# The Role of Area-Yield Crop Insurance Program face to the Mid-Term Review of Common Agricultural Policy

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**Abstract:**

The mid-term review of Common Agricultural Policy increases the complexity of the decision-making process of farmers. The subsidies are substituted for a single decoupled income payment. The farmers decide what crops and livestock will produce based on climate, soils conditions and agricultural market signals and not based on subsidies granted to each one of the crop and livestock activities. The area-yield crop insurance program might have an important role on increasing production and facing natural catastrophes.

This paper studies the introduction of the area-yield crop insurance program to reduce the risk originating from the variability of farmers' income and to compare this alternative with other agricultural policy alternatives in the context of the mid-term review of Common Agricultural Policy. The comparison of the introduction of the area-yield crop insurance program with other agricultural policy alternatives is made through an approach using concepts of the Cumulative Prospect Theory, because besides defining that the results are appraised in agreement with changes in relation to the initial wealth, this theory treats in a differentiated way gains and losses.

A discrete sequential stochastic programming model with five states of nature is developed to study agricultural policy alternatives. The objective function is constituted by a set of functions (the value function and the probability weighting function) differentiated for gains and losses, in that the total value of the game is given by the sum of the positive and negative components. The value functions and the weighting probabilities are elicited by the Trade-off and Certainty Equivalent methods for a group of farmers in the Alentejo dryland region of Portugal. The set of constraint restrictions describes the environment in which the Alentejo farmers develop their crop and livestock activities in all their components: production, financial, marketing and taxes.

Model results show the introduction of the area-yield crop 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 new Agricultural Policy guarantees a minimum farm income, while the area-yield crop insurance program allows making face to the agricultural production variability and avoids the abandonment of the farming activity in the Alentejo dryland region.

**Key words:** Cumulative Propospect Theory, Mid-Term Review of the Common Agricultural Policy, Discrete Sequential Stochastic Programming Model, Area-Yield Crop Insurance program.

## 1- Introduction

The uncertainty of the farmers' income has been one of the great concerns of farmers, agricultural economists and policymakers under the successive Common Agricultural Policy reviews.

The mid-term review of Common Agricultural Policy increases the complexity of the decision-making process of farmers. The subsidies are substituted for a single decoupled income payment. The farmers decide what crops and livestock will produce based on climate, soils conditions and agricultural market signals and not based on subsidies granted to each one of the crop and livestock activities. The area-yield crop insurance program might have an important role on increasing production and facing natural catastrophes.

The problem of this study is the decrease and the variability of the farmers' income in producing crops activities in the Alentejo region of Portugal. This paper studies the introduction of the area-yield insurance program to reduce the risk originating from the variability of farmers' income and to compare this alternative with other agricultural policy alternatives in the context of the mid-term review of Common Agricultural Policy.

The farmers will stop deciding with base on subsidies and they will make their decisions independent of crop and livestock activities they choose to produce and they can start to make decisions based on negative results. The Cumulative Prospect Theory allows modeling the farmers' behavior, because when defining that the different results are appraised relatively to the initial wealth, it permits its appraisal in terms of gains and of losses. When defining concave function for gains and convex function for losses, this theory permits the existence of risk aversion for gains and of risk seeking for losses.

This research work has two objectives. The first objective seeks to characterize the farmers' behavior under the mid-term review of the Common Agricultural Policy. The second objective studies the introduction of the area-yield insurance crop program to reduce the risk originating from the variability of farmers' income and to compare this alternative with other agricultural policy alternatives in the context of the mid-term review of Common Agricultural Policy.

**2 - Methodology**

Kahneman and Tversky presented a choice model called Prospect Theory in 1979, that explains the violations of the Expected Utiliy Theory for choice among games with a reduced number of results. This theory has two key elements: i) a concave function for gains and a convex function for losses and steeper for losses than for gains; ii) a nonlinear transformation of the scale of probabilities that overweights the low probabilities and underweights the moderate and high probabilities. This theory had some comments relatively to the detection of dominated solutions, the weak specification of the probability weighting function and the difficulty for applying the games to a high 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. This model, called rank-dependent Expected Utiliy, uses an utility function of the type von Neumann-Morgenstern and a nonlinear transformation of the probabilities, where the decision weights are determined by the cumulative probability function. Schmeidler developed a model that allows the application of the Expected Utility Theory to the ambiguity in 1989.

