Viability of the raw cotton production in Spain after the decoupling of the subsidies

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Abstract

Considering the latest reform of the EU's Cotton Regulation of 29th April 2004, which will come into force in the 2006/07 season, we analyse its impact on the cotton production sector of Andalusia. The decoupling of subsidies implies that producers will be entitled to 65 per cent of the amount received in the reference period (three years) irrespective of the crop chosen to grow. The remaining 35 per cent (slightly higher) is paid as cotton area payment. In this research, first from a survey carried out in 2004 we obtained six groups of producers using factor analysis and cluster analysis. Then, based on this characterization, we assess the impact of two policy scenarios: (a) the implementation of the reform without any additional measures, and (b) the addition of a complementary environmentally based area payment plus the modulation of the decoupled subsidy up to 50 per cent according to raw cotton quality. In the first scenario most producers would reduce the use of inputs to a minimum and leave the raw cotton in the fields. In the second scenario the production of cotton would shift from conventional toward Integrated Production with a reduction of 30% with respect to the current area.

JEL classification: Q11, Q18.

Key-Words: Cotton, Spain, Mid-Term Reform, Simulation, Multi-Criteria Decision Making.

1. Introduction

Cotton is the most important irrigated arable crop in Southern Spain with an average of some 92,410 ha (period 1999-2003-) being grown by 9,200 farms. In addition to its extent, cotton cultivation in this Objective 1 region has an undoubted relevance from a social point of view, employing 1.47 million man-days (Farm Accountancy Data Network, 2000) and two-thirds of the total farm labour generated from irrigated extensive arable crops (Arriaza *et al*., 2000). Furthermore, the cotton production involves a complex economic sector of input supplier companies and 27 ginning firms.

This study analyzes the economic viability of the cotton cultivation in Spain after the implementation of the Council Regulation (EC) No 864/2004 of 29 April 2004 in the season 2006/07. Following the decoupling of the subsidies of this reform, the producer receives 65% of the subsidies obtained during the reference period (2000-2002) as a fixed payment of 1,509 €/ha, for an eligible area of 70,000 ha, and 35% as area payment (up to 1,039 €/ha). In order to receive this area payment the producer does not need to harvest the raw cotton; the only requirement is to reach the open capsule stage. This requirement would make it more profitable for most producers to shift from conventional production to semi-abandonment cotton production, which would involve a drastic reduction in input usage (fertilizers, pesticides and irrigation water) and no harvest.

Within this framework, the first objective of the paper is to analyse the foreseeable impacts of the implementation of subsidy decoupling and check the above hypothesis regarding the breakdown of the Spanish cotton sector. In order to prevent crop abandonment, two additional policy measures might be considered under the new rules:

- A supplementary crop-specific environmental area payment to encourage a shift from conventional production to integrated production.
- The modulation of the cotton area payment to a maximum of 50%, according to the quality of the raw cotton that producers sell to the ginning companies.

The second objective of the paper is to evaluate the convenience of both measures and consider their effects on the cotton sector.

