A methodological way of evaluating innovative cropping systems integrating risk beliefs and risk preferences

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Abstract

In the paper, we propose a methodological way of leading an economical assessment of innovative cropping systems (ICSs). The originality lies in the integration of the crop management flexibility and the farmers' risk perception and risk preferences. Two conventional cropping systems have been studied (continuous irrigated maize and wheat/sunflower rotation). For each of them, an innovative long rotation has been co-designed by farmers to reach various objectives, notably reduce the pressure on natural resources. The methodological protocol is tested thought a sample of 23 specialized cash crop farmers of Southwestern France is surveyed: subjective probabilities linked to climatic risk perceived are assessed and farmers' risk aversion is elicited through experimental lotteries. Without risk consideration, the adoption of ICSs should be discouraged, given the 2010-2011 crop price situation (mean gross margin loss of about 15 %). Accounting for the farmers' risk perception and risk aversion, and using a risk criteria analysis the results are more mitigated. An adoption premium, computed for each farmer, shows that although all farmers are almost equally risk averse, the levels of adoption premiums are heterogeneous, due to different individual risk perceptions. Finally the paper proposes a method to account for risk preferences and subjective beliefs that raise heterogeneity in the attitude towards innovative cropping systems…

Key words: innovative cropping systems, risk, subjective probability, adoption premium

JEL classification: D0, Q12, Q55

Introduction

In the context of climate change, European arable farmers are more concerned with environmental regulations and are encouraged to reduce the use of chemical inputs (Water Framework Directive 2000/60/EC, Ecophyto 2018 in France). In cash crop farms, innovations are designed at the cropping scale and consist in modifying the cropping system management[1]. This implies greater changes than the sole change in technical operations but also provides better long run results. Technical factors influencing these changes are more complex and take place over a longer period (a rotation can last up to six or seven years). A cropping system (CS) includes i) a succession of crops associated with ii) a crop management type applied to each, as well as iii) intermediary crops. The yearly crop management involves an ordered and logical set of operations. Innovative cropping systems (ICSs) have been designed in order to reach objectives to lower pressures on natural resources. The design can be initiated either by experts (*de novo* prototyping) or by farmers themselves, by using *in-situ* knowledge (*co-design*). In *de novo* prototyping, a group of experts, imagines and designs new prototypes without *a priori* constraints. Then prototypes must be tested prior to their diffusion. When prototyping involves pilot farms, which is the case in the experience reported here, information spreads simultaneously with conception (Vereijken, 1997).

To discriminate the most adaptable cropping system, at the farm scale, an *ex-ante* evaluation of the systems built up is required (Debaeke et al., 2009). In conducting this evaluation, one has to consider that the adoption of innovative cropping systems is highly influenced by the farmers' characteristics and also by farmers' context (Pannell et al., 2006). As usually admitted, conventional cropping systems are impacted by with yield uncertainty. Crop yields are strongly dependent to local soil-climate context and yield predictions are always subjective. . The change in crop management in ICSs also entails additional yield uncertainty linked to the lack of knowledge. Therefore, both risk perceptions and risk preferences are individual characteristics that can influence the adoption behavior of ICSs. Indeed, depending on their psychological attitudes towards risk, the uncertainty inherent to an innovative cropping system will affect farmers differently. In order to address the risks linked to the change in farming practices, we propose to integrate risk assessment and farmers' preferences and beliefs in the analysis.

The Subjective Expected Utility (SEU) model of Savage (1954) with known utilities and unknown probabilities can allow us to analyze individual behaviors under uncertainty. Although violations of the basic axioms of the Expected Utility (EU) Theory, SEU models have been implemented by many researchers, including Kahneman and Tversky (1979). In some studies applied to agricultural uncertainties, it was proved that the EU or SEU model remains representative of observed behaviors (Bocqueho et al. 2010; Dury et al, 2010; Reynaud and Couture, 2012).

[1] A cropping system is a sequence of technical operations taking place over several years

Farmers' preference direct elicitation methods are now more and more widespread in the economic literature. It is very well adapted to assess pure preferences of individual farmers (Binswanger and Siller, 1983; Reynaud and Couture, 2012). Through experimental methods with lottery games, risk aversion coefficients can be elicited (Holt and Laury, 2002; Tanaka et al, 2010; Bocqueho et al. 2010; Dury et al, 2010).

. In a first step, the level of risk is evaluated through its distribution. As a starting point, we suppose that the perceived risk is influenced by the degree of flexibility of the farm management decisions. A technology will be perceived as riskier if it locks the planting decision for more than a year, and if the technical operations are not revisable. Two types of flexibilities exist: the inter-year and the intra-year flexibility. The inter-year flexibility is the change in crop succession, which is a way for farmers to deal with anticipated price variations. The inter-year flexibility, which deals with market risk, won't be studied here: the crop succession is considered as not revisable since it needs to be adopted to reach the environmental objectives targeted during the design step. The intra-year flexibility concerns the various sequential stages of crop management over one year, called "technical operations". In order to reach their yield objectives, farmers have to adapt their technical operations in response to climate risk (Just, 2003). By doing this, farmers can adapt their cropping systems to the externalities they deal with and cannot control (Tanaka et al., 2002).

Some models of decision making are dealing with farmers' production strategies and their constraints (economical, working time, farm machinery…) (Aubry et al., 1998). Some farming operations or are compulsory (sowing, harvest) and chronologically established (sowing after previous crop, harvest for instance). Other operations are flexible in time or technique (chemical or mechanical weeding) and are called "revisable". Some models of decision making are interested in decision rules or decision patterns and attempt to determinate the decision process itself (Dury et al, 2010). In this paper we won't investigate the reasons of the management variability from one farmer to another but only the possible alternatives and their probability. We assume here that farmers can assess the relative likelihood of uncertain events by assigning subjective probabilities to these events. This probability assessment provides a way of analyzing the individual risk perceptions through farmers' beliefs (Chavas et al., 2010, Hardaker et al., 2004).

The aim of this paper is to propose a methodological way of leading an economic assessment of innovative long rotation cropping systems in three points i) the accounting of technical flexibility of farmer's decisions), ii) the assessment of risk perceptions and iii) the elicitation of risk preferences. This methodology is tested through surveys among a sample of 23 specialized cash crop farms of Southwestern France.

The first section of the paper proposes a definition of what is called "innovative cropping systems" and exposes the nature of the technical decisions we consider in the flexibility analysis. The second section proposes a theoretical framework to analyze farmers' decision under uncertainty. The third section presents the way data are obtained on risk perceptions and risk preferences among a sample of cash crop farmers. In section 4, the main outputs of the survey are combined to give an appraisal of the riskiness linked to the adoption of innovative cropping systems through two criteria: stochastic dominance of subjective risk distributions and the evaluation of an individual "adoption premium" that mitigates the risk linked to the new systems.

Section 1 - Definition of innovative cropping systems

The innovative cropping systems co-designed

The innovative cropping systems have been co-designed by farmers jointly with local farming experts in South Western France. Those new cropping systems are tested in the field by volunteer farmers. They have been built up as an alternative to both most widespread cropping systems of south western France: continuous irrigated maize and short rotation of sunflower on wheat. Cash crop farmers feel more and more concerned about environmental damages (water use, soil erosion, water pollution such as nitrogen lixiviation or pesticides transfers in the aquifer) that induce a decrease in soil fertility in the long run. In a context of increasing prices of farm inputs, farmers also seek input saving strategies. Innovative cropping systems (ICSs) seem to suit well those objectives: saving strategies and natural resources conservation. They are long rotation, combining conventional agronomic management (rotation, leguminous crops to reduce fertilizers use…) and new technological improvements, to reach a low input crop management. The introduction of intermediary crops and the alternation of crops from different botanical families enable to decrease the pressure on natural resources. New technical practices (harrow chain, precise row treatments) allow a decrease in pesticides used to avoid diseases resistance problems.

The aims of the design are to improve soil fertility in the long run and to maintain a reasonable average income. During the design step, a few profitable crops, technically mastered by farmers, have been kept into the rotation, in order to insure a minimum income. Designers have also introduced beneficial crops that may be less profitable (pea) but which allow agronomic improvements (less nitrogen loss, better soil conservation) and/or crops that imply specific marketing contracts (rape seed). The table 1 presents the traditional cropping systems and their long rotation alternative[2].

