Project 502184

GENEDEC

A quantitative and qualitative assessment of the socio-economic and environmental impacts of decoupling of direct payments on agricultural production, markets and land use in the EU

STREP
Priority 8.1.B.1.1: "Sustainable management of Europe's natural resources"

Work package 5, Deliverable D8.3

Possible options and impacts of decoupling within Pillar-II of CAP

Due date of deliverable: 30/11/2006
Actual submission date: 28/02/2007

Start date of the project: 1st of March 2004 Duration: 39 months

Lead contractor: FAL

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Project co-funded by the European Commission within the Sixth Framework		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	X
RE	Restricted to a group specified by the consortium (including the Commission Services)	X
CO	Confidential, only for members of the consortium (including the Commission Services)	

Content

1 Introduction

Pillar-II of the Common Agricultural Policy (CAP) was introduced as a way to put more emphasis on the development of rural areas and the protection of the environment. In the last decades the budget for measures supporting rural development and environmental management of farmland was expanded and prices for agricultural products were reduced. This was seen as a way to reduce the trend for intensification and support low intensity farming systems. Measures of Pillar-II were also regarded as a potentially useful way to support participating farms. In the 2003 CAP Reform the trend towards Pillar-II measures was extended by the introduction of mandatory modulation. However, during the negotiations of the financial framework 2007-2013 the plans for the extension of Pillar-II were significantly cut back.

Deliverable 8.3 pursuits two main objectives: First, to analyse the impact of decoupling on the effect of Pillar-II measures and second, to analyse effects of Pillar-II measures on production. Both questions are of major relevance: if decoupling significantly alters the effect of Pillar-II, it might be necessary to adjust the affected measures. If on the other hand Pillar-II measures significantly affect production this is of importance in the context of the ongoing WTO negotiations because payments of Pillar-II are classified as green-box compatible and therefore must have no, or at most minimal, trade-distorting effects. This topic is of particular importance as Green-Box measures are criticized within the Doha round of WTO negotiations and members of the G20 group asked for a revision of the Green-Box.

Pillar-II measures are diversified and for most measures insufficient data is available to apply quantitative models. Therefore, it is not possible to evaluate the entire range of measures and partners emphasised on four case studies:

– Decoupling and agri-environmental measures. A case study of the Compensatory Allowance Scheme for reducing irrigation in Castile-La Mancha, Spain.
– Economic and environmental consequences of the CAP cotton sector reform: a stochastic bio-economic modelling.
– Assessing the impact of decoupling on farmers' acceptance of environmental measures to reduce nitrogen input in cotton production: a case study for the region Thessaly in Greece.
– Decoupling of Pillar-II measures - Modification of the ‚Less Favoured Area' premium scheme – A case study for Germany.

In the 6th Chapter the findings of the case studies are briefly summarised.

2 DECOUPLING and AGRI-ENVIRONMENTAL MEASURES. A case study of the Compensatory Allowance Scheme for reducing irrigation in Castile-La Mancha, Spain

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***Unidad Asociada CSIC-UPM "Métodos Estadísticos".*

GENEDEC project. 29 December 2006.

2.1 Introduction

The new reform of the EU's Common Agricultural Policy (CAP) proposed in 2003 will lead to an increase in the already substantial resources earmarked for agri-environmental programmes. Hence there is an interest in analyzing their effects on the farms eligible to participate in such programmes.

The agri-environmental measures addressed in this paper, the ones designed to compensate farmers for reducing irrigation water consumption, have been in place since 1993 for the farms in Castile-La Mancha located over aquifers 23 and 24. One of the most important objective of these measures, known as the Compensatory Allowance Scheme (CAS), was intended to conserve the Tablas of Daimiel National Park, a UNESCO Biosphere Reserve included in the Ramsar Convention list of natural wetlands. Park viability depends on the water supplied by aquifer 23, whose piezometric level declined by 20.6 meters between 1974 and 1993 due to the expansion of the irrigated farming area (SERNA and GAVIRIA, 1995).

The CAS was in force from 1993 to 1997, as one of the agri-environmental measures envisaged in Council Regulation (EEC) No 2078/92, and was subsequently extended to cover the period 1998-2002 pursuant to Council Regulation (EC) No 1257/1999. A new CAS approved in 2003 differed from the preceding schemes in a number of respects, as discussed below.

The period during which the new CAS measures will be in effect, 2003-2007, overlaps with the period for implementation of the measures for decoupling aid under new CAP reform whose principles are set out in Council Regulation (EC) No 1782/03.

This paper presents a representative farm model that integrates the two types of measures to analyze whether their effects on farm holdings are independent of or conditioned by possible interactions, and if so in what manner.

The analysis was conducted by comparing the model results for a base year (scenario determined by CAP scenario and agri-environmental measures for 2002) to the results obtained for a simulation year using new CAS scenario and different decoupling policies.

Simulated results were obtained with the partial decoupling policy adopted by Spain as well as for scenarios assuming the continuation of Agenda 2000 and full decoupling measures. With the results for these latter two scenarios it was possible, on the one hand, to compare the effects on farms of the implementation of partial decoupling to the effects of continuing the policy of coupled aid in place in the base year (Agenda 2000), and on the other to verify the consistency of model results by comparing findings for full and partial decoupling.

A farm level, Positive Mathematical Programming (PMP) model was used for the analysis. Devised by HOWITT (1995) and complemented with maximum entropy (PARIS and HOWITT, 1998), this programming technique provides for calibrating a model in such a way that, for the base year, its results reproduce the level of activities in the unit modelled (farm or region). Its substantial development in the last few years is reflected in the reviews by HECKELEI and BRITZ (2005) and de FRAHAN (2005). For a comparison of such approaches to other mathematical programming models as an optimal tool to analyze the effects of agricultural policy, see ARRIAZA and GÓMEZ LIMÓN (2003).

The model presented here features certain characteristics that are rather unusual in PMP models, such as the inclusion of a specific case of crops not grown on the farm in the base year, or of permanent crops, such as vineyards, whose area may be increased in simulation year. Moreover, the calibration procedure defined in the model obviates the need to distinguish between preferred and marginal crops.

A detailed presentation of the decoupling and agri-environmental scenarios considered in this paper is given below. This is followed by the description of the types of farms, the model and the calibration procedure used in this study. The paper concludes with an analysis of the results obtained.

2.2 Scenarios and assumptions

The policy measures used to define the base year scenario were the 1998-2002 CAS measures and the Agenda 2000 COP crop payments in 2002. The scenarios for which the results were simulated were as follows: i) 2003-2007 CAS and Agenda 2000 COP crop aid in 2002; ii) 2003-2007 CAS and partial decoupling arrangements (essentially 25% of coupled aid for COP crops); and iii) 2003-2007 CAS and full decoupling measures.

Details on the base year and the various simulation scenarios are given in Tables 2.1 and 2.2. The model described in section 4 constitutes the general formulation for studying all these scenarios.

The following assumptions were made:

i) market prices are constant in all scenarios and in line with the prices most often reported in the survey we refer later;

ii) although the modulation measures (reductions in total direct payments) are to be phased in, the simulation assumed them to be in the final phase: in other words, a 5% reduction was applied to amounts over €5,000;

iii) the total (compulsory and voluntary) set-aside rate considered is up to 50% of the area receiving COP crop and set-aside area aid (this rate is frequent in the region under study);

iv) in the decoupling scenarios the area of set-aside land considered in the simulation year is the same as in the base year;

v) the farm’s decoupled payments are determined on the basis of its area crop distribution in the base year. In other words, the base year replaces the new CAP reform reference period in the model.

Table 2.1: Characteristics of the 1998-2002 and 2003-2007 Compensatory Allowance Schemes

1998-2002 Compensatory Allowance Scheme	2003-2007 Compensatory Allowance Scheme
Irrigated vineyards not eligible for aid	Vineyards eligible for aid
Area of fallow and set-aside included to compute the volume of water that can be drawn	No provision made for fallow land irrigation
Reduction commitments:	Reduction commitments:
50% reduction: maximum water consumption – 2,100 m^3/ha	50% reduction: 977.5-m^3/ha maximum, excepting vineyards, where maximum consumption is 500 m^3/ha
70% reduction: maximum water consumption – 1,200 m^3/ha·year	100%: no water authorised for any use whatsoever
100% reduction: no irrigation on the holding, except for vineyards	
Aid:	Aid:
Annual, per hectare of irrigated fields (excluding vineyards), as reported by holding	Annual, computed from the area accredited to be entitled to irrigation water
Payments per ha:	Payments per ha:
50% reduction: €179.40/ha	50% reduction: €209/ha
70% reduction: €296.60/ha	100% reduction: €518/ha
100% reduction: €414.10/ha	Total aid:
50 and 70% reductions are eligible for direct aid for irrigated crops	First 40 ha: 100% of premium per ha
100% reduction is eligible for direct aid for non-irrigated crops	From 40 to 80 ha: 60% of premium per ha
	Over 80 ha: 30% of premium per ha
100% reduction is incompatible with direct aid for irrigated land; holdings receive aid for non-irrigated land	All reduction in irrigation is compatible with aid for irrigated COPs (even if reduction is 100%)

Source: Castile-La Mancha Regional Department of Agriculture Order of 6 March 1998 and Castile-La Mancha Regional Department of Agriculture and the Environment Order of 25 February 2003.

Table 2.2: CAP measure scenarios for COP crops

	Base year 2002 Agenda 2000	Full decoupling (Decoupled payments)	Partial decoupling	
			Coupled payment	Decoupled payment
Direct aid for cereals	€63/t	€63/t	€15.75/t	€47.25/t
Direct aid for protein crops	€72.5/t	€63/t	€15.75/t	€47.25/t
Protein crop premium	–	€55.57/ha	€55.57/ha	–
Compulsory set-aside (Agenda 2000)	10%	–	–	–
Set-aside payment	€63/t	63€/t	–	€63/t
Compulsory set-aside provided in the 2003 CAP Reform		Base year set-aside	Base year set-aside	

Reference yield: i) non-irrigated cereals, protein crops and set-aside: 2.1 t / ha, ii) irrigated cereals, excepting maize: 4.2 t/ha, iii) irrigated maize: 6.1t/ha, iv) protein crop and irrigated set-aside: 5.1 t/ha.

Source: Council Regulation (EC) No 1251/1999 and Council Regulation (EC) No 1782/2003.

2.3 Farm types

The effect of the interactions between decoupling and agri-environmental measures on farms in the region was analyzed for three farm types defined on the basis of information on 51 farms surveyed in 2002. The survey initially focused on the analysis of the effect of the new CAS on farms with vineyards, whose inclusion for computing the area eligible for aid is one of the more prominent features in the CAS for the 2003-2007 period.

In keeping with the objective of the present paper, the farms selected from among the ones surveyed were those liable to be affected by decoupling as defined in the new CAP reform: i.e., given the characteristics of the farms in the region, this meant the holdings growing COP crops. A total of 29 farms were so identified and subsequently divided into three groups: the first comprised holdings that were not receiving CAS payments either in the base year or in the simulation year when the scenario was the continuation of Agenda 2000 measures; the second, farms receiving CAS payments in the base year but ceased to participate in the CAS scheme in the simulation year under the Agenda 2000 scenario; and the third, farms that were receiving CAS payments in the base year and continued to receive them in the simulation year assuming Agenda 2000 provisions. None of the farms selected received CAS payments in the simulation year if it was not receiving payments for reducing water consumption in the base year.

The first group comprised 9 farms, the second 7 and the third 13 (5 with a 50% and 8 with a 70% reduction commitment in the base year). The farm types considered were the mean farms in each group, here denominated FT1, FT2, FT3.1 and FT3.2. Their sizes were, for FT1, 50.75 ha devoted to non-irrigated and 76.16 to irrigated crops; for FT2, 19.06 ha non-irrigated and 46.60 irrigated; for FT3.1, 0.80 ha non-irrigated and 40.66 ha irrigated; and FT3.2, 4.88 ha non-irrigated and 26.57 ha irrigated.

The crop distribution in the base year for these farm types is shown under the column headed “base year 2002” in Tables 2.3 to 2.6.

The yields and water used per ha for the various crops considered in the model are the mean figures for all the farms surveyed. The variable costs were computed taking account of information provided by experts in addition to the data gathered from other studies.

2.4 The Model

2.4.1 Model matrix (variables and constraints)

The system of constraints included in the model may be divided into two main groups: one relating to the agricultural policy measure sub-model and the other the agri-environmental measure sub-model. The first group is essentially part of the PROMAPA.G model (see JUDEZ et al., 2004) - developed to analyse the effects on farms of the new CAP reform in Spain.

2.4.2 Agricultural policy measure sub-model

The following notation is used in its description:

H = land type set (h=1: non-irrigated land; h=2: irrigated land)

I = crop set ($I_1 \subset I$ the subset of COP crops)

X_{hi} = area (ha) of i in land type h.

XC_h = area (ha) of compulsory set-aside in land type h.

XV_h = area (ha) of voluntary set-aside in land type h.

XSG_{hi}= area (ha) of crop i in land type h receiving a direct payment under the general CAP scheme.

XSS_{hi} = area (ha) of crop i in land type h receiving a direct payment under the simplified CAP scheme.

XSG_h, XSS_h= total area (ha) of land type h receiving direct payments under the general and simplified CAP schemes, respectively.

IG_h = binary variable indicative of participation in the general scheme (IG_h=1: yes, IG_h=0: no).

IS_h = binary variable indicative of participation in the small producer scheme (IS_h=1: yes, IS_h=0: no).

In addition, the following real values are assumed for right-hand members and coefficients:

Ah = area (ha) of land type h existing on the farm.

sch = proportion of compulsory set-aside entitled to aid.

svh = maximum proportion of set-aside (compulsory + voluntary) entitled to aid.

t_h= theoretical reference yield (in t/ha) in the region for land type h.

T = maximum production to be eligible for the small producer scheme.

g= sufficiently large magnitude.

The agricultural policy measure sub-matrix is subject to the following constraints:

$$\sum_{i \in I} X_{hi} + XC_h + XV_h \leq A_h \qquad \forall h \in H \tag{1}$$

$$-X_{hi} + XSG_{hi} + XSS_{hi} \leq 0 \qquad \forall (h,i / h \in H, i \in I_1) \tag{2}$$

$$-\sum_{i \in I_1} XSG_{hi} + XSG_h \leq 0 \qquad \forall h \in H \tag{3}$$

$$-\sum_{i \in I_1} XSS_{hi} + XSS_h \leq 0 \qquad \forall h \in H \tag{4}$$

$$XC_h - sc_h \cdot XSG_h = 0 \qquad \forall h \in H \tag{5}$$

$$XC_h + XV_h - sv_h \cdot XSG_h \leq 0 \qquad \forall h \in H \tag{6}$$

$$\sum_{h \in H} t_h \cdot XSS_h \leq T \tag{7}$$

$$IG_h + IS_h \leq 1 \qquad \forall h \in H \tag{8}$$

$$XSG_h - g \cdot IG_h \leq 0 \qquad \forall h \in H \tag{9}$$

$$XSS_h - g \cdot IS_h \leq 0 \qquad \forall h \in H \tag{10}$$

$$IG_2 + IS_1 \leq 1 \tag{11}$$

$$IG_1 + IS_2 \leq 1 \tag{12}$$

Under equation (1), the farming area plus the set-aside area for a given type of land can never exceed the area of that type of land on the farm. Expression (2) is applied solely to COP crops and limits the area of each crop receiving aid (under either the general or small producer scheme) to the area of that crop. Equations (3) and (4) define the total area receiving aid in each type of land under the general (3) and the simplified (4) scheme. Constraints (5) and (6) determine the hectares of compulsory and voluntary set-aside required to be eligible for aid. Equation (7) limits the area of the farm – through a maximum production limit – that can qualify for aid under the small producer scheme. Finally, constraints (8) to (12) allow the farm as a whole to participate in the general or small producer scheme or to refrain from participating in either.

Where full or partial decoupling scenarios are involved, account must also be taken of the following constraints relating to the single farm payments (SFP) and the modulation. For their formulation let the variables be defined as follows:

XSP= area (ha) eligible for the SFP in the simulation year.

XM1= lowest tranche of aid, exempt from modulation.

XM2= second tranche of aid, subject to modulation at a rate of $m_2 \cdot 100\%$.

And the real values of the second members and coefficients as:

AP= area in ha entitled to the SFP in the reference period.

M_1= amount of aid, in euros, exempt from modulation.

dp= amount, in euros, of payment entitlement per ha.

In the present case, the area entitled to the SFP is the set-aside plus the area growing COP crops. Therefore, in the reference year AP would be:

$$AP = \sum_{h} \sum_{i \in I_1} \overline{\overline{X}}_{hi} + \sum_{h \in H} \left(\overline{\overline{XC}}_h + \overline{\overline{XV}}_h \right)$$

and the amount of the SFP per hectare, dp, would be:

$$dp = \left[\sum_{h \in H} \sum_{i \in I_1} \left(dg_{hi} \cdot \overline{\overline{XSG}}_{hi} + ds_{hi} \cdot \overline{\overline{XSS}}_{hi} \right) + \sum_{h \in H} \left(dc_h \cdot \overline{\overline{XC}}_h + dv_h \cdot \overline{\overline{XV}}_h \right) \right] \Big/ AP$$

where:

$\overline{\overline{XSG}}_{hi}, \overline{\overline{XSS}}_{hi}, \overline{\overline{XC}}_{h}, \overline{\overline{XV}}_{h}$ = value of variables XSG_{hi}, XSS_{hi}, XC_h and XV_h in the reference period to be eligible for the SFP.

dg_{hi}, ds_{hi}= decoupled CAP aid per ha of crop i in land type h on the farm participating in the general and small producer scheme, respectively.

dc_h, dv_h= decoupled CAP aid per ha of (compulsory and voluntary) set-aside. This type of aid accounts for 100% of all aid in full or partial decoupling scenarios.

With these notations, the model constraints, based on the formulation of de Frahan *et al.* (2005) are:

$$XSP \leq AP \qquad (13)$$

$$XSP - \sum_{h}\sum_{i \in I_1} X_{hi} - \sum_{h \in H}\left(XC_h + XV_h\right) \leq 0 \qquad (14)$$

$$XM1 + XM2 - dp \cdot XSP - \sum_{h}\sum_{i \in I}\left(ag_{hi} \cdot XSG_{hi} + as_{hi} \cdot XSS_{hi}\right) \leq 0 \qquad (15)$$

$$XM1 \leq M_1 \qquad (16)$$

where:

ag_{hi}, as_{hi} = CAP aid coupled to crop i in land type h where the farm participates in the general or small producer scheme, respectively. Under partial decoupling, this aid accounts for 25% of the total, and is nil in the event of full decoupling. Under the Agenda 2000 scenarios (the base year scenario) coupled aid accounts for 100% of the total.

Under constraints (13) and (14) the hectares entitled to the SFP in the simulation year must be the lowest of the following two values: hectares eligible for the SFP in the reference period (13) or hectares eligible for the SFP in the simulation year (14).

Equations (15) and (16) define the total sum (XM1 and XM2) of coupled and decoupled aid associated with COP crops. Under this formulation, as discussed below, the part of the aid exempt from modulation (XM1) can be distinguished, through the economic function, from the part subject to reduction because of modulation (XM2).

2.4.3 Agri-environmental measure sub-model

Here, in addition to the foregoing, account must be taken of the following notations:

J= set of possible irrigation doses (m^3/ha) for crops growing on irrigated land. One of the elements in this set is nil irrigation.

K= set of reduced water consumption formulas to which a farm receiving CAS payments can commit (k=1: 100% reduction; k=2: 70% reduction; k=3: 50% reduction).

L= set of successive area tranches to which the formulas in set K are applied. In the 1998-2002 CAS, there was only one tranche, whereas in the 2003-2007 CAS there are three (the first includes the first 40 hectares, the second the 40 to 80 hectare interval and the third the rest of the farm). The aid per hectare differs from one tranche to another, declining in ascending order of tranche.

X_{2ij}= area (ha) of crop i on irrigable land with an irrigation dose of j per ha.

XC_{2k}=ha of compulsory set-aside in land participating in reduced water consumption formulas.

XV_{2k}= area (ha) of compulsory set-aside in land participating in reduced water consumption formula k.

XE_{ik}= area (ha) of crop i participating in reduced water consumption formula k.

$XCAS_{kl}$= area (ha) of the l-th tranche on the farm participating in reduced water consumption formula k.

XW= total m^3 of water used on the farm.

IW_k= binary variable indicating participation in the CAS under formula k (IW_k=1: participating under formula k; IW_k=0: not participating under formula k).

