Socio-Economic and Environmental Impact of AGENDA 2000 and Alternative Policy Choices for Market Liberalization on an Irrigated Area in Northwestern Spain

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Abstract

This paper presents a methodology to evaluate the impact of different policy scenarios using a farmer's utility function. The analysis shows the impact on farmers and on the environment. The case study is a community of irrigated farms (Bajo Carrión) in Northwestern Spain. The results obtained show how Agenda 2000 has little impact on farm crop distribution, gross margins, employment and environment (use of fertilizers and water). The most radical scenario (a 15 per cent COP price cut and no area payments) produces a 37.3 per cent reduction in farm gross margin, and an increase in fertilizer use of 6 per cent.

Keywords: *Agenda 2000, Socio-economic impact, Environmental impact, Multicriteria model, Irrigated agriculture, Spain*.

Introduction

Following the arguments of Agenda 2000, it seems clear that the Common Agricultural Policy has to be reformed. Buckwell (1998) in a report published by DG VI of the European Commission points to three main arguments to support this reform, briefly: (a) *domestic dissatisfaction*, related to a lack of need to ensure food supply as in the 1960s, unfair distributive effects for smaller farmers, environmental costs from farm intensification, difficulties with the supply controls and consumers' worry about quality; (b) *external pressures*, from EU's commitments toward a more liberalised trade in agricultural products; (c) *the enlargement of the EU* makes it rather difficult to extend the existing agricultural policy to the Central and Eastern European Countries.

To overcome all these problems, Agenda 2000 moves in the same direction as the CAP reform of 1992: price cuts compensated by direct payments. In the new Common Agricultural and Rural Policy for Europe (CARPE), the farmers will be paid to provide an "environmental good" without price in the market, moving gradually away from commodity-based support.

Agenda 2000 might be considered as an initial step towards a new CARPE that will progressively link environmental and amenity related payments with the traditional farm support (minimum price and area payments).

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Objectives

Bearing in mind the need for a new CAP-CARPE, our main objective is to quantify the impact of different policy scenarios on economic (agrarian rent), social (farm employment) and environmental (water consumption and level of fertilizers) variables. To achieve this objective, a composite utility function for all farmers in a community of irrigated farms will be elicited, considering three attributes: gross margins, risk and amount of labour. Weights for each attribute within the utility function will be obtained using observed overall crop distribution in the community of irrigated farms.

A community of irrigated farms in Spain (Bajo Carrión, north-western Spain) will be used as the source of data and all the relevant conclusions should apply to these farmers.

Methodology

Most economic analysis relies on the objective of profit maximisation. According to traditional economic theory, entrepreneurs make decisions that maximise profit, as their sole objective. However, it is plausible that farmers consider many other objectives such as risk avoidance, amount of working capital, external employment, etc. In the agricultural field there are many researchers who support this multi-criteria approach, see for example Gasson (1973), Hatch *et al*. (1974), Herath (1981), Cary and Holmes (1982), Sumpsi *et al*. (1993, 1997), Gómez-Limón and Berbel (1995), Gómez-Limón *et al*. (1996) and Amador *et al*. (1998).

Amador *et al* (1998) propose a method to assess a utility function without direct interaction of farmer researcher, thus avoiding complex questions to evaluate lotteries. They rely upon the theoretical soundness of Multi-Attribute Utility Theory (MAUT) and explain the pragmatic limitation of such a method. Instead, they show how it is possible to elicit the farmer's utility function by observing only the actual crop distribution. The following explains the main steps of this method.

(1) To define mathematically objective i, f_i, as a function of decision variables (**X**) -area covered by each crop-, $f_i = f_i(\mathbf{X})$.

(2) To obtain the pay-off matrix. The element of this matrix f_{ij}, is the value of the i-th objective when the j-th objective is optimised.

(3) To solve the following system of q (number of objectives) equations:

$$\sum_{j=1}^{q} w_j f_{ij} = f_i \qquad i = 1, 2, ..., q$$

$$\sum_{j=1}^{q} w_j = 1$$

where f_{ij} is the pay-off matrix element and f_i is the value achieved by the i-th objective.

