Analysing Farmers' Decision-Making Process Face to the Mid-Term Review of Common Agricultural Policy in the Alentejo Dryland Region of Portugal

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Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Providence, Rhode Island, July 24-27, 2005

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Abstract:

This paper describes an experiment that was carried out in order to examine the decision making process of farmers in the Alentejo dryland region of Portugal.

Cumulative Prospect Theory allows modeling the Alentejo dryland farmers' decision process, because when they decide what crops and livestock activities will produce the different results are appraised relatively to the initial wealth, which permits its appraisal in terms of gains and of losses.

An inquiry is developed to study the Alentejo dryland farmers' preferences, which intend to determine risk preferences through a set of games. A discrete sequential stochastic programming model is developed to examine farmers' decision-making process face to the mid-term review of the Common Agricultural Policy. The objective function, that maximizes the total value of the game, portrays the farmers' behavior face to risk and it is constituted by the set of functions (value function and probability weighting function) ranked upward. The total value of the games will be given by the sum of the positive and negative components.

Model results show that Cumulative Prospect Theory portrays the Alentejo dryland farmers' decision-making process quite well. All the farmers produce durum wheat as main agricultural production and choose the maximum of number of cattle heads and sheep herds. The full decoupling of income payment from agricultural production leads to the abandonment of the durum wheat production. The beef cattle farmers keep their production and the sheep farmers reduce their herds drastically. The introduction of 50% of sheep premium, proposed by the Portuguese Government, raises sheep production, accompanied of the increase of the pasture area. These results permit to conclude that the Portuguese Government's proposal is sufficiently cautious because, on the one hand, when associating to 100% of suckler cow premium allows the use of the shares negotiated with European Union in 2003 and when associating to 50% of sheep premium permit the maintenance of sheep herd. On the other hand, the Portuguese Government's proposal of crop subsidies not linked to agricultural production forces the farmers to choose alternative agricultural activities in the bad soils. Finally, the introduction of the area crop-yield insurance program associated with the new Common Agricultural Policy is an interesting alternative for the Alentejo dryland farmers, because the new Common Agricultural Policy only secure a minimum farm income level, while the insurance program permits making face to agricultural production variability and avoids the abandonment of the agricultural activity.

KEY WORDS: Cumulative Prospect Theory, Discrete Sequential Stochastic Programming Model, Risk Preferences, The Common Agricultural Policy

JEL CLASSIFICATION: C65, D81

1 - Introduction

This paper intends to know, to characterize and to identify the farmers' behavior and to analyze the introduction of the area-yield crop insurance program in the Alentejo dryland region of Portugal, face to the emerging reality for the mid-term review of the Common Agricultural Policy.

The review of the Common Agricultural Policy determined that some subsidies can be substituted by a sole payment by farm, that will always be received by the farmers even though they produce or not. The farmers will start deciding what crop and livestock activities will produce based on climate and soils conditions and on the signals revealed by the market. The farmers start to face the sole payment as an additional compensation to farm income. If the conditions are not propitious, it can lead to the decrease or even to the abandonment of the agricultural activity. The Prospect Cumulative Theory allows to model the farmers' behavior face to the mid-term review of the Common Agricultural Policy, because when defining that the different results are appraised relatively to the initial wealth, it permits an evaluation in terms of gains and of losses. When defining a concave function for gains and a convex function for losses, this theory permits the existence of risk aversion behavior for gains and of risk seeking behavior for losses.

The problem of this research work is the decrease of the agricultural production on the part of the farmers face to the mid-term review of the Common Agricultural Policy. The farmers will stop making agricultural production decisions with base in subsidies. They will start to decide with base in the climate conditions and in the signals revealed by market.

This research work has three objectives. The first objective seeks to characterize and to model the farmers' behavior before the beginning of the mid-term review of the

Common Agricultural Policy. The second objective intends to study the farmers' behavior, when confronted with the introduction of full and partial decoupling of income payments from agricultural production proposed by the mid-term review of the Common Agricultural Policy, what force the farmers to make their decisions according to the signals revealed by the markets. The third objective analyses the farmers’ behavior face to the introduction of the area-yield crop insurance program.

A discrete sequential stochastic programming model is developed to study those objectives and the decision making process in the Alentejo dryland region. The objective function, that maximizes the total value of the crop and livestock activities, portrays the farmers’ behavior face to risk. This model is constituted by a set of functions (the value function and the probability weighting function) differentiated for gains and for losses, in that the total value of the game will be given by the addition of the positive and negative components. The set of constraints describes the environment in which the farmers developed their crop and livestock activities in all their components: production, financial, commercial and taxes. The model has five nature states, elaborated in agreement with the expected value of crop and livestock production.

