Assessment of agricultural policy options for sustainable ground-water management: A case study of wetland conservation in Spain

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Assessment of agricultural policy options for sustainable ground-water management: a case study of wetland conservation in Spain

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Abstract. The decrease in water resources is one of the major preoccupations of international institutions in the present context. In several parts of the world, such as the Mediterranean area, over-exploitation of water is the result of easy availability and minimal investment costs but it causes serious damage to wetland ecosystems. Agricultural and environmental policies incorporating water management problems must therefore be developed. The case of the wetlands in the "Tablas de Daimiel" national park in Spain, deteriorated by the over-use of water in irrigated farming, is examined here. The author makes a number of reflections concerning the new context of the European Union development policy and also analyses the profitability of the political options in which it is attempted to integrate environmental and economic objectives.

Keywords. Spain – water management – European Union – agricultural policy

Résumé. *Dans le contexte actuel, la diminution des ressources en eau est une des préoccupations majeures des institutions internationales. Dans plusieurs régions du monde telles que la Méditerranée, la surexploitation de l'eau est due à un accès facile et à des coûts d'investissement minimaux, mais elle est à l'origine d'une dégradation importante des écosystèmes des zones humides. Il est donc nécessaire de développer des politiques agricoles et environnementales qui intègrent les problèmes de gestion de l'eau. Ce texte propose d'étudier le cas des zones humides du parc national « Tablas de Daimiel » en Espagne qui ont été dégradées par la sur-utilisation de l'eau en agriculture irriguée. D'une part l'auteur apporte quelques réflexions sur le nouveau contexte de la politique de développement de l'Union européenne ; d'autre part, il analyse la rentabilité des options politiques qui essaient d'intégrer des objectifs environnementaux et économiques.*

Mots clés. *Espagne – gestion des eaux – Union européenne – politique agricole*

I - Introduction

1. Integrated water management in irrigation agriculture

Water resources are becoming increasingly scarce in many areas in the world and access to water has been reported as one of the major constraints for economic development by a number of international institutions (Rosegrant *et alii,* 2002). The World Commission on Water has pointed out that as world population tripled in the last century, water consumption increased six-fold and future estimates foresee a further increase of about 50% in the next 30 years (UN, 1997). Projections for 2025 estimate that over one half of the world's population will live under severe water stress conditions. This so called "gloomy arithmetic" has come about at high environmental cost and deterioration of water quality. In the past century, 50% of all the world's wetlands have disappeared, a great number of the most important groundwater aquifers have been over-mined while water tables have been progressively deepened and many are damaged, with permanent salinisation and marine intrusion (World Bank, 2002).

Irrigation agriculture is a key sector for food production and economic development but it consumes a large proportion of all available water resources, 70% on average in the world and up to 90% in countries or regions in which water is scarce (Seckler *et alii,* 2000; IWMI, 2000). Past policies world-wide relied extensively on technical solutions for the development of new water catchments based on the construction of dams, reservoirs and water conveyance facilities. Water was delivered at highly subsidised prices, increasing

public costs, exhausting the natural resource base and causing environmental damage. Economic, social and institutional solutions have gradually been incorporated and effective water management has proved to be crucial for promoting modern agriculture, food production and economic development (Rosegrant *et al.*, 2002, Margat and Vallée, 1999).

In this context, environmental impacts and social participation of stakeholders requires the design of cost-effective policies that will address the dual objective of achieving more efficient use of water among competing uses and securing the environmental sustainability of the water resource base. Thus one of the major challenges for public authorities and government agencies is the development of laws, regulations and institutions that will seek economic production, social acceptance and resource conservation by considering the socio-economic and ecological benefits in an integrated approach to water management.

Groundwater is a strategic source of water in many regions in the world, such as the Mediterranean region, that face water scarcity problems and uneven distribution of rainfall in both space and time. The use of groundwater for irrigation has been increasing in these regions due to easy access, the low investment costs of the switch to irrigation and high profitability. These irrigation operations have been basically developed by private initiative resulting in many cases from the private ownership of wells. They have caused the over-exploitation of aquifers and the progressive degradation of associated wetland ecosystems of high ecological value. Conservation of these valuable wetlands requires the development of an appropriate context of agricultural and environmental policies in an integrated approach to water management that will meet the objectives of economic, social and environmental sustainability.

2. Objective of the study: economic development and environmental sustainability

Following this new trend in water management, this paper focuses on a case study of the preservation of wetlands in Spain that had been degraded as a result of the long-term over-drafting of the aquifer resulting from the progressive overuse of groundwater for irrigation agriculture (Llamas, 2001, Iglesias, 2001). The study analyses the cost-effectiveness of alternative policy options that seek to integrate environmental and economic objectives. This means exploring the potential capacity of agricultural policy programmes to include environmental requirements such as the conservation of water resources. The study is centred on the wetlands of the “Tablas de Daimiel” national park situated in the La Mancha region of the southern central Spanish plateau. This case study is discussed and a number of concluding reflections are made concerning policy advising in the new context of EU policy development.

