CAP-IRE

Assessing the multiple Impacts of the Common Agricultural Policies (CAP) on Rural Economies (Fp7 SSH - 216672)

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COOPERATION

Deliverable n.D3.2

TITLE
INTEGRATED ANALYSIS

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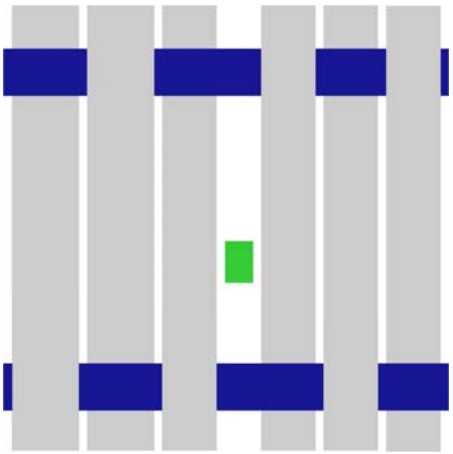

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SUMMARY

This document represents deliverable D3.2 INTEGRATED ANALYSIS of the project CAP-IRE. The main objective of WP3 is to provide an analysis of the interconnections between the issues dealt with in WP4 through WP9, aimed at the identification of a policy-relevant classification of households/areas with respect to CAP effects.

The main objective of this document is to provide a cross-issue analysis of the empirical evidence derived from the project and to derive qualitative insights leading to policy implications from the project.

The project adopts a mixed method approach. The backbone of the project is represented by a large survey (survey A) of 2363 farm-households in 11 case study areas (CSA) in 9 EU countries, using a homogenous questionnaire aimed at collecting information about present status of the farm-households, and expected changes under two main policy scenarios: a baseline and a NO-CAP scenario. This is accompanied by in-depth analyses using different tools to address specific issues in selected case study areas. These main research activities are supported, on the one hand, by a background scenario analysis and on the other by a strong stakeholder support through interaction with an advisory board at project level and a local participatory network in each CSA.

In this paper we perform two main exercises. First we review the results of the project thematic WPs through a qualitative integrated analysis. Then we turn to a quantitative analysis in which we elaborate farm typologies and a representation of cross-thematic linkages. The quantitative analysis is mainly based on the data obtained in survey A of the project, while the qualitative analysis is based on the deliverables produced in WP2, WP4, WP5, WP6, WP7, WP8 and WP9, as well as on the same analysis carried out in WP3.

We then turn to summarising the main messages and to derive policy implications for the current debate.

The background analysis carried out in the project CSAs emphasises the heterogeneity of different rural areas and types of agriculture, as well as of economic contexts. The CAP is itself taking different formats in different areas, particularly when comparing Western EU with New member states.

The straight results of survey A show a declining trend in farm number, with a reduction particularly relevant for small farms and older farmers. The removal of the CAP would bring major changes, of which the most important would be the additional exit of about one third of the farms that would stay in the baseline, accounting for the same proportion of land and labour in the sample. The removal of the CAP would in addition slow down expected increases in farm size, investment, innovation and labour use.

Farm heterogeneity reflects however in a very diversified behaviour, including opposite reactions to policy changes by different groups. The main explanatory variables detected remain some classical explanatory variables, such as location,

specialisation, farm size, famer's age, education, use of farm advice. Some more attitudinal-related factors (e.g. cultural attachment to locality) affect more specific choices, such as the decision about where to buy input.

The scenario simulation shows that the baseline, based on current (2009) CAP, already brings some relevant changes. However the most important impact would be brought by a liberalisation scenario, with potentially disruptive effects in term of farm income, while labour changes would strongly depend on the kind of farm activities.

The quantitative analysis allowed the identification of five main groups of farm-households based on stated intentions about the future and stated reactions to policy. This exercise allowed to identify in particular those farms willing to change in the next future by increasing in size and endowment of capital.

This exercise confirms, on the aggregate, the main insight from the thematic workpackages. In particular it hints at the idea that largest farms, with more educated and younger farmers are also those more willing to grow and innovate. In this farms, all components of farm structure tend to grow altogether, which is consistent with the expectation that thematic changes are connected into a whole farm and household strategy.

The BN exercise allowed to represent in a consistent framework the main interconnections identified by the thematic work packages and to represent the effects of such interconnections on the final nodes (variables) with a satisfactory degree of credibility compared to the original data.

The summary of main findings emphasises the role of exits as the pivotal variable for future changes. Several indications are derived also in relation to the current policy debate, particularly supporting a more targeted use of first pillar funds and differentiated policies according with farm types (small vs. large, active vs. inactive).

Altogether, the project support the perceived need to maintain a Common Agriculture Policy in place if the objectives that society attaches to agriculture and rural areas are to be achieved.

1 OBJECTIVES

The objective of CAP-IRE is to develop concepts and tools to support future CAP design, based on an improved understanding of the long-term socio-economic mechanisms of change in rural areas.

The reaction of farm households to CAP reforms is analysed under the lens of six thematic, and one cross-thematic, viewpoints: 1) farm structural adjustment, investment and innovation; 2) chain interactions between agriculture and related economic sectors; 3) environmental sustainability; 4) social sustainability; 5) interactions between rural communities and the rest of the world; 6) farm and rural governance issues; 7) the interplay between the previous aspects.

This document is the draft version of deliverable D3.2 INTEGRATED ANALYSIS.

The document is the final deliverable of WP3, the main objective of which is to provide an analysis of the interconnections between the issues dealt with in WP4, Wp5, WP6, Wp7, Wp8 and WP9, aimed at the identification of a policy-relevant classification of households/areas with respect to CAP effects.

The specific original objectives of the WP are:

a) to classify households and identify farm household typologies according to their characteristics and in relation to the impact of the CAP;
b) to classify sub-regions and identify rural typologies according to their reaction to the CAP;
c) to connect socio-economic (household) development and rural typologies based on the joint analysis of CAP, territorial and human interactions.

These objectives are addressee in this document by providing a cross-issue analysis of the empirical evidence derived from the project and through an original quantitative exercise based on data originated from survey A of the project, altogether leading to final policy implications from the project.

This document relies heavily on project deliverables, available on the project website www.cap-ire.eu.

In order to meet this objective, we first provide an overview of the source of data and information used in the document, that also involves describing data collected and methods used during the project (section 2). Then we turn to the summary of the main results generated through the thematic analysis of the project (section 3). In addition to that, an original addition of this document is represented by the quantitative analysis (section 4). Then we turn to summarising the main insights from the project (section 5) and to put them in context through deriving policy relevant considerations to the present policy debate on the CAP reform (section 6). We end with some final conclusions (section 7).