Finally, the right-hand member and coefficient values are defined as follows:

E_l= maximum number of ha in the 1-th tranche eligible for CAS aid. Since in the 1998-2002 CAS there was only one tranche (l=1), in the base year E_l is equal to the farm's irrigable area. In the 2003-2007 CAS: E_1=40 and E_2=40.

w_{ij}= m^3 of water per ha - irrigation dose j - received by crop i.

v_k= maximum allowable volume of extracted water, in m^3, per ha of (compulsory or voluntary) set-aside under reduced water consumption formula k.

v_{ik}= maximum allowable volume of extracted water, in m^3, per ha of crop i subject to reduced water consumption formula k.

Agri-environmental measure sub-model constraints are:

$$-X_{2i}+\sum_{j}X_{2ij}\leq 0 \qquad \forall i\in I \tag{17}$$

$$\sum_{k\in K}XE_{ik}-\sum_{j}X_{2ij}\leq 0 \qquad \forall i\in I \tag{18}$$

$$\sum_{k\in K}XC_{2k}-XC_{2}\leq 0 \tag{19}$$

$$\sum_{k\in K}XV_{2k}-XV_{2}\leq 0 \tag{20}$$

$$-\sum_{i\in I}XE_{ik}-XC_{2k}-XV_{2k}+\sum_{l\in L}XCAS_{kl}\leq 0 \qquad \forall k\in K \tag{21}$$

$$\sum_{k\in K}XCAS_{k1}\leq E_{1} \tag{22}$$

$$\sum_{k\in K}\left(XCAS_{k1}+XCAS_{k2}\right)\leq E_{1}+E_{2} \tag{23}$$

$$XW-\sum_{i\in I}\sum_{j\in J}w_{ij}\cdot X_{2ij}=0 \tag{24}$$

$$XW+\sum_{k\in K}g\cdot IW_{k}-\sum_{k\in K}\sum_{i\in I}v_{ik}\cdot XE_{ik}-v_{k}\cdot\left(XC_{2k}+XV_{2k}\right)\leq g \tag{25}$$

$$\sum_{k\in K}IW_{k}\leq 1 \tag{26}$$

$$-g\cdot IW_{k}+\sum_{i\in I}XE_{ik}+XC_{2k}+XV_{2k}\leq 0 \qquad \forall k \tag{27}$$

Equation (17) makes it possible to break down each crop grown on irrigable land into various sub-crops that differ in their respective irrigation dose (one of the sub-crops, e.g., j=1, corresponds to no irrigation). Constraint (18) limits the area of each crop participating in reduced water consumption formula k to the area of irrigated land used to grow that crop. Equations (19) and (20) are analogous to (18) for the compulsory and voluntary set-asides, respectively.

Constraint (21) defines the total farm area, within a given tranche, participating in reduced water consumption formula k. As noted above, there are three tranches in the simulation year (2003-2007 CAS) and a single tranche in the base year. Constraints (22) and (23) define the areas of farmland, by tranche, participating in reduced water consumption formulas in the simulation year.

Equation (24) determines the volume of water used on the farm. Expression (25) ensures that to participate in CAS under formula k the farm must use a volume of water less than or equal to the volume established in the programme for that formula (the compulsory and voluntary set-asides only contribute, a certain volume of water to the volume allowed under each formula, in the base year). Finally, constraints (26) and (27) ensure that the farm may participate in no more than one CAS formula.

Model treatment of permanent crops merits specific comment. Such treatment entails including constraints that allow for increases in the area devoted to such crops (different varieties of vineyards in this case) in all scenarios. The formulation of this type of constraints is illustrated assuming that $I_2 \subset I$ corresponds to the subset of permanent crops. Let:

$\overline{X}_{hi}$ be the area (ha) of crop i growing on land type h in the base year;

$\overline{X}_{2ij}$ be the area (ha) of crop i with irrigation dose j growing on irrigable land in the base year;

XN_{hi} be the increase in land type h area (ha) devoted to permanent crop $i \in I_2$;

XN_{hij} be the increase in land type h area (ha) with irrigation dose j devoted to permanent crop $i \in I_2$;

The above-mentioned constraints are:

$$X_{hi} - XN_{hi} \leq \overline{X}_{hi} \qquad \forall \left(h,i \middle/ h=1, i\in I_2 \right) \tag{28}$$

$$X_{hij} - XN_{hij} \leq \overline{X}_{hij} \qquad \forall \left(h,i,j \middle/ h=2, i\in I_2 \right) \tag{29}$$

Constraint (28) ensures that the total non-irrigated land area growing a permanent crop is less than or equal to the sum of the land existing in the base year plus any new plantation area.

Equation (29) is similar to (28) for each of the crops associated with different irrigation doses. Note that $\overline{X}_{2ij}$ is equal to $\overline{X}_{2i}$, since in the base year, crop i is irrigated at a single constant dose.

2.4.4 Economic function

For scenarios that do not involve decoupling measures (such as Agenda 2000), the aim is to maximize the following function:

$$\begin{aligned}&\sum_{i\in I}\left(r_{1i} - \frac{1}{2}\cdot\sum_{i'\in I} q_{1ii'}\cdot X_{1i'}\right) X_{1i} + \sum_{i\in I}\sum_{j\in J} r_{2ij}\cdot X_{2ij} - \frac{1}{2}\cdot\sum_{i\in I}\left(\sum_{i'\in I} q_{2ii'}\cdot X_{2i'}\right)\cdot X_{2i} \\ &- c\omega\cdot XW - \sum_{i\in I_2}\left(r_{1i} - r'_{1i}\right)XN_{1i} - \sum_{i\in I_2}\left(r_{2ij} - r'_{2ij}\right)XN_{2ij} + \sum_{k\in K}\sum_{l\in L} s_{kl}\cdot XCAS_{kl} + \\ &+ \sum_{h\in H}\sum_{i\in I_1}\left(ag_{hi}\cdot XSG_i + as_{hi}\cdot XSS_{hi}\right) + \sum_{h\in H}\left(ac_h\cdot XC_h + av_h\cdot XV_h\right)\end{aligned} \tag{30}$$

Where:

r_{1i}= revenues per ha of crop i growing on non-irrigated land (excluding aid).

r_{2ij}= revenues, excluding aid, per ha of crop i on irrigated land with irrigation dose j, less cost (excluding water) per ha of irrigated crop i with irrigation dose j, plus cost of non-irrigated farming.

$q_{1ii'}$, $q_{2ii'}$ = PMP-estimated coefficients to calibrate the model in the base year.

$c\omega$= cost of water per m^3

ac_h, av_h= CAP aid coupled to ha of compulsory and voluntary set-aside in land type h, respectively. Such aid is nil (all aid is decoupled) in full or partial decoupling scenarios.

s_{kl}= aid per ha in tranche 1 participating in reduced water consumption formula k.

For permanent crops, $i \in I_2$, r_{1i} and r_{2ij} are the yearly revenues per ha for crop i, whereas r'_{1i} and r'_{2ij} are the yearly revenues per ha assigned to new plantations. In this study yearly revenues r_{1i} refer to yearly revenues per ha of fully productive vineyards. A year's revenues - r_{2ij} - assuming fully productive crops, are computed by subtracting from annual income the difference between the costs (excluding water) per ha in the year in question at irrigation dose j and the costs per ha of the non-irrigated crop.

Coefficients r'_{1i} and r'_{2ij} were obtained by subtracting the yearly costs of crop planting from r_{1i} and r_{2ij}.

For scenarios with full or partial decoupling, the target function to be maximized is (30), substituting the expression $XM1 + (1 + m_2) \cdot XM2$ for the last two terms, assuming that the reduction due to modulation is $m_2 \cdot 100\%$ of the total amount of aid in excess of M_1. In the present case, m_2=0.05 and M_1=5,000.

Note that if the quadratic cost functions in (30), i.e., $\frac{1}{2}\left(\sum_{i' \in I} q_{hii'} \cdot X_{hi'}\right) \cdot X_{hi}$, are replaced by the linear functions $c_{1i} \cdot X_{hi}$ - where C_{1i} is the cost per ha of non-irrigated crop i –, the resulting economic function constitutes the maximization of the farm's gross margin (with linear cost functions).

2.4.5 Calibration

Model calibration for the base year involves estimating coefficients $q_{1ii'}$ and $q_{2ii'}$ with PMP techniques. The following discussion first addresses the problem and its solution in general terms and then describes its application to the specific case under study.

General problem and solution

Assume X to be a vector with N components representing the different levels of activity, X_n, on the farm; $b=(b_1, b_2, ..., b_m, ..., b_M)^T$, the vector for the farm's available resources; and $A=\{a_{mn}\}$ the matrix MxN of technical coefficients in which a_{mn} represents the needs in terms of resource m per unit of activity n.

The calibration problem may be briefly described as follows: the aim is to obtain a concave function f(X) such that if $\overline{\mathbf{X}}$ is a level of activity established *a priori*, the expression below holds where $\mathbf{X}=\overline{\mathbf{X}}$:

$$\begin{cases} \max_{x} f(\mathbf{X}) \\ s.t.: \\ \mathbf{A}\cdot\mathbf{X} \leq \mathbf{b} \\ \mathbf{X} > \mathbf{0} \end{cases} \tag{31}$$

Assume λ^* to be a positive M-dimensional vector with elements λ^*_m such that:

$$\lambda^*_m > 0 \quad if \quad \sum_{n=1}^{N} a_{mn} \cdot \overline{X}_n - b_m = 0 \tag{32}$$

$$\lambda^*_m = 0 \quad if \quad \sum_{n=1}^{N} a_{mn} \cdot \overline{X}_n - b_m < 0 \tag{33}$$

The calibration problem is solved by any function f(X) fulfilling the following conditions:

$$\left(\frac{\partial f(\mathbf{X})}{\partial x_n} \right) = \sum_{m=1}^{M} a_{mn} \cdot \lambda^*_m \qquad n = 1,2,3,\ldots,N \tag{34}$$

The proof for the foregoing can be found in JÚDEZ et al. (1998; 2001), where its application is proposed for the direct calibration of models, i.e. by-passing the so-called first phase of PMP (use of a linear program with calibration constraints to determine λ^*_m).

Application to the present case

Expressions to estimate the unknown parameters in f(X)

In this case f(X) is expression (30). Considering $q_{hii'} = 0$, when $i' \neq i$, coefficients q_{1ii} and q_{2ii} that calibrate the model are obtained by applying equation (34), from which:

$$q_{1ii} = \frac{r_{1i} - \sum_{m} a_{m1i} \cdot \lambda^*_m}{\overline{X}_{1i}} \tag{35}$$

$$q_{2ii} = \frac{\bar{r}_{2ij} - \sum_m a_{m2i} \cdot \lambda_m^*}{\bar{X}_{2i}} \tag{36}$$

where:

a_{m1i}, a_{m2i}= coefficients in constraint m for the variables X_{1i} and X_{2i}, respectively

$\bar{r}_{2ij}$ = value of r_{2ij} corresponding to crop i with irrigation dose j.

$\bar{X}_{1i}, \bar{X}_{2i}$ = area (ha) of non-irrigated and irrigated land, respectively, devoted to crop i in the base year.

Note that for the model to calibrate activities X_{2i} for the base year, the irrigation dose j actually used must be known so that variable X_{2ij} associated with such dose is equal to $\bar{X}_{2i}$. This is achieved by making the variables X_{2ij} that do not correspond to the irrigation dose for the crop equal to zero in the base year.

In the more general case, considered in this paper, where $q_{hii'} \neq 0$, the number of parameters to be estimated is greater than the number of equations (34) that must hold for the model to be calibrated. The parameters were estimated with the maximum entropy method described by PARIS and HOWITT (1998).

In this case matrix $\mathbf{Q}$ is:

$$\mathbf{Q} = \begin{bmatrix} \mathbf{Q_1} & \mathbf{0} \\ \mathbf{0} & \mathbf{Q_2} \end{bmatrix}$$

where $\mathbf{Q_1} = \{q_{1ii'}\}$ and $\mathbf{Q}_2 = \{q_{2ii'}\}$ are symmetric matrices whose elements are the parameters to be estimated for non-irrigated and irrigated crops, respectively. Moreover, the weights applied in this study to obtain the support values required to estimate the elements Q, after entropy maximization, correspond to the first sets of weights used by PARIS and HOWITT (1998). The support values are obtained by combining such weights with the marginal cost ratios, which in the present case are shown as expressions (35) and (36).

Finally, note that the procedure used to include crops with different irrigation doses can be regarded to be a specific case of inclusion, in a PMP model, of crops that are not grown on the farm in the base year. Indeed, variables X_{2ij} can be considered to be variables associated with different crops related to X_{2i} only to the extent that they have certain common costs.

Determination of dual values λ^{*}_{m}

The numerous constraints existing in the model described led to the determination of the dual values λ^{*}_{m} from the first phase of the PMP. Such values are the dual values of the constraints in the optimum solution for the model:

$$\max l(\mathbf{X}) \tag{37}$$

subject to:

$$\mathbf{A}\cdot\mathbf{X} \leq \mathbf{b} \tag{38}$$

$$X_{hi} \leq \overline{X}_{hi} \qquad \forall(h,i) \tag{39}$$

$$\mathbf{X} \geq \mathbf{0} \tag{40}$$

where $l(\mathbf{X})$ is the gross margin found with the linear cost function referred to above and where the expressions in (39) are the calibration constraints.

Be it said that the classic calibration equations are: $X_{hi} \leq \overline{X}_{hi} + \varepsilon_{hi}$ (ε_{hi} is a small real number) rather than equations (39) used in this paper. When the classic equations are used, the following constraints are normally established:

$$\sum_{i} X_{hi} \leq \text{Land type h farm area} \qquad \forall h$$

where: $\sum_{i} \overline{X}_{hi} = \text{Land type h farm area} \qquad \forall h$

Under these conditions there is generally one crop (the least profitable, called marginal crop) for which the calibration constraint is not binding and whose respective dual value is consequently nil. The result is that marginal activities are treated differently than the so-called preferred activities in the calibration. A number of procedures has been proposed to side-step this problem (see for instance JÚDEZ et al. (1998) and GOHIN and CHANTREUIL (1999)), but in light of the formulation of the present model, all activities can be made to be treated as preferred activities by simply disregarding the tiny variation - ε_{hi} - in the calibration equations. Indeed, in the present case, all the calibration expressions in (39) are saturated, since there is one for each crop, whereas the set-aside that forms a part of the farm area (see equation (1)) and produces revenues in the base year (albeit lower than crops themselves) is calibrated with no need to use calibration constraints. As discussed above, moreover, in simulation year scenarios involving decoupling, this set-aside is constant and equal to the value in the base year.

2.5 Results

2.5.1 Farm type 1 (FT1)

This farm type does not participate in CAS payments in the base year or under any of the scenarios considered in the simulation year. Its performance in the latter is conditioned only by the different measures envisaged for COP crops in the various scenarios.

Table 2.3 gives the variations with respect to the base year in crop distribution and economic results for each scenario.

In the event of both partial and full decoupling, COP crops (with the exception of barley) are replaced by non-COP crops.

Even though the non-COP crops (potato and onion) replacing the COPs consume more water, this input is only slightly higher in the decoupling scenarios. This is because the increase in water needs occasioned by the greater area devoted to non-COPs is largely offset by the decline in the area devoted to maize, whose water consumption is very similar to the levels required for non-COP crops.

It should also be noted that the possibility of replacing COP crops enables farmers to organize their production more efficiently when direct aid is decoupled from these crops. In the absence of modulation, such efficiency would be translated into an increase in the farm’s gross margin. This effect is naturally more intense under full than partial decoupling.

Table 2.3: Crop distribution and economic results for farm type 1 (FT1) under different scenarios

	Base year 2002 1998-2002 CAS and Agenda 2000	2003-2007 CAS measures Agenda 2000		Partial decoupling		Full decoupling	
		value	variation (%)	value	variation (%)	value	variation (%)
Non irrigable land (ha)							
COP crops							
Barley (ha)	44.86	44.86	0.00	44.86	0.00	44.86	0.00
Set-aside (ha)	5.89	5.89	0.00	5.89	0.00	5.89	0.00
Irrigable land (ha)							
Vineyard							
Airen (ha)	20.18	20.18	0.00	20.18	0.00	20.18	0.00
Cencibel (ha)	12.27	12.27	0.00	12.27	0.00	12.27	0.00
COP crops							
Barley (ha)	23.49	23.49	0.00	23.53	0.17	23.67	0.77
Pea (ha)	1.15	1.15	0.00	1.04	-9.57	0.87	-24.35
Maize (ha)	3.92	3.92	0.00	3.78	-3.57	3.74	-4.59
Set-aside (ha)	7.82	7.82	0.00	7.82	0.00	7.82	0.00
Non COP crops							
Sugar beet (ha)	4.11	4.11	0.00	4.28	4.14	4.34	5.60
Potato (ha)	2.11	2.11	0.00	2.15	1.90	2.16	2.37
Onion (ha)	1.11	1.11	0.00	1.12	0.90	1.12	0.90
Water							
Water consumption (m^3)	146,770	146,770	0.00	147,380	0.42	147,700	0.63
m^3/ha irrigable land	1,927	1,927		1,935	0.42	1,939	0.63
Economic results							
Gross margin (000 €)	116.73	116.73	0.00	116.42	-0.27	116.59	-0.12
c.p b.m. (000 €)	17.37	17.37	0.00	17.35	-0.12	17.37	0.00
c.p a.m. (000 €)	17.37	17.37	0.00	16.73	-3.68	16.75	-3.57
CAS aid (000)	0.00	0.00		0.00		0.00	
Total aid/gross margin a.m. (%)	14.88	14.88		14.37		14.37	
CAS formula	none	none		none		none	

c.p. b.m.: compensatory payments before modulation c.p.a.m.: compensatory payments after modulation Total aid= c.p.a.m+ CAS aid

2.5.2 Farm type 2 (FT2)

As shown in Table 2.4 this holding participated in the 1998-2002 CAS with a commitment to a 50% reduction in water consumption. A relatively large area (4.4 ha), however, was devoted to water-intensive non-COP crops (sugar beet, potato, melon and maize), and there were over 15 ha of irrigated vineyards (nearly 1/3 of which with high quality “Cencibel” vineyard). As noted above, under the 1998-2002 CAS vineyards were excluded from maximum allowable water consumption calculations. Moreover, the “Cencibel” variety requires approximately 1,700 m^3/ha of water and is not viable with smaller amounts. Changing such a vineyard to a non-irrigated crop entails a very substantial decline in profitability. In light of these findings, it is not in the interest of the farm to continue to participate in the CAS under the conditions imposed for the period 2003-2007.

Table 2.4: Crop distribution and economic results for farm type 2 (FT2) under different scenarios

	Base year 2002 1998-2002 CAS and Agenda 2000	2003-2007 CAS measures Agenda 2000		Partial decoupling		Full decoupling	
		value	variation %	value	variation %	value	variation %
Non irrigable land (ha)							
Vineyard							
Cencibel (ha)	2.64	2.64	0.00	2.6	-1.52	2.58	-2.27
COP crops							
Barley (ha)	11.31	11.31	0.00	11.36	0.44	11.38	0.62
Set-aside (ha)	5.11	5.11	0.00	5.11	0.00	5.11	0.00
Irrigable land (ha)							
Vineyard							
Airen (ha)	10.16	10.16	0.00	10.16	0.00	10.16	0.00
Cencibel (ha)	4.94	4.94	0.00	4.94	0.00	4.94	0.00
COP crops							
Barley (ha)	17.04	17.04	0.00	17.06	0.12	17.25	1.23
Pea (ha)	1.57	1.57	0.00	1.43	-8.92	1.20	-23.57
Set-aside (ha)	8.49	8.49	0.00	8.49	0.00	8.49	0.00
Non COP crops							
Sugar beet (ha)	1.79	1.79	0.00	1.86	3.91	1.88	5.03
Potato (ha)	0.86	0.86	0.00	0.87	1.16	0.88	2.33
Melon (ha)	1.75	1.75	0.00	1.78	1.71	1.79	2.29
Water							
Water consumption (m^3)	61,120	61,120	0.00	61,830	1.16	62,110	1.62
m^3/ha irrigable land	1,312	1,312		1,327	1.16	1,333	1.62
Economic results							
Gross margin (000 €)	57.31	51.66	-9.86	51.65	-9.88	51.78	-9.65
c.p b.m. (000 €)	9.99	9.99	0.00	9.99	0.00	10.00	0.10
c.p a.m. (000 €)	9.99	9.99	0.00	9.74	-2.50	9.75	-2.40
CAS aids (000€)	5.65	0	-100.00	0	-100.00	0.00	-100.00
Total aid/gross margin a.m. (%)	27.29	19.34		18.86		18.83	
CAS formula	50% reduction	none		none		none	

c.p.b.m.: compensatory payments before modulation c.p.a.m.: compensatory payments after modulation Total aid= c.p.a.m+ CAS aid

On the assumption that the Agenda 2000 measures continue to be in effect, the farm’s withdrawal from the CAS involves no change in crop distribution, although its gross margin drops by nearly 10% due to the loss of CAS payments.

