THE EFFECTS OF FUTURE CAP REFORMS ON FARMING SUSTAINABILITY AND INVESTMENT BEHAVIOUR

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Paper prepared for presentation at the 114th EAAE Seminar
'Structural Change in Agriculture', Berlin, Germany, April 15 - 16, 2010

Abstract

The role of the Common Agricultural Policy (CAP) in influencing farm income, and on-farm and off-farm investments has been highlighted by a wealth of literature on this topic. The objective of this paper is to assess ex-ante the effect of different post-2013 policy (CAP) and market scenarios on farm investment behaviour and the related overall sustainability of farming activity. The model adopted is based on farm household dynamic programming with the maximisation of the household net present value (NPV) with a time horizon until 2020.

Keyword: Investment Behaviour, Mathematical Programming Model, Dynamic Household Models, Sustainability.

Introduction

The relevance of policy instruments in influencing farm income, and on-farm and off-farm investments has already been stressed throughout literature on this topic, concluding that the Single Farm Payment (SFP) has a relevant impact on both on-farm and off-farm investment decisions. In addition, the second pillar of the CAP (rural development) provides, amongst other measures, co-financing for investment on-farm, making it a direct focus for analysing policy impact on investment behaviour.

The objective of this paper is to assess ex-ante the effect of different post-2013 CAP and market scenarios on farm investment behaviour and the related sustainability of farming. The model adopted is based on farm household dynamic programming with the maximisation of the household net present value with a time horizon until 2030. The choice to apply a mathematical programming model is based on possibility to simulate future farmers' behaviours under hypothetical situation or different scenarios. In addition, the use of farm-household approach allows to allocate resources to on-farm and off-farm activities as well as to invest within our outside the farm.

After introducing the methodology in section 2 and the case studies and scenario description in section 3,we will present the results in Section 4, before discussing and summarising in the key points in section 5.

Methodology

Following Gallerani et al. (2008), we use a dynamic household model to simulate the reaction of a sample of individual farm households to decoupling in the medium-long term.

The choice of this approach was based on different considerations. The choice of a normative model is due to the difficulty of collecting *ex post* data related on very recent reforms, the need to represent innovative policy mechanisms and also due to the possibility of more easily simulating alternative scenarios. The dynamic approach is a straightforward requirement to deal with investment and is adopted by much of the research on this issue. On this line, a recent comprehensive theoretical framework on investment in agriculture using this approach is provided by Gardebroek and Oude Lansik (2004). Finally, the choice of a household model was justified by the need to define investment choice as embedded in the overall objectives of the "social" decision making unit.

One of the challenges of the investment modelling approach is to provide a good representation of the households' objective function, usually characterised by a mix of consumption and leisure objectives. This wider range of objectives can be captured through multi-criteria analysis. While multi-criteria models are broadly used, relatively few applications of multi-criteria analysis are combined with multi-period programming, except a few cases. For example, Wallace and Moss (2002) propose a multi-criteria model applied to strategic decisions of the farm household. In Gallerani et al. (2008) multi-criteria programming is used as alternative to NPV maximisation, through the adoption of two modelling options: a) a NPV-maximising, consumption constrained model; and b) a multi-objective recursive model.

In this paper we restrict our attention to the net present value (NPV) maximising model formulation, in which, however a consumption objective is incorporated through a constraint to the expected consumption level of the household. The main motivation for the choice to limit the multi-criteria component of the model is to simplify the computational part of the analysis, by maintaining the main information contents of the model.

One of the challenges with representing investment is that real investment behaviour implies discontinuities due to the indivisibility of capital goods. One way of taking this into account is to adopt dynamic integer programming as used, for example buy Asseldonk *et al*. (1999), who provide a programming approach to farm technology adoption, including technology change. This approach can be easily extended to investment behaviour as adopted in our context (excluding the representation of technology change).

The model used is a deterministic model, not suitable to address uncertainty and risk, which are major components of investment choice. This choice is justified by the need to consider longer term scenario descriptors, rather than short-term fluctuations, and also due to insufficient empirical data to design the price volatility in future scenarios.

Combining the elements discussed above, we propose a household-level dynamic programming model, which can be represented as follows:

$$Z = F[z_1(x_t), z_2(x_t), \ldots z_q(x_t) \ldots, z_Q(x_t)] \tag{1}$$

s.t.

$$x \in X \tag{2}$$

$$x \geq 0 \tag{3}$$

where:

Z = objective function;

z_q = value of attribute/objective q, q=1, 2, …, Q;

X = feasible set;

x_t = vector of decision variables.

The objective function is a representation of household utility. The farm household is expected to take decisions based on an objective function defined as a combination of multiple criteria, each defined as a function of the set of decision variables. Decision variables change their value over time, so the utility function implicitly assumes some aggregation over time and related time preference. The maximisation is subject to constraints on decision variables, represented by the feasible set and by non-negativity constraints. The empirical specification of the model follows the NPV maximising version used by Gallerani et al. (2008).

