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MANAGEMENT OF CLIMATE RISKS IN THE WINE SECTOR:

A FIELD STUDY ON RISKY BEHAVIOUR

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Abstract

In agriculture, there is need for a deeper analysis of management of climate risks, because the farmers appear to have a paradoxical position: they perceived that they are strongly exposed to climate risks but, they do not want to pay for adapted tools, arguing that this is too expensive or complex.

However, under risk, it is well-known that the decision-makers could be subject to paradox (Allais for example). Our assumption is that to know better the behaviours of farmers in general risky situations will help to understand their reluctance to use the weather market.

We conducted a study over the wine growers in the Maine-et-Loire department. 60 wine growers have responded to the questionnaire about climate risk management, and 29 amongst them have completed the second questionnaire about risky behaviours.

Results will be presented at the EAAE congress.

Keywords

Expected utility, Field experiments, Management of climate risks, Paradoxes

1 Introduction

In a recent French fruits and vegetables commission, many themes where proposed to be studied. One of them was “management of climate risks for apricot producers”. It was argued that it was not possible for these last ones to be insured and that the professional organisation had to “do something”. It has raised many questions but it has not been possible to reconcile all the points of view and the proposition has been rejected. This example shows the need for a deeper analysis of management of climate risks (MCR) in fruit production.

We will here focus on the wine sector. Like all the agricultural sectors, it is subjected to many risks, particularly the climatic ones .Facing climatic events, the wine owners can lose partially or sometimes completely their harvest in very little time and are find themselves in a critical financial standing. In fact, the MCR is placed at the center of the concerns of the actors in this sector: It is essential to develop tools which allow the wine owners to reduce their risks and to continue their activity facing unfavourable climatic events.

There is a paradox between the need for insurance and the very weak use of financial tools (insurance, weather derivatives…). Since the producers are conscious of the gravity and the

frequency of the climate risk, it must be treated with the standard tools of risk management (REJDA, 2002) but the behaviour of the producers is paradoxical because they do not want to pay for a financial solution (too expensive, too complicated…). For example, the introduction on the financial market of Paris of Winefex has been a failure a few years ago.

Is this gap between the supply and the demand on the weather market surprising? Not really if we remind that since the Allais paradox in the fifties, the standard theory of choice under risk, expected utility (EU), has faced to numerous violations (see the survey of STARMER, 2000). Risky situations seem to favour "irrational" behaviours: the behaviour of farmers under climate risk could be one anomaly amongst others.

We think we need to study more deeply the behaviour under risk of farmers. Hence, we have questioned them in two steps. The first one was a classical questionnaire about their perception of climate risks, and their strategies for these risks. The second questionnaire was inspired from the traditional problems used in experimental economics, in the spirit of KAHNEMAN. and TVERSKY (1979), in order to study the behaviour under risk. However, these questionnaires have not been done in a laboratory: this is a field study.

Our assumption is that to know better the behaviours of farmers in general risky situations (that have been already studied in the literature) will help to understand their reluctance to use the weather market.

Section 2 will present the framework of our work, both on MCR and behaviour under risk. The following section presents the questionnaires. Section 4 analyses the results. The last section concludes.

2 The framework

Our work is concerned with two literatures: the first one studies how farmers manage the climate risks and the second one focuses on risky behaviours.

2.1 The management of climate risks in agriculture

In a large part of industries, climate appears to be a more important source of uncertainty than traditional financial risks. As Météo-France said, between 20 and 30 percent of gross domestic product (GDP) are exposed to adverse weather in industrialised countries, and the proportion rises to 70-80 percent if indirect effects are taken into account. Makers of soft drinks and ice-cream, farmers, viticulturists and energy producers are just a few examples of the sectors that can be badly affected by sharp changes in temperature and rainfall.

Nevertheless, most of the time, risk management still refers to rate and change risk. In order to understand this, one may first define climate risk in economy and difficulties to measure and then to manage this source of uncertainty. As our study is focused on agriculture and more specifically viticulture, we emphasize on agriculture and industry wine sector.