Where the scenario includes decoupling of COP crop direct payments, an increase is observed in the irrigable land area devoted to barley, sugar beet and non-COP crops (potato and melon) at the expense of peas. This change, which is naturally more intense under full than partial decoupling, entails higher water consumption levels. The loss of CAS aid under decoupling arrangements also involves a 10% decline in gross margin.

2.5.3 Farm type 3.1 (FT3.1)

The characteristics of this farm type and FT2 are similar in terms of water consumption per hectare in the base year, although the former has a smaller proportion of high quality "Cencibel" vineyards and non-COP crops. Like FT2, it participates in the base year in CAS under a commitment to reduce water consumption by 50%.

As Table 2.5 shows, in all the CAP scenarios considered, the farm opts for the same 50% reduction commitment under the new CAS, which necessitates lowering its water consumption substantially (by between 46 and 42% depending on the CAP scenario). This reduction is achieved by eliminating maize, cutting back the area devoted to sugar beet by over 75% and irrigating the "Airén" variety vineyard less than in the base year.

Although as in the case of farm type FT2 the gross margin decreases in all CAP scenarios (more where the Agenda 2000 measures are assumed to continue), the decline is less steep in FT3.1.The downturn in the gross margin (disregarding aid) is due, in this case, to the smaller amount of irrigation water used by the farm with the different scenarios simulated.

Table 2.5: Crop distribution and economic results for farm type 3.1 (FT3.1) under different scenarios

	Base year 2002	2003-2007 CAS measures					
	1998-2002	Agenda 2000		Partial decoupling		Full decoupling	
	CAS and Agenda 2000	value	variation %	value	variation %	value	variation %
Non irrigable land (ha)							
Barley (ha)	0.72	0.72	0.00	0.57	-20.83	0.51	-29.17
Set-aside (ha)	0.08	0.08	0.00	0.08	0.00	0.08	0.00
Irrigable land (ha)							
Vineyard							
Airen 800 m^3/ha (ha)	0.00	16.18		16.18		16.18	
Airen 1000 m^3/ha (ha)	16.18	0.00		0.00		0.00	
Cencibel (ha)	1.32	1.00	-24.24	1.06	-19.70	1.07	-18.94
COP crops							
Barley (ha)	12.26	13.63	11.17	15.65	27.65	15.64	27.57
Maize (ha)	2.00	0.00	-100.00	0.00	-100.00	0.00	-100.00
Set-aside (ha)	7.4	9.51	28.51	7.4	0.00	7.4	0.00
Non COP crops							
Sugar beet (ha)	1.50	0.34	-77.33	0.37	-75.33	0.37	-75.33
Water							
Water consumption (m^3)	53,110	28,710	-45.94	30,750	-42.10	30,750	-42.10
m^3/ha irrigable land	1,306	706	-45.94	756	-42.10	756	-42.10
Economic results							
Gross margin (000 €)	36.01	33.47	-7.05	34.31	-4.72	34.31	-4.72
c.p b.m. (000 €)	6.50	6.77	4.15	6.52	0.31	6.50	0.00
c.p a.m. (000 €)	6.50	6.77	4.15	6.45	-0.77	6.42	-1.23
CAS aid (‘000)	4.15	8.40	102.41	8.44	103.37	8.44	103.37
Total aid/gross margin (%)	29.58	45.32		43.40		43.31	
CAS formula	50% reduction	50% reduction		50% reduction		50% reduction	

c.p. b.m.: compensatory payments before modulation c.p.a.m.: compensatory payments after modulation
Total aid= c.p.a.m+ CAS aid

2.5.4 Farm type 3.2 (FT3.2)

As Table 2.6 shows, this farm, which benefited in the base year from payments for a 70% reduction in water consumption, consumes comparatively little water per hectare.

Assuming the continuation of CAP Agenda 2000 measures, in the simulation year the farm opts for the total elimination of irrigation, with a substantial reduction in farming activity. This reduction translates into a decline in the farming area and a considerable increase in set-aside, up to the maximum allowable to receive the direct payment, i.e., 50% of the arable land. This increase can be explained by the fact that under Agenda 2000 and the new CAS, set-aside receives coupled aid as if it were irrigated land, even when the farm is no longer irrigated.

When partial and full decoupling measures are assumed, the set-aside receives decoupled aid only and, as mentioned above, is considered in the model to be of the same size as in the base year. As a result, the increase in gross margin observed under Agenda 2000 arrangements is absent in those scenarios, prompting the farm to commit to a 50% reduction in water consumption under the new CAS. That means a lower water consumption (of around 5%) than in the base year, a commitment met at the expense of the water supplied to the vineyard. Despite the decline in irrigation water, in both decoupling scenarios the gross margin increases slightly.

Table 2.6: Crop distribution and economic results for farm type 3.2 (FT3.2) under different scenarios

	Base year 2002 1998-2002 CAS and Agenda 2000	2003-2007 CAS measures					
		Agenda 2000		Partial decoupling		Full decoupling	
		value	variation %	value	variation %	value	variation %
Non irrigable land (ha)							
Barley (ha)	0.56	0.56	0.00	0.56	0.00	0.56	0.00
Oat (ha)	1.88	1.87	-0.53	1.87	-0.53	1.87	-0.53
Set-aside (ha)	2.44	2.44	0.00	2.44	0.00	2.44	0.00
Irrigable land (ha)							
Vineyard							
Airen 800 m^3/ha (ha)	0.00	0.00		4.56		4.63	
Airen 1000 m^3/ha (ha)	9.16	(7.32)	-20.09	4.60		4.53	
COP crops							
Barley (ha)	9.18	(7.99)	-12.96	9.21	51.96	9.34	1.74
Wheat (ha)	0.66	(0.60)	-9.09	0.63	-4.55	0.64	-3.03
Pea (ha)	0.82	(1.03)	25.61	0.81	-1.22	0.68	-17.07
Set-aside (ha)	6.75	9.63	42.67	6.75	0.00	6.75	0.00
Water							
Water consumption (m^3)	18,120	0.00	-100.00	17,210	-5.02	17,230	-4.91
m^3/ha irrigable land	682	0.00	-100.00	648	-5.02	648	-4.91
Economic results							
Gross margin (000 €)	19.71	21.58	9.49	19.76	0.25	19.79	0.41
c.p b.m. (000 €)	5.72	6.39	11.71	5.73	0.17	5.73	0.17
c.p a.m. (000 €)	5.72	6.39	11.71	5.69	-0.52	5.69	-0.52
CAS aid (‘000)	5.16	13.76	166.67	5.55	7.56	5.55	7.56
Total aid/gross margin. (%)	55.20	93.37		56.88		56.80	
CAS formula	70% reduction	100% reduction		50% reduction		50% reduction	

( ): Area of irrigated land transformed to non irrigated land c.p. b.m.: compensatory payments before modulation c.p.a.m.: compensatory payments after modulation Total aid= c.p.a.m+ CAS aid

Finally, the farm’s gross margin rises by nearly 10% in the Agenda 2000 scenario, in spite of the decline in activity. This is due to the substantial increase in aid when the farm abandons irrigation. The higher gross margin naturally goes hand-in-hand with greater farm dependence on subsidies, which account for nearly 94% of such earnings.

2.6 Conclusions

It may be deduced from the above analysis that if there were no CAS measures in place in the region, the move from Agenda 2000 to decoupling measures would lead farms toreduce the COP crop area and increase the area devoted to sugar beet and horticultural crops. This effect would entail an increase in water consumption.

Moreover, regardless of their situation in the base year and whether or not they participate in the new CAS measures in the simulation year, for all farms the continuing Agenda 2000 scenario is associated with lower water consumption than the full or partial decoupling scenarios. This is because the activities requiring less irrigation water (COP crops and set-aside) receive more beneficial treatment (higher area-coupled aid) under the Agenda 2000 measures.

Farmer's decisions to commit to irrigation water reduction measures under the new CAS depend, in turn, only on their status in the base year, and are unaffected by the decoupling measures considered in the simulation year: Agenda 2000, full or partial decoupling. The reduced water consumption formula chosen, however, does depend on these scenarios for some farms.

This study draws a distinction between two groups of farms participating in the 1998-2002 CAS measures in the base year. One of these withdraws from the CAS in the simulation year and the other extends its participation under the 2003-2007 CAS. The first group does not vary its crop distribution in the simulation year if the Agenda 2000 measures remain in effect, but its gross margin declines due to the downturn in CAS aid. For such farms, decoupling policy entails a drop in income similar to the decline observed under Agenda 2000, but with higher water consumption.

In the second group the water consumption varies widely, depending on the individual farm status in the base year and the decoupling scenario in the simulation year. In this group gross margin rises in some cases and declines in others.

Finally, this study has shown that the PMP model is a very useful tool for analyzing the interactions, under European agricultural policy, between decoupling measures and agri-environmental CAS measures. Its use could be extended by defining farms types that would represent all the farms of the region covered by the CAS, even if the information available on farm activities were less precise than in this study. With these new farm types, estimates could be made for the region as a whole in respects such as the reduction in the volume of water consumed when the new CAS is implemented jointly with the decoupling policy adopted by Spain, or the amount of the total aid associated with the CAS and with the decoupling measures. The model may also be used as a decision-making tool when establishing a new CAS measure: for instance, to define the sum of the aid per ha required to attain a given objective under different reduced water consumption formulas. Possible uses of the model with farm types defined on the basis of the 1999 Spanish Agricultural Census are illustrated in PINIÉS (2006).

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3 Economic and environmental consequences of the CAP cotton sector reform: a stochastic bio-economic modelling

Jean-Baptiste Butlen and Philippe Quirion

Abstract

In a deterministic framework decouplingof subsidies typically yields a double dividend, i.e., an increase in farmers' welfare and in the environmental quality (cf. e.g. DEBOVE and JAYET, 2006). This optimistic conclusion does not necessarily stand under uncertainty and farmers' risk-aversion. According to our bio-economic modelling of cotton production in Greece, decoupling does reduce a little the driving forces of environmental degradation (excessive nitrogen fertiliser and water abstraction) and slightly increases farmers' expected profit. Yet farmers' expected utility is reduced, because of an increase in the risk they bear. Indeed the previous CAP regime protected farmers against fluctuations in cotton world prices. In addition, it had a kind of built-in insurance since the amount of subsidies was lower in years with a higher than expected yield thanks to good weather conditions. In addition, decoupled subsidies do decrease production compared to coupled subsidies, but raise production compared to *laissez-faire*. As a consequence, whether they should be put in the WTO green box is debatable.

Another key element of the CAP reform is cross-compliance. The Greek government decided to implement cross-compliance in cotton production through a cap on nitrogen fertiliser at 130 kg/ha, which induces, in our simulation, a 39% reduction compared to the previous CAP regime. This would slightly reduce production compared to *laissez-faire*, allowing the UE decoupled subsidies to belong to the green box. Although this implementation of cross-compliance reduces fertiliser and water use, they remain well above what is recommended by environmental scientists. Adding a reform of water pricing, i.e., replacing the current tax per irrigated area by a tax per volume abstracted, would reduce the inputs use and nitrate leaching to a more sustainable level.

3.1 Introduction

Following the general reform of the Common Agricultural Policy (CAP) adopted in 2003 in Luxemburg, the European Commission approved in 2004 a reform of cotton subsidies, whose implementation began in January 2006[1]. Instead of the previous guaranteed cotton price, which was well above the international price, cotton growers now receive both a fully decoupled subsidy (the single farm payment) and a subsidy proportional to the area cultivated. In addition, if they are caught in non-compliance with a list of environmental criteria, a portion of the subsidy is retained. This part of the reform is labelled cross-compliance.

The economic impact of decoupling of agricultural subsidies has been studied by many scholars (for a survey, cf. SWINBANK et al., 2005), both with analytical and applied models. Decoupling of cotton subsidies in the EU has been mainly assessed through applied partial equilibrium models, which consistently predict a decrease in EU production, although by a different amount (BORRESCH et al. 2005, ARAUJO BONJEAN et al. 2005, GILSSON et al. 2004 and KARAGIANNIS 2005). Some of these studies also assess the impact of the reform on EU producers' welfare and conclude that the reform would let them better off. However several issues remain to be addressed.

First, these assessments assume risk neutrality. Yet risk aversion may change the picture because EU cotton producers typically own very small farms[2] (5 ha in average) and the inter-annual variability in both world cotton price and yield is important. Indeed, it is well-known since HENNESSY (1998) that under risk-aversion, even a decoupled payment may impact production (cf. SERRA et al., 2006, and references therein). Second, cotton production in the EU causes severe environmental problems, including nitrate leaching, aquifer depletion and seawater intrusions. Although the Luxemburg CAP reform aims at mitigating the environmental impacts of agriculture, whether and to what extent it will succeed in the case of cotton production remains an open question. Third, the cross-compliance provisions are not taken into account in the above assessments, yet they might reduce producers' welfare. Indeed, the implementation of cross-compliance in Greece puts a cap on nitrogen fertilisers use per ha, which is likely to reduce yield.

In this paper, we link an agronomic model to a stochastic economic model, which allows us to address these three issues. First, to take into account risk aversion, we use a Constant Relative Risk Aversion (CRRA) utility function and three stochastic variables:

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[1] On 7th September 2006, the European Court of Justice cancelled the reform in its decision C 310-04. However, pending a new proposal by the Commission, the reform is still applicable.

[2] Most studies conclude that risk aversion decrease with wealth, hence, ceteris paribus, with farm size.

world cotton price, nitrogen fertiliser price and weather. As we will see, this framework causes decoupled payments to impact farmers' behaviour. Second, the production function stems from an agronomic (crop & soil) model, in which yield depends on weather, on the amount of nitrogen fertiliser and on the volume of irrigation. The latter two items, which are key driving forces of environmental degradation, are thus endogenous in our model. In addition, the agronomic model quantifies nitrate leaching.

This coupling of an agronomic model with a stochastic economic model casts a new light on the cotton CAP reform. First, it confirms that decoupling reduces yield and input (fertilisers and irrigation) use, even under risk aversion. However, absent cross-compliance, input use remains much higher than the level recommended to halt the environmental damages mentioned above. Second, even though the sanctions for non-compliance with the environmental criteria may be seen as mild (we assume a 5% cut in subsidies) they would be high enough to promote compliance, were the control rate larger than planned (1% of farms every year). Third, addressing nitrate leaching requires limiting the amount not only of nitrogen fertilisers but also of irrigation water. This in turn requires replacing the existing water tax per hectare irrigated by a tax proportional to the water volume used. We show that this reform would significantly reduce water consumption and nitrate leaching. Fourth, although decoupling slightly increases farmers' expected profit compared to the previous CAP regime, it reduces farmers' expected utility and certainty-equivalent profit. This is because farmers now support the uncertainty in world cotton price.

The rest of the chapter is organised as follows. In section 3.2, we present the agronomic and economic models and the coupling methodology. The assessment of the cotton CAP reform and of the proposed water tax reform is presented in section 3.3. Section 3.4 concludes.

3.2 A bio-economic model of cotton production in Greece

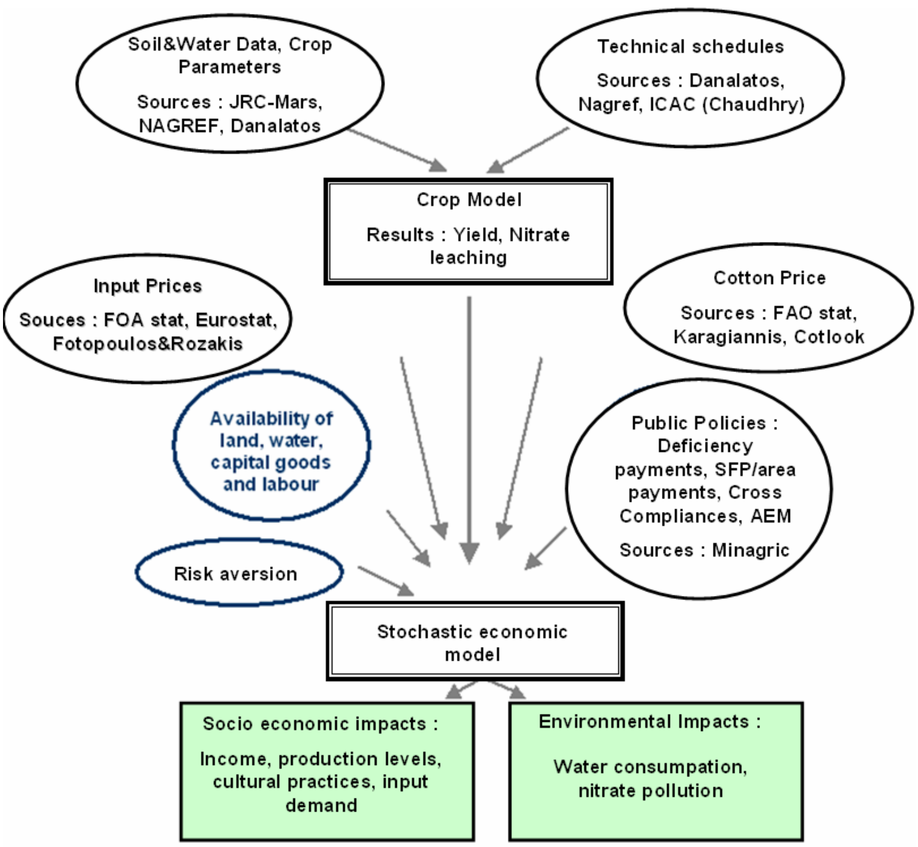
3.2.1 Data Collection and Modelling Principles

To assess the influence of public subsidies and of cross-compliance provisions on farmers' behaviour, a bio-economic model is useful: in their decisions (regarding in particular the level of inputs) farmers take into account these policy provisions but also the influence of inputs on cotton yield. The former requires an economic model while the latter is best described by an agronomic model. We run our agronomic model for a representative field situated in Larissa, Thessaly, one of the main cotton producing areas in Greece[3]. The model provides cotton yield as a function of the amounts of water and nitrogen fertiliser, for a given weather. For seven climatic years (representative of Thessaly climate), we fit the cotton yield response to inputs use. The set of these seven yield functions forms the stochastic production function of the economic model. We assume that each year has an equal probability of occurrence.

The economic model is based on the maximisation of an utility function by a risk-averse representative farmer. The farmer chooses the level of nitrogen fertiliser and of irrigation which maximises its expected utility, taking into account the public policy and three stochastic variables: weather, cotton price and fertiliser price.

Basic data are presented in an appendix. Agronomic data are taken from DANALATOS (1993), NAGREF (Greek National Agricultural Research Foundation) and JRC European Commission Join Research Centre, MARS database). Socio-economic and policy data come from ROZAKIS (2004), ROZAKIS and DANALATOS (2006), ROZAKIS and PANTZIOS (2003), FAOstat and conversations with Minagrics (Greek ministry of agriculture) officials (Figure 3.1).

Figure 3.1: Main data sources and model structure



[3] Greece represents 80% of the EU cotton production.

3.2.2 Agronomic modelling

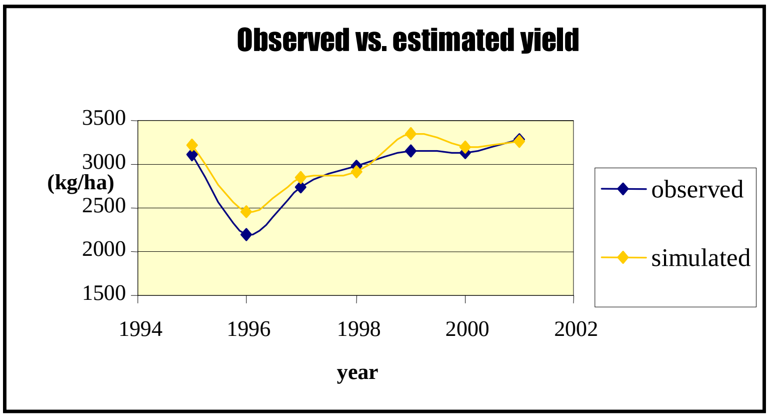
As an agronomic model, we use CotonSimbad (JALLAS et al., 1998), a cotton crop and soil model developed by the French research centre CIRAD as an offspring of the U.S. GOSSYM model (REDDY et al., 2002). CotonSimbad is a physiologically detailed simulation model of the growth and development of the cotton plant system. Three types of input are required: initial soil (hydrologic characteristics, carbon and nitrogen initial contents…), daily weather (temperature, solar radiation, rainfall and wind speed) and cultural practices. The main output is the dry seed cotton yield.

