Impact of subsidized inputs credits on land allocation and market-oriented agriculture in rural households in Mali

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Abstract

The worldwide increases in food prices during 2007-2008 period has led many countries to set up fund to support agricultural producers through credits and subsidies systems. The government of Mali, since 2008, has adopted a strategy focused on inputs supply to facilitate farmers' access to fertilizers and pesticides to ensure food security in rural area. The aim of this study is to analyze the link between access to these credits, land allocation behavior and the degree of commercialization of rural farmers in Mali. We adopt an instrumental variable method to test the effect of credit access on land allocation for different types of crops namely: food crops, semi-commercial crops and purely commercial crops. We also examine the impact of credit on cash earning from the sales of agricultural products. This amount cash earning being moreover considered as a good indicator of degree of commercialization or degree of market participation. Our estimations results show that access to credit strongly encourages the development of cash crops. Beyond simple access, we find that the amount of credit has a nonlinear effect on land allocation. We also find that credit appears as a factor of increase in the degree of commercialization of agricultural products.

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Introduction

According to FAO, the agriculture represents about 30 to 60% of GDP in the Least Developed Countries and employs between 40 to 90% of the active population. This agricultural sector still the main source of foreign exchange reserves in three quarters of these countries and provides most of the subsistence food and income for rural populations. However this sector remains confronted with many constraints mainly in Africa region where two thirds of this continent face drought risks due to instability of rainfall and its uneven distribution in space and time (FAO, 1996). Weather conditions are important factors in the excessive volatility of agricultural production. Apart from these climatic hazards, land degradation and fertility loss are recognized to be the main factors limiting agricultural productivity. The deterioration of soil fertility resulting from population pressure leads to a reduction in fallow time and results in permanent use of land. These behavioral changes in the modes of agricultural operations have not been sufficiently accompanied by intensive use of means of production to offset losses of soil nutrients. For examples according to the World Bank, the intensity of fertilizer use in sub-Saharan Africa are only 12.5 kg / hectare against 89.6 in average in Latin America and 106.7 in Southeast Asia. (World Development Indicators, 2007). Moreover, Sanchez and Leasky (1996) show that the nutrient deficits of agricultural land have accumulated over the years and are evaluated approximately to 700 kg / ha of nitrogen, 100 kg for phosphorus for 100 million of hectares in sub-Saharan Africa between 1965 and 1995. These accumulations of deficits highlight the vulnerability of subsistence farmers in Africa because of difficulty to compensate losses of nutrients essential to maintain or increase production. To date where conservation of natural resources is in the heart of international debate, the major challenge for these countries is still transformation of subsistence agriculture to ensure reproduction of soil fertility and improve agricultural productivity, a major guarantee for sustainable food security.

Over the period 2007-2008, the rise in food prices worldwide has led, in many African countries, to multiple events often referred to as "hunger riots". Since that time, one have witnessed the introduction of support mechanisms to agricultural producers in some of these countries through government credit et inputs subsidies schemes in order to boost production, increase food security and fight against poverty through improvement of farm incomes.

Mali, like many countries, has adopted a strategy of agricultural intensification by setting up a support fund for agricultural activities and development of agricultural areas. One of the key features of this strategy is the supply of inputs subsidies to facilitate access to pesticides, insecticides and other herbicides for a larger number of producers in the growing of rice, cotton and other cereals such as maize, sorghum and millet. This initiative comes after period where inputs market was driven by liberalization agreements with a mode of supply provided by private structures essentially towards cotton and rice production areas. At present, there is a supply made in the form of agricultural credits involving farmers' organizations and accompanied by a price subsidy. The supply process involves several actors including:

The State: which supported the creation of a National Bank of Agricultural Development and ensures development of decentralized financial services, encourages creation and maintenance of development agencies to facilitate the supply of inputs and support for producers.

Private structures: playing a leading role in importation and distribution of fertilizers and pesticides by passing to foreign firms the calls for tender reflecting the needs of development agencies and producers.

Development Agencies or Development projects which have a mission of public services consisting in promotion of agricultural development in their zones of intervention. These organizations, in connection with the Direction of the Public Markets, purchase inputs, by call for tender to agrochemical firms and to place them at the disposal of the organizations.

Fund and credit agencies: the function of agricultural credit is provided by the National Bank of Agricultural Development and decentralized financing services such as credit and savings banks.

Producers and their associations: producers are generally grouped into village associations to deal with supply problems. But individual producers can send their input needs through associations which convey them to the regulatory or finance companies. Distribution of input credits to producers and repayment guarantees are provided by these associations which a play important role through the mechanism of joint liability.

The aim of this research is to try to study the link between access to these subsidized credits and recipients' orientation choices towards commercial agriculture.

One can first imagine that this subsidy policy is an incentive for farmers as it would lead, through easy access to credit, to an increase in the use of inputs within the framework of intensification of food and cash crops productions. One can make assumption that a farmer who subscribes to this credit is motivated by a profitability concerns. So he will have the motivation to invest in high yielding crop varieties and more financially profitable. Thus, access to inputs credit could influence farmer' crop choices and therefore his land allocation behavior between different crops.

In corollary credit can also act on agricultural incomes from sales of harvests. Indeed credit being regarded as a factor of improvement of productivity; recipient can record an increase in his possibility of sales because of the surplus of production generated by this improvement. The surplus on consumption is determined as the supplement of production obtained after considering the quantity corresponding to the household subsistence threshold. In this sense, we think that credit access can contribute to increase in the degree of commercialization of farm households. This is the fundamental assumption we try to test empirically by adopting an econometric approach linking access to credit and land allocation. Also we test the impact of credit on cash incomes obtained from the sales of agricultural products. The remainder of the paper is organized as follows: section 1 presents the conceptual and theoretical framework of the study. In the second section, we present data and descriptive statistics. Section 3 is devoted to the presentation of the econometric models and in the 4th section, we discuss results followed by the conclusion.

1. Conceptual framework and literature review

We depart from the theoretical framework proposed by Chambers and Just (1989) considering a farmer producing n varieties of crops by a combination of a quantity of variable inputs x and an agricultural surface s considered as fixed. One supposes an absence of joint production in inputs uses but possible reallocation of s between crops. In this configuration, the decision of farmer is characterized by two stages. In the first stage, he maximizes his profit on each type of crops conditionally to fixed quantity of input s so to determine profit accruing to each crop. And in the second stage, he allocates in an optimal way s in order to obtain profit function aggregating all crop choices. So given the production possibility frontier for a crop *i*,

$$Q^i\left(x^i, s^i\right) = \left\{q_i: \left(x^i, s^i\right) \rightarrow q_i\right\},$$

Possibility frontier for all crop is given by the following expression:

$$Q(x, s) = \left\{q: q_i \in Q^i\left(x^i, s^i\right);\ \sum_{i=1}^{n} x^i \leq x\ ; \sum_{i=1}^{n} s^i \leq s;\ \ i = 1, \dots, n\right\}$$

Where q_i represents the optimal output corresponding to the crop *i*, x^i optimal quantity of variable inputs necessary to obtain this output. s^i is the fraction of s allocable to the production of *i*. Profit function associate with each crop is then expressed as follow:

$$\pi^i\left(p_i, p_x, s^i\right) = max\left\{p_i y_i - p_x x^i: q_i \in Q^i\left(x^i, s^i\right)\right\} \qquad (1)$$

Where p_i represents the price of output *i* and p_x the prices vector of variable inputs x^i. We suppose, for the moment that, variable inputs prices' vector includes labor remunerated at wage price and other inputs including seeds and fertilizers purchased at market prices.