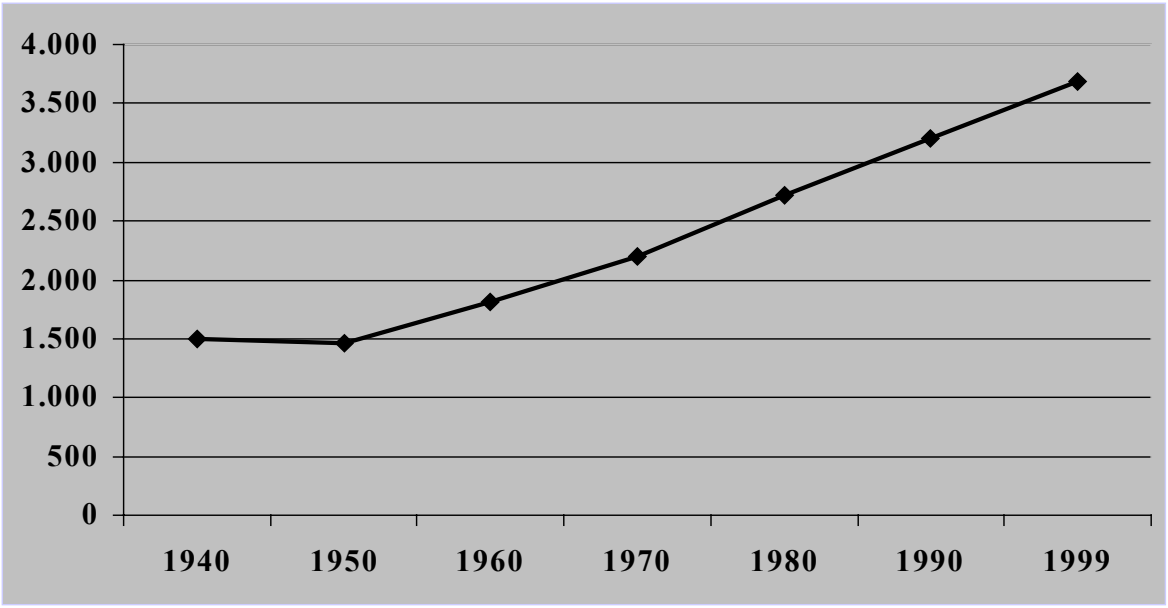
II - Agricultural policies and water use

1. Irrigation policies in Spain

Water resources in Spain are determined by uneven distribution and time and spatial variability of rainfall. Only 10% of water resources are available in the natural environment in comparison with a European average of around 40% (MIMA, 2000). Irrigation policies in the past were characterised by rapid expansion of subsidised public works, such as irrigation networks, dams, reservoirs and inter-basin water transfers. These policies have been widely questioned as elsewhere because of the high public costs and environmental damage. Irrigation policies have now changed and are strongly determined by the progress in water legislation and planning and by the evolution of the CAP reforms (Agenda 2000 reforms and the EU Water Framework Directive). Thus, efforts are concentrated on the rehabilitation and modernisation of existing systems, better water management, increased irrigation efficiency, the adoption of modern irrigation technologies and small-scale irrigation and private initiative (MAPA, 2001).

Irrigation agriculture in Spain is the largest consumer of water in the country, using up to 80% of all available resources (MAPA, 2002). Irrigated land totals over 3,6 million ha, the largest area in the EU, representing 15% of all arable land. However, in economic terms, irrigation agriculture is a key sector in the economy as it accounts for 60% of total agricultural production and 80% of all farm exports (MAPA, 2000). Production of one irrigated ha is six times that of a rainfed ha on average for the country as a whole.

Figure 1. Evolution of irrigated area in Spain (ha)



2. The CAP and irrigation agriculture in the EU

EU policies have strongly affected water consumption in the agricultural sector of the Mediterranean EU countries. The CAP and regional development funds have encouraged large-scale irrigation as a response to production-related direct payments; this has been more acute in the southern EU member states (Baldock *et al.*, 2000). In spite of this, policies in the EU have been seeking more balanced, sustainable integration of the agricultural and environmental sectors. Recent EU environmental policies have been likely to result in a reduction in irrigated areas and an increase in the efficiency of water use. In fact, the trend for integrating environmental objectives in the CAP has been increasing since the first specific initiative of the McSharry reform under Regulation 2078/92 concerning agri-environmental aid. The reform of the CAP under Agenda 2000 gives new impetus to the consideration of environmental conditions in the CAP regimes. One of these instruments is cross-compliance, in which direct payments are conditioned to meeting specific environmental requisites (Article 3 of Common Rules regulation 1259/1999) (Dwyer *et al.*, 2000, Brouwer and Lowe, 2000). Cross-compliance thus has clear potential to contribute to attaining the combined goal of economic development, social stability and nature conservation (as it has been especially stated in the current mid-term review of the CAP) (Commission of the EC, 2002). Thus there is a clear need to carry out specific analyses of the potential of these programmes that are being increasingly considered in various EU contexts (Petersen and Shaw, 2000; Brouwer, 1999).

III - Case study: wetland conservation in the La Mancha region of Spain

1. Competing uses of groundwater: irrigation agriculture and wetland preservation

Past national policies and subsequent CAP production-related direct payments have encouraged the development of irrigation in Spain. As a result, intensive irrigation has caused overexploitation of aquifers and wetland degradation in several Spanish regions of great ecological value (Varela-Ortega *et al.,* 2002, Sumpsi *et al.,* 2000). When water mining exceeds the natural recharge of the aquifer, over-drafting occurs and the wetlands become degraded as the natural flora and fauna disappear.