The model is filled in with the farm type characteristics, i.e., a typical Greek cotton farm, that is a medium size (7.5 ha, capital: 2718€; source FOTOPOULOS & PANTZIOS, 1998) cotton monoculture in Thessaly (Larissa, 39'36 N, 22'27 E) with a medium risk aversion (ρ = 2). The main technical and agronomic characteristics can be summarised in the following way (DANALATOS 1993, ROZAKIS 2004, ROZAKIS and DANALATOS 2006, ROZAKIS and PANTZIOS 2003, MANOS et al. 2002):

- a calcil vertisoil (clay slim)
- dry climate (mean annual rainfall: 381 mm, mean daily temperature : 21,3°C)
- intensive and modern production practices: drip irrigation, high rate of fertilization fragmented in several application (20-10-0 before sowing, ammonitrate after emergence).

The estimated yield curve is calibrated with real yield series. This calibration plays on two parameters: the emergence date and a « damages » module, which simulates pests' attacks. We treat meteorology as a stochastic variable and inputs use as decision variables. We thus run the agronomic model for seven observed recent years. As shown by Figure 3.2 below, the model satisfactorily reproduces yearly observed yield.

Figure 3.2: Observed yield vs. yield simulated by the model

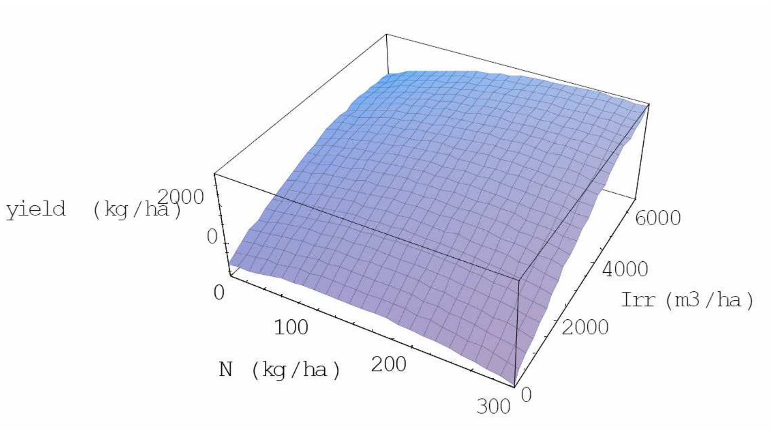


For each of the seven simulated years (1995-2001), 72 scenarios of cultural practices (featuring various levels of fertilisation and irrigation) are tested in order to fit an annual yield response curve to different amounts of irrigation or fertilisation. This way, interactions between irrigation, fertilisation, weather and soil characteristics are taken into account[4]. The regression model chosen is quadratic[5]:

$$Yield = a + b\,N + c\,N^2 + d\,W + e\,W^2 + f\,N{*}W$$

Where N is the total amount of nitrogen (kg/ha), W the total amount of water (m^3/ha), a, b, c, d, e and f are regression coefficients. Figure 3.3 below displays the function for 1997.

Figure 3.3: Production function for year 1997



For all seven years, regressions bring satisfying results: the explanatory power is high ($R^2 \in [0.91, 0.99]$) and coefficients have the expected signs ($a > 0$, $b > 0$, $c < 0$, $d > 0$, $e < 0$ and $f > 0$).

In addition CotonSimbad provides an assessment of nitrogen leaching at two meters under the soil surface. We estimate a leaching function through a statistical regression, as we did for cotton yield. The functional form chosen is taken from SIMELIUS et al. (2002):

$$N\ leaching = g + h\,N^{1/2} + i\,N + j\,W$$

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4 Admittedly, the statistical estimation of the production function from the "quasi-data" generated by the agronomic model might be sensitive to the number of quasi-data generated. A sensitivity analysis (not presented here) showed that this is not the case here.

5 We also tested Mitscherlich-like models but the quadratic model fitted the data better.

We get $g < 0$, $h < 0$, $i > 0$ and $j > 0$, which is consistent with the literature. Unfortunately, the regression is not statistically robust, with $R^2 \in [0.3, 0.6]$. However we could not find a better functional form in the literature.

3.2.3 Economic modelling and policy scenarios

$$profit_{i,j,k} = \tilde{p}_i \times \tilde{y}_j - \tilde{p}_k^n \times n - p^w \times w - r + g(.)$$

$$u_{i,j,k} = \frac{(profit_{i,j,k} + \omega)^{1-\rho}}{1-\rho}$$

$$eu = \frac{1}{n_i} \sum_{i=1}^{n_i} \left(\frac{1}{n_j} \sum_{i=1}^{n_j} \left(\frac{1}{n_k} \sum_{k=1}^{n_k} u_{i,j,k} \right)\right)$$

$$CE = ((1-\rho)\, eu)^{1/(1-\rho)} - \omega$$

$\tilde{y}_j$: incertain crop production function

ϖ : initial wealth (€/ha)

$\tilde{p}_i$: incertain cotton price (€/kg)

$\tilde{p}_k^n$: incertain fertilizer price (€/kg)

p^w: water price (€/m^3)

ρ : coefficient of the relative risk aversion

n: fertilizer amount (kg/ha)

w: irrigation amount (m^3/ha)

r: charge (€/ha)

g(.): public policy payment

$profit_{i,j,k}$: profit (€/ha)

u: utiliy

CE: certainty equivalent profit

Box 1. The basic model

The microeconomic model represents the inputs choice by an individual farmer facing variability in both prices and yields. We assume that the farmer maximises its expected utility, with a Constant Relative Risk Aversion (CRRA) utility function. Such a functional form has already been utilised in the literature, e.g. by the OECD (2005). It accounts for the observed negative impact of wealth on absolute risk aversion (cf. e.g. OECD, 2004, p. 31). All stochastic variables (weather, cotton price and fertiliser price) are supposed to keep the same distribution as in previous years. We compare five scenarios:

i. *Laissez-faire*, in which the profit function is simply defined by:

$$profit_{i,j,k} = \tilde{p}_i \cdot \tilde{y}_j - p_k^n \cdot n - p^w \cdot w - r$$

ii. *Old_CAP*, based on a deficiency payment, in which:

$$profit_{i,j,k} = price\,(1 - penalty_j) \cdot \tilde{y}_j - p_k^n \cdot n - p^w \cdot w - r$$

The target price is known by the farmer in advance, but when the national cotton production passes a given threshold (the national quantity guaranteed) a penalty applies. We put in the model the penalty actually applied by the EU for each of the seven years for which we estimated a production function. Since the penalty is triggered by the national production, not by the individual farmer's production, we model it as a stochastic exogenous variable, influenced by aggregate production, thus by weather, but not by the farmer's decisions.

iii. *Decoupling*, in which:

$$profit_{i,j,k} = \tilde{p}_i \cdot \tilde{y}_j - p_k^n \cdot n - p^w \cdot w - r + s$$

with:

$$S = Single\ Farm\ Payment + aid\ per\ ha$$

This scenario represents the central element of the cotton CAP reform, i.e., decoupling. We choose *S* such that it equals the expected subsidy in the *Old_CAP* scenario. In other words, the reform is assumed to be budgetary neutral (in average), which is in line with the Luxemburg agreement. This can be true only in average: some regions may receive more subsidies than before the reform, some other less.

iv. *Decoupling_CC* (for cross-compliance), in which:

$$profit_{i,j,k} = \tilde{p}_i \cdot \tilde{y}_j - p_k^n \cdot n - p^w \cdot w - r + s$$

With:

$$S = (Single\ Farm\ Payment + aid\ per\ ha)\ if\ n < 130$$

$$S = (1 - 0.05)\,(Single\ Farm\ Payment + aid\ per\ ha)\ if\ n > 130$$

Here we assume that cross-compliance is implemented in the following way: if the nitrogen fertiliser input overshoots 130 kg/ha, farmers loose 5% of their subsidies. This implicitly assumes that all farms are controlled, which is of course not realistic; we turn back to this point in the next section.

The way cross-compliance is implemented by the Greek government for cotton production does not include any direct provision to reduce the amount of irrigation. Yet, as we already mentioned, excessive irrigation yields severe environmental problems. Hence we run a last scenario in which the current water tax per hectare irrigated is replaced by a tax per m^3 actually abstracted, following a proposal by MANOS et al. (2002)

and LATINOPOULOS (2005). We compute the tax rate so that the reform is budgetary neutral: farmers pay the same amount before and after the water tax reform. This facilitates policy conclusions since we do not have to take into account the public budget.

v. *Decoupling_CC+Irr tax*, in which:

$$profit_{i,j,k} = \tilde{p}_i \cdot \tilde{y}_j - p_k^n \cdot n - \left(p^w + t_v^w\right) \cdot w - \left(r - t_a^w\right) + s$$

With:

$S = (Single\ Farm\ Payment + aid\ per\ ha)\ if\ n < 130$

$S = (1 - 0.05)\ (Single\ Farm\ Payment + aid\ per\ ha)\ if\ n > 130$

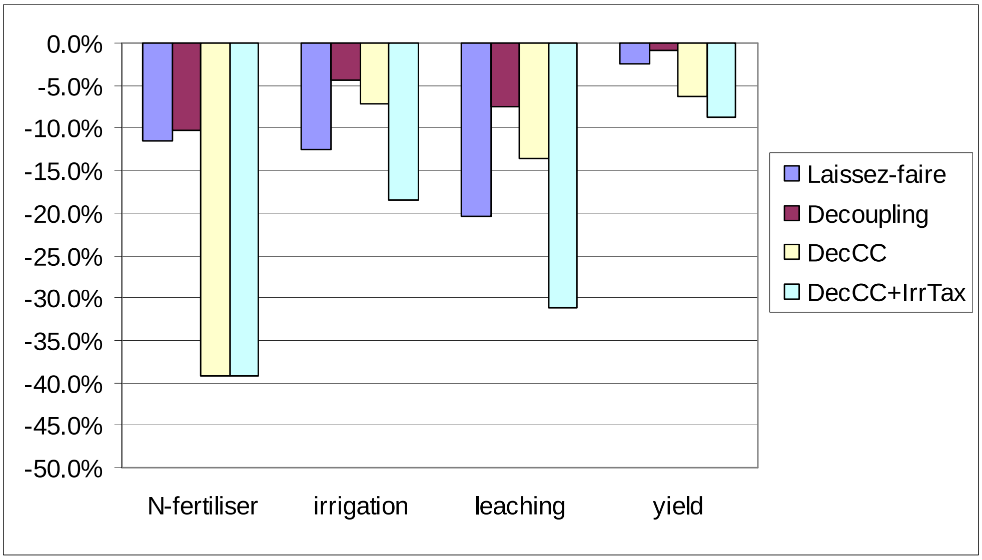
t_v^w : water tax rate per m^3 (after the reform)

t_a^w : water tax rate per ha (before the reform – 188 €/ha, ROZAKIS and DANALATOS, 2003)

3.3 Results

3.3.1 Physical impact of the reforms

Figure 3.4: Physical impact of the scenarios compared to *Old_CAP*



As is apparent from Figure 3.4, *Decoupling* alone has a modest impact on physical variables: the amount of nitrogen fertiliser decreases by 10% and water by only 4%. This entails a decrease in yield of only 0.8% and of nitrate leaching of 8%. The comparison of *Decoupling* with the *Laissez-faire* scenario shows that "decoupled" subsidies impact production: *Laissez-faire* would reduce yield by 2.4%, three times as much as *Decoupling*. This result could cast some doubts on the non-distortionary nature of such "decoupled" subsidies: do they belong to the WTO "green box" even though their impact is close to that of coupled aids?

Cross-compliance draws a different picture. Given our assumptions (100% of farms controlled, 5% of subsidies retained in case of fraud), profit maximisation leads farmers to comply with the nitrogen cap[6]. As a consequence, the amount of nitrogen fertiliser is cut by 39% under *Dec_CC* compared to *Old_CAP*. However irrigation is only reduced by 7% and nitrate leaching by 14%; the latter appears to be more driven by the amount of water than by the amount of nitrogen. Under this scenario, the amount of water used (500 mm) is significantly higher than the irrigation rules recommended by NAGREF (400 mm). Yield is cut by 6% and is now lower than under *Laissez-faire*, indicating that decoupled subsidies, if conditioned to cross-compliance provisions, do not distort international trade to the detriment of other cotton producers – an interesting finding for EU negotiators at the WTO.

The water tax reform, *Dec_CC+Irr_tax*, brings environmentally appealing results. With the budgetary neutral tax level (0.0428 €/m^3), nitrogen input is still cut by 39% compared to *Old_CAP*, but irrigation is now reduced by 18% and leaching by 31%[7]. The irrigation level (439 mm) is now close to NAGREF recommendation (400 mm). Yield is of course reduced, by 8% compared to *Old_CAP*, but by only 2.5% compared to *Dec_CC*. This may be seen as a modest price to pay for a significant environmental improvement. However, the water tax reform would require the installation of water meters, whose cost is not taken into account here.

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6 If we assume a one-period game in which the regulator leads purely random inspections and that 5% of subsidies are retained in case of fraud, the yearly control rate has to be higher or equal to 40% for farmers to comply with the reform. This is much higher than the 1% yearly control rate expected. However, in reality, the regulator may have some prior information on who are the most likely smugglers. In addition, a farmer caught in fraud is likely to be controlled again in subsequent years, which increases the expected cost of fraud. Hence assessing the control rate for which farmers will comply with cross-compliance would require a much more elaborate framework.

7 The water tax level we assess is much lower than that recommended by MANOS et al. (2002): 0.15 €/m^3. Consistently, it achieves a lower cut in the irrigation level.

3.3.2 Impact on farms profitability

Figure 3.5: Impact of the scenarios on farms profit

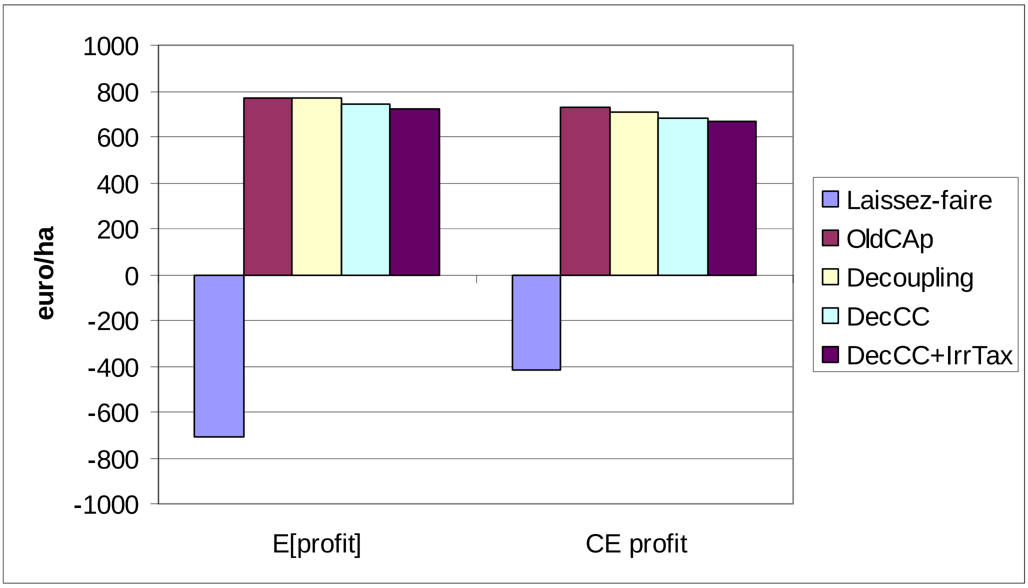

Figure 3. above displays the impact of the five scenarios on farms expected profit and on the certainty-equivalent profit. Profit here means net profit, i.e., it takes into account land price and the amortization of fixed costs.

In the *Laissez-faire* scenario, the expected profit and the certainty equivalent profit are negative whatever the level of inputs, which indicates that without subsidies, growers should abandon cotton production provided that they can sell their capital. In all other scenarios, these two indicators are positive.

Under *Decoupling* the expected profit increases slightly (by 0.3%) compared to *Old_CAP* which is consistent with the existing literature (cf. SWINBANK et al., 2005). The underlying mechanism is the following: farmers' productive choices (i.e., the level of inputs) are less distorted by decoupled payments than by coupled payments (they are closer to what they would be under laissez-faire). Since we model budgetary neutral reforms, i.e., the same level of subsidies in every scenario but *Laissez-faire*, farmers' expected profit is higher with less distortionary subsidies.

However certainty-equivalent profit decreases by 3% under *Decoupling* compared to *Old_CAP*. The explanation is that risk is lower under *Old_CAP* than under *Decoupling* since in the latter, farmers bear the risk associated with world cotton price. In addition, as explained above, under *Old_CAP*, when a good weather brings a higher than expected cotton production, the deficiency payment is reduced by a penalty. This constitutes a kind of built-in insurance which helps reducing the variance in expected profits.

Both the expected profit and the certainty-equivalent profit is reduced under *Dec_CC* (respectively by 4 and 6%) and a little more under *Dec_CC+Irr_tax* (respectively by 5 and 8%). This is simply due to the lower yield induced by the decrease in inputs use. The certainty-equivalent profit decreases only by 2% under *Dec_CC+Irr_tax* compared to *Dec_CC*. In other words, the revenue-neutral water tax reform alone would only have a very small impact on farmers' utility.

3.4 Conclusion

In a deterministic framework, decoupling typically yields a double dividend, i.e., an increase in farmers' welfare and in the environmental quality (cf. e.g. DEBOVE and JAYET, 2006). This optimistic conclusion does not necessarily stand under uncertainty and farmers' risk-aversion. According to our bio-economic modelling of cotton production in Greece, decoupling does reduce the driving forces of environmental degradation (excessive nitrogen fertiliser and water abstraction) and slightly increases farmers' expected profit. Yet farmers' expected utility is reduced, because of an increase in the risk they bear. Indeed the previous CAP regime protected farmers against fluctuations in cotton world prices. In addition, it had a kind of built-in insurance since the amount of subsidies was lower in years with a higher than expected yield thanks to good weather conditions. In addition, decoupled subsidies do decrease production compared to coupled subsidies of the same amount, but raise production compared to *laissez-faire*. As a consequence, whether they should be put in the WTO green box is debatable.

Another key element of the CAP reform is cross-compliance. The Greek government decided to implement cross-compliance in cotton production through a cap on nitrogen fertiliser at 130 kg/ha, which induces, in our simulation, a 39% reduction compared to the previous CAP regime. This would slightly reduce production compared to *laissez-faire*, allowing the UE decoupled subsidies to belong to the green box. Although this implementation of cross-compliance reduces fertiliser and water use, they remain well above what is recommended by environmental scientists. Adding a reform of water pricing, i.e., replacing the current tax per irrigated area by a tax per volume abstracted, would reduce the inputs use and nitrate leaching to a more sustainable level.

Our approach may easily be applied to other crops than cotton, even though risk aversion may be less an issue for arable crops, since inter-annual price fluctuations is probably lower for most crops, and farmers' wealth larger.

Some other feature may be included in our approach. Insurance against the risk of a drop in world cotton price could improve the impact of the reform on farmers' welfare. Including rotations and crop choice would also be interesting, but would require the use of another crop model. We leave this for future research.

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4 Assessing the impact of decoupling on farmers' acceptance of environmental measures to reduce nitrogen input in cotton production: a case study for the region Thessaly, Greece

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4.1 Introduction

In the aftermath of the 2003 CAP Reform the EU applied the principle of decoupling to several other market organisations including the cotton market regime. It was decided to abolish the deficiency payment system for cotton which guaranteed cotton ginners and farmers product prices about three times higher than the world market price (KARAGIANNIS, 2005). Instead a scheme based on partially decoupled direct payments was introduced and the price for cotton was cut to the world market level.

As mentioned by BUTLEN and QUIRON (Chapter 3) cotton production in the EU has negative implications on the environment such as nitrate leaching, aquifer depletion and seawater intrusions. Therefore, the reform is not only of interest with respect to its economic impact, but also with respect to its impact on the environment. In contrast to the analysis of BUTLEN and QUIRON, the main objective of this chapter is to analyse the impact of decoupling on farmers' acceptance of voluntary environmental measures to reduce nitrogen input. For the analysis, the farm group model EU-FARMIS is applied. To be able to simulate the acceptance of environmental measures, the model is extended to better represent different intensity levels of cotton production. In comparison to the crop model applied by BUTLEN and QUIRON, EU-FARMIS has the advantage that not only cotton but most other crop and livestock activities in Greece are represented. Therefore, the competition of cotton with other crops is taken into account. Furthermore, the impact on farms differing in size and type can be distinguished. The analysis focuses on Thessaly in Greece, which is one of the major European cotton growing regions. To give an overview of the impact on total cotton production in Greece, other Greek regions are included in the analysis as well. The analysis uses the nitrogen input functions estimated by BUTLEN and QUIRON.

The chapter is structured as follows: First, model and model adjustments implemented for this study are described. Then, the analysed scenarios are explained and obtained results are presented. It is closed with an outlook on further model development.

4.2 Methodology

The analysis for this paper was done using EU-FARMIS, a well-established model for assessing policy impacts at the farm level. The model is briefly described in the following. A detailed documentation is given in OFFERMANN et al. (2005), BERTELSMEIER (2005) and Deliverable D2 (REHMAN, 2006).