(4) If the former system does not give a set of w (weights of each objective), the sum of positive and negative deviational variables is minimised (L_1 criterion).

$$\text{Min} \sum_{i=1}^{q} \frac{n_i + p_i}{f_i}$$

subject to: $$\sum_{j=1}^{q} w_j f_{ij} + n_i - p_i = f_i \quad i = 1, 2, ..., q;$$

$$\sum_{j=1}^{q} w_j = 1$$

This resembles goal programming, although in the right-hand-side, these are not targets but achieved values.

(5) To form the farmer's utility function with the set of w_j obtained in (4):

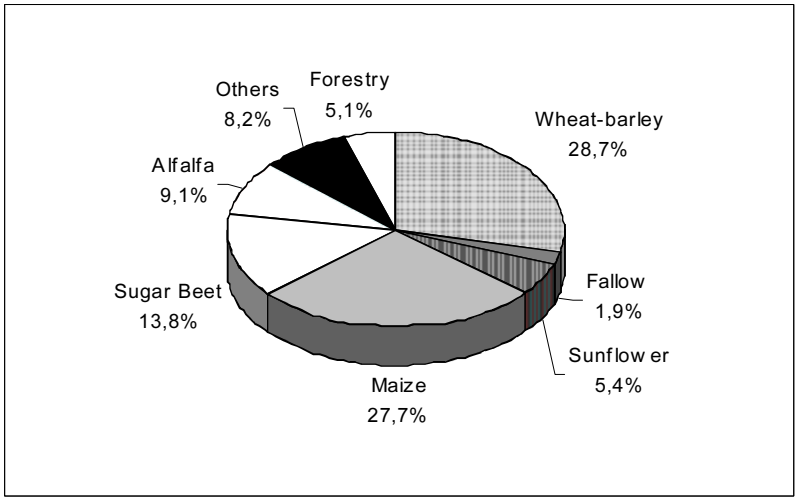
$$u = \sum_{i=1}^{q} \frac{w_i}{k_i} f_i(X)$$

where k_i is a normalising factor (e.g. maximum value of the i-th objective in the pay-off matrix minus minimum).

The case study

Bajo Carrion is an agricultural area of north-western Spain, in the province of Palencia. Although the water facilities were built in the seventies, the community of irrigated farms was established in 1982. There are 6,600 hectares and 907 farmers (average size of 7.27 ha). Each farmer may use 4,000 m^3/ha from the 1st of April to 31st of September. They pay a fixed amount of 6,300 pesetas per year. The crop distribution in the period 1997-97 is shown in Figure 1.

Figure 1. Crop distribution in *Bajo Carrión* in 1997/98



Source: Community of irrigated farms *El Bajo Carrión*

Data of the model

Three main sources of data were used: regional government, community of irrigated farms and some interviews with technical staff in the community and with farmers.

In the analysis permanent crops were not considered, except alfalfa since farmers could change easily to annual crops due to minor variation in relative profitability among crops. The activities in the model were: common wheat, barley, oat, sugar beet, maize, sunflower, alfalfa and fallow.

Yield and price time series were used to assess risk by calculating the total absolute deviation of gross margins. The period covered is 1993-97. All the data are shown in the Appendix 1. For prices, the base year is 1997 using a general price index to account for inflation.

Deficiency payments for cereal, oilseed and protein crops (COPs) were included in gross margins. Sugar beet does not have area payment but a subsidy of 400 pesetas per tonne.

Variable costs (seeds, fertilisers, pesticides, machinery and labour) were provided by a survey of more than 50 farmers in this community of irrigated farms.

The model

Multi-criteria methods allow us to obtain non-dominated solutions (Paretian optimality). The farmer decides which plan (crop distribution) maximises his/her utility function.

Decision variables

Farmers' preferences are revealed by hectares allocated to each crop. The decision variables represent the hectares for each crop in the model (see Figure 1), thus, in our model, X_j is the area covered by j-th crop. Considerations of downward sloping demand curves, through the linearisation of the demand curve, were not taken into account in this model since the level of production does not affect commodity prices.

