ECONOMIC FEASIBILTY OF ORGANIC FARMS AND RISK MANAGEMENT STRATEGIES

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Abstract— **Organic farmers must face different risks than conventional farmers Due to the special features of management of their productive system, and due to the specific characteristics of their cultivations. This study analyses the specific risks that organic farmers must manage as well as the different strategies that there are developing nowadays. Even if the Spanish farmers rely on the insurance system to manage their risks, today organic farmers do not have specific insurance products to manage them.**

The methodology and results presented in this study include a risk analysis carried out by evaluating statistical, probabilistic, and stochastic properties of the organic production data. We evaluate and discuss the aspects of our study that relate to other international studies. Productions considered in this research are olives, vineyard and cereals.

Specific risk management strategies developed by organic farmers – in contrast with conventional farmers – have been identified and quantified, showing the different attitudes based on their risk perception and the potential vulnerability of their farms. Agricultural insurance tool for organic farmers in Spain has been studied and analyzed as an important risk management

Keywords— **Risk management, organic farming, stochastic simulation, risk strategies and agricultural insurance.**

I. INTRODUCTION

Agricultural production is exposed to special risks due to its dependency of the natural and climatic conditions, which originate strong oscillations of the prices and the supply of agricultural products, in combination with economic problems, natural catastrophes and shortage of energy. Last reforms of the CAP have gradually reduced the instruments of risks and crisis management, replacing them by direct payments to the farmers.

Agriculture is in a world-wide context based on a series of facts that are entailing a considerable increase of the risks in the development of the different agricultural activities. Aspects like the liberalization of the agricultural policies, the globalization of the agricultural interchanges, the increasing environmental restrictions, the frequent changes in the agricultural structure in which a great polarization of the power in the agro-alimentary chain exists, or those risks derived from the climatic change are even some of the causes by which farmers are seeing themselves forced nowadays, to develop a clear strategy of risk management in their cultivations (SUMPSI, 2006).

The responsibility of the prevention and the risk and crisis management related with the production, the methods of production, the commercialization and the stability of the rent, fall more and more to the own agricultural cultivations. These must be oriented by the market more and more. In this point is where organic productions are reaching more importance every time. Their benefits for the food security, environment, etc. already are recognized in numerous studies. This is the main reason which public policies support more and more to this kind of productive system. In this document aspects related to risk management in organic farming are analyzed, specially the different tools and strategies from risk management available for these farmers nowadays in Spain.

II. METHODOLOGY

Under criteria of surface and relative importance of the commented productions of organic farming, and trying to include the higher amount of producing regions of our country, the most representative regions

of these cultures have been chosen, being these the following ones: Andalucia, Aragón, Castilla y León, Castilla la Mancha, Cataluña, Extremadura, Murcia and Comunidad Valenciana. (Table 1).

Table 1 Surface of organic farming by regions 2006 (hectares)

Regions	Cereals	Vegetables	Citrus fruits	Fruits	Olive grove	Vineyard	Nuts
Andalucía	37.701	2.136	1.400	567	42.147	632	23.325
Aragón	24.929	68	-	221	1.365	468	688
Castilla León	5.749	110	-	11	8	574	10
Castilla la Mancha	15.621	394	-	114	7.791	4.864	3.895
Cataluña	2.027	234	29	137	2.318	1.377	764
Extremadura	8.674	65	-	1.054	35.036	436	1.393
Murcia	4.188	998	168	393	1.228	3.679	7.151
Comunidad Valenciana	2.240	319	517	370	2.030	2.516	4.003
Other regions	12.175	715	70	999	1.508	2.285	3.371
Total	113.304	5.039	2.184	3.866	93.431	16.831	44.600

For the elaboration of questionnaires a series of questions has been elaborated to determine what could happen, why and how, and how the agricultural cultivation can be affected, without forgetting any important risk that it could happen. In addition, the design of the questionnaire has included a series of questions destined to identify and to classify the cultivations based on its productive systems as well as the strategies of risk management used by them nowadays.