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.

A finite set of states of nature is represented by S and the set of the results is represented by X. It is assumed that X includes a neutral result (0) and that all of the elements of X are gains or losses. The game y is a function of S in X, that allocate to each state $s \in S$ a consequence y(s) = x, with $x \in X$. The game y is represented then as a sequence of pairs ($x_i$, $A_i$), that it originates $x_i$ if $A_i$ to happen. A positive subscript is used to represent the positive results, a negative subscript to represent the negative results and a zero subscript to represent the neutral results. The positive part of y, represented by y+, is obtained by y+(s) = y(s) if y(s) > 0, and y+(s) = 0 if y(s) ≤ 0. The negative part of y, repesented by y -, is defined in a similar way.

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

$$V(y) = V(y+) + V(y-) \qquad (1)$$

where:
V– value of the game; and,
$y$ - game; $y^+$ – positive part of the game; and $y^-$ – negative part of the game.

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

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

(2) where:

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

The value function has the following characteristics: (i) defined on deviations 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) steeper for losses than for gains. The graphic representation is as follows:

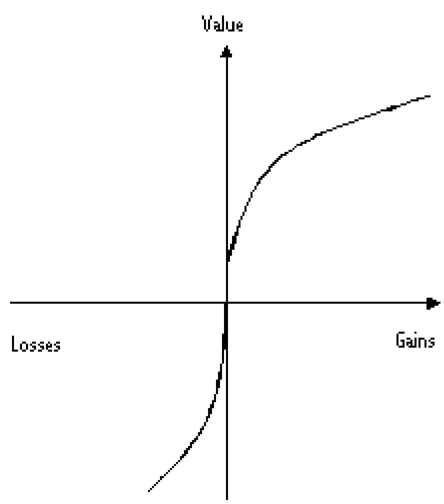


Figure 1 - The value function

The value 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:

$$v(x_i) = \begin{cases} \lambda_1 \, x_i^{\omega_1} & \text{if} \quad 0 \le i \le s \\ -\lambda_2 \, (-x_i)^{\omega_2} & \text{if} \; -m \le i < 0 \end{cases} \tag{3}$$

where:
v– value function;
$x_i$ – results; and,
$\lambda_1$, $\lambda_2$, $\omega_1$, $\omega_2$ – function parameters.

The parameter $\lambda_1$ 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:

$$h_s^+ = f^+(p_s) \text{ and } h_i^+ = f^+\left(\sum_{i}^{s} p_i\right) - f^+\left(\sum_{i+1}^{s} p_i\right), \qquad 0 \le i \le s-1 \tag{4}$$

$$h_{-m}^- = f^-(p_{-m}) \text{ and } h_i^- = f^-\left(\sum_{-m}^{i} p_i\right) - f^-\left(\sum_{-m}^{i-1} p_i\right), \qquad 1-m \le i \le 0 \tag{5}$$

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:

$$f(p) = \frac{\delta p^{\gamma}}{\delta p^{\gamma} + (1-p)^{\gamma}} \qquad (6)$$

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

The graphic representation is as follows:

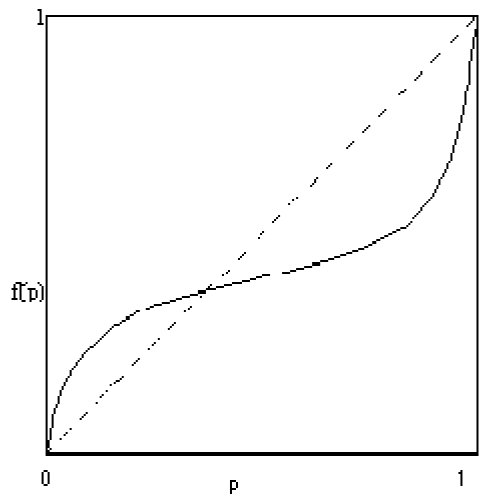


Figure 2 - Probability Weighting Function

González and Wu 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 changes in probabilities as they move away from the reference point. In the domain of the probabilities, the two endpoints 0 and 1 represent the reference points in the sense that one represents the “certainty that it doesn' t happen” and another represents the "certainty that it happens." 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 concept of diminishing sensitivity supplies an incomplete explanation of the representation of probability weighting function. Even if this concept permits to explain the curvature of the probability function, it does not says anything on overweighting and underweighting relatively to the non-transformed probabilities (45º line). 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 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, as to interpersonal comparisons in that an individual attributes a larger consideration to a choice domain than the other.