Objectives

After several surveys in the region, we conclude that farmers choose a crop distribution, which maximizes gross margins, minimizes risk and minimizes the total amount of labour employed. Considering these "*a priori*" objectives, we will follow the steps explained previously, thus we need the mathematical form for each objective.

We used *gross margins* (GM) as a proxy for profit. Gross margins are defined as sales plus subsidies minus variable costs. We maximised total gross margins (TGM) that is:

$$\text{Max } TGM = \sum GM_j \cdot X_j$$

Risk is an important factor in agricultural production. Farmers have a marked risk aversion, therefore the model should include this objective. We consider both, production and market risk at once, using the compact version of the MOTAD model, which computes the sum of the negative gross margins deviations (Hazell, 1971),

$r_i = \sum \mathrm{n_j}$ risk associated to crop i; $\mathrm{n_j} = \mathrm{GM_{average}} - \mathrm{GM_{year\text{-}j}}$

Therefore, our objective is the minimization of total risk,

$\text{Min } R_k = \sum r_i$ risk associated to crop distribution k

Although this approach makes no allowance for correlation between gross margins of different crops, quadratic programming models and MOTAD models yield similar results (see Hazell and Norton, 1986).

Labour is for some crops the most expensive input. Besides, there are additional problems such as the difficulty of either finding workers or dealing with them. Therefore, farmers avoid using too much labour. At the same time, labour is an index of crop management difficulty, another criterion considered by farmers. Total labour (TL) is defined as:

$$\text{Min } TL = \sum L_i \cdot X_i$$

where L_i is the number of man-hours of labour per hectare of crop X_i

Constraints

Land constraint. The sum of all crops must be equal to 100, thus we obtain the results in percentages and do not allow land to be idle.

CAP constraints. We considered a 5 per cent of set aside for COPs. Sunflower is limited to 50 per cent of the farm area. Sugar beet, because of the quota, is limited to maximum hectares in the period.

Rotational constraints. Alfalfa is the sole non-annual crop, staying for 4 years and after this period, alfalfa cannot be sown during 3 years. The maximum area covered by alfalfa may be calculated as:

$$X_{alfalfa} \leq m/(m+n) = 4/(4+3) \cdot 100 = 57.14$$

Market constraints. Alfalfa is the only perishable crop in the list considered. We decided to limit its hectares to the maximum in the period 1993-97.

Appendix 2 shows the model.

Assumptions of the model

We assume that prices for cereals will be 15 per cent lower than the current intervention price as proposed in Agenda 2000. These prices are expected to be closer to world prices. Nevertheless, it could be useful to carry out a price sensitivity analysis for each policy scenario.

With flat-rate area payment for cereals and oilseeds (all defined scenarios), the Blair House agreement is no longer binding, thus, there is no constraint on maximum hectares for oilseeds relative to COPs.

Modulation of the compensatory payment will be not considered. Besides, since most farms in the area of study have a small to medium size, it would not apply to them.

Variable and fixed costs will remain unchanged.

Policy scenarios

As we have stated, one of the scenarios to consider was Agenda 2000. This was referred to as Scenario *A*. In this Scenario, prices were cut down by 15 per cent and compensatory payments increased by the same percentage. A set aside rate of 10 per cent is included in the constraint..

The average yield used in Spain to calculate the area payments for COPs has been increased in Agenda 2000 from 2.64 t/ha to 2.90 t/ha. This action brings closer the theoretical

and real yields in Spain. This increment has been applied on a regional basis. In the area of study the changes have been as follows:

1997 average yield = 3.1 ⇒ 2000 average yield = 3.6
1997 maize yield = 6.5 ⇒ 2000 maize yield = 7.5
1997 other cereals yield = 3.0 ⇒ 2000 other cereals yield = 3.5

We considered also the effects of a reduction in prices of 15 per cent involved in Agenda 2000 without any increment in the compensatory payments (Scenario *B*).