Table 2 Summary of the questionnaire made to organic farmers

Block of questions	Obtained data
1. Classification of the cultivations	Information on the cultivation of the cultivation as a whole
2. Data of yields and sale prices of the product	Characterization of the reality of the market and organic product production
3. Risk Analysis: Identification	To identify the importance that the farmer gives to each one of the identified risks
4. Risk Analysis: Evaluation	To evaluate the affection level that each one of the risks has on the productions
5. Risk Analysis: Strategies and techniques of management	Valuation which the farmers do on the different strategies from risk management, especially the importance of the agricultural insurance system

The accomplishment of questionnaires has tried to include the higher number of representative agricultural productions of our country. The study has been focused in the following ones: cereals, vegetables, fruits, citrus fruits, vineyard, olive grove and nuts. Questionnaires include 192 productions of organic fruits (apricot, plum, apple, peach, pear and cherry), 136 organic cereal productions (wheat, barley, oats and rye), 72 of nuts (almond and hazelnuts mainly), 40 of organic citrus fruits, 51 productions of organic olive grove, 20 of organic vineyard and 36 of vegetables and flowers, doing a total of 547 productions distributed in 312 cultivations.

Table 3 Distribution of the number of made surveys

Regions	Cereals	Vegetables	Citrus fruits	Fruits	Olive grove	Vineyard	Nuts	TOTAL
Andalucía	59	21	25	56	13	5	42	221
Aragón	52	7	5	49	9	4	7	133
Castilla - León	1	-	-	-	-	1	-	2
Castilla la Mancha	21	2	-	1	9	4	12	49
Cataluña	1	-	-	-		-	-	1
Extremadura	-	-	-	14	1	-	1	16
Murcia	2	4	6	44	17	4	10	87
Comunidad Valenciana	-	2	4	28	2	2	-	38
TOTAL	136	36	40	192	51	20	72	547

With the purpose of validating the information contributed by the surveys, a series of personal interviews to professionals of the sector has been made. The objective has been to value some opinions of different agents with formation in the matter, separated totally of the production. Finally the results of the survey have been evaluated considering the existing information about risks in organic farming in our country (LABRADOR et al., 2006; COAG, 2006).

In these interviews, special emphasis has been made for evaluate the tools and strategies of existing risk management nowadays in these productions, as well as in the possible adaptation of the existing ones for conventional production. In addition, it has been deepened in the possible capacities that techniques of organic farming can have to mitigate and/or to manage the risk, finding out the level of affection of each one and the productions in which these risks have higher importance. Also information has been successfully obtained on the opinion that these professionals have about the Spanish system of agricultural insurances, identifying its strengths and weaknesses in relation to organic farming.

Some results that help us in the prediction and the explanation of organic farmer's attitude in order to face and manage the risk in their cultivations have been obtained by a statistical analysis of the different variables from the questionnaires. Specific attitude of agricultural insurance contracting developed by these farmers has been analyzed. An analysis of existing risk management strategies and tools nowadays has been made, analyzing their utility, their effectiveness and their level of implantation in each case. Furthermore, the opinion that the farmers have about the Spanish system of agricultural insurances has been analyzed. Thus, aspects like the levels of hiring, the predisposition to sign, the hiring of the different products by organic farmers, etc. have been studied.

The quantification of the incidence that the different risks identified through the surveys have on most representative organic productions of our country has been made in this phase. The objective has been to value the level of risk which the cultivations are exposed, as well as the capacity of these to react before the incidence of any risk or catastrophe, based on the probability that they have to obtain income as well as the quantity of it (LIEN et al., 2006).

With the purpose of analyzing with higher detail the probability of occurrence of the risks, a comparison of the incidence that different risks have between organic and conventional cultivations has been made, using data from experimental cultivations. Three studies of comparative risk analysis between organic and conventional production have been made, including cereal productions, vineyard and olive grove pertaining to cultivations located in the regions of Valladolid and Toledo as it can be seen in Figure 1.

