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The Economic Determinants of the On-farm Management of Rice Cultivars in the Rhone River Delta (France)

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The economic determinants of the on-farm management of rice cultivars in the Rhone River Delta (France)

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Abstract

The aims of our paper are to identify economic determinants of the on-farm cultivars diversity and to empirically characterize the farmers' diversification choices. We focus on the private decision making process involving the choice of rice cultivars and the corresponding allocation of farmland. For a specific crop, the choice of cultivars, and the resulting cultivars portfolio, involves the farmer comparing benefits and costs. Among the many costs involved, we focus on diversity's management costs. Our results rely on original data collected during the spring 2009 in the study area, and involve a sample of 86 economic units growing rice. We estimated a count data model, in which the endogeneous variable is the number of cultivars grown on the farm. After that, we studied the factors explaining the portfolio choice in terms of commercial rice grain, and the on-farm repartition between these different types. A multinomial logit model was used, with three alternatives, be specialized into a particular type of rice grain (long or round), or grow simultaneously these two types, or finally be diversified with niche market varieties. And finally we estimated the percentage of long rice compared to the percentage of round rice with a linear regression model. The results confirm the importance of the interactions between market related benefit and the management constraints on land and labor.

Keywords: varietal diversity, rice cultivar, multinomial logit
JEL Classification:

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Introduction

During the last two decades, the erosion of biodiversity has been largely debated in scientific and international Conferences. In the same way, innovations and technological progress in agriculture worldwide generated specific concerns for agro biodiversity erosion. For Smale, *"the biodiversity of crops encompasses phenotypic as well as genotypic variation, including cultivars recognized as agromorphologically distinct by farmers and varieties recognized as genetically distinct by plants breeders. Typically, farmers' varieties do not satisfy International Union for the Protection of New Varieties of Plants (UPOV) definitions of variety because they are heterogeneous, exhibit less uniformity and segregate genetically. Where it is necessary to distinguish between varieties selected and managed by farmers and those by professional plant breeders, the terms « landraces » and « modern varieties are assigned"*.

Usually, the modernization of agriculture is meant as reducing genetic diversity on-farm by specialization of farms in the most profitable crops and cultivars. The process involves both the quasi disappearance of landraces and the concentration of acreage around genetically homogeneous cultivars. As a matter of fact, the increase of the number of cultivars released by the breeding sector does not automatically involves significant increase in the genetic diversity, because breeders are focusing their efforts on the same crop's traits. It is then necessary to take into account allelic diversity to fully describe the process.

Analyzing the genetic (allelic) diversity of 96 Canadian oat cultivars released from 1886 to 2001, Fu and al. found a significant decrease of alleles in cultivars released after 1970. Moreover, they failed to detect significant diversity changes among cultivars released from different breeding programs or period (Fu, 2003). This empirical evidence has been reinforced by the theoretical analysis of breeders strategies elaborated by Ambec and al. (Ambec, 2008).

Heisey and al. (Heisey, 1997) elaborated an in-depth analysis of the costs of genetic diversity. They emphasized the public good dimension of the genetic diversity, and the dual meaning of the costs, either from the farm management perspective, or from the social welfare viewpoint. The discrepancy between the private and the social value of the genetic diversity of plant genetic resources is the core issue of the conservation policies.

In this paper, we focus our analysis on the cultivars diversity and on the private decision making process involving the choice of rice cultivars and the corresponding allocation of farmland. For a specific crop, the choice of cultivars, and the resulting cultivars portfolio, involves the farmer comparing benefits and costs. Benefits are induced by prices and yield differences. Prices for different grains commercial types often exhibit important gap, while yields often remain comparable. As a consequence the cultivar portfolio structure appears to be one important factor of the profit distribution. Among the many costs involved, we focus on diversity management costs. From a general economic point of view, the issue is related to the concept of economies of scope, first elaborated by Panzar and Willig (Panzar, 1981). *"Whenever the costs of providing the services of the sharable input to two or more product lines are sub-additive (i.e. less than the* *total costs of providing these services for each product line separately), the multi-product cost function exhibits economies of scope".* Economies of scope explicitly posit the presence of a sharable, "quasi-public" input (from the view point of the technology). The specific issue we are dealing with, the on-farm management of cultivars, involves another dimension, due to the allocatable character of the land. Sharable or "quasi-public" input is the opposite of allocatable quasi-fixed input, which could not be shared by several lines of product or crops at the same time. Allocatable fixed or quasi-fixed inputs should be devoted to only one line of product. As a matter of fact, these characterizations depend on the technology used and on time frame considered altogether.

In the following, we will investigate the several lines of attack found in the literature, then we will present the conceptual framework. The local context and global empirical results will be presented. They rely on original data collected during the spring 2009 in the study area, and involve a sample of 86 economic units growing rice. We will first show the estimates of a count data model to explain the number of varieties grown in the farm. Then we will focus on the farmers' choices regarding the commercial types of rice grain, with the estimate of two models, a multinomial logit, to explain the specialization, or at contrary the diversification choice mde by farmers, and after that, a linear regression one, to better understand the substitutability choice between the two main commercial types of rice grain.

1 Literature review

Diversity or greater scope provides benefits, but also involves costly management, because it is easier and cheaper to manage few items than more. The sources of such a costly management of scope rest on several levels. Economics of scale, competition and coordination costs, risk, agronomic constraints (weeds management, salinity management, etc... The interactions between both aspects (allocatable fixed input and costly management of scope) frame the farmer's choice of crops or cultivars.

