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# Family Farms and Investment Capacities

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*This article aims to shed light on the conditions under which family farmers in developing countries could be able to invest and develop. This question is of particular interest in the Office du Niger area in Mali because, since 2006, the Malian government has been seeking to attract new investors there, under the assumption that they will be more able than family farmers to develop agriculture. On the other hand, the main union of family farmers in this area promotes investment by family farmers themselves. Based on the farming system concept, a thorough field survey was carried out, combining quantitative and qualitative methods for data collection and processing. The data analysis shows that access to properly irrigated land, and access to short and medium-term credit to purchase inputs and equipment, are currently the main factors limiting farm productivity and investment capacities. The study suggests that for agriculture to develop in Mali, the peasant way is fully credible.*

*Keywords: farming system, agricultural surplus, irrigation scheme, land grabbing, Mali.*

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## Introduction

After decades of neglect of the agricultural sector in many developing countries, by both national governments and international public aid (Lipton 1977; Krueger, Schiff and Valdés 1991; World Bank 2007), a broad consensus has emerged on the need to invest in this sector. This is well illustrated by the World development report 2008 of the World Bank. While this report is ambiguous as to the kind of players best placed to invest in agriculture, this issue has raised a debate, especially since large-scale corporate and public investments have developed following the agricultural prices spike on international markets in 2007/08. Some consider these investments mainly as a source of livelihood opportunities for those living in rural areas in poor countries, recognizing however that some risks do exist but judging that they can be managed by appropriate government sponsored institutions (Deininger and Byerlee 2011). Others, concerned by the risk of marginalization of family farmers, reflect on collaborative business models that may structure agricultural investments so that they benefit family farmers to some extent (Cotula and Leonard 2010; Vermeulen and Cotula 2010). Others still consider that most investments in smallholder agriculture are made, and are to be made, by smallholders themselves, mainly through labor investments, while acknowledging that many constraints burden these investments (Scoones et al. 2010; Lowder, Carisma and Skoet 2012; HLPE 2013).

On the other hand, the history of many parts of the world in recent decades shows that, with the support of appropriate policies, family farmers have been able to

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invest, to increase their production, productivity, and competitiveness. It has been true in Asian countries that pursued green revolution policies from the mid-1960s onward (Hazell and Ramasamy 1991; Mellor 1998; Trébuil and Hossain 2004; Griffon 2006; De Janvry and Byerlee 2009). Elsewhere in North America and in Western Europe, from the 1930s and 1950s respectively, it is family farmers who, beyond the public investments and the private investments in agricultural commodity chains upstream and downstream of the production stage, have made the productive investments needed to complete the second major agricultural revolution of the Modern Era, which has resulted in an enormous accumulation of fixed and circulating capital in family farms, and huge productivity gains (Mazoyer and Roudart 2000, 2006; Weis 2007; McMichael 2009; Roudart and Mazoyer 2012).

The objective of this paper is to analyze whether family farms in the Office du Niger zone in Mali are able to accumulate capital from agricultural activities. This question is of particular interest because, since 2006, the Malian government has been seeking to attract new investors there, public or private, national or foreign (Cotula et al. 2009; Oakland Institute and CNOP 2011). It has done so for lack of money to develop new irrigated land, but also under the assumption that these new investors will be more able than family farmers to develop agriculture in this area (Adamczewski et al. 2013). About 500 potential investors might have obtained a license, for a total of about 600,000 hectares (ha) in 2011 (Hertzog et al. 2012), more than six times the area currently irrigated and cultivated in the zone. However, the flow of the Niger River and the capacity of the irrigation system will not allow to irrigate such an area, which suggests conflicts over access to water. In this context, the main union of family farmers in the area, namely the SEXAGON (Syndicat des exploitants agricoles de l'Office du Niger), took position on the land question. SEXAGON (2009, 2010) claims that the lack of access to irrigated land is one of the main factors limiting the productivity and investment capacity of family farms in the area. Therefore, it demands greater and more secure access to irrigated plots by family farmers.

Thus, in this article, we analyze the economic feasibility of the strategy proposed by the SEXAGON. We first briefly present the main features of agriculture in this area, before to expose our research approach, to analyze the results and limitations of this research, and then to conclude.

## Main features of agriculture in the Office du Niger zone

### *Irrigated crops*

The Office du Niger zone is an irrigated area of about 86,000 ha located in the Niger River Inner Delta. This is a gravity irrigation scheme, originating in the water that accumulates behind the dam of Markala (Office du Niger 2010).

This zone began to develop in 1932, under the aegis of the French authorities. Its development experienced many setbacks, so that it was almost abandoned in the late 1970s. Yet, at that time, stakeholders—including farmers, the State, the Office du Niger and donors—decided to begin a process of rehabilitation of water infrastructures, and a gradual introduction of technical cum institutional innovations. This process stretched over a period of nearly 20 years, during which family farmers greatly increased crop yields, raised the number of harvests per year and diversified crops—in different ways according to their ecological, economic and social conditions—to the point that many authors consider this

renaissance of the zone as a success story (Jamin 1994; Coulibaly 1997; Couture et al. 2002; Kuper, Tonneau and Bonneval 2002; Aw and Diemer 2005).

Today, the main crop is by far rice, which occupies almost all developed surfaces in the wet season (from June to October) and in the early dry season (November–December). A second rice crop occupies less than 20% of the irrigated land during the hot dry season (from February to June). Vegetable crops—especially shallot but also peanut, sweet potatoe, okra, tomato—occupy about 5% of the irrigated area during part of the dry season (November–March) (Dave et al. 2012). Sugarcane is grown throughout the year in one large farming unit. The main type of livestock is cattle, which is raised extensively in the savanna. Some goats, sheep and poultry are raised in the farmyards.