Fig. 1. Space location of the experimental cultivations

The data have been used to define a model that explains the economic yield of the cultivations in absence of public aids. This model has been developed from the empirical data of prices, yields and direct costs of production (sowing, prunes, working, etc.), according to the expression: Profitability = Income - Expenses, or what is the same:

Value added (prices of market) (€/ha) = [Price (€/kg) x Yield (kg/ha)] - Production costs (€/ha)

It has been possible to compare the distribution of the probability of obtaining benefits that organic and conventional cultivations have comparatively, based on the productive variability of their main components as yields, sale prices of different products and direct costs used in each case.

In order to obtain the distribution functions, the method used has been the stochastic generation from a variable considered as the source of the inherent risk to the agricultural production. The selected variable is the income obtained by the agricultural activity according to the type of production (organic or conventional). The method followed in the stochastic generation of the synthetic series of data has been the Monte Carlo simulation that has been widely used to create great series of data from temporary series of

observed limited data (ROBERT AND CASELLA, 1999).

In agriculture, this method has been used to characterize the statistical properties of the costs, prices, or yields like answer to external factors (IGLESIAS AND QUIROGA, 2006; BIELZA, 2006; GIBBONS and RAMSDEN, 2005; LOBELL and ORTIZ-MONASTERY, 2006; LIMAYE et al., 2004). The characterization of the distribution functions of the yields of cereal, olive grove and vineyard allows us to be able to establish the levels of risk for each one by kinds of production (organic or conventional).

In this case, Monte Carlo method has been applied to obtain distribution functions of the income perceived by farmers, consisting in a synthetic generation of variable series being used a Latin sampling Hypercube sampling method (JUST and WENINGER, 1999; ATWOOD et al., 2003). Monte Carlo simulations are an important component of calculation of probabilistic risk and uncertainty, since it allows generating random series of statistical distributions (ROBERT AND CASELLA, 1999). The technique Latin hypercube (MCKAY et al., 1979) is a variant of the technique of Monte Carlo simulation that uses a fixed combination of data used when the dependent variable (y) is function of a series of variables (x_1, x_2, ..., x_n) like in the example of the obtained rent.

In the present study, distribution functions used in the model have been "extvalue" in the case of yields and prices and "lognormal" in the case of the direct costs of production under criteria of allocation of functions that the computer program used develops (@risk). The number of made iterations has been 5000. Thanks to this kind of analysis, the quantification of the risks incidence identified on each production by means of the economic viability of them can be reached. This quantification is based on different levels of risk which these productions must face. So risk factor of each one can be obtained and a comparison between the different cultivations that allows us to value this risk of comparative form can be made.

Finally, a revision of the different techniques that are being applied at the moment outside the cultivations to manage the risk has been made. In addition, also the opinion of farmers and professionals of other countries has been analyzed on the matter (HANSON, 2004; MADGE, 2005). Furthermore, the viability of the techniques of insurance in this kind of productions has been analyzed from the results that are being obtained in the rest of productions of our country. In addition, risks for which the usual practices of risk management in organic farming are insufficient and therefore it is precise to apply new strategies, have been determined.

III. RESULTS

Comparative economic analysis of organic cultivations compared with the conventional ones: field test

After risk perception, potential vulnerability and others have been studied, a comparative study of the economic viability of real cultivations that share identical productions in organic and conventional has been made. So it has been introduced the temporary variable in the study for value the behaviour of the different cultivations throughout the years. In table 4 the statistical description of each one of the variables considered in the model for each production is detailed (cereal, olive grove and vineyard).