Allocation of farmland to several crops not only involves comparing inputs and outputs, but also management costs and constraints (Coyle, 1993, Livingston, 2008, Carpentier, 2009). Because farmland could be considered as a quasi-fixed input, and because the allocation of land to potential uses faces a bulk of constraints (calendar and labour allocation, weeds management, salinity management...), acreage decisions entail often a more or less diversified cropping system. In the context of agricultural production, some agro-ecological constraints could induce the need of rotating crops over the same plot, to avoid for instance infestation by weeds or by predators. In that perspective, the plot itself should be shared over time by several crops, and the plot becomes a sharable input. By contrast, if the technology for controlling weeds through chemicals is available and efficient, it is possible to allocate plot to only one crop, the most profitable one. In such a situation, the disappearance of agro-ecological constraints turns the sharable input into one allocatable. With an allocatable fixed or quasi-fixed input, it is always possible to share the total amount among several products or crops, which is the so-called acreage decision. It is easy to understand that if no economies of scale exist, the firm or the farm will specialize in the most profitable product.

Two main approaches have been presented in the literature: the cost function, and the partial adjustment approaches.
Carpentier and Letort proposed to use the concept of "implicit management cost" of the land allocation decision process (Carpentier, 2009). They introduced the trade-off between the crop gross margins of the different crops and the "implicit management cost" of the chosen allocation, C(s). They proposed to interpret C(s) *"as a reduced form function approximating i) the unobserved variable costs associated with a given acreage (energy costs,...) and ii) the effects of binding constraints on acreage choices, e.g. agronomic constraints or constraints associated to limiting quantities of fixed inputs"*. The partial adjustment approach is employed to account for adjustment costs and for constraints on the present acreage choices. The decision is made at each plot level, with reference to a long term choice of acreage shares, and the adjustment is made by reference to the acreage shares during the preceding agricultural season.

Consider now a specific crop, for instance wheat, corn or rice. The farmer faces the choice of the scope of cultivars, and the level of the genetic diversity of the crop chosen. Cultivars are designed to respond to different needs or uses. The rice cultivars are usually classified according to descriptive or technological properties of the grain. Demand and prices for each specific class depend on the marketing strategies of the collectors and the industry. But neither of them is completely specialized in a specific category. Because they are few collectors, each with slightly different strategies, and because farmers are usually selling rice to one or two collectors only, the structure of the demand is usually translated from the market up to the farmers. As emphasized by Panzar and Willig, this situation arises *"from the failure of the market to sustain efficient vertical disintegration"* (Panzar and Willig, 1981). Moreover, they are also endogenous strategic considerations in keeping the supply balanced between different types of commercial grains.

Even if considering a homogeneous technology, the choice of the portfolio of cultivars is formally analogous to the one of acreage decisions. For M. Pitt and G. Sumodiningrat, *"treating seed variety choice as fixed, as most studies do, results in underestimates of (the absolute value of) input demand and output supply elasticities... Different profit functions exist for each variety, reflecting the differences in their biological technology. If seed variety choice is itself part of the cultivators profit-maximization problem, then there exists a single profit function- the meta-profit function- which treat variety choice as a variable input and from which all variety-specific profit function can be derived by treating seed variety as fixed"* (Pitt, 1991). The econometric estimation method they proposed follows a three stage procedure, first estimating the seed variety switching equation, then the profit functions and the sets of inputs demand equation. The specific context (adoption of high yield variety in Indonesia) made the econometric specification of the estimation procedure easier, relative to case studies where the number of cultivars is higher.

Raising the question of the determinants of millet diversity at the household-farm level, in the Indian context, Nagarajan and al. proposed recently (Nagarajan, 2007) to use an ordered discrete choice model able to take into account up to five cultivars of millet. To pledge for the ordered probit forms they adopted, they identify the latent variable underlying the choice of more variety as the index of millet richness on-farm.

In the same vein, Benin and al.(Benin, 2004) , dealing with the two levels of biodiversity on-farm, cereal crops diversity and intra-crop diversity, in Ethiopia, observed that *"a sample selection problem occurs because the diversity index for cereal i exists only when the household cultivates the cereal"*. They also observed that *"a large proportion of households that cultivate a specific cereal grow only one variety so that both indices are censored at* 0*"*. Eventually, they proposed to use the CLAD method (Censored Least Absolute Deviation). Finally, Park and Florkowski (2003) present an adoption model for peach varieties. They use a count data model, with a poisson regression, to explain the number of adopted varieties.