4.2.1 Model and Data

EU-FARMIS is a comparative-static process-analytical programming model based on Farm Accountancy Data Network (FADN) data, with individual farm data being aggregated to farm groups. Production is differentiated for 27 crop activities and 15 livestock activities. The matrix restrictions cover the areas of feeding (energy and nutrient requirements, calibrated feed rations), intermediate use of young stock, fertiliser use (organic and mineral), labour (seasonally differentiated), crop rotations, and political instruments (e.g., set-aside, quotas). A positive mathematical programming (PMP) procedure (see, e.g., HOWITT 1995, HECKELEI 2002) is used to calibrate the model to the observed base year levels. For the calculation of the non-linear cost function, external information about supply elasticities is used. This approach is well suited to model farm activities, such as crops, that make use of different production technologies, and whose exchangeability is restricted by agronomic limitations such as crop rotations. However, the standard form of PMP might be less suitable to model the impact on activities which are very similar and differ only with respect to selected agronomic practises. For example, in the case of agri-environmental measures, the standard activity and the agri-environmental measure should not be viewed as separate activities but as variants of the same activity. The methodology should take into account the enhanced flexibility of farmers to switch between these production variants. Therefore, the following describes first the standard calibration approach used in EU-FARMIS, and second the adjustments implemented to analyse the acceptance of agri-environmental measures for cotton production.

Standard calibration in EU-FARMIS

EU-FARMIS uses PMP to calibrate the model to the observed activity levels. PMP follows a two step procedure. First, an LP model is solved, where, in addition to the set of resource constraints, a set of calibration constraints is added. The calibration constraints represent the observed activity levels:

$$\max Z = \sum_i (p_i y_i + sub_i) x_i - c_i x_i \quad (1)$$

with $$\sum_i a_{il} x_i \le b_l \quad \forall\, l \quad [\pi_l] \quad (2)$$

$$x_i \le x_i^* + \varepsilon \quad \forall\, i \quad [\lambda_i] \quad (3)$$

$$x_i \ge 0 \quad \forall\, i \quad (4)$$

where:

Z scalar of the objective function value,

p_i product prices,

y_i yields,

i index for the activities,

sub_i subsidies,

x_i production activity levels,

c_i accounting costs per unit of activity,

a_{il} input coefficients,

l index for the resources

b_l available resource levels,

x_i^* observed activity levels,

ε small positive number to prevent linear dependency between the structural constraints (2) and the calibration constraints (3),

π_l duals associated with the allocable resource constraints,

λ_i duals associated with the calibration constraints.

It is assumed that the observed activity levels represent the optimal solution. The dual values of the calibration constraints are interpreted as unobservable costs or profits. In a second step these dual values are used to derive a new objective function. Ceteris paribus the new model should reproduce the solution of the base year in absence of the calibration constraints. An unlimited number of approaches and functional forms can be used to achieve this goal. In EU-FARMIS the objective function is extended by a quadratic cost term which implies increasing marginal cost. The slope of the marginal cost function is derived from exogenous supply elasticities as described in Equation 5:

$$\omega_i = \frac{p_i y_i + sub_i}{\varepsilon_i^{x,GE} x_i^*} \qquad (5)$$

where:

ω_i slope of the marginal cost function,

p_i product prices,

$\varepsilon_i^{x,GE}$ supply elasticity.

For calibration, additionally, a linear term has to be calculated. To calibrate the model to the observed activity level x_i^* the linear and nonlinear term together must equal λ_i. Hence, the linear term is the residual of the dual of the calibration constraint λ_i minus the product of ω_i and x_i^*.

$$\delta_i = \lambda_i - \omega_i x_i^* \qquad (6)$$

δ_i and ω_i are used to from a new quadratic objective function:

$$\max Z = \sum_i (p_i y_i + sub_i) x_i - c_i x_i - \delta_i x_i - \frac{1}{2} \omega_i x_i^2 \qquad (7)$$

Inclusion of cotton production variants in EU-FARMIS

Using the standard PMP approach, with all non-diagonal elements of Q equal to zero, it is implicitly assumed that all activities represent separate crops with independent cost functions. However, it seems reasonable that substitution of similar production activities should be easier than substitution of completely different ones. This is especially the case if activities differ only with respect to the intensity of production or with respect to selected environmental restrictions. In this context ROEHM and DABBERT (2003) proposed an approach to differentiate between separate activities and agri-environmental measures. Based on these ideas EU-FARMIS was extended to analyse the impact of decoupling on the acceptance of agri-environmental measures for cotton production. In this context Equation 7 is extended to Equation 8 by the inclusion of j production variants:

$$\max Z = \sum_{ij}\left(\left(p_i y_{ij} + sub_{ij}\right)x_{ij} - c_{ij}x_{ij} - \delta_{ij}x_{ij} - \frac{1}{2}\omega_{1i}x_{ij}^2 - \sum_{k\neq j}\frac{1}{2}\omega_{2i}x_{ik}^2\right) \quad (8)$$

where:

j,k indices for variants of activity i,

ω_{1i} parameter determining the value of the nonlinear cost term of the intensity j in dependence of the level of the variants j,

ω_{2i} parameter determining the value of the nonlinear cost term of the variant j in dependence of the level of the other variants k ≠ j.

The term $\sum_{k\neq j}\frac{1}{2}\omega_{2i}x_{ik}^2$ is added to take the close relationship among the variants of the activities into account. The term provides that marginal costs of each variant do not only depend on the level of the variant considered but on the level of the other variants x_{ik} as well. The new coefficients are derived in the following way:

$$\omega_i = \frac{\sum_j x_{ij}(p_i y_i + sub_i)}{\varepsilon_i^{x,GE} x_i^{*2}} \quad (9)$$

$$\omega_{1i} = \omega_i\left(\left(J-1\right)\phi_i + 1\right) \quad (10)$$

$$\omega_{2i} = \frac{\omega_i J - \omega_{1i}}{J-1} \quad (11)$$

$$\delta_{ij} = \lambda_i + \lambda_{ij} - \omega_{1i}x_{ij}^* - \sum_{k\neq j}\omega_{2i}x_{ik}^* \quad (12)$$

where:

J number of variants,

ϕ_i parameter determining the exchangeability of variant levels,

λ_{ij} duals associated with the calibration constraints of each variant,

δ_{ij} additional linear cost term associated with each variant.

First, in Equation 9 ω_i has to be derived. Analogous to Equation 5, ω_i is calculated for the whole activity. As the activity consists of several variants in Equation 9 the sum of all variants is divided by the square of x_i. Ceteris paribus ω_i should remain unchanged.

In Equations 10 and 11 ω_{1i} and ω_{2i} are calculated. While ω_{1i} and ω_{2i} do differ among activities the same coefficients are applied for all variants of each activity. Consequently, the "supply elasticity"[8] differs between variants unless their level in the base is the same. This is because in the chosen formulations ω_{1i} and ω_{2i} do not depend on the observed level of the variant, but on the observed level of the activity. This makes it possible to model measures which are not observed in the base year. The relative value of ω_{2i} in comparison to ω_{1i} is determined by ϕ_i. ϕ_i can range from 0 to 1. If it equals 0, ω_{1i} equals ω_{2i}. As a consequence the value of the quadratic cost term does not depend on the level of each variant but only on the sum of all variants, i.e., the total level of the activity. Hence, the substitution among variants is flexible. On the other hand variants are treated as separate activities if ϕ_i equals 1. In Equation 12, in analogy to Equation 6, the residual linear term for each variant is calculated.

Implementation of thresholds

The method described above allows for the inclusion of production variants in the analysis that are not observed in the base year. However, the approach might not lead to realistic results if economically unattractive production variants are included in the analysis because the calibration method described above neutralizes the differences in economic attractiveness of all variants and activities at the observed activity level. Therefore, activities which are not observed in the base year might enter the solution immediately after their comparative economic attractiveness is marginally increased. This might lead to unrealistic results if it is considered that under normal circumstances, farmers would only apply such measures if an economic incentive is granted.

Hence, for the analysis of the acceptance of environmental measures, the difference in the economical attractiveness between the standard variant and the environmental measure was calculated and included in the cost function in the form of a threshold. The environmental measure is only applied if its economic attractiveness is increased by more than the value of the threshold. This allows a more realistic representation of farmers' behaviour. One drawback of the chosen approach is the alteration of the activity's elasticity. As long as not all variants/measures are applied the elasticity of the entire activity is reduced. Alternatively, a formulation could have been chosen that keeps the elasticity in the base year constant. However, in this case the elasticity would increase after the new variants entered the solution.

[8] Not an own price elasticity is used but an elasticity than takes both, changes of the own price and changes of the level of coupled subsidies into account.

Implementation of an environmental measure for cotton production

Cotton production in the EU causes environmental problems. This paper focuses on environmental measures to reduce nitrogen input. BULTEN and QUIRON estimated functions explaining cotton yield by nitrogen input and irrigation (Equation 13). They used data from the period 1996-2001 and calculated different functions for each year. It was decided to use the function of the year 2001 for this study because it shows a similar output level compared to the one observed in the base year (2002). Additionally, the production technology used in 2001 and 2002 should be similar.

$$y = -1464.5 + 10.4717N - 0.033871N^2 + 0.00078413NW + 1.6499W + 0.00018727W^2 \quad (13)$$

where:
y yield of cotton in kg/ha,
N nitrogen input kg/ha,
W irrigation in m^3/ha.

As more than 90% of Greek cotton is irrigated and irrigation is not covered by EU-FARMIS it is assumed that the entire cotton area in Greece is irrigated. Additionally, it is assumed that farmers apply the combination of water (5400m^3/ha) and nitrogen input which is optimal according to the calculations of BULTEN and QUIRON. Consequently, Equation 13 is simplified to Equation 14.

$$y = 1984.2 + 14.283N - 0.033871N^2 \quad (14)$$

According to Equation 13, the optimal nitrogen input given the nitrogen and cotton prices assumed in the model is about 200kgN/ha. The output is about 3.5 t of un-ginned cotton dry matter per ha. This, of course, is an average figure, and the equation does not fit to all farm groups: There are several ways to deal with this problem. For this study, it is decided to calculate a farm individual constant that shifts the function to correspond to the observed yields.

Based on this function, for each farm group, the optimal nitrogen input was calculated. It was found that the optimal nitrogen input is significantly higher than the amount proposed by environmental scientists. For the region Thessaly, KARYOTIS et al (2002) proposed values ranging from 70 kg N/ha – 130 kg N/ha depending on local attributes like soil type, texture and slope. As a basis for the environmental measure analysed here, a maximum nitrogen input of 100 kg N/ha is chosen. This value is used to establish an additional cotton production variant in EU-FARMIS. The reduction of nitrogen input leads to a decrease of the cotton yield and farmers will not be willing to apply this variant without a monetary incentive.

Implementation of mulching

After the 2003 CAP Reform farmers are eligible to receive direct payments without the need to produce. This means that instead of applying environmental measures, farmers might decide to stop cotton production completely and to keep the land in good agricultural and environmental condition instead. In this context, it was decided to introduce a third variant – mulching. Formally mulching is implemented analogously to the environmental measure. A threshold was calculated by subtracting all costs of cotton production (normal intensity) from the sum of sales and subsidies. This term was added to the cost function of mulching (after calibration).

Aggregation of farm groups

EU-FARMIS uses farm groups instead of single farms to ensure the confidentiality of individual farm data, but also to increase manageability and increase the robustness of the model system in the face of data errors which may exist in individual cases. As stratification criteria for the establishment of farm groups, region, farm type, share of cotton acreage and total amount of cotton are chosen. The focus of the analysis is on Thessaly. Therefore, for all regions but Thessaly only one farm group is formed. The incorporation of the other regions is necessary to consider the development of total cotton production in Greece. In total 25 farm groups are established.

4.2.3 Implementation of the 2003 CAP reform

The 2003 CAP Reform left Member States many options for implementation. Greece decided to fully decouple all direct payments and to determine entitlement levels based on farm individual, historical references. The new scheme started in 2006. Although Greece opted for full decoupling, it makes use of Article 69 which allows to retain a part of the premium plafonds to support selected measures that enhance quality or have positive environmental externalities. In this context, 10% of the plafonds for arable crops and beef and 5% the plafond for sheep are retained (EU COMMISSION 2007).

In the European cotton market a deficiency payment system has been in place since the accession of Greece to the EU. Cotton ginners received payments equal to the difference between a guide price (1063 €/t) guaranteed by the EU and the world market price for un-ginned cotton[9]. Ginners, on the other hand, had to pay farmers a price equal to the minimum price for un-ginned cotton (1009 €/t). To limit the whole budget of the support

[9] A market price for un-ginned cotton is not available because un-ginned cotton is not tradable. Instead it is determined regularly by the European Union based on Article 4 of Regulation (EC) 1051/2001.

scheme, the target price depended on the total acreage of cotton grown in each country. Thus, in Greece the minimum price was significantly lower.

The market regime for cotton was reformed in 2004 together with hops, tobacco and olives in the following year. An overview about the reform is given in Table 4.1. In contrast to the initial reform, in the case of cotton, Member States had few options for national implementation. The deficiency payment system was replaced by a scheme based on partially decoupled direct payments. From 2006 on, 35% of the support is given in the form of coupled direct payments. In Greece, for the first 300,000 ha of cotton 594 €/ha and for the next 70,000 ha 343 Euro/ha are granted. The remaining amount (966 €/ha) enters into the calculation of the Single Farm Payment. The price for un-ginned cotton drops from about 750 Euro/ton of un-ginned cotton to the world market price which is in the range of 200-300 €/ton. To lower the burden of cotton production on the environment, Greece introduced an upper limit for nitrogen fertilization of 130 kgN/ha.

Table 4.1: Reform of the cotton market regime in Greece

	Single Farm Payment	Coupled direct payment
Share of the budget of former support scheme	65 %	35 %
Payment level	966 €/ha	594 €/ha for the first 300k ha 343 €/ha for the next 70k ha

Source: European Commission (2004)

4.2.4 Scenarios

Scenarios differ with respect to three dimensions: First, the general policy framework (either Agenda 2000 or MTR), the level of the monetary incentive to reduce nitrogen input and the parameter ϕ_i that determines the exchangeability among production variants. As no statistical information is available about the magnitude of ϕ_i it seems necessary to analyse the sensitivity of results. The target year in all scenarios is 2013.

Policy scenarios

Agenda scenarios: Four scenarios are based on the Agenda 2000. The general policy framework represents the situation in the target year that would have been realised if decoupling had not taken place. Compared to the base year 2002, all important elements of Agenda 2000, like price reductions for milk, beef and cereals, adjustment of direct payments and the milk quota extension are implemented. The scenario differs from the original Agenda 2000 package as the changes of the milk market regime and the abolishment of the rye intervention decided in the 2003 CAP Reform are included in the underlying price scenarios. The scenarios differ with respect to the financial incentive to reduce nitrogen input. The scenario names reflect the magnitude of the financial incentive in €/ha (**AG0**, **AG250**, **AG500**, **AG750**).

MTR scenarios**:** Four scenarios are based on the National Implementation of the 2003 CAP Reform in Greece. As previously described direct payments for arable crops (excluding cotton) are fully decoupled and entitlement levels are determined based on farm individual, historical references. The plafonds for arable crops and beef and the plafond for sheep is reduced by 10 and 5%, respectively. Coupled direct payments for cotton are set to 594 €/ha[10]. For the calculation of the reference amount each ha of cotton in the reference period is taken into account with 966 €/ha. As the Agenda scenarios, MTR scenarios differ with respect to the financial incentive to reduce nitrogen input. Accordingly scenario names are **MTR0**, **MTR250**, **MTR500** and **MTR750**.

Price scenarios

Next to the policy framework, price projections are important for farm model based policy analysis, because prices in EU-FARMIS are taken as exogenous. Price assumptions are given in Table 4.2. Most price projections were realised in cooperation with IDEMA, another project of the 6th Framework Programme. For this purpose BALKHAUSEN and BANSE (2006) applied the partial equilibrium model ESIM. Projections for both the continuation of Agenda 2000 and the MTR were provided. The projection for cotton is based on the "World market price for un-ginned cotton," regularly set and published by the European Commission (EUROPEAN COMMISSION, 2001). The variability of the price for cotton is relatively high and price development is uncertain. Here, a price drop of 65% is assumed which corresponds to the assumptions of KARAGIANNIS (2005). ESIM prices of the scenario "coupled direct payments" are used for the scenarios (Agenda, AG250, AG500, AG750) and prices for the ESIM scenario "National Implementation" are used for the GENEDEC scenarios (MTR, MTR250, MTR500, MTR750). Details are given in Table 4.2. Price projections differ only between Agenda and MTR. It was assumed that the incentive level granted for the application of environmental measures has no impact on the price level.

[10] A further differentiation of the payment level was not implemented because it is circumstantial and with respect to the results not necessary as due to decoupling total cotton acreage is reduced below 300,000 ha.

Table 4.2: Price scenarios

	Relative change to Agenda %
Wheat	4.0
Rye	0.0
Cotton	-65.0
Barley	6.5
Oats	7.2
Grainmaize	7.1
Rape	2.7
Other oilseeds	2.4
Potatoes	10.7
Milk	-4.7
Beef	11.8
Pork	2.0
Sheep meat	25.9
Eggs	2.2
Poultry meat	2.0

Source: ESIM / IDEMA

Sensitivity analysis

In addition to the policy framework and the price scenarios, the model response heavily depends on the choice of the parameter ϕ_i. If ϕ_i equals zero, the adjustment between variants is similar to the adjustment in an LP model. If ϕ_i equals 1, adjustment is similar to the relationship between the activities. To check the influence the analysis is conducted with values ranging from 0 to 0.5.

4.3 Results

First, the impacts of the reform of the cotton market and decoupling in Greece are summarized. Afterwards, the findings concerning the acceptance of the environmental measures and insights obtained by the sensitivity analysis are presented.

4.3.1 Impact of the cotton market reform in absence of environmental measures

The results of the scenario MTR are compared to the Agenda 2000 scenario. For this analysis it was assumed that ϕ_i is equal to 0.1. Impacts at the sector level on land use, production and income are displayed in Table 4.3.

Land use and Livestock

- The total **cereal** acreage is reduced by 7.2 % on average. **Durum wheat** and **grain maize,** which are of major importance in Greece, are both significantly reduced. On the other hand, **soft wheat** and **barley** are extended because they are less affected by decoupling. This is due to the relatively low amount of coupled direct payments granted to soft wheat and barley in the baseline.
- The acreage of **arable fodder plants** and **oilseeds** is extended because these are less affected by decoupling as well. The extension of roughage fodder production might seem implausible because livestock is reduced as well. This can be explained, however, with the adjustment of the fodder rations in EU-FARMIS and a reduction of the intensity of production.

Cotton production is reduced by 28.9% due to the drop of the market price for cotton. This implies that the total area of cotton is well below 300,000 ha[11]. The reduction would even be more pronounced if cotton farmers had more alternatives to cotton production. However, cotton farms are generally specialised on cotton production. About 90% of total cotton production is located on farms with a cotton share of more than 80% of total UAA. Additionally, the alternatives for production, such as durum wheat and grain maize are heavily affected by decoupling as well. Therefore, the main alternative is to stop production. Part of the land is mulched, i.e., managed in order to meet the cross compliance restrictions and to keep the land in good agricultural and environmental condition. However, no land becomes fallow (i.e., is not kept in good agricultural condition) because the average entitlement level (SFP) in Greece is high due to the reforms of cotton, hops, tobacco, olives and durum wheat, and almost the entire area is eligible to receive payments. The impact on livestock differs as well. The number of dairy cows remains stable. The effect of decoupling of milk premiums and the reductions of milk prices are offset by the increase of productivity. Consequently, milk quota remains binding. However, the number of bulls and suckler cows is reduced significantly. Pigs and poultry are not directly affected by decoupling. Sheep are reduced as well, but due to favourable price projections the reduction is less pronounced than in the case of bulls and suckler cows.

Impacts on income

For the assessment of the impact of the reform on agricultural incomes, the indicator Farm Net Value Added (FNVA) is used. FNVA measures the return to labour, land and

[11] This is the case even if it is taken into account that cotton production is underrepresented in the sample. According to EUROSTAT (2007) cotton area in 2002 was 360k ha and therefore, only 93% of Greek cotton production is represented.

capital irrespective of their ownership so that the profitability of similarly structured farms can be compared.