One of the most remarkable examples of wetland deterioration has been the case of the wetlands in the "Tablas de Daimiel" National Park in the La Mancha region of Spain's southern central plateau. This fragile ecosystem was progressively degraded as a result of overexploitation of the aquifer by the intensively irrigated adjacent farms (Llamas, 2001). This valuable wetland had gained a considerable international reputation for its great ecological value as a habitat of European and African aquatic birds and hibernating waterfowl. Catalogued in the Wet Areas of Europe, UNESCO Biosphere reserve, RAMSAR agreement, EU Birds Directive and Habitats Directive, the area has attracted much international attention (Baldock *et al.*, 2000).

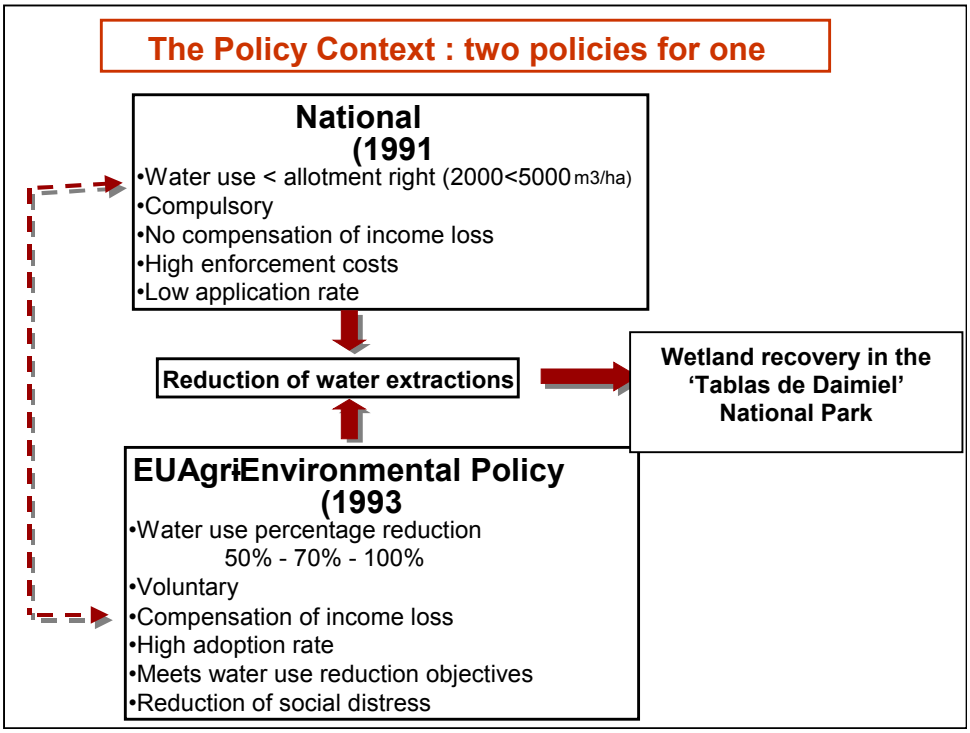
Recovering these lost wetlands requires effective policies aimed at promoting environmental sustainability by eliminating excessive ground water use. In Spain, public ownership of water (including ground water after the enacting of the Water Law of 1985) states that irrigators are granted administrative concessions of water use rights defined by specific water allotments. Water use for irrigation is heavily subsidised in Spain and water charges are paid, in general, on an area basis. Volumetric water charges are therefore rare and so current water management policies do not provide price incentives for water conservation in irrigation agriculture in Spain. Spain thus needs policy instruments to integrate water conservation in agricultural policy programmes (Varela *et al.*, 1998, Iglesias, 2001)

Figure 2. Situation of the "Tablas de Daimiel" National Park

2. The policy framework for recovery of the wetlands

Two different policy programmes coexisted in the region for attaining the same objective of eliminating groundwater depletion and conserving the lost wetlands: a Spanish policy and a EU policy. These two on-going policies created policy synergy of unquestionable economic, social, environmental and institutional interest in the region. However, the instruments of these two policies were drastically different, making the case worth studying. The area covered over 120 000 ha and affected around 8 400 farmers (Viladomiu and Rosell, 1997). The policy framework of the study area is shown in Figure 3.