2 Some indicators have been proposed to evaluate environmental or social impacts of the ICS. This part won't be exposed in this paper but this "multicriteria approach" is available in Annex 1and Source: Office *of Coordination of Agricultural Machinery*
Annex 2

Table 1: Innovative cropping systems design

	Conventional cropping system	Design objectives	Innovative cropping systems
Cropping system 1	Continuous irrigated maize	• Decrease pest pressure • No bare soil in winter	Wheat$_{(intercrop)}$ / Soybean /Wheat / Oil seed Rape $_{(grow\ again)}$ / Maize / Sunflower
Cropping system 2	Wheat / Sunflower rotation	• Decrease pest pressure • Use agronomic tools • Working time staggering	Sunflower / Wheat$_{(intercrop)}$ / Sorghum / Wheat / Pea/Rape seed / Wheat$_{(intercrop)}$

Definition of intra-year flexibility: revisable and non-revisable decisions

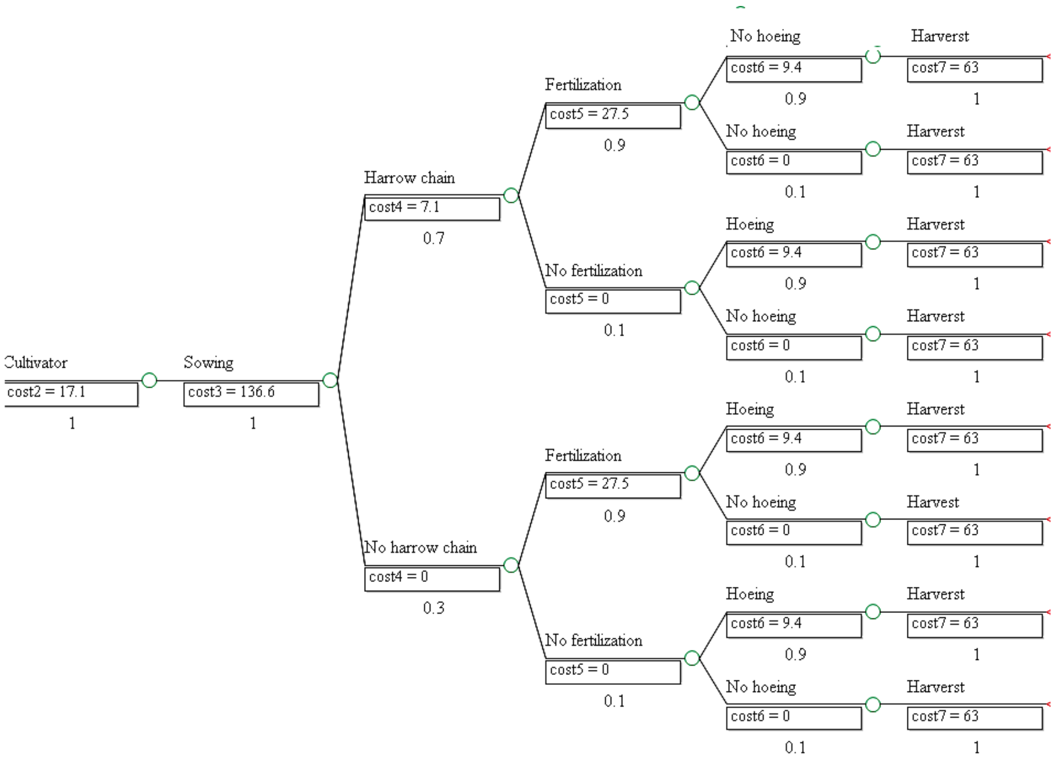
For a complete appraisal of risk perception, we decompose the decisions into the different technical operations. This should enable us to evaluate farmer's intra-year flexibility. The different technical operations occurring along one year are first detailed for each crop of the crop succession. Each operation is characterized by its production cost. Two types of operations are distinguished: those that are certain and those that are revisable, so that a probability tree can be built. Farmers have to sow or harvest for sure, but, they can remove a fungicide or fertilization application if considered as not necessary: the probability linked to each farming operation depends on individual risk assessment. The threshold of treatment is a subjective evaluation for each farmer even if decision rules or baselines are available. Each node of the probability tree corresponds to a revisable operation, for which several options are possible. Subjective probabilities assigned to each branch are directly assessed by proposing risk scales to farmers for each risky operation (Annex 3). A probability tree is designed for each crop of both conventional and innovative cropping systems. The probability distribution is assessed for each farmer, considering the previous crop in the crop rotation. Decision trees are elaborated for each crop ad crop trees are aggregated at the rotation scale in order to obtain cost distributions for each long rotation cropping system (6 or 7 years of rotation). Partial adoption is excluded[3]. Considering the yield distribution also assessed by farmers ($\tilde{y}_c$) (Annex 4) and a given expected market price for each crop (p_c), distributions of the total Gross Margin ($\widetilde{GM}$), at the rotation scale, for both conventional and innovative cropping systems, can be estimated (Equation 1)

$$\widetilde{GM} = \sum_c (p_c * \tilde{y}_c) - \tilde{w}_c$$

(Equation 1)

[3] ICS have been design with a long run agronomical coherence, the adoption of a crop with an innovative crop management for one or two years cannot be consider as an innovative system

Figure 1: Example of a probability tree



Section 2: Theoretical approach of farmer's decision under uncertainty

A theoretical framework in economics is proposed to approach farmer's decision under uncertainty. As mentioned before, the only source of risk considered is yield risk. We assume that farmers are reluctant to implement innovative and low input cropping systems because of a probable higher risk exposure . In order to assess both the level of risk perceived and individual preferences towards risk, we propose to rely on an expected utility framework.

Subjective distributions of risk linked to both conventional and innovative systems are first elicited in order to lay out a comparison in terms of level of risk perceived (criteria of stochastic dominance). A First Order Stochastic Dominance (FOSD) criterion is proposed. But it doesn't take the individual risk aversion into account. Therefore, in a second step, an experimental protocol of direct elicitation of preferences is implemented. The estimation of the level of risk aversion, combined with an estimation of the subjective risk distributions, enables us to have a global view of adoption, considering both beliefs and preferences. We then calculate individual adoption premiums for ICSs.

First order stochastic dominance

In order to apply the FOSD criteria to the distribution elicited among farmers, we estimate the Cumulative Distribution Function (CDF) of the total gross margin per hectare ($\widetilde{GM}$), cumulated during the whole rotation. According to the FOSD criterion, the less risky cropping systems are selected, i.e., under this criteria ICSs are preferred by farmers if and only if, for all values of *x* $CDF(GM_{CS}(x)) - CDF(GM_{ICS}(x)) \geq 0$. Graphically, the cumulative distribution function of ICSs is to the right of the distribution function of CSs so that they do not cross. When a CS dominates another according to the FOSD, it signifies that all decision makers with increasing utility function prefer this CS.

Adoption premium

The stochastic dominance criterion only implicitly integrates individual preferences. A protocol has been built to estimate farmers' pure preferences and the complete preference function can be used to calculate an Adoption Premium (noted *AP*) for ICSs (Equation. 3). Assuming that farmers aim at maximizing their expected utility function, the adoption premium is the monetary compensation required for each area under innovative CS, to make farmers indifferent with conventional CSs. The adoption premium is close to the risk premium concept. A risk premium evaluates the monetary amount that individuals are ready to pay to avoid risk by choosing a secure alternative whereas, in this study, both cropping systems, conventional and innovative, are risky. The adoption premium measures the effort for each individual to adopt an ICS. The utility function *U* is assumed to be DARA-CRRA[4] (Equation 4).

$$E\left(U\left(\widetilde{GM}_{ICS} + AP\right)\right) = E\left(U\left(\widetilde{GM}_{CS}\right)\right)$$

(Equation 2)

$$U\left(\widetilde{GM}\right) = \frac{\widetilde{GM}^{1-RRA}}{1-RRA}$$

(Equation 3)

GM_{CS1} and GM_{ICS1}: Continuous irrigated maize and its alternative gross margin are noted
GM_{CS2} and GM_{ICS2}: Wheat/sunflower rotation and its alternative gross margin are noted
AP : Adoption Premium

EU: Expected utility

RRA: Coefficient of relative risk aversion

[4] Decreasing Absolute Risk Aversion, Constant Relative Risk Aversion

Section 3 - Data

Data concerning risk attitudes have been collected among a sample of 23 cash crop farmers in Southwestern France.

