Preferences, norms and constraints in farmers' agro-ecological choices: case study using a choice experiments survey in the Rhone River Delta, France

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Abstract

The aim of this paper is to elicit the sensitivity of farmers to payment for agro-environmental services in a context of strong ecological and policy constraints. We present results from a choice experiment survey performed among the whole population of agricultural decision-makers (104) in the Camargue area. Several econometric models have been estimated, the most significant being the Latent Classes one. Three classes have been identified, two of them representing farmers with strong committment to a specific technology (either very chemicals intensive or organic farming), the main class encompassing farmers complying with the norms of the PGI « Riz de Camargue ». The estimated parameters of the utility function, together with the parameter of the monetary attribute provided the monetary value of each relevant agro-ecological attribute and the associated outcomes (average and risk yield). Outcomes of the choice experiments make a strong case for differentiating incentives for spreading environmental friendly technologies.

Keywords : Agricultural Technological Choices, Agro-environmental measures, Policy Instruments design, Choice Experiments, Sample Selection Model, Latent classes Model, Random Parameter Model, Rice production, Organic farming

JEL Classification : Q12, Q26, Q28

Introduction

Overall in the world the complex relationship between the technology of agriculture and the environment is placed under scrutiny. The motivations behind that interest are context-dependant, and pertain to market strategies, to strategies of international negotiation or to consumers demand for pesticides-free products. Moreover, the protection of the environment itself could be locally important, specially in area with a great natural heritage value, as in the Camargue area. In such a context, it is difficult to organize the spatial coexistence of intensive agriculture and biodiversity rich area (Green et al. 2005). Mainly because the importance of spillover arising from the intrication of water channel network. If zoning and specialization of zones in segregated spaces for intensive agriculture and biodiversity conservation prove to be not possible or very difficult, then it is worth to look at the distribution of farmers preferences and motivations when they choose their technology of rice production.
In each case, balancing between the economic efficiency and the preservation of the environment calls for a careful analysis of the farmers ability to change their practices. Compensating payments could be in some cases necessary to motivate farmers to adopt environmental friendly technologies, but if this is done, they are not automatically undifferentiated.

The general assumption of the paper is that farmers face several norms and constraints, but they have nevertheless a scope for expressing individual choices. To test that hypothesis, we used a choice experiment approach. Choice experiments are useful tools to measure either the willingness to accept or the willingness to pay for a set of attributes characterizing goods, services or technology. In that paper, we will present the results of the choice experiment survey performed among the whole population of agricultural decision-makers (104) in the Camargue area, Rhone River delta, France. Moreover, using suitable econometric models, such as Random Parameter Logit or Latent Class Models, it will be possible to asses and characterize the underlying heterogeneity in the farmers technology choices. More precisely, we would like to gain insights on the heterogeneity of farmers preferences regarding both the attributes of the technology and the related compensatory payments.
Our use of choice experiment to assess the farmer willingness to accept for specific attributes of agricultural technology with differentiated impacts on the environment is , according to authors' knowledge of the literature, original. The results are useful inputs for the design of policy instruments, as long as the regulator is concerned for efficient use of public funds. Helping in the design of differentiated payments. for specific environmental services could be a beneficial outcome of our research[1].

[1] This research is co-funded by the two Regional Government of Provence-Côte d'Azur and of Languedoc -Roussillon

1 Litterature review

The issue we are about investigating is related to three different fields of the literature : agricultural household models, technology adoption and choice experiments.

The first field is on the issue of separability between household decision making and farm management and concern the impact of individual utility function of the farm manager, on the choice of farming style and of production technology.

The second field of relevant literature concerns the technology adoption process, and how we can discriminate between individual factors and social infuences and interactions pertaining either to collective action or to commercial relationships ?

Finally , it is worth to examine how the question at stake has been investigated in the choice experiments litterature.

In their choice of production technology, farmers have preferences not only regarding productivity or profitability, but also for various attributes of crops, animals or farming practices. Utility-based adoption models already provide evidence of the importance of the technology's perception by the farmers. Batz et al . show that the speed and the level of adoptipon of a specific technology depend on the level of the investment required, the risk involved, and the complexity and the difficulties of the task involved in the curse of the implementation (Batz, 2003).

Adesina et al. draw attention to the lack of concerns about the farmers' perceptions of the characteristics of the technology. They use a Tobit model of adoption of new and improved rice cultivars in Sierra-Leone, and show that the characteristics of a cultivar that are taken into account are not only those related to yield or input use, but also those related to subjective traits (Adesina et aL, 1993).

In a context of subsistence farming, Dalton used a hedonic model of rice traits showing that yield is not a significant factor in the adoption, compared with the length of plant lifecycle, plant height, grains properties (colour, elongation, swelling and tenderness). (Dalton, 2004).