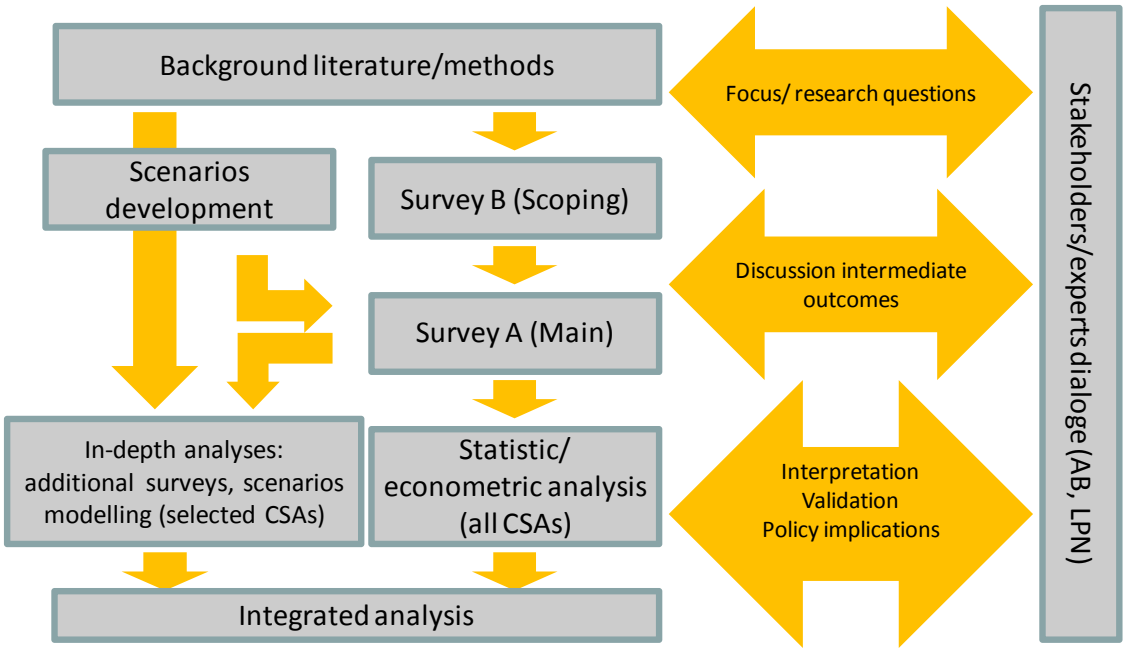
2 METHODS, DATA SOURCES AND LIMITATIONS

2.1 CAP-IRE methods overview: a mixed approach

This document represents the final integrated outcome of the project CAP-Ire and, as such, represents a summary of all activities carried out in the project and relies on the whole methodological approach of the project.

CAP-IRE used a mixed methods approach as illustrated in Figure 1.

Figure 1 – CAP-IRE methodological approach



The project addresses the wide issue of the role of the CAP in rural economies. In order to do that, the project's approach develops from the available literature, in which a variety of methods are proposed to assess policy effects. As the main idea of the project is to study future tendencies in rural areas and how the CAP affects such tendencies, the project relies mainly on surveys using stated intentions approaches. The main component of the project following such approach is survey A, using a common questionnaire in 11 case study areas (CSA) in 9 countries and finally providing 2363 usable observation (farm-household interviews). This survey was prepared through a smaller but more detailed survey (survey B) aimed at scoping and selecting key questions and issue, which provided 55 interviews with the same coverage of countries and CSAs. Results of survey A are then submitted to statistic and econometric analysis to explain key behaviour in a thematic perspective related to individual WPs in the project, hence separately addressing: 1) farm structural adjustment, investment and innovation; 2) chain interactions between agriculture and related economic sectors; 3) environmental sustainability; 4) social sustainability; 5)

interactions between rural communities and the rest of the world; 6) farm resilience and rural governance issues.

In parallel to this analysis, also more specific exercises have been carried out under the label of in-depth analyses. These are differentiated by thematic area, each using different methods to be applied in different CSAs, in order to provide specific insights on a selection of locally relevant issues. This includes simulation tools, such as mathematical programming, as well as additional surveys examining specific behaviour on more focused topics (e.g. input provision).

As the project looks at the future, a scenario exercise was needed to build a background to both survey and modelling exercises. Rather simplified scenarios were used in the surveys to collect reactions to different future by farmers, while more elaborated scenarios were used in the in-depth analysis as an input to modelling.

In parallel to this workflow, the project benefited of a continuous interaction with stakeholders, providing inputs to focusing research questions, on-going reactions on intermediate results, interpretation and validation of final results, and support to the discussion of policy implications.

In the following paragraphs, three main components of the methods used are further discussed: a) scenario analysis; b) Survey A; c) in-depth analyses.

2.2 Scenario analysis

The scenario analysis was developed on two levels.

For the purposes of the survey A, in which scenarios supported the collection of stated intentions, two simple and extreme scenarios were developed:

- A baseline scenario based on the CAP as it was implemented in 2009 (time of the survey);
- A NO-CAP scenario assuming the complete removal of the CAP starting in 2013.

For the purposes of the simulations exercises in the in-depth analysis, four main scenarios were considered:

A. Baseline scenario: CAP continues in the current form;
B. Liberalisation scenario: The CAP is completely abolished starting in 2013;
C. Regionalisation scenario: after 2013 the CAP budget is reduced by 50% from current levels, while the relative importance of pillar1 and pillar 2 remains as in baseline.
D. Environment scenario: after 2013 the CAP budget is reduced by 50% from current levels, while the relative importance of pillar1 and pillar 2 is reversed.

Two of the scenarios - Baseline and No Cap – can be considered as the same as those used in the Survey A of the project. The two remaining scenarios – Regionalisation and Environment - are described in detail in Cristoiu et al. (2009).

Details of scenarios, background documents and motivations are available in Cristoiu et al. (2009).

2.3 Survey A

The main survey ("Survey A") contained questions concerning farm/household characteristics, patterns of change in a baseline scenario (present CAP) and reactions to an extreme "NO-CAP scenario". The main sampling features of survey A are summarised in Table 1.

Table 1 – Survey A – Sample features

CSA	Number of interviews (farm-households)	Way	Response rate
1. Emilia-Romagna (Italy)	300	Telephone	62%
2. Noord-Holland (Netherlands)	300	Postal	21%
3. Macedonia and Thrace (Greece)	300	Telephone / Face to face	55%
4. Podlaskie (Poland)	249	Face to face	95%
5. North East of Scotland (UK)	168	Telephone	68%
6. Andalusia (Spain)	201	Face-to-face	75%
7. South-East Planning Region (Bulgaria)	273	Face-to-face	92%
8. Centre (France)	140	Face-to-face	35%
9. Midi-Pyrénées (France)	155	Face-to-face	31%
10. Lahn-Dill-District (Germany)	117	Postal	20%
11/1 Ostprignitz-Ruppin / North-East Brandenburg (Germany)	160	Postal	14.6%
Total	2363		

The sample was selected by random methods from the list of beneficiaries of CAP payments in each Case study area, with appropriate stratification according to the features of each area. The survey was carried out mostly between April and June 2009, with some latest interviews up to September 2009.