Agriculture production closely relies to natural resources which are not controlled by farmers (water, temperature, …). Moreover, climate has indirect impacts for example by the way on their effects on moistures and diseases. Then, agriculture is a sector very dependent on climate. As far as viticulture industry is concerned, the impact of the weather is huge. Then, if there is a lack of sunshine exposure or cool temperatures during the stages between pre-bloom and maturation, the quality of grapes can be significantly affected, and consequently the vintage of resulting wine (DON and KUSY, 2007). But, what is climate risk?

Two types of weather risk can be identified. First of all, natural catastrophes continuously increased this last ten years. On one hand, the impact of extreme climate events, like floods, violent storms and droughts on an economy is more and more evident. It represents a real

challenge for agriculture and consequently for insurance and financial industry. On the other hand, even if the consequences of global warning can be less extreme, it increases weather volatility and then the uncertainty of cash-flow and earnings. Viticulture is concerned by these two sources of risk. What has been done to manage this source of uncertainty?

Many reports in insurance (ADEME, 2007) and financial services industry, theoretic and empirical studies have pointed out impacts of climate change on global economy and more specifically on agriculture. Some decisions have been taken both by the financial services sector and governments. It shows that a lot of decision-makers are aware of the importance of managing climate risk.

It is now possible to manage climate risk through weather derivatives. These financial products appeared in 1996. It was first an over-the-counter market largely driven by the energy sector. Weather derivatives began to be traded on the Chicago Mercantile Exchange on September 1999 (GEMAN and LEONARDI, 2005). Payoffs of these derivatives are contingent on weather indices based on climate factors. The underlying meteorological variables for weather contracts are temperature, precipitation, humidity, and wind speed, or any combination of those. Currently, the most contracted weather variable in the energy and financial sector is temperature. As all derivatives, these contracts help firms to manage unforeseen climatic changes.

Concerning France (see internet site of Metnext), Météo-France (France's national weather service) and Euronext, a subsidiary of NYSE Euronext, have just teamed up to launch a joint venture named Metnext specializing in innovative solutions for index-based MCR. Metnext will offer two types of services: customized services of businesses and assistance with the development of indices as a benchmark for hedging products.

The weather contracts offer the further advantage of trading like options, which traditional insurance or re-insurance contracts do not offer. Anyway, insurance contracts are used by agricultural producers to cope with climate risks. Moreover, insurance sector and governments are aware of the capacity of insurance to help firms to mitigate the economic losses and to facilitate the adaptation to climate risk.

Weather derivatives are most used in the energy sectors. Although the use of these contracts is potentially widespread it seems that firms in many sectors have not yet planned a hedging policy or even measured their exposure to weather risk. As the agriculture sector is concerned, "many empirical studies have shown that agricultural producers are risk-adverse. If perfect Arrow-Debreu contingent markets were available without transaction cost, risk-aversion would not be an issue. But contingent claim markets associated to the agricultural sector are often incomplete, leading producers to adopt a range of self-insurance and consumption smoothing strategies, and governments to intervene. However, some recent innovations based on climatic or area-yield index could be a promising alternative for sharing climate risks in agriculture" (BOURGEON, 2007).

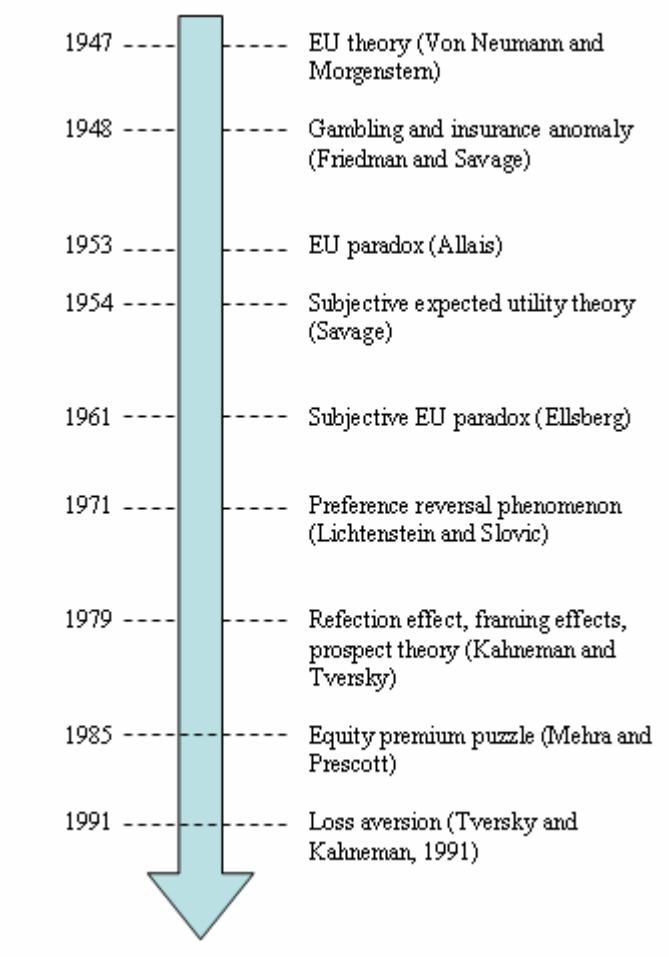
Climate risk exists and insurance and financial services industries provide different contracts to manage the uncertainty due to climate change. So, why are they not so used, specially in the viticulture industry?