Figure 3. The policy framework



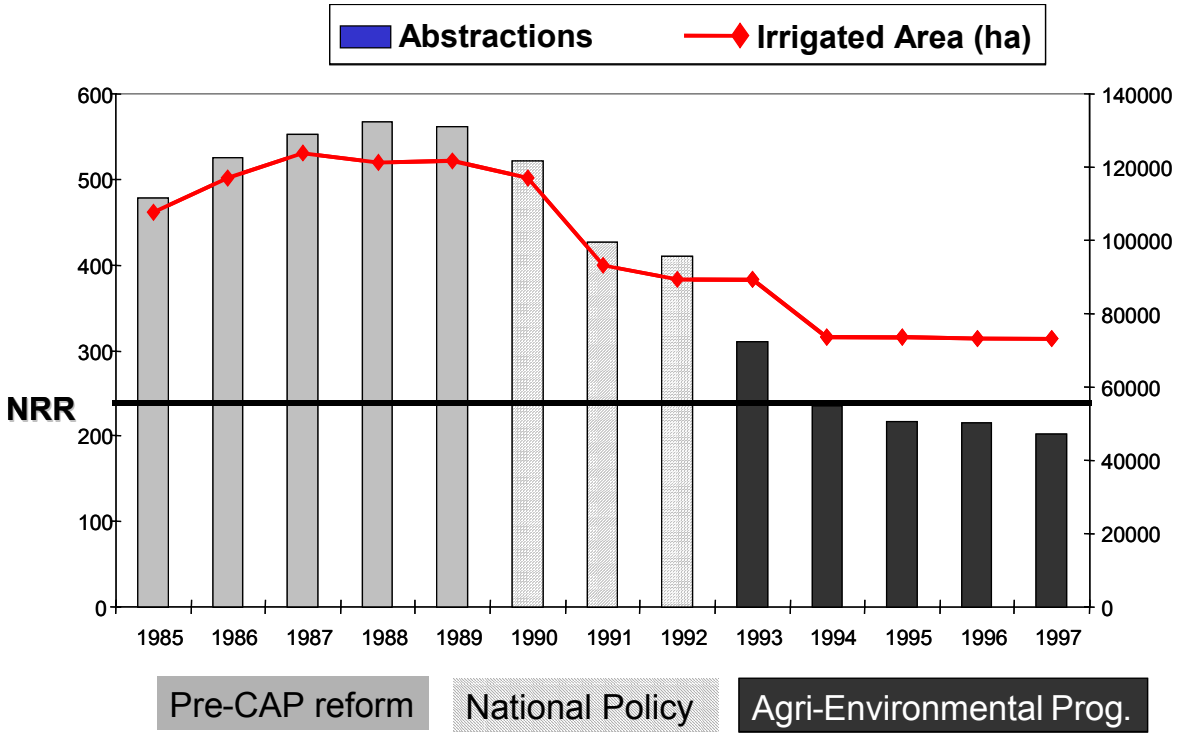
The progressive over-drafting of the "Mancha Occidental" aquifer resulted in the Water Authority in the Guadiana river basin officially declaring the overexploitation of the aquifer, and a specific Spanish regionally-based policy was enacted in 1991 defined by a strict Water Management Regime. This regulation imposed water extraction limitations from the individually operated wells on a compulsory quota system that reduced the irrigators' water allotment entitlement. Water use quotas were established according to farm size, with larger farms having the greatest limitations. On average, water use was restricted to 2 000 m^3/ha, well below the previously established average entitlement volume of 5 000 m^3/ha (MOPTMA-CHG, 1995). Farmers received no compensation for the income loss that resulted from using less water on their irrigated farms. This policy was not well accepted by the farmers in the region and social unrest followed, making the policy difficult to enforce and resulting in an overall low adoption rate.

By 1993, the regional government of Castile-La Mancha had implemented a EU policy under the CAP Environmental programmes of Regulation 2078/92. The programme's environmental objective was to recover the wetlands of the "Tablas de Daimiel" National Park by compensating the farmers that voluntarily chose to reduce water consumption on their farms. The programme set three levels of water use reductions (50%, 70% and 100%) and the corresponding annual compensation payments (an average of € 179 per ha, € 296 per ha and € 414 per ha respectively in 1999)[1] (JCC-LM,1999). The programme largely met its

environmental, economic and social objectives and by mid-1997 a large proportion of the farmers had joined it, covering over 90% of the area. (Viladomiu and Rosell, 1997). Annual water abstractions had been reduced to 300 million m^3, exceeding the programme objective (255-270 million m^3 per year) (JCC-LM, 1999) (Figure 4). The programme also contributed to reducing social distress in the area as farmers were compensated for their income loss and crop diversification to less water-demanding crops that reduced environmental strain was also promoted.

Figure 4 shows the evolution of water abstraction and irrigated area in the region and their relationship to the subsequent policy programmes applied in the region. It can be seen that water consumption and irrigated area increased during the years of the pre-reform CAP and the projected reductions in water abstraction and irrigated area were not attained until the CAP Agri-environmental regulation 2078/92 was applied. The compulsory quota system of the Spanish policy did achieve some water-use reduction but this fell well short of the projected levels. It is clear that the policy programmes within the CAP have had contradictory effects. On the one hand, the production-related CAP programmes induced an increase in irrigation that had unquestionably positive economic and social effects contributing to the overall economic development of a region that had stagnated for decades. On the other hand, these programmes had negative environmental effects such as the over-drafting of the aquifer and degradation of the associated wetlands. To remedy this effect, another CAP programme had to be applied in the form of Agri-environmental aid (Regulation EEC 2078/92).