The main information source for the construction of this model was obtained through the interviews to a set of farmers in the Alentejo dryland region. These interviews, besides they intended to determine the attitudes face to the farmers' risk, allowed to collect farm data to develop those mathematical programming models. The determination of the farmers' individual preferences, through the application of a questionnaire, allowed to collect data to apply the Prospect Cumulative Theory.

2 - Methodology

Kahneman and Tversky presented a choice model called Prospect Theory in 1979, that explains the violations of the Expected Utility Theory for choice among games with a reduced number of results. Later Quiggin proposed a new representation of the probabilities in 1982, that instead of transforming each probability separately, it transforms the cumulative probability function. Face to the scientific advances during the 80' s, Tversky and Kahneman developed a new version of the Prospect Theory, which they called Cumulative Prospect Theory. This theory incorporates cumulative probability functions, it extends Prospect Theory to the ambiguity and it allows its application to games with any number of results. The criticism formulated to the old theory is resolved through the inclusion of cumulative probability functions that avoid the choice of dominated solutions.

The value function has the following characteristics: (i) defined for alterations starting from the reference point; (ii) concave for gains and convex for losses; (iii) more sloping for losses than for gains. This research work used an adaptation of Tverky & Kahneman value function (1992). The decision weights are defined in a cumulative way and depend on the probability weighting function that captures psychologically the distortion of the probabilities on the part of the decision makers. This research work used a two parameters function as Gonzalez & Wu (1999). This authors affirm that this function allows to portray two behaviors of the decision maker: (i) diminishing sensitivity; (ii) attractiveness. The property of diminishing sensitivity presented by Tversky and Kahneman means that the people become less sensitive to alterations in the probabilities as they stand back of the reference point. In agreement with the principle diminishing sensitivity, increases close to the extreme points of the scale of probabilities have larger effects than increases in the intermediate points of the scale. The sensitivity to alterations in the probabilities decreases as the probabilities stand back of the reference point, what suggests that function is an inverse-S-shape. The "step function" shows smaller sensitivity to alterations of the probabilities than the quasi-linear function, except close to the extreme points 0 and 1. The probability weighting function can be completely below or completely above the identity line or it can cut the identity line in any point. The higher is the function the greater is attractiveness of the game. González and Wu refers that this concept can be applied to the assessment of a game by two individuals in that one attributes a larger consideration than other for finding the game more attractive.

A discrete sequential stochastic programming model is developed to study the decision making process in the Alentejo dryland region. This model that describes the risk behavior of the farmers in the Alentejo dryland region has five states of nature, developed in agreement with the expected value of crop and livestock production. The objective function describes the risk behavior of the farmers in agreement with the Cumulative Prospect Theory. This model is constituted by a set of functions (value function and probability weighting function) differentiated for gains and for losses, in that the total value of the game will be given by the addition of the positive and negative components of the game. The set of constraints describes the environment in that the farmers developed their crop and livestock activities in all their components: production (crop and livestock activities), financial, commercial and taxes. The different alternatives (games), derived from farmer decisions, are assessed through the following model, with $-m \leq i \leq s$:

$$\text{Max } V(y) = \sum_{i=-m}^{0} h_i^{-} v(x_i) + \sum_{i=0}^{s} h_i^{+} v(x_i) \tag{1}$$

subject to:

$$x_i \in F_D \tag{2}$$

where:
V– value of the game;
y – alternatives (games);
h – decision weights;
v – value function;
F_D – opportunity set;
x_i – results by state of nature; and,
s – number of states of nature (-m,..., s).

The games will be assessed through the following expression (Tversky and Kahneman, 1992):

$$V(y) = V(y+) + V(y -) \tag{3}$$

where:
V– value of the game; and,
y – game.

The positive and negative components of the game are determined by the following expressions, with $-m \le i \le n$:

$$V(y^{+}) = \sum_{i=1}^{n} h_i^{+} v(x_i) \text{ and } V(y^{-}) = \sum_{i=-m}^{0} h_i^{-} v(x_i) \tag{4}$$

where:
h– decision weights;
v– value function; and,
x– results.