There are two answers. First of all, the wine sector is concerned by weather conditions for a long time and advances in technology provide different ways to manage risks due to climate changes. Secondly climate obviously represents just one of many sources of risk to which producers of wine are exposed and respond. Then, they have to take into account the impact of non-climatic as fluctuations in currency and interest rates, changes to governments support programs, commodity market downturns…

2.2 Risky behaviour: an accumulation of violations of expected utility theory

While EU has been developed as a solution to the St-Petersburg Paradox (BERNOULLI, 1738), this theory formalized by Von Neumann and Morgenstern (1947) has also raised some new paradoxes and anomalies. It seems as if a new theory raises some new contradictions, as summarized in the figure 1. The list is not necessarily exhaustive but it corresponds with the well-known results in the literature.

Figure 1: Decision under risk: theories and behaviours



It seems as if the new theoretical developments (EU and the extension to unknown probabilities with subjective EU) has led to new contradictions. Let present these ones in a few words. Friedman and Savage (1948) have argued that the standard concave utility function (representing risk aversion) was inconsistent with the coexistence of gambling and insurance behaviours for the same person. It could be explained in the framework of EU but we an unrealistic utility function. The paradoxes of Allais (1953) and Ellsberg (1961) are simply inconsistent with EU and subjective EU, whatever is the utility function: these contradictions are more critical for these theories. The following contradictions are not paradoxes but have increased the doubt about the empirical validity of EU. Note also that most of these contradictions have been obtained with experimental results but some stylized facts have been also observed: coexistence of gambling an d insurance, framing effects or equity premium puzzle.

Finally, the prospect theory (KAHNEMAN and TVERSKY, 1979) has been a revolution because it was a behavioural theory, contrary to the normative previous one. The accumulation of

observed behaviours has led a large part of the theoreticians to reconstruct their models in the framework of behavioural economics.

Numerous contradictions of EU will be studied in our questionnaire. Hence, we will be able to compare the decisions of wine growers with the results obtained in the literature.

3 The methodology of the study

We will first present the methodology, and then the studies of the MCR (questionnaire A) and behaviours under risk in the wine sector (questionnaire B).

3.1 Methodology

Since this work is financed by the Pays de Loire region (west of France, main city Nantes) and that INH and University of Angers are located in the Maine-et-Loire, we limited our study to the department of Maine- et- Loire, in the west of France . We built our sample on an equiprobable drawing of lots among all the 880 wine growers indexed in the directory, 200 of whom were selected. Hence, there was no bias in the construction of the sample and we hoped to have a large rate of responses since INH and University are well-known in the sector.

25 wine growers have been first contacted by post (end phone if necessary) in order to test a first version of the questionnaire. Hence, the questionnaire has been administrated with the following rates of responses.