Birol and al. analyzed the valuation of agrobiodiversity by Hungarian small farmers in their Home gardens using a choice experiment. They rely on four components of the home-garden system (Richness of crop varieties and fruits trees, crop landrace, integration of crops and livestock production, organic production versus pesticides use). Preferences of small farmers who are oriented toward the satisfaction of the household's needs are described by the mean of the prefered choice sets, and translated into monetary terms (Birol 2008).

Roessler and Scarpa use a choice experiment survey to assess the preferences of farmers breeding pigs in Vietnam. Based on the set of five attributes (growth, reproduction, disease resistance, feeding needs and physical appearence), they identified two types of breeders as folow : « resources driven » and « demand driven or market oriented » breeders. (Roessler, 2007).

Birol et al. presented a latent class approach for the Mexican smallholders facing a choice between the use of the traditional « milpa » system, based on the conservation of genetically diverse maize , and the GM maize (Birol 2006).
Dupraz and al. (Dupraz, 2003) stated that farmers' households are together producers and consumers of the environment they contribute to forging. They accomodate the multifonctionnality of the agricultural production in considering the technological flexibility of their environmental supply. Using a contingent valuation survey , they confirmed that farmers behaviour is influenced by environmental preferences. More precisely, Davies and Hodge found that two attitudinal factors, « stewardship orientation » and « technological beliefs » were by far the most signiifcant in determining the acceptabilitiy of cross-compliance in the CAP implementation (Davies, 2006). As a consequence, structural and socio-demographic factors were considerably less impportant. They identified clusters of farmers according to their overall attitudinal orientation.
In the same line , Schmitzberger and al., using the concept of « styles of farming » elaborated by Van der Ploeg, established the link between those styles, land use intensity and motivations for biodiversity conservation and participation in agri-environmental programs (Schmitzberger et al, 2005). Van der Ploeg defined styles of farming as « a unity of thinking and doing ». Farming styles encompasse human attitudes, farming objectives, economic success and ecological performance. (Van der Ploeg, 1994). Identifying and characterizing the main farming styles inside a set of farmers or an area proved very useful to target some subsets of farmers able to foster a wider adoption of improved weed management strategies by broadacre croppers in Australia (Howden, P. and al., 1998)

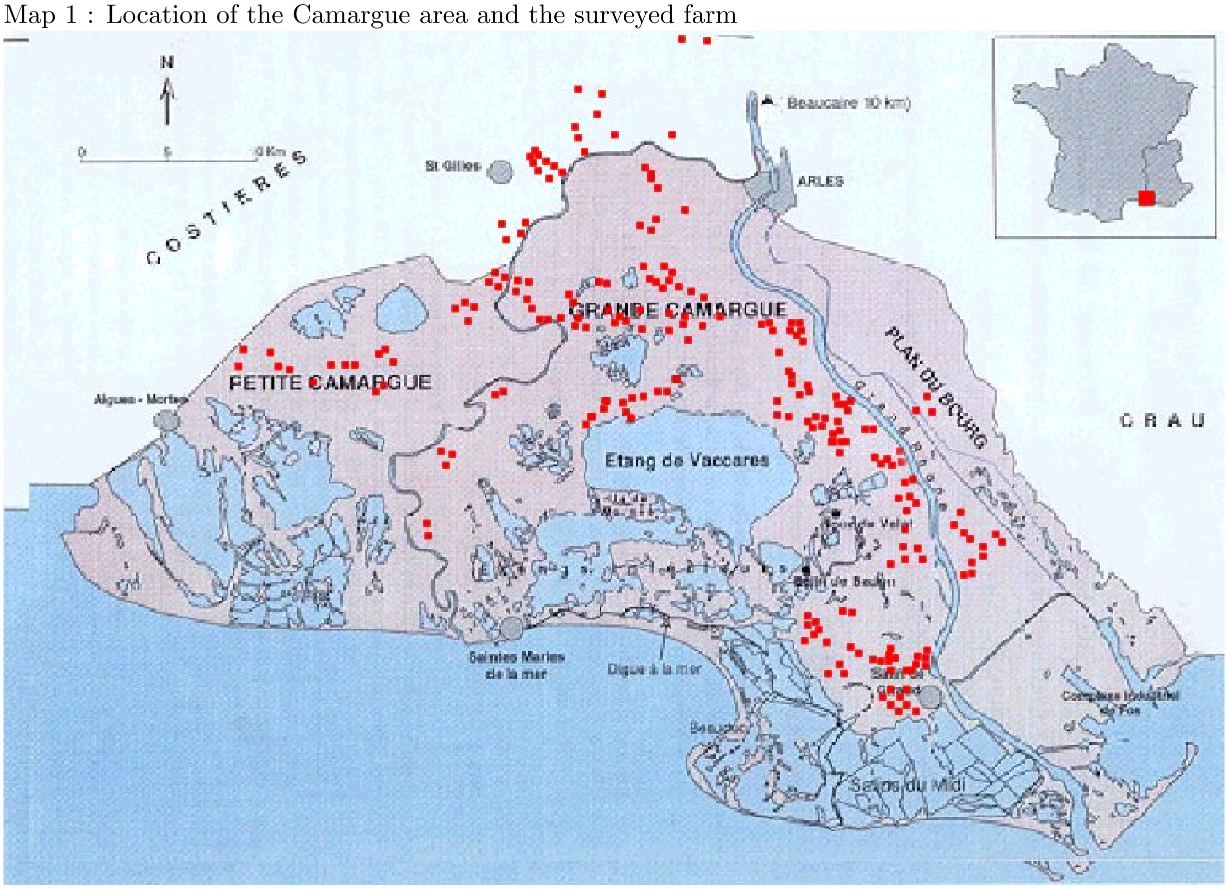
Finally, two main conclusions arise from this literature review. The first one is related to the importance of subjective factors and preferences in the choices of technology 's attributes (even if few papers are dealing explicitly with the implementation). The second is about the importance of the diversity of perceptions and farming styles or subcultures (the heterogeneity issue).