In this model, equation (1) is substituted by:

$$\text{Max } Z = \sum_t \delta F_t(x_t) \qquad (4)$$

$$\text{s.t. } C_t \le C^* \qquad (5)$$

where δ is a discounting factor, $F_t(x_t)$ is the net cash flow expressed as a function of the activities carried out in time period *t*, C_t is the annual consumption and C^* is the minimum acceptable yearly consumption accepted by the household. Equation 4 is connected to (5) and both are connected to the investment behaviour by the fact that $x_t = f(I_{t'})$ and $I_{t'} = g(C_{t'})$, with *f* being an increasing function (i.e. net cash flows are increased by investment I) and *g* a decreasing function (due to the trade-off between investment and savings). *t'* represent any period $t' < t$. More details are provided in Viaggi et al. 2010.

Case Study Description

A representative model has been implemented for each of 18 different farming systems in 8 EU countries. Farming systems are differentiated with respect to region (Mediterranean, Eastern and Central regions), specialisation (arable, livestock and tree) and altitude (plain and mountain). The distribution of the models is presented in Table 1.

TABLE 1[1]

The individual farms used for modelling within each system were selected through expert judgment, according to representativeness principles mainly based on household characteristics, farm size, type and combination of production processes.

The main characteristics of the modelled farm households, based on the information collected from the survey, are shown in Table 2. Generally speaking, a greater portion of the farm households modelled are individually or family-run; only a few farms in Bulgaria and Italy are limited liability companies.

The farmers tend to be younger of the averages in the case study areas. Legal owners older than 60 years of age have only been simulated in Italy and Spain.

Generally, the available household labour is sufficient to cover the labour required by the farm, since only 5 farm-households use external labour. Furthermore, more than half of the farm households simulated allocated at least one household member to off-farm work.

Twelve farm-households use credit and the debt/asset ratio is higher than 50% for seven of them. In Italy and Poland the ratio is particularly low compared to the other countries.

All farm households are owners of some part of the land they cultivate; in addition, 15 out of 18 farms/households also rent-in land. The amount of Usable Agricultural Area (UAA) operated is heterogeneous among the farms/households modelled (from 15 ha to 295 ha per farm). In most cases, however, the UAA of modelled farms is higher than the average UAA for each case study area, yet there are relevant exceptions, such as the Italian mountain livestock farms and most of the German models.

The amount of the Single Farm Payment (SFP), and the share of this payment in farm income,[2] is very high. The payment received by the farmers ranges from 1,000 € to 91,410 € per farm. Generally, for those farm households for which the data on farm income was available, the share of SFP is over 10% of total farm income. Only one farm household in Italy (IT80MCA) has a ratio of SFP/farm income lower than 10%, as a consequence of the high amount of land invested in forest and timber production.

The number of SFP entitlements varies from 0 to 164[3].

TABLE 2

[1] In the tables: BG=Bulgaria, DE= Germany, ES=Spain, FR= France, GR=Greece, IT=Italy, NE= Netherlands, PO=Poland; P=plain, M=Hilly/mountain; C=Conventional; A=Arable crops, L=livestock, T=trees.

[2] Defined as total farm revenue (including CAP payments) minus variable costs, including the renting-in of land and external services costs.

[3] For Poland this number refers to the area generating payments, while proper entitlements in the EU15 are not in place.

Six different scenarios were developed: a baseline (2009 Health Check reform including already planned policy measures such as milk quota soft landing), and five alternative scenarios (Table 3).

The formulation of scenarios was carried out in coordination with The European Commissions Directorate-General for Agriculture and Rural Development. The scenarios are defined based on two main parameters: product prices and SFP payments. Note that against these parameters, all others (production costs, salaries, interest rates, etc.) are held constant across scenarios. Two of the scenarios (1.1 and 1.2) use as a basis the scenarios identified in the Scenar 2020 II study (Nowicki et al., 2009), in particular the reference scenario and the liberalisation scenario (Table 3).

TABLE 3

The specification "current prices" intends to refer to the prices (both for inputs and outputs) at the time of the start of the study (beginning 2009).

Scenarios 1.1 and 1.2 are the central scenarios of the study, in which the set of prices is the one generated by the ESIM model and used for the Scenar 2020 II study[4]. The conditions of the Scenar 2020 II reference scenario are used as the baseline conditions in our study (scenario 1.1, -30+LSP).

Scenario 2.1. assumes Health Check CAP until 2013 + 30% decrease in (fully decoupled) payments after 2013 + lower output prices while Scenario 2.2 assumes Health Check CAP until 2013 + gradual reduction of (fully decoupled) payments after 2013 (to zero in 2020) + lower output prices.

Scenarios in group 3 simulate additional combinations of payment reduction and prices. In particular, Scenario 3.1 provides for a radical change in payments (total abolition) after 2013, while maintaining current prices and Scenario 3.2 provides a (minor) change in payments.