In Scenario *C* we went further and reduced the compensatory payments in Agenda 2000 by 50 per cent. Two factors may push policy in this way: (a) the next round of negotiations of the WTO, as it is plausible to expect a pressure to reduce subsidies, and (b) the increase in FEOGA expenditure as a consequence of the accession of Eastern European countries.

Scenario *D* shows the effect of a total liberalization of the agricultural market in the European Union. We considered a reduction in price of 15 per cent of all commodities and the elimination of any compensatory payments. This may seem quite unrealistic but it is worthseeing the impact. The set aside rate in this case is zero.

Initial discussions of Agenda 2000 considered a single yield for all annual crops in irrigated land. This possibility is studied in Scenario *E*. Thus, this yield would be calculated on a regional basis, considering a weighted average of current yields for irrigated land. The result of this calculation is 5.6 ton/ha.

All the scenarios are summarized in Table 1.

Table 1. Policy scenarios

	Current Scenario	***Scenario A*** **Agenda 2000**	***Scenario B*** **Ag. 2000 without compensatory payments increase**	***Scenario C*** **Ag. 2000 and partial liberalization**	***Scenario D*** **Ag. 2000 and total liberalization**	***Scenario E*** **Ag. 2000 and a sole yield**
Cereals price variations	*Current*	*-15% current*	*-15% current*	*-15% current*	*-15% current*	*-15% current*
Subsidy (ecus/ton)	*Cereals = 54.34* *Oilseed = 94.24* *Proteins= 78.49* *Set-aside=68.83*	*Cereals = 63* *Oilseeds = 63* *Proteins = 72.5* *Set-aside = 63*	*Cereals = 54.34* *Oilseeds= 94.24* *Proteins= 78.49* *Set-aside=68.83*	*Cereals = 31.5* *Oilseeds = 31.5* *Proteins= 36.25* *Set-aside = 31.5*	*Cereals = 0* *Oilseeds = 0* *Proteins = 0* *Set-aside = 0*	*Cereals = 63* *Oilseeds = 63* *Proteins = 72.5* *Set-aside = 63*
Yields used to Calculated payments (ton/ha)	**Average = 3.1** *Maize = 6.5* *Other cereals = 3.0*	**Average = 3.6** *Maize = 7.5* *Other cereals = 3.5*	**Average = 3.6** *Maize = 7.5* *Other cereals = 3.5*	**Average = 3.6** *Maize = 7.5* *Other cereals = 3.5*	**Average = 3.6** *Maize = 7.5* *Other cereals= 3.5*	*Average = 5.6*
Set-aside	*5%*	*10%*	*10%*	*10%*	*0%*	*10%*

Results

To model the impact of the previous scenarios, we must find first the farmers' utility function. Optimising each objective separately and obtaining the values of the other objectives at the optimal crop distribution, we have the pay-off matrix as in Table 2.

Table 2. Pay-off matrix for gross margins, risk and amount of labour

	Optimum values			*Observed values*
Achieved values	**GM**	**MOTAD**	**Labour**	
GM (pesetas/ha)	14,127,856	3,635,470	2,776,139	12,328,862
MOTAD (units/ha)	3,602,744	334,002	565,270	2,158,370
Labour (man-days/ha)	810.3	111.3	40.0	706.5

The weights for each objective are calculated using the observed values of each objective from the current crop distribution. Since the initial system does not have a solution, we use goal programming to minimize the sum of negative deviations to obtain the weights for each objective, as explained in step (4). The following formula represents the farmers' utility function that attempts to reproduce the farmers' decision process:

$$U = 0.757 \cdot GM - 0.243 \cdot Risk - 0.000 \cdot Labour$$

Thus, only gross margins and risk will be considered in the farmers' utility function. To normalize this expression we have to divide each coefficient by the observed value of each objective. The utility function appears as:

$$U = 6.67 \cdot GM - 7.45 \cdot Risk$$

This utility function was used to model the impact of Scenarios *A* to *E*. We present the results on crop distribution, gross margins, total income, labour and use of water and fertilizers.