2. Economic analysis of cotton cultivation in Spain

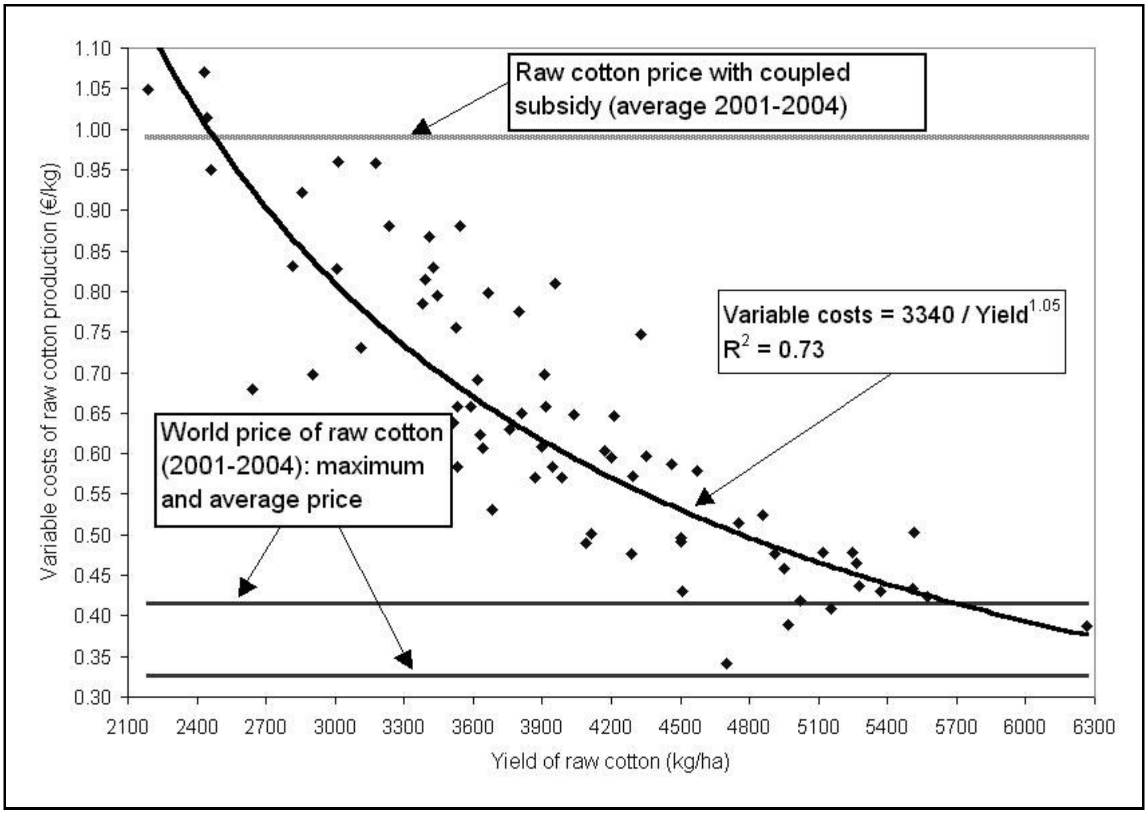
2.1. Source of data

The database of an accounting company containing data on 125 farms for the seasons1999/2000 to 2002/2003 was used to calculate average yields, variable costs and gross margins of cotton and other substitutive crops such as cereals, oilseed, sugar beet and vegetables. The cotton output response to input dosage (water and fertilizer) was estimated from the Andalusian Agricultural Experimental Network (RAEA) trials. Finally, a mail survey carried out in 2004 through the FEOGA regional organism targeted the census of cotton producers in Andalusia, which had a response rate close to 10% (835 valid questionnaires), made it possible to build a typology of farmers to distinguish among different responses to agricultural policy scenarios according to individual utility functions.

2.2. Cotton variable costs by yields

Statistical analysis of the data revealed that variable costs per kg of raw cotton depend on cotton yield, which itself depends on the farm irrigation system (gravity, sprinkle or drip) and the type of sowing (with or without plastic protection). The analysis of the production variables costs therefore does not consider either farm size or any other structural characteristic, but exclusively cotton yields, as the following figure shows.

Figure 1. *Relationship between variable costs and yields in cotton cultivation*



Source: Data on variable costs and yields of 73 farms during the period 2000/01–2002/03