More details about sample characteristics and descriptive outcomes are given in Raggi et al. (2010) (D2.13-23). Further information about the individual CSAs is available from Deliverables D2.1-12 of the project.

Analyses of survey A included statistical and econometric analyses to explain the determinants of the current direction of change and the impact of the CAP concerning:

- Exits form farming
- Farm size and structure
- Innovation
- Chain connections
- Labour use
- Input use
- Networking and governance structures.

2.4 In depth analyses

In depth analysis were carried out using different methods in different areas to address specific complementary issues compared to survey A.

In particular, in-depth analyses included:

- Real option models simulating technology adoption in Emilia Romagna (IT), Midi-Pyrénées (France), Podlaskie (Poland), Noord-Holland (Netherlands), South-East Planning Region (Bulgaria).
- Spatial tracking analysis to explore the linkages between farm households and their immediate local economy in North East Scotland (United Kingdom), Podlaskie (Poland).
- SAM-based analysis to capture linkages between farm households and the regional economy in North East Scotland (United Kingdom)
- Indicator-based analysis (Driving forces-Pressures-State-Impact-responses - DPSIR) in Andalusia (Spain).
- Scenario analysis based on multi-criteria decision making in order to assess the impacts of different policies on social indicators in Macedonia and Thrace (Greece), Andalusia (Spain), South East Planning Region (Bulgaria).
- New institutional economics to represent connections between different households and different issues in North East Scotland (United Kingdom), Noord-Holland (Netherlands), South-East Planning Region (Bulgaria), and Centre (France).

A summary of methods used, including elaboration on survey A and in-depth analysis is given in Table 2.

Table 2– Synthesis of methods used by thematic WPs (survey A and in-depth)

WP	Methodology	Policy issue	1. Emilia-Romagna (Italy)	2. Noord-Holland (Netherlands)	3. Macedonia and Thrace (Greece)	4. Podlaskie (Poland)	5. North East of Scotland (UK)	6. Andalusia (Spain)	7. South-East Planning Region (Bulgaria)	8. Centre (France)	9. Midi-Pyrénées (France)	10. Lahn-Dill-District (Germany)	11. Ostprignitz-Ruppin (Germany)	Main data sources
WP3a	Multiple correspondence analysis (MCA) based on household reactions to policies	Classification of farm-households based on thie reaction to policy												Survey A
WP3b	Bayesian Networks	Representing multiple interconnections among thematic issue and explaining reaction to policy change												Survey A
WP4a1	Econometric model (logit and multinomial logit)	Analysis of determinant of structural change and reaction to policy change												Survey A
WP4a2	Econometric model (logit and multinomial logit)	Analysis of determinants of farm-houshold innovation and reaction to policy change												Survey A
WP4b	Real Option model implemented throuigh mathematical programming	Simulating the impact of policy scenarios and uncertainty on technology adoption at the farm-household level	X	X		X			x		X			Additional survey and secondary data
WP5a	Descriptive statistical analysis	Tendency of direct links between farm households and other economic agents, and the role of the CAP												Survey A
WP5b1	SAM-based analysis	Capture linkages between farm household and the regional economy, and understand the effects of different policy scenarios					X							Additional survey and secondary data
WP5b2	Spatial tracking analysis	Understanding the spatial connections of farm-households				X	X							Additional survey and secondary data
WP6a	Econometric analysis	Understanding the environmental effects of the CAP compared to the no-CAP scenario												Survey A
WP6b	Indicator based analysis (DPSIR)	Describing and quantify interconenctions between th CAP and environmental variables in sepected case study areas			X			X		X			X	Additional survey and secondary data
WP7a		Multivariate techniques for grouping and classification of households according to different polices using the social indicators specified above												Survey A
WP7b	Multicriteriamathematical programming models	Analisis of the effects of different policy scenarios on basic social indicators at the farm-household level			X			X	X					Additional survey and secondary data
WP9a	Econometric techniques	Analyse the role of networks and governance structure in farm-households resilience												Survey A
WP9b	New institutional economics-based stakeholder meetings	Represent connections between different households through governance mechanisms		X					X	X				Additional survey and secondary data
WP9c	Dynamic model of structural change in the dairy sector	Representing sectors' structural adapatation to changes in the policy context		X			X		X	X				Additional survey and secondary data

2.5 Stakeholder interaction

The project has been based on a strong dialogue with stakeholders by means of an Advisory Board (14 members) and a Local Participatory Network in each case study area (involving about 100 participants altogether). These stakeholders played a key role in shaping research questions, interpreting the results and deriving policy implications.

LPNs met three times during the project life:

1. at the beginning to discuss project settings and specific research priorities in each area;
2. half way during the project to discuss preliminary results;
3. at the end of the project to discuss final results and provide dissemination through a final conference in each area.

The advisory board was consulted four times:

1. through a questionnaire about future challenges and research priorities at the beginning of the project;
2. at the starting of the empirical part, to discuss the methods and clarify targeted research questions;
3. half way during the project, in the occasion of a meeting with the commission services, to discuss preliminary results;
4. at the end to discuss final results and policy implications, and provide dissemination through a final conference.

2.6 Main limitations

In spite of the large territorial and numerical coverage the sample used for the wide survey A cannot be claimed to be representative of Europe or even of the selected regions, though in most of the cases it could be expected to be representative of the beneficiaries of the CAP payments, based on the sampling methods used.

Some potential limitations related to survey A also apply to: a) the way the interview was made, which could be amenable of raising strategic answers; b) the timing of the survey, that was carried out at the end of a period of big instability of agricultural prices and after the breakthrough of the financial crisis. Perceptions about the future could have been affected by such specific conditions.

However, the sampling method can be considered the most consistent allowed by the resources of the project

The credibility of the main messages has been validated through a round of local LPN meeting and is expected to be rather robust.

Detailed insights coming from in depth analysis, though strengthened by the use of rigorous methods and internal reviewing, are mainly addressing specific case study areas, so conclusions should be taken as well documented examples rather than generalised views on EU rural areas.

3 SINTHESIS OF SURVEY A AND THEMATIC ANALYSES

3.1 Synthesis of survey A results

A summary of survey A results under baseline and no-CAP scenario is provided in Table 3.