Crop distribution

Crop distribution changes by scenario can be seen in Table 3. Some of these results show a similar pattern. The increase of the set aside rate (except in Scenario D) is due to the CAP reform from 5 to 10 per cent. It is worth noting the apparent paradox of taking out production of highly fertile land when, from an environmental point of view, it would be more suitable to do so in less productive and much more environmentally sensitive land.

Table 3. Crop distribution changes in each scenario (hectares)

Scenario	*Other cereals*	*Maize*	*Sugar beet*	*Sunflower*	*Alfalfa*	*Set-aside*
Current	33,10	31,94	15,95	6,25	10,55	2,21
A	13,73	47,72	20,50	0,00	11,91	6,14
B	14,67	46,77	20,50	0,00	11,91	6,14
C	17,41	44,04	20,50	0,00	11,91	6,14
D	29,93	37,66	20,50	0,00	11,91	0,00
E	30,74	30,70	20,50	0,00	11,91	6,14

In all scenarios there is an increase of sugar beet and alfalfa hectares as a consequence of the relative improvement of these agricultural products with respect to COPs. The increase of alfalfa and sugar beet is limited in the constraint set (market and quota constraints, respectively).

The substitution of sunflower for sugar beet and alfalfa is due to the reduction of the profitability of sunflower (with the same area payment as cereals in Agenda 2000 and all

scenarios in this study except *B*), making this crop less attractive. Yet, the Spanish government has suggested an extra payment for oilseed based on its positive impact on the environment.

Scenario *A*. An increase of maize hectares is expected (49 per cent increase over current hectares) and a reduction of winter cereals (58 per cent). These changes would have been hardly predicted from a profit maximising model since the reform has a little impact on the gross margins for maize and winter cereals. The substitution effect can be explained by the two components of the utility functions. Thus, the increase of subsidies and the reduction of prices make the maize a much more interesting crop due to the almost similar gross margins but lower risk. It is worth noting, that the maximisation of total gross margins as the sole objective, would have produced less changes due to the small variations in crop gross margins.

Scenario *B*. In this case, without the increase of the area payments, the results are similar to those obtained in Scenario *A*, substituting winter cereals for maize, although less intensively. The gross margins for maize and winter cereals are reduced compared to Scenario *A,* but the relative improvement of maize justifies the change. As in the previous scenario, the cause of the substitution is the same, that is, similar maize gross margin after the implementation of Agenda 2000, but lower risk. Thus, although there is not area payments compensation, the changes in the composition of total income as a consequence of the price reduction and the increase of the theoretical yields in Spain (i.e. the increase of area payments), produce this substitution.

Scenario *C* and *D*. The progressive reduction of area payments in both scenarios causes the substitution of maize for winter cereals. In the extreme case (Scenario *D*, no area payments), the hectares of maize and winter cereals are similar. These changes can be explained from the effect of the liberalization measures on these crops and how the new composition of the crop total income, changes the value of the farmers' utility function.

The different scenarios show the distorting effect of the new Common Agricultural Policy, positively biased towards maize, that makes this crop less risky due to its relatively high area payments.

Scenario *E*. In this scenario, all theoretical yields are merged for all COPs. The model predicts the same hectares for winter cereals and maize. This result supports our previous comment on the distorting effect of the CAP.

Total gross margins and total income

The changes in total gross margins and total income are presented in Table 4.

Table 4. Economic impact of different scenarios

Scenario	**Gross margin**		**Total income**	
	Pesetas/ha	Relative change	Pesetas/ha	Relative change
Current	130,188		271,245	
A	133.117	2,25%	288.017	6,18%
B	126.648	-2,72%	280.727	3,50%
C	108.002	-17,04%	259.711	-4,25%
D	81.542	-37,37%	230.945	-14,86%
E	128.911	-0,98%	269.047	-0,81%

Scenario *A*. According to the simulation results, Agenda 2000 implies a slightly positive impact on total gross margins (2.3 per cent) and total income (6 per cent). This is due to an increase of sugar beet and alfalfa. However, if the previous crop distribution is not changed, the reform will have a negative effect on both variables of 7 and 4 per cent, respectively. Thus, the effect of Agenda 2000 on COPs is slightly negative, albeit a positive farm effect if all the crop changes are considered.