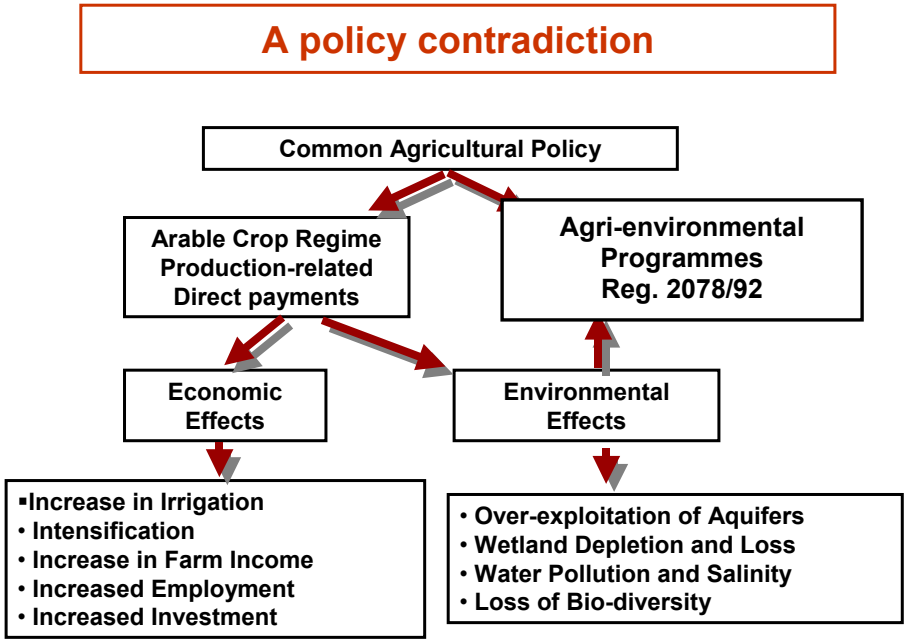
Figure 4. Evolution of water abstraction and irrigated area in relation to policy programmes



3. A policy contradiction?

It has been seen in the preceding section that historically the CAP has had two clear and distinctive effects in the Daimiel zone. The pre-1992 CAP production-related payments encouraged the extension of irrigation in the area, with unquestionably positive socio-economic effects. These were basically an increase in farm income, the development of irrigation-related firms, an increase in employment opportunities and overall economic development in a region that had suffered for a long time. On the other hand, these CAP programs had negative environmental effects such as overexploitation of the aquifer, degradation of the valuable associated wetlands and the loss of aquatic flora and fauna. To remedy these negative ecological effects, another CAP programme was applied in the area under the Environmental programmes of the post-1992 reform. This “policy contradiction” (shown in Figure 5) deserves special attention as it is an example of the increasing need for policy programmes to include environmental requirements among their objectives. This study in centred precisely on this particular issue and on the potential of the new CAP programmes under Agenda 2000 to attain the combined objectives of economic and environmental sustainability.

Figure 5. Policy contradiction under CAP programmes



IV - Assessment of policy options for sustainable water management

Following the discussion in the previous section, two different policies have been applied until now in the Daimiel National Park area of the La Mancha region to limit water abstraction and to ensure sustainable aquifer management. The ultimate objective of these polices was to recover the degraded associated wetlands. However, other policy options proposed in Agenda 2000, such as cross-compliance programmes, have not yet been analysed for attaining the same objective.

1. Analytical framework

The objective of this case study is the comparative assessment of alternative policy options that seek to integrate environmental objectives in agricultural policy programmes with the common objective of achieving sustainable use of the aquifer and the recovery of the wetland ecosystem. For this purpose, the comparative effects that alternative CAP scenarios will have on the environment (water conservation), the private sector (farmers income) and the public sector (public expenditure) are analysed. That is to say the comparative cost-effectiveness of alternative policy options. The central aim of the analysis is to find out whether the implementation of the Agenda 2000 Cross-Compliance programmes will enable a reduction in over-draft from the region's aquifer without substantially reducing farmers' incomes and without increasing the burden on the public budget.

For the purpose of the analysis, a water management model was used consisting of a dynamic mathematical programming model developed in previous research (Sumpsi *et al.*, 1998, Varela-Ortega *et al.,* 1998) and further adapted to the specific case study (Sumpsi *et al.,* 2000). The model is a constrained optimisation farm model in which the farmer maximises his profit function considering technical, economic, financial and policy constraints[2]. The study zone was represented by a set four statistically-based representative farms that characterise the irrigated agriculture in the area and the variety of farming systems (Table 1).

Table 1. Farm typology

	F-1	F-2	F-3	F-4
Area (ha)	8	24	30	70
Soil quality	low	high	medium	medium and low
Cropping pattern	vine	horticulture and arable crops	melon/sugarbeet, arable crops and vine	arable crops
Coverage (% of area)	22	19	28	31

Source: Sumpsi *et al.* (2000)

2. Policy scenarios

Four policy scenarios were chosen within the CAP framework; they represent different alternative policy options (Varela *et al.*, 2002):

E1 (reference scenario): without integration of environmental objectives in the CAP, this corresponds to the area-based CAP direct payments of the 1992 McSharry reform.

E2 (agri-environmental payments): policy applied that corresponds to CAP direct payments and income compensation payments of the Agri-environmental programme (1997). It includes the integration of environmental objectives.