Table 3 – Summary of survey A results under Baseline and no-CAP scenario

Variable (up to 2020)	Baseline	No-CAP	Difference (No-CAP-Baseline)
Percentage of farm households that would continue farming	76%	45%	-30%
Share of land operated by those exiting farming	7%	31%	23%
Percentage of those exiting that would sell the farm	31%	40%	8%
Percentage of those continuing that…			
would increase household labour on farm	22%	19%	-4%
would increase non-household labour on farm	21%	15%	-5%
would increase owned land	27%	19%	-8%
would increase land rent in	29%	19%	-9%
would increase the number of animal (only farms with animals)	44%	31%	-13%
would increase other activities	15%	18%	3%
would increase the use of fertilisers and pesticides	12%	10%	-2%
wold increase farm endowment of machinery	32%	15%	-17%
would increase the use of credit	16%	25%	10%
would change who they sell their product to	14%	14%	0%
would increase the production under contract	17%	14%	-4%
change the legal status of the farm	9%	8%	-1%
adopt robotization/precision farming innovation	14%	9%	-4%
adopt energy/energy crop innovation	22%	19%	-3%
adopt e-commerce innovation	8%	10%	2%

Data source: Survey A, 2363 observations, all CSAs

The main figures show the relevance of the CAP to support continuation of farming. Against a tendency to a further reduction of the number of farms in the baseline (-25%) the removal of the CAP would bring an exit of further 30% of the farms. In addition, while the farms exiting in the baseline represent a negligible share of the sample in terms of land (7%) and labour, the farms that would leave if the CAP was removed would account for about 30% of both land and labour. Land reallocation would occur mainly through selling (growing in the no CAP scenario) and renting out.

As for the other parameters, the majority of farms that would continue would have no change (50 to 80% in most cases). A relevant share would show increases, with a rather different amount in the baseline (the most frequent is machinery endowment and land renting-in, letting alone increase in animal reared, which is however emphasised by the fact that the total is represented by livestock farms only).

Lower changes in the baseline concern innovation adoption and changes in legal status.

The removal of the CAP would have most frequently a negative effect on the willingness of increasing the selected parameter by those staying in farming. The most relevant effects are related to machinery endowment and animal rearing. On the contrary for “increase in the use of credit”, “involvement in other activities” and “adoption of e-commerce” would apply to a higher share of remaining farms if the CAP was removed.

Altogether, the contribution to avoid exists seems to be the main role of the CAP; however, it also reveals non-neutral with respect with farm selection and changes.

3.2 Synthesis of thematic analyses: determinants and scenarios outcomes

An analysis of determinants of different farm reactions is provided in Table 4.

The table shows as a number of classical variables (age, farm size, etc.) remain key determinants of the studied behaviour. Age and farm size are particularly important for exits, while structural adaptation and organisational variables seem to be more affected by a variety of determinants. It is relevant to note that location, particularly with reference to Easter Europe has a major role in structural change, innovation and environmental issues.

Table 4 – Analysis of determinants from thematic WPs

Dependent variable	Model type	Data source	Others	Baseline		No-CAP		Differential effect	
				Positive effect	Negative effect	Positive effect	Negative effect	Positive effect	Negative effect
Decision to Exit (1)	Logit	Survey A	WP3	Age Land rent out	Advisory services Sell to private Land owned Live on farm N. Household members Part time	Age Land rent out SFP per farm Sell to other farms	Land owned Land rent-in Live on farm N. Household members Percent of hh income from farming		
Resilience (Decision to continue if the CAP is removed) (2)	Binary Logit							Percent of farmland rent-in Income from farming >50% Specialisation in crops IT, NL, Po, Uk, BG, France (Midì-Pyreneés	Percentage of part-time labour Single farm payment per hectare Age
Number of changes (2)	Count model							Percentage of farmland rent-in Household number Membership of social organisations membership of farmers union Higher eductaion Speciailsed	Percentage of part-time labour Age IT, GR

								livestock NL, BG	
Land increasing effect (3)	Multinomial logit	Survey A	WP4					Hh full time more than 2 Permanent crops SFP payment	Hh full time UAA less than 10ha
Land Decreasing effect (3)	Multinomial logit	Survey A	WP4					Size more than 50ha Rent in land Field crops Permanent crops Grazing livestock Mixed crops Eastern EU	Plain UAA less than 10ha
Labour increasing effect (3)	Multinomial logit	Survey A	WP4					Mixed crop livestock SFP/ha Farm income more than 50%	Hh full time Less than 10ha UAA North Europe Low education level
Labour decreasing effect (3)	Multinomial logit	Survey A	WP4					Hh full time Rent in land Field crops Permanent crops Grazing livestock Mixed crops Rent in of land from relatives	Livestock dairy more than 50 heads Mediterranean Low education level
Capital (without livestock) increasing effect (3)	Multinomial logit	Survey A	WP4						Less than 10 UAA Grazing livestock

Capital (without livestock) decreasing effect (3)	Multinomial logit	Survey A	WP4					More than 100 UAA Centre EU Eastern EU Advisory system Sell to private Sell to coop house 18	Less than 10 UAA
Capital (with livestock) increasing effect (3)	Multinomial logit	Survey A	WP4					Sell through contracts	Ln of age
Capital (with livestock) decreasing effect (3)	Multinomial logit	Survey A	WP4					n. full time equivalent UAA house 18	Age more than 60 Presence of unemployed SFP payment1000e Centre EU
Number of innovations (3)	Zero inflated multinomial logit	Survey A	WP4	Plain Hill full_time_equ UAA_more50 Unemploy_c pay_sfp_1000e Med Education level high Rent in land form relatives hh_partitme ln_age	Less 10 ha UAA cows grazing_livestock Ln_age Eastern EU f_inco_more50	Full time eqtuivalent Ha UAA North EU hh_activity_d advisory_d Sell_contract hh_partitme ln_age edu_level_low	Less than 10 ha UAA grazing_livestock mixed_crop_livestock mixed_livestock ln_age Eastern EU f_inco_more50		
Probability of purchasing fertilisers	Probit	Spatial tracking survey Scotland	WP5	Attachment to locality Nearest_city	No. of Retired				

locally (4)									
Probability of purchasing fertilisers locally (4)	Probit	Spatial tracking survey Podlaskie	Wp5	Attachment to locality Off farm work Mixed farms					
Intended increase in the use of agro-chemicals (5)	logit	Survey A (invariant behaviour)	WP6					Location (BG)	
Intended increase in the use of agro-chemicals (5)	logit	Survey A (invariant behaviour)	WP6					Agri-environmental mesasures Farmes' union No land owned	
Decrease chemical use (5)	logit	Survey A	WP6					Owned land	G_Revenue (<10%) Age_groups (covariate) [Organ_prod=Yes]
Decrease water use (5)	logit	Survey A	WP6					LFA (No) Region_code (Only Bulgaria)	Age (covariate) Owned Land (No)
Invariant behaviour in animal rearing (5)	logit	Survey A	WP6					Age (41-65) SFP_group (covariate)	Land_group (covariate) specialist (crops & grazing)
Change in animal	logit	Survey A	WP6						

rearing (5)									

Sources: (1)Mishra et al., 2010; (2) Polman et al., 2010 (3)Bartolini et al., 2010; (4) Roberts et al., 2010; (5) Giannoccaro adn Berbel, 2010

For innovation adoption, together with farmer's age and farm size, an important role is played by farm specialisation, farmers' level of education, the amount of labour used on farm and use of technical advice.