The value function has the following characteristics: (i) defined for alterations starting from the reference point; (ii) concave for gains ($v''(x) < 0$, for $x>0$) and convex for losses ($v''(x)>0$, for $x < 0$); (iii) more sloping for losses than for gains. This function is an adaptation of the function proposed by Tversky and Kahneman in 1992 and in agreement with to present theory and it is the necessary and sufficient conditions to represent v(x) through the following function:

$$v(x_i) = \begin{cases} \lambda_1 \, x_i^{\omega_1} & \text{if } \; 0 \le i \le s \\ -\lambda_2 \, (-x_i)^{\omega_2} & \text{if } -m \le i < 0 \end{cases} \qquad (5)$$

where:
v– value function;
x_i – results; and,
λ_1, λ_2, ω_1, ω_2 – function parameters.

The parameter λ does not have any effect on the curvature of the function, given that this parameter is only responsible for the utility scale (González and Wu, 1999).

The decision weights (h_i) are defined in a cumulative way through the following expressions:

$$h_s^+ = f^+(p_s) \text{ and } h_i^+ = f^+\left(\sum_{i}^{s} p_i\right) - f^+\left(\sum_{i+1}^{s} p_i\right), \qquad 0 \le i \le s-1 \qquad (6)$$

$$h_{-m}^- = f^-(p_{-m}) \text{ and } h_i^- = f^-\left(\sum_{-m}^{i} p_i\right) - f^-\left(\sum_{-m}^{i-1} p_i\right), \qquad 1-m \le i \le 0 \qquad (7)$$

where:
p – probabilities;
f^+, f^- – probability weighting functions; and
h_s and h_m – decision weights.

The value of the decision weights depends on the probability weighting function, that captures psychologically the distortion of the probabilities on the part of the decision makers. The probability weighting functions f^+ and f^- are strictly increasing inside of the interval [0, 1], with $f^+(0) = f^-(0) = 0$ and $f^+(1) = f^-(1) = 1$. They have been the functions used to represent the probability weighting function that should have the inverse-S-shape. This work used the following function of two parameters:

$$f(p) = \frac{\delta \; p^{\gamma}}{\delta \; p^{\gamma} + (1-p)^{\gamma}} \qquad (8)$$

where:
f– probability weighting function;
p–probabilities;
γ - Parameter that represents the curvature; and,
δ - Parameter that represents an upward.

The objective function is obtained through the elicitation near the decision makers that allow to estimate different functions. For elicitation of the value function was used “trade-off” method (Wakker and Deneffe, 1996). The application of this method to the Cumulative Prospect Theory requires the extraction of two functions, because it is necessary to bid to positive component and negative component of the value function. Then, it is necessary the development of two sets of different questions. For the probability weighting function was used the certainty equivalent method. The application of this method to Cumulative Prospect Theory suffers some alterations, because to determine the value of the decision weights, it is necessary to know the value function. The obtained certainty equivalent is substituted in the following equality:

$$V(CE) = h_1\, v(x_H) + h_2\, v(x_L), \text{ com } x_H > x_L \qquad (9)$$

As $h_1 = f(p_1)$ and $h_2 = f(p_2+p_1) - f(p_1) = 1 - f(p_1)$, solving in order $f(p_1)$, it is obtained the following identity:

$$f(p_1) = \frac{v(CE) - v(x_L)}{v(x_H) - v(x_L)} \qquad (10)$$

The function value that was estimated previously, doesn' t need the knowledge of the decision weights to determine its value. Substituting in the previous equation the value function (equation 3) and given that $x_L = 0$ in the elicitation of the certainty equivalent, then $f^+(p)$ and $f^-(p)$ are calculated by the following expressions:

$$f^+(p) = \left(\frac{CE_1}{x_1}\right)^{\omega_1} \quad \text{and} \quad f^-(p) = \left(\frac{CE_2}{x_1'}\right)^{\omega_2} \qquad (11)$$

where:
f^+, f^- – probability weighting function for positive and negative values;
p – probabilities;
CE_1, CE_2 – positive and negative certainty equivalents;
x_1, x_1'– positive and negative results; and,
ω_1, ω_2 – parameters of the value function.

The probability weighting function is estimated by the confrontation of the probabilities presented above to the decision makers with the resulting values calculated by the above formulas. The elicitation process is independent of the value function and of the decision weights used in this research work that was recommended by Quiggin (1993) and used by Bouzit and Gleyses (1996) for estimating the functions of the rank-dependent Expected Utility.