Scenarios *B*, *C* and *D*. The results from these scenarios are clearly negative, with a reduction in total gross margins of 3.7, 17 and 37 per cent, respectively. The impact would be greater if the substitution of COPs for sugar beet and were not possible. This results would make it difficult for many small producers to continue their farming activities. The implications of such policies should be carefully considered in the future WTO negotiations and the Eastern enlargement.

Scenario *E*. The last scenario has a small negative impact on farm income and rural economy.

Farm labour

In all scenarios there is an increase of farm employment ranging from 9.84% (Scenario *E*) to 12.99% (Scenario *D*). This is due to the increase of sugar beet and maize (except in Scenario *E*). However, most of this labour will be provided by the farmer's relatives and hiring will be needed just for some activities (irrigation and harvest).

Table 5. Amount of labour, use of fertilizers and water consumption for all scenarios

Scenario	***Amount of labour***		***Use of fertilizers***		***Water consumption***	
	man-day labour/ha.	Relative change	Units/ha	Relative change	m^3/ha	Relative change
Current	7.00		216.16		4.863	
A	7,80	11,50%	243,75	12,76%	4.862	0,00%
B	7,80	11,40%	241,74	11,83%	4.835	-0,56%
C	7,78	11,14%	235,95	9,15%	4.757	-2,18%
D	7,91	12,99%	229,16	6,01%	4.750	-2,32%
E	7,69	9,84%	207,65	-3,94%	4.372	-10,08%

Environmental issues (water and nitrates).

The use of fertilizers (nitrates) increases in all scenarios except in Scenario *E* (-3.9 per cent). A positive correlation can be drawn between the increase of fertilizers and the in

crease of maize hectares. Thus, even with a higher set aside rate, the new CAP does not reduce the pressure on the environment, in terms of fertilizer use.

In the case of water consumption, there is no significant change. The increase of consumption from the increase of maize hectares is offset by the higher set aside rate. In Scenario *E*, with the same hectares for maize and winter cereals, the water consumption decreases by 10 per cent.

Conclusions

The impact of different agricultural policy scenarios on irrigated areas in Northern-West Spain has been shown. The main points may be summarised as follows:

The multicriteria approach is revealed as a useful tool to assess economic, social and environmental impact of changes in prices and compensatory payments. This technique may gain from targeting homogeneous groups of farmers, obtaining a separate utility function for each group.

Risk plays a key role in explaining the behaviour of farmers in this region, according to the value of the risk coefficient in the utility function.

The implementation of Agenda 2000 would result in changes in the crop distribution, with the substitution of sunflower and winter cereals (wheat, barley and oats) for sugar beet, alfalfa and especially maize. These changes would not have much impact on total gross margins and total income.

As compensatory payments are reduced (even to zero), a new change in crop distribution occurs, with a substitution of maize for winter cereals. Besides, these scenarios imply a reduction of total gross margins ranging from 2.7 to 37.37 per cent. Such figures would make it impossible for many farmers to continue their activity.

However, the reduction of the area payments do not necessarily imply taking out of business many farmers, especially the small ones, since rural development measures could obtain a bigger slice of the cake only moving away (gradually, but firmly as stated in the Buckwell's Report) from price support and compensatory payments.

The use of a sole yield instead of the current regionalization plan would have little impact, since it would not alter the equilibrium between maize and winter cereals.

All scenarios have a positive effect on farm employment although the impact on rural employment should be lower since most extra farm labour would be undertaken by the own farm family.

The environmental impact of Agenda 2000 cannot be labelled as friendly since it promotes a change towards more, in terms of fertiliser use, intensive crops. This effect is reduced by the increase of set aside rate.

References

Amador, F., Sumpsi, J.M. and Romero, C. (1998). A non-interactive methodology to assess farmers' utility functions: An application to large farms in Andalusia, Spain. *European Review of Agricultural Economics* 25, 95-109.

Buckwell, A. (1998). The new orientation of the CAP toward an integrated rural policy. *ITEA* 19, 236-253.