Input purchasing decisions see a lower number of significant variables and appearing variables more connected to individual attitudes, with a dominant role of attachment to locality.

Changes in the of chemicals and other environmental parameters seems to be usefully explained in relation to the technology adopted (agri-environmental schemes, organic) and location, together with other recurring variables, such as farm size and farmer's age.

Results from scenario simulation are summarised in Table 5.

Table 5 – Summary of scenarios simulations

	Case	**Baseline**	**No-CAP**	**Subsidiarity (regionalisation)**	**Environment**
Structural change and innovation (WP4)(1)	Real option models simulating adoption of Methane digester in Emilia Romagna (IT),	No adoption	No adoption	No adoption	% adoption 2009-2013+4% adoption 2014-2020
	No-tillage techniques in Midi-Pyrénées (France),	50% adoption 2009-2013+13% adoption 2014-2020	50% adoption 2009-2013+0% adoption 2014-2020	50% adoption 2009-2013+0% adoption 2014-2020	50% adoption 2009-2013+0% adoption 2014-2020
	Concentration in livestock and robotisation in dairy farm Podlaskie (Poland),	No adoption	No adoption	0% adoption 2009-2013+1% adoption 2014-2020	0% adoption 2009-2013+12% adoption 2014-2020
	Robotisation in dairy farm in Noord-Holland (Netherlands),	48% adoption 2009-2013+48% adoption 2014-2020	73% adoption 2009-2013+23% adoption 2014-2020	23% adoption 2009-2013+72% adoption 2014-2020	33% adoption 2009-2013+65% adoption 2014-2020
	Hygienic and veterinary standards for livestock breeding in South-East Planning Region (Bulgaria)	100% adoption 2009-2013	100% adoption 2009-2013	100% adoption 2009-2013	100% adoption 2009-2013
Chain interaction (WP5) (2)	SAM in North-East Scotland	Output=-0.11%; Regional GDP=-0,09%; Agr. Output=-3.13-5.81%; higher negative effects on livestock and large farms; output sel. non-farm sector= -0,04-0,41%	Output=-0.32%; Regional GDP=-0,26%; Agr. Output=-6,26-18,62%; higher negative effects on livestock and large farms; output sel. non-farm sector= -0,10-1,11%	Output=-0.22% Regional GDP=-0,20% ; Agr. Output=-4,70-12,22%; higher negative effects on livestock and large farms; output sel. non-farm sector=-0,07-0,76%	Output=-0.28% Regional GDP=-0,25%; Agr. Output=-5,16-16,22%; higher negative effects on livestock and large farms; output sel. non-farm sector=-0,10-0,55%
Environmental	DPSIR framework	% of farm area	% of farm area		

sustainability (WP6) (3)	in Andalucia	decreasing fertilisers and pesticides use=11,55%, % of farm area decreasing water use=0,5%, % of land cultivated with organic farming=12,4	decreasing fertilisers and pesticides use=25%, % of farm area decreasing water use=10,5%, % of land cultivated with organic farming=4,96%		
Social sustainability (WP7) (4)	Multicriteria decision making models Greek farm households	Labour use=-2,5% to +3,5%; income=-1,6% to +3,8%	Labour use= -11,9% to -2,5%; income= -40,5% to -3,9%	Labour use=-3,8% to -1,1%; income= -3% to -0,4%	Labour use= -6,9 to -2,2%; income= -4,1% to 0%
	Spanish farm households	Labour use = -1,7% to 0%; income= -0,2% to +2,9%	Labour use= -14,7% to +3,2%; income= -49,6% to -28,3%	Labour use= -4,9% to 0%; income= -17,4% to -7,4%	Labour use= -9,5% to +3%; income= -28,2% to -13,9%
	Bulgarian farm households	Labour use= -2,2% to +0,5%; income= -2,9% to +0,8%	Labour use= -3,6% to -1,6%; income= -43,5% to -33,4%	Labour use= -2,5% to 0% ; income= -14,8% to -12,5%	Labour use= -2,8% to -0,9%; income= -25,4% to -20,7%
Governance (WP9) (5)	The Netherlands dairy sector	Number of farms= -27,7%;Total production=+15,1%			
	France dairy sector	Number of farms= -47,4%;Total production=+0%			
	Bulgaria dairy sector	Number of farms= -75,6%;Total production=-5,0%			
	Scotland dairy sector	Number of farms= --38%;Total production=+0%			

Sources: (1)Bartolini et al., 2010; (2) Roberts et al., 2010; (3) Giannoccaro adn Berbel, 2010; (4)Manos et al., 2010; (5) Polman et al., 2010

These results derive from four thematic areas of the project: structural change and innovation, chain effects, environmental sustainability and social sustainability. For the second and fourth thematic area, results are directly expressed as changes compared to the status quo which makes more evident that also the Baseline scenario implies changes compared to the status quo.

All other scenarios would have more relevant, and generally negative effects compared to the baseline, although scenarios show a very differentiated effect with respect to different issues.

The liberalization=NO CAP scenario would have by far the worst impact on all parameters, with the only exception of some earlier adoption of innovation connected to the attempt to benefit of CAP payments while they are still in place. Otherwise negative effects can be witnessed in regional economy (drop of GDP and output), social and economic parameters at farm level (labour and income). The impact on environmental situation appears as more contrasted, with a reduction in the use of

polluting input on the one hand, but also the drop of organic production and likely of agri-environmental practices.

The two remaining scenarios are closer to the baseline as farm level adaptation is concerned, but are rather closer to the Liberalization scenario if the effects on the whole economy are considered.

4 CROSS-THEMATIC TYPOLOGIES AND REPRESENTATION OF INTERCONNECTIONS

4.1 OBJECTIVES AND APPROACH

The main objective of this section is to provide a quantitative synthesis of the work carried out in the project by responding to the objective of WP3 using information derived through survey A.

In particular we use survey A data in order to respond to two main questions:

a) Is it possible to identify farm-household typologies based on their reaction to policy changes and considering the full set of thematic issues addressed in the project? What would be the resulting categories?

b) How can the linkages between different thematic components (in terms of status quo, tendency and policy effect) be represented? What would be the main policy relevant connections?