The answer to the first objective, that seeks to characterize the farmers' behavior before the beginning of the mid-term review of the Common Agricultural Policy, is obtained by the development of a mathematical programming model for each farmer for the 2001/2002 marketing year. The answer to the second objective requires the introduction of decoupling issues of the mid-term review of the Common Agricultural Policy in each one of the mathematical programming models relative to each farmer to analyze farmer's behavior with respect to full and partial decoupling of income payments from agricultural production. It is possible to verify that the implementation of full decoupling of income payments from agricultural production should drive to the decrease of the agricultural production, that can be softened with the implementation of some of the alternatives of the partial decoupling of income payments from agricultural production. The answer to the third objective, that analyzes the farmers' behavior of the farmers, requires the introduction of the area-yield crop insurance program in each one of the mathematical programming. Face to the foreseeable decrease of the agricultural production, the introduction of this insurance program allows an increase of agricultural production, constituting an alternative to partial decoupling of income payments from agricultural production. Ideally, the sole payment should be reduced in agreement with the contribution of the Portuguese government for the premium rate. The results analysis obtained by the mathematical programming models, through the Prospect Cumulative Theory, allows to conclude about the acceptability of this insurance program in complement with the sole payment by the farm.

The basic validation criteria considered in this research are the assessment of the model conceptualization to portray each farm and the comparison with farm characteristics or with observed changes in farm production patterns at the Alentejo dryland region. Secondly, sensitivity analysis is used to compare model results against farm characteristics or observed changes in farm production patterns in the Alentejo dryland region.

3 - Data and Information

The development of a mathematical programming model is extraordinarily demanding in terms of data. The data and information can be divided in general data for each one of the farms as well as specific data to each one of the farms. There are many data sources from studies and research works, Government agencies and European Union. A lot of information was collected in contacts with researchers and technicians in crop and livestock production. It was necessary to get information about the climatic conditions to define the states of nature and to obtain the occurrence probabilities of each one of them. It was defined a set of crop activities (contained in rotations) and livestock (beef cattle and sheep activities), whose costs were estimated in agreement with the methodology of the Farming Accounting Data. The soils were divided in three categories according to its productivity. Three technologies of beef cattle production were considered and two technologies of sheep production. The time period is divided in five periods of animal feeding, that they are related with the annual distribution of the dryland pasture production and with variations of its nutritional value in the Alentejo dryland region. It was considered the farmer' s possibility to finance his own farming activity with equity and with borrowed and purchased funds. There is also considered a tax on the farm income.

The specific data of each one of the farms were obtained through interviews. These interviews allowed to obtain specific agricultural data of each one of the farms such as: area, soil types, crop and livestock technologies, agricultural machinery, agricultural labor and perception face to the risk. It was in the interviews that they were obtained the attitudes face to the risk, through the elicitation of the value function and of the probability weighting function.

The inquiry shows that the farmers are extremely dependent of crop production, namely of the durum wheat. All the farmers produce durum wheat in the largest possible area, because it is the crop activity with the largest subsidy value by hectare.

The interviews were accomplished for thirty five farmers and it was possible to elicit values for the estimation of the value function and probability weighting function for nine farmers. The data for these nine farmers are represented in the table 3.1.

Table 3.1 - Farm Characteristics

Descriptions	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8	Farm 9
				Agricultural Area					
Total area	1200	660	180	570	600	200	260	1020	550
Cultivated area	1160	360	150	300	480	200	260	620	550
Pastures areas	40	300	30	270	120	-	-	400	-
Good Soils		60							150
				Livestock Production					
Beef cattle	400	150	90					450	
Sheep				100	600				
				Farm Income					
The best	150.0	100.0	40.0	100.0	100.0	30.0	50.0	125.0	60.0
Normal	75.0	50.0	20.0	25.0	15.0	5.0	10.0	75.0	25.0
The worst	-100.0	-50.0	-20.0	-50.0	-75.0	-25.0	-40.0	-75.0	-35.0

Notes: Areas in hectares, Livestock production in animal units and farm income in thousands of Euros.
Source: Data collected by inquiries.

The analysis of the table 3.1 allows to verify that three of the farms do not have any livestock production, two of them produce sheep and four of them produce beef cattle. These results will be used as a limit superior and a limit inferior in the estimation process of the value functions and the probability weighting functions.

4 - Results

The estimation of the parameters of the objective function is a difficult process, because it is necessary to estimate four different functions (two value functions and two probability weighting functions). The results are presented in table 4.1. The parameters λ_1 and λ_2 do not have any effect in the curvature of the value function, they have influence on the utility scale. The aversion to the losses among farmers is compared through the λ_2/λ_1 ratio. The aversion to the losses is practically inexistent for decision makers of farms 2 and 3. The highest value is found for decision makers of farms 1 and 8. The aversion value to the losses is 1.87, what it is identical to the value obtained by Tversky and Kahneman (1992).