The remaining two scenarios assume the 2009 policy conditions (Health Check), associated with opposite price hypotheses. Scenario 4.2 (Health Check+current prices) describes the policy as implemented in 2009 and projects it up until 2020. It is used as a reference for validation, as it was the closest to the expectation stated by the farmers. Scenario 4.1. (Health Check+lower prices) describes the same conditions as scenario 4.2 but assumes that output prices are lowered by 20% across the whole simulation period, in analogy with some of the previous scenarios.

The following output indicators are used for measuring economic, social and environmental changes due to the above scenarios: farm income, household income, net investments, amount of on-farm labour, nitrogen and water use.

[4] This study, still unpublished, will replicate the homonymous study carried out in 2006 (European Commission, 2006).

Results

The effects of scenarios on farm income are illustrated in Table 4.

TABLE 4

Under Scenario 1.2 (GR+LSP), the hypothesis of a reduction of CAP payments and the liberalisation scenario provokes a small reduction of farm income in the first period. Farm income is reduced more consistently in the second period when the reduction is between -3% in DE 19 PCL to -100% in PO04PCL (due to abandonment of farming activity in the second period). For the others, the reduction of farm income is between -3% and -55%.

The hypothesis of scenario 2.1 (-30%+LP) determines a further reduction in farm incomes compared to the previous scenario. Generally, the reduction is concentrated during the second period, and ranges between -13 and -88% compared to the baseline. However, the two livestock farms in Germany under scenario 2.1 (-30%+LP) have a positive increase in farm profit compared to the baseline of 8% and 9%. The positive change in farm profit is a consequence of the significant reduction in milk prices in the baseline scenario, and in particular during the second period.

Under scenario 2.2 (GR+LP) the reductions in farm income in the first period are quite homogeneous with respect to scenario 2.1. Further reductions in farm income, with respect to scenario 2.1, appear in the second period, highlighting the relevance of the CAP payments on farm income support.

Scenario 3.1 (-100+CP) implies a complete abolition of the SFP with a constant current price level. The changes in farm income with respect to the baseline condition are extremely variable between farms, and can be positive or negative in one or both periods. During the first period, eight farms (mainly belonging to livestock systems) have positive change with a maximum of increase of 14%. The increase in farm profit in the second period is still maintained by six farms.

Under scenario 3.2 (-15+LP) the hypothesis determines a strong reduction in farm income compared with the baseline, and compared with the previous scenario (3.1). Two farms exit the agricultural sector (BG09MCL and PO04PCL). With respect to the previous scenario (3.1), the reduction of the SFP by 15% instead of its elimination, results in farm DE DE28MCA remaining in the agricultural sector, even in low price conditions.

The hypothesis in Scenario 4.1 (HC + LP) does not differ from scenario 3.2 in the first period, but provides for a higher value of SFP (+15%) after 2013. Results with respect to farm profits are quite homogeneous between the two scenarios, in particular in the first period. Finally, under scenario 4.2 (HC+CP) the hypothesis of 2009 prices determines changes in both directions with respect to the baseline. During the first period, eight farms increase the farm income with value less than + 15% and all other farms decrease farm income less than -10%. During the second period, with the exception of BG09MCAL, all farms have an increase in farm income indicators. Under the assumption of this scenario, no farms exit the agricultural sector.

The negative effects on farm income, when they occur, are mainly determined by the hypothesis of lower prices. This can be observed in particular by looking at scenario 3.1 (-100+CP) (with no payments after 2014, but lower prices) in comparison with scenario 4.1 (HC+LP) (with current payments, but lower prices by 20%). However, even with current prices as in scenario 3.1 (-100+CP), the complete removal of SFP results in a very significant reduction in farm incomes.

The impact on household income differs from the farm income as it accounts for off-farm income (due to off-farm use of labour and capital). In most cases, it is quite similar to the impact on farm income, due to the high concentration of labour, capital or both in farming activities by the farm-households modelled (with a consequent high share of income from agriculture) (Table 5).

TABLE 5

However, differences across scenarios depend not only on the different initial weights of off-farm income, but also on the possibility of re-allocation of labour and capital between on and off-farm uses[5]. Similar to the case of farm income, farms have changes in both directions in all scenarios with the exception of scenario 1.2.

The strongest decrease is in BG 09 MCL, in which the 4 scenarios, 2.1 (-30+LP), 2.2 (GR+LP), 3.2 (-15+LP) and 4.1 (HC+LP), have reductions of around – 80% and – 90% for the first and second periods in all scenarios compared with the baseline.

In line with the farm income indicator, the "least worst" scenario is 4.2 (-100+CP) with change between -9 % and + 44% in the first period, and between -5% and +152% in the second.

The scenarios proposed, consistently with income reduction, bring about a general reduction in net investments with respect to baseline conditions[6] (Table 6)

TABLE 6

[5] The model allows for the selection of different allocations of household labour between on and off-farm only for those household members who were already involved in an off-farm activities at the time of the survey. This assumption has *de facto* excluded the possibility of allowing the model to allocate off-farm a part or all of the labour of household members who work full-time on-farm. The reason for this constraint is to avoid adding arbitrary assumptions regarding the opportunity costs of on-farm labour to the model.