Table 1: Administration of the questionnaire A

	Sent	Replied	% of answer
Postal questionnaire	100	43	43%
Telephone interview	75	17	23%
Total	175	60	34%

In a second step, the 60 wine growers have been contacted by phone. We have asked to them if they could respond to the questionnaire B. If they were ok, a date was fixed and we come to see them for administrating the questionnaire. It was necessary because the questions need assistance and each question was projected on a screen; they had to be really spontaneous. It takes about 20 minutes, and only one person visit them, so they all had same explanations. Answers were completed on the laptop by the assistant. They would have the result of the study during July, and they were very interested in the results. At the end of each appointment, the assistant made a little conclusion primarily based on the answers for KAHNEMAN and TVERSKY 's lotteries. 29 of the 60 have respond.

3.2 Questionnaire A: management of climate risks

The questionnaire mainly aims at identifying the climatic risks existing in the wine sector and their impacts, the main tools of MCR used, and the needs of the wine growers which were not fulfilled concerning MCR.

This questionnaire is composed of 10 questions divided into three categories (see appendix A):

1) 2 questions concerning the measurements of the principal climatic risks and their impacts in the wine exploitation; the identified risks are dryness, frost, hail, grilling, wind and lightning (storm).

2) 7 questions concerning the tools of MCR used by the wine growers, the obstacles of installation of these tools and the needs of the wine growers which were not fulfilled, primarily covering 3 main tools of MCR:

- The forecasting tool (the measurements of information management);
- The prevention tool (the measurements of technologies management);
- The compensation tool (the measurements of financial management);

3) 1 question concerning the identity of the interviewed grower.

The time needed to fill out this questionnaire is estimated to 15 minutes.

3.3 Questionnaire B: behaviour under risk

Appendix B presents the questionnaire. As we do not want that the subjects rely some questions, the questions are presented in the appendix in a comprehensive order while the order was slightly different in the questionnaire: the order is specified in the first column.

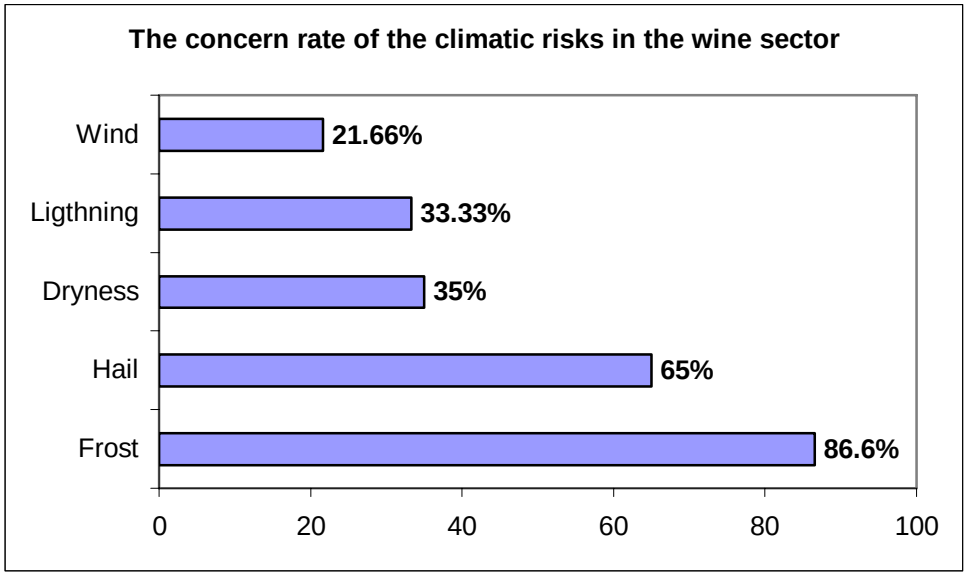
There was 55 questions: 20 were choices between hypothetical lotteries (table A2), 14 were questions about more generally risky behaviour (table A3), and the others were questions about them and their enterprise (tables A4 and A5).

4 The results

4.1 Management of climate risks

We clearly notice on one hand a diversity of the climatic risks in the wine sector (hail, storm, wind, grilling, dryness, frost) and on the other hand that frost and hail remain the most salient climatic risks. The figure 2 illustrates these results;

Figure 2: The concern rate of the climatic risks in the wine sector



When we look more deeply to these two risks, we can estimate the frequency and the gravity, as Even if the risk of hail (average annual frequency: 0.78/year) is more frequent than that of

frost (average annual frequency: 0.47/year), we clearly see that for the "Average Repercussion" scenario, the annual repercussion of frost and hail account respectively for 16.36% and 11.46% of the total turnover. Therefore, we can deduce that the repercussions of the gravity of hail remain less important than those noticed for frost whatever the manpower of the exploitations are.