E3 (Agenda 2000 with cross-compliance): incorporates cross-compliance in the Agenda 2000 reforms, introducing changes to crop direct payments and support prices. Direct payments are tied to compliance with limitations on water extraction (Q) as follows:

Q less than 2000 m^3/ha/year	will receive 100% of CAP aid
Q between 2000 - 3000 m^3/ha/year	will receive 70% of CAP aid
Q between 3000 - 4000 m^3/ha/year	will receive 40% of CAP aid
Q more than 4000 m^3/ha/year	will receive 0% of CAP aid

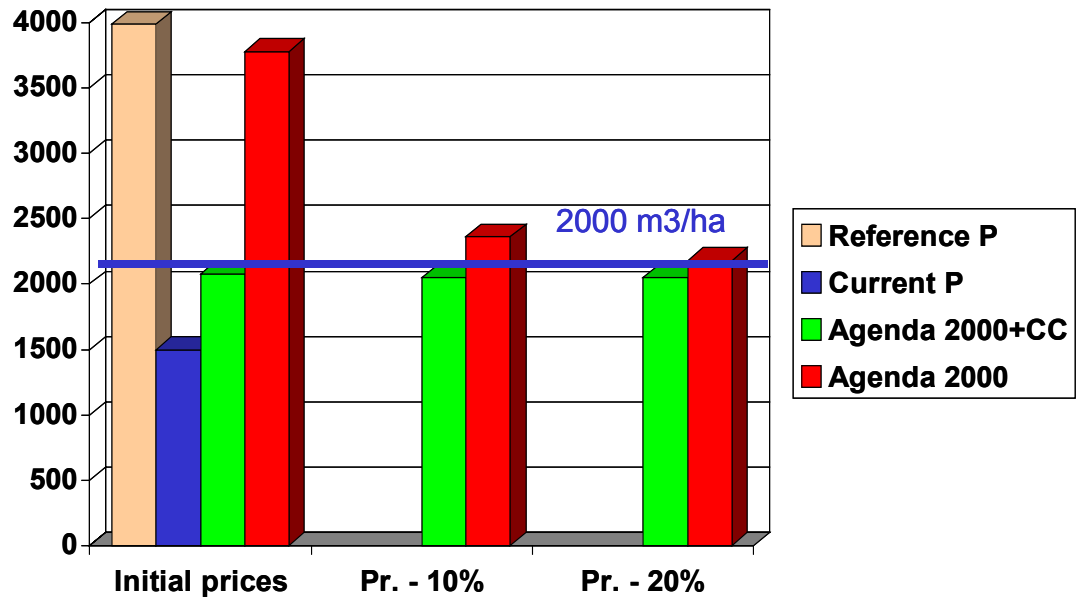
E4 (Agenda 2000 without cross-compliance): this corresponds to the Agenda 2000 reforms to crop direct payments and support prices without integration of any environmental objectives in the CAP.
In Scenarios E3 and E4, three different levels of price support for COP (cereals, oilseeds, protein) crops, initial base-line prices (1999), and reductions of 10% and 20% were assumed to reflect the likely crop price fluctuations on the world market.

V - Results and discussion

The comparative results of the aggregated effects of policy options are summarised in Table 2 and in the figures below. The results are shown for water consumption (Figure 6), farmers' income (Figure 7) and public expenditure (Figures 8 and 9)

Water consumption:

Figure 6. Water consumption (m^3/ha)



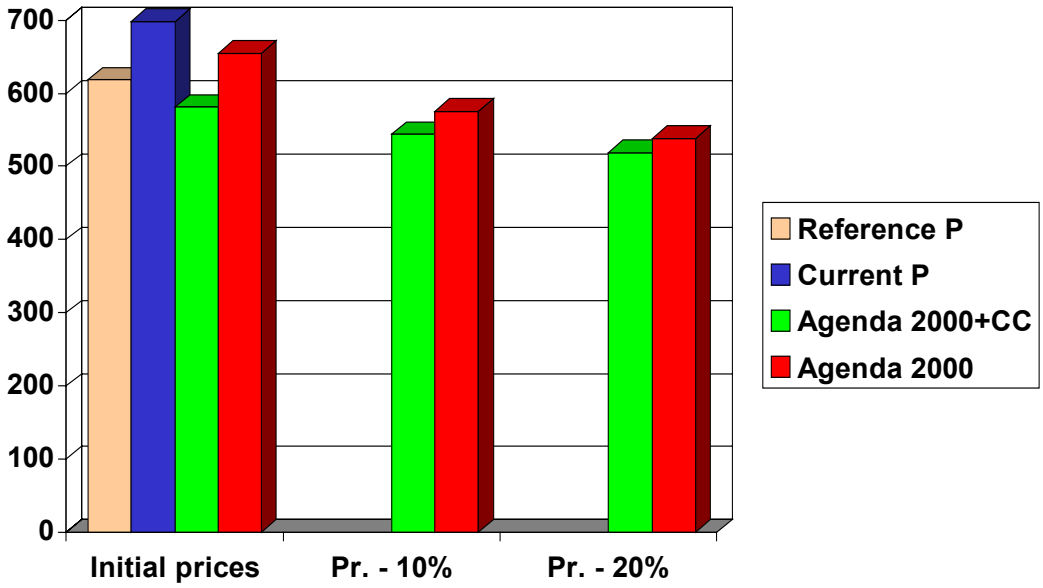
In the reference scenario (E1) water consumption is high, rising to 4 000 m^3/ha, well above the maximum limit of 2 000 m^3/ha allowed by the Spanish water regulation regime to ensure aquifer recovery (corresponding to the natural recharge rate of the aquifer). Thus, over-drafting of the aquifer will continue and even worsen without environmental measures.