*Family farms almost exclusively*

Almost all farming units are family farms (Coulibaly, Bélières and Koné 2006; Bélières et al. 2011) in which all (or nearly all) the agricultural work is performed by members of the manager's family. They number between 22,635 (our estimate obtained by dividing the total irrigated area of the zone (86,201 ha) by the average size of family farms according to our survey (3.81 ha)) and 43,000 (Office du Niger's estimate (2010), probably overstated as a farmer with land in two villages is counted twice, and some peasant families pretend to be separated in order to try to have access to more land). Irrigated land is allocated to family farms by the administration of the Office du Niger, which recognizes that the shortage of land relative to demand has become such that the official criteria for land allocation are no longer operational (Office du Niger 2008). In fact, these criteria are ambiguous. Based on our survey, the farms size vary between 0.25 and 30 ha, with all their land being irrigated, and this size is only weakly correlated with the family size.

Peasant families have variable sizes ranging from 2 to over 100 individuals, and include between 1 and 10 households. Nearly all households are managed by a man (female headed households do exist but are very rare). They comprise one to four maternal cells, that is a group formed by a mother and her children (which corresponds to the word baa-bôdâ in the Bambara language), as, under the Islamic law, a man can have up to four wives. Each maternal cell includes between 0 and 10 children. Thus, the number of agricultural workers as well as the consumption needs vary greatly from one family to another.

Moreover, in this area as in most other rural areas of developing countries, many farmers practice also nonagricultural activities (Ellis 2000; Haggblade, Hazell and Reardon 2007, 2010; Davis et al. 2010). Several authors have underlined that such activities constitute a coping strategy for survival rather than an accumulative strategy (Bezu and Barrett 2010; Losch, Fréguin-Gresh and White 2012). That is the case for the large majority of rural non farm activities in Mali (CEPIA et al. 2007; Michigan State University et al. 2008).

On the other hand, these activities, whether agricultural or not, may be carried out individually (responsibility, products and related costs amounting to the person who engages in them), or by a small group within the family (a maternal cell for example), or by the entire family. In this last case, responsibility, products and related costs then accrue to the manager. In rural African societies, this overlap of activities, decision levels and objectives pursued at every level was already well explained by Ancey (1975) and we took this into account in the framing of our research object.

In family farms, the manager is usually the head of the family. He has a responsibility to ensure the renewal of the farm as well as the satisfaction of the current consumption needs of the family members (Coulibaly, Bélières and Koné 2006). This is a difficult task, which often entails tensions or even conflicts with other family members according to their status (male or female, old or young, married or single etc.) and personality. However, this type of analysis is beyond the scope of our work.

## Research method

To assess whether family farms in the Office du Niger area may or may not accumulate capital, we used the concepts of farming system, family farm income and net investment capacity in an in-depth field survey of farm managers and family members.

*Farming system, family farm income, net investment capacity*

The concept of farming system has received several definitions, in the tradition of both French-speaking and English-speaking authors (Brossier, de Bonneval and Landais 1993; Colin and Crawford 2000; Gafsi et al. 2007; Gilbert, Norman and Winch 1980). Drawing on Chombart de Lauwe and Poitevin (1957), we consider that a farming system is the combination of production factors and production activities on a farm. Production factors are land, labor, equipment and farm buildings. As for production activities, for each crop, the sequence of operations carried out from soil preparation to harvest, the products obtained and the costs for each operation were studied in detail. Similarly, for each species of animal raised we examined the sequence of operations performed since the birth of an animal until its sale or consumption, the products obtained and the costs for each operation.

With such a definition, the concept of farming system can also be used to represent a set of farms whose production factors and production activities are similar enough so that they are classified into one category. Two criteria were adopted to classify the farms: the characteristics of the farm equipment and the combination of production activities (Mazoyer 1963, 1992).

As mentioned above, family farms in the Office du Niger area are complex entities that combine agricultural and non agricultural activities at different levels of decision. The concept of farming system was used to analyze agricultural activities carried out by the whole family under the responsibility of the farm manager. Agricultural activities conducted individually or by a sub-group do not contribute to the investments made under the family farm as a whole, therefore they should not be taken into account when evaluating the net investment capacity of the family farm.

We call annual family farm income the income accruing to the agricultural activities under the whole family. This income is equal to the value of plant and animal products (consumed on farm or sold) less the value of goods and services consumed to produce them. It is decreased, as appropriate, by wages, land rents and interest on capital borrowed, and augmented, where applicable, by receipts from the provision of agricultural work for others (plowing, threshing, etc.). Goods and services consumed to produce are of two types: intermediate inputs (seeds, fertilizers, pesticides, animal feed, veterinary fees, etc.), and the depreciation and maintenance of the farm equipment and buildings.

We call net investment capacity the difference between the family farm income

and the value of consumption needs supported by the farm manager. The income derived from non-farm activities is not considered here because, as mentioned above, the overwhelming majority of these activities are not part of an accumulative strategy. Consumption needs are not only those of the family farm workers, but they also include those of their dependents (young children, sick or disabled or elderly people) and, where applicable, other persons who reside permanently or temporarily on the farm. Conversely, some family farm workers and other family members may not reside on the farm at certain times of the year. This mismatch between the group of agricultural workers, the group of consumers and the group of residents was emphasized long ago (Gastellu 1980). We took that into account by distinguishing in each farm surveyed the group of agricultural workers, full or part time, on one hand, and the group of consumers, full or part time, on the other hand.