Table 4.3: Impact of the 2003 CAP Reform including the reform of the cotton market regime in Greece

		Agenda abs	MTR abs	Relative change (%)
Cereals	1000 ha	1,165	1,081	*-7.2*
Soft wheat	1000 ha	139	183	*31.7*
Durum wheat	1000 ha	638	497	*-22.2*
Barley	1000 ha	119	145	*22.3*
Grain maize	1000 ha	207	190	*-8.5*
Oats	1000 ha	54	57	*5.9*
Oilseeds (Food)	1000 ha	28	38	*35.6*
Protein crops	1000 ha	15	17	*9.9*
Potatoes	1000 ha	21	22	*4.8*
Sugarbeets	1000 ha	41	41	*0.0*
Arable forage crops	1000 ha	193	285	*47.5*
Set-aside	1000 ha	56	56	*-0.8*
Grassland	1000 ha	68	68	*0.1*
Cotton	1000 ha	337	240	*-28.8*
Intensive cotton	1000 ha	337	240	*-28.8*
Extensive cotton	1000 ha	0	0	
Mulched area	1000 ha	0	77	
Fallow	1000 ha	36	36	
UAA	1000 ha	3,099	3,099	
Dairy cows	1000 heads	69	69	
Suckler cows	1000 heads	102	53	*-48.3*
Bulls [1)]	1000 heads	20	16	*-20.5*
Fattening pigs [1)]	1000 heads	16	16	*-0.2*
Poultry	1000 heads	24,918	25,011	*0.4*
Sheep	1000 heads	17,429	17,142	*-1.6*
Economic indicators				
Production value	Mill. €	7,461	6,867	*-8.0*
Total subsidies	Mill. €	2,087	2,450	*17.4*
Variable input	Mill. €	-3,301	-3,150	*-4.6*
Depreciation	Mill. €	-1,445	-1,401	*-3.1*
Taxes	Mill. €	-58	-58	
Interest	Mill. €	-24	-23	*-6.1*
Wages	Mill. €	-214	-151	*-29.1*
Rents	Mill. €	-366	-64	*-82.5*
Income indicators				
Farm Net Value Added (FNVA)	Mill. €	4,774	4,739	*-0.7*

1) Annual production.

Source: FARMIS; INLB-EU-GD AGRI/G.3.

At the sectoral level, the reform has almost no effect on FNVA compared to the reference. It is slightly reduced due to the sugar market reform, the reduction of milk prices and the reduction of the cotton acreage. Additionally, based on Art. 69 of Regulation (EC) 1782/2003, part of the premium plafond is retained. However, the measures funded with this money are not represented in the model. Therefore, there is a negative bias in the simulations. Modulation, on the other hand, which leads to a significant reduction of support in other EU-Member States plays almost no role because of the size of Greek farms. Most receive less than 5000 € of direct payments per farm and are not effected by modulation. Positive, on the other hand, is the increase in cereal and meat prices and the enhanced market orientation.

4.3.2 Impact of decoupling on the acceptance of environmental measures

The analysis is conducted for the region Thessaly in Greece. Results for Agenda and MTR and three different incentive levels to reduce nitrogen input in cotton production are given in Table 4.4.

On all crops except cotton only the general change of the policy framework from Agenda to MTR, but not the level of the incentive to apply the environmental measure, has a significant impact. Variations of the incentive to apply the environmental measure mainly influence the choice of the cotton production variant and the amount of mulched land. This is, of course, due to the model formulation. As mulching and extensive cotton production are formulated as variants of cotton production, substitution among them is more flexible.

As expected, the amount of extensive cotton increases with increasing monetary incentive. In the decoupling scenarios 250 € seems to be the threshold, afterwards extensive cotton enters the solution. At lower levels the standard variant of cotton production is more attractive. In the MTR scenarios, at low incentive level mulching is more attractive than extensive cotton as well. With increasing incentive mulching is substituted by extensive cotton production (see Figure 4.1).

Looking at Figure 4.1 it becomes apparent that the share of extensive cotton of total cotton is higher in the MTR scenarios than in the Agenda scenarios. Due to the abolishment of the deficiency payment scheme and partial decoupling, the difference in economic attractiveness between intensive and extensive cotton production is reduced. However, the difference is comparatively low if the magnitude of the incentive is considered (see Figure 4.2).

The farm groups in Thessaly are differentiated with respect to their share of cotton in crop rotation and according to their size. However, the impact between farm groups did not differ significantly with respect to the adaptation of environmental measures.

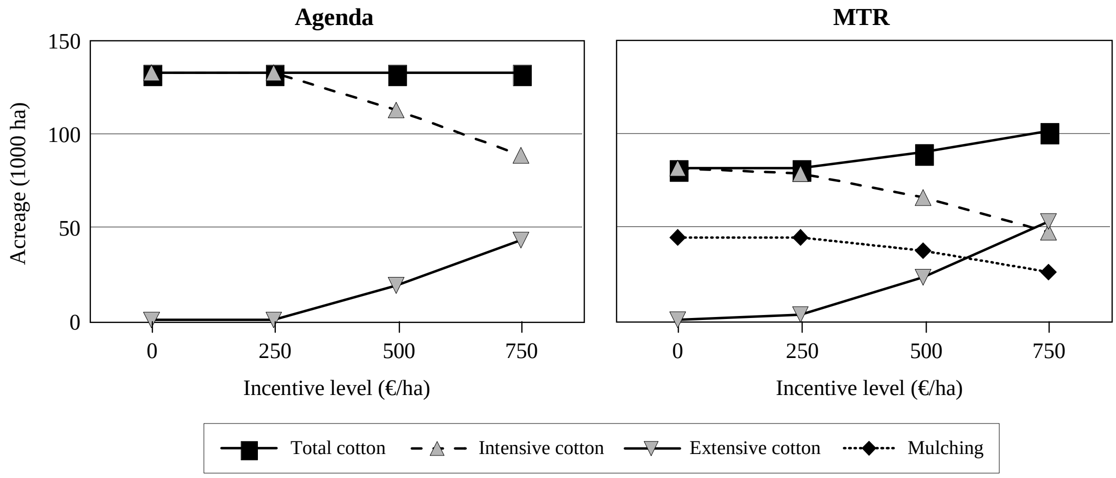
Table 4.4: Impact of environmental measures to support extensive cotton production in Agenda and MTR: a case study for Thessaly

		Agenda	AG250	AG500	AG750	MTR	MTR250	MTR500	MTR750
Cereals	1000 ha	151.7	151.7	151.7	151.7	152.5	152.3	151.7	151.2
Soft wheat	1000 ha	10.6	10.6	10.6	10.6	13.3	13.3	13.3	13.3
Durum wheat	1000 ha	80.9	80.9	80.9	80.9	73.6	73.5	73.1	72.9
Barley	1000 ha	19.8	19.8	19.8	19.8	25.5	25.5	25.4	25.3
Grain maize	1000 ha	38.7	38.7	38.7	38.7	38.0	38.0	37.8	37.6
Oats	1000 ha	1.3	1.3	1.3	1.3	1.7	1.7	1.7	1.7
Protein crops	1000 ha	2.8	2.8	2.8	2.8	3.6	3.6	3.6	3.6
Potatoes	1000 ha	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Sugarbeets	1000 ha	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8
Arable forage crops	1000 ha	22.4	22.4	22.4	22.4	26.4	26.4	26.4	26.4
Set-aside	1000 ha	5.7	5.7	5.7	5.7	5.8	5.8	5.8	5.8
Grassland	1000 ha	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Cotton	1000 ha	132.9	132.9	132.9	132.9	82.1	82.7	90.7	102.6
Intensive cotton	1000 ha	132.9	132.9	113.3	88.8	82.1	78.6	66.8	48.3
Extensive cotton	1000 ha		0.0	19.6	44.1		4.0	23.9	54.2
Mulched area	1000 ha					44.9	44.6	37.2	25.9
Fallow	1000 ha	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
UAA	1000 ha	387.1	387.1	387.1	387.1	387.1	387.1	387.1	387.1
Dairy cows	1000 heads	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Suckler cows	1000 heads	30.1	30.1	30.1	30.1	17.1	17.1	17.1	17.1
Bulls 1)	1000 heads	2.9	2.9	2.9	2.9	2.0	2.0	2.0	2.0
Sheep	1000 heads	1,888.3	1,888.3	1,888.3	1,888.3	1,844.9	1,844.9	1,844.9	1,844.7
Economic indicators									
Production value	Mill. €	1,190.4	1,190.4	1,183.5	1,174.8	863.8	863.9	871.0	881.8
Total subsidies	Mill. €	208.6	208.6	218.4	241.7	361.7	363.0	378.6	414.1
Environmental measure for cotton	Mill. €		0.0	9.8	33.1		1.0	11.9	40.7
Variable input	Mill. €	-462.9	-462.9	-461.9	-460.6	-391.4	-391.9	-400.2	-412.4
Depreciation	Mill. €	-157.4	-157.4	-157.4	-157.4	-139.1	-139.2	-141.9	-146.1
Taxes	Mill. €	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1
Interest	Mill. €	-4.1	-4.1	-4.1	-4.1	-3.3	-3.3	-3.4	-3.6
Wages	Mill. €	-90.0	-90.0	-90.0	-90.0	-56.5	-56.9	-61.0	-66.8
Rents	Mill. €	-82.1	-82.1	-82.1	-82.1	-24.1	-24.3	-25.3	-25.8
Income indicators									
Farm Net Value Added (FNVA)	Mill. €	770.3	770.3	774.3	790.1	686.6	687.4	699.1	729.1

1) Annual production.

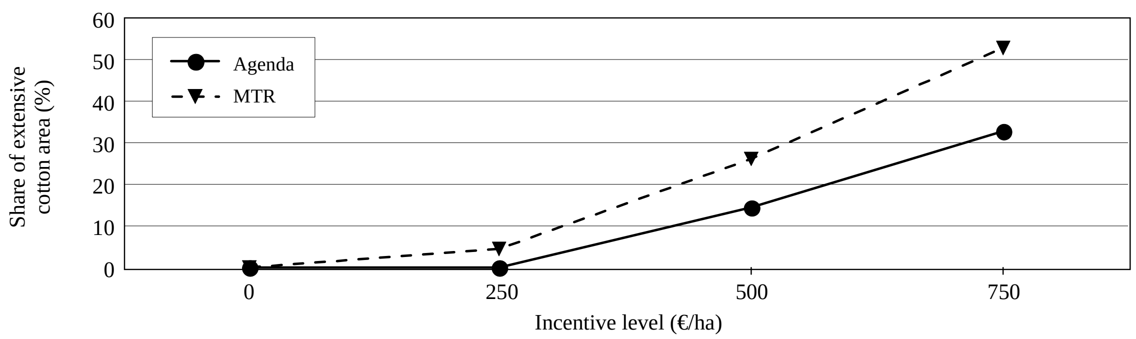
Source: FARMIS; INLB-EU-GD AGRI/G.3.

Figure 4.1: Area of cotton production variants and of mulching in the MTR scenarios



Source: FARMIS; INLB-EU-GD AGRI/G.3.

Figure 4.2: Share of extensive cotton acreage



Source: FARMIS; INLB-EU-GD AGRI/G.3.

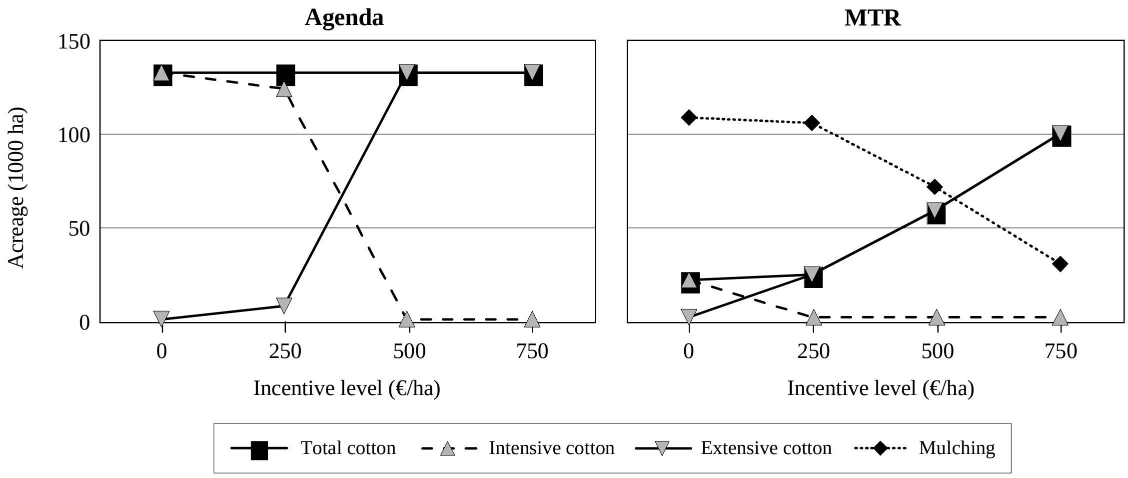
4.3.3 Sensitivity analysis

To analyse the impact of ϕ_i on the results, simulations with ϕ_i equal to 0, 0.25 and 0.5 are additionally conducted. The results concerning their impact on cotton and mulching are shown in Figures 4.3-4.5.

When ϕ_i equals 0, adjustment between variants is similar to an LP model. It is shown that in the case of the Agenda scenarios in all farm groups the low nitrogen input variant is more attractive than standard cotton production when the incentive surpasses 500 €/ha. In the MTR scenarios standard cotton production becomes unattractive compared to mulching. With increasing incentive, mulching is replaced by the extensive cotton production variant. In the case of higher values for ϕ_i the tendency of results is similar, however, the changes are less pronounced.

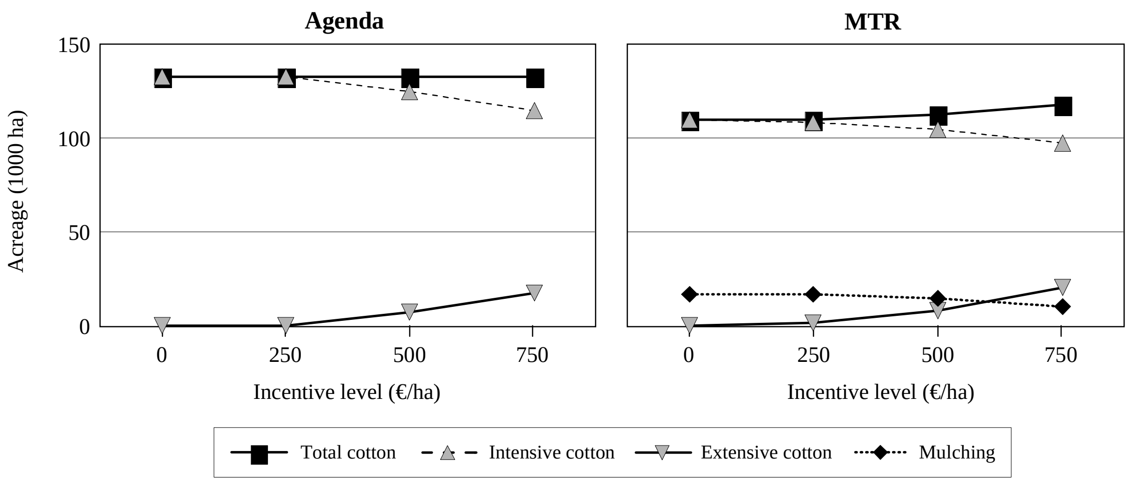
It is shown that the results heavily depend on the choice of ϕ_i. This to some extent limits the value of results because no statistical information is available about its "true" value. Therefore, for future analyses, significant effords have to be undertaken to gain more information about ϕ_i.

Figure 4.3: Area of cotton production variants and mulching in the Agenda and MTR scenarios for ϕ_i = 0.



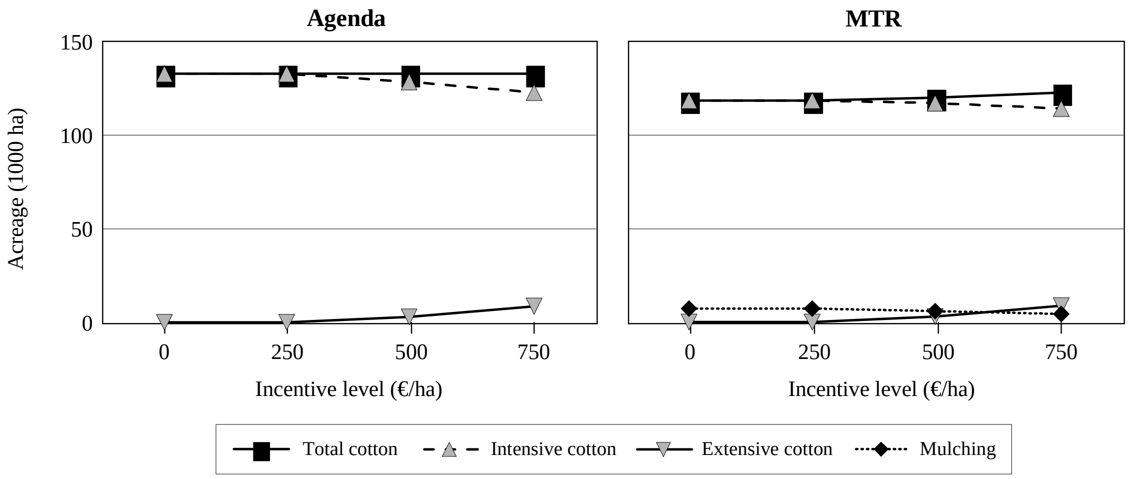
Source: FARMIS; INLB-EU-GD AGRI/G.3.

Figure 4.4: Area of cotton production variants and mulching in the Agenda and MTR scenarios for ϕ_i = 0.25



Source: FARMIS; INLB-EU-GD AGRI/G.3.

Figure 4.5: Area of cotton production variants and mulching in the Agenda and MTR scenarios for ϕ_i = 0.5



Source: FARMIS; INLB-EU-GD AGRI/G.3.

4.4 Conclusions

To be able to assess the impact of decoupling on farmers' acceptance of environmental measures, EU-FARMIS was enhanced to better reflect the close relationship between different variants of the same activity. The new model formulation allows for a more flexible substitution between these variants compared to separate activities. For this analysis the activity cotton production is further differentiated into intensive cotton production, an extensive variant based on an environmental measure to reduce nitrogen input and the option to keep the land in good agricultural and ecological condition without producing output.

It is shown that the reform of the cotton market increases farmers' acceptance to apply environmental measures which aim at a reduction of nitrogen input because the reduction of cotton prices decreases the economic attractiveness of intensive cotton production. However, two weaknesses of these measures are shown: First, compared to the magnitude of the monetary incentive, the effect is rather limited. Second, and more importantly, the analysis showed that due to decoupling the justification for the proposed environmental measures is in question because decoupling leads to a significant reduction of cotton production, and the incentives granted to apply environmental measures partially reverse this trend. The measures do not only give an incentive to shift from intensive cotton production to the low input variant but they increase the economic attractiveness of cotton production compared to land management i.e., "mulching" as well. With increasing incentive total cotton acreage increases. Hence, the proposed environmental measures are not fully decoupled.

Although considerable progress was made, the applied methodology and data base still needs to be improved. Results in EU-FARMIS generally depend on the choice of the supply elasticities. In the case of the introduced variants of cotton production, additional information about the exchangeability between these production variants is necessary. While in the first case information about the magnitude of the elasticities is available, such information is absent in the latter case. Therefore, the analysis can only show the bandwidth of results, and interpretation should proceed with care. Therefore, future model development should aim at both, solving some of the open questions connected with the implementation of thresholds and the improvement of the empirical database.

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5 Decoupling of Pillar-II measures - Modification of the ‚Less Favoured Area' premium scheme – A case study for Germany

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5.1 Introduction

The ‚Less Favoured Area' (LFA) scheme in Germany will be affected by recent policy changes in several ways. First, due to budget constraints, LFA premia (compensatory allowances) will be adjusted, resulting in premium changes between the German Laender of + 15 - 25.7 % from 2007 onwards. Eligible regions for the LFA scheme, eligible crops and premium levels will be modified, but final decisions have not been taken, yet.

With regard to the WTO (and the unresolved question of production linkages) it is of interest to assess the impacts of Pillar-II measures with special regard to production and income (OECD, 2004; CAHILL, 2006; SWINBANK & TRANTER, 2005). The LFA scheme has been chosen as an example because the definition of the measure is rather clear such that it can easily be implemented in farm programming models.[12]

The existing LFA scheme might have some production effects, as intensive arable crops, set-aside, fallow land and mulching area are not eligible for premia (PLANKL et al., 2006; BERNHARDS et al., 2003). Further, premium levels are differentiated by arable cash crops and grassland. Wrt this background the following options are analysed:

- Modification of premium level (up to ±50 %)
- Phasing out of LFA premia
- Harmonisation of premium level between eligible arable crops and grassland
- Extending the eligible criteria towards all crops +/- set aside.

FARMIS is used for the quantitative analysis. Farm groups are selected with regard to the underlying subject (LFA and non-LFA areas, farm type, share of grassland), based on the national FADN. Regions considered are Baden-Wuerttemberg, Bavaria and Brandenburg, which receive more than half of the total LFA budget in Germany.