Water use reduction is highest (over 60%) in the environmental payments policy (Scenario E2) and total annual water consumption is 1 500 m^3/ha, even less than the water conservation target set. In the cross-compliance scenario (E3), water consumption is reduced by 50%, meeting the required annual limit of 2 000 m^3/ha. When crop prices fall, it is seen that water consumption is stable in the cross-compliance scenario. Cross-compliance policies are thus inelastic to variations in crop prices. In the case of absence of cross-compliance programmes in the Agenda 2000 policy (Scenario E4), water consumption is practically unchanged with respect to the reference policy (only a 5% difference) and will exceed the permitted limit.

However, if prices decrease by 10% or 20%, water consumption is reduced sharply as crops with high water requirements become less profitable.

Farmers income:

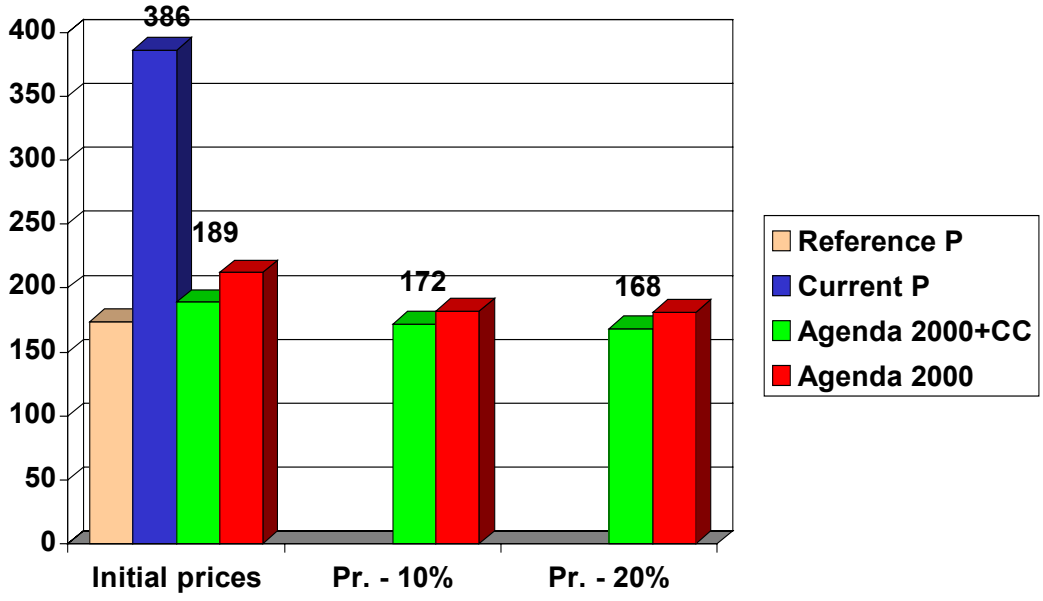
Figure 7. Farm Income (€/ha)



Agri-environmental payments have resulted in large increases in farm income as compared to the reference policy (13% more). In the case of the Agenda 2000 cross-compliance policy, farm income is only slightly lower than in the reference policy (6% less). When crop prices decrease, farm income in the cross-compliance policy remains fairly stable. In the absence of cross-compliance in the Agenda 2000 scenario (E4), farm income will increase by 6% if prices are maintained but will decline to equivalent levels to the cross-compliance policy if prices are reduced (85-90% of the baseline reference scenario).

Public expenditure :

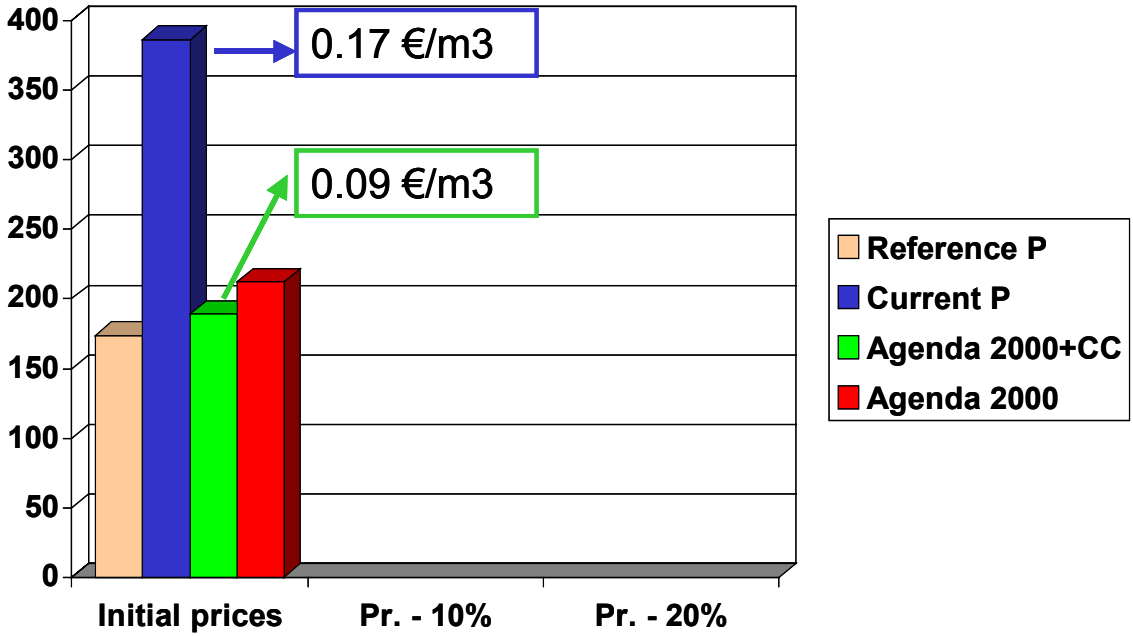
Figure 8. Public Expenditure (€/ha)