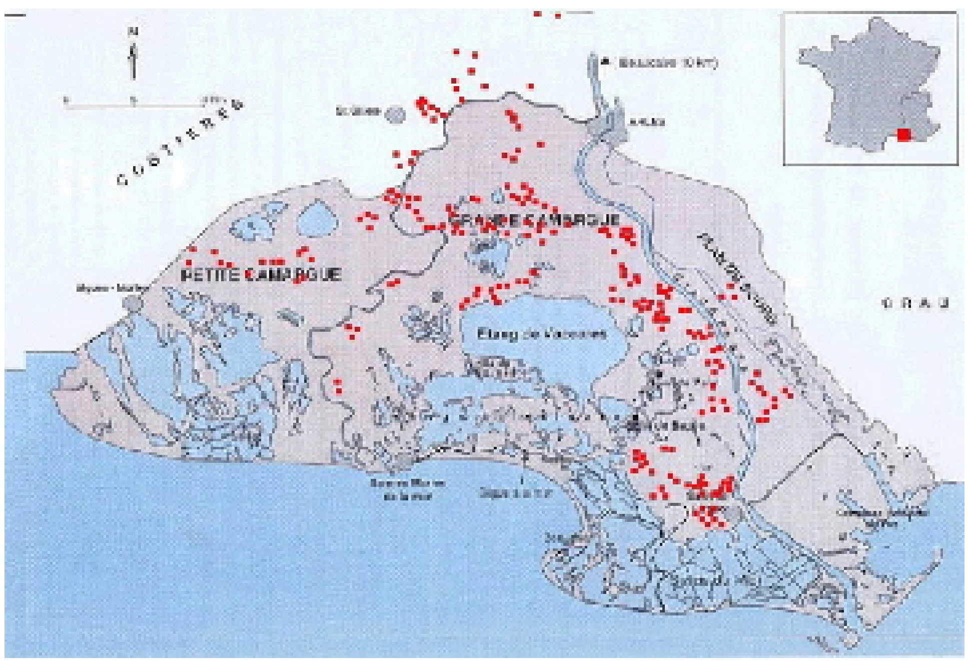
2 Local context

The Camargue is a large area made of intricate fields, marshes and lagoons in and around the Rhone River Delta (South of France). It belongs to the set of biodiversity hotspots around the Mediterranean Sea registered in the Ramsar convention and also in the European Framework « Habitat, Fauna and Flora ». The area has been recently accepted as part of to the « Man and Biosphere » reserves network. Several local institutional arrangements for managing water and biodiversity in the landscape have been finally designed in a context of conflicting interests (Water Local commission, and Parc Naturel de Camargue). Wheat production and cattle are the main agricultural activities, while various recreational activities, commercial hunting among them, provide high income to landlords. The agricultural production is very intensive, but the use of pesticides and herbicides is highly controlled by several administrative regulations and collective institutional arrangements.

Irrigated rice growing is used to flush salt from the rootzone after some years of dry farming. However the rice cultivars need to be adapted to the local weather conditions (low spring and autumn temperatures, wind). Due to the latitude, and the shorter vegetative cycle, it's necessary to use more seeds per hectare than in southern latitude. As a result, the production costs are high and the average yields low. In the actual setting of the CAP, farmers are entitled to unconditional payments varying from 400 to 1000 Euros/ ha.

Beside adaptation to local agro-ecological conditions, the choice of cultivars is commanded by demand driven attributes, like the morphology of the grain or the technological characteristics. Markets use a classification of grain in categories like : Round, Long A, Long B, Medium, Colored and Perfumed. The rice breeding is mainly controlled by Italian breeders, and as a consequence, few locally designed cultivars are found on local farms. Few (5) local rice collectors are also seeds providers. They buy seeds in Northern Italy, and provide them to their patrons in Camargue, in a context of one implicit joint contract linking seed delivering and grain collection

There are no significant differences between the average yield of cultivars belonging to a different grain type. As a consequence, the price of seeds doesn't depend on this factor, but reflects the differences in a price of the grain type they are belonging to, a year before. When the market price falls, the farmer's margin is then reduced. After two years of high grain prices, the market dropped in 2009 to its level of years 2005 − 2006. Specific grains (like Ermes, Tam tam, Artemide, Giano ou Lido) get a premium, whereas more common grain (belonging to Long B category for instance) get the lower market price (See table 6 in appendix). Naturally, the choice of grain categories grown by a single farm reflects the own constraints, costs and strategy and, as a result, the grain portfolio in each farm results in a different structure.



Location of the Camargue area and the surveyed farm

3 Data collection and processing

We surveyed farmers in Camargue during the spring 2009, and collected information on the allocation of land they made in 2008 among several rice cultivars. For each economic unit, made from one or more operational units (farms), we described the list of each cultivar grown, its acreage, and the quantity of seeds used per hectare. We matched this information with that collected on the characteristics of the farm during a choice experiments survey, Winter and Spring 2008 (Jaeck, 2009) . We eventually get a very rich data base on 86 economic units, representing 10000 ha of rice, that is to say half of the total rice acreage in the area.

3.1 Cultivars grown

In our sample, we identified 35 different rice cultivars, but as a matter of fact, few of them make up most of the rice acreage: Selenio, Arelate, Brio and Eurosis constitute more than 70% of the total rice acreage in 2008 (see figures 1, 2 and 3 in appendix). Among the numerous cultivars with little area, some are old ones, or are not suited to the market, and, for that reason, abandoned. Some others are recently released cultivars, being tested by few or even one farmer. In such a distribution, with a fat part and a thinly tail, we are able to recognize the effects of a cultivar life-cycle. Finally, some cultivars correspond to a niche market, and their acreages remain thin for that reason.

3.2 Farms' economic performance

We elaborated the farm's gross margin (FGM) indicator. We did different computations for conventional farms and organic producers. The distribution of the farm according to their economic performance exhibits FGM ranging from -181 to 1414 euros. The median FGM is 602 euros. The main variables explaining the differences in economic performance are the type of crop rotation used, the level of yield and the allocation of land to different commercial types of rice grains.