In the following we address these two questions using two distinct methods: Multiple Correspondence Analysis (MCA) plus cluster analysis to address question a); Bayesian Networks to address question b).

4.2 MCA and CLUSTER analysis

In this section, we identify farm/farm-household typologies with respect to stated intentions in the two policy scenarios (baseline and no-CAP), and, as a result, provide a classification of farm/farm-household based on stated reactions to policy.

We first address this issue applying MCA to the information collected through survey A and then formalise the derived classification by applying Cluster analysis on the coordinates generated by the MCA.

The MCA is a suitable tool to address our classification purposes as the outcome of survey A in terms of information about intentions is represented by categorical variables.

Multiple Correspondence Analysis is a descriptive/exploratory technique designed to analyze multi-way tables containing some measure of correspondence between the rows and columns. The results provide information which is similar in nature to those produced by Factor Analysis techniques. The result is an identification of a new space which shows the relationships between the modalities for each variable in terms of distance. The distance detects the variability concept both between the modalities and between the observations (DeLillo et al. 2007, AA.VV 2006). When in the new space the modalities or the observations plotted are close (far) then the modalities or the observations present homogeneity (heterogeneity).

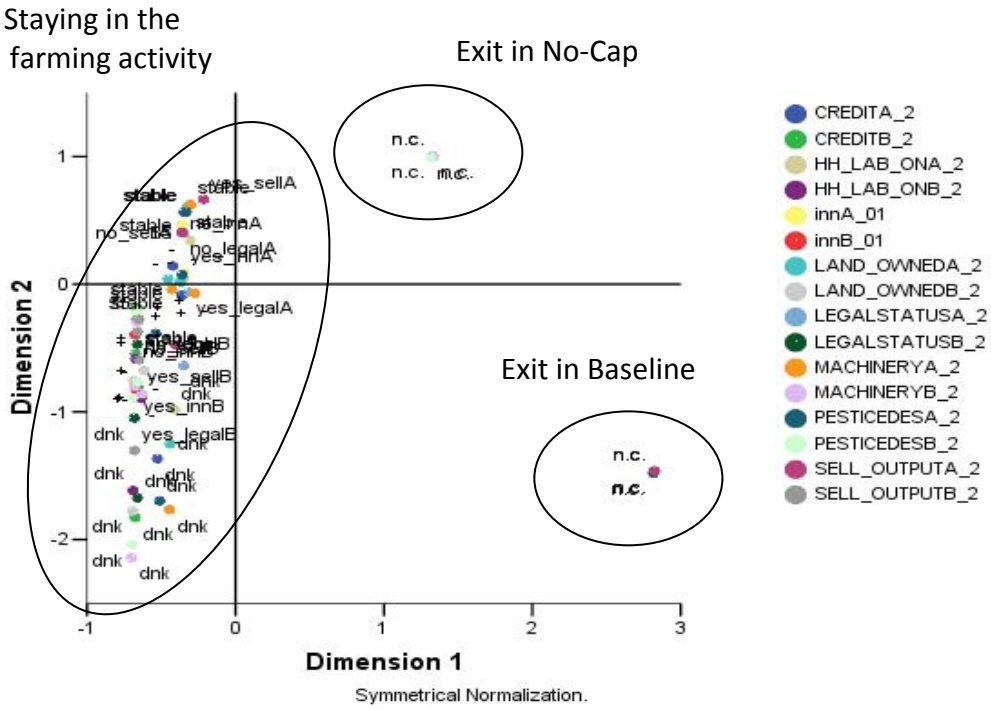
In the Table 6 the variables used in the analysis are reported. The intention of this part of the work is to consider jointly those variables that are relevant for the other WPs (WPs 4-9) in the two policy scenarios.

Table 6 – Questions used in the MCA analysis

Question	Label
4.06	Household labour used on farm
4.07	Household labour off farm
4.08	Non-household labour used on farm
4.09	Owned land
4.10	Land rented-in
4.11	Land rented-out
4.14	Use of pesticides and fertilizers in the farm
4.15	Use of water in the farm
4.16	Building
4.17	Farm endowment of machinery
4.19	Use of credits for the farm
4.20	Would you change who you sell your output to?
4.22	Production under contract
4.23	Would the legal status of your holding change?
4.26	Presence of at least one the innovation

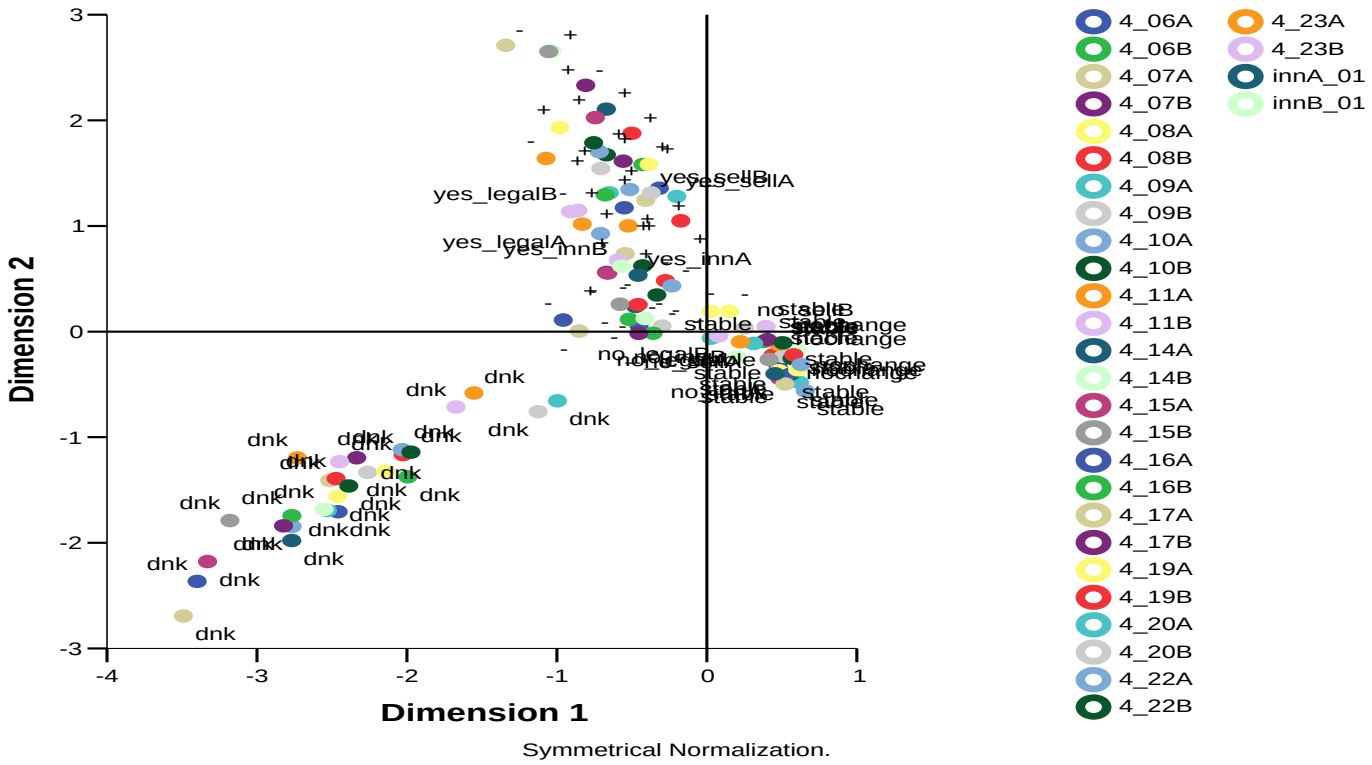
The first approach of the analysis is to consider all observations including those related to farms willing to exit in the No-CAP scenario or even in the Baseline scenario. The analysis was conducted using a symmetrical normalization in a bi-dimensional space, then the categories of the variables are plotted in a new space. As expected, in the new space, the group of those quitting in Baseline, those quitting in No-Cap and those staying in farming are well separated and identified (Figure 2).