Table 4 Statistical description of the data used in the model

	Mín	Máx	Average	Standard Dev.	Asimetry		Curtosis	
	Estad.	Estad.	Estad.	Estad.	Estad.	Error típico	Estad.	Error típico
CC_Price_€_kg	,1156	,1334	,1225	,0054	,875	,717	,726	1,400
CC_Costs_€_ha	302,36	539,20	424,39	60,98	-,211	,717	3,102	1,400
CC_Yield_kg_ha	1408,98	3412,19	2443,73	586,30	-,013	,717	,478	1,400
CE_Price_€_kg	,1685	,2140	,1864	,01488	,906	,717	,108	1,400
CE_Costs_€_ha	262,58	303,55	282,67	14,04	,061	,717	-1,201	1,400
CE_Yield_kg_ha	1500,00	2200,00	1936,66	202,11	-1,095	,717	2,390	1,400
OC_Price_€_kg	,3338	,6227	,4755	,1098	,266	,687	-1,753	1,334
OC_Costs_€_ha	373,13	518,36	457,96	55,13	-,587	,687	-1,246	1,334
OC_Yield_kg_ha	477,00	1833,24	1108,96	448,32	-,020	,687	-1,235	1,334
OE_Price_€_kg	,4006	,7472	,5706	,1318	,266	,687	-1,753	1,334
OE_Costs_€_ha	291,04	404,32	357,20	43,00	-,587	,687	-1,246	1,334
OE_Yield_kg_ha	73,0083	2558,76	882,76	896,04	,822	,687	-,690	1,334
VC_Price_€_kg	,2193	,6965	,4031	,1558	,821	,687	,138	1,334
VC_Costs_€_ha	761,37	1057,70	934,45	112,49	-,587	,687	-1,246	1,334
VC_Yield_kg_ha	3666,40	6895,68	5360,23	1186,08	-,047	,687	-1,551	1,334
VE_Price_€_kg	,2631	,8358	,4838	,1870	,821	,687	,138	1,334
VE_Costs_€_ha	779,32	1082,62	956,47	115,14	-,587	,687	-1,246	1,334
VE_Yield_kg_ha	2071,36	6712,00	4532,06	1375,46	-,242	,687	-,250	1,334

CC: Conventional barley, EC: Organic barley; OC: Conventional olive; OE: Organic olive; VC: Conventional vineyard; VE: Organic vineyard

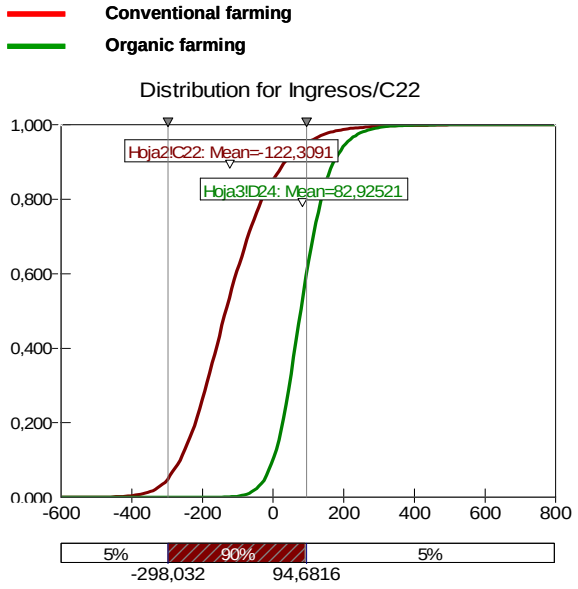
It has been verified that most of the times, productive yields are lower in organic production systems that in conventional ones. Nevertheless, at the same time, it has been observed that the variations or oscillations of yields and prices are quite smaller in organic productions than in conventional ones. This fact, together with the higher value than organic products have in the market, causes that in some cases organic cultivations are more viable economically than conventional ones.

From the experimental data of these cultivations, the distribution functions have been obtained by their stochastic generation from a considered variable like the source of the inherent risk to the agricultural production. The selected variable is the profit (income less direct costs) obtained by the agricultural activity according to the type of production (organic or conventional).

First case contemplates an example of culture of barley in a cultivation situated in the region of Valladolid (Castilla y León). As it is possible to be observed in table 4, the existing difference as far as the asymmetry analysis demonstrate the smaller direct costs of production of organic and conventional barley in this cultivation, which is a determining factor in the economic result of this cultivation. Similarly, it is clear that yields in conventional barley are higher, whereas prices are lower.