[12] This is not the case for Agri-Environmental Policy because the measures are numerous and not differentiated in the FADN data base.

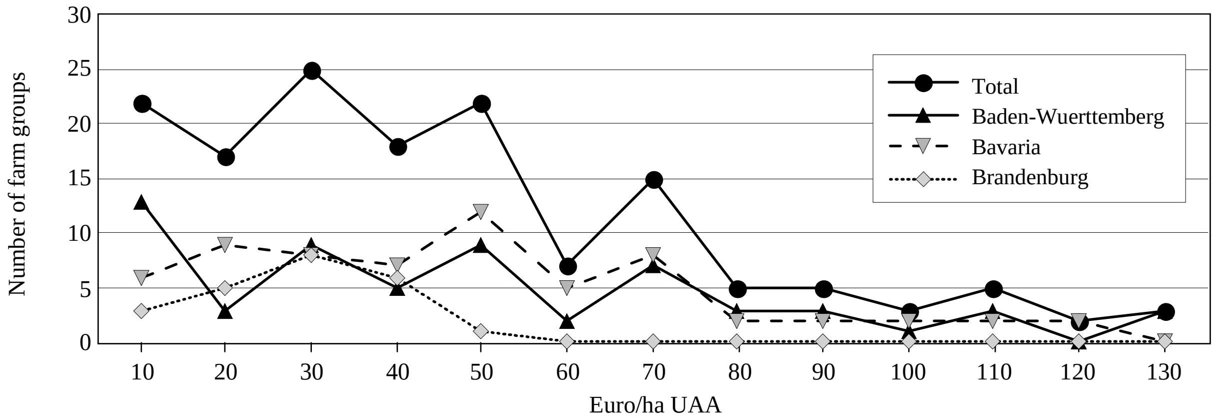
5.2 Model, data and scenarios

As structural policy in Germany is mainly in responsibility of the Laender, different LFA schemes are implemented by the Laender. Common guidelines are a) premium differentiation for LFA areas depends on the soil quality index (reciprocally differentiated up to 30 on an index up to 100), b) premiums differ between arable cash crops and grassland; premium levels for arable cash crops are half of those for grassland, c) extensive arable crops and grassland are eligible for premia while set-aside, mulching and fallow land are excluded. The LFA scheme is not applied in Lower Saxony, although there are LFA regions.

The above mentioned principles are applied in the considered Laender Baden-Wuerttemberg, Bavaria and Brandenburg (BERNHARDS et al., 2003; PLANKL et al., 2006). Premium levels are therefore derived from LFA premium account in FADN data for each farm group. The 'higher' premium level for grassland is also applied for 'other' arable fodder crops (excl. fodder maize). Premium level for arable crops is only half of those for grassland. Wheat, maize, vegetables, sugar beets, potatoes, vegetables, set-aside including non-food crops and mulching land are not eligible for premia. Maximum premium level for grassland is 180 €/ha.

As an indication of premium levels, the distribution of average premiums related to UAA is shown in Figure 5.1. In the main share of underlying farm groups the premium level is below 80 €/ha. Premium levels of more than 100 €/ha are only reached in Baden-Wuerttemberg and Bavaria due to higher shares of LFA areas, mountain areas and grassland.

Figure 5.1: Distribution of LFA premium levels in the farm groups



Source: FARMIS 2007.

Premium levels are modified in 2007; they will be reduced in Baden-Wuerttemberg and Bavaria by 25.5 % and 25.7 %, respectively, while they will be almost constant in Brandenburg (+0.5 %)[13]. Options being discussed are a flat rate for arable crops of about 25 €/ha, further premium differentiation between mountains and other LFA areas; the modification of the formula for premium calculation related to soil quality and a new definition of LFA regions based on objective criteria. The state of discussion is reviewed and evaluated within a thesis (EHRMANN, 2007, forthcoming), realised within the GENEDEC project.

Model and data

For the quantitative analysis, the farm group model FARMIS is applied using national FADN data for the selection of farm groups. Average farm accounting data for the economic years 2003/04 and 2004/05 are used. Farm groups are selected for the three Laender by farm types, type of LFA region, grassland share and size of dairy cow stock (Table 5.1), resulting in 173 farm groups, thereof 68 groups in Baden-Wuerttemberg, 78 in Bavaria and 27 in Brandenburg.

Table 5.1: Scheme for the selection of farm groups

<table>
<tr><th>Region</th><th>Share of LFA on UAA</th><th>Farm type</th><th>Farm size (cows)</th><th>Share of grassland on UAA</th></tr>
<tr><td rowspan="5">BW1
BW2
BW incl. Mount.
BY1
BY2
BY incl. Mount.
BB</td><td rowspan="5">0 %
0-50 %
50-99 %
>= 100 %</td><td rowspan="3">Dairy & beef</td><td>no cows</td><td><70 %</td></tr>
<tr><td>0-30 / 0-100[1)]</td><td rowspan="2">>=70 %</td></tr>
<tr><td>>30 / >100[1)]</td></tr>
<tr><td>Pigs & poultry</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Arable cropping</td></tr>
</table>

1) Brandenburg.
Source: Ehrmann (2007).

The model is calibrated for the base year while scenarios are defined for the target year 2015, assuming a full implementation of the 2003 CAP reform (full decoupling, regional implementation with unified and regionally differentiated entitlements for eligible UAA) including the sugar market reform. Price projections are based on ESIM being used for the scenario analysis in Delivery 7 of the GENEDEC project.

[13] Change rates are based on internal calculations; they are close to figures published in (DEUTSCHER BAUERNVERBAND 2007).

LFA premia are implemented at the activity level, therefore they are considered as coupled (to production).

Production linkages are influenced by the level and differentiation of LFA premia as well as by eligible crops. Referring to these criteria the following options are analysed:

Reference:

– Reduction of premia by 25.7 % in Baden-Wuerttemberg, 25.5 % in Bavaria and 0.5 higher premium for Brandenburg (Baseline), taken as **Ref**erence (for the following LFA-Options

Scenarios:

– Change of premium level (as percent of the base year level):
  – Reduction by 30 and 50% (**Pr-30**/**Pr-50**)
  – Increase by 50% (**Pr+50**)
  – Abandoning LFA payments (**no_Pr**)
– Equalisation of premium levels for eligible crops (**Pr_eq**) under consideration of premium reductions of Ref.
– Change of eligible crops**…** under consideration of premium reductions of Ref:
  – All arable crops (**excluding set-aside**) being eligible for LFA premia; premiums are differentiated between arable and grassland, (**Pr_AC-SA**)
  – All arable crops (**including set-aside**) being eligible for LFA premia premiums are differentiated between arable and grassland, (**Pr_AC+SA**)

The last three options[14] can be seen as steps of further decoupling, because eligibility criteria will influence competitiveness between arable crops and set-aside (SA), respectively fallow/mulching. Competitiveness between arable crops (AC) and grassland use will be influenced by different premium levels for Pr_AC-SA and Pr_AC+SA.

[14] Without changing the programming framework of FARMIS, calculation of premium levels and model calibration have to realised for each of these three options. Effects of model calibration on supply seems to be minor.

5.3 Results

At first, impacts of recently introduced premium reductions are shown at aggregated level. The latter scenario will be taken for the other policy options to show their partial effects. A distinction will be made between supply (as indicator for production linkages) and income effects.

5.3.1 Impacts of LFA premium reductions within the baseline

LFA premia in Baden-Wuertemberg and Bavaria are reduced by 25% while they are almost constant in Brandenburg. Income or supply effects are therefore insignificant for Brandenburg (Table 5.1).

Reduction of premium levels will reduce competitiveness of crops eligible for LFA premia, therefore barley, rye, oat, food oilseeds and protein crops are reduced by less than 0.5 %. Grassland use will be reduced and intensified. Non eligible crops will become more favourable, i. e., wheat, maize, non-food oilseeds. Although non eligible, set-aside and fallow is almost constant, while mulching area will increase by one third on average, respectively by half in the South (referring to the rather low level in the Base).

Beside suckler cow production, livestock production is not at all affected by LFA premium changes. Suckler cows are reduced by 2 and 3 % in Baden-Wuerttemberg and Bavaria. Production system of suckler cows is rather extensive and linked to pasture. Being coupled, LFA premia can be seen as a subsidy for grassland use. Reduction of ‘grassland subsidy’ will negatively affect the competitiveness of grassland dependent suckler cow production.

Income effects are more pronounced than supply effects and changes of land use. FNVA will decrease by 1 and 1.3 % in Baden-Wuerttemberg and Bavaria, respectively. Farm adaptation allows to compensate for about one fourth of LFA premium reductions.

Table 5.1: Impacts of adjustments of LFA premia within the Baseline

		Bavaria		Baden-Wuerttemberg		Brandenburg	
		Base [1]	Ref [2] Δ % of Base	Base [1]	Ref [2] Δ % of Base	Base [1]	Ref [2] Δ % of Base
Economic indicators							
Production value	Mill. €	5,644	*0.1*	2,400	*0.0*	871	*0.0*
Total subsidies	Mill. €	1,424	*-3.1*	529	*-2.7*	311	*0.0*
Direct payments	Mill. €	932	*0.0*	333	*0.0*	221	*0.0*
LFA premia	Mill. €	155	*-27.0*	50	*-26.9*	17	*0.5*
Agri-envir. premia	Mill. €	164	*-1.4*	103	*-0.7*	29	*0.0*
Farm Net Value Added (FNVA)	Mill. €	2,231	*-1.4*	1,006	*-1.1*	497	*0.0*
Land use							
Cereals	1,000 ha	1,046	*0.1*	460	*0.1*	315	*0.0*
Wheat	1,000 ha	422	*0.6*	202	*0.6*	108	*0.0*
Barley	1,000 ha	413	*-0.2*	165	*-0.3*	42	*0.0*
Rye	1,000 ha	35	*-0.3*	7	*-0.2*	87	*0.0*
Corn	1,000 ha	66	*0.3*	41	*0.2*	16	*0.0*
Oats	1,000 ha	36	*-0.1*	32	*-0.4*	14	*0.0*
Oilseeds (Food)	1,000 ha	123	*-0.4*	46	*-0.4*	82	*0.0*
Protein crops	1,000 ha	25	*-0.3*	4	*-0.3*	23	*0.0*
Arable fodder crops	1,000 ha	335	*0.0*	90	*0.0*	74	*0.0*
Non-Food	1,000 ha	28	*1.8*	13	*0.7*	16	*0.0*
Set-aside	1,000 ha	148	*0.0*	60	*0.0*	46	*0.0*
Grassland	1,000 ha	1,035	*-0.2*	456	*-0.3*	255	*0.0*
Intensive grassland	1,000 ha	597	*-1.3*	276	*-0.6*	121	*0.0*
Extensive grassland	1,000 ha	397	*-3.1*	165	*-3.2*	97	*0.1*
Mulched area	1,000 ha	39	*46.4*	15	*36.9*	37	*-0.2*
Fallow	1,000 ha	5	*5.4*	1	*0.0*	2	*-0.2*
Livestock production							
Suckler cows	1,000 heads	42	*-2.0*	24	*-3.4*	43	*0.0*
Bulls [3]	1,000 heads	283	*0.2*	69	*0.2*	24	*0.0*
Production							
Cereals	1,000 tons	7,285	*0.2*	3,157	*0.1*	1,564	*0.0*
Milk	1,000 tons	7,501	*0.0*	2,152	*-0.1*	795	*0.0*
Beef	1,000 tons	227	*0.0*	58	*-0.2*	22	*0.0*
Pork	1,000 tons	732	*0.0*	351	*0.0*	82	*0.0*

1) LFA premium level derived from the base year.
2) Change of FLA premium level by -25 % in Bavaria and Baden-Wuerttemberg, +0.5 % in Brandenburg.
3) Annual production.
Source: FARMIS 2007.

5.3.2 Variation of LFA premium level

LFA premia are reduced by the same percentage for all Laender (Tables 5.2 and 5.3). The first option (-30 %: **Pr-30**) has only minor effects in the South as premia are only reduced by another 5 % compared to Ref. Premium reductions are proportional to the cut for Brandenburg, affecting supply and income. As been mentioned before, eligible arable crops will be reduced, especially rye and food-oilseeds. Although natural conditions for wheat are less favourable, it will be extended by 0.4 %. Silage maize as well as non food oilseeds will increase on debit of fodder from grassland. Set-aside[15] is constant but fallow and mulching areas will increase. This is an indicator that LFA premia will hold UAA in production and prevent land abandonment/mulching to a certain degree. Income will be reduced by 1 %.

Table 5.2: Impacts due the variation of LFA premia (Total of 3 Laender)

		Ref	Scenarios (variation of LFA premia) Δ % of Ref			
			Pr -30	Pr -50	Pr -100	Pr +50
Economic indicators						
Production value	Mill. €	8,919	*0.0*	*0.0*	*0.1*	*-0.1*
Total subsidies	Mill. €	2,206	*-0.7*	*-2.9*	*-8.1*	*8.3*
Direct payments	Mill. €	1,487	*0.0*	*0.0*	*-0.1*	*0.0*
LFA premia	Mill. €	167	*-8.8*	*-35.7*	*-100.0*	*105.0*
Agri-envir. premia	Mill. €	294	*-0.3*	*-1.2*	*-3.7*	*2.7*
Farm Net Value Added (FNVA)	Mill. €	3,692	*-0.3*	*-1.3*	*-3.8*	*4.0*
Land use						
Cereals	1,000 ha	1,823	*0.0*	*0.1*	*0.1*	*-0.3*
Wheat	1,000 ha	736	*0.2*	*0.6*	*1.6*	*-1.7*
Barley	1,000 ha	618	*-0.1*	*-0.3*	*-1.2*	*0.9*
Rye	1,000 ha	128	*-0.3*	*-0.6*	*-1.1*	*0.8*
Corn	1,000 ha	123	*0.1*	*0.4*	*0.9*	*-0.8*
Oats	1,000 ha	81	*-0.1*	*-0.4*	*-1.4*	*0.9*
Oilseeds (Food)	1,000 ha	250	*-0.1*	*-0.4*	*-1.3*	*1.0*
Protein crops	1,000 ha	52	*-0.2*	*-0.4*	*-1.1*	*0.8*
Arable fodder crops	1,000 ha	499	*0.1*	*0.2*	*0.5*	*-0.4*
Non-Food	1,000 ha	57	*0.3*	*1.2*	*3.1*	*-2.9*
Set-aside	1,000 ha	254	*0.0*	*0.0*	*0.0*	*-0.1*
Grassland	1,000 ha	1,742	*0.0*	*-0.2*	*-0.4*	*0.8*
Intensive grassland	1,000 ha	984	*-0.2*	*-0.8*	*-2.1*	*2.1*
Extensive grassland	1,000 ha	641	*-1.0*	*-3.5*	*-10.7*	*8.0*
Mulched area	1,000 ha	114	*6.9*	*24.1*	*72.0*	*-50.7*
Fallow	1,000 ha	8	*3.6*	*8.3*	*38.8*	*-10.9*
Livestock production						
Suckler cows	1,000 heads	108	*-1.1*	*-3.2*	*-8.2*	*5.7*
Bulls [1)]	1,000 heads	376	*0.0*	*0.1*	*0.7*	*-0.5*
Production						
Cereals	1,000 tons	12,024	*0.0*	*0.1*	*0.2*	*-0.4*
Milk	1,000 tons	10,446	*0.0*	*0.0*	*0.0*	*0.0*
Beef	1,000 tons	306	*0.0*	*-0.1*	*0.1*	*0.0*
Pork	1,000 tons	1,166	*0.0*	*0.0*	*0.1*	*-0.1*

1) Annual production.
Source: FARMIS 2007.

15 Compulsory and voluntary set aside area is summarized under “set-aside”.

Table 5.3: Impacts due to the variation of LFA premium level

	Bavaria				Baden-Wuerttemberg				Brandenburg			
	Scenarios Δ % of Ref				Scenarios Δ % of Ref				Scenarios Δ % of Ref			
	Pr -30	Pr -50	Pr -100	Pr +50	Pr -30	Pr -50	Pr -100	Pr +50	Pr -30	Pr -50	Pr -100	Pr +50
Economic indicators												
LFA premia	-6.3	-34.0	-100.0	111.0	-6.1	-33.8	-100.0	110.5	-31.4	-51.5	-100.0	52.5
Agri-envir. premia	-0.2	-1.2	-4.0	3.4	-0.1	-0.7	-2.3	1.6	-1.8	-3.0	-6.6	2.7
Farm Net Value Added (FNVA)	-0.2	-1.4	-4.3	4.6	-0.2	-1.0	-3.2	3.6	-1.1	-1.7	-3.2	1.8
Land use												
Cereals	0.0	0.1	0.0	-0.3	0.0	0.1	0.2	-0.5	0.0	0.0	0.2	0.0
Wheat	0.1	0.6	1.7	-1.8	0.1	0.5	1.5	-1.8	0.5	0.8	1.6	-0.8
Barley	0.0	-0.3	-1.2	1.0	-0.1	-0.3	-1.1	0.8	-0.3	-0.4	-0.7	0.4
Rye	-0.1	-0.4	-1.4	1.1	0.0	-0.2	-0.5	0.3	-0.4	-0.7	-1.0	0.7
Corn	0.0	0.3	0.8	-0.8	0.0	0.2	0.6	-0.7	0.7	1.2	2.5	-1.2
Oats	0.0	-0.3	-1.7	1.0	-0.1	-0.4	-1.5	1.0	-0.3	-0.4	-0.7	0.4
Oilseeds (Food)	-0.1	-0.4	-1.6	1.3	-0.1	-0.4	-1.5	1.2	-0.3	-0.5	-0.8	0.5
Protein crops	-0.1	-0.3	-1.3	1.0	0.0	-0.3	-1.1	0.8	-0.3	-0.5	-0.8	0.5
Arable fodder crops	0.0	0.1	0.5	-0.4	0.0	0.1	-0.1	-0.2	0.4	0.7	1.0	-0.4
Non-Food	0.3	1.6	4.3	-4.5	0.1	0.8	2.5	-1.9	0.4	0.7	1.5	-0.7
Set-aside	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	0.0
Grassland	0.0	-0.2	-0.3	1.0	0.0	-0.2	-0.4	0.9	-0.1	-0.2	-0.6	0.1
Intensive grassland	-0.2	-0.9	-2.2	2.7	-0.1	-0.5	-1.3	1.3	-0.8	-1.4	-3.5	1.0
Extensive grassland	-0.6	-3.0	-10.3	8.4	-0.6	-3.4	-10.7	8.6	-3.5	-5.8	-12.2	5.5
Mulched area	5.1	26.4	85.9	-67.2	4.7	28.9	93.2	-65.5	10.9	18.1	39.2	-17.1
Fallow	0.9	5.1	39.7	-8.8	0.0	0.0	23.6	0.0	13.0	21.5	42.4	-21.5
Livestock production												
Suckler cows	-0.5	-2.8	-8.6	6.5	-0.6	-3.7	-10.9	9.2	-2.0	-3.2	-6.2	3.2
Bulls	0.0	0.2	1.0	-0.6	0.0	0.2	0.7	-0.5	-0.7	-1.2	-1.8	0.4
Production												
Cereals	0.0	0.1	0.1	-0.4	0.0	0.1	0.3	-0.5	0.0	0.1	0.3	0.0
Milk	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.1	0.0	0.0	0.0	0.0
Beef	0.0	0.0	0.3	-0.2	0.0	-0.2	-0.4	0.4	-0.5	-0.8	-1.4	0.5
Pork	0.0	0.0	0.1	-0.1	0.0	0.0	0.1	-0.1	0.0	0.0	0.0	0.0

Source: FARMIS 2007.

A further reduction of LFA premia (**Pr-50**) strengthens the above mentioned tendencies:

– Eligible arable crops (cereals beside wheat, food oilseeds and protein crops) will be reduced up to 0.5 %. They will be substituted by non-eligible crops, mainly wheat.

– Compulsory set-aside is not affected, but non-foods (partly on set-aside) will increase by 1.2 %.

– Mulching area - being non-eligible – will increase by one fourth. As a consequence, suckler cow production will be reduced by 3.2 %.

– Income effects are becoming more important (-1.3 % on average). Depending on the premium level, income losses up to 40 €/ha of UAA can be expected (Figure 5.1).

A phasing out of LFA (**Pr-100**) premia is not (yet) under policy negotiation. It is considered here with regard to the question of production linkages of LFA premia. Impacts are the following (the reverse can be interpreted as 'coupling effect' of LFA premia):

– Although the cereal area is almost constant, substitution between LFA eligible and non-eligible arable crops will be enforced. Wheat area increases up to 1.6% while rye, barley and oat will be reduced by 1 to 1.5 %, each. Figure 5.2 shows that about 15 % of farm groups increase cereal areas by 5 % and more. Rye production is influenced by LFA premia (Figure 5.5).