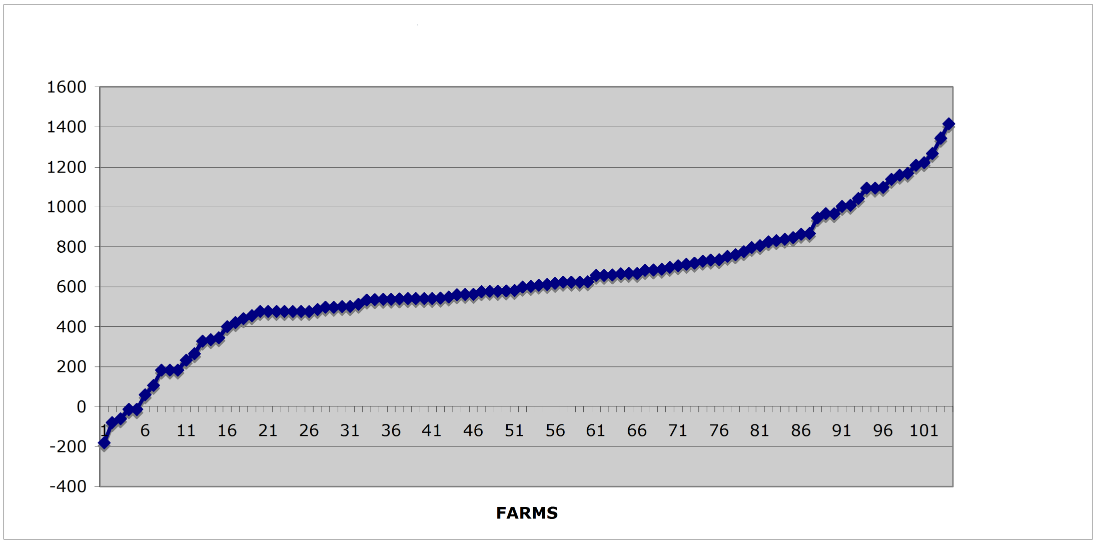


Figure 1. Distribution of farms' gross margin (FGM)

4 Conceptual framework

Consider that the farmer faces the problem of allocating his land to K different crops, or cultivars, in an optimal way, between the acreage shares s_k for $k = 1, ..., K$ with $\sum_{k=1}^{K} s_k = 1$. The output obtained with the crop (or type grain) k is sold at price p_k . The quantity of seeds used is x_k and the price for these latter is denoted w. Each crop or cultivar gives a yield y_k. So we can define the farmers'profit or gross margin function per hectare of any crop $k = 1, ..., K$ as follow :

$$\pi_k(p_k, w) = \underset{y_k, x_k}{Max}[p_k y_k - x_k w] \tag{1}$$

The decision-making process of allocation between the different crops will imply to taking into account a trade-off between the crop gross margins $\pi_k(p_k, w)$ of the different crops on the one hand and the "implicit management cost" of the crop k, c_k, on the other hand. So we can note the farmers' restricted profit function:

$$\pi(s; p, w) = \sum_{k=1}^{K} s_k \pi_k(p_k, w) - c_k + e_k \tag{2}$$

with e_k being known to the farmer but random from the econometrician's point of view. Its expectation is normalized to zero.

We can define the probability that the farmer chooses crop k with a standard multinomial logit form:

$$P_k(p, w) = \frac{\exp[\sigma^{-1}(\pi_k(p_k, w) - c_k)]}{\sum_{k=1}^{K} \exp[\sigma^{-1}(\pi_k(p_k, w) - c_k)]} \tag{3}$$

The choice of cultivar portfolio appears to be one important determinant of the gross margin distributionin the farmers population.

5 Econometric approach

5.1 Models specification and dependent variable

Our goal is now to identify the main drivers of the on-farm, intra-crop diversity, and to estimate the parameters of the underlying function explaining this choice. We could assume that the number of cultivars is a good proxy for the diversity's management costs: when these costs are high, the number of varieties is expected to be low, and conversely, to be high when these costs are low.
We will first estimate a gamma model for counts, considering the number of cultivars as a continuous dependent variable. We estimated such a model to take into account the dispersion of the parameters revealed by the overdispersion test obtained in the poisson model[1].
In a subsequent stage of our research, we will seek to better understand the on-farm acreage repartition choice between the different commercial types of rice grains. Let us specify here what these commercial types are. As we said before, the rice grains are classified into six categories, Round, Long A, Long B, Medium, Colored and Perfumed rice, based on agronomic and physical characteristics. From a commercial point of view, we can retain three classes, Round, Long (Long A and Long B), and Niche market (Medium, Colored and Perfumed)[2]. About the question of surface repartition between this various commercial types, the reasoning is as follows: either the farmer devotes all his acreage to a unique category[3], or chooses to grow the two main rice grains (long and round), or decides to have niche varieties[4]. So, we obtain a discrete choice model with three alternatives. That's why we will estimate a multinomial logit model. Finally, we will improve this second step of our analysis by studying the ratio of long varieties with regard to the round varieties[5]. We will thus estimate a simple linear regression model to determine the factors affecting this on-farm proportion.

[1] The results of the Poisson regression and the overdispersion tests are presented in appendix, in table 5

[2] because these three last classes are all marginal in the rice market

[3] Farmers are always specialized either in long or in round rice, but never in the niche varieties.

[4] The niche varieties are present in combination with the two main commercial types, except for two farmers who only grow round rice with niche varieties.

[5] in terms of percentages of long and round varieties in the total acreage

5.2 Independent variables

We intuitively identified a set of factors having an impact on the on-farm diversity[6].

We suppose that the following assumptions imply a greater diversity :

- control of a greater acreage through the land concentration or the size of the farm,
- to appoint more permanent workers,
- practicing short term rotation close to rice monoproduction,
- being involved in agro-ecological research and test various cultivars.

Whereas the following factors generate a lower cultivar diversity:

- managing or controlling a lower acreage
- managing vineyards or spring crops being substitutable to rice
- managing on-farm alternatives enterprises, like recreational activities in spring or early summer
- being family (labour constrained) farm without wages workers

As complementary variables, we proposed also to take into account the name of the grain collector and the geographical location, in relation to the probability of occurrence of the salinity issue.