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 Mediterannee 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 institutionnal 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 institutionnal 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). As a result, the production costs are high and the average yields low. In the actual setting of the CAP, farmers are entitled to uncoupled compensatory payments varying from 400 to 1000 Euros/ ha.

Map 1 : Location of the Camargue area and the surveyed farm

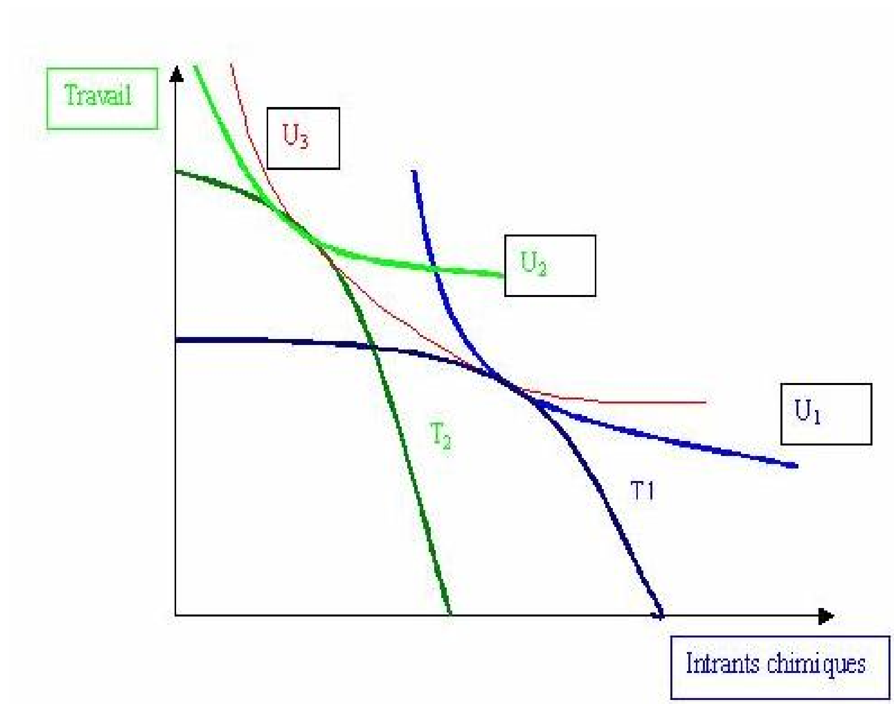


3 Model of technology choice

We assume that farmer's population exhibits a diversity of preferences regarding the prefered technology. Preferences diversity encompasses both the aversion/addiction to pesticides use, the aversion to the use of seasonal wage workers, the risk aversion, among others. It is well known that agricultural production faces a number of constraints arising from the climat, the local agro-ecological conditions or the farm's structure. The multiplication of constraints limits the scope for expressing preferences. Moreover, it is often difficult to distinguish constrained choices from unconstrained one.
For instance, farmers practising organic farming face several agro-ecological constraints arising from the diffiuclty of controling the weeds. As a consequence, the long rotation of rice is a necessity (one year of rice , three years of others cereal) in that case. But that constraint could be softened by controling weeds trough manual weeding, which is costly and implies high transactions costs. As a consequence, farmers averse to the use of wage workers could prefer to reduce the rice area.