[6] The percentage has been calculated as the ratio between the difference of net investment under the scenario and the baseline, and the absolute value of net investment under baseline conditions. This is the case due to the impossibility of calculating percentages starting from a negative value in the baseline.

Two farm households (DE12PCA, and GR09PCA) do not see a change in net investments in different scenarios. Some of the other farm households have a reduction in investment, such as in FR06PCA; IT21MCL; IT80MCA, whilst other farm households have increased disinvestments in existing assets with the exception of farm IT75PCL, which has a substantial increase in investment [7].

Farmer behaviour is differentiated among farm households, and is quite consistent for all time periods in the scenarios. This is generally a consequence of farm specialisation, farm endowment and the age of assets. In fact, the scenario assumptions (mainly payment and price reductions) generally only justify a replacement of the existing investment, or the execution of already planned investments.

Along with farm income and household income, the worst values of the indicators are under scenarios 2.1 (-30+LP) and 2.2 (GR+LP).

Scenario 4.2 (HC+CP) presents the highest net investment value, due to the assumption of higher (2009) prices and payments. The investment activity with respect to the baseline is strongest in the Poland farms.

As is the case for other indicators, on-farm labour is mainly reduced compared to scenario 1.1. under the other scenario conditions hypothesised (Table 7).

TABLE 7

With the exception of scenario 4.2 the amount of on-farm labour is reduced or is constant among scenarios and over time. In scenario 4.2, only three farms see the amount of on-farm labour reduced with respect to the baseline. In many cases (already detected through the income indicator) the scenario hypotheses determine abandonment of the farm activity with respect to the baseline. In addition, different scenario hypotheses impact strongly on the amount of on-farm labour for the farm households that do not exit the agricultural activity. The value of on-farm labour indicators for these farm households is very differentiated among scenarios, with higher reductions observed in scenarios 2.1 (-30+LP) and 2.2 (GR+LP).

The different scenarios determine a lower change in the use of nitrogen and water, compared to the other indicators (Table 8 and Table 9).

TABLE 8

[7]Values of net investment of -100% mean that under the scenario conditions the farmers do not undertake the investment realised in the baseline. Further reductions of net investment indicators, under scenario conditions (e.g. less than -100%) imply that in addition to no investment realised in baseline, the farmer disinvests the existing assets.

TABLE 9

The cases with the highest reduction in both water and nitrogen use (100%) can be the results of either the abandonment of a farm activity, or the substitution of crops that use significant water or nitrogen for those that does not use any water or nitrogen. Similarly to the other indicators, only in scenario 4.2 farm intensify production with a higher use of both water and nitrogen per hectare.

Conclusion

The modelling results show that price decreases in the range of 20% would have a very detrimental effect on economic sustainability and investment. Generally speaking, we observe very strong changes in farm results and investment due to relatively small changes in context parameters, mainly due to the narrow profit margins.

All scenarios identified would worsen economic results compared with the present situation (baseline scenario). This is partly attenuated by the Scenar 2020 II hypotheses, where price dynamics are explicitly taken into account, allowing for some recovery in the 2014-2020 period, which would compensate decreased payments. The outcomes of the models would in turn require a careful examination, as they are based on ceteris paribus assumptions about the economic context. For example, we witnessed a relevant number of exits from farming. However, given the employment difficulties in other sectors, it could well be that we are nonetheless observing a decision by farm-households to stay in farming (or even a move towards agriculture in some areas).

As a result of the current difficult economic context, and the mostly pessimistic market scenarios, the role of policy seems to be very relevant not only in the decision to invest but also in the decision to continue farming activity. The SFP appears to have a more direct role in ensuring farm and household profitability, through covering production costs, providing income integration and contributing to investment payoff. Second pillar funding can have a major role in supporting investments on farm. However, the variability of farming results and investment seems to indicate that an even more relevant issue is to help income stabilisation for farms that have carried out investments.

Several improvements can be devised for the present study. This can include, among others: a) the consideration of uncertainty and risks in the model; b) the analysis of further more realistic scenarios as soon as the reform process will advance.

References

Asseldonk (van) M.A.P.M. Huirne R.B.M., Dijkhuizen A.A. and Beulens A.J.M. (1999). Dynamic programming to determine optimum investments in information technology in dairy farms, Agricultural Systems 62: 17-28.

European Commission (2006). Scenar 2020. Scenario study on agriculture and the rural world, Brussels.

Gallerani, V., Gomez y Paloma, S., Raggi, M., Viaggi, D.,. (2008). Investment behaviour in conventional and emerging farming systems under different policy scenarios. JRC Scientific and Technical Reports, Institute for Prospective Technological Studies (IPTS), Seville.

Gardebroek, C. and Lansink, A. G. J. M. O. (2004). Farm-specific adjustment costs in Dutch pig farming. *Journal of Agricultural Economics,* 55**,** 3-24.