Table 2: Estimation of frost and hail risks

	Hail	Frost
Total effect / turnover	14.7%	34.81%
Annual frequency	0.78	0.47
Average effect / turnover	11.46%	16.36%

Table 3: Estimation of spending in tools for frost and hail risks

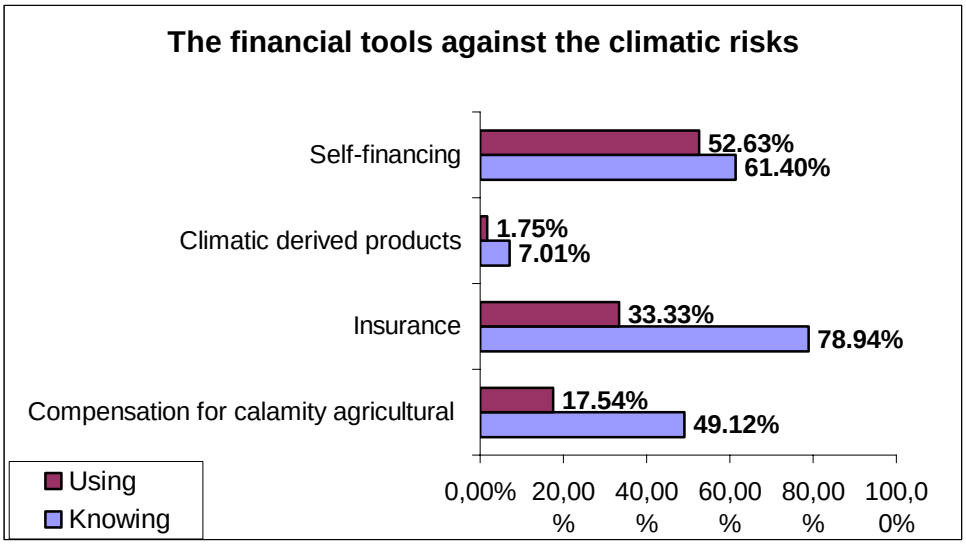
	Spend in % of the turnover				
	0	]0;2]	]2;5]	>5	Average
Risk of hail	0%	0.7%	0.25%	0.5%	**1.45%**
Risk of frost	0%	0.47%	0.65%	0.26%	**1.38%**

According to the table 3 above we notice that the average expenditure used by the wine growers to protect themselves from the risk of the frost, which is more threatening - is only 1.38% of the total turnover, whereas that devoted to protect themselves from the risk of hail accounts for 1.45% of the total turnover. We note that the spending (table 3) are little in relation with the impact for both risks (table 2) but the paradox is accentuated since the spending is greater for the lower risk.

Globally, we notice that 97% of the wine growers had to face the climatic risks in their orchards. Nevertheless, 38.59% of the wine exploitations use protection measures against the climatic risks.

But what is their knowledge of the tools of MCR? Are they used? The figure ** summarize the situation: all the tools are rarely used.