Farmers' sample and structure of the survey

Farmers have been surveyed by groups during meetings (11 of them) or face to face interviews (12 interviews) during Spring 2012. Survey presentation was the same for individual and collective interviews. Even during meetings, farmers answered individually without any cooperation. The Annex 5 presents the farmers and farms characteristics. The survey is composed of four parts; i) background information, farm structure, ii) frequency of the different farming operation for all crops present in the rotation, considering the previous crop and according to both different cropping systems (innovative and conventional), iii) a "Visual Impact" method (Hardaker et al,. 2004) to evaluate subjective probabilities concerning yields; iv) an experimental protocol, previously proposed by Holt and Laury (2002), to elicit farmers' preferences

Assessing the frequency of farming operations

The annual crop management is exposed in details to each participant. It is composed of all technical operations color coded (grey for the certain operation and white for the revisable). In order to estimate the farmers' subjective probabilities linked to the different revisable operations, farmers are asked to rate, on a decade, the frequency of each operation. For each revisable operation farmers have to choose, on a Likert scale, the frequency, from "never" to "always", with 5 degrees (Annex 3). The farmer answer to this question for all the crops of the conventional and innovative cropping systems, some crops being under both conventional and innovative management but with different techniques and preceding crop, such as wheat, maize or sunflower.

Assessing subjective probability for crop yields

Each farmer is asked to state his subjective yield prediction. This evaluation is done for all the crops of each CS. According to the Visual Impact method, designed by Hardaker et al. (2004), several yield-intervals of yield are proposed to the participant who has to allocate tokens to each yield interval. The probability of each interval is the ratio of the number of tokens allocated to this interval divided by the total number of tokens used. The participant also has to rate the level of confidence in his own prediction from 1 to 10.. To ensure a good understanding of the crop management, it is exposed in details to farmers next to the visual impact table (Annex 4).

Risk preferences elicitation method

We employ an experimental procedure to elicit attitudes towards risk, called a multiple price list, previously proposed by Holt and Laury (2002This experimental framework corresponds to an artefactual field experiment according to the List's terminology. The experimental protocol lasts half an hour.

In a first treatment, subjects are provided with a series of binary choices for four sets of tasks. The first two sets involved choosing between binary risky alternatives (with known probabilities) in the gain domain, and the second two sets in the loss domain with variable probabilities (Annex 6). Additionally, in a second treatment, as in Tanaka et al (2010), subjects are also faced four series of binary choices but with fixed probabilities (Annex 7).

In the first treatment, each task set table had ten decisions (see Table 2 for example of task in the gain domain).

Table 2: MPL Task in the gain domain

Question	Lottery A		Lottery B		CRRA Range
1	20€ 1 chance out of 10	16€ 9 chances out of 10	38,5 1 chance out of 10	1€ 9 chances out of 10	RRA ≤ -0.95
2	20€ 2 chance out of 10	16€ 8 chance out of 10	38,5 2 chance out of 10	1€ 8 chance out of 10	RRA ≤ -0.95
3	20€ 3 chances out of 10	16€ 7 chances out of 10	38,5 3 chance out of 10	1€ 7 chance out of 10	-0.95 ≤ RRA ≤ -0.49
4	20€ 4 chance out of 10	16€ 6 chance out of 10	38,5 4 chance out of 10	1€ 6 chance out of 10	-0.49 ≤ RRA ≤ - 0.15
5	20€ 5 chance out of 10	16€ 5 chance out of 10	38,5 5 chance out of 10	1€ 5 chance out of 10	-0.15 ≤ RRA ≤ 0.15
6	20€ 6 chance out of 10	16€ 4 chance out of 10	38,5 6 chance out of 10	1€ 4 chance out of 10	0.15 ≤ RRA ≤ 0.41
7	20€ 7 chance out of 10	16€ 3 chance out of 10	38,5 7 chance out of 10	1€ 3 chance out of 10	0.41 ≤ RRA ≤ 0.68
8	20€ 8 chance out of 10	16€ 2 chance out of 10	38,5 8 chance out of 10	1€ 2 chance out of 10	0.68 ≤ RRA ≤ 0.97
9	20€ 9 chance out of 10	16€ 1 chance out of 10	38,5 9 chance out of 10	1€ 1 chance out of 10	0.97 ≤ RRA ≤ 1.37
10	20€ 10 chance out of 10	16€ 0 chance out of 10	38,5 10 chance out of 10	1€ 0 chance out of 10	1.37 ≤ RRA

Subjects are shown different binary lotteries and must select either option A (the safe lottery) or option B (the risky lottery) for each decision. The payoffs in Euros for option A are fixed at 20 and 16 while the payoffs for option B are fixed at 38 and 1. In each successive row, the likelihood of receiving the larger payoff increases. As the probability of the high payoff outcome increases option B becomes more attractive relative to option A, and at some point subjects will switch their preference. A risk neutral subject would choose option A up to decision number 4, and then choose option B from decision number 7 to 10. Hence a risk neutral participant would switch from the safe option to the risky option at the 5th decision, while sooner (later) such a switch occurs, the more risk seeking (averse) the subject is. By assuming constant relative risk aversion, the subject risk aversion is then directly related to the line at which he switches from preferring option A to preferring option B going down the table.

Subjects have also been asked to complete the same lottery task as in Table except that all payoffs have been multiplied by a factor 20. In the same way, participants have completed two sets of tasks in the domain of losses (Annex 6).

In the second treatment, as in Tanaka et al. (2010) and Bocqueho et al. (2010), subjects are presented with a succession of pair of binary lotteries with fixed probabilities. These are four series of questions. In the first two series, payoffs are all positive whereas, in the third series, lotteries mix positive and negative outcomes and in the last series, payoffs are all negative (Annex 7).

The participants were recruited by invitation via phone and were told that depending upon their decisions; they had a chance of earning real money. Each participant was hosted on separate days, some by groups but with independent answers. The experiment was conducted by using decision sheets which the subjects filled out manually. They were told that for all the tasks, they would be paid on one randomly chosen decision number so that each subject received payments for one decision. The subjects received an endowment at the beginning of the experiment and were told that even if they lost money during the course of the experiment, their total earned income from the experiment could not be negative. On average a subject earned 20.50€ for participating in a session. These four sessions were conducted over the period of February to April 2012. (Detailed instructions of the experiment are available upon the authors).

Section 4 - Results

This section exposes the outcomes of the evaluation of the ICSs, compared with conventional CSs by using the different evaluation criteria mentioned in the previous section : i) comparison of mean gross margins, ii) comparison under the FOSD criterion, iii) comparison of the levels of Adoption Premiums.. All farmers have specialized cash crop systems but, farming practices are heterogeneous due to local soil and climate variability. Some heterogeneity also comes from farm sizes and structures, and farmers' behavior.

Evaluation of the CSs under certainty

The CSs (conventional and innovative) are evaluated without accounting for yield or cost variability. The data basis gathers the information to calculate gross margin and other indicator from the Office of Coordination of Agricultural Machinery and master data from the extension services. The average yield reported on table 5 corresponds to the objective yield declared consensually by the group of farmers during the design step. The market prices are mean value observed during the 2010-2011 season by a cooperative society (Annex 8). During this crop season market prices were high compared with the previous year. The production cost was evaluated with the cropping management designed by the group of farmers during the co-design, considering appearance of all the technical operations with certainty; then it is the maximum cost (tables 3 and 4).