## Field surveys

To evaluate the net investment capacity of family farms in the Office du Niger zone, we conducted field surveys combining quantitative and qualitative methods (Kanbur 2003; Marsland et al. 2000). The main survey dealt with the different dimensions of the farming system concept (see above). A complementary survey focused on the current consumption needs the farm manager needs to satisfy.

*Surveys stages*

The surveys were carried out in four phases. First an exploratory phase was implemented in November 2010, during which we conducted observations of the cultivated landscape and interviewed farm managers and other family members. It should be noted that one of the co-authors had been living in this ecological and social environment for several months every year since 2006. A comprehensive farming system questionnaire was then developed and 20 villages were chosen, over five sectors of the Office du Niger area, as places where to carry out the comprehensive interviews. These villages were selected to represent different levels of prosperity, this depending in particular on the location relative to the irrigation system.

During the second phase implemented in January 2011, in each of these 20 villages, a group interview was conducted with local authorities to establish the exact land configuration of each farm.

During the third phase (February and March 2011), 20 family farms were randomly selected in each of these 20 villages in order to carry out an in-depth interview with the manager, and other family members as appropriate, based on the above-mentioned questionnaire. Therefore we designed a two-stage cluster sampling technique, with a random draw within the village cluster. The surveys were implemented by the authors and 12 local interviewers trained for this purpose. At the end, it turned out that the procedure of random selection had not been followed in one village and it was removed from the sample. However, the sample of 380 family farms surveyed (20 surveys x 19 villages) is large enough to provide estimates of proportions of farming system categories with a margin of error of less than 5% for a confidence level of 95% (Agresti and Finlay 2009).

The questionnaire included both closed-ended and open-ended questions. Many of the closed-ended questions called for numerical answers (yields, inputs quantities, etc.), which constitute a base of about 140,000 data. Open-ended questions called

for discursive answers dealing with the reasons and meanings farmers associate to their farming practices.

During the fourth phase implemented in April 2011, we carried out a specific survey with 60 farm managers, focusing on the nature and the value of the consumption needs which they must provide for their families. These 60 farm managers were those previously interviewed in 3 villages, spread over 3 sectors of the Office du Niger area. These specific interviews were stopped after having outstripped "saturation" in the sociological sense (new interviews did not provide any new information on the issue investigated).

*Data processing*

The family farms surveyed were first classified into 12 farming system categories, according to the nature of the equipment and the combination of cropping activities (Table 1). Livestock activities can be conducted in addition to these cropping activities.

Based on the data on peasant families composition, eight family types were identified according to the number of maternal cells, ranging from one to eight. For each of these types, the maximum number of people and the maximum number of full-time agricultural workers per family during its demographic cycle were estimated (Chayanov 1986).

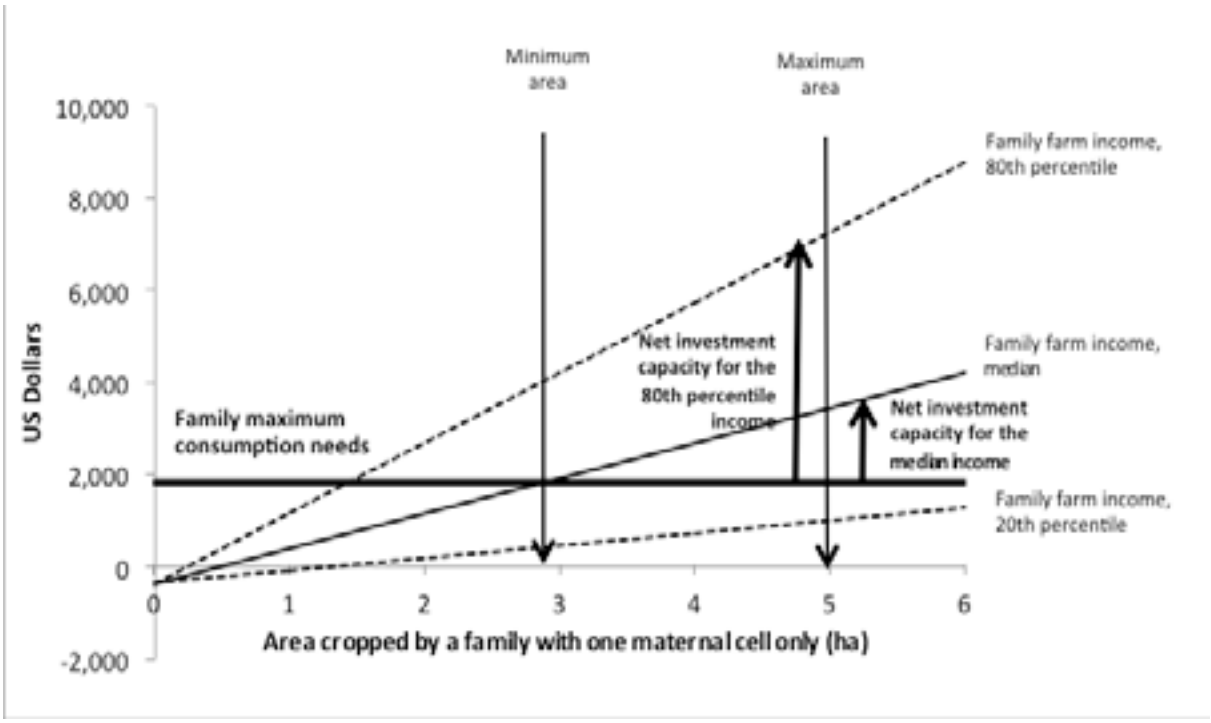
For each of the 380 farms surveyed, we calculated the net added value and the income derived from agricultural activities carried out under the responsibility of the farm manager for the year 2010. To represent synthetically and in an easily interpretable way the survey results, we developed models. Each model can be represented by a simple graph (Figure 1) (Roudart 2001). Each graph is established for a given farming system category and a given family type. It assumes that 100% of the farm area is planted to rice in the wet season, in agreement with the survey data. In farm models including dry-season crops, the area under dry-season rice is set at 25% of the farm area; the dry-season vegetable is shallot, because it represents three quarters of the area under vegetables, and its area is set at 10% of the farm area. These percentages are averages for farms planting dry-season crops in the sample. They are higher than those calculated over the entire area of the Office du Niger area as part of the farmers do not grow these dry-season crops.