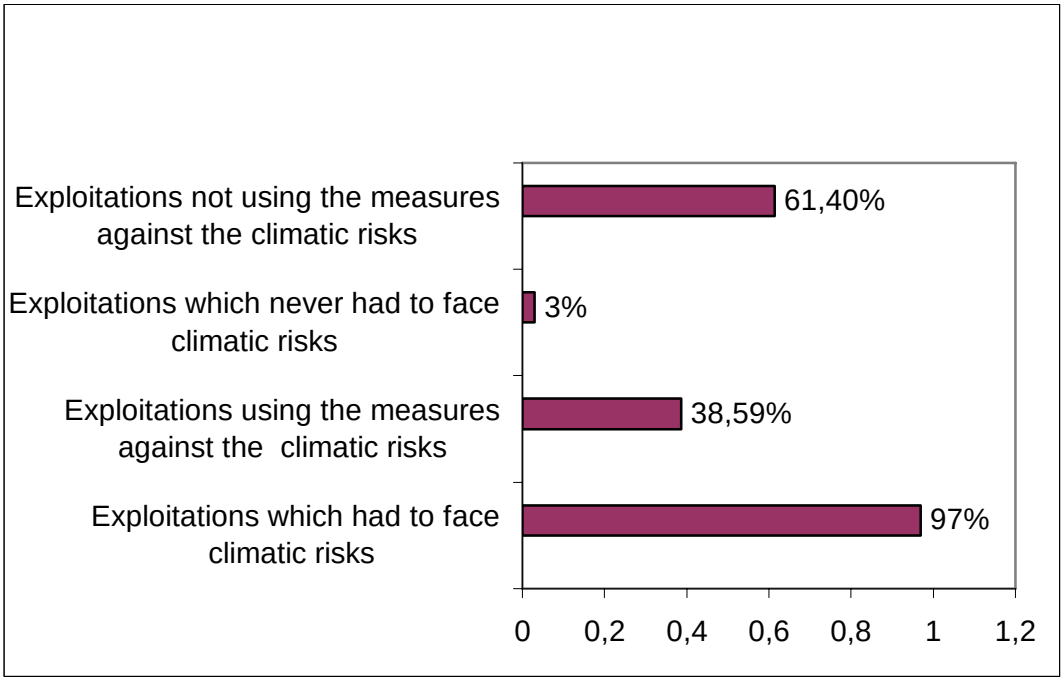
Figure 3 Knowledge and use of tools of MCR



Although frost is less frequent and it has stronger effects on the turnover than hail, we clearly see that the wine exploitations of Maine-et-Loire devote little higher a share of their turnover to be protected from the risk of hail than the risk of frost and that the exploitations having a large manpower are those which protect themselves more against those two climatic risks. This difference can be explained by the fact that the tools available against the risk of hail are more effective and they are better adapted to the needs for the wine growers compared to the tools used against the risk of frost.

More generally, there is very little taking into account of MCR, although this risk is perceived as very important. The figure 4 illustrates this paradox.

Figure 4 Comparison between perception of CR and the rate of utilisation of tools of MCR



4.2 Behaviour under risk

The analysis of these results is in progress, but if we look at the table A2 in the appendix, we observe some well-known contradiction of EU.

The questions show that, although there is only 29 respondents, that we refund some classical results:

The questions 32 (or 34) and 33 are in line are in lien with the Allais paradox, since the subjects are significantly more risk seeking in the question 33. The certainty effect leads people to choose the safer option in questions 32 and 34.

The questions 32 and 36 illustrates the reflection effect: in question 36, most of the people choose the risky option.

The results will be analysed more deeply. Although, the number of subject is limited (29), the results appears to be in line with the standard results. For example, the question 40 to 48 following then Holt and Laury (2002) procedure show that the subject have responded correctly to the questions since the percentage of people choosing B increase regularly with the probability of winning 38 500 €.

Conclusion

At the present time, we carry out the same survey for the fruit sector. It appears that they protect themselves better against these risks than the wine growers, since 82% of them have MCR tools. Hail and frost are also the two principal climatic risks. Since hail is more frequent and has more effects on the turnover than frost, the expenditure for the hail protection is higher than those for frost.

The first results show that there is a paradox between the need for tools for MCR and the very weak use of them. We will see if the relation with behavioural patterns under risk will help us to understand this result.

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Appendix

Appendix 1: questionnaire sent on MCR

Madam, Sir,
We currently carry out a survey to know the behaviours of the wine growers with respect to the climatic risks. Your answer is important because it will enable us to identify the strategies installation, by the producers of the wine sector, to face the climatic risks.