Relation (1) defines individual profit (or quasi-rent) associated with each crop. And maximization program of the farmer makes it possible to determine optimal quantities of variable inputs x^i and corresponding quantities of output for crop *i*. Thus we have:

$$q_i\left(p_i, p_x, s^i\right) = \frac{\partial \pi^i(p_i, p_x, s^i)}{\partial p_i} \qquad (1a)$$

$$x_j^i\left(p_i, p_x, s^i\right) = -\frac{\partial \pi^i(p_i, p_x, s^i)}{\partial p_{x_i}} \qquad j = 1, \dots, m \qquad (1b)$$

The maximization of the multicrop profit function is translated in relation (2)

$$\pi(p, p_x, s) = \max_{s^1, \dots, s^m}\left\{\sum_{i=1}^{n} \pi^i\left(p_i, p_x, s^i\right): \sum_{i=1}^{n} s^i = s\right\} \qquad (2)$$

This relation leads to deduct the optimal quantities associated with each variable inputs and corresponding output. These quantities are expressed as follow:

$$x_j(p,p_x,s) = -\frac{\partial \pi(p,p_x,s)}{\partial p_{x\,j}} = -\sum_{i=1}^{n} \frac{\partial \pi^i(p_i,p_x,\tilde{s}^i)}{\partial p_{x\,j}} = \sum_{i=1}^{n} x_j^i(p_i,p_x,\tilde{s}^i) \quad j = 1,\dots,m \qquad (2a)$$

$$q_i(p,p_x,s) = \frac{\partial \pi(p,p_x,s)}{\partial p_i} = \frac{\partial \pi^i(p_i,p_x,\tilde{s}^i)}{\partial p_i} = q(p_i,p_x,\tilde{s}^i) \qquad i = 1,\dots,n \qquad (2b)$$

Where s^i represents the interior solution corresponding to the optimal surface dedicated to crop i in the maximization of multicrop profit function. $x_j(p,p_x,s)$ and $y_i(p,p_x,s)$ represent respectively quantity of variable inputs and corresponding optimal quantity of output. Farmer allocates agricultural surface between crops in manner to equalize their marginal profit (first order conditions). Thus we have :

$$\frac{\partial \pi^i(p_i,p_x,\tilde{s}^i)}{\partial s_j^i} = \frac{\partial \pi^1(p_i,p_x,\tilde{s}^1)}{\partial s_j^1} \qquad i = 2,\dots,n\,;\, j = 1,\dots,k$$

Within this analytical framework, producer is regarded as a rational agent taking into account, in his production decision, both inputs prices and outputs prices to then determine an optimal allocation of productive factors. That shows that it is likely that he could be influenced, in his production choices, by market prices in particular those of outputs.

But according to Sadoulet and de Janvry (1995), small farmers in the developing countries, often organized at household level, have specifity to integrate in their decisions both production, consumption and reproduction along time. According to these authors, the production decisions are generally semi-commercial. Even if markets function well, agricultural production is sold only when subsistence needs are met. In this case, household can be modeled as an agent solving two separate problems: the first is a profit maximization problem and the second is a utility maximization problem with focus on household consumption. Without loss of generality, we suppose that agricultural household is a single decision maker integrating the possibility of labor supply but also consumption of leisure. With this hypothesis, the structural form of the household maximization program can be rewritten as follows:

$Max\, U(c_a,c_m,c_l,h)$	: Utility function
$G(q_a,x,w_1,s) = 0$	: Production function
$p_x x + p_m c_m = p_a(q_a - c_a) + \omega(w_2 - w_1)$	:Budget constraint (cash constraint)
$c_l + w_2 = E$	: Time constraint

Where $c_a, c_m, c_{l,}$ represent respectively consumption of agricultural goods evaluated at the price p_a, consumption of manufactured goods purchased at the market price p_m and consumption of leisures and others domestic activities evaluated at the wage rate ω.
$G(.)$ represents production function of quantity q_a of agricultural goods by combination of variable inputs x and fixed inputs s. w_1 and w_2 are respectively productive labor and household labor supply in or out-farm remunerated at wage rate ω. E represents household total available time (or time endowment) and h household characteristics.

According to Sadoulet and de Janvry (1995), if markets function perfectly and that all prices are exogenous and transactions cost are negligible, production choices, consumption and labor supply are taking according to the opportunity costs. Under these conditions, it is out of importance that household sells its production to buy other goods for consumption or it uses its labor force for production or that it sells it on the market. Thus under separability hypothesis, household decisions are made sequentially. First by profit maximization and then by the maximization of consumption and leisure according to the level of profit achieved (separability of decisions). Thus the optimal situation can be presented as follow:

$\pi^* = \pi^*(p_a, p_x, \omega, s)$: Maximum profit

$c_a = c_a(p_a, p_m, \omega, h, y^*)$: Consumption of agricultural goods

$c_m = c_m(p_a, p_m, \omega, h, y^*)$: Consumption of manufactured goods

$c_l = c_l(p_a, p_m, \omega, h, y^*)$: Consumption of leisures

with $y^* = p_a q_a - p_x x - \omega w_1 + \omega E$: Full incomes constraint.

These equilibrium conditions require an absence of market imperfections and a complete absence of transactions costs concerning goods and factors. However there may be a number of imperfections characterizing economic environment, in particular information asymmetry, market absence, difficult access to geographical zone, lack of infrastructures etc. Thus difficulties related to transactions costs, low local market size, price risks and risk aversion are main sources of market imperfections facing rural farmers.

But one of the major causes of market imperfections evoked by authors remains the difficulty of access to credit. Indeed, seasonal variation in agricultural expenditures and incomes implies that household must face both a constraint of annual income equilibrium but also a constraint to balance its agricultural budget. With a limited or non-existent access to credit, budget balance especially becomes a major constraint when expenditures are high for the purchase of inputs. Consequently, credit constraint can limit the optimal production or can acts on consumption choices. The behavioral changes induced by these imperfections translate in the household maximization program and Lagrangian associated with this program is presented as follows:

$$L = U(c,h) + \lambda\left[\sum_{i\in T}\bar{p}_i(q_i + E_i - c_i)\right] + \eta\left[\sum_{i\in TC}\bar{p}_i(q_i + E_i - c_i) + K\right] + \phi G(q,s) + \sum_{i\in NT}\mu_i(q_i + E_i - c_i)$$

Where T indicates the set of tradable goods in reference to the literature on trade theory, TC the set tradable goods subject to credit constraint and NT the set non-tradable goods. $\bar{p}_i$ is the effective exogenous price of good i on the market and K represents access to credit.