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 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 (the 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 restrictions describe the environment in that the farmers developed their crop and livestock activities in all their components: production (crop and livestock), financial, commercial and taxes. The different alternatives (games), derived from farmer decisions, are assessed for the following model, with $-m \leq i \leq s$:

$$\text{Max } V(y) = \sum_{i=-m}^{0} h_i^{-} v(x_i) + \sum_{i=0}^{s} h_i^{+} v(x_i) \qquad (7)$$

subject to:

$$x_i \in F_D$$

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 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 the 'trade-off' method (Wakker and Deneffe, 1996), that eliminates completely the distortions determined by the nonlinearity of the probabilities in the measure of the utility. This method notices that the probabilities p, the reference results $x_R$ e $x_r$ ($x_R > x_r$) and the minimum result $x_0$ (for example: $x_0$ ). It is asked to the decision maker which the result $x_1$ that turns him indifferent between the game ($x_1$, p; $x_r$, 1-p) and the game ($x_0$, p; $x_R$, 1-p). The values p, $x_r$, $x_0$, e $x_R$ are fixed and the analyst varies $x_1$ until that the decision maker reveals indifference between the two games. Soon afterwards, it is asked to the decision maker that bids the result $x_2$ that turns him indifferent between the pair of games ($x_2$, p; $x_r$, 1-p) and ($x_1$, p; $x_R$, 1-p). Again the values p, $x_r$, $x_1$ and $x_R$ are fixed, varying $x_2$ until that the decision maker reveals indifference between the two games. Substituting the values found in the utility function (u) is obtained the following equality for the first indifference:

$$p\ u(x_1) + (1-p)\ u(x_r) = p\ u(x_0) + (1-p)\ u(x_R) \quad (8)$$

Then:

$$p\ (u(x_1) - u(x_0)) = (1-p)\ (u(x_R) - u(x_r)) \quad (9)$$

For the second indifference, it is obtained the following equality:

$$p\ (u(x_2) - u(x_1)) = (1-p)\ (u(x_R) - u(x_r)) \quad (10)$$

Equaling (9) the (10) and making u(x0) = 0 are obtained the following equality:

$$u(x_2) = 2\ u(x_1) \quad (11)$$

This procedure continues until that an enough number of results is considered. In a generic way, any $x_i$ is defined such that the decision maker is indifferent between game ($x_i$, p; $x_r$, 1-p) and ($x_{i-1}$, p; $x_r$, 1-p), that in combination with other indifferences originates that $u(x_i) = i * u(x_1)$. It can establish $u(x_i) = i * \alpha$ for any parameter positive arbitrary $u(x_1) = \alpha$ (for example: $\alpha = 1/n$, with n denoting the index of the last result $x_n$) (Wakker and Deneffe, 1996). The application of this method to the Cumulative Prospect Theory demands 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. To estimate the decision weights in the Cumulative Prospect Theory is also necessary to elicit a function separately for the gains and a function for the losses. For the probability weighting function was used the certainty equivalent method. In this method the procedure for getting the utilities is the following: in first place, they notice two resulted $x_H$ and $x_L$, with $x_H > x_L$, such that the interval includes all the results of interest; in second place, they are attributed two values arbitrarily to the extreme points, as for instance $u(x_L) = 0$ and $u(x_H) = 1$, soon afterwards it is requested to the decision maker that establishes the certainty equivalent such that this is indifferent for ( $x_L$, p; $x_H$, 1-p). Substituting this value in the expected utility function, it is obtained the following equality:

$$U(CE) = p\,U(x_L) + (1-p)\,U(x_H) \qquad (12)$$

Varying the probabilities systematically new games are built in which are obtained new values of the certainty equivalent, that are going to be substituted in the previous equation, allowing to determine several points of the utility curve. The use of this method that varies the probabilities and it maintains the same results in all of the games, allows to prevent some inconveniences of other variants of this method that determines the probabilities and vary the results, although it can suffer of the certainty effect, given that the distortion of the probabilities is more pronounced near the extreme points.