Table A1: Questionnaire A

Questions	Answers
1. Do you have already to deal with certain climatic risks in your production process?	☐Yes. If yes, indicate them in the following list (question with multiple choices). ☐Hail ☐Storm ☐Wind ☐ Netting (strong heat) ☐Dryness ☐ Freezing ☐Others. Specify which:
	☐No. Not. So not, do you think that climatic risks are to be feared in the months or years to come? (Then, you can pass to question 10) ☐ No ☐ Yes. Specify which:
2.1. ➢ The 1st climatic Risk, most important which you are or were already confronted.	Open answer
Installation to prevent them	Open answer
Frequency of this risk:	Open answer (number of times /year)
Consequences generated by this climatic risk:	Open answer
Indicate possible measurements installation to prevent these risks:	Open answer
Which share of your sales turnover was used last year to set up these measurements?	☐ I do not have anything spent ☐Inferior than 2% of turnover ☐ Between 2% and 5% of turnover ☐ Higher than 5% of turnover
2.2. ➢ The 2nd climatic Risk, most important which you are or were already confronted.	Open answer
Installation to prevent them	Open answer
Frequency of this risk:	Open answer (number of times /year)
Consequences generated by this climatic risk:	Open answer
Indicate possible measurements installation to prevent these risks:	Open answer

Which share of your sales turnover was used last year to set up these measurements?	☐ I do not have anything spent ☐Inferior than 2% of turnover ☐ Between 2% and 5% of turnover ☐ Higher than 5% of turnover
3. If you have information allowing envisaging the climatic risks, where do you find this information? (Question with multiple choices):	☐ Weather France ☐Media (TV, press, radio, living room…) ☐Other publicly-owned establishments or parapublic (INRA, CEMAGREF…) ☐Your own experiment ☐Others ☐Not, I do not have this type of information
4. If you have means (technologies, materials, methodologies…) to prevent these risks, how did you find them? (question with multiple choices)	☐ Thanks to your experiment ☐ Thanks to your formation ☐ Thanks to publicly-owned establishments or parapublic (CEMAGREF, NIAR…) ☐ Others ☐ I do not have by this type of technology.
5. Can you indicate the technological means to us (technologies, materials, methodologies…) you currently have to protect you from the climatic risks?	Open answers
6. Which financial means know you to compensate for and cover the possible losses caused by the climatic catastrophes? (Question with multiple choices)	☐ Compensation for calamity agricultural (FNGCA) known ☐ Insurance known ☐ Climatic derived products known ☐ Self-financing known
	☐ Compensation for calamity agricultural (FNGCA) used ☐ Insurance used ☐ Climatic derived products used ☐ Self-financing used
7. If your establishment cannot set up measurements necessary to cover certain climatic risks against, which are the possible constraints which prevent them? (question with multiple choices)	☐ The price ☐ Inefficiency ☐ Technological complexity ☐ The insufficient communication ☐ Others, specify which:
8. Did your establishment subscribe an	☐ Yes

insurance to be covered against the climatic risks? the insufficient communication with the insurers Others, specify which:	☐ No. So not, which are the possible constraints which prevent them? (question with multiple choices) ☐ the price ☐ inefficiency ☐ the complexity of the process ☐ the insufficient communication with the insurers ☐ Others, specify which :
9. Are the insurances you are subscribed to responsive to the effect of protection from climatic risks?	☐ Yes ☐ Somewhat ☐ Not really ☐ Never Which are all no satisfied waiting (if it is necessary):
10. To allow us to better include/understand your answers, please supplement the fields below:	Name of your establishment: Localization of your establishment: Manpower of your establishment Permanent: Seasonal workers: Cultivated wine species: The surface of production: Annual production: Sales turnover: between ____ € and _____€.