Figure 1 shows the variation of the family farm income according to the area cultivated by the family for three income levels: low, median, high. The low income represents a situation where the added values obtained for each crop considered are low, at the level of the 20th percentile of the sample (which corresponds to the upper level of the first quintile). The high income corresponds to the level of the 80th percentile of the sample (which corresponds to the bottom level of the fifth quintile). Taking rice as an example, several reasons explain these differences in added value among farmers using the same equipment. First, reasons related to yield: it is higher where access to irrigation water is optimum (this factor being largely under the control of the Office du Niger, and not of farmers), where access to inputs, including mineral fertilizers, is satisfactory, and where soil preparation takes place at the right time (this is not always the case for farmers without animal-drawn equipment who need to rent one from a neighbor). Another reason is related to prices: those farmers who are not forced, for financial reasons, to sell their rice soon after harvest can store it and sell it later on at higher prices. The management of crops does vary across equipment levels, but does not vary according to crop combi-

**Table 1.** Characteristics of the 12 categories of farming systems in the *Office du Niger* area, their percentages in the sample and number of observations

| Crop combination / Equipment | Wet-season rice | Wet-season rice + dry-season rice | Wet-season rice + dry-season vegetables | Wet-season rice + dry-season rice + dry-season vegetables | TOTAL |
|---|---|---|---|---|---|
| Manual equipment (dabas, hoes, sickles) | 9% (34) | 13% (49) | 11% (42) | 16% (61) | 49% (186) |
| Manual + Animal-drawn equipment (plow, harrow, donkey, cart) | 6% (23) | 13% (49) | 4% (15) | 16% (61) | 39% (148) |
| Manual + animal-drawn + motorized equipment (power-tiller) | 2% (7) | 6% (23) | 1% (5) | 3% (11) | 12% (46) |
| TOTAL | 17% (64) | 32% (121) | 16% (62) | 35% (133) | 100% (380) |

**Figure 1.** Family farm income and family consumption needs depending on the cropped area, in the *Office du Niger* area, Mali



nation. Therefore, for each crop, the median and percentiles were estimated on the basis of all the observations made for each equipment level, which means between 16 (shallot, motorized equipment) and 186 (wet season rice, manual equipment) observations, and more than 75 observations for all crops with manual or animal-drawn equipment (Table 1).

Figure 1 also shows the value of the consumption needs of the family, assuming that these needs are at their highest given the demographics of the family. This represents the demographic situation which is the most unfavorable to the net investment capacity of the farm, and models therefore lead to estimate minimum net investment capacities. For a family with one maternal cell only, this corresponds to a situation where there are 9 persons of all ages. Based on results from the specific survey, the current consumption needs to be provided by the farm manager were estimated at 100,000 CFA Francs per person and per year, equivalent to 203 US Dollars of 2010 (the average exchange rate for the year 2010 was at 492 FCFA per USD). Nearly half of this value corresponds to food cereals needs, and almost 20% to other food needs (vegetables and other condiments accompanying cereals), the remaining third corresponding to non-food needs (clothing, school, health, transport, firewood, electricity, home care, other).

The graph displays the maximum area that the family workers can cultivate, which is determined by the maximum number of agricultural workers and by the type of equipment used. For instance, in the case of a family composed of only one maternal cell with five full-time farm workers, a motorized equipment allows to plow and harrow up to 6 ha, while an animal-drawn equipment does not allow to deal with more than 5 ha. The graph also displays the minimum area, that corresponds to the point where the family farm income just covers the consumption needs of the family. At this point, there are both (enlarged) reproduction of labor and simple reproduction of capital as, in the calculation of the family farm income, the costs of farm capital renewal were duly subtracted. For areas smaller than the minimum, the family farm income is not enough to both meet the family consumption needs and renew the farm capital.

Finally, the net investment capacity indicated on the graph corresponds to the vertical distance between the straight line representing the family farm income and the straight line representing the consumption needs for the areas between the minimum and the maximum. In this case, enlarged reproduction of capital from agricultural activities implemented under the aegis of the whole family is possible. The minimum area is thus a threshold beyond which there may be accumulation. Finally, it should be noted that the net investment capacity can be interpreted as a surplus allowing to feed non-farming people, the surplus being defined here as the part of the agricultural produce that is not consumed on the farm, whether in kind or in cash.