Cary, J.W. and Holmes, W.E. (1982). Relationship among Farmers' Goals and Farm Adjustment Strategies: Some Empirics of a Multidimensional Approach. *Australian Journal of Agricultural Economics* 26, 114-130.

Gasson, R. (1973). Goals and Values of Farmers. *Journal of Agricultural Economics* 24, 521-537.

Gómez-Limón, J.A., and Berbel J. (1995). Aplicación de una metodología multicriterio para la estimación de los objetivos de los agricultores del regadío cordobés. *Investigación Agraria: Economía* 10, 103-123.

Gómez-Limón, J.A., Sánchez, F.J., Rodríguez, A. and Lara, P. (1996). Socioeconomic Impact Evaluation of the Drought in Irrigated Lands in Southern Spain: A Multicriteria Decision Making Approach.. *Lectures Notes in Economics and Mathematical Systems* 455, 84-92.

Guyomard, H., Baudry, M. and Carpentier, A. (1996). Estimating crop supply response in the presence of farm programmes: application to the CAP. *European Review of Agricultural Economics* 23, 401-420.

Hatch, R.E., Harman, W.L. and Eidman, V.R. (1974). Incorporating Multiple Goals into the Decision-Making Process, A Simulation Approach for Firm Growth Analysis. *Southern Journal of Agricultural Economics* 7, 103-10.

Hazell, P.B. (1971). A linear Alternative to Quadratic and Semivariance Programming in Farm Under Uncertainty. *American Journal of Agricultural Economics* 53, 53-62.

Hazell, P.B.R. and Norton, R.D. (1986). *Mathematical Programming for Economic Analysis in Agriculture*. New York: Macmillan Publishing Company.

Herath, H.M.G. (1981). An Empirical Evaluation of Multiatribute Utility Theory in Peasant Agriculture. *Oxford Agrarian Studies* 10, 240-254.

Lansink, A.O. and Peerlings, J. (1996). Modelling the new EU cereals and oilseed regime in the Netherlands. *European Review of Agricultural Economics* 23, 161-178.

Russell, N.P. and Fraser, I.M. (1995). The potential impact of environmental cross-compliance on arable farming. *Journal of Agricultural Economics* 46, 70-79.

Sumpsi, J.M., Amador, F. and Romero, C. (1993). A research on the andalusian farmers' objetives: methodological aspects and policy implications. en Aspects of the Common Agricultural Policy. VIIth EAAE Congress, Stresa, Italy.

Sumpsi, J.M., Amador, F. and Romero, C. (1997). On farmers' objectives: A multi-criteria approach. *European Journal of Operational Research*. 96, 64-71.

APPENDIX 1. Data on prices, yields, costs and gross margin for main crops in *Bajo Carrión*

Year	Wheat	Barley	Oat	Maize	Sugar b.	Sunflow.	Alfalfa	Set-aside
Agricultural commodity prices (pesetas/kg)								
1993	24.0	22.7	21.9	26.2	7.5	31.5	15.9	0
1994	24.0	21.1	21.1	26.8	7.9	32.4	17.7	0
1995	27.1	24.1	24.6	26.8	7.8	35.2	23.6	0
1996	24.3	22.2	22.2	27.0	7.5	29.8	21.1	0
1997	23.4	21.0	21.0	23.5	7.6	32.0	21.6	0
Yields (kg/ha)								
1993	4,375	4,795	4,828	4,978	69,943	1,806	11,955	0
1994	3,986	4,338	3,985	9,007	54,796	2,580	9,963	0
1995	3,403	3,653	3,525	8,533	61,188	2,322	10,627	0
1996	4,618	4,715	3,218	9,481	66,851	2,236	12,177	0
1997	4,387	4,479	3,057	9,007	63,508	2,124	11,568	0
Compensatory payments (pesetas/ha)								
1997	32,669	32,669	32,669	68,061	0	56,657	0	45,978
Total income (pesetas/ha)								
1993	137,538	141,649	138,586	198,329	551,275	113,603	190,331	45,978
1994	128,416	124,286	116,746	309,099	457,241	140,202	176,044	45,978
1995	124,782	120,706	119,417	297,096	502,657	138,396	250,267	45,978
1996	145,026	137,192	103,989	323,776	526,710	123,293	256,566	45,978
1997	135,329	126,726	96,876	279,375	508,661	124,635	249,406	45,978