Nowicki, P., V. Goba, A. Knierim, H. van Meijl, M. Banse, B. Delbaere, J. Helming, P. Hunke, K. Jansson, T. Jansson, L. Jones-Walters, V. Mikos, C. Sattler, N. Schlaefke, I. Terluin and D. Verhoog (2009). *Scenar 2020-II – Update of Analysis of Prospects in the Scenar 2020 Study* – Contract No. 30–CE-0200286/00-21. European Commission, Directorate-General.

Agriculture and Rural Development, Brussels. Wallace, M. T. and Moss, J. E. (2002). Farmer Decision-Making with Conflicting Goals: A Recursive Strategic Programming Analysis. *Journal of Agricultural Economics,* 53**,** 82-100.

Viaggi, D., Bartolini, F., Raggi, M. and Sardonini, L. (2010). Homogenised Key Findings (Draft Final Report). FARM INVESTMENT BEHAVIOUR UNDER THE CAP REFORM PROCESS.

Table 1 – Number of models and distribution across case studies

Area	Specialisation	Technology	DE	ES	FR	GR	IT	NE	PO	BG	Total
Mountain	Arable	Conventional	1				1			1	3
		Emerging									0
	Livestock	Conventional	1				1		1	1	4
		Emerging									0
Plain	Arable	Conventional	1		1	1	1		1	1	6
		Emerging									0
	Livestock	Conventional	1				1	1	1		4
		Emerging									0
	Trees	Conventional		1							1
Total			4	1	1	1	4	1	3	3	18

Table 2 – Main characteristics of the farm households modelled

Code	Legal status	House hold components (#)	Age farmer	Use of external labour	Members working off farm	Household debt/assets ratio	Land owned (ha)	Land rent-in (ha)	Land rent-out (ha)	SFP (€) (average 2006-2009)	SFP/ income ratio	Rights (#) (average 2006-2009)
BG07PCA	limited company	5	57	yes	no	0.50	15	280	-		-	
BG09MCL	individual/family run	4	59	yes	no	-	7	80	-		-	
BG14MCA	individual/family run	3	56	no	no	-	4	196	-		-	
DE12PCA	individual/family run	2	55	no	no	0.94	35	16	1	33,500	0.36	89
DE19PCL	individual/family run	2	56	yes	no	1.00	36	-	-	12,438	0.05	33
DE28MCA	individual/family run	2	28	no	yes	1.00	19	20	5	14,000	0.66	61
DE40MCL	other	3	51	no	no	0.70	38	22	-	22,000	0.13	60
ES03PCT	individual/family run	3	68	yes	no	-	150	-	-	40,000	0.13	120
FR06PCA	individual/family run	3	40	no	yes	0.99	11	142	-	50,000	0.23	140
GR09PCA	individual/family run	2	57	yes	no	0.41	2	26	-	14,160	0.48	34
IT21MCL	individual/family run	7	37	no	yes	-	8	7	-	7,500	0.08	14
IT37PCA	individual/family run	7	48	no	yes	0.06	105	5	-	34,500	0.29	107
IT75PCL	limited company	3	58	no	yes	0.02	45	15	-	25,657	0.18	34
IT80MCA	limited company	4	79	no	yes	-	34	32	-	1,000	0.16	na
NE08PCL	individual/family run	4	52	no	yes	0.60	28	31	-	20,757	0.20	na
PO03PCA	individual/family run	6	59	no	no	0.15	61	80	-	26,915	0.24	164
PO04PCL	individual/family run	5	52	no	yes	0.13	34	20	-	9,832	0.96	59
PO18MCL	individual/family run	3	60	no	no	-	25	-	-	3,239	0.26	17

Table 3 – Scenarios

	Specification	**Correspondence with scenar2020 II**
1.1 (-30+RSP) **Reference**	Health Check CAP until 2013 + 30% decrease in (fully decoupled) payments after 2013 + lower prices	Same policy and prices as Reference scenario in Scenar 2020 II
1.2 (GR+LSP)	Health Check CAP until 2013 + gradual reduction of (fully decoupled) payments after 2013 (to zero in 2020) + lower prices	Same policy and prices as liberalisation scenario in Scenar 2020 II
2.1 (-30+LP)	Health Check CAP until 2013 + 30% decrease in (fully decoupled) payments after 2013 + lower prices	Same policy as reference scenario in Scenar 2020 II
2.2 (GR+LP)	Health Check CAP until 2013 + gradual reduction of (fully decoupled) payments after 2013 (to zero in 2020) + lower prices	Same policy as liberalisation scenario in Scenar 2020 II
3.1 (-100+CP)	Health Check CAP until 2013 + no payment after 2013 + current prices	
3.2 (-15+LP)	Health Check CAP until 2013 + 15% decrease in flat-rate payments at national level after 2013 + lower prices	Same policy as conservative CAP in Scenar 2020 II
4.1 (HC+LP)	Health Check CAP + lower prices (-20%)	
4.2 (HC+CP) **Validation**	Health Check CAP + current prices	

Table 4 – Results of different scenarios – Farm income (% difference with respect to baseline)