Assuming a diversity of preferences related to the use of pesticides ant to the use of seasonnal wage workers, we propose to distinguish, as in Schmitzberger, (Schmitzberger, 2005) two subpopulations, the productivity oriented farmers, the environmentally friendly oriented farmers and a third subset of support oriented farmers. While the farmers belonging to the first style of farming are willing to use more pesticides and grow more rice, the second one are willing to avoid them, and accept to use more workers to remove weeds. The third group of farmers belonging to the support optimizers could choose either one technology or another, depending of what is giving the more profitable outcome.

Figure 1 shows how the production possibilities frontiers, expressing the diversity of technologies, could fit with the preferences related to the corresponding farming styles.



4 Survey design and data collection

Before proceeding to the survey implementation, we gained the support of the main stakeholders in the Delta, the rice growers side (Centre Français du Riz, Syndicat des Riziculteurs de France et Filière, SRFF) and the Environmental and Landscape Agency side (Parc Naturel Régional de Camargue, PNR). That proved to be very important in securing a good stewardship of the survey and good conditions for the interviews. Interviews were managed by the authors and by 3 professional surveyors, each having in charge a specific area.

The attributes choosen to describe cropping technology should be credible and relevant. Nonetheless, the number of attributes is constrained by the cognitive burden involved in the choice tasks.We thus identified six attributes, assuming they are the main factors explaining the farmers technology choices

(Table I below). Three of them are related to agro-ecological means; the length of life cycle of rice cultivar, the weeds control technology and the type of crop-rotation. Two other concern outcome; the average yield over five years and the the yield variability. The final attribute is a monetary attribute, representing a compensating payment.
Weeds control appears to be one of the main problems in irrigated rice cropping in the area. The technology chosen has implications in terms of workforce, use of herbicides, and impact on the biodiversity and environment. It is therefore important will to define farmers' sensibility about the choices of weed control technology. The practices proposed in the choice sets are currently practised in the area, even if not very widespread, for instance, manual and mechanical weeding.
The choice of the rice cultivar, involving the length of the crop' life cycle, is another relevant attribute insofar as it has consequences on production risk.
The type of crop rotation on the same plot is constrained by the weed control and by the salinity of the root zone. When the weed control is not good enough, it is necessary to leave rice cropping for wheat or alfa-alfa. But after a few years of wheat cropping, it is necessary to go back to irrigated rice cropping, to flush salt from the root zone[2].

We used a fractional factorial design to create the experiment structure. An optimal and efficient design is characterized by three properties, orthogonality, balance and minimum overlap (Huber et Zwerina, 1996). We generated it with SAS® software program, following guidelines by Kuhfeld (2004). The efficient choice task design resulted in 24 choice sets. In order to limit the number of tasks per respondent, we split them in two blocks. Two sets were discarded due to the lack of realism, so each rice grower faced 11 choice sets, each containing three options. We could not introduce a status quo alternative, given that each farmer has a different business. There were two alternatives and one opt-out option, in which the farmer choose to leave his land unexploited. This later option can provide null or even negative utility (Table II). The main interest of the opt-out option is twofold : not to force respondents to choose an unsatisfactory option, and being relevant, because the fallow is an option in the actual CAP.

The questionnaire was organized in three parts. The first one is about the respondent 's personal identity, with some opinion questions concerning their conception of the farmers 'profession, and their sensibility with respect to environmental preoccupations.. The second one is the choice experiment exercise itself, The last part concerns questions about the description of the entreprise, for instance the size, the crops, the crop rotation, the suppliers, the customers, and the presence of marshes...

Starting from a list of 200 farming entities delivering rice to the rice processing industry, the final whole population of decision makers has been defined as a list of 104 managers involved in the economical and technological decision making process (often, the same manager is in charge of managing several farming

[2]We are grateful to J.C. Mouret (INRA, UMR Innovation) and to C. Thomas (CFR) for their helpful advices and comments. Final choice of attributes remains our responsability

units). One would remarks that the list represents the entire population of the decisions maker, and not simply a sample.

Table I : Attributes description and levels

Attributes	Description	Levels
Weeds control technology	Method of weeds control	1 : intensive chemical weeding (three applications or more), 2 : chemical weeding with one or two applications, 3 : lines seeding and mechanical weeding, 4 : counterfacted seeding and manual weeds removing
Cultivar choice	Rice cultivar characterized by a different length of life cycle	1 : short cycle : 140-150 days, 2 : medium cycle : 150-160 days, 3 : long cycle : > 160 days
Crop Rotation' type	Rice return time on the same plot. It is the number of years of rice growing	1 : long rotation (1 year of rice /5 years), 2 : "cereal" rotation (2 years of rice / 5 not necessarily consecutive years), 3 : "intensive cereal " rotation (2 or 3 consecutive years of rice)
Average yield over five years	Average of the wheat yield for a five years period	1 : < 2 tons, 2 : [2 ; 5 t[, 3 : [5 ; 7 t [, 4 : ≥7 t
Yield variability	Frequency of yields below the average	1 : 0 year, 2 : 1 year, 3 : 3 years
Compensatory payment	Extra income offered either by the market, or by the CAP over the base margin created by the scenario	1 : 0 Euro, 2 : 400 Euros / ha, 3 : 700 Euros / ha, 4 : 1000 Euros / ha