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:

$$V(CE) = h_1\,v(x_H) + h_2\,v(x_L), \text{ com } x_H > x_L \qquad (13)$$

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:

$$f(p_1) = \frac{v(CE) - v(x_L)}{v(x_H) - v(x_L)} \qquad (14)$$

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:

$$f^+(p) = \left(\frac{CE_1}{x_1}\right)^{\omega_1} \quad \text{and} \quad f^-(p) = \left(\frac{CE_2}{x_1'}\right)^{\omega_2} \qquad (15)$$

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,
$\omega_1$, $\omega_2$ – 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 under the mid-term review of the Common Agricultural Policy, will be achieved by the adjustment of the mathematical programming model to each farmer decisions. Here, the value of the objective function represents the farm income in each nature state. The second objective studies the introduction of the area-yield crop insurance program and compares this alternative with other agricultural policy alternatives in the context of the mid-term review of Common Agricultural Policy. This mathematical programming model will be reformulated to introduce the area-yield crop insurance program.

### 3 - Data and Information

The main information source for the development of this mathematical programming model was obtained through 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 collecting farm data to develop this mathematical programming model. The determination of the farmers' individual preferences, through the application of a questionnaire, allowed collecting data to apply the Cumulative Prospect Theory including the area-yield crop insurance program. The development of an optimization model is extraordinarily demanding in tems of data. The data and other information can be collected 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. To the similarity of the accomplished work Carvalho (1999), Lucas (1995), Marques (1988) and Serrão (1988), 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), 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 and two technologies of sheep production were considered. The agricultural year 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 the obtaining of specific agricultural data of each one of the farms such an as: area, soil types, crop and livestock technologies, agricultural machinery, workers 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 interviews were accomplished for 35 farmers and it was possible to elicit values for the estimation of the value function and probability weighting function for 9 farmers. The data for these nine farmers are represented in the tables1. It is verified that the farm activities are diversified in terms of the dimension and of the oak-plantation farms where livestock feed. The analysis of the table 1 allows verifying 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 function. The average value will be used for validation of the model. The inquiry asked the farmers if they would be willing to change the production technology substantially, all of them answered no and with respect to livestock production, they were not willing to increase their production because they would harm the oak-plantation activities. 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 (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.

This paper considers that the calculation of the premium rate is equal to the expected value of the indemnity insurance. For the calculation of the premium rate, it was considered the whole Alentejo region as constituting a single area in terms of insurance. It was considered that the average production is the production of the state of nature 3, where the level of critical production is of 90% of the average production and the farmers choose a cover level of 100% (Miranda, 1991).

Table 3.2 - Premium rates and Indemnities

| | Durhum Wheat | Common Wheat | Barley for brewing | Common Barley | Oats | Tricale | Sunflower |
|---|---|---|---|---|---|---|---|
| Production – State 1 | 1050 | 1250 | 1250 | 950 | 900 | 1000 | 300 |
| Production - State 2 | 1050 | 1250 | 1250 | 950 | 900 | 1000 | 600 |
| Average Production | 2100 | 2500 | 2500 | 1900 | 1800 | 2000 | 600 |
| Critical Production | 1890 | 2250 | 2250 | 1710 | 1620 | 1800 | 540 |
| Indemnified Prod –St 1 | 840 | 1000 | 1000 | 760 | 720 | 800 | 240 |
| Indemnified Prod –St 2 | 840 | 1000 | 1000 | 760 | 720 | 800 | 0 |
| Probability of Loss | 0.37333 | 0.37333 | 0.37333 | 0.37333 | 0.37333 | 0.37333 | 0.18667 |
| Premium rate | 0.07148 | 0.08510 | 0.08510 | 0.06468 | 0.06127 | 0.06808 | 0.01021 |

Notes: Production in kilos per hectare and premium rate in thousands of euros per hectare
Source: Authors' calculations

The indemnified production is calculated by the difference between the critical production and the production of the nature states corresponding to the bad years (states of nature 1 and 2). The premium rate is calculated by the loss probability (production less than average production) multiplied by the critical production and the intervention price. This research work uses the values of loss probability calculated by Ventura-Lucas (1995) and Carvalho (1999). The value of the indemnities received by each farm will be calculated multiplying the indemnified production by the production area in hectares and the intervention price.