Figure 2 – MCA results for the selected variables in Baseline and No-Cap scenario considering all records.



The main interest of the analysis is to better investigate the behaviour of those having intentions to stay in farming at least in the baseline scenarios. This has been achieved conducting a MCA using a symmetrical normalization in a bi-dimensional space over both those staying in Baseline and in No-Cap scenario (Figure 3).

Figure 3 – MCA results for the selected variables in Baseline and No-Cap scenario



. Graphically, Figure 3 presents the identification of three main groups arising from the analysis: those deciding to have no change, those mostly stating to not knowing and those mainly deciding to change (increase or decrease, also depending on the concerned variables).

The outcome of this classification basically isolates a group of those willing to change. However, this is likely a very heterogeneous group in terms of reaction to policy and background explanatory variables. For a better investigation of the MCA results, casting light on the internal composition of the group, a k-means cluster analysis is applied.

Five groups (farm-household typologies) were chosen and identified. In Table 7 the final cluster centers are reported and they represent the center of mass of the cluster considering the scores associated in the new space dimensions . Observing the position of the cluster in the MCA space, it is possible to interpret cluster 1 as the group of those having no intention to change, cluster 2 as the group of those who do not know (dnk) together with those having no intention to change, cluster 3 as the group of those that have intention to increase, cluster 4 as the group of those have intention to increase together with those having no intention to change and cluster 5 as the group of those who do not know. Those having an intention to decrease are not concentrate in only one clusters and this is checked observing how the category decrease of the MCA variables is uniformly distributed between the clusters.

Table 7 - Final Cluster Centers and cluster definition

	Cluster				
	1 Stable	2 Stable/ Dnk	3 Increase	4 Stable/ Increase	5 Dnk
Object scores dim 1	0.60	-0.95	-0.71	-0.07	-3.31
Object scores dim 2	-0.35	-0.59	1.86	0.54	-2.16

In Table 8 the number of observations in each cluster is shown. In agreement to the answers, the majority of the observations belong to the cluster “1 Stable” while cluster “5 Dnk” is the smaller. In the analysis the missing observations are 370 that represent the group of those have intention to quit the farming activity in both scenarios and that cannot enter in the analysis.

Table 8 - Number of Cases in each Cluster

Cluster	N. of obs
1 Stable	970
2 Stable/Dnk	304
3 Increase	146
4 Stable/Increase	542
5 Dnk	31
Total	1993

In the following we review and discuss the composition of each cluster according with the main descriptive variables available from the survey, in order to characterise the main farm typologies identified.

Due to the size of cluster "1 Stable", it includes, generally, the largest share of farm-households by country. The other clusters are smaller and the distribution of the farm-household appears more differentiated between country (Table 9).

Table 9 - Distribution of farm household in the clusters (number of)

	CLUSTER					
	1 Stable	**2 Stable/ Dnk**	**3 Increase**	**4 Stable/ Increase**	**5 Dnk**	**Total**
IT	154	59	4	36	3	256
NL	36	61	11	85	4	197
GR	231	9	0	33	0	273
PL	172	0	2	66	0	240
UK	93	35	1	28	1	158
ES	97	12	4	39	4	156
BG	16	25	91	98	2	232
FR1	31	27	8	47	9	122
FR2	50	34	2	36	6	128
DE1	41	20	5	24	2	92
DE2	49	22	18	50	0	139
Tot	970	304	146	542	31	1993

The farm-households distribution by country is shown in Table 10 and by cluster in Table 11. Distribution by country shows that all countries have a major concentration on the cluster "1 Stable" and in particular Greece and Poland, while in Bulgaria and in The Netherlands the farm households are concentrated in two different clusters "3 Increase" and "4 Stable/Increase".

Table 10 – Conditional percentage distribution of farm household by country

	CLUSTER					
	1 Stable	**2 Stable/ Dnk**	**3 Increase**	**4 Stable/ Increase**	**5 Dnk**	**Total**
IT	60.16	23.05	1.56	14.06	1.17	100.00
NL	18.27	30.96	5.58	43.15	2.03	100.00
GR	84.62	3.30	0.00	12.09	0.00	100.00
PL	71.67	0.00	0.83	27.50	0.00	100.00
UK	58.86	22.15	0.63	17.72	0.63	100.00
ES	62.18	7.69	2.56	25.00	2.56	100.00
BG	6.90	10.78	39.22	42.24	0.86	100.00
FR1	25.41	22.13	6.56	38.52	7.38	100.00
FR2	39.06	26.56	1.56	28.13	4.69	100.00
DE1	44.57	21.74	5.43	26.09	2.17	100.00

DE2	35.25	15.83	12.95	35.97	0.00	100.00

The distribution by cluster shows that the cluster of "1 Stable" mostly contains farm-households from GR, PL, IT and ES; the cluster of "2 Stable/Dnk" mostly contains farm-households from NL and IT, cluster "3 Increase" mostly contains farm-households from BG and DE2, cluster "4 Stable/Increase" contains farm-households from BG, NL and PL, and the last cluster "5 Dnk" does not contain farm-household from GR, PL and DE2.