Agri-environmental programs (Scenario E2) have much higher public funding requirements than the other policies. In fact, public expenditure doubles in this policy option with respect to the reference policy, reaching annual expenditure of € 386 per ha. In contrast, the cross-compliance alternative will require only small increases in public funds with respect to the reference scenario (9% more), well below the agri-environmental payments option currently applied (€ 189 per ha). Should the crop price decrease by 10% or 20%, the cross-compliance policy will be less costly for the public budget than the reference policy of the 1992 CAP programmes.

The cost-effectiveness of the alternative policies is shown in Figure 8, where the public expenditure needed to save one cubic metre of water in each of the policy programmes that include environmental measures can be compared. In the case of the agri-environmental programmes, each cubic metre saved will cost an average of € 0,17 for the public budget. As in the case of the cross-compliance program, each cubic metre of water saved will cost € 0,09 almost half the amount.

Figure 9. Public expenditure per cubic metre of water saved (€/m^3)



VI - Concluding reflections

- Water use reduction and hence wetland recovery is greater in the agri-environmental payments policy than in the cross-compliance policy, but the differences are not sharp and the required limit to water extraction will be met in both policies;
- a cross-compliance option in Agenda 2000 causes farmers to undertake water saving strategies by growing less water-demanding crops. Large-scale irrigation will be sharply reduced for COP crops (such as maize), and modern water-saving drip irrigation techniques will persist for high value-added crops (melon);
- farmers' incomes are increased with the agri-environmental payments policy but need considerable public funds, as the cross-compliance policy will imply only small reductions in farm income and much smaller public resources;
- in fact, cost-effectiveness is higher in the cross-compliance policy than in the agri-environmental policy that requires double the public resources to saving a unit of water volume;
- balanced integration of environmental objectives in policy programmes is more effectively achieved by the cross-Compliance policy than with any of the other policy programmes. The cross-compliance option in Agenda 2000 will achieve substantial reduction in water consumption with a moderate decrease in farm income at a low public cost;
- market liberalisation, a decrease in crop prices and the elimination of price support programmes reduces water use to an extent equivalent to cross-compliance.

In general, it cannot be concluded that there is a single response to the question of which will be the most efficient instrument for integrating environmental objectives in agricultural policies. It is a question of policy choice. Public choice of policies and instruments for the efficient and integrated management of water resources requires the avoidance of policy contradictions (such as that seen in the CAP programmes applied in the study area and shown in Figure 5).

Consequently, it will be necessary to seek consistency between policy options and policy instruments. In this respect, if a policy of water quotas is chosen, this will imply the direct application of the "Polluter Pays Principle", a compulsory measure with no compensation to the farmers and that will result in high private costs, high policy implementation and enforcement costs but low public expenditure. If an income compensation policy instrument is chosen, this implies the application of voluntary incentive schemes which in turn result in broad social acceptance, high public cost and high monitoring costs. The question that arises in this case is whether farmers should receive income compensation payments to comply with existing environmental regulations such as the halting of overexploitation of the aquifer. Should a policy instrument such as cross-compliance be chosen, the difficulty will lie in how to define properly the environmental conditions on a case-by-case basis that will have to be met to receive CAP aid and will result in low public cost and low enforcement costs.

Finally, the efficient management of water resources will require the consideration of economic and environmental externalities in all policy alternatives. This implies, accordingly, consideration of the technical, economic, institutional and environmental issues as well as the participation of all stakeholders in the decision-making process, the public sector, the private farmers and the environment (future generations).

Table 2. Results of policy scenarios

Policy scenario		Water consumption (m^3/ha)		Farm income (€/ha)		Public expenditure (€/ha)	
		Total	%	Total	%	Total	%
(E1) Reference policy		3,985	100	618	100	174	100
(E2) Current policy		1,500	38	698	113	386	222
(E3) Agenda 2000 with cross- compliance	Initial prices	2,080	52	581	94	189	109
	10% lower	2,046	51	544	88	172	99
	20% lower	2,046	51	519	84	168	97
(E4) Agenda 2000 without cross-compliance	Initial prices	3,776	95	655	106	212	122
	10% lower	2,359	59	575	93	182	105
	20% lower	2,180	55	538	87	181	104

Source: Varela *et al*. (2002)

Notes

[1] The programme was the most expensive of all environmental programmes in Spain and one of the most expensive in the entire EU, with a five-year budget of ECU 104 million (1993-97)

[2] For a complete description of the model , see Varela-Ortega *et al*. (1998), Sumpsi *et al* . (2000)

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