Table 1 presents the independent variables which will allow us to test our hypothesis.

[6] by on-farm diversity, we refer to the number of varieties grown, but also to the diversification in terms of commercial types.

variable	description
BIO	Percentage of total rice area of the farm in organic farming
SAURIZ	Total rice acreage of the farm, in ha
NEXPL	Number of farms managed by the farmer
MADAR	Dummy variable that indicates if the farm sells its output to the enterprise "Comptoir agricole du Languedoc"
MARAIS	Percentage of total farm area used as marshes
SUDCEREA	Dummy variable that indicates if the farm sells its output to the cooperative "Sud Céréales"
TOURTOUL	Dummy variable that indicates if the farm sells its output to enterprise "Tourtoulen"
STETHOMA	Dummy variable that indicates if the farm sells its output to the enterprise "Société Thomas"
PERSONNE	Number of workers
ACTRECRE	Dummy variable that shows the presence or not of recreational activities in the farm
SUPERFIC	Total acreage of the farm
TROUPEAU	Dummy variable that shows the presence or not of cattle in the farm
ROTATION	Percentage of rice in the rotation system
Z2	Variable effect coded that indicates if the farm is located in the zone 2
Z3	Variable effect coded that indicates if the farm is located in the zone 3
Z4	Variable effect coded that indicates if the farm is located in the zone 4
Z5	Variable effect coded that indicates if the farm is located in the zone 5

Table 1: Description of variables

6 Estimates and discussion

6.1 The number of cultivars

Examining the distribution of cultivars among farms in our sample, we observe that the average number of cultivars per economic unit is 3.73, so close to 4. The distribution is asymmetrical, with a maximum number of cultivars per farm equal to 10. The distribution looks bimodal, with two peaks, one for 3 and one for 2 cultivars.

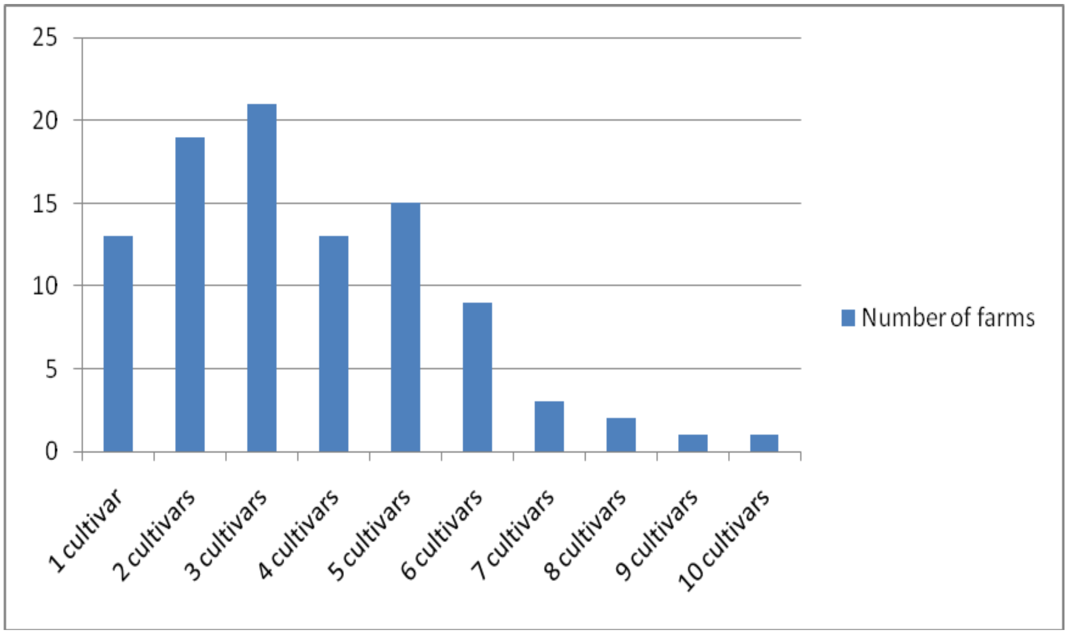


Figure 2. Number of cultivars

Count data results of the determinants of the number of cultivars are given in table 2.

The estimate results are pretty good; the constant is 0.91, which is consistent with the fact that all farms grow rice. The share of rice area under organic technology management (BIO) is very significant, with a weak and negative coefficient. The apparent contradiction with the negative impact of this parameter is explained by the fact that only few rice varieties are suitable for organic farming, given farmers can't use herbicides, so they need to have seeds that compete well with the weeds. Farmers and specialists agree that only a few varieties have this quality. As expected, the area given to the rice ($SAURIZ$) is significant, but has little positive weight, whereas the number of farms managed ($NEXPL$) is heavier and has a negative coefficient. The coefficient of $SUPERFIC$, the overall area of the farm, is very low but significant. The two rice collectors in relation with a greater number of varieties are $TOURTOUL$ and $STETHOMA$, the first one having a diversification strategy in its rice sales, and the last one being involved in organic and niche paddy marketing. It is relevant to make here the link between the number of varieties and the on-farm acreage repartition choice made in terms of commercial rice grain. We can notice that farmers having niche varieties correspond to diversified farmers, in all three commercial categories, and with more than four varieties. So because of these reasons, this is a good explanation of the positive coefficients for $TOURTOUL$ and $STETHOMA$, and we understand better why farmers who sell their output to collectors adopting such a market and commercial strategy can grow a higher number of varieties