Table 4.1 - Parameters of the Value Function

Farms	λ_1	ω_1	λ_2	ω_2	λ_2 / λ_1
1	0.3927	0.6150	1.5202	0.4157	*3.87*
2	0.7522	0.5267	0.8242	0.5518	*1.10*
3	2.4550	0.3785	2.6771	0.3632	*1.09*
4	0.6060	0.5722	1.0497	0.4800	*1.73*
5	0.7402	0.5069	1.0549	0.5112	*1.43*
6	1.7967	0.4328	2.4738	0.4425	*1.38*
7	1.4796	0.4629	2.2301	0.3044	*1.51*
8	0.4683	0.6215	1.6270	0.3869	*3.47*
9	1.5488	0.4346	1.9669	0.3980	*1.27*
Arithmetic mean		*0.5057*		*0.4282*	*1.87*

Source: Model results

The parameters ω_1 and ω_2 are related to the curvature of the value functions (Table 4.1). If these values are analyzed separately, they can be interpreted has an aversion measure to risk. The positive part of the value function means that the closer of 1 the values are, the smaller the risk preference is. While the negative part of the value function represents that the close of 1 the values are, the larger the risk preference is. The parameter of the positive part of the value function (ω_1) vary between 0.3785 and

0.6150. This means that the decision maker of the farm 3 presents larger aversion to the risk than the decision maker of the farm 8. For the negative part of the value function (ω_2), the parametrs vary between 0.3044 and 0.5518. This means that the decision maker 7 presents larger risk preference for negative results than the decision maker 2.

This analysis assumes that the value function is independent of the probability weighting function, what it is not true. The Cumulative Prospect Theory works for the whole and a good part of the risk aversion behaviors are explained by the probability weighting function. The parameters of the value functions are used later to estimate the probability weighting functions, whose values are represented in the Table 4.2.

Table 4.2 - Parameters of the Probability Weighting Function

Farms	Positive function		Negative function	
	δ_1	γ_1	δ_2	γ_2
1	1.2407	0.5584	1.3280	0.3627
2	1.1619	0.5762	0.7262	0.6728
3	1.2930	0.3629	1.7574	0.5154
4	0.9341	0.6956	1.4751	0.5969
5	1.4149	0.6600	0.7753	0.6612
6	1.9035	0.5839	1.0478	0.4886
7	1.3532	0.5720	1.5046	0.3766
8	1.0159	0.5155	1.3549	0.4936
9	1.3788	0.4948	1.0584	0.4511
Arithmetic mean	*1.2728*	*05452*	*1.1900*	*0.4938*

Source: Model Results

The parameters γ_1 and γ_2 are related to the concept of diminishing sensitivity. In agreement with this concept increases close the extreme points of the scale of probabilities have larger effect than increases near the intermediate points of the scale. The smaller curvature the larger sensitivity to the probabilities. These parameters should vary between 0 and 1 only that one exists an overweighting of the low probabilities and an underweighting of the high probabilities. The parameter of the probability weighting function for the positive results (γ_1) varies between 0.3629 for the decision maker of the farm 3 and 0.6956 for the decision maker of the farm 4. The parameter of the probability weighting function for the negative results (γ_2) varies between 0.3627 for the decision maker of the farm 1 and 0.6728 for the decision of the farm 2.

With respect to the parameters δ_1 and δ_2, its interpretation is associated to the concept of attractiveness of the game. In agreement with this concept the most attractive for the decision maker is the game the most weighting he allocates it. For the probability weighting function of positive results (δ_1), this parameter varies between 0.9341 for the decision maker of the farm 4 and 1.9035 for the decision maker of the farm 6. For the probability weighting function of negative results (δ_2), the value of the parameter varies between 0.7262 for the decision of the farm 2 and 1.5046 for the decision of the farm 7.