APPENDIX 1. Data on prices, yields, costs and gross margin for main crops in *Bajo Carrión (con.)*

Year	Wheat	Barley	Oat	Maize	Sugar b.	Sunflow.	Alfalfa	Set-aside
Variable costs (pesetas/ha)								
1993	52,718	53,072	50,091	146,741	241,794	58,290	97,985	9,026
1994	55,354	55,726	52,596	154,078	253,884	61,205	102,884	9,477
1995	57,990	58,379	55,100	161,415	265,974	64,120	107,784	9,928
1996	61,522	61,935	58,457	171,247	282,174	68,025	114,349	10,533
1997	63,525	63,952	60,360	176,823	291,362	70,240	118,072	10,876
Gross margins (pesetas/ha)								
1993	84,820	88,576	88,495	51,588	309,481	55,313	92,346	36,953
1994	73,062	68,560	64,150	155,021	203,357	78,997	73,160	36,501
1995	66,793	62,326	64,317	135,680	236,683	74,276	142,484	36,050
1996	83,505	75,257	45,532	152,530	244,537	55,268	142,218	35,445
1997	71,804	62,774	36,516	102,552	217,299	54,395	131,334	35,102
Gross margins, base year 1997 (pesetas/ha)								
1993	102,208	106,735	106,637	62,164	372,925	66,652	111,276	44,528
1994	83,847	78,681	73,620	177,905	233,376	90,658	83,959	41,890
1995	73,168	68,276	70,456	148,632	259,276	81,366	156,084	39,491
1996	86,224	77,707	47,015	157,496	252,499	57,068	146,848	36,600
1997	71,804	62,774	36,516	102,552	217,299	54,395	131,334	35,102
MEDIA	83,450	78,834	66,849	129,750	267,075	70,028	125,901	39,522
Labour requirements (man-day labour/ha)								
	3.22	4.01	4.01	4.30	21.00	2.64	9.84	0.40
Use of fertilizers (Units/ha)								
	110.00	110.00	110.00	358.00	255.00	75.00	190.00	0.00
Water consumption (m^3/ha)								
	2,800	2,800	2,800	7,200	4,200	2,800	7,200	0

Source: Survey on farmers and official statistics

APPENDIX 2. Multicriteria model (current situation)

Variables	X1	X2	X3	X4	X5	X6	X7	X8	Mean negative deviations						
	WHEAT	BARLEY	OATS	MAIZE	S. BEET	SUNF.	ALFAL.	S.-ASIDE	n1	n2	n3	n4	n5		
					Objectives										
GM	83.450	78.834	66.849	129.750	267.075	70.028	125.901	39.522							
MOTAD									1	1	1	1	1		
MO	3,22	4,01	4,01	4,30	21,00	2,64	9,84	0,40							
					Constraints										
GM 1993	-18.758	-27.900	-39.788	67.586	-105.850	3.376	14.624	-5.006	1					>=	0
GM 1994	-397	154	-6.771	-48.155	33.699	-20.630	41.941	-2.368		1				>=	0
GM 1995	10.282	10.559	-3.607	-18.882	7.799	-11.338	-30.184	31			1			>=	0
GM 1996	-2.774	1.127	19.834	-27.747	14.576	12.960	-20.948	2.923				1		>=	0
GM 1997	11.647	16.061	30.333	27.198	49.776	15.633	-5.434	4.420					1	>=	0
Total area	1	1	1	1	1	1	1	1						=	100
CAP 1	-0,05	-0,05	-0,05	-0,05		-0,05		1						>=	0
CAP 2	-0,5	-0,5	-0,5	-0,5		1		-0,5						<=	0
CAP 3					1									<=	20,5
Rotation 1				1										<=	50
Rotation 2					1									<=	50
Rotation 3						1								<=	50
Frequency 1							1							<=	57,14
Market							1							<=	11,91