As it is possible to be observed in figures 2 and 3, the analysis made by Monte Carlo simulations demonstrates the higher probability that organic barley cultivations have compared with conventional ones. In the axis of the "x" is represented the value of the profit (€/hectare) that can be obtained in each productions in absence of amortizations and aids to the production in equality of conditions. In the axis of "y" is represented the probability that both production systems have to obtain profits in the same conditions. As it is possible to be observed, the cultivation of organic barley, represented in green, has a higher probability of obtaining profits than the conventional one, represented in red.

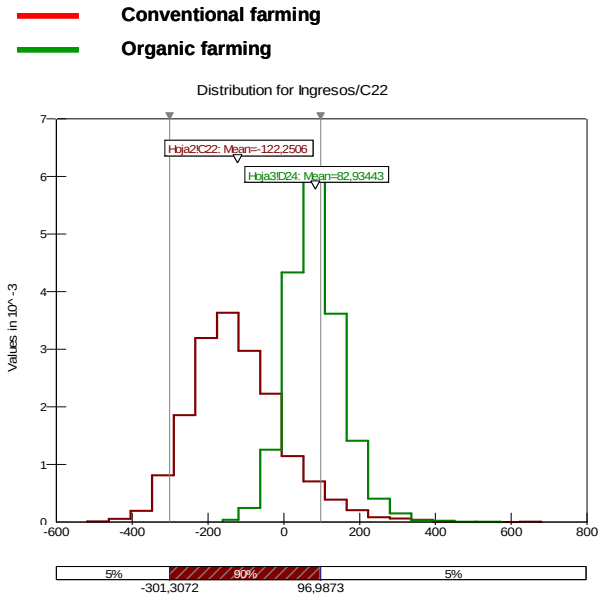
Fig. 2. Probability of obtaining and quantity of the profit obtained in the cultivation of organic and conventional barley: Cumulative curve



In the histogram pertaining to the production of organic barley, a higher leptokurtosis is observed, which indicates a smaller variability of the results of

the model and, therefore, a smaller risk of obtaining a bad economic result in the cultivation.

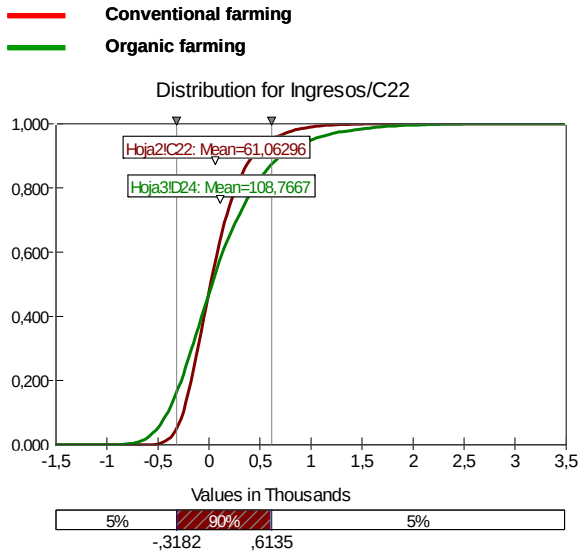
Fig. 3. Probability of obtaining and quantity of the profit obtained in the cultivation of organic and conventional barley: Histogram



In the second case, an identical test has been made in an olive grove cultivation located in a dry land situated in the region of Toledo. It can be deduced from the results of table 4 that, in the case of the olive grove, the smaller differences that the analysis of the asymmetry of direct costs of production, demonstrate that these costs do not lodge so many differences as in the case of the barley. Nevertheless, there are some differences in the yields which are a bit higher than in the case of the barley, like it happens with the data of prices.

