

THE DETERMINANTS OF THE DIFFUSION OF NEW AGRICULTURAL TECHNIQUES. The case of Lake Alaotra, MADAGASCAR

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ABSTRACT

The geographical characteristics of Madagascar present opportunities in terms of agricultural operations. However, there has been no significant return in agriculture and structural constraints continue to hamper the development of this sector. Several direct and indirect interventions by development actors dictated by rural development policies think to remedy the situation by bringing new techniques, but the problem that arises is In what cases is the innovation process necessary in the farm?

Assuming that the farm requires innovation processes adapted to the characteristics of the farmers. This work provides analyses characterizing the farm of Lake Alaotra, the epicenter of rice cultivation in Madagascar.

Keyword: *Agriculture, Farmers, Technique, Innovation, Development*

INTRODUCTION

Innovation is always seen as a pathway to performance, whether in the primary, secondary or tertiary sectors. It can bring technical or organizational changes depending on the objectives. In the context of perpetual change of the current business environment, the achievement of survival objectives depends largely on innovation. Moreover, innovation has a special role to play in addressing the environmental and developmental crises that persist in the world. In the field of agriculture, in all regions of the world, alone or with external support, farmers innovate, test new practices, and evolve their activities in order to make the most of their environment or adapt to its evolution (Bentz B, 2002).

The role of agricultural development is to strengthen farmers' capacity for innovation, to broaden the range of possible choices, to provide farmers with relevant and validated references and keys to better control their economic and institutional environment.

The 1970s and 1980s saw the multiplication of large integrated projects aimed at harmonious development of the territory by integrating social components. The techniques proposed were often part of a development model tested in experimental stations or coming directly from a favorable area, without any adaptation process. Moreover, these projects were often carried out in social environments undergoing rapid change (Alary V., 2006). But the problem that arises is to know **When is the innovation process necessary on the farm?**

Since independence, successive agricultural policies in Madagascar have constantly promoted technical and organizational improvements to family farms in order to increase production and make them more efficient.

They are mainly oriented towards improving rice yields, since rice is a staple food for the Malagasy and a strategic product. This product is a major economic and social issue at the national level because two out of three (2/3) farmers in Madagascar are directly involved in this area. The objective of this work is therefore to identify the determining factors in the dissemination of new cropping techniques in Madagascar, more specifically in Lake Alaotra, the epicenter of rice cultivation in the country.

The economic characterization of the farms presents the results after a series of statistical treatments and comparative analyses of the responses obtained by site on farm identification, cropping systems, and agricultural materials. The results of the questionnaire on the adoption or not of the new techniques, the year of adoption and the adoption strategies complete this previous information for the study of the processes.

First, the results are processed using Xlstat, a software program whose interface is based entirely on Microsoft Excel, both for data retrieval and for the restitution of results. The quantitative variables are directly entered in numerical values, the qualitative variables have been coded in numbers in order to express the different modalities. Thus, we obtain a database containing all the farmers met in the field. The data can be processed using the usual statistical and graphical functions of the software.

I- CONCEPTUAL BASIS

The farm is a unit that uses production factors to carry out one of the agricultural activities (agriculture, livestock, fishing). Agricultural activities include: production activities, activities that extend the value chain (processing, storage, etc.), and complementary activities that support the farm (crafts, etc.).

The farm has three major concerns: to produce its means of subsistence, to develop economic activities linked to a market, and to ensure sustainable management of renewable resources.

According to the capitalization of experiences of services to farmers (HTPSE/MAEP/DCE 2008), in Madagascar, there are two main categories of farms:

- The Family Farms (EAF), of informal character, whose management is based on the family unit;
- Modern" or "industrial" farms, managed by a natural or legal person, which comply with the law on companies or the law on cooperatives. This type of farm is still very marginal. To access the services required for its development, this type of unit uses specific networks, different from those generally used by FAEs.