Given credit constraint and market imperfections, farmer is facing implicit prices defined by the following relations:

$p_i^* = \bar{p}_i$: If good i is tradable and non constrained by credit.

$p_i^* = \bar{p}_i\left(1+\frac{\eta}{\lambda}\right)$: If good i is constrained by credit.

$p_i^* = \frac{\mu_i}{\lambda}$: If good i is non tradable.

λ represents marginal utility procured by cash earning from crop selling. μ_i is marginal utility in endowment in non tradable goods and η marginal utility of credit.
Given the presence of tradable and non tradable goods, farmer production decision is taking regarding implicit prices vector p^*. Thus, the solution considering credit constraint is as follow:

$q = q(p^*, s)$: Production choice

$\pi^* = \sum p_i q_i$: Profit Maximization

$c = c(p^*, y^*, h)$: Consumption demand

where $y^* = \pi^* + \sum {p_i^*}_i E_i + \frac{\eta}{\lambda} K$: Full incomes constraint

It follows from this analysis that credit constraint is one of the major factors influencing household production and consumption choices. That leads authors to conclude that demand of any good entering in credit constraint to loosen or tighten is influenced by the value of credit through its price. Hence household will tend to produce or sell more goods aiming at loosening constraint. And conversely, for goods requiring credit like fertilizers, it will tend to purchase less when implicit value of credit is high.

These theoretical results highlight the central role of market in inputs demand and outputs commercialization. However the concept of agricultural commercialization remains very complex regarding multiple studies realized on this subject. Some authors have shown that agricultural commercialization in smallholders is a long process beginnig by transformation of subsistence agriculture in a semi-commercial then in a fully commercialized agriculture. According to Pingali and Rosegrant (1995), in subsistence agriculture, the primary objective of farmer remains food self-sufficiency. In subsistence agriculture, farmer combines, in his production process, essentially non tradable inputs and goods locally generated by household. But in a semi-commercialized agriculture, inputs are obtained by a combination of non-tradable and tradable goods. While in purely commercialized agriculture, inputs are mainly purchased from market and the objective of farmer remains profit maximization.

Although it seems commonly accepted in the literature that commercialization contributes to well-being improvement in rural area, serious difficulties remain about classification of farmers according to their degree of commercialization. Some studies such as Janvry et al.(1991) or Fafchamps (1992) propose a distinction based on food crops and cash crops. For these authors, allocation of household resources to these various types of crops can reflect the degree of commercialization. But distinction between food crops and commercial is still very far from achieving unanimity. Some are focused on the nature of the crop (food or non-food) or on the orientation (intended to be sold on the market or not) and others consider the proportion of household production sold on market. In this regard, several indicators have been proposed to measure the degree of commercialization of farm households.

von Braun et al.(1994) consider 3 types of indicators of commercialization. The first index measures the proportion of outputs and inputs bought on market to the total value of household production. Second index suggested is defined as the ratio of total of goods and services bought on market and household total incomes. The third indicator is related to the level household financial integration measured as the ratio of total cash transactions and household total incomes. Unlike the second indicator, this third indicator is interested only in household cash transactions while in the second, are taken into account all payments in natures.

Strasberg et al.(1999) use the HCI (Household Commercialization Index) which is the gross value of crop sales on the gross value of agricultural production. For theses authors, when HCI=0 means that household is entirely directed towards self-sufficiency. And when HCI→1 means very high degree of commercialization. Gabre-Madhin et al.(2007) propose some extensions of these preceding indices and add two additional indicators. The first is MP index (Market Position) made up of AMP (Absolute Market Position) and NMP (Net Market Position). Household market position is defined as the ratio of total volume of purchases and sales to the total volume of stock. The total volume of stock is defined as the total of inventoried stocks from one season to another. The second index is the household specialization index which measures the ratio of the total value of products purchased in market but non produced by household to the gross value of household production. This index aims to see how household is specialized in its production highlighting its comparative advantages. This makes it possible to see how household behaves in the production of goods for which it is more efficient and in the purchase of goods for which it is less efficient in the production.

This review helps to understand smallholder behaviors in their profit maximization process. It also highlights the effect market imperfections on these behaviors while credit access is considered as a factor limiting these imperfections. Based on these theoretical foundations, one supposes that access to inputs credits considered as a mean to limit market imperfections and to improve agricultural productivity, it can encourages farmer to orient his choices towards productions with high yields. This change in behavior results in an optimal allocation of agricultural surfaces and an increase in incomes from the sale of agricultural surplus. In an attempt to measure degree of commercialization, the different varieties of crop have been classified in 3 main groups: food crops, semi-commercial crops and purely commercial crops. It is considered that allocation of agricultural surfaces between these 3 groups can constitute a good indicator for degree of commercialization. This approach is then supported by considering the total amount of sales reported by household. Indeed, regarding the various indicators previously presented, ours remain however limited due to lack data relative to household total production.

2. Data and descriptive statistics

Data come from a household survey conducted by CERDI in Mali over the period April-May 2011 in the perspective of Impact Evaluation of the Multifunctional Platforms Program in Mali. Agricultural information were collected on households' like the number of plots, the total agricultural surface, inputs uses, modes of procurement in inputs, main cultivated crops and crop sales. In total, 2412 households were interviewed and approximately 51% of them received subsidized inputs credit granted by various actors in agricultural sector under cover of central government.

In the analysis, crops are classified in 3 different groups: cereals group, the group of roots, tubers, vegetables and fruits and the group of cotton and jatropha. These groups are defined on the basis of their role in feeding habits but also according to their character relatively commercial.

Cereals such as millet, sorghum, rice as well as corn represent the main crops grown in Mali and constitute households' feeding base. Unlike other types of crops such as vegetables, fruits and cotton, cereals are likely to be sold only when household subsistence level is reached. On the other hand, products such as tubers, even if they occupy an important place in feeding needs, can be directly produced for market commercialization. This is mainly for two reasons. First, these crops can easily be cash-converted because of their relative scarcity. Second reason is that they do not have a storage life comparing to cereals which can be stored in the attics until next season. In contrast cotton or jatropha, are purely commercial crops. For these differences, it appears necessary to make some distinction regarding preceding two categories. The idea would be finally to see, according to these 3 types of crops, what is the role of credit on farmer behaviors.

The following table provides information on the sample considered.