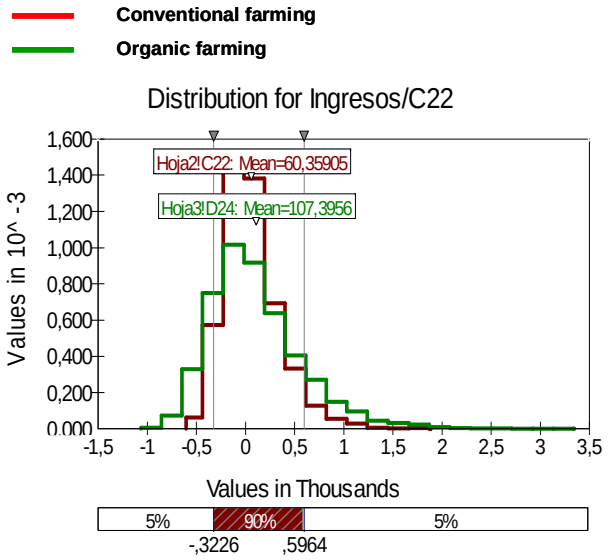
As it is possible to be observed in figures 4 and 5, the differences between the probability of obtaining profits between the organic system and the conventional one, are more reduced than in the previous case. Even considering the differences of prices perceived by organic farmers (20% higher), the yields and the production costs of the dry land olive grove (organic and conventional) make the profitability of both productions almost equal in absence of aids. Even so, in the figure it is possible to not how the probability of obtaining income superior to 0 is similar in cultivations of organic and conventional olive grove. Nevertheless, these results emphasize that perceived average income in cultivations of organic olive grove, in absence of aids are similar than conventional ones.

Fig. 4. Probability of obtaining and quantity of the profit income obtained in the organic and conventional cultivation of olive grove: Cumulative curve



In the histogram pertaining to the production of organic olive grove a higher leptokurtosis is observed, reason why exists a smaller variability in the obtaining of profits and, therefore a smaller risk of obtaining a bad economic result in the cultivation.

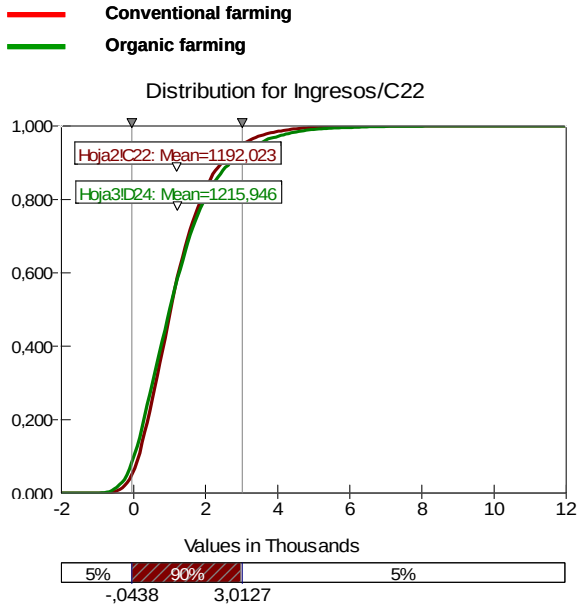
Fig. 5. Probability of obtaining and quantity of the profit obtained in the cultivation of organic and conventional cultivation of olive grove: Histogram



Last case of present study has been made in a cultivation of vineyard in a dry land situated in the region of Toledo. The existing differences of productive yields between organic and conventional vineyard productions of this cultivation are clearly compensated because of the higher quantity of the prices perceived by the organic grape and the similarity of direct costs of production.

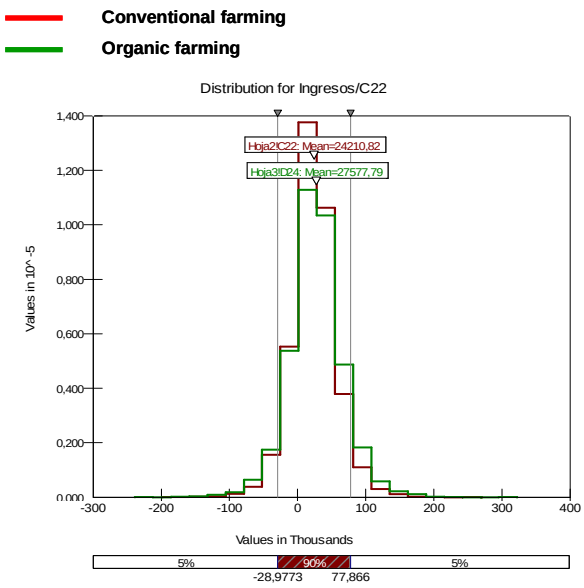
As it is possible to be observed in figures 6 and 7, the probability of obtaining profits in this cultivation of organic and conventional vineyard is practically identical. It is important to consider that the average profit obtained in the cultivation is considerably higher than in both cases studied previously. In addition, in this case, direct costs of production are more reduced than those of the culture of olive grove.