The FAEs can be classified into three main types:

- Market-oriented FAEs that sell a significant portion of their production (especially rice), invest in their activities and capitalize (purchase of land cattle, motorized equipment, etc...). These FAEs, managed by literate farmers (including "converted" managers), regularly resort to external labor;

- Food self-sufficient farms (type 2) that periodically generate agricultural surpluses other than rice (rice fields are between 0.5 and 1 hectare in size). These farms generally have a few head of zebu cattle that allow them to smoke the plots. This type of farm is also not confronted with the problems of the "hunger gap. They occasionally mobilize outside labor;

- Farming enterprises with a cyclical or chronic rice deficit (type 3), small in size (less than 1 ha), some of which have a few rice plots (between 25 and 50 ares in size), which are regularly confronted with lean season problems, as they are obliged to sell part of their rice at harvest time, in particular to repay loans (these farming enterprises are chronically in debt). These deficits are compensated for either by occasional outside work, or by diversification of activities (handicrafts, off-season crops, etc.). These farms do not have large livestock. L'exploitation agricole est donc une unité économique de base finalisée et constituée par ses moyens humains, matériels et financiers. Son monde de fonctionnement est influencé par l'environnement interne et externe. L'innovation introduite peut modifier une partie ou la totalité de la pratique agricole parce que cette unité est un système ouvert interdépendant.

The operation of the farm is the set of decisions made according to the constraints and to achieve general and specific objectives. Thus, land, human and financial factors are managed with the socio-organizational dimension.

Agricultural policy is public policy. Generally speaking, public policies constitute the set of measures undertaken by the State based on studies of national needs to satisfy the general interest. A policy presupposes the simultaneous presence of explicit objectives, implementing institutions (public or private), mechanisms facilitating this implementation, resources (financial, human, etc.), and political will with real continuity. Thus, the term "agricultural policy" naturally encompasses all state interventions taken to orient the activity of the rural sector and its development in the medium and long term by modifying productive structures and defining the rules of the game of competition. (Herbel et al, 2003).

II- RESULTS

The results are oriented to the current situation of farmers, which is none other than the results of dissemination and/or technical improvements over the years. It develops the characteristics of the farms that justify the use of innovation.

2.1 History of operations

The history serves as a frame of reference for analyses of farm evolution. Three communes that are representative of the extension activities of DMC systems in Lac Alaotra were chosen to identify the samples. The table below shows the distribution of samples by commune, with the percentage of heads of households surveyed in Imerimandroso-Ambaniala (63% of those interviewed) being the highest because of its popularity, followed by Antanandava (33% of those interviewed) and Tsarahonenana (1% of those interviewed). For the sake of representativeness, all categories of farms, from the oldest to the youngest, were interviewed. The oldest farms were created in 1952 (end of the colonial period) and the youngest in 2004 (just at the beginning of the period of state disengagement and liberalization of the private sector).

Table 1: Spatial and temporal distribution of farmers interviewed

PDE	agricultural Politics	COMMUNE			TOTAL
		I	II	III	
Before 1960	Diversification	3%	0%	3%	6%
1960 à 1982	nationalization policy and interventionism	14%	10%	0%	24%
1982 à 1991	Structural adjustment and liberalization	23%	7%	0%	30%
1992 à 1997	Sustainable development: rice intensification	10%	10%	0%	20%
1998 à 2002	Sustainable development: dissemination of DMC	7%	7%	0%	14%
2003 à 2008	Disengagement of the State and liberalization of the private sector	7%	0%	0%	7%
TOTAL		63%	34%	3%	100%

Source: Authors, 2023

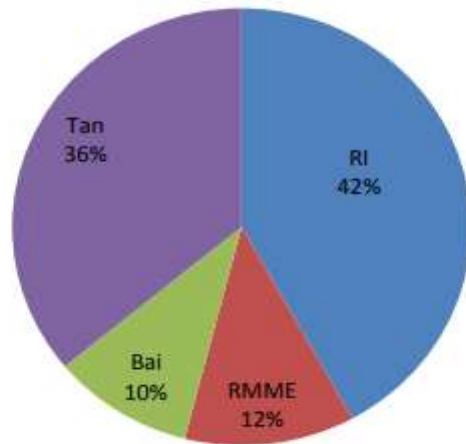
The 6.5% of farms in Imerimandroso-Ambaniala were created before the 1960s, the rest after. The majority of farms were created between 1982 and 1991, the period of application of the structural adjustment policy and liberalization and the transition from SOMALAC to the two zones. On average, farms were established around 1986, the year in which rice intensification and the promotion of conservation agriculture or SCV were launched in Lake Alaotra (the standard deviation is equal to 0.096, a very narrow significance, and the temporal distribution of farmers follows a normal distribution. These farmers are mainly found in Lake Alaotra

2.2 Housing and farm buildings

The farmers' dwellings are built of baked brick (hard) and without floors (96%), and more than half (58%) were built by the current residents, either by family labor themselves (19% of the constructions) or by outside labor. The remaining 42% were inherited. In general, the dwelling houses are used as storage buildings for agricultural products, as no farmer has a granary. Only 3.2% of the population have houses with a floor. The average cost of construction is estimated at Ar 1,560,000. Livestock pens are built next to the dwelling house.