Table 1 Descriptive statistics

	Mean	SD	Min	Max	obs
Farmers characteristics					
Farm size (in hectares)	*7.85*	*6.46*	*0.125*	*56.75*	*2318*
% Households reporting cereals as main crop	*68.59*	---	---	---	*1654*
% Households reporting cotton/jatropha as main crop	*25.75*	---	---	---	*621*
% Households reporting Tubers, vegetables or fruits as main crop	*05.65*	---	---	---	*136*
% Households receiving input credit	*50.95*	---	---	---	*1229*
% Households selling a part of its harvest	*40.09*	---	---	---	*967*
Number of households	***2412***	---	---	---	*2412*
Land allocation behavior					
Households not receiving credit					
% acreage allocated to cereals	*0.84*	*0.22*	*0.00*	*1.00*	*1137*
% acreage allocated to tubers, vegetables or fruits	*0.15*	*0.21*	*0.00*	*1.00*	*1137*
% acreage allocated to cotton/jatropha	*0.009*	*0.05*	*0.00*	*1.00*	*1137*
Households receiving credit					
% acreage allocated to cereals	*0.71*	*0.19*	*0.00*	*1.00*	*1181*
% acreage allocated to tubers, vegetables or fruits	*0.17*	*0.18*	*0.00*	*1.00*	*1181*
% acreage allocated to cotton/jatropha	*0.11*	*0.15*	*0.00*	*0.86*	*1181*
Households reporting cereals as main crop					
% acreage allocated to cereals	*0.78*	*0.19*	*0.11*	*1.00*	*1590*
% acreage allocated to tubers, vegetables or fruits	*0.14*	*0.16*	*0.00*	*0.87*	*1590*
% acreage allocated to cotton/jatropha	*0.06*	*0.12*	*0.00*	*0.86*	*1590*
Households reporting cotton/jatropha as main crop					
% acreage allocated to cereals	*0.58*	*0.04*	*0.54*	*0.61*	*597*
% acreage allocated to tubers, vegetables or fruits	*0.10*	*0.01*	*0.09*	*0.11*	*597*
% acreage allocated to cotton/jatropha	*0.31*	*0.05*	*0.27*	*0.36*	*597*
Households reporting tubers, vegetables or fruits as main crop					
% acreage allocated to cereals	*0.42*	*0.39*	*0.00*	*0.96*	*131*
% acreage allocated to tubers, vegetables or fruits	*0.56*	*0.40*	*0.03*	*1.00*	*131*
% acreage allocated to cotton/jatropha	*0.008*	*0.03*	*0.00*	*0.13*	*131*
Average amount of credit received *(x 1000 in CFA)*	251.10	511.4	6.000	5205.5	1229
Cash earning from harvest selling (x 1000 in CFA)					
Earning from selling of Cereals	*403.3*	*696.4*	*4*	*4750*	*218*
Earning from selling of Cotton or jatropha	*1150*	*981.5*	*300*	*2000*	*673*
Earning from selling of Tubers, vegetables or fruits	*239.7*	*355.6*	*30*	*1250*	*179*
Total	***402.7***	***691.4***	***4***	***4750***	***1016***

1$US=456.52CFA in average over survey period

We first see on this table that 50.9% of interviewed households report having received credit of agricultural inputs. In growing season, average amount of credit received is about 251.1 thousands CFA with a very high dispersion from 6 thousands CFA to 5. 205 million CFA.

Concerning agricultural activities, the average farm size exploited is 7.85 hectares and approximately 69% of households report cereals as main crop. Slightly more than quarters of households cultivate cotton as their main crop and only 5.6% of households report having main crops constituted of tubers, vegetables defined in regard to classification previously evoked.

On the side of land allocation, we see that households not receiving credit allocate about 84% of their agricultural surface to cereals crops, 15% to tubers, vegetables and fruits and only

0.9% to purely commercial crops (cotton, jatropha). When we look at these proportions among households receiving credit, we find that the share of cereals is relatively lower than in the first group (71%) although cereals still dominant. We note however that the share of commercial crops is very high in this group, 11% of agricultural surfaces while no clear differences emerge with respect to intermediate crops (15% and 17%).

These statistics above show a significant difference in land allocation to cereals and cotton cultivations. This first result can be explained by the fact that, as 25% of households are cotton farmers, they might have an easy access to credit than other farmers. One can think so because there is a strong reverse causality between access to credit and cotton cultivation. In other words, “a farmer has credit because he cultivates cotton and reversely he cultivates cotton because he has credit”. But the role of credit can go beyond this simple correlation. For example a farmer can borrow credit on motive of cotton cultivation, but he may decide to use part of this credit in cereals production and other crops. For example in the case of inputs such as fertilizers and herbicides, a farmer can use both on cotton field and elsewhere to fertilize or maintain others crops. In this context, a better comprehension of land allocation behaviors requires adopting an econometric approach trying to control this apparent causality.

When we turn to land allocation between different groups of crops previously defined, we note in Table 1 that households reporting cereals as main crop give little place to cotton cultivation. On the other hand households cultivating cotton on principal basis allocate a significant part of their surface to cereal growing. This seems to reflect a certain form of hedge against risk by diversifying their agricultural activities. We note that in the first group the shares of agricultural land space allocated to cereals and to cotton are respectively 78% and 6%. While in the second group, these proportions are respectively 58% and 31%. That shows well that even in households where main reported crop is cotton, more than half of agricultural surface are devoted to cereals production. When we look at the side of household producing mainly vegetables, tubers and fruits, we note that the cotton cultivation still very marginal and is about 0.8% of total surface with a maximum of 13% observed. In this group composed predominantly of vegetable growers, distribution of surface is done mainly with cereals which occupy about 42%.

These statistics give a general overview on households land allocation behavior regarding their credit access status and main crops. However, these statistics may contain a certain limit which is necessary to note. Indeed, in the rural households, reported agricultural surfaces are likely to be subject to mixed crops system, a farming system generally composed of a principal crop and a secondary crop. Agricultural statistics tools can help to determine intensity and yield of each crop on the piece by means of agricultural survey. Unfortunately, this was not the objective of this survey. In this situation, not being able to provide accurate information about secondary crops, analysis is limited to principal crop representing which annual production is the highest. Nevertheless, in the remaining of analysis, no significant loss of information occurs because we are interested in sales of agricultural product. At this level, the concept of principal and secondary crops on a given piece of land loses relevance since we are focusing on the total sales of harvests and this no matter their nature.

In this regard, we noted in Table 1 that 40% of households report selling at least part of their harvests and sales yield on average 402.7 thousands CFA a year but with a very large variability in the sample going from 6 thousands to 4.750 million CFA. Obviously, highest incomes are realized from sales of cotton and jatropha which yield on average 1.150 million

CFA/year and represent about 3 times incomes from sales of cereals (302.3 thousands CFA/year) while sales of vegetables products yield approximately 239.7 thousands CFA.
Given gross returns of these various crops, can credit access influence farmers' agricultural choices? Trying to give a descriptive answer to this question, one can take the ratio income-credit for each type of crop. This ratio can be a simple way to measure performance or productivity of credit. Thus, farmer, being considered as a rational agent, could readjust his choices according to this productivity. That is the assumption on which is based our theoretical approach. And the purpose of the econometric section is to test empirically validity of this intuition.

3. Econometric models and estimation methods

As the objective is to try to measure the effect of credit access on the recipients' behaviors in land allocation and market orientation, we develop two econometric models to measure separately impact on production process through land allocation and impact which can observed through sales of agricultural products.