Table II : example of a choice set

In the event where the following technical itineraries would be the only you face to produce, Which one would you prefer adopt ?

options	Scenario A	Scenario B	Scenario C
Weeds control technology	Fake seeding and manual weeding	Lines seeding and mechanical weeding	
Crop rotation	“intensive cereal”	“cereal”	
Varietal choice	Short cycle	Long cycle	
Average yield over five years	[5 ; 7 t [	< 2t	
Variability= risk over five years	1 bad year with respect to the average	1 bad year with respect to the average	
Margin differential	0 euros / ha	1000 euros / ha	Leave the land unexploited
	A /_ /	B /_/	C /_/

5 Models Estimations

The choice data were analyzed and estimated using LIMDEP 9.0 software program, and more precisely the package NLOGIT 4.0. We have four quantitative attributes (varietal choice, average yield, risk and monetary attribute), and two qualitative (weeds control technology and crop rotation) we have coded using effect coding. For the two scenarios proposed, the rice growers' indirect utility derived from the attributes of our choice experiment study takes this form :

$$Vij = CV(Zvarietal\ choice) + RISK(Zrisk) + ROL(Zlong\ rotation)$$
$$+ROC(Zcereal\ rotation) + AEM(Zmanual\ weeding)$$
$$+ASM(Zmechanical\ weeding) + ACHI(Zintensive\ chemical\ weeding)$$
$$+RDT(Zyield) + PRI(Zmargin\ differential)$$

and the following form for the third alternative, the opt-out one :

$$Vij = ASC$$

We introduce here an Alternative Specific Constant (ASC) to take into account effects on utility which are not explained by the attributes, and the utility function takes a such form in this option because of the absence of attribute and level to describe it, given it is an opt-out alternative. This is a way to model these situations in choice experiment work. After having estimated a basic multinomial logit model, several others models were estimated to consider first the presence of the opt-out option (sample selection model), and then to better integrate the heterogeneity in the rice growers tastes (Random parameter model and latent class model).

5.1 The basic multinomial logit model

Table III : Estimates of the multinomial logit model

Variable	Value	std error of β
ASC	-0,6942	0,8667
Cultivar choice	-0,0078	0,0057
Rotation		
"Cereal"	0,1453**	0,0645
Long	-0,2491***	0,0697
Weeds control technology		
Manual	-0,1135	0,0735
Mechanical	-0,4751***	0,0777
Intensive chemical	0,1146	0,0787
Risk	-0,1983***	0,0442
Yield	0,0226***	0,0019
Prime	0,0011***	0,0001
Number of observations	1144	
Number of parameters	10	
Log likelihood	-1154,521	
Rho-squared	0,14347	
*, **, *** means statistically significant at 90%, 95% and 99% significance level		

For qualitative variables, we chose as reference levels those which are the most widespread among the current practices of the rice growers in Camargue. The parameter attributes associated with levels "cereal" rotation, long rotation, mechanical weeding, and those for risk, yield and prime are all significant, at the 1% level of confidence (except "cereal" rotation, significant at the 5% level of confidence). We can note that long rotation and mechanical weeding are unfavorable to producers, whereas "cereal" rotation, higher yield and premium bring a greater utility to respondents. The parameter estimate of risk is found to be negative, as expected, that is an increasing risk is associated with a decreasing utility, signifying that farmers are adverse to risk. The ASC of the opt-out option is not significant, that can be explained by the fact that the hypothesis of Independence of Irrelevant alternatives (IIA) is violated, insofar as the choice of this option depends clearly on the two other scenarios proposed to the respondent. The IIA property was tested using the Hausman and McFadden (1984) test. The results are reported in table IV below. All the information must be included in the estimation, and this is not the case with the MNL model. Moreover, the non significance of attribute levels manual weeding and intensive chemical weeding can be the result of a too big heterogeneity in the population of rice growers for these factors, and can reveal the presence of classes in which the preferences would be different. For all those reasons the MNL model is definitively not appropriate.

Table IV : IIA test

Alternative dropped	χ^2	Degree of freedom	Probability
Scenario A	28,0554	10	0,001769
Scenario B	19,3113	10	0,036482

5.2 The sample selection model

The sample selection model is a two step model, in which we first estimate a probit model to explain the choice of the opt-out option, and then we use this information to find the value of attributes' parameters estimates with a selection. In the probit model, as well as the attributes characterizing the scenarios, we introduce instrumental variables, like the practice of additional recreational activities by the respondent, the presence of cattle or sheeps on the farm and the choice by the producer of the response "stop rice growing" to a question on his reaction to the possibility of a hypothetical ban on the use of chemical weedkillers. The table V presents the final results, those of the selection model.