## Results and discussion

*Factors limiting the investment of family farms*

According to our survey data, only 16% of family farms are in a position to accumulate. The main reason for that, as alleged by the respondents, is the too tiny irrigated area per farm (this being equal to the total farm area). Indeed, nearly 90% of surveyed farms have an area smaller than the minimum required to be able to accumulate capital for the median farm income

(Roudart and Dave 2013).

The second most important limiting factor according to the survey is access to formal short-term (one year) credit to finance the purchase of inputs (seeds, mineral fertilizers, pesticides) and the rental of animal-drawn equipment for those farmers with manual equipment only. About half of the farm managers surveyed do not have access to such credit in the wet season because they are considered unreliable by lenders. In addition, during the dry season, almost no formal short-term credit is available. Therefore only farmers with savings can grow crops in this season, on areas often limited by their level of savings. Ultimately, because of limited access to short-term credit, yields and farm incomes of the majority of the farms are far below what they could be. Table 2 displays the variation in yields and added-values per hectare for rice according to our survey. As for wet-season rice, the yield of the 20th percentile is 57% of the yield of 80th percentile (on average for the three types of equipment). This proportion is 30% for the added-value (it is lower than the proportion for yields, as the margin between the gross product and the costs is relatively more affected by the difference in yields).

The third most important limiting factor according to the survey is access to medium-term (three to five years) credit to purchase animal-drawn or motorized equipment. Half of the farms of our sample do not have these kinds of equipment, and less than 5% of family farm managers have benefited from such credits. As shown in Table 2, this type of equipment entails an increase in the yields and added values per ha, and thus in farm incomes. As for wet-season rice, the median yield with manual equipment represents 85% of the median yield with motorized equipment. And this proportion is 55% for the median added-value.

Were these constraints lifted, what could be the investment capacities of family farms according to our farming system models?

*Potential investment capacities estimated by the models*

*Farming system with wet-season rice, dry-season rice, shallot, and animal-drawn equipment*

This is one of the most common farming systems in the area. The results are presented in Figure 2, constructed following the above-mentioned principles and methodology (Figure 1), and gathering the eight family types.

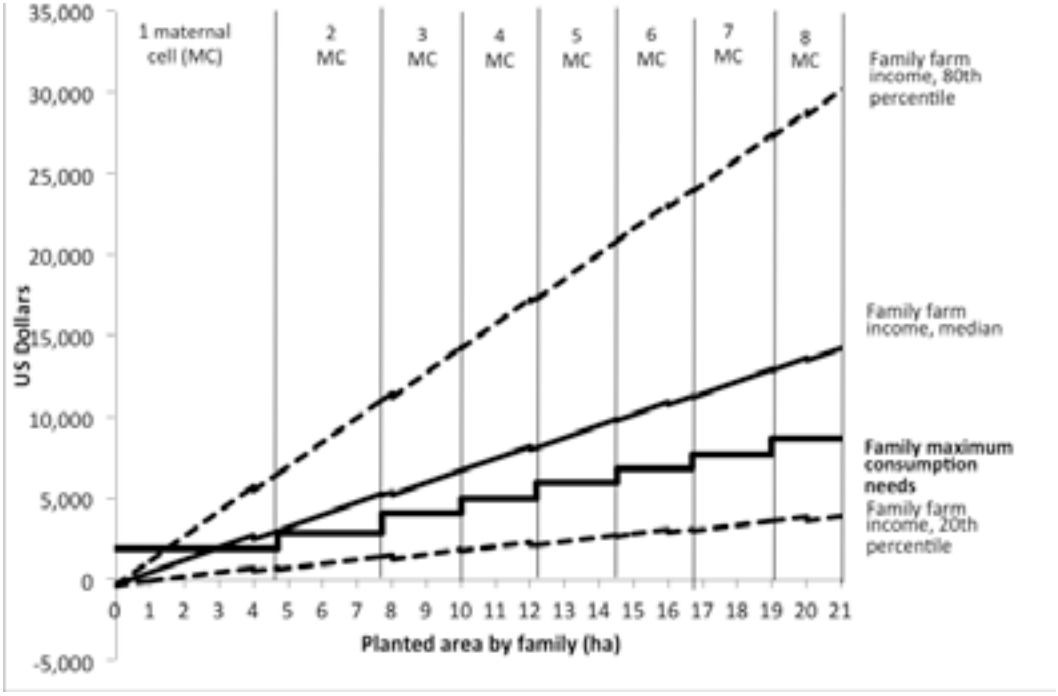
It shows a minimum area for accumulation of 2.9 ha for the median, and 1.4 ha for the 80th percentile. Beyond these minimum areas, the net investment capacity increases with the area cropped by maternal cell and with their number in the family, subject to the necessary adjustments: the value of the maximum consumption needs increases in increments with each additional maternal cell; the family farm income drops a notch when the purchase of a new animal-drawn equipment is necessary to be able to cultivate a larger area, i.e. every 4 ha; the family farm income also decreases, but only slightly, with each additional maternal cell to be equipped with hand tools.