3.1 Credit and land allocation behaviors

Relation between access to credit and allocation of agricultural surfaces is tested by first determining share in total surface occupied by each type of crop reported by household. This share is calculated as the proportion of total surface farmer dedicates to each crop group. This calculation leads to form a system of three equations specified econometrically by relation (3):

$$S_{ij} = \beta_{0j} + \beta_{1j}X_i + \beta_{2j}T_i + \varepsilon_{ij} \qquad i = 1, \ldots, N;\ j = 1,2,3 \qquad (3)$$

Where S_{ij} represents proportion of total acreage farmer i dedicates to crop group j. Variable T_i represents inputs credit, X_i household characteristics and those of its economic environment and ε_{ij} stochastic errors.

Several variables are included in the model to control for other factors likely to influence surface allocation. These variables are essentially suggested in literature and encompass household characteristics: age of household head, his years of schooling, household size, number of children under 12 years, household dependency ratio, main used agricultural equipments. They also variables concerning villages characteristics in particular distance to the nearest market, local market size measured by the number of inhabitants in the village. We also add distances to paved and laterite roads considered as good indicators of village accessibility.

Endogeneity of credit

Credit access appears strongly endogenous. As mentioned in the descriptive section, there may be a reverse causality between credit and land allocation. Moreover, credits are generally distributed by financing institutions with a strong involvement of villages associations and agricultural cooperatives which provide guarantees through joint liability. And individual producers must submit their needs via these producers' organizations which can decide to support or not these individual requests. This generates a form of selection or endogeneity in credit access. One way to deal with this problem is the use of instrumental variable approach. Challenge is then to find an instrument which explains land allocation only through its effect on credit.

In the literature some studies such as Ricker-Gilbert (2008) and Godvin (2011) try, in their estimations, to correct endogeneity of credit by using instrumental variable method. On households data in Ghana, Godvin (2011) uses household distance from to the source of information on program of credit. More precisely, he uses distance between household residence and the point of distribution of credit vouchers. For this, he supposes that households that are too distant from the points of distribution are less likely to have credit because of difficulty to access information on program of credit. On the other side, in Malawi, credit distribution is essentially seen as a local management concern. That is why Ricker-Gilbert (2008) uses as instrument for credit access, household residence duration in village i.e. number of years since household lives in the village. According to author, residence duration can determines household socio-political capital which is often necessary to get credit. According to him, household which has a socio-political tenure in village is more socially connected and has a certain influence making. Thus this household can easily get credit relatively to others that are less connected.

In this study, we use an instrument relatively similar to that of Ricker-Gilbert (2008). It is household participation in community interest works in village. One can think that household which participates regularly in community activities such as labor supply for construction of a public edifice in the village (school, health center …) or regular participation in social and cultural activities, acquires a good reputation and renown in the village. Good reputation in village could lead to confidence which is largely necessary in credit contracts. Thus household, participating in community works develops and weaves a social network which can include any potential village decision maker responsible for distribution of credit. Consequently, whether member of agricultural cooperative or not, this household is more likely to obtain credit relatively to a household that is not sufficiently involved in community activities. Validity of this instrument is examined and results of tests are provided in Table 2 obtained from instrumentation equations related to the first stages of estimations results.

Table 2 Summary results for first-stage regressions

	Probability of receiving credit(Probit)			Amount of credit received (OLS)		
	Coef.	Std.Err.	P>|t|	Coef.	Std.Err.	P>|t|
Age household head	-0.0043	(0.0032)	*0.17*	-0.0009	(0.0028)	*0.747*
Year schoolling househ head	-0.0231	(0.0126)	*0.067*	-0.0035	(0.0196)	*0.860*
Household size	0.0211	(0.0232)	*0.364*	-0.0283	(0.0353)	*0.423*
Nber children under 12	-0.0021	(0.0494)	*0.966*	0.1472	(0.0609)	*0.017*
Household Dependancy ratio	-0.0928	(0.1103)	*0.400*	-0.3453	(0.1455)	*0.019*
Agricultural cooperative in village	0.2159	(0.1079)	*0.045*	0.1697	(0.2185)	*0.438*
Participate in Community work in the village	0.2714	(0.1135)	*0.017*	0.5223	(0.1657)	*0.002*
Participate in economic interest group	0.1683	(0.1489)	*0.258*	0.5057	(0.3473)	*0.147*
Use of animal traction	0.4598	(0.1293)	*0.000*	0.6483	(0.1893)	*0.001*
Use of tractor machine	0.8630	(0.2954)	*0.003*	3.0284	(1.2009)	*0.012*
Distance to market	0.0058	(0.0073)	*0.424*	0.0061	(0.0075)	*0.415*
Local market size(population village)	0.0000	(0.0000)	*0.567*	0.0001	(0.0001)	*0.232*
Distance to paved road	-0.0047	(0.0017)	*0.006*	-0.0027	(0.0018)	*0.135*
Distance to laterite road	0.0080	(0.0046)	*0.085*	0.0019	(0.0046)	*0.683*
Dummy Region 2	0.9820	(0.2071)	*0.000*	0.2638	(0.1159)	*0.024*
Dummy Region 3	0.3073	(0.2330)	*0.187*	-0.0527	(0.1550)	*0.734*
Dummy Region 4	1.1608	(0.2016)	*0.000*	0.2481	(0.1662)	*0.137*
Dummy Region 5	2.0767	(0.1881)	*0.000*	1.6125	(0.3523)	*0.000*
Constante	-2.0619	(0.3016)	0.000	-0.9632	(0.3084)	*0.002*
Inverse Mills Ratio	-----	-----	-----	0.8331	(0.4787)	*0.086*
Nber obs			2197			2142
PseudoR2/R2			0.365			0.175
Chi2(18)/ F(19,200)			403.1			9.250
Prob>Chi2/Prob>F			0.000			0.000

Excluded instrument : Participate in Community work in the village
Angrist-Pischke multivariate F test of excluded instrument: F(1, 200)= 15.51 Prob> F = 0.0001
Kleibergen-Paap Underidentification test : Chi-sq(1)=13.52 P-val=0.0002
Kleibergen-Paap Weak identification test using Stock-Yogo critical values F=15.51>8.96(15% LIML size)
Hansen overidentification test P.value= 0.000 (equation just identified)

Robust standard errors adjusted for 201 clusters(villages)

In addition to household participation in community work variable which meets exclusion and orthogonality conditions, other factors seem to influence access to credit. In first, we note that presence of agricultural cooperative acts positively on the probability of access to credit even if its influence on the amount of credit is not significant. It also appears that producers using agricultural machineries (animal traction and machine tractor) have a very high probability of access to credit and a high possibility of having a very high amount. These results are significant at least at the maximum error of 5%. Distance to paved road seems to influence negatively the probability of access to credit but not significant effect is observed on the received amount. But this result is nuanced by influence related to laterite road which shows a significantly positive effect on the probability of access to credit at 10% level. However results concerning these accessibility variables should be interpreted with some restraint because they are not fulfilling exclusion conditions as they are variables supposed to act on both access to credit and the left hand side variable. Same situation occurs regarding years of schooling of household head which seems negatively correlated with participation in the program of credit at 10% level.