Table 3: Price and cost evaluation under certainty of the continuous maize and the innovative cropping system

	Conventional CS 1	**Innovative CS 1**					
Crops	Continuous maize Years 1 to 6	Sunflower Year 1	Soft wheat Year 2	Soybean Year 3	Soft wheat Year 4	Rapeseed Year 5	Maize Year 6
Cost (€/ha)	1 237	464	711	636	711	340	908
Objective yield (t/ha)	12.00	3.00	8.25	3.50	8.25	3.75	12.00
Market Price (€/t)	185	420	180	330	180	330	185
Gross margin (€/ha)	982	795	774	519	774	897	1 312
Cumulated gross margin (€/ha)	***5 895***	***5 073***					

Sources: Cost data: Office of Coordination of Agricultural Machinery, Extension services; Price data: Cooperative society

Table 4: Price and cost evaluation under certainty of the wheat/sunflower rotation and the innovative cropping system

	Conventional CS 2		**Innovative CS 2**						
Crops	Sunflower Years 1, 3, 5, 7	Durum wheat Years 2,4,6	Sunflower Year 1	Durum wheat Year 2	Sorghum Year 3	Durum wheat Year 4	Pea Year 5	Rapeseed Year 6	Durum wheat Year 7
Cost (€/ha)	428	550	311	589	281	589	612	688	589
Objective yield (t/ha)	2.5	4.5	2.5	4.5	5.0	4.5	4.0	2.5	4.5
Market Price (€/t)	420	200	420	200	180	200	190	450	200
Gross margin	622	350	739	311	618	311	147	437	311
Cumulated gross margin (€/ha)	***3 401***		***2 876***						

Sources: Cost data: Office of Coordination of Agricultural Machinery, Extension services; Price data: Cooperative society

The evaluation under certainty shows that the ICSs have a lower cumulated gross margin than the conventional ones, from -14% to -15%. Without any flexibility and without consideration for labor constraint, and assuming that farmers aim at reaching the maximum income, ICSs will be excluded from the cropping plan. However this evaluation neglects the yield variability, which can be higher for innovative management. Furthermore, the crop management can be revised in reaction to soil or sanitary conditions and adapted, inducing different production costs from one farmer to another. Even if the evaluation of the gross margin is useful and allows discriminating cropping systems, it is difficult to determinate whether ICSs will be adopted by farmers or not, especially when the gross margin differential is not high.

Evaluation the CSs accounting for risk perceptions

In this section, the results are focused on two farmers' cases ("type 1" farmer and "type 2" farmer) from the same area, with the same farm characteristics (crops, level of specialization…), so that the only difference between both lies in the risk attitude. Thus, the yield and cost distributions are compared for three crops managed under both conventional and innovative techniques: wheat, maize and sunflower. The mean yield and cost and the related dispersion (standard deviation) are reported in table 5.

Table 5 : Yield and cost mean and standard deviation distribution per farmer

			"type 1" farmer				*"type 2" farmer*			
Crop	*Cropping system*	*"Objective" Yield*	*Mean Yield (q/ha)*	*Std Dev*	*Mean Cost (€/ha)*	*Std Dev*	*Mean Yield (q/ha)*	*Std Dev*	*Mean Cost (€/ha)*	*Std Dev*
Maize	**CS 1** (Continuous maize)	120	113	6.9	1 507	232.2	115.0	6.3	838	53.4
	ICS 1 (Alternative to continuous maize)	120	117	11.0	983	174.1	123.0	5.1	574	28.9
Soft wheat	**CS 2** Wheat/sunflower rotation)	82,5	70	8.4	494	10.3	62.0	8.4	634	25.2
	ICS 1 (Alternative to continuous maize)	85	70	2.5	596	33.0	57.0	3.1	653	38.1
Sunflower	**CS 2** Wheat/sunflower rotation)	25	33	1.5	423	0	22.0	1.5	423	0
	ICS 1 (Alternative to continuous maize)	30	30	1.5	339	0	25.2	1.6	295	0
	ICS 2 (Alternative to wheat/sunflower rotation)	25	30	1.5	283	0	25.0	1.5	283	0
Durum wheat	**CS 2** Wheat/sunflower rotation)	45	55	2.5	534	9.2	57.2	2.5	518	0
	ICS 2 (Alternative to wheat/sunflower rotation)	45	42	3.0	561	24.1	50.0	2.5	547	34.0

Sources: Cost data: Office of Coordination of Agricultural Machinery, Extension services; Yield data: own survey

Even if the farm and farmer's characteristics are close, table 5 shows that risk perceptions are different. For "type 1" farmer, innovative cropping management on maize and sunflower allows a yield increase but wheat is perceived as less productive under innovative practices. For "type 2"farmer the innovative cropping management is almost always less productive than the conventional one, expect for maize; the maize yield is perceived higher with innovative crop management for both farmers, which might be due to the fact that positive agronomic rotational positive effects are expected with little uncertainty.

The production costs are really different among both farmers, especially for maize and soft wheat. However they both consider that the innovative crop management is less expensive for maize and sunflower. At the opposite, both soft and durum wheat have a higher and more variable production cost under innovative practices. This gap is principally due to a higher mechanization cost. Pest treatments are generally replaced by mechanical techniques (harrow chain, hoe…) more expensive and less mastered by farmers.

This analysis shows that risk perceptions bring heterogeneity among similar farming systems. Maize and sunflower are generally more productive and less expensive with an innovative cropping management. For the other crops, farmers' risk assessments are variable. This shows that an analysis of crop profitability under certainty is probably inadequate considering the variability of individual risk perceptions and considering also crop management flexibility.

Stochastic dominance analysis

As explained in the former section with the First Order Stochastic Dominance (FOSD) analysis the risk perception is appraised at the cropping system scale. The probability trees and the yield assessment enable to calculate the gross margin distribution. The Cumulative Distribution Function (CDF) of the total gross margin of both conventional and innovative CSs are compared two by two. The FOSD analysis enables a visual discrimination of the less risky system. If the Cumulative Distribution Function of the CS is always located under the alternative CDF (if they never cross), then this CS is less risky (figures 2, 3, 4 and 5).

Figure 2: "Type 1" farmer cumulative distribution functions of both innovative and conventional systems for the continuous maize

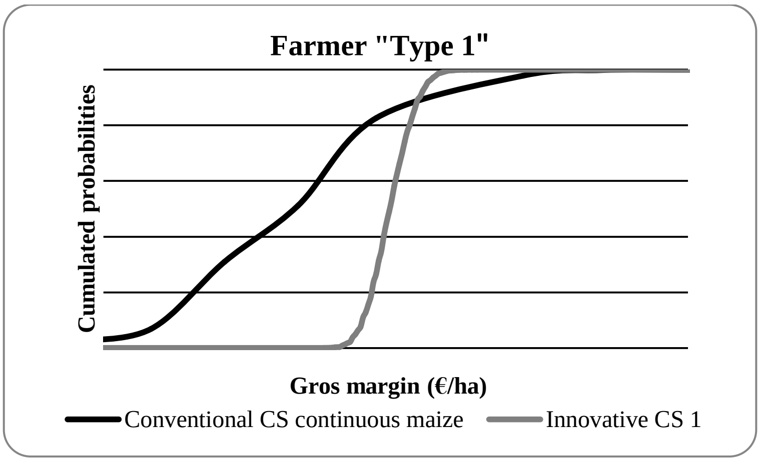


Figure 3: "Type 1" farmer cumulative distribution functions for both innovative and conventional systems for the wheat/sunflower rotation

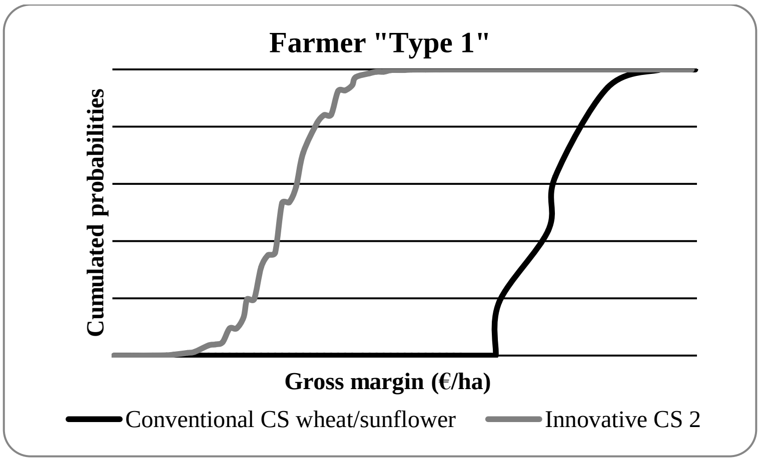


Figure 4: "Type 2" farmer cumulative distribution functions for both innovative and conventional systems for the continuous maize