Code	**12_GR+LSP**		**21_-30+LP**		**22_GR+LP**		**31_-100+CP**		**32_-15+LP**		**41_HC+LP**		**42_HC+CP**	
	2009-2013	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*
BG 07 PCA	0%	-24%	-45%	-60%	-45%	-81%	-5%	-71%	-45%	-49%	-45%	-37%	-5%	9%
BG 09 MCL	0%	-3%	-100%	-100%	-100%	-100%	-7%	-11%	-100%	-100%	-100%	-100%	-10%	-3%
BG 14 MCA	0%	-23%	-36%	-47%	-36%	-66%	-4%	-60%	-36%	-37%	-36%	-26%	-4%	10%
DE 12 PCA	0%	-13%	-26%	-30%	-26%	-79%	-2%	-30%	-26%	-24%	-26%	-19%	-2%	5%
DE 19 PCL	0%	-3%	-16%	8%	-16%	6%	9%	36%	-16%	9%	-16%	10%	9%	42%
DE 28 MCA	-1%	-55%	-86%	-100%	-86%	-100%	-5%	-100%	-41%	-46%	-42%	-80%	-4%	31%
DE 40 MCL	0%	-5%	-17%	9%	-17%	7%	10%	38%	-17%	11%	-17%	15%	10%	60%
ES 03 PCT	-6%	-21%	-55%	-88%	-55%	-88%	-7%	-23%	-55%	-87%	-51%	-66%	-1%	3%
FR 06 PCA	0%	-14%	-13%	-10%	-13%	-20%	14%	-6%	-13%	-4%	-13%	1%	14%	32%
GR 09 PCA	-1%	-15%	-36%	-39%	-36%	-42%	-1%	-17%	-36%	-35%	-36%	-27%	-1%	13%
IT 21 MCL	0%	-8%	-23%	-2%	-23%	-7%	8%	27%	-23%	0%	-23%	3%	8%	45%
IT 37 PCA	-16%	-9%	-71%	-100%	-85%	-100%	-2%	-27%	-28%	-30%	-28%	-55%	-2%	2%
IT 75 PCL	-2%	-10%	-22%	0%	-20%	-12%	7%	14%	-21%	-2%	-21%	1%	1%	39%
IT 80 MCA	0%	-24%	-54%	-72%	-54%	-91%	-54%	-68%	-1%	30%	-54%	-64%	-1%	56%
NL 08 PCL	0%	0%	-74%	0%	-74%	0%	84%	0%	-74%	0%	-74%	0%	84%	0%
PO 03 PCA	0%	-7%	-33%	-25%	-33%	-31%	0%	3%	-33%	-21%	-33%	-19%	0%	22%
PO 04 PCL	-77%	-100%	-89%	-100%	-89%	-100%	-77%	-100%	-89%	-100%	-89%	-100%	-1%	1008%
PO 18 MCL	-5%	-22%	-65%	-53%	-44%	-53%	1%	-39%	-44%	-53%	-37%	-36%	2%	230%

Table 5 – Results of different scenarios – Household income (% difference with respect to baseline)

Code	12_GR+LSP		21_-30+LP		22_GR+LP		31_-100+CP		32_-15+LP		41_HC+LP		42_HC+CP	
	2009-2013	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*
BG 07 PCA	0%	-19%	-46%	-61%	-46%	-73%	-5%	-61%	-46%	-51%	-46%	-40%	-5%	7%
BG 09 MCL	0%	-3%	-86%	-92%	-86%	-92%	-8%	-15%	-86%	-92%	-86%	-92%	-9%	-5%
BG 14 MCA	0%	-16%	-29%	-39%	-29%	-51%	-3%	-44%	-29%	-31%	-29%	-24%	-3%	7%
DE 12 PCA	0%	-11%	-25%	-31%	-25%	-59%	-2%	-28%	-25%	-27%	-25%	-22%	-2%	5%
DE 19 PCL	0%	-2%	-16%	4%	-16%	2%	9%	32%	-16%	4%	-16%	5%	9%	37%
DE 28 MCA	-1%	-30%	-56%	-60%	-56%	-60%	-5%	-56%	-32%	-34%	-32%	-50%	-3%	19%
DE 40 MCL	0%	-4%	-18%	5%	-18%	4%	9%	38%	-18%	7%	-18%	9%	10%	52%
ES 03 PCT	-2%	-11%	-37%	-43%	-37%	-44%	-3%	-12%	-37%	-43%	-35%	-37%	-1%	2%
FR 06 PCA	0%	-12%	-12%	-10%	-12%	-19%	14%	-4%	-12%	-5%	-12%	0%	14%	30%
GR 09 PCA	-1%	-14%	-40%	-45%	-40%	-46%	-2%	-12%	-40%	-41%	-40%	-36%	-1%	13%
IT 21 MCL	0%	-5%	-16%	-3%	-16%	-6%	5%	16%	-16%	-2%	-16%	0%	5%	27%
IT 37 PCA	-12%	-8%	-44%	-56%	-51%	-56%	-2%	-21%	-22%	-24%	-22%	-36%	-2%	2%
IT 75 PCL	-1%	-8%	-18%	-3%	-16%	-10%	4%	9%	-17%	-4%	-17%	-1%	2%	28%
IT 80 MCA	0%	-2%	-10%	-8%	-10%	-9%	-10%	-8%	0%	1%	-10%	-7%	0%	4%
NL 08 PCL	0%	0%	-42%	-6%	-42%	-6%	44%	17%	-42%	-6%	-42%	-6%	44%	152%
PO 03 PCA	0%	-6%	-34%	-30%	-34%	-32%	0%	2%	-34%	-27%	-34%	-25%	0%	16%
PO 04 PCL	-23%	-8%	-26%	-5%	-26%	-5%	-22%	-6%	-26%	-5%	-26%	-5%	-1%	27%
PO 18 MCL	-5%	-8%	-42%	-26%	-36%	-27%	0%	-5%	-36%	-27%	-33%	-28%	2%	83%

