the majority of the farmers adopted 1, 2 or 3 out of the 4 elements of the popularized technical package. The choice of these elements, taken individually or combined, responds to strategic and specific needs. Current research and services of agricultural should take it into account and propose popularization according to the various contexts: not a standard technical

package, but various alternatives responding the specific needs of the farmers and corresponding to the characteristics of their lands. This "contextualization" of the research and of the agricultural popularization will also help to give value to peasant knowledge and expertise.

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