Fig. 6. Probability of obtaining and quantity of the profit income obtained in the cultivation of organic and conventional vineyard: Cumulative curve



The curtosis analysis throws almost identical results in both productions, reason why it can be deduced that, in this cultivation, the economic variability is similar so risk faced is very similar.

Fig. 7. Probability of obtaining and quantity of the profit obtained in the cultivation of organic and conventional vineyard: Histogram



Different productions, on the different handlings, the irrigation, on the economic balance of the different organic and conventional cultivations can vary considerably.

Strategies of risk management in organic farms

Nowadays numerous strategies exist at the disposal of farmers to manage the risk of their agricultural cultivations. These strategies can be very different, either they are developed in the same cultivation or outside it either they are related with the production or with market, etc. The strategies that organic farmers follow differ a lot from those used by conventional ones, mainly, because of the nature of the different used productive systems in each case. In addition, the tools available for risk management which they can use differ so much, aspect analyzed in the present section.

Most of the existing strategies nowadays for the risk management in cultivations of organic agriculture and the stabilization of the rents of the farmers, are developed by they themselves within the own cultivation. The culture of species of opened pollination for obtaining of own seed resistant to diseases and pests, the introduction of variability by means of the crossing with traditional seeds, the delayed plantation to diminish the risk of frosts, the accomplishment of adapted irrigations, the rotation of cultures and the diversification of cultures, varieties and dates of sowing, are some of the most habitual examples.

As it can be observed in table 5, most of organic farmers with a high level of diversification in their cultivations, aware a lower level of climatic risks. Furthermore, those farmers with a low level of diversification in their farms affirm that have a high level of pest and diseases in their cultivations.

Table 5 Climatic risk importance against diversification strategies

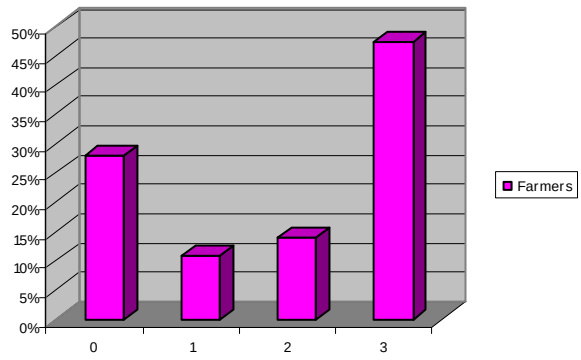
Cuantificación riesgos de origen climático	Índice de diversificación estratificado 2	3	4	Total
40	1 0.34	1 0.34	2 0.69	4 1.38
50	0 0.00	0 0.00	1 0.34	1 0.34
60	7 2.41	4 1.38	3 1.03	14 4.83
70	8 2.76	8 2.76	8 2.76	24 8.28
80	26 8.97	11 3.79	11 3.79	48 16.55
90	33 11.38	16 5.52	14 4.83	63 21.72
100	26 8.97	14 4.83	16 5.52	56 19.31
110	26 8.97	6 2.07	12 4.14	44 15.17
120	15 5.17	13 4.48	8 2.76	36 12.41
Total	142 48.97	73 25.17	75 25.86	290 100.00

Nowadays, the use of external strategies of risk management like vertical integration in organic productions, the markets of agricultural futures, etc.

becomes very difficult because of the reduced size of the cultivations and the limited development of the sector. Nevertheless, in Spain there is a great tradition and formation in agricultural insurances. Organic farmers do not have specific products designed to be able to cover own risks in these productions, although there are many of them that have signed an agricultural insurance last years, which demonstrates certain insurance culture of these farmers.