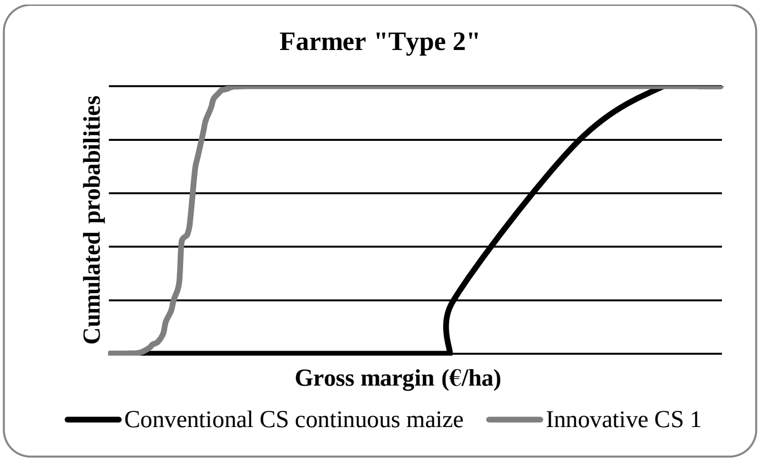
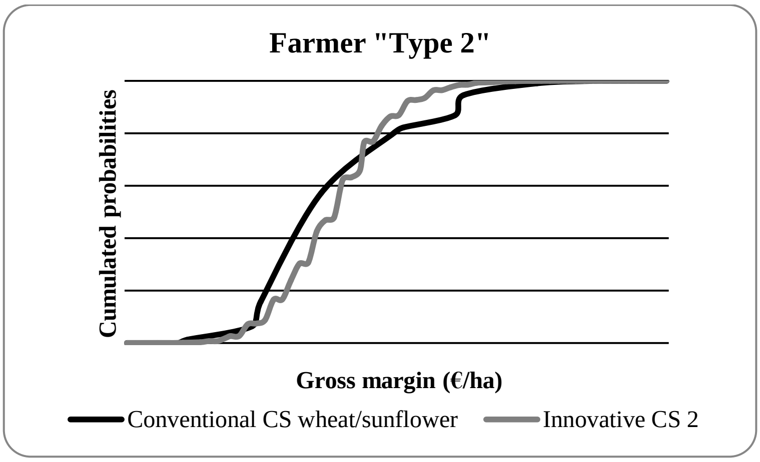


Figure 5: “Type 2” farmer cumulative distribution functions for both innovative and conventional systems for the wheat/sunflower rotation



As previously seen in table 3, farmers’ perceptions concerning the risk linked to ICSs are different. At the cropping system scale, “type 1” farmer assesses the wheat/sunflower rotation as less risky than its innovative alternative. For the continuous irrigated maize the FOSD criterion does not clearly discriminate both systems since the curves are crossing. At the opposite, the irrigated maize is perceived as less risky by “type 2” farmer and there is no possible discrimination concerning the level of risk assigned to wheat/sunflower rotations. The FOSD criterion thus allows sorting some cropping systems. However FOSD does not enable to precisely measure the degree of the preference of one system compared to another. Furthermore, if the CDF curves are crossing it is not possible to determinate which system is preferred by the farmer.

Individual preferences analysis: flexibility and risk aversion

The previous CS classification integrates the farmers’ cropping management flexibility. However, under different farm contexts, it is not possible to distinguish the CS that will be preferred. This analysis can be complemented by considering farmers’ individual preferences. The protocol of elicitation of the relative risk aversion among the sample of 23 reveals a coefficient varying from 0.60 to 0.85 and a mean value of 0.75 for the whole sample. The master table of Holt and Laury attributes, for each RRA coefficient, a qualitative level of risk aversion from “risk loving” to “extremely risk averse” (Holt and Laury, 2002). Our values exhibit a high level of relative risk aversion. This result is consistent with the works using this same method of elicitation (Reynaud et al 2010).

Level of adoption premium

Considering the two previous aspects (CS flexibility and risk aversion) we evaluate an adoption premium for each farmer of the sample. This premium measures the financial effort that makes the innovative CS equally preferred with the conventional CS. This measure can be treat as a risk premium with the difference that, in this case, there is no opposition between a secure and a risky situation but two risky situations. It does not only account for the difference of mean gross margins between both alternatives, but also integrates individual risk perceptions and risk aversion. We use the individual RRA coefficient obtained with the experimental protocol of each farmer. We also quote the adoption premium as percentage of the conventional gross margin (fig. 6 and 7).

Concerning the alternative to continuous irrigated maize, (6 year rotation, noted ICS 1), farmers “type 1” and “type 2” show opposite results. While “type 2” needs a high effort, more than 600 €/ha (more than 50% of the gross margin), to adopt the ICS, the adoption premium is negative for “type 1” farmer. Without any adoption premium, “type 1” farmer would adopt the ICS if he has the possibility. The wheat/sunflower alternative cropping system will be easily adoptable by “type 2” farmer with a negligible effort, while the adoption premium is higher for “type 1” farmer (200 €/ha).

Figure 6 : Level of adoption premium (€/ha/year), and percentage of the gross margin (continuous maize)