The following figure summarizes the distribution of exploited agricultural surfaces. Rainfed crops are grown on tanety and baiboho, and irrigated rice is grown on well-irrigated rice fields and rice fields with poor water control. Some farmers adopt DMC as an off-season crop on rice fields.

Figure 1 : Distribution of exploited areas



Source : Authors, 2023

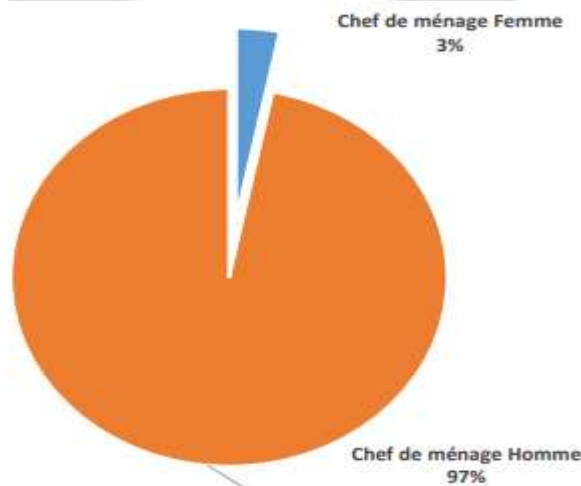
According to this graph, rice fields occupy 54% of the useful surface area, of which 42% are well-irrigated rice fields (RI) and 12% RMME. Farming on tanety and baiboho represents 46%. Thus, crop diversification on tanety covers 36% of the useful surface area per farmer. Groundnuts and legumes dominate on baiboho (10%). On average, a farmer owns 1.43 ha of well-irrigated rice field (RI), 1.26 ha of tanety, 0.41 ha of RMME and 0.34 ha of baiboho. Of the total area, about 23% of the RMME and tanety are used for DMC techniques. In this zone, apart from the usual rainfed crops, rice cultivation and DMC techniques on tanety are important agricultural activities that generate income for farmers.

2.3 Available manpower

The head of the household is primarily responsible for making the final decisions for the farm. The 97% of heads of household are male and about 3% are mothers, or heads of single-parent households. These are abandoned or widowed women.

In the case of households headed by a father and a mother, women often take care of extra-agricultural activities such as small trade (complementary activities). But for other activities, the fathers of the family always take responsibility and make strategic decisions concerning the entire farm. There is a division of labor at the family level, but most of the labor force is flexible and can work in all family activity systems. Fathers are mainly involved in the main income-generating activities, and mothers and elders may be involved in household activities. Mothers and children usually assist fathers by providing temporary labor in the field. The children take care of the poultry. Thus, for single-parent, female-headed households, the mother of the family assumes both the role of head of the farm and of the family itself.