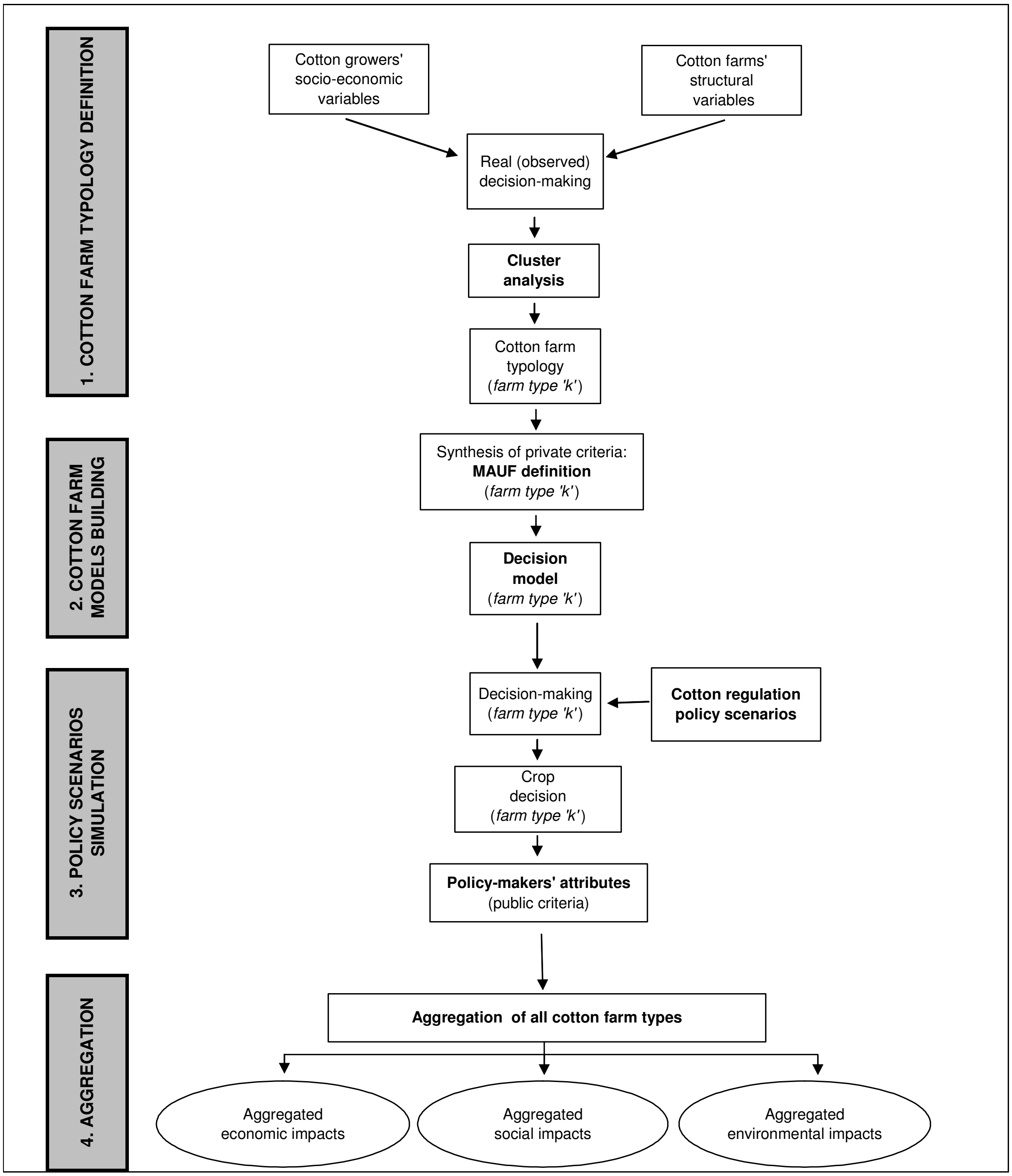
The average cotton price that producers received with the previous coupled subsidy, and the inverse nonlinear relationship between variable costs and yields shown in Figure 1, mean that for most cotton producers, the optimum strategy has been the maximization of production (yields increase). However, following the reform undertaken in April 2004, the price of raw cotton for EU producers in the 2006/07 season would not be able to cover their variable costs. Even assuming the maximum world price in the 2001-2004 period, only producers with yields above 5,600 kg/ha would do it. In the survey, which returned 835 valid questionnaires, only 2% of producers match this target. The initial conclusion becomes straightforward: unless some corrective measures are introduced, Spanish cotton cultivation, or at least its harvest, will come to an end.

3. Methodology

3.1. Outline

The methodology adopted by this study can be graphically displayed as in Figure 2. According to this plan, the proposed methodology can be divided into four principal stages, as outlined below.