Table V : Estimates of the sample selection model

Variable	**Value**	**std error of β**
ASC	0,6679***	0,0406
Cultivar choice	-0,0040***	0,0003
Rotation		
"Cereal"	0,0297**	0,0142
Long	-0,0539***	0,0142
Weeds control technology		
Manual	-0,0308*	0,0159
Mechanical	-0,0815***	0,0165
Intensive chemical	0,0175	0,0173
Risk	-0,0201**	0,0086
Yield	0,0052***	0,0004
Prime	0,0003 ***	0,0000
Number of observations	2415	
Log likelihood	-1411,562	
Log likelihood (restricted)	-1730,990	
Rho-squared	0,22893	
Chi-squared	638,86	
significance level	0,0000	
*, **, *** means statistically significant at 90%, 95% and 99% significance level		

We can note that more variables are significant, and the global model is better, in terms of McFadden ρ^2, which is becoming here much better[3]. The ASC becomes significant and positive. The attributes "cultivar choice" and "manual weeding" become significant too and negative, as expected. Indeed, it is clearly possible to see the repulsion exerted by the mechanical and manual weeding, which are viewed by the respondents as costly practices, in time and money. The fact that the utility decreases as the length of the life cycle increases is consistent with the risk aversion, because the longer is the life cycle, the more the risk is high[4]. The sign and the significance of attributes parameters related to the crop rotation, risk, yield and prime are still the same. The attribute level intensive chemical weeding is the only one no significant.

Nevertheless, due to the existence of a significant group of farmers practicing organic farming, we decided to estimate two models taking into account this heterogeneity in the population, the random parameter model and then the latent class model.

[3]According to Hensher and Johnson (1981) ρ^2 values between $0,2$ to $0,4$ are consider to be extremely good fits.

[4]A seed with a long life cycle forces the rice growers to sow earlier, and thus it can be risky if the weather is cold during the fertilization, that causes a bad rice rising.

5.3 The random parameter model

In the random parameter models, an assumption over the distribution of each of the random parameter (the density function $f(\beta/\theta)$ must be defined. In this paper, random parameters are specified to be distributed according to the weibull distribution.

Table VI : Estimates of the random parameter model

Variable	**Value**	**std error of β**
Random Parameters		
ASC	0,4957	1,6382
Manual weeding control	-2,1191***	0,5925
Non Random Parameters		
Cultivar choice	-0,0114	0,0071
Rotation		
"Cereal"	0,2291**	0,0923
Long	-0,4297***	0,1216
Weeds control technology		
Mechanical	-0,4755***	0,0992
Intensive chemical	0,1895*	0,1023
Risk	-0,2079***	0,0626
Yield	0,0312***	0,0043
Prime	0,0015***	0,0002
Number of observations	1144	
Log likelihood	-1154,5208	
Log likelihood (restricted)	-1256,8125	
Pseudo rho-squared	0,21752	
Chi-squared	546,7686	
significance level	0,0000	
*, **, *** means statistically significant at 90%, 95% and 99% significance level		

The model is still better than the basic MNL one. The manual weeding is now very significant, that proves that this attribute level is indeed heterogeneous among the rice growers population. The attribute related to the length of the life cycle appears now to not be very significant, because it is statistically significant at less than the 90% significance level. But the attribute level intensive chemical weeding is now significant, with a positive influence on the farmers indirect utility. Nothing is change for the other attributes parameters. As we know that heterogeneity exists in our population, we will thus determine how producers split into classes, and estimate attributes parameters for each of them. That's why a latent class seems to be the most relevant model.

5.4 The latent class model

Table VII: Estimates of the latent class model

Variable	Class 1	Class 2	Class 3
ASC	- 2,5141**	3,5569**	5,3621**
Varietal choice	- 0,0074	0,0095	0,0183
rotation			
"Cereal"	0,1235	0,2156**	0,2093
Long	- 0,3509***	- 0,3318***	0,5052*
Weeds control technology			
Manual	- 0,0157	- 0,7728***	1,5897***
Mechanical	- 0,5397***	- 0,8994***	1,3060***
intensive chemical	0,0424	0,7935***	- 1,1725***
Risk	- 0,1963***	- 0,3139***	- 1,0818***
Yield	0,0238***	0,0221***	0,0577***
Prime	0,0010***	0,0018***	0,0010*
Probability of class	0,6014	0,296	0,100
Number of observations	1144		
Log likelihood	-1154,521		
Log likelihood (restricted)	-1256,812		
Pseudo Rho-squared	0,3089		
Chi-squared	776,3506		
significance level	0,0000000		
*, **, *** means statistically significant at 90%, 95% and 99% significance level			