Thus, for the median farm income, the net investment capacity of a family with one maternal cell reaches the annual repayment of an investment loan for a pair of oxen (295 USD) for a planted area of 3.27 ha (credit for a pair of oxen is granted for three years, with an interest rate of 9% per annum). It reaches the total amount of the annual repayment of such a loan and of the economic depreciation of a complete set of animal-drawn equipment (a plow, a harrow,

**Table 2.** Variation in yields and added values per hectare for rice, in the sample

| | 20th percentile yield (tons/ha) | Median yield (tons/ha) | 80th percentile yield (tons/ha) | 20th percentile gross added-value (USD/ha) | Median gross added-value (USD/ha) | 80th percentile gross added-value (USD/ha) |
|---|---|---|---|---|---|---|
| **Wet-season rice** | | | | | | |
| Manual equipment | 1.7 | 3.0 | 3.75 | 17 | 338 | 600 |
| Animal-drawn equipment | 2.25 | 3.3 | 4.0 | 260 | 493 | 717 |
| Motorized equipment | 2.9 | 3.5 | 4.2 | 401 | 613 | 865 |
| **Dry-season rice** | | | | | | |
| Manual equipment | 2.2 | 3.1 | 3.9 | 92 | 400 | 603 |
| Animal-drawn equipment | 2.3 | 3.1 | 4.1 | 214 | 453 | 720 |
| Motorized equipment | 2.2 | 3.2 | 3.7 | 224 | 528 | 712 |

**Figure 2.** Estimated investment capacities of family farms with an animal-drawn equipment, wet-season rice (100%), dry-season rice (25%) and shallot (10%)



a yoke of oxen, chains, a donkey and a cart, 350 USD) for a planted area of 3.34 ha. It reaches the annual repayment of an investment loan for a power-tiller (1691 USD) for a planted area of 6.8 ha (credit for a power-tiller is granted for four years, with an interest rate of 11% per year). As mentioned above, the net investment capacity can be interpreted as a surplus. For the median farm income, the surplus reaches the value of the annual rice ration of 10 people (200 kg / person / year x 0.49 USD / kg x 10 persons = 976 USD / year ) for an area of 4.4 ha. This means that a family with one maternal cell has the capacity to provide basic food rations to more than 10 non-farm people beyond 4.4 ha. This is a minimum estimate because the peasant family is supposed by the model to be at its demographic maximum, and it has to sell agricultural products to also satisfy non-food consumption needs.

For the 5th quintile, the same amounts of net investment capacity are logically achieved for areas smaller than for the median income level, and the surplus generated can feed more than 10 non-farm people with 2.1 ha, more than 50 people with 5.5 ha, and more than 100 non-farm people with 9.7 ha.

However, the family farm income corresponding to the 1st quintile never reaches the threshold of the family consumption needs: therefore accumulation is impossible, and it is not even possible to both meet the family consumption needs and renew the farm capital with such level of family farm income.

*Important points on the estimates made for the 2010 crop year*

A similar analysis was carried out for every major type of farming system and the main results are shown in Table 3. In general, regardless of the farming system category and the family type, farms with low income (1st quintile) do not generate any net investment capacity, or cannot meet both the family consumption needs and renew the farm capital based on their family farm income. This income can even be negative, a situation that is clearly not sustainable. In 2010, this was mainly due to dysfunctions in the irrigation system leading to flooding or water shortage. The situation of not meeting the family consumption needs or not renewing the farm capital is sustainable insofar as other sources of non-farm incomes supplement the family farm income obtained by the manager.

In the case of all farming systems with manual equipment, the median farm income is very close to the consumption needs, which implies that the net investment capacity is weakly positive, negative, or nil. However, even with this limited equipment, farms belonging to the 5th quintile get a net investment capacity from certain areas (from 3.6 ha by growing wet season rice only, and from 2 ha by growing three crops (wet season rice, dry season rice and shallot), for a family composed of one maternal cell only).

As for all the farming systems with wet-season rice as the sole crop, the median farm income is close to the consumption needs or below, except in the case of the motorized equipment where it is slightly above. Again, farms of the 5th quintile get a net investment capacity from certain areas (from 3.6 ha with a manual equipment and from 3 ha with a motorized equipment, for a family composed of one maternal cell only).

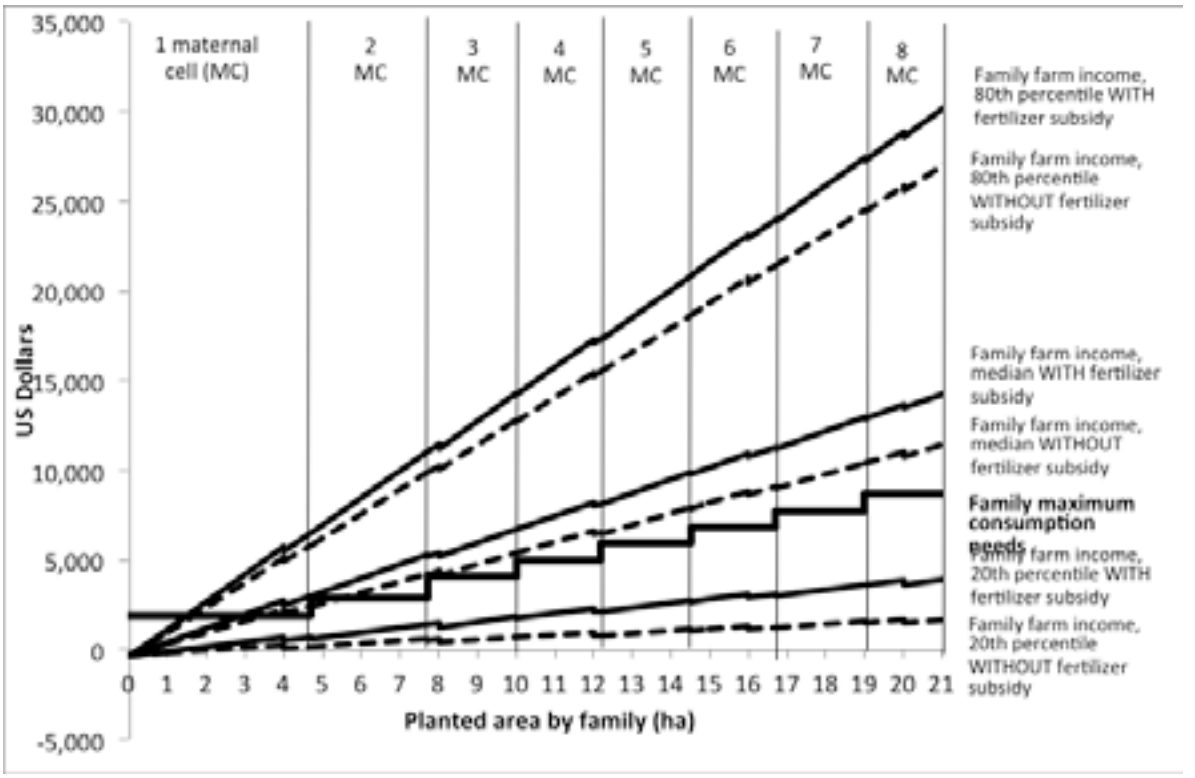
In general, as expected, the net investment capacity increases with the level of equipment and the number of dry season crops. In the case of the median farm income obtained with three crops and an animal-drawn equipment, the net investment