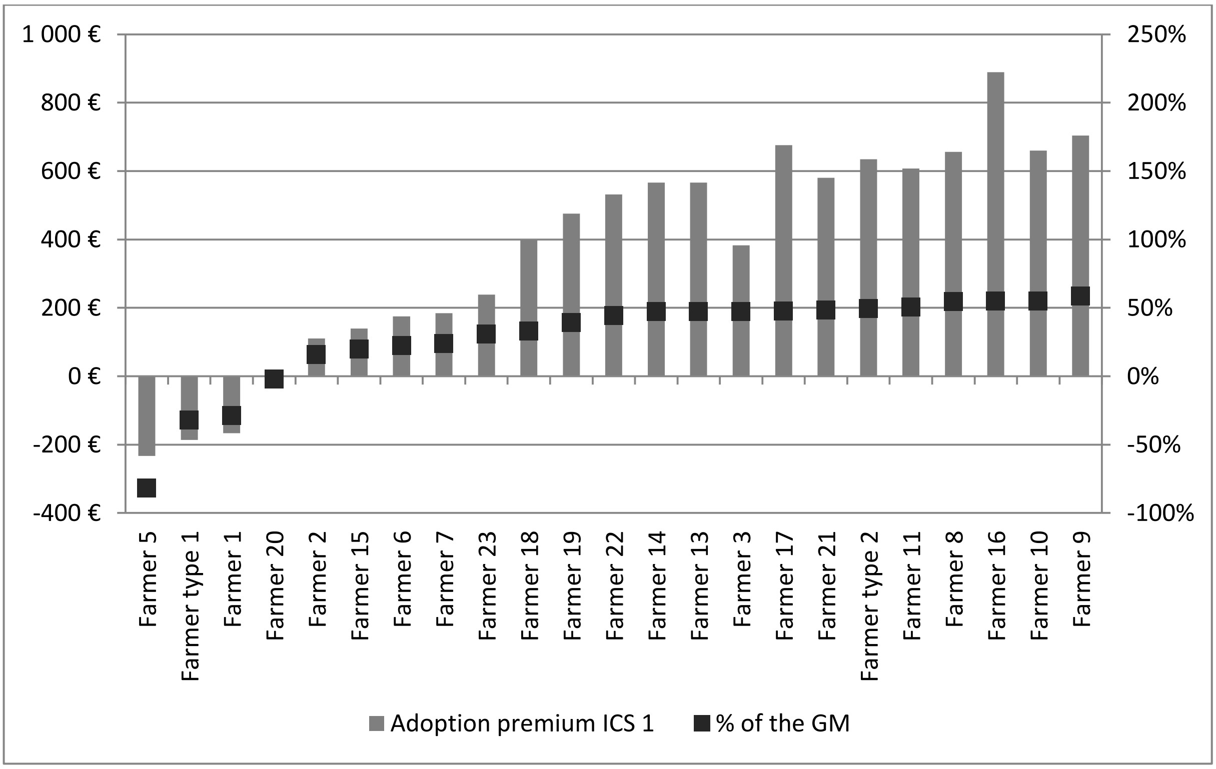
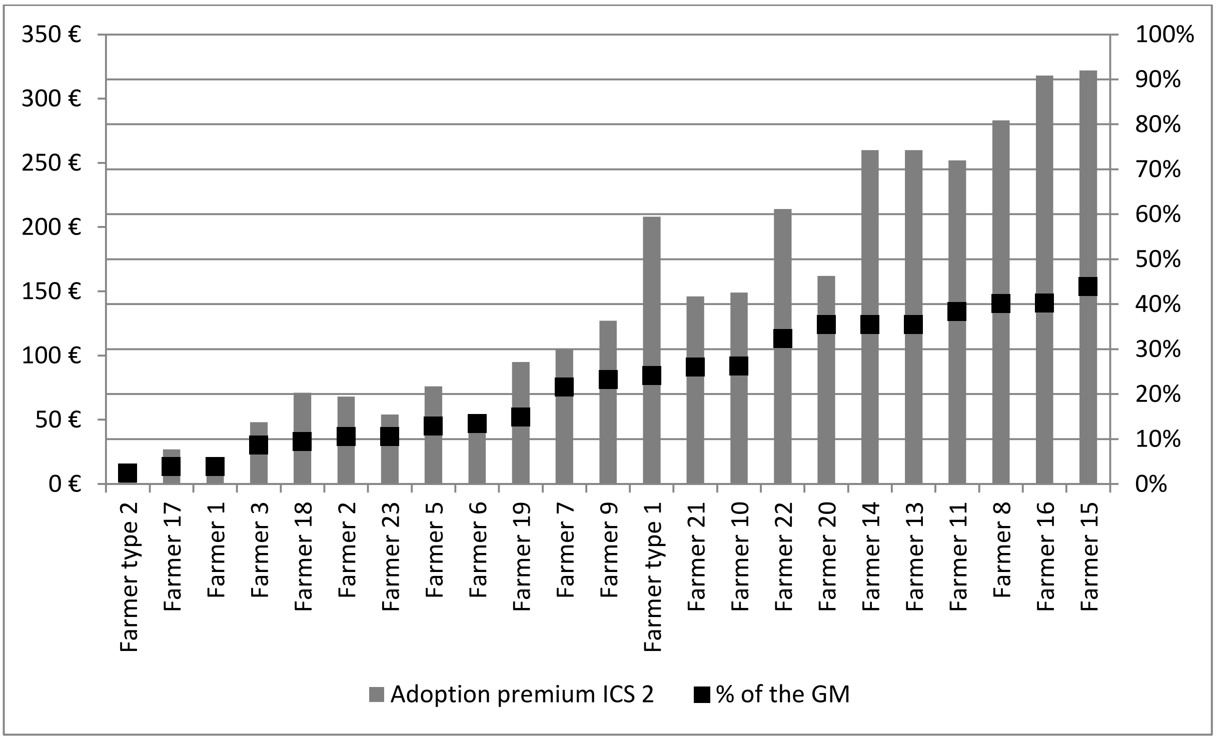


Figure 7 : Level of adoption premium (€/ha/year), and percentage of the gross margin (wheat/sunflower rotation)



The adoption premium varies from one farmer to another due to the integration of risk beliefs and preferences and crop management flexibility. Considering the ICS 1, alternative to the continuous maize, the levels of adoption premium are high, more than 200 €/ha/year for the majority of farmers. Even if the mean premium is high, some farmers show an adoption premium low or negative. A negative premium means that, for those farmers, the ICS 1 is already considered as less risky than the conventional one. The results are really heterogeneous, but in terms of percentage of the gross margin, the premium does not overpass 50%. We can distinguish three groups of farmers. The first group is composed of farmers with high level of risk premium representing around 50% of their gross margin. Those farmers will hardly adopt the ICS or will need a great effort. The second group is composed of farmers with a medium adoption premium from 0 to 250 €/ha/year (farmers 7, 6, 23, 15 and 2). This premium represents around 25% of their gross margin. Those individuals will be possible adopters with a suitable support (advice, financial support…). Finally the third group gathers farmers with negative adoption premium; they should adopt the ICS without any incentive (farmers 14, 33, "type 1" and 18). Those last four farmers are in the same production area and already have rotations in a part of their farm. The change between continuous maize and the innovative cropping system seems less risky for them. They master the cultural itinerary of some crops consequently the change is less uncertain for them. At the opposite the non-adopters farmers, with high level of adoption premium, have specialized cropping system. The ICS is unknown for them; they have never grown the crops. They might overweight bad events on yields because the new system seems more risky.

The results for the alternative to the wheat/ sunflower rotation (ICS 2), show lower level of adoption premium: the mean premium is around 140€/ha/year for the whole sample without any negative premium (fig. 7). This cropping system seems more attractive, even if some farmers have higher adoption premiums (more than 30% of the gross margin of conventional systems: farmers 15, 16, 22, 8, 11, 20, 13 and 14). There is also a group of possible adopters with low adoption premium (farmers “type 2”, 17, 1, 3, 18, 2, 23, 5, 6 and 19). As previously, we can distinguish three groups from the less to the more adopters. Some farmers, like farmer 1 and 5, will easily adopt both innovative cropping systems. Farmers have already experienced this rotation in their crop acreage, thus they are more aware of the technical aspects and beneficiate of a better information to estimate risks The other farmers are not in the same group for the two cropping system. Farmers are generally specialized in one of the conventional cropping system or the other (continuous maize or wheat/sunflower) so they do not have the same information and knowhow for all crops. This consideration can explain the difference of behavior between the two alternative situations. However, because of the farmers sample size these conclusions cannot be generalized.

The differences of level of AP within our sample are not linked to the risk aversion. The level of risk aversion is close between farmers and the coefficient is constant between both systems. The integration of the risk perception (yield and crop management) induces this heterogeneity and allows a more accurate evaluation of the ICS adoption. This also means that accounting for risk aversion gives only a partial approach of risk, because variability can arise among farmers, due to different risk perceptions.

Discussion -Conclusion

In this paper we propose a method to evaluate the adoption of new cropping systems integrating the flexibility of crop management and the farmers' risk preferences (risk beliefs and risk aversion). We use subjective assessments with a field-survey among 23 cash crop farmers. The analysis under certainty gives an inadequate picture of farmers' behavior, and leads to exclude the adoption of ICSs in a 2010-2011 crop price situation because of a loss in the mean gross margin of about -14 to -15 %. On average, our approach shows that, in the sample, farmers are risk averse (mean RRA coefficient of about 0.75). By choosing two cases of contrasted farmers inside this sample, we show that risk perceptions can be different among individuals and can change the hierarchy of CSs. An individual approach is required to approach the adoption behavior of farmers and enables us to quote an adoption premium, integrating both risk aversion and risk perceptions.

This paper proposes an economic assessment of innovative cropping systems, integrating individual risk preferences and beliefs. Through this approach of farmers' preferences, we theoretically account for the whole costs and benefits at the individual scale (including agro-ecological benefits, labor constraint…). But the calculation of multiple criteria linked to the different CSs, such as labor input or environmental pressure indicators, is not done here. The calculation of pressure indicators could complete this approach. Concerning the adoption premium, the level of incentive that could be distributed to farmers in order to make them adopt the new systems has to be balanced with the public good possibly jointly produced: the mitigation of water pollution at river basin or global scale for instance, or the enhancement of biodiversity.