Figure 1 : Distribution of heads of households



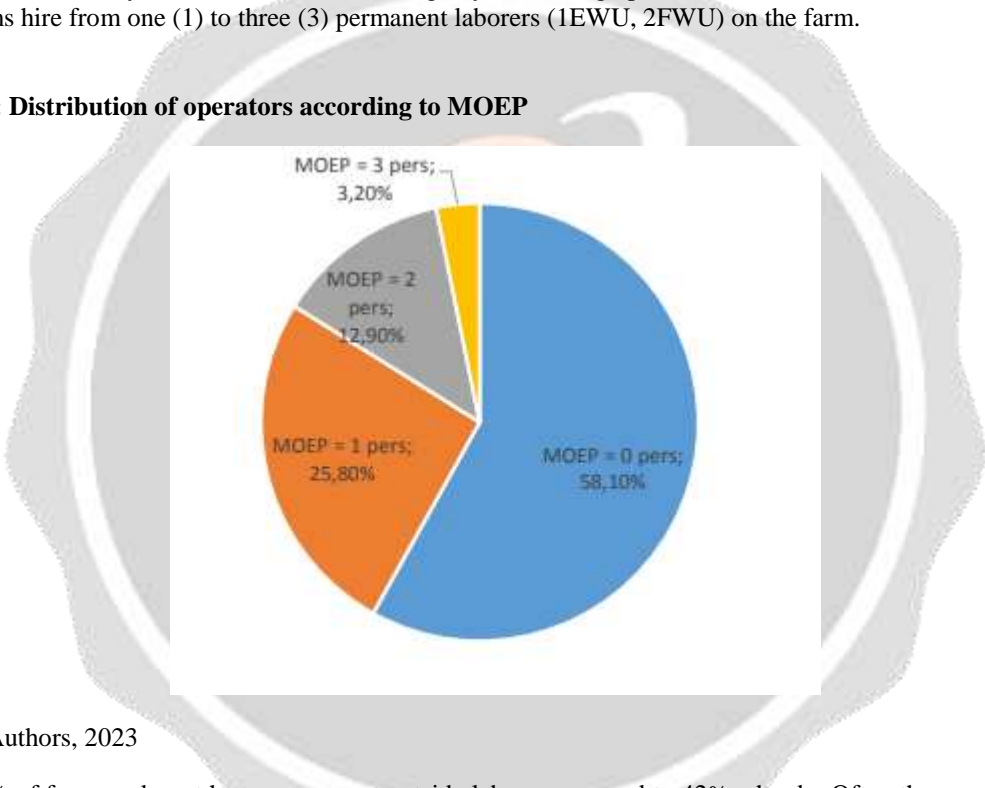
Source : Authors, 2023

In this study, the size of a household was evaluated by the number of people to be fed in the family. On average, a family feeds 6 to 7 individuals. The household sizes of the farmers studied ranged from 2 to 13 persons. The standard deviation (22) is about 2.5. In other words, a great deal of diversity is observable from one family to another. The results of the number of children under and over 15 years old are the same, we have met families with up to 5 children. But on average, the number of children per household under 5 years old varies from 2 to 3.

A household normally engages at least one permanent person (PP) in the achievement of its agricultural and non-agricultural objectives. Some families engage up to 5 PPs. Older children (over 15 years old) contribute significantly to the achievement of the family's agricultural and non-agricultural objectives (production and financial objectives) and to the leadership role of both the farm and the family itself.

The permanent labor force on the farm is the combination of permanent family labor (FFL) and permanent outside labor (OUL). The calculation of human labor units (HLU) is done as follows: o adults (men or women) over 15 years old are considered as one (1) HLU o children under 15 years old = 0.5 HLU The number of working hours in a day is 8 hours with 20 working days on average per month. For the Imerimandroso samples, some farms hire from one (1) to three (3) permanent laborers (1EWU, 2FWU) on the farm.

Figure 2 : Distribution of operators according to MOEP

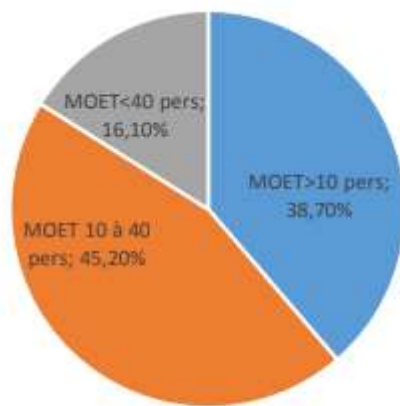


Source : Authors, 2023

The 58.1% of farmers do not have permanent outside labor, compared to 42% who do. Often these workers take care of the geese and guard the zebus. They are paid between Ar70,000 and Ar150,000 annually, if paid in cash. The amount in kind is 18 vata of paddy and Ar110,000 of cash, this second mode of payment can reach up to Ar220,000 because the price of a vata of paddy is estimated at Ar6,000.

All the farms in the area use temporary labor, especially for rice cultivation. In Imerimandroso, rice growing activities are carried out by permanent family labor for 34% of farmers. And for the remainder, 66% of the farmers, rice growing activities are carried out by temporary external labor. The price of a man-day varies between Ar1. 500 and Ar2.500 at the time of the 2008 surveys. (Appendix: Excel database on Imerimandroso). The following figure represents the distribution of farms in Imerimandroso according to the number of temporary laborers engaged in all agricultural activities.

Figure 3 : Number of Temporary Foreign Workers (TFW)



Source : Authors, 2023

For example, while the number of permanent laborers per household does not exceed 5, the number of temporary workers in rice production can exceed 40. For example, the majority of households employ between 10 and 40 temporary laborers per year to carry out rice-growing activities only, intervening in several stages of the production cycle, notably during transplanting and harvesting.

2.4 Farm equipment of farmers

All the exploitations of the site have manual tools (angady or spade, antsimbary or sickle,).