– Formerly eligible food-oilseed will be reduced and partially replaced by non-eligible non-food oilseeds.

– Grassland, formerly eligible for LFA premia, will be affected, too, because premium losses are higher than for arable crops. It will be reduced by 0.4 % on average. To retain roughage fodder demand, grassland will be intensified (reduction of extensive grassland by 10 %) and partially replaced by silage maize.

– Mulching area will increase (72 %), especially in the South.

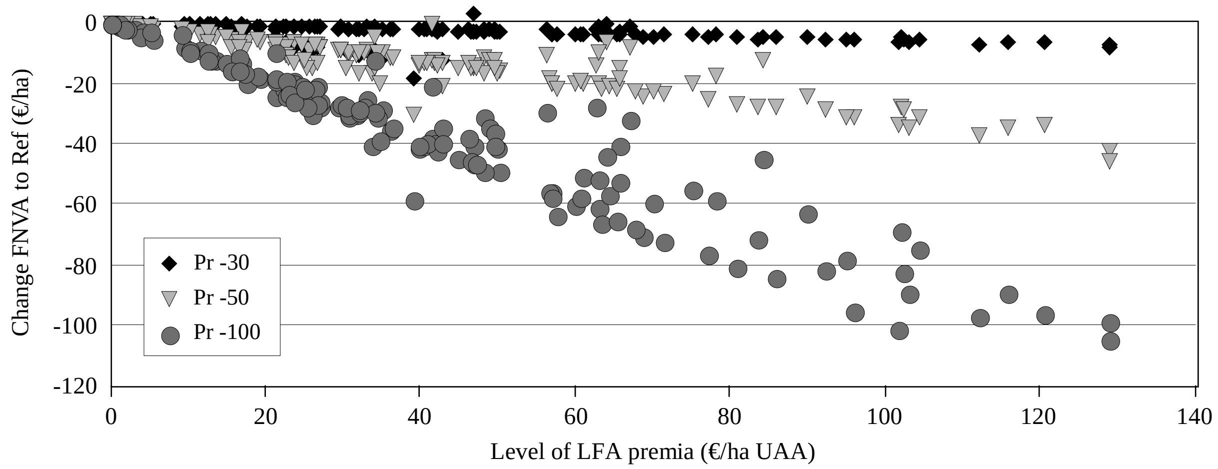
– Related to grassland use suckler cow production will be reduced by 8 %, being negatively affected by reduction of subsidies for fodder areas (Figure 5.2).

– Linked to the reduction of 'extensive' crops, agri-environmental premia will be reduced by 3.7 %.

– Farm income will be reduced by -3.8 %. Income losses are correlated with LFA premia in the Base, but there is a significant variation due to farm adaptation (Figure 5.1).

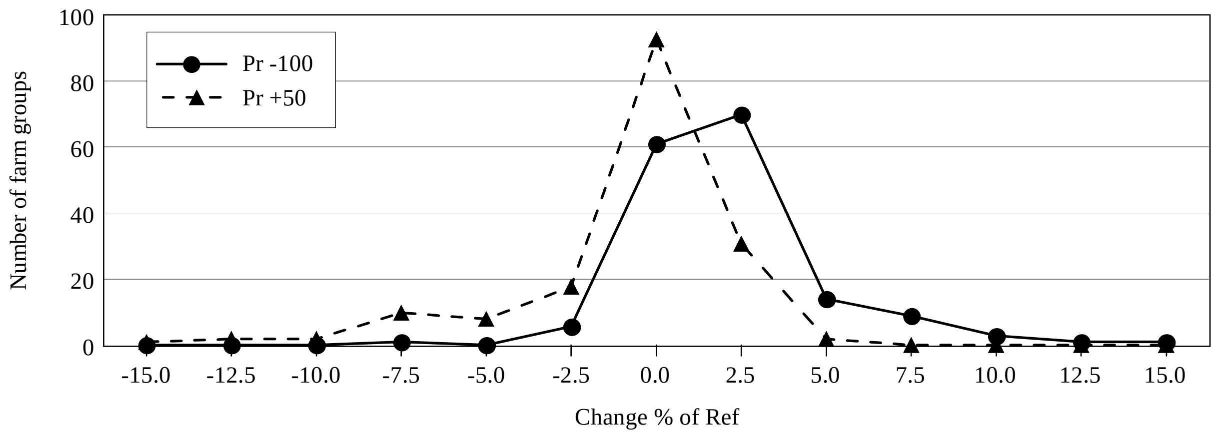
Supply effects show that LFA premia, due to applied eligible criteria, are coupled, but the coupling effect is limited. This is due to the fact that production incentives are most pronounced for grassland, for which only few production alternatives are available in regions and farms with high shares of grassland. One option under decoupling is 'mulching', which would be extended without LFA premia. It can therefore be concluded that LFA premia prevents 'grassland fallow/mulching' from in a certain degree. One of the options of the LFA scheme 'maintaining agricultural land use' in less favoured regions seems to be proved. It is an open question, if the rather limited 'production effects' of LFA premia are of relevance for WTO negotiation (OECD, 2004; CAHILL, 2006).

Figure 5.2: Change of FNVA due to reduction of LFA premia



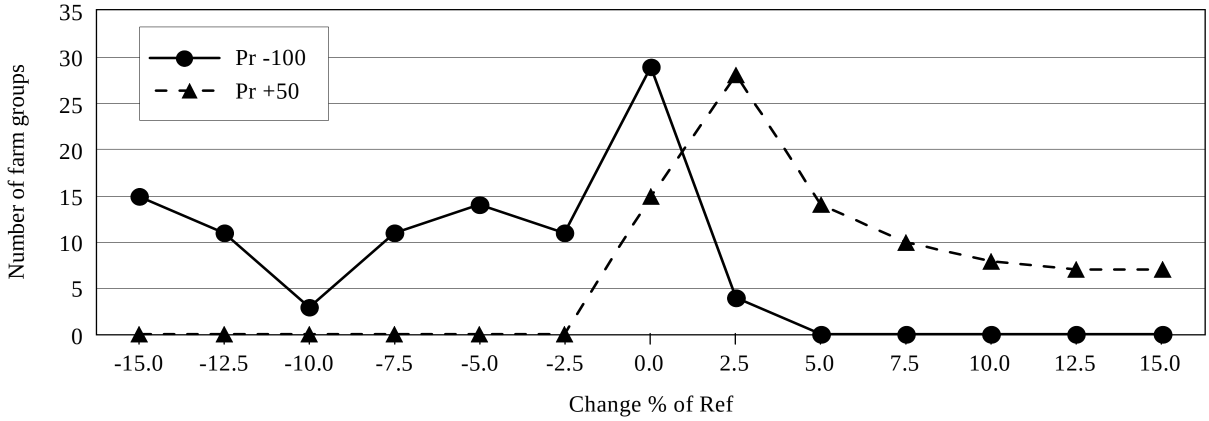
Source: FARMIS 2007.

Figure 5.3: Change of cereal areas due to the variation of LFA premia



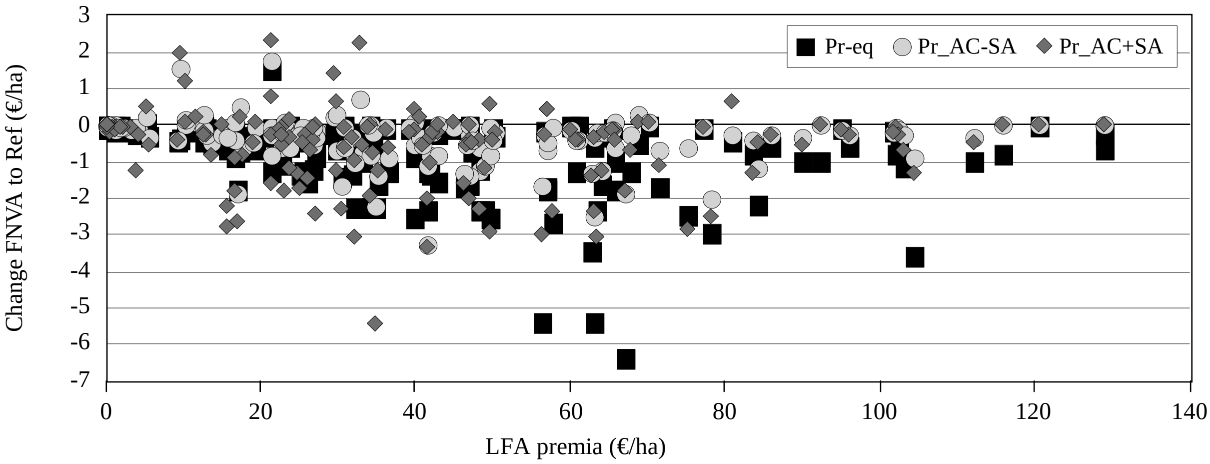
Source: FARMIS 2007.

Figure 5.4.: Change of suckler cow production due to the variation of LFA premia



Source: FARMIS 2007.

Figure 5.5: Change of FNVA due to the modification of eligibility criteria for LFA premia



Source: FARMIS 2007.

The other way round would be an increase of LFA premia, i.e, additional budget transfers from 1st to the 2nd Pillar of CAP via Modulation. This is tested for 50% higher premiums (**P+50**). Effects are the following:

- Eligible arable crops will be extended while non-eligible's will be reduced.
- Grassland use increases by 0.8 %, which gives an incentive for suckler cow production, increasing by 5.8 %.
- Non-production on UAA will be reduced, mainly mulching (-51 %) and fallow (-11 %).
- Positive income effects of 4% remain thanks to higher LFA premiums. Especially small sized dairy farms in the South will be favoured.

Table 5.4: Impacts of modification of eligible criteria for LFA premia resp. their level

		Total			Bavaria			Baden-Wuerttemberg			Brandenburg		
		Scenarios Δ % of Ref			Scenarios Δ % of Ref			Scenarios Δ % of Ref			Scenarios Δ % of Ref		
		Pr-eq	Pr_AC-SA	Pr_AC+SA	Pr-eq	Pr_AC-SA	Pr_AC+SA	Pr-eq	Pr_AC-SA	Pr_AC+SA	Pr-eq	Pr_AC-SA	Pr_AC+SA
Economic indicators													
LFA premia	Mill. €	-1.2	0.2	0.4	-0.6	0.4	1.2	-1.3	0.3	0.8	-4.5	-1.6	-6.1
Agri-envir. premia	Mill. €	0.2	0.1	0.1	0.3	0.2	0.3	0.0	0.0	-0.1	0.0	0.0	0.1
Farm Net Value Added (FNVA)	Mill. €	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1	-0.2
Land use													
Cereals	1,000 ha	-0.2	-0.2	-0.4	-0.2	-0.2	-0.4	-0.1	-0.2	-0.5	0.1	-0.1	-0.4
Wheat	1,000 ha	0.0	-0.6	-0.7	0.0	-0.7	-0.8	0.0	-0.6	-0.9	0.0	0.0	-0.1
Barley	1,000 ha	-0.4	0.2	-0.1	-0.5	0.2	-0.1	-0.3	0.2	-0.2	0.1	0.0	-0.3
Rye	1,000 ha	0.1	0.0	-0.4	-0.3	0.2	-0.1	-0.1	0.1	-0.1	0.2	-0.1	-0.6
Corn	1,000 ha	0.0	-0.3	-0.4	0.0	-0.3	-0.4	0.0	-0.2	-0.4	0.0	-0.1	-0.2
Oats	1,000 ha	-0.3	0.1	-0.4	-0.5	0.1	-0.4	-0.3	0.1	-0.5	0.2	-0.1	-0.5
Oilseeds (Food)	1,000 ha	-0.4	0.3	0.0	-0.6	0.4	0.1	-0.5	0.4	-0.1	-0.1	0.1	-0.2
Protein crops	1,000 ha	-0.3	0.2	-0.1	-0.5	0.4	0.1	-0.5	0.3	-0.1	0.0	0.0	-0.4
Arable fodder crops	1,000 ha	0.0	0.0	0.0	0.1	-0.1	-0.1	0.1	0.0	-0.1	0.0	0.2	0.3
Non-Food	1,000 ha	0.0	0.0	2.8	0.0	-0.1	3.8	0.0	0.0	2.5	0.0	0.0	1.2
Set-aside	1,000 ha	0.0	0.0	-0.1	0.0	0.0	-0.2	0.0	0.0	0.1	0.0	0.0	0.0
Grassland	1,000 ha	0.2	0.1	0.3	0.3	0.2	0.3	0.2	0.2	0.1	-0.1	0.0	0.3
Intensive grassland	1,000 ha	0.2	0.1	0.2	0.3	0.2	0.3	0.0	0.1	0.2	0.0	-0.1	0.0
Extensive grassland	1,000 ha	0.6	0.5	0.6	0.8	0.6	0.8	0.7	0.6	0.5	-0.1	0.0	0.2
Mulched area	1,000 ha	-2.2	-1.8	-1.4	-3.4	-3.0	-2.7	-2.0	-2.2	-3.3	-0.3	0.2	1.6
Fallow	1,000 ha	-0.1	0.0	2.9	0.0	0.0	1.9	0.0	0.0	0.0	-0.4	0.1	7.2
Livestock production													
Suckler cows	1,000 heads	0.4	0.3	0.5	0.6	0.4	0.6	0.8	0.6	0.7	0.0	0.1	0.3

Source: FARMIS 2007.

5.3.3 Modification of the LFA scheme

The analysis goes in three directions: (a) equalisation of premium levels for all eligible arable crops and grassland; (b) extension of eligibility to all arable crops excluding or (c) including set-aside. Premiums are differentiated between arable and grassland for options b) and c), but at the same principles as for the Ref (2007[16]). Results are summarized in Table 5.4.

Impacts of an **equalisation of premium** level (**Pr_eq**) for eligible crops (referring to premium budgets of Ref) can be summarized as follows:

– Change of land use within eligible arable crops is not at all clear. Some of them will be extended (rye) while others will be reduced (barley, oats, food-oilseeds). Intensive cereals and set-aside are not affected.

– The increase of grassland use by 0.2 % can be explained by the reduction of mulching (of grassland) by -2.2 %. It might also be influenced by model calibration[17] required for this option (see Capter 2).

– Income effects are rather marginal

It can be concluded that an equalisation of LFA premium levels for eligible crops induces little crop substitution between eligible crops. Set-aside as well as mulching is hardly affected.

The **extension of LFA premia towards all arable crops** beside set-aside (Pr_AC-SA) should give an incentive for wheat production, which is not proved by the model results. Relative small reductions of wheat areas might go in favour of food-oilseeds and protein crops. Mulching of grassland will be slightly reduced.

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16 Change of LFA premia by -25% in the South and by +0.5 % in Brandenburg.

17 As mentioned in Chapter 5.2 input-output coefficients are calibrated for each of these 3 options to be consistent with LFA premium accounts in the base year. Calibration will influence land use and supply effects in a certain degree. Another alternative would be to use normative LFA premium levels or to apply premium levels of eligible arable crops to former non-eligible ones. In this case the total of LFA would be extended with the number of eligible crops and therefore not in consistency with budget constraints. The latter option is analysed in the diploma thesis of EHRMANN (2007).

Extension of eligibility towards all arable crops including set-aside (but not for fallow and mulching: Pr_AC+SA) gives an incentive for non-food oilseeds on set-aside areas, especially in the South. All other arable crops beside potatoes will be reduced by less than 1 %. Grassland use will increase by 0.2 % which is mainly due to the reduction of mulching areas. Related to grassland use the production of suckler cows increases by 0.3 %.

Income effects for the last three options are rather minor. Figure 5.3 shows, that FNVA in most farm groups vary between ± 3 €/ha. Negative effects are more pronounced for ‘unified premium levels for LFA’. There is no clear correlation between premium level in the base and income changes.

5.4 Conclusion and recommendations

LFA premia compensate partly for income losses induced by less favourable natural conditions. As they are paid for eligible crop areas excluding intensive arable crops, set-aside, fallow and mulching, they have some ‘production linkages’. Production is favoured against non-production, extensive crops against intensive ones and grassland against arable land use. Production linkages of LFA premia might be enforced under full decoupling of direct payments. However, these expectations might be reduced under the national implementation of decoupling. The unified regionalised entitlements of UAA, together with Cross Compliances requirements gives an incentive for production against non-production (KUEPKER and KLEINHANSS, 2007). Allocation effects of decoupled premia – due to their higher premium level - might therefore be more important than ‘partially coupled’ LFA premia.

Reduction of LFA premia due to budget constraints will negatively affect eligible crops. For 50 % premium level of the base year, areas of eligible crops will be reduced up to 0.5 % while non-eligible cereals will be extended. Non-production (fallow and mulching) will go up, especially if LFA premia would be abandoned. Within livestock production only suckler cow production is affected because it is cross subsidized via higher LFA premium levels for grassland.

It is well known that LFA premiums’ shares on income is relatively high in less favoured areas. Therefore, income losses are more important, the higher the share of LFA and grassland.

Increasing LFA payments is a real option for the use of budget from modulation. An additional ammount of ten percent will be given to Laender with high shares of rye.[18] In Brandenburg for example it has been discussed to use this budget via additional premiums on LFA. Results show that this will give an incentive for rye production, but area increase is much less than area reductions due to lower rye prices following the phasing out of rye intervention.

An easy way of reducing production linkages of LFA premia would be the harmonisation of premium levels of eligible crops and to extend the eligible criteria towards all crops. It is an open question, if non-production should be included. As set-aside and mulching is eligible for entitlements under the Single Farm Payment, there is probably no public interest in giving an additional incentive via LFA premia.

The most crucial point of the LFA scheme is that it isn’t targeted enough. More than 50 % of UAA in Germany falls under the scheme. Premium level in large parts of these areas are low, such they are neither important with regard to production nor to income. On the other hand, premiums might not enough to compensate for natural disadvantages of e.g. mountain areas. A better targeting of the scheme is therefore required (PLANKL et al., 2007).

[18] Article 10 (4) of Council Regulation (EC) No 1782/2003

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6 Summary

In this deliverable four case studies are conducted to analyse both, the impact of decoupling on the effect of Pillar II measures and their impact on production. The main findings are summarised in the following:

In the first case study, the impact of decoupling on the Compensatory Allowance Scheme for reducing irrigation in Castile-La Mancha, Spain, is analysed. For this purpose the PROMAPA.G model is applied. It is found that in comparison to Agenda 2000 the new policy regime leads to an increase of irrigation due to the decrease of the economic attractiveness of activities which require little irrigation water (COP crops and set-aside). Farmer’s decisions to commit to irrigation water reduction measures under the new CAS depend only on their status in the base year, and are unaffected by the decoupling measures considered in the scenarios. For some farms, however, the choice of the water consumption formula does depend on these scenarios.

The second study analyses the consequences of the reform of the cotton sector in Thessaly, Greece. This is done with an agronomic simulation model which is linked to a stochastic economic model. It is concluded that decoupling reduces the incentive to apply excessive amounts of nitrogen fertiliser and lowers the amount of irrigation water. Additionally, farmers' income is expected to rise slightly. However, farmers' expected utility is reduced as the applied utility function takes the increased price risks induced by the reform into account. Cross-Compliance leads to a reduction of nitrogen input by 39% but nitrogen input remains well above what is recommended by environmental scientists. It is recommended to replace the current tax per irrigated area by a tax per volume abstracted to further reduce input use and nitrate leaching.

The third case study analyses the impact of decoupling on cotton production in Thessaly as well. In contrast to the previous study, it is focussed on the impact of decoupling on farmers’ acceptance of potential environmental measures to reduce nitrogen input in cotton production. The analysis is conducted with EU-FARMIS, a mathematical programming model based on PMP. Results show that the reform of the cotton market increases farmers’ acceptance to apply environmental measures. However, compared to the magnitude of the monetary incentive, the effect is limited. Furthermore, it is shown, that the monetary incentive granted for extensive cotton production leads to an extension of total cotton production. Hence, the proposed environmental measures are not fully decoupled.

In the fourth case study the effects of modifications of the ‚Less Favoured Area’ premium schemes on production and income in Germany are analysed. For this study the version of FARMIS based on German FADN data is applied. It is concluded that premiums have an impact on production due to the selectivity of benefiting activities (e.g. seta-side is not eligible). Even livestock production is partially affected. Suckler cow production is cross subsidized by LFA payments. Production effects could be reduced by an extension of eligible activities and a harmonization of payment levels.

Results of the case studies show that decoupling partially alters the effect of Pillar II measures. On the one hand decoupling might have negative side affects which could be addressed and on the other hand some measures might have become obsolete or counterproductive. In any case, to guarantee the efficiency of the policy instruments, it is necessary to check whether individual measures still achieve envisaged policy goals in the changed agricultural policy framework. It should be evaluated whether an adjustment of the set of measures is required. Due to the complexity and diversity of Pillar-II measures, such detailed assessments should be conducted by local experts familiar with the specifics of the measures and the requirements in the region.