Concerning the validity test of excluded instrument, we find that participation in community activities seems to be a good instrument. Indeed, this variable is positively and significantly correlated with the probability of receiving credit at 5% and correlated with the amount of credit at 1%. For its validity, the Angrist-Pischke exclusion test provides a F-stat equal to 15.51 exceeding the *ad hoc* threshold of 10 tabulated by Staiger and Stock (1997). This leads to rejection of weak identification hypothesis at 1% (hypothesis of weak instrument). Relaxing *i.i.d* hypothesis on errors and retaining cluster structure of data, the F-test suggested by Kleibergen and Paap (2006), obtained by modification that of Cragg-Donald (1993), seems more appropriate to test instruments weakness in clustered sample. Results of this test give a F=15.51 which is higher than 8.96 corresponding to the size of maximum distortion at 15% level in a LIML estimation according to Stock and Yogo (2005) tabulation. This leads to reject once more the null hypothesis of weak identification. These first tests are then supported by the LM test of Kleibergen-Paap testing the underidentification hypothesis. Given preceding results, results of this test would be obvious. But this time, the approach consists to test the rank of coefficient matrix of the reduced form of structural equation expressed in function of excluded instrument. Under hypothesis of underidentification, the rank of this matrix is $R = K - 1$ where K is the number of endogenous variables($K = 1$). Hence, it is to test $R = 0$. Under the null, this statistic is distributed as a Chi2 with $L - K + 1$ degrees of freedom. Where L is the number of excluded instruments($L = 1$). Given the Pvalue associated with this test we can reject the null hypothesis at the 1% level. However, given the uniqueness of excluded instrument, the Hansen test of overidentification is not conclusive. So the equation of credit remains just identified, but it appears to be technically adequate regarding identification condition.

This control of endogeneity of credit allows adding an identification equation to the econometric specification defined by equation (3) to thereby form a system of structural equations presented in the following form:

$$\begin{cases} S_{1i} = \beta_{01} + \beta_{11}X_i + \beta_{21}T_i + \varepsilon_{i1} \\ S_{2i} = \beta_{02} + \beta_{12}X_i + \beta_{22}T_i + \varepsilon_{i2} \\ S_{3i} = \beta_{03} + \beta_{13}X_i + \beta_{23}T_i + \varepsilon_{i3} \\ T_i = \beta_{04} + \beta_{14}X_i + \beta_{24}Z_i + \varepsilon_{i4} \end{cases} \qquad i = 1, \dots, N \qquad (4)$$

This system is estimated by adopting the 3SLS procedure. The choice of 3SLS is particularly due to the fact that it gives possibility to improve estimators. By using residuals of each equation of the system to perform a feasible generalized least squares (FGLS), it makes it possible to correct any form of heterocedasticity and possible correlation of errors.

By compiling data on the *N* households in equation (4) we can write the system in a matrix form:

$$Y = H\beta + \epsilon \quad \text{with} \quad E(\epsilon\epsilon') = \sum \qquad (4')$$

Where $\sum$ represents variance-covariance matrix of errors. Each equation in this system (4′) is estimated by 2SLS to then determine instrumented values of endogenous variables. This instrumented values are grouped in a matrix expressed as follow:

$$\hat{H}_j = X(XX')^{-1}X'Z_i \quad j = 1, \dots, 4 \qquad (5)$$

In the second step we use residual matrix of each equation estimated in first stage to calculate the estimated value of $\sum$ and apply the transformation of Aitken (1935) and then we estimate transformed equation by FGLS to determine $\hat{\beta}$. Thus we have:

$$\hat{\Sigma} = \frac{\hat{\epsilon}\hat{\epsilon}'}{N}$$

$$\hat{\beta}_{3SLS} = \left(\hat{H}'\left(\hat{\Sigma}^{-1} \otimes I\right) \hat{H}\right)^{-1} \hat{H}'\left(\hat{\Sigma}^{-1} \otimes I\right) Y \qquad (6)$$

Where I is a $N \times N$ unitary matrix , $\otimes$ is Kronecker product.

The system is first estimated by considering access to credit as a binary variable taking 1 if household received credit during crop season and 0 otherwise. Results of this estimation are presented in Table 3. The second estimation is performed by replacing access status by amount of credit received by farmer. In this estimation, amount of credit is considered 0 for households without access to credit. However, this treatment could lead to an estimation bias if relevant techniques are not applied to control this systematic selection. For this, we use the inverse of Mills Ratio obtained from equation related to the probability of receiving credit. This correction factor is generated and introduced into equation of amount of credit to control selection bias. Results of estimations with amount of credit are provided in Table 4.

Table3: Impact of inputs credit on farmer land allocation

3SLS	% of farm acreage dedicated to Cereals	% dedicated to tubers, vegetables and fruits	% dedicated to cotton or jatropha
Credit(=1 if receives credit)	-0.5645***	-0.0091	0.0656***
	(0.1031)	*(0.0099)*	*(0.0058)*
Age household head	0.0083**	-0.0007**	-0.0001
	(0.0037)	*(0.0004)*	*(0.0002)*
Year schoolling househ head	0.0397**	-0.0058***	0.0018**
	(0.0168)	*(0.0016)*	*(0.0009)*
Household size	-0.0108	0.0009	0.0001
	(0.0293)	*(0.0028)*	*(0.0016)*
Nber children under 12	-0.0097	-0.0032	0.0042
	(0.0572)	*(0.0055)*	*(0.0032)*
Household Dependancy ratio	0.1202	-0.0087	-0.0034
	(0.1211)	*(0.0116)*	*(0.0068)*
Agricultural cooperative in village	-0.0904	-0.0018	0.0108**
	(0.0941)	*(0.0090)*	*(0.0053)*
Participate in economic interest group	-0.0754	0.0109	-0.0034
	(0.1774)	*(0.0169)*	*(0.0099)*
Use of animal traction	0.2822**	-0.0397***	0.0115
	(0.1336)	*(0.0128)*	*(0.0075)*
Use of tractor machine	0.1568	-0.0234	0.0078
	(0.3430)	*(0.0328)*	*(0.0192)*
Distance to market	0.0155***	-0.0011**	-0.0005
	(0.0053)	*(0.0005)*	*(0.0003)*
Local market size(population village)	0.0029	-0.0036	0.0007
	(0.0024)	*(0.0023)*	*(0.0013)*
Distance to paved road	0.0035**	-0.0002*	-0.0001
	(0.0014)	*(0.0001)*	*(0.0001)*
Distance to laterite road	0.0042	-0.0005*	0.0001
	(0.0031)	*(0.0003)*	*(0.0002)*
Dummy Region 2	-0.6211***	0.0817***	-0.0196**
	(0.1649)	*(0.0158)*	*(0.0092)*
Dummy Region 3	1.7994***	-0.1531***	-0.0269***
	(0.1583)	*(0.0151)*	*(0.0089)*
Dummy Region 4	0.6051***	-0.0592***	-0.0014
	(0.1556)	*(0.0149)*	*(0.0087)*
Dummy Region 5	-0.6183***	0.0152	0.0466***
	(0.1584)	*(0.0151)*	*(0.0089)*
Constante	7.3261***	0.2704***	-0.0030
	(0.2697)	*(0.0258)*	*(0.0151)*
Observations	2197	2197	2197
F-stat	39.02	22.37	36.32
Prob F-stat	0.000	0.000	0.000
R-squared	0.2438	0.1560	0.2309