Table 4.3 – Model Results for the 2000 Agenda

Description	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8	Farm 9
Crop Activities									
Durum Wheat	323.7	124.6	35.6	148.0	234.1	75.2	107.5	147.9	267.5
Sunflower		27.0				49.6	45.0		67.5
Oats	13.3	50.0						95.0	
Oats/Vicia	20.9	7.9	14.6	6.6	19.8			57.0	
Pastures	513.4	300.	100.0	270.0	120.0			500.0	
Setaside	328.7	150.5	29.8	145.4	226.1	75.2	107.5	220.1	215.0
Total Area	*1200.0*	*660.0*	*180.0*	*570.0*	*600.0*	*200.0*	*260.0*	*1020.0*	*550.0*
Livestock Activities									
Beef Cattle	400	150	90					450	
Sheep				1080	625				
Farm Income									
State of Nature 1	-1 354	13 047	2 322	-2 776	-30 877	-8 150	-5 407	2 745	-25 435
State of Nature 2	32 246	27 526	9 023	6 455	-16 419	-3 239	- 417	36 478	-13 662
State of Nature 3	77 777	46 501	17 733	27 334	15 897	5 626	11 105	82 405	19 907
State of Nature 4	115 220	64 066	22 511	44 171	40 557	13 172	21 900	108 641	48 120
State of Nature 5	119 211	67 940	23 450	45 431	42 489	16 302	24 902	112 923	55 045
Subsidies									
Livestock subsid.	129 422	62 036	32 823	25 704	14 860	0	0	142 795	0
Crop subsidies	135 291	62 462	14 681	60 983	96 427	39 133	53 383	74 640	119 945
Total subsidies	264 713	124 499	47 504	86 687	111 287	39 133	53 383	217 435	119 945
Objective Function Value	4.0506	5.0666	6.3855	1.9482	0.0810	1.7243	1.3252	5.0910	1.1122

Notes: Crop activities in hectares, livestock activities in animal units and monetary values in Euros
Source : Model Results.

The introduction of the value functions and the probability weighting functions in the mathematical programming models forced to the programming of the objective function with a set of instructions of the type IF…THEN. The models were run in the MINOS program. These models describe the farmers' behavior well. The results for the 2000 Agenda are shown in Table 4.3. All of the models choose durum wheat as the main crop activity in the Alentejo dryland region. With respect to the livestock activities, the models choose the maximum that the farmers are willing to produce. The value of the subsidies was calculated in the model, and it corresponds with the value received by the farmers with adjustments when they pass over the maximum area. After the validation the models with the 2000 Agenda, it was introduced in the models the full decoupling of income payments from agricultural production and the maximum modulation that will go into effect in the 2006/07 agricultural year.

Table 4.4– Model Results with the new CAP– Full Decoupling of Income Payments

Description	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8	Farm 9
				Crop Activities					
Barley		43.8	20.7	63.8	48.6			36.1	67.5
Oats	136.8				34.8			27.9	
Sunflower	105.3	2.5							67.5
Oats/Vicia	64.6	64.7	46.1		1.7			142.3	
Pastures	824.3	442.0	110.9	270	120.0			786.0	
Setaside	69.0	107.0	2.3	236.2	394.9	200.0	260.0	27.7	415.0
Total area	*1200.0*	*660.0*	*180.0*	*570.0*	*600.0*	*200.0*	*260.0*	*1020.0*	*550.0*
				Livestock Activities					
Beef cattle	400	150	74					450	
Sheep				182	74				
				Farm Income					
State of Nat. 1	21 944	34 916	6 303	25 745	12 765	9 926	17 319	24 857	2 534
State of Nat. 2	56 484	40 806	11 733	26 485	13 706	9 926	17 319	58 986	9 224
State of Nat. 3	78 991	48 962	15 538	31 729	20 454	9 926	17 319	74 399	17 986
State of Nat. 4	94 223	54 808	18 300	36 644	26 751	9 926	17 319	85 680	26 199
State of Nat. 5	103 949	56 754	19 438	36 890	27 089	9 926	17 319	90 030	32 337
				Subsidies					
Dec. payment	235 105	111 938	43 409	75 371	94 768	33 894	45 983	198 293	101 466
Objective Function Value	5.2916	5.6272	6.5627	4.2536	3.3402	4.8515	5.5393	5.7417	4.9544

Notes: Crop activities in hectares, livestock activities in animal units and monetary values in Euros.
Source: Model Results.

Model results are presented in Table 4.4. With full decoupling of income payment from agricultural production, all of the farms do not produce durum wheat. The farm 9, that has good soils, does not produce durum wheat and it starts to produce barley and oats. With respect to the beef cattle farms, these farms maintain the number of cattle heads, they increase the pasture and forage areas and they substitute durum wheat for oats and barley. The sheep farms reduce their herds drastically and they substitute durum wheat for barley and oats. As the decoupling of income payments is not related to farm production, the variability of the results decreases and the difference between the farm income of the nature state 1 and 5 is lower than previously. The level of subsidies decreases due to the new values of the specific subsidy to the durum wheat and the modulation.