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Annex 1 : Description of the innovative cropping system 1; alternative to continuous maize

Crops	Fuel consumption (l/ha)	Production Cost (€/ha)	Treatment Frequency Index[5]	Labor input (hours /ha)
Soft wheat	91.5	680.6	3.0	4.7
Soybean	68.0	575.7	3.0	2.9
Soft wheat	91.5	680.6	3.0	4.7
Oilseed rape	84.5	288.0	2.0	4.3
Maize	85.5	848.0	1.2	5.0
Sunflower	68.5	464.5	1.0	3.8
Mean	***81.6***	***589.6***	***2.2***	***4.2***

Source: Office of Coordination of Agricultural Machinery

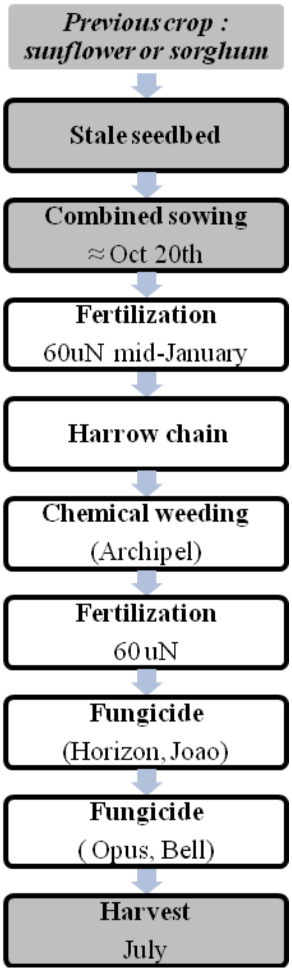
Annex 2 : Description of the cropping system 2: alternative to wheat/ sunflower

Crops	Fuel consumption (l/ha)	Production Cost (€/ha)	TFI	Labor input (hours/ha)
Sunflower	53.0	311.0	1.3	3.0
Durum wheat	91.5	589.0	3.0	4.7
Sorghum	57.5	281.2	0	3.2
Durum wheat	91.5	589.0	3.0	4.7
Pea	128.5	612.5	4,9	7.6
Rapeseed	107.0	687.8	5.5	8.0
Durum wheat	91.5	589.0	3.0	4.7
Mean	***88.6***	***522.9***	***2.9***	***5.1***

Source: Office of Coordination of Agricultural Machinery

5 The treatment frequency index or TFI is a pesticides use indicator corresponding to :
TFI = Dose of pesticide applied per hectare / Dose homologated per hectare

Annex 3 : Example of the assessment of the subjective probabilities on the technical operations



Innovative soft wheat

Two fertilization are planned for this crop :

You will do the first fertilization:

Never Rarely

Sometimes Very Often

Always

You will do the second fertilization:

Never Rarely

Sometimes Very Often

Always

You will weed with harrow chain:

Never Rarely

Sometimes Very Often

Always

You will apply weed killer:

Never Rarely

Sometimes Very Often

Always

You will apply the first fungicide:

Never Rarely

Sometimes Very Often

Always

You will apply the second fungicide:

Never Rarely

Sometimes Very Often

Always

Likert scale	**Corresponding frequency**	**Corresponding probability**
Never	0 year on a decade	0
Rarely	1 to 3 years on a decade	0.25
Sometimes	4 to 6 years on a decade	0.5
Very Often	7 to 9 years on a decade	0.75
Always	10 years on a decade	1

Annex 4 : Yield estimation method

Yield interval	**Tokens**	**Total Tokens**
50-55 quintals		
55-60 quintals		
60-65 quintals		
65-70 quintals		
70-75 quintals		
75-80 quintals		
80-85 quintals		

Please indicate from 1 to 10 your confidence level in your yield distribution:
1 2 3 4 5 6 7 8 9 10

Annex 5 : Farmers' sample

Survey area	Razes (30,4%)	Gers (30,4%)	Lauragais (26,1%)	Ariège (13,0%)
Marital status	Married (14 ; 60,9%)	Single (7 ; 30,4%)	Married (2 ; 8,7%)	
Soil	clay limestone (78,3%)	boulbènes (26,1%)	clay-loam (4,3%)	
Irrigation	No irrigation (52,2%)	Through coverage (21,7%)	Water canons/Sprinklers (4 ; 17,4%)	Hose winding drum (3 ; 13,0%)
Engagement in an network	No (91,3%)	Yes (8,7%)		
Pluriactivity	No (69,6%)	Yes (30,4%)		

	Mean	**Standard Déviation**	**Minimum**	**Maximum**
Age	39	11.3	23	62
Number of dependent person	0.82	1.26	0	5
Utilized agricultural area	145.5	57.6	42	250
Utilized agricultural area irrigated	32.7	44.1	0	140
Area owned	58.6	51.8	0	160
Labour unit	1.7	0.9	1	4

Source : own survey, 2012, April

Annex 6 : Set of lotteries in the gain and loss domains with variable probabilities

Question	Lottery A		Lottery B	
1	20€ 1 chance out of 10	16€ 9 chances out of 10	38,5€ 1 chance out of 10	1€ 9 chance out of 10
2	20€ 2 chance out of 10	16€ 8 chance out of 10	38,5€ 2 chance out of 10	1€ 8 chance out of 10
3	20€ 3 chance out of 10	16€ 7 chance out of 10	38,5€ 3 chance out of 10	1€ 7 chance out of 10
4	20€ 4 chance out of 10	16€ 6 chance out of 10	38,5€ 4 chance out of 10	1€ 6 chance out of 10
5	20€ 5 chance out of 10	16€ 5 chance out of 10	38,5€ 5 chance out of 10	1€ 5 chance out of 10
6	20€ 6 chance out of 10	16€ 4 chance out of 10	38,5€ 6 chance out of 10	1€ 4 chance out of 10
7	20€ 7 chance out of 10	16€ 3 chance out of 10	38,5€ 7 chance out of 10	1€ 3 chance out of 10
8	20€ 8 chance out of 10	16€ 2 chance out of 10	38,5€ 8 chance out of 10	1€ 2 chance out of 10
9	20€ 9 chances out of 10	16€ 1 chance out of 10	38,5€ 9 chance out of 10	1€ 1 chance out of 10
10	20€ 10 chances out of 10	16€ 0 chance out of 10	38,5€ 10 chances out of 10	1€ 0 chance out of 10

Question	Lottery A		Lottery B	
11	400€ 1chance out of 10	320€ 9 chances out of 10	770€ 1chance out of 10	20€ 9 chances out of 10
12	400€ 2 chances out of 10	320€ 8 chances out of 10	770€ 2 chances out of 10	20€ 8 chances out of 10
13	400€ 3 chances out of 10	320€ 7 chances out of 10	770€ 3 chances out of 10	20€ 7 chances out of 10
14	400€ 4 chances out of 10	320€ 6 chances out of 10	770€ 4 chances out of 10	20€ 6 chances out of 10
15	400€ 5 chances out of 10	320€ 5 chances out of 10	770€ 5 chances out of 10	20€ 5 chances out of 10
16	400€ 6 chances out of 10	320€ 4 chances out of 10	770€ 6 chances out of 10	20€ 4 chances out of 10
17	400€ 7 chances out of 10	320€ 3 chances out of 10	770€ 7 chances out of 10	20€ 3 chances out of 10
18	400€ 8 chances out of 10	320€ 2 chances out of 10	770€ 8 chances out of 10	20€ 2 chances out of 10
19	400€ 9 chances out of 10	320€ 1 chance out of 10	770€ 9chance out of 10	20€ 1 chance out of 10
20	400€ 10 chances out of 10	320€ 0 chance out of 10	770€ 10 chances out of 10	20€ 0 chance out of 10