Robust clustered standard errors in parenthsesis adjusted for 201 clusters., ***p<0.01, **p<0.05, *p<0.1

Table 4: Impact of amount of credit on farmer land allocation

3SLS	% of farm acreage dedicated to Cereals	% dedicated to tubers,vegetables and fruits	% dedicated to cotton or jatropha
Amount of credit	-0.5268***	-0.1877***	0.7145***
	(0.0682)	*(0.0660)*	*(0.0347)*
Amount of credit squared	0.0431***	0.0140	-0.0571***
	(0.0098)	*(0.0094)*	*(0.0050)*
Age household head	0.0077**	-0.0073**	-0.0004
	(0.0037)	*(0.0035)*	*(0.0019)*
Year schoolling househ head	0.0407**	-0.0585***	0.0178**
	(0.0169)	*(0.0163)*	*(0.0086)*
Household size	-0.0054	0.0071	-0.0017
	(0.0292)	*(0.0283)*	*(0.0149)*
Nber children under 12	-0.0021	-0.0149	0.0170
	(0.0570)	*(0.0551)*	*(0.0290)*
Household Dependancy ratio	0.1262	-0.1245	-0.0017
	(0.1204)	*(0.1165)*	*(0.0612)*
Agricultural cooperative in village	-0.0868	0.0032	0.0836*
	(0.0936)	*(0.0906)*	*(0.0476)*
Participate in economic interest group	0.0268	0.0408	-0.0676
	(0.1792)	*(0.1734)*	*(0.0911)*
Use of animal traction	0.3900***	-0.3841***	-0.0059
	(0.1332)	*(0.1289)*	*(0.0677)*
Use of tractor machine	0.3014	-0.1370	-0.1644
	(0.3449)	*(0.3337)*	*(0.1753)*
Distance to market	0.0156***	-0.0102**	-0.0054**
	(0.0052)	*(0.0050)*	*(0.0027)*
Local market size(population village)	0.0028	-0.0030	0.0002
	(0.0024)	*(0.0023)*	*(0.0012)*
Distance to paved road	0.0036***	-0.0023*	-0.0014*
	(0.0014)	*(0.0014)*	*(0.0007)*
Distance to laterite road	0.0039	-0.0056*	0.0017
	(0.0030)	*(0.0029)*	*(0.0015)*
Dummy Region 2	-0.7381***	0.8915***	-0.1534*
	(0.1651)	*(0.1598)*	*(0.0839)*
Dummy Region 3	1.7878***	-1.5232***	-0.2645***
	(0.1585)	*(0.1534)*	*(0.0806)*
Dummy Region 4	0.5751***	-0.5426***	-0.0324
	(0.1534)	*(0.1484)*	*(0.0779)*
Dummy Region 5	-0.4794***	0.2891*	0.1903**
	(0.1538)	*(0.1488)*	*(0.0782)*
Constante	7.1835***	2.6652***	0.1514
	(0.2691)	*(0.2604)*	*(0.1368)*
Observations	2142	2142	2142
F-stat	37.02	19.78	62.16
Prob F-stat	0.000	0.000	0.000
R-squared	0.2683	0.1639	0.3811

Robust clustered standard errors in parenthsesis adjusted fo 201 clusters., ***p<0.01, **p<0.05, *p<0.1

3.2 Access to credit and degree of commercialization

In this section, we are interested in the impact of credit on total sales of agricultural products. As supposed previously, credit is considered as a factor of productivity improvement which can translate in an increase in farmer potentiality of sales because of production surplus but also in increase in household degree of commercialization. This hypothesis is tested through the following econometric specification:

$$Y_i = \alpha_0 + \alpha_1 X_i + \alpha_2 T_i + u_i \qquad i = 1, \ldots, N \qquad (7)$$

Where Y_i represents degree of market participation of household i. This degree of participation is captured by total sales of household agricultural products. T_i represents credit variable and X_i household characteristics and those of its economic environment and u_i the errors.

Three methods of are proposed to estimate this equation. The first is Limited Information Maximum Likelihood estimation (LIML). This is a general method defined among *k-Class estimators* with $k = \lambda$. It includes 2SLS when $k = 1$ and equivalent to OLS when $k = 0$ (Davidson and MacKinnon, 1993). In presence of homoscedasticity, LIML still asymptotically equivalent to 2SLS, but, one of the advantages of LIML over 2SLS is that it remains invariant to any normalization used in the system and appears adapted in presence of a potential weakness of instruments (Greene, 2003; Hahn, Hausman et Kuersteiner, 2004, Baum et Schaffer, 2007). Results of this estimation correspond to model 1 in Table 5.
In descriptive statistics, it was found that only $2/5$ of households report having sold part of its harvests. This generates a very high frequency of corner solutions. And to attempt to correct this problem, we perform the instrumental variable Tobit estimation. This method is suggested by Wooldridge (2003) which proposes a Maximum Likelihood Estimation of joint distribution of left hand side and endogenous variables conditionally on exogenous variables of the system. The results of this regression are presented in the column (2) of Table 5.

Moreover, to improve analysis, it would be necessary to distinguish effect of credit on household orientation choice towards market from effect on degree of participation (terminologies used by Moti and Berhanu, 2010). For that, we use *Cragg-model* or *Double-Hurdle model* which provides possibility of separating these two levels of analysis. Indeed some households receiving credit report not selling their harvests whereas certain households not receiving credit are market oriented. The goal of distinction is simply to be able to separate probability of participation in market and degree of commercialization. The Tobit model does not give an explanation to corner solutions. It is limited only to explain the probability of a positive outcome.

The best alternative, which seems adapted is *Double-Hurdle model* proposed by Cragg (1971). This estimation method explains both probability of observing a positive value and effect on quantity$[P(Y > 0|X, Z); E(Y|X, Z; Y > 0)]$. Questions now are: what is the household' probability of participation in market according to credit status and what is the real effect of credit on degree of commercialization. Cragg (1971) suggests estimating the first level by Probit and the second level by a truncated regression in which residuals have a truncated normal distribution. Results of these estimations are presented in Table 5 in the two columns of model (3).