Appendix 2: questionnaire on risky behaviour

Table A2: Questionnaire B – Part on choices between lotteries

			Score	
Question	Lottery A	Lottery B	Average	St. Dev
32	(30 000, 1)	(40 000, .2;30 000, .75)	1,66	1,63
33	(30 000, .25)	(40 000, .2)	3.79	2,69
34	(30 000, 1)	(40 000, .8)	1.90	2,02
38	(100 000, .01)	(1 000, 1)	5,41	2,47
35	(- 100 000, .01)	(- 1 000, 1)	4,17	2,65
36	(- 30 000, 1)	(- 40 000, .8)	6,45	1,13
37	(- 30 000, .25)	(- 40 000, .2)	4,79	2,23
49 (*)	(- 20 000, .5)	(- 10 000, 1)	4,03	2,75
52	(20 000, .5)	(10 000, 1)	6,61	1,26
48	(20 000, .1 ; 16 000 , .9)	(38 500, .1;1 000 , .9)	1,11	0,56
47	(20 000, .2 ; 16 000 , .8)	(38 500, .2;1 000 , .8)	1,28	1,14
46	(20 000, .3 ; 16 000 , .7)	(38 500, .3;1 000 , .7)	1,72	1,87
45	(20 000, .4 ; 16 000 , .6)	(38 500, .4;1 000 , 6)	1,83	2,07
44	(20 000, .5 ; 16 000 , .5)	(38 500, .5;1 000 , .5)	2,26	2,42
43	(20 000, .6 ; 16 000 , .4)	(38 500, .6;1 000 , .4)	2,31	2,25
42	(20 000, .7 ; 16 000 , .3)	(38 500, .7;1 000 , .3)	3,72	2,75
41	(20 000, .8 ; 16 000 , .2)	(38 500, .8;1 000 , .2)	4,39	2,81
40	(20 000, .9 ; 16 000 , .1)	(38 500, .9;1 000 , .1)	5,66	2,44
39	(20 000, 1)	(38 500, 1)	7	0

* It was assumed that they received 20 0000 € before choosing

Table A3: Questionnaire B – General questions on risky behaviour

Question	statement	1	7	Average	St.Dev
18	Driving at the speed of 150 km/h	Without risk	Risk maximum	3,41	1,45
19	Smoking more than 5 cigarettes for a day	Without risk	Risk maximum	4,83	1,84
20	Having a sexual relation not protected out of couple	Without risk	Risk maximum	5,48	1,45
21	A close relation who wants to carry out the turn of the world by boat	Without risk	Risk maximum	4,38	1,49
22	Daily, think you take risks	Without risk	Risk maximum	3,41	1,52
23	You a are in town, and have to stop on a paying parking lot	You pay without hesitation	You don't pay without hesitation	3,17	2,65
26	When an innovation appears, you wait to see it working before accept it:	I disagree	I agree	4,72	2,23
28	You should say that the risks you take, in comparison with the others are:	Really less important	Really more important	4,03	1,03
30	While applying treatment, you prefer	under proportioning	Over proportioning	3,27	1,11
31	When you are applying a treatment, you prefer actions:	Preventives	Curatives	1,97	1,63
51	One day, you lose for 10 000 € of you collect, and the same day you inherit 10 000€. Do you think it is:	A very strong day	A very good day	4,31	1,78
25	You better manage climatic risks than the others	I disagree	I agree	2,34	1,67
27	To know your competitor's collect date is for you :	Not important	Really important	1,89	1,09
29	A supermarket propose to you to buy 80% of your production for this year. You :	Accept it	Refuse it	6,62	1,16

Table A4: Questionnaire B – General questions quantified

Question	Statement	Average score	St. Dev
2	How old are you?	45,89	11,38
4	Since how many time do you work in wine production	26	14,8
5	Since how many time do you work in this enterprise	21,08	14,27
24	You have to travel by train, and you don't have your tickets. How many times do you want to be at station?	24,13	14,39
16	Can you estimate the global loss by year due to climatic risks, in % of your sales turnover?	8,05	7
17	How many % of your sales turnover is given to an insurance	0,61	1,13
50	When you have insurance, which % of the loss would you like to receive?	25,35	40,39
55	Insurance propose to you a new contract which guarantees 100% of losses. Which price give you to such an insurance? (in% of the sales turnover)	3,5	2,45
53	You made a stock exchange placement for 5 years. One year after, your profit is 50%. Which % do you want to sell?	42,52	32,7
54	You made a stock exchange placement for 5 years. One year after, your loss is 50%. Which % do you want to sell?	26,57	38,24

Table A5: Questionnaire B – General questions not quantified

Question	Statement
1	Name and address of the enterprise
3	Family statute and number of children
6	Formation
7	What is you function?
8	Who decide for insurance?
9	Who decide for technical decisions?
10	Formation of who takes decisions
11	Which outlets did you chose?
12	Do you respect a particular schedule of conditions? Which one?
13	Are you independent or in co-operative?
14	Can you describe your production?
15	For those in co-operatives, does the co-operative take part in case of climatic accident?