Table 6 – Results of different scenarios – Net investment (% difference with respect to baseline)

Code	12_GR+LSP		21_-30+LP		22_GR+LP		31_-100+CP		32_-15+LP		41_HC+LP		42_HC+CP	
	2009-2013	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*
BG 07 PCA	0%	-96%	0%	0%	0%	-451%	-44%	-72%	0%	0%	0%	0%	0%	0%
BG 09 MCL	0%	0%	-112%	-100%	-112%	-100%	0%	7%	-112%	-100%	-112%	-100%	-10%	9%
BG 14 MCA	0%	-22%	-11%	0%	0%	-351%	-11%	0%	0%	0%	0%	0%	0%	0%
DE 12 PCA	0%	0%	0%	0%	0%	-644%	0%	0%	0%	-1%	0%	0%	0%	0%
DE 19 PCL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
DE 28 MCA	-75%	-17%	-4449%	100%	-4449%	100%	-3772%	100%	-1279%	35%	-1279%	15%	0%	124%
DE 40 MCL	0%	-46%	-136%	93%	0%	-48%	-181%	139%	-136%	139%	0%	0%	0%	185%
ES 03 PCT	-211%	-356%	-2239%	-259%	-2097%	-412%	-210%	-375%	-2103%	-408%	-1250%	-873%	0%	0%
FR 06 PCA	-4%	0%	-17%	0%	-1%	0%	-3%	0%	-3%	0%	-3%	0%	-4%	0%
GR 09 PCA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
IT 21 MCL	0%	0%	0%	0%	0%	0%	8%	-5%	0%	0%	0%	0%	7%	-2%
IT 37 PCA	-6%	-103%	-13161%	-62%	-13187%	-152%	-6%	-21405%	-39%	-103%	-39%	-17033%	0%	-103%
IT 75 PCL	9%	-6%	7%	3%	7%	-20%	6%	11%	4%	-1%	2%	0%	3%	5%
IT 80 MCA	0%	-7%	0%	-41%	0%	-88%	0%	-40%	0%	3%	0%	-39%	0%	11%
NL 08 PCL	0%	0%	-6%	0%	-6%	0%	40%	0%	-6%	0%	-6%	0%	70%	0%
PO 03 PCA	0%	-15%	0%	-11%	-1%	-681%	0%	-15%	0%	1%	-1%	1%	0%	228%
PO 04 PCL	-60%	85%	-88%	100%	-88%	100%	-68%	96%	-88%	100%	-88%	100%	8%	119%
PO 18 MCL	-46%	12%	-388%	125%	-364%	120%	-337%	122%	-364%	120%	-29%	-6%	76%	146%

Table 7 – Results of different scenarios – Labour on-farm (% difference with respect to baseline)

Code	12_GR+LSP		21_-30+LP		22_GR+LP		31_-100+CP		32_-15+LP		41_HC+LP		42_HC+CP	
	2009-2013	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*
BG 07 PCA	0%	-1%	0%	0%	0%	-50%	0%	0%	0%	-16%	0%	0%	0%	0%
BG 09 MCL	0%	0%	-99%	-100%	-99%	-100%	-99%	-100%	-4%	-3%	-99%	-100%	-7%	-3%
BG 14 MCA	0%	-1%	-3%	-4%	-3%	-18%	-3%	-4%	0%	-4%	-3%	-4%	0%	0%
DE 12 PCA	0%	0%	0%	-11%	0%	-74%	0%	-11%	0%	-11%	0%	-11%	0%	-11%
DE 19 PCL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
DE 28 MCA	-1%	-54%	-81%	-100%	-81%	-100%	-22%	-26%	-1%	-100%	-21%	-75%	0%	20%
DE 40 MCL	0%	0%	0%	-2%	0%	0%	0%	-2%	0%	-1%	0%	0%	0%	5%
ES 03 PCT	-5%	-11%	-32%	-88%	-32%	-87%	-32%	-85%	-5%	-11%	-26%	-54%	0%	0%
FR 06 PCA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GR 09 PCA	0%	-1%	0%	1%	0%	1%	0%	1%	0%	1%	0%	1%	0%	1%
IT 21 MCL	0%	0%	-2%	0%	-2%	0%	-2%	0%	1%	1%	-2%	0%	1%	1%
IT 37 PCA	-20%	0%	-61%	-100%	-80%	-100%	0%	0%	0%	0%	0%	-43%	0%	0%
IT 75 PCL	-1%	3%	-4%	1%	-2%	3%	-3%	0%	2%	2%	-3%	0%	-5%	2%
IT 80 MCA	0%	-17%	0%	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%	20%
NL 08 PCL	0%	0%	-64%	0%	-64%	0%	-64%	0%	78%	0%	-64%	0%	78%	0%
PO 03 PCA	0%	3%	0%	-1%	-3%	-11%	0%	3%	0%	-1%	-2%	1%	0%	3%
PO 04 PCL	-79%	-100%	-82%	-100%	-82%	-100%	-82%	-100%	-79%	-100%	-82%	-100%	0%	811%
PO 18 MCL	-1%	-32%	-71%	-95%	-43%	-95%	-43%	-95%	-1%	-95%	-37%	-76%	0%	259%