The first class involves 60 % of the population of decision-makers. Attributes affecting negatively their utility are the long crops rotation, the mechanical weeding and higher risk , whereas higher compensatory premium and yield increase their indirect utility. This class certainly encompasses farmers committed to the technological norms of the PGI (Protected Geographical Indication) "Riz de Camargue". That norm does not exclude the use of chemicals. One could consider that norm as a main or dominant farming subculture. In that class' estimates, several attributes are not statistically significant. This can be either the consequence of the cognitive complexity involved by the management of a high number of attributes, the respondents focusing only on the main attributes they consider relevant for them, or by the direct influence of the norm on their responses.

Beside that core class 1, there are two opposites classes, one being characterized by the rejection of any agro-ecological practices (one third of the overall population), and the other characterized by their adoption (10%) .

In class 2, all the attributes except the length of the cultivar's life cycle are significant. Crop's rotation including more wheat and intensive chemical weeds control are positively valued, while long rotation, manual or mechanical weeds control are negatively valued. In class 3, the parameter of the length of the cultivar's life cycle is positive and significant, but the attributes characterizing

the preferences for the crop's rotation are not. Indeed, manual or mechanical weeds control are valued positively, while intensive chemical weeding is negatively valued.
In both classes 2 and 3, the ASC are positive, a result contrasted with the negative ASC in class 1. One could interpret that by the difference in the level of the reserve utility associated to the opt-out choice. In other words, farmers belonging to class 1 exhibit a negative utility of the no production option. Farmers belonging to class 2 or class 3 have each a strong and clear farming subculture, and they prefer to not produce instead of implementing one unwanted technology .
These results are in some way surprising, because we have not anticipated the strength of the preferences for an intensive farming system. The remaining question is about the interpretation to be given to that observation. Is it really the expression of a strong farming subculture, or the simple expression of the existence of one strong agro-ecological constraint arising from the presence of salt in the underlying soils layers and aquifer ?

6 Estimation of the "value" of technology' attributes

The monetary value of each attribute, called implicit prices or part-worth, could be calculated from the latent classes estimates, using the following relationship:

$$\textbf{Implicit price} = \left(\beta_{attribute}/\beta_{monetary\ attribute}\right)$$

This implicit price represents the marginal welfare variation for a change in any of the attribute. It corresponds to a compensatory payment that farmer are willing to accept (WTA) for adopting an attribute (or for a one unit improvement in the attribute level), in the case of negative values, or to give it up, in the case of positive values.

Table VIII : Technology' attributes implicit prices (in Euros)

Variables	Class 1	Class 2	Class 3
Cultivar			
rotation			
"Cereal"		119,11	
Long	- 337,39	183,34	510,29
weeds control technology			
Manual		- 426,99	1605,78
Mechanical	- 518,99	- 496,92	1317,14
Intensive chemical	40,81	438,42	- 1184,31
Risk	- 188,74	- 173,41	- 1092,74
Yield	22,89	12,23	58,27

All the farmers in the three classes attached a positive value to higher yields, whereas a negative value has been always attached to the risk attribute. Only the level of the implicit price for those attributes differs from class 1 and 2 to class 3. Class 3, which is certainly associated to organic farming preferences, exhibits a risk aversion considerably higher than the two others groups.

For all the remaining attributes, preferences are very contrasted from classes 3 to class 1 and 2. For the later, negative values are associated with agro-ecological practices, while positive one are given to the intensive use of chemicals. For the PGI "Riz de Camargue" producers, mechanical weeds control and long rotation (two characteristics of organic farming) are highly negatively valued. The aversion for the manual weeds control is more moderate, with a lower negative value. However, we can observe in the second class an important rejection of all organic agro-ecological practices, more especially manual and mechanical weeds control, and a strong preference for the intensive chemical weeding. This class represents indeed an intensive farming subculture. Finally, the last class is the one with the highly contrasted values. All attributes related to the weeds control and the risk's level are very important for these rice growers. They have a strong aversion for an intensive use of chemicals, and are willing to practice a manual and mechanical weeds control.

Conclusion

Using a choice experiment survey, this research has elicited rice growers valuation of attributes describing their technology' individual preferences.

With help of experts and after several tests, we identified five relevant technology's attributes, three related to agro-ecological means (length of life cycle of rice cultivar, weeds control technology, type of crop-rotation), two related to outcome (average yield and yield variability) and finally, a sixth monetary attribute, representing a compensating payment in addition of the base gross margin. Choice sets have been proposed to the farmers, including one opt-out options, leaving the land unexploited.