Table 4.5 – Model Results with the new CAP– Partial Decoupling of Income Payments

Description	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8	Farm 9
				Crop Activities					
Barley		43.8	14.1	27.9	53.8			36.1	67.5
Oats	136.8							27.9	
Sunflower	105.4	2.6							67.5
Oats/Vicia	64.6	64.6	31.3	62.0	39.6			142.3	
Pastures	824.2	442.0	133.0	261.3	193.0			786.0	
Setaside	69.0	107.0	1.6	218.8	313.6	200.0	260.0	27.7	415.0
Total area	*1200.0*	*660.0*	*180.0*	*570.0*	*600.0*	*200.0*	*260.0*	*1020.0*	*550.0*
				Livestock Activities					
Beef cattle	400	150	90					450	
Sheep				1006	564				
				Farm Income					
State of Nature 1	21 994	34 916	5 576	17 164	7 472	9 926	17 319	24 857	2 534
State of Nature 2	56 484	40 806	13 347	21 805	10 819	9 926	17 319	58 986	9 224
State of Nature 3	78 991	48 962	16 437	27 481	17 172	9 926	17 319	74 399	17 986
State of Nature 4	94 223	54 808	18 820	30 725	22 088	9 926	17 319	85 680	26 199
State of Nature 5	103 949	56 754	19 903	32 139	23 186	9 926	17 319	90 030	32 337
				Subsidies					
Dec. payment	160 523	76 638	26 628	62 519	87 338	33 894	45 983	114 389	101 466
Prod. Subsidies	74 582	35 300	16 781	11 976	6 713	0	0	83 904	0
Objective Function Value	5.2916	5.6272	6.5584	3.7267	2.9452	4.8515	5.5393	5.7417	4.9544

Notes: Crop activities in hectares, livestock activities in animal units and monetary values in Euros.
Source: Model Results.

Besides the full decoupling of income payment from agricultural production, the states members might implement the partial decoupling of income payment from agricultural production. Among various alternatives, the Portuguese government decided to assign to farm production 50% of sheep premium, 100% of veal premium, 100% of suckler cow premium and 40% of slaughter premium. If the Portuguese government decides that agricultural production is not linked to the subsidies for crop activities, farms will have to change their crop choices (Table 4.5). So, it is necessary to assign the maximum of premium that is allowed to sheep activities and to associate the subsidies to suckler cows to allow the use of the shares of milk cows negotiated with the European Union in 2003.

The inclusion of the Portuguese Government' s proposal in the mathematical programming models only changes the solutions of the sheep farms. The table 4.5 show that the farms 4 and 5 have different results when the partial decoupling of income payments from agricultural production is introduced. Crop production reduces and pastures areas and sheep production increase for those farms. The decoupling of income payments of 50% has positive effect in the maintenance of the number of cow's heads and increases sheep herds as the Portuguese Government intended. Model results agree to the Portuguese Government' s proposal.

The analysis of the introduction of the area-yield crop insurance program in the Alentejo dryland region, together with other issues of the mid-term review of the Common Agricultural Policy, seems interesting because it allows the Alentejo farmers to have an alternative for making face to the agricultural production variability. Some farmers don' t produce in soils of medium quality or lower, if some subsidies for cereals linked to agricultural production don' t continue to be paid. However, this insurance program can constitute a form of motivating the agricultural production in those soils.

The impact of the introduction of the insurance program with the full decoupling of income payment from agricultural production in the Alentejo dryland region is presented in the table 4.6. These results include the maximum values that the farmers are willing to pay for the premium rate.

The value of the selected agricultural activities is very similar to the results obtained without insurance, except for farm 1 that increases the pastures areas and substitute oats production for barley production. The farms 6 and 7 don' t sign the insurance program and the farm 9 starts to sow barley in the low productivity soils.

Table 4.6– Model Results with the Area-Yield Crop Insurance Program

Description	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8	Farm 9
					Crop Activities				
Barley	154.8	43.8	19.8	66.6	82.3			67.8	99.7
Oats									
Sunflower	99.3	2.6							67.5
Oats/Vicia	123.3	64.6	44.1		2.7			150.7	
Pastures	754.4	442.0	113.9	270.0	120.0			758.1	
Setaside	68.2	107.0	2.2	233.4	395.0	200.0	260.0	43.4	382.8
Total area	*1200.0*	*660.0*	*180.0*	*570.0*	*600.0*	*200.0*	*260.0*	*1020.0*	*550.0*
					Livestock Activities				
Beef cattle	400	150	82					450	
Sheep				182	87				
					Farm Income				
State of Nature 1	28 273	36 371	6 228	27 367	15 405	9 926	17 319	25 520	4 562
State of Nature 2	61 867	42 216	12 661	28 132	16 480	9 926	17 319	61 423	10 353
State of Nature 3	74 408	47 448	15 568	29 889	18 714	9 926	17 319	72 888	15 007
State of Nature 4	91 548	53 294	18 339	35 019	25 072	9 926	17 319	84 600	25 701
State of Nature 5	101 837	55 240	19 631	35 277	25 427	9 926	17 319	89 370	31 963
					Indemnities				
State of Nature 1	14 332	4 094	1 527	5 126	6 340	0	0	5 222	10 958
State of Nature 2	11 918	4 032	1 527	5 126	6 340	0	0	5 222	9 317
Objective Function Value	5.3333	5.6289	6.5736	4.2669	3.3810	4.8515	5.5393	5.7577	5.1393

Notes: Crop activities in hectares, livestock activities in animal units and monetary values in Euros.
Source: Model Results.