Table 8 – Results of different scenarios – Nitrogen Used (% difference with respect to baseline)

Code	12_GR+LSP		21_-30+LP		22_GR+LP		31_-100+CP		32_-15+LP		41_HC+LP		42_HC+CP	
	2009-2013	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*
BG 07 PCA	0%	-2%	0%	0%	0%	-50%	0%	-16%	0%	0%	0%	0%	0%	0%
BG 09 MCL	0%	0%	-97%	-100%	-97%	-100%	-33%	-100%	-97%	-100%	-97%	-100%	-32%	-47%
BG 14 MCA	0%	-1%	0%	-2%	0%	-17%	0%	-4%	0%	0%	0%	0%	0%	0%
DE 12 PCA	0%	0%	0%	-2%	0%	-72%	0%	-2%	0%	-2%	0%	-2%	0%	-2%
DE 19 PCL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
DE 28 MCA	-1%	-54%	-80%	-100%	-80%	-100%	-1%	-100%	-17%	-21%	-16%	-74%	0%	20%
DE 40 MCL	0%	-8%	-2%	-63%	-2%	-63%	-2%	-100%	-2%	-49%	-2%	-5%	-2%	104%
ES 03 PCT	-5%	-11%	-32%	-88%	-32%	-87%	-5%	-11%	-32%	-85%	-26%	-54%	0%	0%
FR 06 PCA	0%	0%	0%	0%	0%	0%	0%	-2%	0%	0%	0%	0%	0%	0%
GR 09 PCA	0%	1%	0%	-29%	0%	-76%	0%	-100%	0%	-16%	0%	-1%	0%	-1%
IT 21 MCL	0%	0%	-100%	0%	-100%	0%	0%	0%	-100%	0%	-100%	0%	0%	0%
IT 37 PCA	-20%	0%	-61%	-100%	-80%	-100%	0%	0%	0%	0%	0%	-43%	0%	0%
IT 75 PCL	-1%	6%	-4%	4%	-2%	5%	1%	3%	-3%	2%	-3%	2%	36%	3%
IT 80 MCA	0%	30%	0%	-15%	0%	-21%	0%	-14%	0%	2%	0%	-14%	0%	3%
NL 08 PCL	0%	0%	-62%	0%	-62%	0%	76%	0%	-62%	0%	-62%	0%	76%	0%
PO 03 PCA	0%	6%	0%	-2%	-7%	-26%	0%	-2%	0%	8%	-5%	2%	0%	7%
PO 04 PCL	-79%	-100%	-80%	-100%	-80%	-100%	-79%	-100%	-80%	-100%	-80%	-100%	0%	811%
PO 18 MCL	0%	-26%	-56%	-75%	-19%	-75%	0%	-75%	-19%	-75%	0%	-11%	0%	235%

Table 9 – Results of different scenarios – Water Used (% difference with respect to baseline)

Code	12_GR+LSP		21_-30+LP		22_GR+LP		31_-100+CP		32_-15+LP		41_HC+LP		42_HC+CP	
	2009-2013	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*	*2009-2013*	*2014-2020*
DE 12 PCA	0%	0%	0%	0%	0%	-71%	0%	0%	0%	0%	0%	0%	0%	0%
ES 03 PCT	-5%	-11%	-32%	-88%	-32%	-87%	-5%	-11%	-32%	-85%	-26%	-54%	0%	0%
FR 06 PCA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GR 09 PCA	0%	1%	0%	-21%	0%	-54%	0%	-71%	0%	-11%	0%	0%	0%	0%
IT 37 PCA	-20%	0%	-61%	-100%	-80%	-100%	0%	0%	0%	0%	0%	-43%	0%	0%
IT 75 PCL	-1%	6%	-4%	4%	-2%	5%	1%	3%	-3%	2%	-3%	2%	36%	3%
PO 03 PCA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PO 04 PCL	-79%	-100%	-80%	-100%	-80%	-100%	-79%	-100%	-80%	-100%	-80%	-100%	0%	811%
PO 18 MCL	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%