The econometric analysis of the data demonstrated a great heterogeneity in the preferences among the decision-makers in the area. Random parameters logit and Latent Class Models helped to give a more precise view of that underlying heterogeneity.

Facing the cognitive difficulty of the task choice, respondents certainly used the references of existing collective norms in the Camargue area as benchmarks. The Latent Class Model identified a core class of responses corresponding to the standard of the PGI "Riz de Camargue", and a little one, corresponding to the "organic farming standard". Nevertheless, beside these well-known standard, an important group of respondents, representing one third of the farmers population, expressed their preferences for a technology using more intensive cropping practices. The question about the interpretation to be given to that observation is still open. Is it really the expression of a strong farming subculture, or the simple expression of the existence of an strong agro-ecological constraint pertaining to the presence of salt in the underlying soils layers and aquifer?

Whatever the interpretation would be, the results are nevertheless worthy for the managers of the collective standards or of the corresponding marketing channels. Moreover, they have a great value for policy makers, because they identified and measured the diversity of values attached to the main components of the rice cropping technology in the area.

Estimates of the implicit prices show that breathing spaces exist to bring rice growers about to adopt environmental friendly practices through market or public policies incentives. It's worth noting that the compensatory payment to give to farmers of class 1, the most important in number, is of the same magnitude as the actual "bulk unconditional payment", the so-called "DPU" . Our results could help in designing targeted contracts by sub-area, conservation or environmental objectives.

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ANNEX

Empirical data on the surveyed farmers population

General description of the sample

In Camargue area, the rice growers population is almost exclusively male and old, with more than half of farmers being more than fifty years old. Moreover, producers are relatively well educated, in general or with a special education in agriculture. With regard to the education in agriculture, the population split almost equally into those who don't have any particular education in farming, and those who have received one.

Table I : Socio demographic characteristics of the decision makers

Characteristics	**Frequency**
Age :	
- 18-35 years	14%
- 36-50 years	33%
- More than 50 years	53%
Sexe :	
- Male	98%
- Female	2%
General education :	
- No general education	10%
- Primary education	14%
- Short secondary education	31%
- Long secondary education	23%
- Higher education	22%
Education in Agriculture:	
- No agricultural education	41%
- Primary education	2%
- Short secondary education	16%
- Long secondary education	12%
- Higher education	29%

The rice growing farms in Camargue have usually broadacre (more than 100 ha), and in particular the majority of them are bigger than 200 ha. Only a low percentage (2,5%) of exploitations are very little, that is a net farming area below 50 ha.

Table II: Characteristics of farms

Characteristics	**Frequency**
Net farming area :	
- < 50 ha	2,5%
- [50-100 ha[	23,5%
- [100 ha- 200 ha[	31%
- >= 200 ha	43%
Organic cropping :	
- A part of the whole surfaces in organic	22%
- All surfaces in organic	15%

A typology of rice growers with farming subcultures

We elaborated a typology of the decision makers with respect to the farm's characteristics and to personal conceptions of the profession.

Due to the importance of recreational activities in the Camargue area , we focused on the presence on the farm of pertinent criterion such as additional recreational activities (tourism, commercial hunting, bull race...), marshes (and more precisely swamps for hunting), cattle (belonging to the farm or not), and then we included also the average crop's yields.

We finally identified two main groups:

- the first one encompasses rice growers who focused only on the farming production. We call them "Entrepreneurs in agriculture" given that they have a "productivist" farming subculture and get highest yields. Indeed, only few of them (7%) are concerned by very lower yields ([2t-5t[). They don't manage any additional recreation activities nor natural spaces (no land for cattle or marsh). They represent 40% of the whole population.

- the second one encompasses "Multifunctionals Farmers" who integrate natural area into their management, while their conception of farming takes into account ecological considerations. They combine agricultural production, recreational activities, and manage cattle and marshes. A great part of them get agricultural yields in the range [5t-7t[, but with a greater dispersion than the "Entrepreneurs in Agriculture". They represent 60% of the population.

To complete this general presentation, we end up with linking the former typology to the personal conceptions about the farming profession. That resulted in the definition of two farming subcultures (Table III).

Table III : The farming subcultures among the rice growers

According to you, the farmer profession consists to :	**Frequency**
Overall population :	
- produce quality food products	66%
- produce raw materials for industry at the lower price	1%
- produce quality food products in controling negative impacts on Environment	33%
- produce recreational and environmental services	0%
"Entrepreneurs in Agriculture" :	
- produce quality food products	70%
- produce raw materials for industry at the lower price	1%
- produce quality food products in controling negative impacts on Environment	29%
- produce recreational and environmental services	0%
"Multifunctionals Farmers" :	
- produce quality food products	64%
- produce raw materials for industry at the lower price	0%
- produce quality food products in controling negative impacts on Environment	36%
- produce recreational and environmental services	0%