Question	Lottery A		Lottery B	
21	-38,5€ 1 chance out of 10	-1€ 9 chances out of 10	-20€ 1 chance out of 10	-16€ 9 chances out of 10
22	-38,5€ 2 chances out of 10	-1€ 8 chances out of 10	-20€ 2 chances out of 10	-16€ 8 chances out of 10
23	-38,5€ 3 chances out of 10	-1€ 7 chances out of 10	-20€ 3 chances out of 10	-16€ 7 chances out of 10
24	-38,5€ 4 chances out of 10	-1€ 6 chances out of 10	-20€ 4 chances out of 10	-16€ 6 chances out of 10
25	-38,5€ 5 chances out of 10	-1€ 5 chances out of 10	-20€ 5 chances out of 10	-16€ 5 chances out of 10
26	-38,5€ 6 chances out of 10	-1€ 4 chances out of 10	-20€ 6 chances out of 10	-16€ 4 chances out of 10
27	-38,5€ 7 chances out of 10	-1€ 3 chances out of 10	-20€ 7 chances out of 10	-16€ 3 chances out of 10
28	-38,5€ 8 chances out of 10	-1€ 2 chances out of 10	-20€ 8 chances out of 10	-16€ 2 chances out of 10
29	-38,5€ 9 chances out of 10	-1€ 1 chance out of 10	-20€ 9 chances out of 10	-16€ 1 chance out of 10
30	-38,5€ 10 chances out of 10	-1€ 0 chance out of 10	-20€ 10 chances out of 10	-16€ 0 chance out of 10

Question	Lottery A		Lottery B	
31	-770€ 1 chance out of 10	-20€ 9 chances out of 10	-320€ 9 chances out of 10	-400€ 1 chance out of 10
32	-770€ 2 chances out of 10	-20€ 8 chances out of 10	-320€ 8 chances out of 10	-400€ 2 chances out of 10
33	-770€ 3 chances out of 10	-20€ 7 chances out of 10	-320€ 7 chances out of 10	-400€ 3 chances out of 10
34	-770€ 4 chances out of 10	-20€ 6 chances out of 10	-320€ 6 chances out of 10	-400€ 4 chances out of 10
35	-770€ 5 chances out of 10	-20€ 5 chances out of 10	-320€ 5 chances out of 10	-400€ 5 chances out of 10
36	-770€ 6 chances out of 10	-20€ 4 chances out of 10	-320€ 4 chances out of 10	-400€ 6 chances out of 10
37	-770€ 7 chances out of 10	-20€ 3 chances out of 10	-320€ 3 chances out of 10	-400€ 7 chances out of 10
38	-770€ 8 chances out of 10	-20€ 2 chances out of 10	-320€ 2 chances out of 10	-400€ 8 chances out of 10
39	-770€ 9 chances out of 10	-20€ 1 chance out of 10	-320€ 1 chance out of 10	-400€ 9 chances out of 10
40	-770€ 10 chances out of 10	-20€ 0 chance out of 10	-320€ 0 chance out of 10	-400€ 10 chances out of 10

Question	Loterie A		Loterie B	
1	400€ 3 chances out of 10	100€ 7 chances out of 10	680€ 1 chance out of 10	50€ 9 chances out of 10
2	400€ 3 chances out of 10	100€ 7 chances out of 10	750€ 1 chance out of 10	50€ 9 chances out of 10
3	400€ 3 chances out of 10	100€ 7 chances out of 10	830€ 1 chance out of 10	50€ 9 chances out of 10
4	400€ 3 chances out of 10	100€ 7 chances out of 10	930€ 1 chance out of 10	50€ 9 chances out of 10
5	400€ 3 chances out of 10	100€ 7 chances out of 10	1065€ 1 chance out of 10	50€ 9 chances out of 10
6	400€ 3 chances out of 10	100€ 7 chances out of 10	1250€ 1 chance out of 10	50€ 9 chances out of 10
7	400€ 3 chances out of 10	100€ 7 chances out of 10	1500€ 1 chance out of 10	50€ 9 chances out of 10
8	400€ 3 chances out of 10	100€ 7 chances out of 10	1850€ 1 chance out of 10	50€ 9 chances out of 10
9	400€ 3 chances out of 10	100€ 7 chances out of 10	2200€ 1 chance out of 10	50€ 9 chances out of 10
10	400€ 3 chances out of 10	100€ 7 chances out of 10	3000€ 1 chance out of 10	50€ 9 chances out of 10
11	400€ 3 chances out of 10	100€ 7 chances out of 10	4000€ 1 chance out of 10	50€ 9 chances out of 10
12	400€ 3 chances out of 10	100€ 7 chances out of 10	6000€ 1 chance out of 10	50€ 9 chances out of 10
13	400€	100€	10000€	50€

	3 chances out of 10	7 chances out of 10	1 chance out of 10	9 chances out of 10
14	400€ 3 chances out of 10	100€ 7 chances out of 10	17000€ 1 chance out of 10	50€ 9 chances out of 10

Annex 7 : Set of lotteries in the gain and loss domains with fixed probabilities

Question	Lottery A		Lottery B	
15	400€ 9 chances out of 10	300€ 1 chance out of 10	540€ 7 chances out of 10	50€ 3 chances out of 10
16	400€ 9 chances out of 10	300€ 1 chance out of 10	560€ 7 chances out of 10	50€ 3 chances out of 10
17	400€ 9 chances out of 10	300€ 1 chance out of 10	580€ 7 chances out of 10	50€ 3 chances out of 10
18	400€ 9 chances out of 10	300€ 1 chance out of 10	600€ 7 chances out of 10	50€ 3 chances out of 10
19	400€ 9 chances out of 10	300€ 1 chance out of 10	620€ 7 chances out of 10	50€ 3 chances out of 10
20	400€ 9 chances out of 10	300€ 1 chance out of 10	650€ 7 chances out of 10	50€ 3 chances out of 10
21	400€ 9 chances out of 10	300€ 1 chance out of 10	680€ 7 chances out of 10	50€ 3 chances out of 10
22	400€ 9 chances out of 10	300€ 1 chance out of 10	720€ 7 chances out of 10	50€ 3 chances out of 10
23	400€ 9 chances out of 10	300€ 1 chance out of 10	770€ 7 chances out of 10	50€ 3 chances out of 10
24	400€ 9 chances out of 10	300€ 1 chance out of 10	830€ 7 chances out of 10	50€ 3 chances out of 10
25	400€ 9 chances out of 10	300€ 1 chance out of 10	900€ 7 chances out of 10	50€ 3 chances out of 10
26	400€ 9 chances out of 10	300€ 1 chance out of 10	1000€ 7 chances out of 10	50€ 3 chances out of 10
27	400€ 9 chances out of 10	300€ 1 chance out of 10	1100€ 7 chances out of 10	50€ 3 chances out of 10
28	400€ 9 chances out of 10	300€ 1 chance out of 10	1300€ 7 chances out of 10	50€ 3 chances out of 10

Question	Lottery A		Lottery B	
29	250€ 5 chances out of 10	-40€ 5 chances out of 10	300€ 5 chances out of 10	-210€ 5 chances out of 10
30	40€ 5 chances out of 10	-40€ 5 chances out of 10	300€ 5 chances out of 10	-210€ 5 chances out of 10
31	50€ 5 chances out of 10	-40€ 5 chances out of 10	300€ 5 chances out of 10	-210€ 5 chances out of 10
32	50€ 5 chances out of 10	-40€ 5 chances out of 10	300€ 5 chances out of 10	-160€ 5 chances out of 10
33	50€ 5 chances out of 10	-80€ 5 chances out of 10	300€ 5 chances out of 10	-160€ 5 chances out of 10
34	50€ 5 chances out of 10	-80€ 5 chances out of 10	300€ 5 chances out of 10	-140€ 5 chances out of 10
35	50€ 5 chances out of 10	-80€ 5 chances out of 10	300€ 5 chances out of 10	-110€ 5 chances out of 10

Question	Lottery A		Lottery B	
36	-680€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
37	-750€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
38	-830€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
39	-930€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
40	-1065€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
41	-1250€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
42	-1500€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
43	-1850€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
44	-2200€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
45	-3000€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
46	-4000€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
47	-6000€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
48	-10000€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10
49	-17000€ 1 chance out of 10	-50€ 9 chances out of 10	-100€ 7 chances out of 10	-300€ 3 chances out of 10

Annex 8 : Sale price for the 2010-2011 campaign

Crop	Price (€/t)
Durum wheat	200
Soft wheat	180
Sunflower	450
Maize	185
Soybean	330
Sorghum	180
Pea	190
Oilseed rape	330
Rape seed	450