The model also analyzed other agricultural alternatives associated with the decrease of the premium rate, assuming that the Government contribution would increase. Model results show that crop production increases, while forage production and setaside area decrease.

Table 4.7 – Objective Function Values for Alternatives Agricultural Policies

Description	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8	Farm 9
Agenda 2000	4.0506	5.0666	6.3855	1.9482	0.0810	1.7243	1.3252	5.0910	1.1122
Full Decoupling	5.2916	5.6272	6.5627	4.2536	3.3402	4.8515	5.5393	5.7417	4.9544
Partial Decoupling	5.2916	5.6272	6.5584	3.7267	2.9452	4.8515	5.5393	5.7417	4.9544
Insurance Program	5.3333	5.6289	6.5736	4.2669	3.3810	4.8515	5.5393	5.7577	5.1393

Source : Model Results.

This paper ends with the analysis of the values of the objective function obtained for each one of the studied agricultural policies. The analysis of the table 4.7 displays that the maximum values for the objective function are obtained when the farmers choose the area-yield crop insurance program with the full decoupling of income payments from agricultural production. These results also confirm that the selected agricultural policies under the mid-term review of the Common Agricultural Policy have the preference relatively to the proposals of the 2000 Agenda.

5 - Conclusions

This research work studies the farmers' behavior when they are confronted with the mid-term review of the Common Agricultural Policy. Three objectives are defined in this research work. The first objective develops a mathematical programming model to study the farmers' behavior in the Alentejo dryland region of Portugal during the 2000 Agenda. The second objective intends to foresee the farmers' behavior, when they are confronted with the review of the mid-term of the Common Agricultural Policy in 2003, in agreement with the perspectives of full and partial decoupling of income payments from agricultural production. The third objective analyses the farmers' behavior face to the introduction of the area-yield crop insurance program. This research work will have as theoretical base the Cumulative Prospect Theory. This theory allows to model the decision makers' behavior, when defining a concave value function for gains and convex for losses, it permits the existence of behaviors of preference or aversion to risk for the results be classified as losses and gains, respectively. With the mid-term review of Common Agricultural Policy in 2003, the subsidies are not linked to agricultural production and the decision makers will stop incorporating the subsidies in their decision process. The theoretical base of this theory constitutes the objective function of a discrete sequential and stochastic programming model, whose the set of constraints describes the crop and livestock farms in their productive, financial, commercial and taxes components.

Model results show that the decision makers' behavior is very well described by this mathematical programming model. All the analyzed farms produce durum wheat as main agricultural production and choose the maximum of number of cattle heads and sheep herds. The full decoupling of income payment from agricultural production lead to the abandonment of the durum wheat production. The farms without livestock production have tendency to abandon the agricultural production except for the good soils. The beef cattle farms keep their production, increasing the level of the animal feeding due to the increases of the forages and pastures areas. The sheep farms reduce their herds drastically.

The introduction of 50% of sheep premium, proposed by the Portuguese Government, raises sheep production, accompanied of the increase of the pasture area. These results permit to conclude that the Portuguese Government' s proposal is sufficiently cautious because, on the one hand, when associating to 100% of suckler cow premium allows the use of the shares negotiated with European Union in 2003 and when associating to

50% of sheep premium increases sheep production. On the other hand, the Portuguese Government' s proposal of crop subsidies not liked to production forces the farmers to choose alternative agricultural activities in the bad soils.

Finally, the introduction of the insurance program with the full decoupling of income payments from agricultural production shows that the selected agricultural activities by farmers are very identical to the agricultural activities without the insurance program. The purchasing of the area-yield crop insurance originates an increase of crop production in the medium soils and an increase in sheep production.

The introduction of the insurance program with full decoupling of income payments from agricultural production under the mid-term review of the Common Agricultural Policy has positive effects in the agricultural production. This alternative has the decision makers' preference too. The new Agricultural Policy guarantees a minimum farm income, while the insurance program allows to make face to the agricultural production variability and avoids the abandonment of the agricultural activity in the Alentejo dryland region of Portugal.

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