**Table 3.** Cropped areas (in ha) and net investment capacities (N.I.C., in USD) for different farming system categories in the Office du Niger area. Results for the median farm income.

| Farming systems / Net Investment Capacities (N.I.C.) | | Minimum area for accumulation | **N.I.C. of 295 USD** (annual repayment of a credit for a pair of oxen) | **N.I.C. of 350 USD** (idem + annual depreciation of a complete animal-drawn equipment) | **N.I.C. of 813 USD** (cash purchase of a pair of oxen) | **N.I.C. of 1,691 USD** (annual repayment of a credit for a power-tiller) | | **N.I.C. of 976 USD** (value of the annual rice ration of 10 persons) | **N.I.C. of 4,878 USD** (value of the annual rice ration of 50 persons) | **N.I.C. of 9,756 USD** (value of the annual rice ration of 100 persons) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wet-season rice** | **Manual equipment** | | | | | | | | | |
| | **Animal-drawn equipment** | 7,4 | | | | | | | | |
| | **Motorized equipment** | 5,5 | 8,1 | 8,2 | 9 | 22 | | 11,6 | | |
| **plus cattle rearing** | **Motorized equipment** | 4,3 | 4,9 | 7,1 | 7,9 | 11,8 | | 8,2 | | |
| **Wet-season rice + dry-season rice on 25% total area** | **Manual equipment** | | | | | | | | | |
| | **Animal-drawn equipment** | 3,7 | 4,6 | 4,7 | 7,3 | 18,7 | | 7,6 | | |
| | **Motorized equipment** | 4,5 | 4,9 | 5 | 5,6 | 8,6 | | 7,6 | 22,5 | |
| **plus cattle rearing** | **Motorized equipment** | 3,5 | 3,9 | 4 | 4,7 | 7,7 | | 4,9 | 21,6 | |
| **Wet-season rice + dry-season shallot on 10% total area** | **Manual equipment** | 7,5 | | | | | | | | |
| | **Animal-drawn equipment** | 3,6 | 4,4 | 4,5 | 7 | 14,4 | | 7,3 | | |
| | **Motorized equipment** | 3,9 | 4,3 | 4,4 | 5 | 7,6 | | 5,2 | 17,3 | |
| **plus cattle rearing** | **Motorized equipment** | 3,1 | 3,5 | 3,5 | 4,1 | 5,3 | | 4,3 | 13,7 | |
| **Wet-season rice + dry-season rice (25%) and shallot (10%)** | **Manual equipment** | 3,9 | 4,5 | 4,6 | 7,6 | | | 14,2 | | |
| | **Animal-drawn equipment** | 2,9 | 3,27 | 3,34 | 3,9 | 6,8 | | 4,4 | 18,6 | |
| | **Motorized equipment** | 3,4 | 3,7 | 3,8 | 4,3 | 5,2 | | 4,4 | 11,5 | 22,4 |
| **plus cattle rearing** | **Motorized equipment** | 2,7 | 3 | 3 | 3,6 | 4,5 | | 4,4 | 10,8 | 21,7 |

NB: in each case, the results displayed correspond to the minimum of maternal cells.

**Figure 3.** Investment capacities of family farms planting three crops with an animal-drawn equipment in the *Office du Niger* area, with or without fertilizer subsidy.




capacity reaches the value of the annual rice ration of 50 persons from 18.6 ha. With a motorized equipment, it reaches this level from 11.5 ha (and from 10.8 ha when a livestock rearing activity is added to the three crops).

According to the whole set of model estimates based on the distribution of yields and added-values in 2010, more than half of the family farms in the Office du Niger zone could accumulate capital from family-based agricultural activities, had they access to the minimum areas needed for that. And this proportion could still be considerably increased if the farms located below the median family farm income could, through credit, access production means enabling them to increase the added-value per ha of their crop production.