## 4 - Results

The decision farmers' behavior is very well described by these mathematical programming models. After the validation the models with the 2000 Common Agricultural Policy reform, it was introduced in the models the full and partial decoupling payments and the area-yield crop insurance program under the mid-term review of the Common Agricultural Policy to attain the two objectives proposed for this research work. Model results presented in Table 4.1, with full decoupling of income payment from agricultural production, show that all of the farms do not produce durum wheat.

Table 4.1– 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 | | 43.9 | 20.7 | 63.8 | 48.6 | | | 36.1 | 67.5 |
| Oats | 136.8 | | | | 34.8 | | | 27.9 | |
| Sunflower | 105.3 | 2.6 | | | | | | | 67.5 |
| Oats/Vicia | 64.6 | 64.5 | 46.0 | | 1.7 | | | 142.3 | |
| Pastures | 824.2 | 442.0 | 111.0 | 270 | 120.0 | | | 786.0 | |
| Setaside | 69.1 | 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 | 11 773 | 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 |

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

The farm 9, that has good soils, does not produce durum wheat and it starts to produce barley. 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 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. The level of subsidies decreases due to the new values of the specific subsidy to the durum wheat and the modulation.

Table 4.2 – Model Results with the new CAP– Partial Decoupling of Income Payments

| Description | Farn 1 | Farm 2 | Farm 3 | Farm 4 | Farm 5 | Farm 6 | Farm 7 | Farm 8 | Farm 9 |
|---|---|---|---|---|---|---|---|---|---|
| *Crop Activities* | | | | | | | | | |
| Barley | | 43.9 | 14.1 | 27.9 | 53.8 | | | 36.1 | 67.5 |
| Oats | 136.8 | | | | | | | 27.9 | |
| Sunflower | 105.3 | 2.6 | | | | | | | 67.5 |
| Oats/Vicia | 64.6 | 64.5 | 31.3 | 62.1 | 39.6 | | | 142.3 | |
| Pastures | 824.2 | 442.0 | 133.0 | 286.2 | 193.0 | | | 786.0 | |
| Setaside | 69.1 | 107.0 | 1.6 | 193.8 | 313.6 | 200.0 | 260.0 | 27.7 | 415.0 |
| *Total area* | *1200.0* | *690.0* | *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 | 21 944 | 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 | 26 826 | 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 |

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

Among various alternatives under the mid-term review of the Common Agricultural Policy, 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. Model results of the Portuguese government's proposal are presented in Table 4.2, which shows 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 4.3. 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 4.3– 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 | |
| Set-aside | 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 |

Notes: Crop activities in hectares, livestock activities in animal units and monetary values in Euros.
Source: Model Results for the Area-Yield Crop Insurance with Full Decoupling Payments

This model also analyzed other agricultural alternatives associated with the decrease of the premium rate, assuming that the Portuguese government contribution would increase. Model results show that crop production increases, while forage production and set-aside area decrease.

Table 4.4 – 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 |
|---|---|---|---|---|---|---|---|---|---|
| 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 4.4 displays that the maximum values for the objective function are obtained when the Alentejo farmers choose the area-yield crop insurance program with the full decoupling of income payments from agricultural production. These results also confirm that the area-yield crop insurance program have the preference relatively to other proposals under the mid-term review of the Common Agricultural Policy.

## 5 - Conclusions

This research work studies the farmers' behavior when they are confronted with the mid-term review of the Common Agricultural Policy. Two objectives are defined in this research work. The first objective intends to foresee the farmers' behavior, when they are confronted with the review of the mid-term of the Common Agricultural Policy, in agreement with the perspectives of full and partial decoupling of income payments from agricultural production. The second 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 modeling 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 are classified as losses and gains, respectively. With the mid-term review of Common Agricultural Policy, 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, where the set of constraints describes the crop and livestock farms in their productive, financial, and commercial and taxes components.

Model results show that 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 linked to production forces the farmers to choose alternative agricultural activities in the bad soils.

Finally, the introduction of the area-yield crop 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. This insurance program has the Alentejo farmers' preference. The new Agricultural Policy guarantees a minimum farm income, while the area-yield crop 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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