Table 5: Impact of amount of credit on crop selling

	(1)	(2)	Double-Hurdle Model(3)	
Variables	**LIML**	**IVTOBIT**	**PROBIT**	**TRUNCREG**
Amount of credit	0.5488**	1.5911**	0.1708***	0.1661***
	(0.2746)	*(0.8093)*	*(0.0423)*	*(0.0475)*
Age household head	0.0086	0.1588*	0.1463**	0.3584
	(0.0247)	*(0.0818)*	*(0.0636)*	*(0.3895)*
Year schoolling househ head	0.0340*	0.1317**	0.0538	1.3180*
	(0.0205)	*(0.0657)*	*(0.0539)*	*(0.7696)*
Farm size	0.2343***	0.3573***	0.0903*	-0.0877
	(0.0436)	*(0.1004)*	*(0.0476)*	*(0.0833)*
Household size	-0.1275**	-0.4132*	-0.2624***	-0.3523
	(0.0576)	*(0.2286)*	*(0.1014)*	*(0.3807)*
Farm sizeX Household size	0.0496	0.0156	0.0507	-0.0580
	(0.0325)	*(0.0458)*	*(0.0669)*	*(0.0704)*
Nber children under 12	0.0826**	0.2573**	0.1154**	-0.1950***
	(0.0359)	*(0.1221)*	*(0.0487)*	*(0.0642)*
Household Dependancy ratio	-0.1087***	-0.3181**	-0.1441**	0.6217
	(0.0407)	*(0.1490)*	*(0.0722)*	*(0.4395)*
Agricultural cooperative in village	0.0975**	0.3871**	0.0135	0.5254***
	(0.0460)	*(0.1848)*	*(0.0160)*	*(0.1867)*
Participate in economic interest group	-0.0084	-0.0690	-0.0637	0.0390
	(0.0307)	*(0.0741)*	*(0.0504)*	*(0.2729)*
Use of animal traction	-0.0068	-0.0377	-0.0810	1.6451**
	(0.0161)	*(0.0740)*	*(0.0566)*	*(0.6992)*
Use of tractor machine	0.2384**	0.3514**	0.0055	0.6443***
	(0.1168)	*(0.1466)*	*(0.0651)*	*(0.1520)*
Distance to market	-0.0049	-0.2275*	-0.0321**	-0.4346**
	(0.0212)	*(0.1270)*	*(0.0126)*	*(0.1771)*
Local market size(population village)	0.0642**	0.1068	-0.0082	-0.0382
	(0.0277)	*(0.0675)*	*(0.0505)*	*(0.0760)*
Distance to paved road	-0.0046	0.0158	0.1084	-0.9907
	(0.0187)	*(0.1263)*	*(0.0953)*	*(0.8729)*
Distance to laterite road	0.0008	-0.2167*	-0.1750	-4.2765*
	(0.0149)	*(0.1136)*	*(0.1068)*	*(2.3784)*
Dummy Region 2	-0.0837	0.3588	0.3294	0.9615
	(0.0635)	*(0.3736)*	*(0.2619)*	*(4.1670)*
Dummy Region 3	-0.0678	-1.5935**	-1.0703***	17.9614***
	(0.0559)	*(0.6963)*	*(0.4104)*	*(6.0024)*
Dummy Region 4	-0.2713***	0.1817	0.4321*	2.2503
	(0.0819)	*(0.2852)*	*(0.2604)*	*(3.9241)*
Dummy Region 5	-0.0829	0.0118	-0.1203	3.7522
	(0.0831)	*(0.3517)*	*(0.2438)*	*(3.8963)*
Constante	0.0162	-2.9337***	-1.2528***	-22.8143***
	(0.1207)	*(0.6610)*	*(0.3190)*	*(5.3494)*
Observations	2142	2142	2142	2142
F-stat/Chi2	8.01	147.01	101.6	42.09
Prob>F/Prob>Chi2	0.000	0.000	0.000	0.001
R-squared/pseudo R2	0.4192	--------	0.5049	--------

Robust clustered standard errors in parenthsesis , Bootstrap standard errors for model (3), ***p<0.01, **p<0.05, *p<0.1

4. Discussion of results and conclusion

Models we have estimated were improved by introducing other control variables to try to capture factors that can influence households land allocation behavior and its degree of commercialization.

First, we find that household characteristics play a central role in agriculture market orientation. We noted that age of farm head is positively correlated with the proportion of agricultural surface dedicated to cereal crops and negatively correlated with the development of intermediate crops. But no significant effect is observed on purely commercial crops. Results also show that household heads' educational level acts positively on both cereal and commercial crops but with a negative effect on intermediate crops (Tables 3, 4 and 5). This would probably means that most educated household heads are those with a high skills and capacity to access and process information related to market situation leading to a form of efficiency in the production process

After controlling for households characteristics, we also find that distance to market negatively influences household commercial orientation and degree of commercialization (Tables 3, 4 and 5). Results concerning commercial orientation in particular surfaces allocation towards market oriented crops, show that distance to market favor cereal crops to the detriment of semi-commercializable crops (Tables 3 and 4). But its impact on purely cash crops remains ambiguous because effect is not significant in Table 3 and appears negative in Table 4. This last result would be rather a reflection of lack of access to information. For example, one can think that households that are more distant from markets are those which have less access to information related to the evolution of situations concerning cash crops market even if these crops are mainly intended for export. A similar result is observed on to nearest paved road and substantially on distance to laterite road. These variables, considered as village accessibility indicators, tend to favor development of non-tradable crops mainly intended for household consumption. Especially these accessibility variables discourage growing semi-commercial and purely commercial crops mainly because of transactions costs they generate. In this case, as suggested in the literature, distance to market and distances to permanent roads are factors that influence negatively commercial orientation and thus degree of commercialization of agriculture in rural area.

Effects of credit

Concerning impact of inputs credit, results presented in Table 3 show that access to credit favors development of cash crops to the detriment of food crops while its effect seems not significant on vegetable crops and tubers. This result tends to reinforce our idea that access to inputs credit favors land allocation towards high yields crops. But analysis done by considering amount of credit shows that beyond simple access to credit, the amount of credit has a nonlinear effect on surface allocation (Table 4). Significance of quadratic term of amount shows that the amount of credit encourages, at first, cash crops by discouraging food and intermediate crops. And then, an amount of credit sufficiently important leads farmer to decrease the share of cash crop to develop food crops.

This seems rather logical since a very high amount of credit means sufficient availability of productive resources that gives possibility to farmer to grow other crops. Consequently sufficient availability of resources resulting in an improved productivity leads to a high commercialization. This relation is tested in Table 5 where we find that amount of credit acts positively on degree of commercialization. This result remains statistically significant at any significant level lower than 5%. Thereafter, while trying to distinguish effect of credit on commercialization choices from his impact on degree commercialization, one arrives to results that not only credit influences farmer orientation choices towards market but also its degree of participation in market.

Despite of the use of relatively rigorous estimations techniques, this study still remains a relatively summary attempt because of unavailability of sufficient data for a better analysis of effect of such agricultural credit program. Indeed, a more thorough analysis would require to have broad and detailed information on program operation. That would allow determination of a credible counterfactual group in order to be able to implement more specialized techniques. Nevertheless, results of this study suggest encouragement of any initiative aiming to promote access to agricultural inputs. This could lead to create conditions of a durable food safety and a strong participation of peasantry in market for an effective fight against poverty and welfare improvement in rural area.

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