Figure 2. *Outline of methodology*



The first stage differentiates among the different groups of cotton growers to be analyzed. These groups, as has been observed, should be sufficiently homogeneous in their decision-making behaviour (weighting of the objectives considered) to allow aggregate models to be constructed and resolved without unwanted bias. This classification of farmers was performed by the cluster analysis. Once homogeneous groups of farmers have been defined, the second stage builds the mathematical models. For each cluster a different multi-criteria model was developed, in order to allow independent simulations based on the decision-making behaviour of the various groups of farmers to be run. The third stage of the study performs the simulations. Thus, considering from the regulation for the cotton sector scenarios already explained, the decisions taken, i.e. crop mixes, by the clusters of farmers were obtained in the different cases.

3.2. Multi-criteria programming approach

Taking into account the evidence about how farmers take their decisions while trying to simultaneously optimize a range of conflicting objectives, we have proposed Multi-Attribute Utility Theory (MAUT) as the theoretical framework for the MCDM programming modelling technique to be implemented. MAUT, particularly as developed by Keeney and Raiffa (1976), has often been claimed to have the soundest theoretical structure of all multi-criteria techniques (Ballestero and Romero, 1998). At the same time, from a practical point of view, the elicitation of utility functions has presented many difficulties. In this paper, we have followed a methodology that tries to overcome these limitations, assuming some reasonable simplifications.

In an additive Multi-Attribute Utility Function (MAUF), alternatives are ranked by adding contributions from each attribute. Since attributes are measured in terms of different units, normalization is required to enable them to be added. The weighting of each attribute expresses its relative importance. Although the additive utility function represents a simplification of the true utility function, the mathematical form, Edwards (1977), Farmer (1987), Huirne and Hardaker (1998) and Amador *et al*. (1998) have all shown that the additive function yields extremely close approximations to the hypothetical true function even when the conditions of utility independence are not satisfied (Fishburn, 1982; Hardaker *et al*., 1997).

Having justified the use of the additive utility function, we take the further step of assuming that the individual attribute utility functions are linear. Its simplest mathematical form is:

$$U_j = \sum_{i=1}^{n} w_i r_{ij} \,, \qquad i = 1, \ldots, m \qquad (1)$$

where r_{ij} is the value of attribute i for alternative j.

Finally, from a theoretical point of view, it is worth mentioning that in addition to the theoretical advantages of this approach explained above, the additive-linear utility specification used in this paper has been chosen on the basis of a comparison with other specifications, as explained in Arriaza and Gómez-Limón (2003).

After a survey of the study area, we concluded that cotton growers choose a crop distribution that takes the following objectives into account:

- *Maximization of total gross margin (TGM)*, as a proxy of profit. TGM is obtained from the average crop gross margins from a time series of seven years (1993/1994 to 1999/2000) in constant 2000 euros.
- *Minimization of variable cost (TVC).* This objective implies not only a reduction of costs but also a decrease of risk assumed by farmers and a reduction of managerial involvement (variable costs-intensive crops are most risky and require more technical supervision).

3.3. MAUF elicitation technique

We have selected a methodology that avoids the necessity of a process of interaction with farmers, and in which the utility function is elicited on the basis of the revealed preferences implicit in the real values of decision variables (i.e. the actual crop mix). The methodology adopted for the estimation of the additive MAUFs is based upon weighted goal programming and has previously been used by Arriaza *et al.* (2002), Gómez-Limón *et al.* (2002 and 2004) and Gómez-Limón and Riesgo (2004). As *Dyer* (1977) demonstrated, the weights obtained are consistent with the following separable and additive utility functions:

$$U = \sum_{i=1}^{q} \frac{w_i}{k_i} f_i(x) \qquad (2)$$

where k_i is a normalizing factor.

3.4. Models for scenario simulations

In order to simulate the various cotton regulations considered, we have decided to estimate optimal crop-mixes in each case (groups of cotton growers and policy scenarios) through the individual mathematical models developed. These models include a set of *decision variables* representing the surface devoted to each crop. Thus, the cotton growers' production adjustments as they face different policy scenarios are based on substitution of crops, depending on their contribution to the farmers' MAUFs.

At this point it is necessary to point out that it is possible to sow cotton with minimum use of inputs and to leave it in the field. We have called this new activity "cotton in semi-abandonment". Two further cotton production possibilities exist: the conventional system ("conventional cotton"), without the 352 €/ha environmental area payment in Scenario B, and the integrated system ("PI cotton"), which includes that area payment. The modulation considered in scenario B applies to all three cotton production possibilities.