Variable	Coefficient	std error of β
Constant	0.91***	0.303
BIO	−0.01***	0.003
SAURIZ	0.001**	0.0007
NEXPL	−0.17**	0.073
MADAR	−0.14	0.094
SUDCEREA	0.07	0.11
TOURTOUL	0.24**	0.125
STETHOMA	0.45***	0.142
PERSONNE	−0.04	0.035
SUPERFIC	0.0005	0.0004
TROUPEAU	0.15	0.141
ROTATION	0.002	0.002
Z2	0.22	0.268
Z3	0.17	0.244
Z4	0.11	0.223
Z5	0.29	0.228
Dispersion parameter Alpha	2.57***	0.648
Number of observations	86	
Number of parameters	17	
McFadden Pseudo Rho-squared	0.0757325	
Model test	0.0000	
*, **, *** means statistically significant at 90%, 95% and 99% significance level		

Table 2: Count model data model results for Number of Varieties

on their own farm. We see here the interactions between farmers' production choices and the final market, via the downstream firms. Contrary to what we expected, the number of permanent wage workers, (*PERSONNE*), the presence of cattle or sheep (TROUPEAU) on the farm and the importance of the rice in the rotation (ROTATION) are not significant in the choice of rice varieties portfolio. The geographical location inside the Camargue area also appears also to be not significant in the number of varieties adopted.
The dispersion parameter is significant, with a value higher than 1, that proves an underdispersion of the distribution, that is variance lower than the mean.

6.2 The farmers' choices for commercial types of rice grain

We study here the factors explaining the on-farm repartition choices between the different commercial types. We can observe that about one farm out of five is specialized in only one category of grain[7]. The same proportion grows niche varieties. The remaining farmers share their acreage between round and long cultivars. So, this analysis of our data shows that farmers choose between three

[7] Among them, 50% are specialized in round rice and 50% in long grains.

alternatives, be specialized, in round or long grains, be diversified but only in these two categories, or be diversified with niche varieties. In order to explain the farmers' choice to be specialized or diversified, with or without niche, we estimated a multinomial logit, with three classes.

Table 3 presents the results of this multinomial logit model. Structural characteristics of the farm seem to be significant and affect the decision of being diversified, with or without niche varieties, instead of specialized. Indeed, the number of farms managed (*NEXPL*) appears to have a heavy negative influence on the probability of being diversified, both with or without niche. This result invalidates our hypothesis, but can be explained by the additional work implied by the management of various units, and thus the specialization is a means of not increasing this extra task. Size factors like *SAURIZ* or *SUPERFIC* have only little impact on the choice of diversification. The surface devoted to rice (*SAURIZ)* tends to increase the probability of belonging to the two diversified classes. However, the total acreage of the farm (*SUPERFIC)* is not significant for the niche varieties class, and has a very low but significant coefficient for the diversified class without niche varieties. Surprisingly, the sign is once again in contradiction with our intuitive assumption, given a bigger total acreage decreases the probability of growing both round and long rice. As a matter of fact, this proves the existence of higher management costs due to the bigger structure. The *BIO* coefficients are weak but significant. Even if this result can appear to be non intuitive, it can easily be explained. Indeed, if the farm produces both conventional and organic rice, it is forced to grow distinct types of varieties in each sector. As a matter of fact, the more the farm has organic acreage (especially when all its surface is in organic farming), the higher the probability of growing only one category of rice grain is. And conversely, if the farm cultivates only a little part of its acreage in an organic way, this would imply it being diversified, in order to distinguish the conventional output associated with a particular commercial rice grain and the organic one, in another commercial type. We understand why the *BIO* coefficient for the class with niche is more significant and a little bit higher, because of the fact that organic farming is also a risky niche strategy, which competes with the other niche varieties strategy. The presence of marshes and the number of workers in the farm have both non significant coefficients. However, the presence of cattle or sheep on the farm highly increases the probability of growing various rice commercial types. This result proves that farmers having cattle or sheep are in a diversification strategy, both in activities introduce on the farm and in commercial rice grains cultivated. Finally, the link with downstream firms seems to have an impact on the probability of growing several commercial types. We gave explanations in the previous section. We know that "Tourtoulen" adopts a diversification strategy and sells all commercial types on the rice market to several customers, in France and abroad. That's why we find a strong positive correlation between the fact that a farmer sells its output to this enterprise and his choice of being diversified. And, as we said before, the rice collector "Thomas" has a niche strategy, which justifies the highly significant coefficient, and its great positive value, associated with the probability of growing niche

Variable	Diversified (long and round)	Diversified with niche varieties
Constant	$-1,64$	$0,68$
BIO	$-0,04$*	$-0,09$***
MADAR	$-1,76$*	$-3,80$***
MARAIS	$-0,04$	$-0,09$
NEXPL	$-3,061$**	$-4,35$***
PERSONNE	$-0,34$	$-0,25$
SAURIZ	$0,07$***	$0,07$***
STETHOMA	$2,99$	$8,23$***
SUDCEREA	$-0,26$	$-0,38$
SUPERFIC	$-0,007$*	$-0,007$
TOURTOUL	$2,17$*	$3,07$**
TROUPEAU	$5,008$**	$5,98$***
Number of observations	86	
Number of parameters	24	
Log Likelihood	$-47,20975$	
Prob (ChiSqd > value)	0.0000	
*, **, *** means statistically significant at 90%, 95% and 99% significance level		

Table 3: Parameters estimates of the multinomial logit model, with three classes, for specialization (reference class), diversification with or without niche varieties

varieties. *MADAR* coefficients are negative, that implies that the more farmers sell their output to this firm, the more they are specialized, either in round or in long rice. Finally, the cooperative (*SUDCEREA*) seems to have no influence on the probability that a farmer chooses to be diversified rather than specialized.