Table 2: Farm equipment availability among farmers

Number	Tractor	Kubota	Chip	Plough	Weeder	Harrow	Sprayer
1	-	9,7%	51,6%	48,4%	22,6%	32,3%	32,3%
2	-	-	3,2%	9,7%	3,2%	9,7%	-
3	-	-	-	-	-	3,2%	-

Source : Authors, 2023

This difference is noted in the ownership of motorized and non-motorized intensification equipment such as the kubota, sprayer, plow, cart and weeder. Most farming households in Imerimandroso own a cart (54.8%) and a plow (58.1%). This is explained by the importance of activities on tanety. The following table summarizes the frequency of availability of the types and numbers of the main production equipment other than small hand tools identified.

It is noted that rainfed cultivation and irrigated rice production use 97% of this equipment. However, no farms had tractors at the time of the survey. This is probably correlated, again, with the dominance of agricultural activities on tanety on the one hand, and the lack of large rice-growing areas on rice fields on the other. Thus, the farms are rather mechanized.

In general, the majority of farms do not yet possess what we might call "basic" intensification equipment such as plows, harrows, and weeders. The cart as a means of transporting materials and products is the most available, with about 52% of farmers having one. The possession of the cart is closely followed by that of the plow, the basic material for plowing. Thus, the availability of these two items of equipment shows the importance of draught oxen among farmers.

Farmers in Alaotra are not yet very well equipped to control insects, with only one-third having their own sprayers. However, according to the interviewees, whatever the need for agricultural equipment, farmers who do not own equipment can rent or borrow from others who do.

III- DISCUSSIONS

The results presented above show that farming in the area remains in the traditional state and is often survival. The characteristics of these farms therefore lead one to think about moving towards new techniques to improve productivity.

However, farms in Lac Alaotra, like farms in other important rice-growing and agricultural areas, rely on risk minimization strategies (Razafimandimby S. et al., 2008). Risk has long been considered the main factor that reduces the rate of adoption of a new technology (Rosenberg, 1976; Lindner et al., 1987). Many studies propose alternatives, but the practices often lead to very contrasting results between risk-taking and the level of wealth of producers (Marra, 2003).

The proposed techniques, which focus on improving productivity through a process of intensification, are ill-suited to the characteristics of farmers who give priority to their survival and the reproduction of the production apparatus, and therefore to securing production. However, intensification leads to an increase in risks that few small producers in disadvantaged areas can take or want to manage. Small farmers or small breeders in developing countries such as Madagascar are often reluctant to accept research-based innovations. However, in areas with high agricultural potential, such as irrigated areas, intensification processes have made it possible to increase the productivity of the land while reducing the risks associated with climatic hazards.

Although the experiences of extension workers and beneficiaries have been enriched by experiences in rice intensification since colonial times, the innovations introduced are still inconsistent with the objectives, i.e., the reactions of the beneficiaries of agricultural development projects. Moreover, the mechanization introduced before independence and the motorization recently adopted spontaneously on the spot have not yet managed to resolve a large part of this constraint. It is therefore verified that farming in the area requires innovation processes adapted to the characteristics of the farmers.

Thus, in order to support farms in their concern for managing innovation by minimizing risks and making the most of the intrinsic experiences of farmers, this work proposes to develop agronomic research on the mobilization of resources over a large area, i.e. from 1 to 5 ha. In fact, experiments on a small area (only a few acres) are profitable but limit the appreciation of farmers' realities. By experimenting on a large area, all possible manifestations of constraints and economic, agronomic, environmental and especially managerial solutions will be re-identified and then reoriented towards facilitation according to the level of farmers' perception. A technical or professionalizing supervision of the rice and agricultural labor force "accompanying innovations" should then be developed with the reality of large-scale experiments and trials. This approach is both a guarantee for future adopters (pioneers or innovators), enhances the professional reintegration of agricultural labor, and accelerates the performance and sustainability of agricultural activities.

CONCLUSION

In conclusion, according to the results of this work, the agricultural exploitation of the zone requires innovation processes adapted to the characteristics of the farmers. However, it should not be ignored that peasant family farms have their own logic in adopting innovations. This is why studies of the innovation process among farmers are always interesting, on the one hand, to have specific knowledge on the acquisition of knowledge on farms and farmers' strategies, and on the other hand, to valorize this knowledge through the development of an approach and dedicated tools for decision support in development projects (technical and organizational). But this knowledge and tools also allow planning the monitoring-evaluation of actions and support the redefinition of elements of public policy for agricultural development. Such a study is crucial in the improvement or development of tools or approaches for decision support and negotiation, which now seems to be a priority in terms of support to sustainable development.

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