For each group of cotton growers an utility function was elicited in order to simulate their response to the policy scenarios. These MAUFs, as explained above, are the ones to be considered as objective functions. In order to model building we identify the following *constraints* applied to each group of farmers:

- *Land constraint*. The sum of all crops must be equal to the total surface available to the farm type of each cluster.
- *CAP constraints*:
    - The level of the area payment is proportionately reduced as eligible cotton area exceeds the maximum area (70,000 ha for Spain).
    - It is forbidden to substitute either COP crops or cotton for vegetables. The maximum increase of vegetables is limited to 10% more than the observed area.
    - Sugar beet is limited because of the quota. In each cluster this crop is limited to the maximum area sown during the period studied (1999-2004).
- *Rotational constraints*. These were taken into account according to the criteria revealed for the farmers in the survey.
- *Market constraints*. We decided to limit the area of perishable crops (vegetables) to the maximum in the period 1999-04 because of the inelasticity of demand for these crops.

Finally, it is also worth noting that the implementation of CAP Reform developed through the Mid Term Review (MTR) has been considered. Thus, area payment of COP crops is reduced to 25% of the current level. The rest is paid as single payment to the producers, following a recently approved national regulation. We also assume the implementation of the Commission's proposal for the reform of the sugar CMO, with a sugar beet price of €32.8/t for 2005/06.

4. Results

4.1. Classification of cotton farmers

In order to simulate the behaviour of farmers who face agricultural policy changes, first, due to clear agro-climate differences, we have classified the survey sample into two sub-samples as follows: *High Guadalquivir* (186 cases) and *Low Guadalquivir* (430 cases).

The classification variables used to group cotton growers within each group have been the area percentage of each crop in their farms. Since a total of 11 crops exceed the maximum suitable for cluster analysis, we carried out factor analysis to reduce the number of classifying variables. In both groups, the number of cases was more than 10 times the number of variables, as a necessary sample size for factor analysis (Nunnally, 1978; Kass and Tinsley, 1979).

Using SPAD 5.0, two factors with eigenvalues greater than 1 and a cumulative explained variance of 55% were retained following Stevens' rule of sample size and importance of factor loadings (Stevens, 1992). While the first factor explains the farm's cotton specialization, the second refers to irrigation water requirements.

Once the number of decision variables was reduced, the cluster analysis used the two factors as classifying variables. Based on the Euclidean distance among cases and the minimum variance method (Ward method) to aggregate them (Hair *et al*., 1998), three clusters in each sub-sample were obtained. The following table summarizes the characteristics of each cluster.

Table 1. *Characteristics of the farm clusters*

	High Guadalquivir			Low Guadalquivir		
	Cluster H1	*Cluster H2*	*Cluster H3*	*Cluster L1*	*Cluster L2*	*Cluster L3*
Main crops	Cotton (47%) Maize (36%)	Cotton (39%) Wheat (23%)	Cotton (99%)	Cotton (45%) Maize (39%)	Cotton (44%) Sugar b. (27%)	Cotton (98%)
Average farm size (ha)	43.1	49.2	4.4	30.2	45.2	6.9
% of producer's income from farming	83%	80%	72%	88%	87%	76%
% of farmers that hire workers	76%	64%	35%	76%	66%	48%
% of irrigation systems (gravity-sprinkle-drip)	52%-29%-19%	39%-39%-22%	33%-12%-55%	13%-5%-82%	32%-21%-47%	28%-10%-62%
Number of farmers	49	36	101	87	128	215
Aggregated area	2,112	1,771	444	2,627	5,784	1,492

Source: Survey of cotton producers in Andalusia (2004).

4.2. Weights of the farmers' objectives

From the observed crop distribution of each group of farmers six MAUFs were elicited. The following table shows the current total gross margin (TGM) and total variable costs (TVC) of the farm derived from the observed crop distribution, the theoretical maximum TGM and its associated TVC, the theoretical minimum TVC subject to the achievement of a minimum TGM (forcing the model to sow the whole farm) and its associated TGM, and finally, the weight attached to each objective in the utility function using the multicriteria technique described above.