Variable	Coefficient	Std error of β
Constant	−2.01*	1.045
BIO	−0.01	0.012
NEXPL	1.76***	0.404
SUDCEREA	0.23	0.497
MADAR	1.54***	0.487
TOURTOUL	−0.28	0.537
STETHOMA	−0.10	0.833
SUPERFIC	−0.0007	0.0009
ROTATION	0.018**	0.009
Number of observations	70	
Number of parameters	9	
Log Likelihood	−132.2952	
Model test	0.0002	
Prob (ChiSqd > value)	0.0001	
*, **, *** means statistically significant at 90%, 95% and 99% significance level		

Table 4: Linear regression model results for estimating the ratio Long/Round

We now want to study more in details the on-farm repartition choice between long and round varieties. To do that, we focused on the proportion of long varieties in total rice acreage in comparison to the percentage of round varieties, which allowed us to calculate a ratio of these two values[8]. As a matter of fact, the higher the ratio is, the higher the surfaces devoted to long rice, compared to those allocated to round grain, are.

Table 4 presents the factors affecting this on-farm repartition choice between the two main commercial types. We can observe that only few variables are significant, proving the difficulty in defining the determinants of the trade-off between long and round rice grains. Indeed, only three elements are significant, with a positive coefficient, so they imply that round varieties are substituted in favour to long varieties. We find two structural determinants (*NEXPL*, *ROTATION*), and once again a market one (*MADAR*).

[8] We omitted specialized farmers, and retained for this analysis only diversified farmers

7 Conclusion

Cultivars of the same crop represent a specific level of the agro-biodiversity, intermediate between the species (crop) and the genes or alleles. For the breeders, they are marketed products, designed to be suited for speficic purposes, mainly increasing and securing the yield. For the farmers, they are items to be managed separately, at the plot level, because the shadow constraint and the difficulty of managing cultivars mix. The choice of the cultivars diversity, the cultivars portfolio, is in essence very similar to the choice of the crops portfolio and the crops rotation design. It is in fact a secondary level of that choice.

On-farm cultivars management is one aspect among others of biodiversity management. As such, it entails some specific management costs. They arise from the allocatable nature of the farmland, as an quasi-fixed input, and also from work's constraints at the time of seeding and harvesting. But management costs are balanced by the benefits arising from the market advantages of some cultivars, price premium or secure sales. As a matter of fact, the choice of cultivars portfolio appeared to be one important factor of the heterogeneity of farms profits. We performed a specific survey in the Camargue Area, the Rhone River delta, to characterize the rice cultivars diversity in the farms growing rice. We identified 35 cultivars, which is pretty high and give empirical evidence of the importance of niche markets strategies among rice growers. Because rice growers are allowed to practice organic farming on a share of the farm, organic farming appears to be part of such a strategy. Beside niche market strategy, we identified farmers with low cultivars diversity, being as a consequence specialized in only one commercial grain type. They represent one out of five rice growers.

We proposed to approach the reality of the cultivars diversity management cost through the number of on-farm cultivars. We first estimated a count data model, in which we explained the number of varieties grown on-farm. Then, a multinomial logit was used to analyze the diversification choice, in terms of commercial rice grain types. The results are encouraging and confirm the importance of the interaction between markets related benefit and the management constraints on land and labour. Indeed, this study proves that the varietal portfolio choices depend certainly on structural characteristics and constraints of the farm, but also on market-driven variables. As a matter of fact, commercial networks and opportunities play a key role in the diversification choice. However, the choice of commercial type is a more complex decision making process, as we could see in the last regression linear model we estimated, which showed that only few structural and market factors are significant in the trade-off made between round and long rice grain.

Our results confirm the importance of the relationship between farmers and collecting firms in the choice of cultivars portfolio. The hypothesis of implicit contracts received a strong support from our estimates and investigating the role of social networks and factors involving truth could shed more light on the making of thoses contracts.

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Variable	Coefficient	std error of β
Constant	0.78***	0.370
BIO	−0.01***	0.004
SAURIZ	0.002***	0.0007
NEXPL	−0.19	0.128
MADAR	−0.15	0.139
SUDCEREA	0.079	0.14
TOURTOUL	0.26	0.165
STETHOMA	0.48**	0.230
PERSONNE	−0.04	0.041
SUPERFIC	0.006	0.0004
TROUPEAU	0.17	0.171
ROTATION	0.003	0.003
Z2	0.24	0.253
Z3	0.18	0.289
Z4	0.11	0.208
Z5	0.31	0.238
Number of observations	86	
Number of parameters	16	
McFadden Pseudo Rho-squared	0.1240407	
Model test	0.00169	
Overdispersion test : $g(\mu_i) = \mu_i$	−8.189	
Overdispersion test : $g(\mu_i) = \mu_i^2$	−7.201	
*, **, *** means statistically significant at 90%, 95% and 99% significance level		