*Simulations for yields and prices*

The results presented above correspond to the yields and prices observed in the 2010 crop year. On that year, the average price of rice paid to producers was below the average for 2008 and 2009 (0.49 USD per kilogram instead of 0.56 USD). In addition, the average yield of the wet-season rice was relatively low at 3.2 tonnes of paddy rice per ha, while it is usually ranging between 3.4 and 3.7 tonnes per ha (Dave 2007). These two factors tend to position our findings as low estimates of the amounts of net investment capacities and the proportion of farms able to accumulate. However, another factor tends to surestimate our findings for 2010 because on that year a subsidy, linked to the "Rice Initiative" launched by the government of

Mali after the soaring of food prices on the international markets in 2008, allowed rice producers to pay the mineral fertilizer at a low price (25 USD per bag of 50 kg instead of 44 USD).

To assess the effects of these factors on the findings, the models were used to conduct simulations taking into account the removal of the fertilizer subsidy, a 10% increase in the rice yields to simulate an average year, a 10% decrease in the rice yields to simulate a very bad year, a 15% increase in the rice price to simulate the average price for 2008 and 2009, and a 10% decrease in the rice price to simulate the average price that prevailed from 2005 to 2007. Figure 3 displays the effects of the removal of the fertilizer subsidy for the farming families planting three crops with animal-drawn equipment. While this scenario entails a reduction in investment capacities and in the proportion of potentially accumulating farms, this proportion remains above 50%.

The analysis of the results of all the above-mentioned simulations reveals that, even when assumptions unfavorable to the investment capacities of family farms are adopted (removal of the fertilizer subsidy, 10% decrease in the rice price, 10% decrease in the rice yields), more than half of these farms could still be able to invest. Of course, on the contrary, the other assumptions favorable to an increase in the investment capacity lead to an increased proportion of family farms able to accumulate capital.

To assess the validity of these results, the limitations of the research approach should now be examined.

*Discussion*

The first limitation of this research is due to the choice of the 19 villages where detailed surveys were carried out. Ideally, these villages would have been spread over the different agro-ecological areas of the Office du Niger area. The choice of the villages was made by the SEXAGON. This union paid attention to the diversity of the types of villages surveyed: rich and poor, variously located vis-à-vis the irrigation system. However, none of these villages belongs to the sector of Béwani because the SEXAGON is not present there. But it is a recently developed sector, representing less than 10% of the wet-season rice area. And the remaining five sectors are almost equally represented.

The second limitation is that the number of farming units surveyed is less than 20 for four categories of farming systems (Table 1), and that may affect the accuracy of our estimates, particularly regarding vegetable crops with motorized equipment. However, this situation concerns only 4% of the farms in the zone.

On the other hand, several factors are supporting the validity of the results. From a qualitative viewpoint, for each category of farming systems, the number of surveys was enough to achieve, and most often exceed, saturation (see above). In addition, on several occasions, the findings were presented to, and widely accepted by, assemblies of peasants, as well as committees bringing together farmers and other competent and concerned stakeholders such as representatives of farmers' organizations, NGOs, the Office du Niger, the Ministry of Agriculture and donors. It is thus reasonable to estimate that the findings are well-grounded in the actual circumstances of the Office du Niger area and valid.

Our research results show that the investment capacities of family farms in the Office du Niger area are all the greater that they have a larger irrigated plot. But the area cultivable by family labor is limited by the work of soil preparation: a family with one

maternal cell can plow a maximum of 5 ha with an animal-drawn equipment. Our results also show that investment capacities remain low with a manual equipment, as well as with wet-season rice as the sole crop. Under these conditions, to promote investment capacities of family farms in the Office du Niger area, it seems desirable to allot them irrigated areas near to the maximum they can grow given the family labor available: 5 ha for a family with a single maternal cell, 8.5 ha (5 + 3.5) for a family with two maternal cells, 11 ha (5 + 3.5 + 2.5) for a family with three maternal cells, and so on by adding 2.5 ha per extra maternal cell. The maximum area cultivable per maternal cell decreases with their number because the maximum workforce per cell decreases (indeed, when the second, third, etc. maternal cells are established, some children of the first maternal cell reach adulthood and leave the household). It also seems desirable that these farming families, once correctly endowed with land, use animal traction and grow dry-season crops. This requires that they have access to irrigation water during the dry-season, as well as to credit.

As the government of Mali does not have the money to fund new irrigation facilities intended for family farmers, the intervention of donors will be needed to implement such measures.

## Conclusion

Since 2006, large tracts of land of the Office du Niger area have been attributed to new investors, with promised volumes of irrigation water in some cases. But, as a matter of fact, very little of this land has been developed so far, to the point that some authors argue that the main objective of many of these investors is to grab land and not to develop it (Adamczewski et al. 2013). This appears to be the case in many areas where large-scale land investments have recently taken place (Anseeuw et al. 2012; Land Matrix 2014).

On the other hand, the SEXAGON wishes that family farmers of this area have access to more irrigated land to develop their agricultural activities. The research results presented here are shedding light on the conditions under which family farms of the Office du Niger area could accumulate capital from agricultural activities conducted under the responsibility of the farm manager. Designed according to the farming system concept, a field survey showed that access to properly irrigated land, and access to short and medium-term credit to purchase inputs and equipment, are currently the main factors limiting farm productivity and investment capacities of family farms in this area.

As the High Level Panel of Experts (HLPE 2013) underlines, governments and donors have an essential role to play in providing public goods and other enabling conditions for smallholders to invest in agriculture. This is well exemplified by the Office du Niger area where tens of thousands of peasants are potential investors, competent and motivated, but need irrigated land and credit in the first place. Were these constraints lifted, others would appear (commercialization of products, procurement of inputs, crop management of dry-season vegetables, etc.). But it remains that for agriculture to develop in Mali, the peasant way appears fully credible.

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