Table 2. *Current and theoretical extreme values of farm total gross margin (TGM) and total variable costs (TVC). Weight of each objective of the utility function*

		High Guadalquivir			**Low Guadalquivir**		
		H1	*H2*	*H3*	*L1*	*L2*	*L3*
Current values (€/ha)	TGM	1,207	1,169	1,572	1,374	1,218	1,548
	TVC	1,538	1,646	2,297	1,859	1,682	2,238
Maximiz. of TGM (€/ha)	TGM	1,365	1,487	1,583	1,468	1,468	1,612
	TVC	1,789	2,232	2,320	2,034	2,088	2,354
Minimiz. of TVC (€/ha)	TGM	390	390	390	390	390	390
	TVC	243	243	243	243	243	243
Weight of the maximization of TGM (w_1)		*84%*	*71%*	*99%*	*90%*	*78%*	*95%*
Weight of the minimization of TVC (w_2)		*16%*	*29%*	*1%*	*10%*	*22%*	*5%*

Data in Table 2 suggest that farms in the H3, L1 and L3 groups could be named as true seekers of profit maximization. On the other hand, farms in groups H2 and L2 seem to opt for a more conservative crop distribution, i.e. a higher proportion of COP crops, resulting in a greater weighting being given to minimization of TVC.

4.3. Simulated changes in crop distribution

Optimization of the six utility functions in both policy scenarios through the farm type simulation model led to important changes in crop distribution of the area of study.

In *Scenario A*, without any additional policy measures, most of conventional cotton (93%) is substituted by a cultivation system of semi-abandonment. The remaining 7% is substituted by other crops. Thus, the aggregated impact shows increases in maize (57% higher than the current level), sunflower (42%) and wheat (34%). According to these results, no cotton farmer would harvest the raw cotton. This radical forecast might be less severe during the first season for psycho-sociological reasons, such as the farmer's tendency to continue with the production, even when not economically rational, attempting to justify accepting the subsidies, etc.

In *Scenario B*, with the additional environmental area payment and the modulation of the area subsidy, 69% of the current hectareage of cotton would continue under integrated production, finishing the crop season with the harvest of all the raw cotton. Most of the cotton growers who would abandon this crop (31% of the current level) would change to maize and wheat, as is shown in Table 3.

Table 3. *Aggregate crop distribution changes in both policy scenarios (ha)*

Crop / Policy scenario	Current	Scenario A	Scenario B
Cotton	5,979 [a]	0	4,147 [b]
Cotton: semi-abandonment	0	5,546	0
Sunflower	466	661	1,399
Protein crops	283	226	226
Vegetables	388	427	427
Maize	2,262	3,547	3,444
Potatoes	252	258	267
Sugar beet	1,564	0	0
Wheat	1,535	2,063	2,819

[a] Conventional cotton
[b] Integrated production of cotton

5. Conclusions

According to the economic analysis carried out in this study, the reform of the cotton market regulation of April 2004 could mean the complete end of cotton production in Spain. Due to the situation of low world prices far below the variable costs of production, the decoupling of subsidies would probably lead to farmers sowing the current cotton area (some 90,000 ha) but in a semi-abandonment system of cultivation, that is, minimizing the use of inputs and leaving the raw cotton in the field.

The alternative scenario proposed in this study includes an additional area payment of approximately 350 €/ha of environmental nature for shifting from conventional cotton production to integrated production. The approved area payment of 1,039 €/ha is also modulated according to the quality of the raw cotton to a maximum of 50% of that amount. The simulation of this alternative scenario suggest that the current cotton area of Spain, some

90,000 ha, could be reduced up to approximately 59,000 ha, a figure that would mean the continued existence of the cotton sector in Spain.

In general, the net increase in FEOGA expenditure of €3 million resulting from the implementation of these additional measures, the environmental payment plus the modulation of the subsidy, would be offset by the continuation of cotton production under more stringent environmental regulations for more than two thirds of cotton producers (some 9,000 at present). This level of production would ensure the continuation of much of the ancillary industrial sector and would justify subsidies from a social point of view.

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