Table 5: Poisson model for counts results for Number of Varieties

8 ANNEX

8.1 Estimates of the poisson model for counts

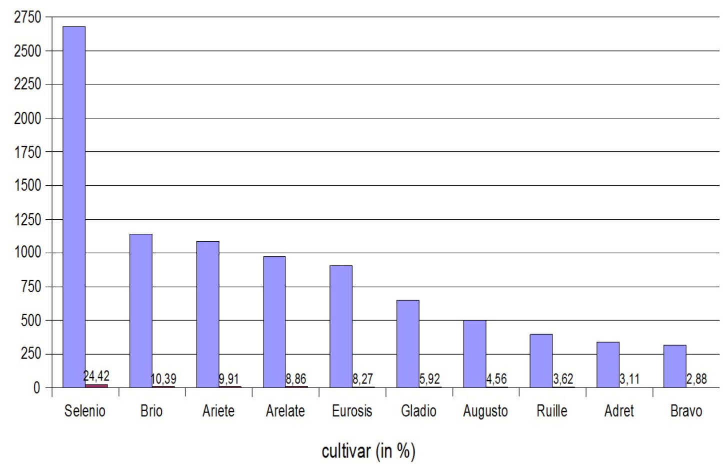
According to Greene (2007), *"under the null hypothesis of equidispersion, the μ_i and μ_i^2statistics have limiting chi squared distributions with one degree of freedom"*. So, the values estimated ($\mid -8.189 \mid$ and $\mid -7.201 \mid$) must be compared with the critical value from the chi squared table with one degree of freedom (3.84). In our poisson model for counts results, the two statistics are higher than this critical value, thus we reject the null hypothesis of equidispersion.

8.2 Seeds prices

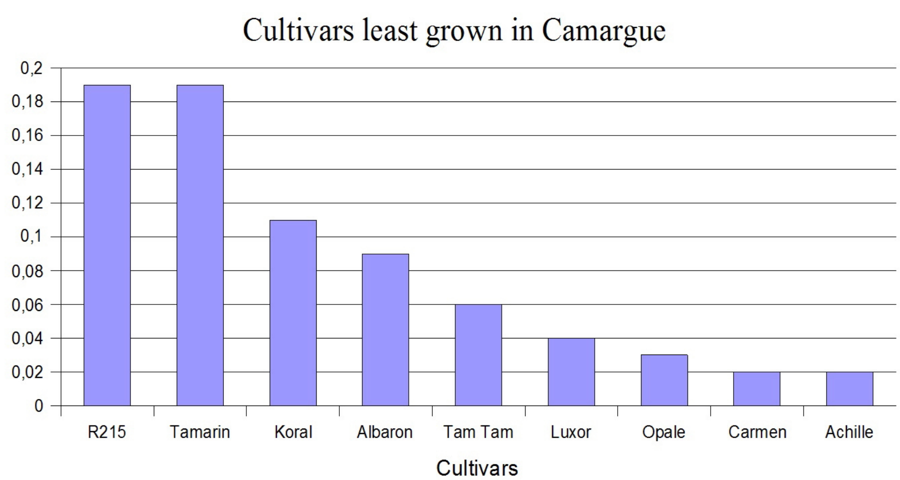
Grain Type	Cultivar	Seeds Price 2007	Seeds Price 2008	Seeds Price 2009	Average Yield (qx)	Grain Market Price 2007 (E/t)	Grain Market Price 2008 (E/t)
Round	Cigalon	562	562	908	47	**225**	**348**
	Centauro	660	675	883	61		
	Selenio	530	518	908	63		
	Ambra	680	582	930	58		
	Balilla	570	559				
	Brio	680	582	951	66		
Long A	Arelate	600	602	871	63	**245**	**428**
	Ariete	640	675	1063	59		
	Opale			947			
	Sirbal			879			
	Augusto	610	580	879	52		
Medium	Lido	600	628	947	69	**267**	**440**
	Loto			947	57		
Long B	Adret		654	654	63	**255**	**289**
	Albaron		654	654			
	Gladio	640	710	1019	58		
	Thaïbonnet	540		753	55		

Table 6: Seeds Price by Grain Type and selected Cultivar/Source : Groupe Sud Céréales, Communication from D. Villenave

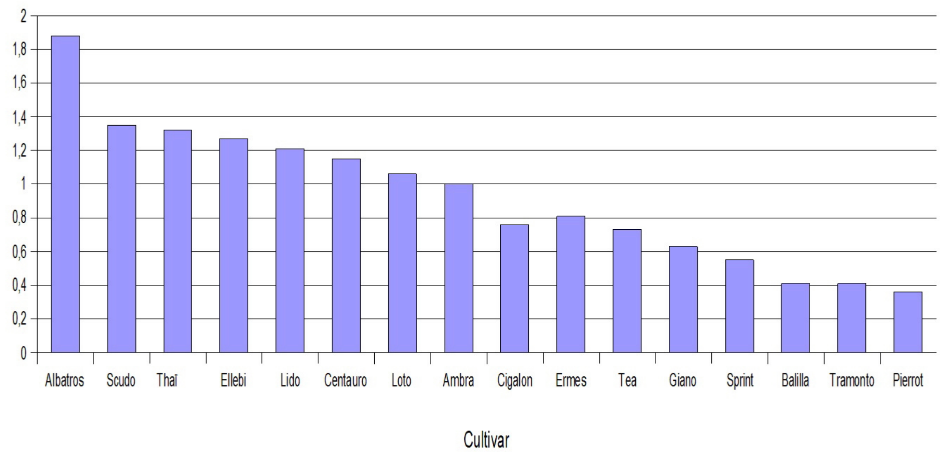
8.3 Description of our data



The ten first cultivars grown in Camargue, in surfaces and in percentages



Varieties least grown in Camargue, in percentages of total rice acreage



The other varieties grown in camargue, in percentages of total rice acreage