100% of polled organic farmers know the system Spanish agricultural insurances system. A high percentage of them have signed to the agricultural insurance in the last 3 years (72%). As it is possible to be observed in figure 13, organic farmers affirm that they have signed an agricultural insurance three last years at least once (47%).

Fig. 8. Number of years that organic farmers have taken out an agricultural insurance



As it can be observed in tables 6 and 7, a high level of climatic risk perception does not condition the agricultural insurance contracting decision. However, a high level of pest a disease risk perception is directly related with agricultural insurance contracting decision

Table 6 Climatic risk importance for farmers and insurance contracting

Número de años que ha contratado el seguro de los últimos 3	Cuantificación riesgos de origen climático							
	40	60	70	80	90	100	110	120
0	2 0.81	2 0.81	9 3.66	13 5.28	12 4.88	14 5.69	10 4.07	11 4.47
1	0 0.00	2 0.81	2 0.81	4 1.63	5 2.03	4 1.63	4 1.63	5 2.03
2	0 0.00	1 0.41	4 1.63	4 1.63	8 3.25	7 2.85	8 3.25	2 0.81
3	0 0.00	7 2.85	6 2.44	19 7.72	31 12.60	20 8.13	16 6.50	14 5.69
Total	2 0.81	12 4.88	21 8.54	40 16.26	56 22.76	45 18.29	38 15.45	32 13.01

Pearson chi2(21) = 16.9821 Pr = 0.712

Table 7 Cultivation risks importance for farmers and insurance contracting

Número de años que ha contratado el seguro de los últimos 3	Cuantificación riesgos de cultivo					Total
	20	30	40	50	60	
0	9 3.54	5 1.97	22 8.66	9 3.54	29 11.42	74 29.13
1	5 1.97	1 0.39	11 4.33	2 0.79	8 3.15	27 10.63
2	7 2.76	2 0.79	4 1.57	1 0.39	21 8.27	35 13.78
3	36 14.17	5 1.97	31 12.20	11 4.33	35 13.78	118 46.46
Total	57 22.44	13 5.12	68 26.77	23 9.06	93 36.61	254 100.00

Pearson chi2(12) = 22.8235 Pr = 0.029

These farmers affirm that insurance premiums must be adapted to the specific risks that organic productions have and new risks as the contamination by plant protection products, the contamination by organisms modified genetically, etc. must be included. In general, they think that the existing products would have to be developed transitorily, although they do not agree with which they would be the high-priority ones.

IV. CONCLUSIONS

The practice of organic farming tries to emulate the natural diversity of natural ecosystems and the biological level of diversity that confers higher stability to the agro-system, allowing a higher flexibility of answer against productive risks like pests and diseases or climatic risks like drought or frosts. This causes that many organic cultivations have a smaller vulnerability against climatic risks and, in

special, against to risks derived from the behaviour of the agro-alimentary markets, reasons these that could justify a higher public support of the institutions to the development of this kind of farming.

Productive yields are lower in most of organic production systems that in conventional ones, it has been observed that the variations of yields and prices are much smaller in productions dedicated to organic farming. Furthermore, higher prices that organic products have in the market cause that in many cases, organic and conventional cultivations have at least the same economic viability than the conventional ones. It is important to note that in cereal productions of some dry land zones, where without public aids is more profitable the organic production than the conventional one. In other studied cultivations like olive grove and vineyard it is not possible to affirm the same because the results are very similar in organic and in conventional productions.

Most of the existing strategies nowadays for the risk management in cultivations of organic agriculture and the stabilization of the rents of the farmers, are developed by they themselves within the own cultivation. Nevertheless, these techniques are not always enough to manage all risks in productions with continuous growth, especially climate risks. This is the reason for develop another kind of tools for risk management as the agricultural insurances which can be useful to guarantee the stability of the rents of these organic farmers, especially in those countries as Spain where these insurance products are developed.

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