Table 11 – Conditional percentage distribution of farm household by cluster

	CLUSTER				
	1 Stable	**2 Stable/ Dnk**	**3 Increase**	**4 Stable/ Increase**	**5 Dnk**
IT	15.88	19.41	2.74	6.64	9.68
NL	3.71	20.07	7.53	15.68	12.90
GR	23.81	2.96	0.00	6.09	0.00
PL	17.73	0.00	1.37	12.18	0.00
UK	9.59	11.51	0.68	5.17	3.23
ES	10.00	3.95	2.74	7.20	12.90
BG	1.65	8.22	62.33	18.08	6.45
FR1	3.20	8.88	5.48	8.67	29.03
FR2	5.15	11.18	1.37	6.64	19.35
DE1	4.23	6.58	3.42	4.43	6.45
DE2	5.05	7.24	12.33	9.23	0.00
Total	100.00	100.00	100.00	100.00	100.00

In the **Errore. L'origine riferimento non è stata trovata.** the distribution of main specialization is shown, highlighting several differences among clusters. In cluster "1 Stable" there are those having a relevant mixed specialization, while in cluster "3 Increase" and "5 Dnk" the arable specialization is more relevant.

Table 12 – Main specialization by cluster

	CLUSTER				
	1 Stable	**2 Stable/ Dnk**	**3 Increase**	**4 Stable/ Increase**	**5 Dnk**
Arable	26.60	28.62	43.15	26.01	45.16
Permanent	9.18	7.57	3.42	4.80	6.45
Livestock	20.21	31.91	28.08	36.16	22.58
Mixed	42.89	29.28	24.66	31.37	22.58
Not applicable	1.13	2.63	0.68	1.66	3.23
Total	100.00	100.00	100.00	100.00	100.00

In the Table 13 the weight of the income from farm activity over the household income is reported divided by cluster. This parameter is rather distributed in all clusters and reflects the, general important weight of farming income in the sample. In fact, in

each cluster almost the half of farm-household depends more than 70% on the farming activity.

Table 13 – Income from farm by cluster

	CLUSTER				
	1 Stable	2 Stable/ Dnk	3 Increase	4 Stable/ Increase	5 Dnk
less than 10%	13.85	11.23	5.56	4.67	10.34
10 -29%	9.41	14.04	6.94	7.66	13.79
30-49%	9.41	9.82	15.97	13.46	3.45
50-69%	13.95	16.49	15.97	18.50	13.79
70-89%	15.86	15.44	15.28	16.26	10.34
more than 89%	37.53	32.98	40.28	39.44	48.28
Total	100.00	100.00	100.00	100.00	100.00

In Table 14 the participation to groups and associations is showed. The distribution within the cluster is different for each group category. About the participation to sport group, those that are in tendency "2 Stable/Dnk", "4 Stable/Increase" or "5 Dnk" have a larger frequency than the other clusters. The majority of the clusters has a high participation to farmers group, except for the cluster "3 Increase". The environmental groups show a low participation by farmers in all clusters.

Table 14 – Participation to other group by cluster

		CLUSTER				
		1 Stable	2 Stable/ Dnk	3 Increase	4 Stable/ Increase	5 Dnk
sport group	yes	25.29	42.33	22.38	40.75	58.06
	no	74.71	57.67	76.22	58.69	41.94
	do not know	0.00	0.00	1.40	0.56	0.00
	Total	100.00	100.00	100.00	100.00	100.00
farmers group	yes	51.89	68.33	40.97	57.20	74.19
	no	48.11	31.67	59.03	42.43	25.81
	do not know	0.00	0.00	0.00	0.37	0.00
	Total	100.00	100.00	100.00	100.00	100.00
environment group	yes	5.05	13.33	8.39	11.05	16.13
	no	94.95	86.67	90.21	88.39	83.87
	do not know	0.00	0.00	1.40	0.56	0.00
	Total	100.00	100.00	100.00	100.00	100.00

In the Table 15 the distribution of place of living of households by cluster is reported and, except for the cluster "1 Stable", the other groups present a larger share of those living on farm.

Table 15 – Live on farm by cluster

	CLUSTER

	1 Stable	2 Stable/ Dnk	3 Increase	4 Stable/ Increase	5 Dnk
yes	59.07	72.28	59.72	68.72	67.74
no	40.93	27.72	40.28	31.28	32.26
Total	100.00	100.00	100.00	100.00	100.00

The family member distribution shows only small differences between the clusters (Table 16) but the average age of the owner is different. As expected the younger owner belongs to the group of "3 Increase", "4 Stable/Increase" or "5 Dnk" while the older are those staying in the clusters of "1 Stable" or "2 Stable/Dnk".

Table 16 – Family characteristic by cluster

	CLUSTER				
	1 Stable	2 Stable/ Dnk	3 Increase	4 Stable/ Increase	5 Dnk
Number of male	1.88	1.85	1.78	1.99	1.77
Number of female	1.79	1.54	1.61	1.76	1.23
Number of young	0.78	1.00	0.69	1.09	0.53
Numbver of old	0.55	0.41	0.22	0.36	0.30
Age	49.10	50.75	42.47	44.04	44.19

In Table 17, the dimension of the farms are presented divided by land rent-out, land rent-in, land owned and total land. The cluster "3 Increase" has on average a larger size of total land (187ha), determined to a large extent by the land rented-in (143ha), that is consistent with the hypothesis that this group is the most active and willing to expand. The cluster "1 Stable" has the lower farm size dimension (69ha) and the dimension of land rented-in is the lower than the other clusters.

In the Table 17 SFP per ha and per farm are also presented. The amount of the SFPs is different between the cluster, with the cluster "1 Stable" having the higher SFP per ha (531€/ha) but the lower SFP per farm.

Table 17 – Land (average) and SFP by cluster

	CLUSTER				
	1 Stable	2 Stable/ Dnk	3 Increase	4 Stable/ Increase	5 Dnk
Rent-out	2.10	2.80	0.74	2.14	0.45
Rent-in	32.51	55.25	143.66	85.58	45.68
Owned	41.03	58.11	43.34	64.79	58.61
Total land	68.97	110.58	187.36	147.91	103.85
SFP per ha	531.45	297.50	350.41	347.61	377.69
SFP per farm	14114.02	29612.12	22838.27	33198.59	19058.65

In the Table 18 several education characteristics are presented. The owners educational level distribution is similar between the clusters even if there are some differences e.g. the cluster "1 Stable" presents a higher concentration on the lower

educational levels. The majority of the owners has an agricultural education in all clusters. The majority (in all clusters more than 50%) of the owners has a specific agri-education. About the higher educational level in household is the upper secondary in all clusters except for the "5 Dnk" group that has a post-secondary non-tertiary education.

Table 18 – Educational level by cluster

		CLUSTER				
		1 Stable	2 Stable/ Dnk	3 Increase	4 Stable/ Increase	5 Dnk
Educational level of the owner	None an primary	21.09	11.71	2.07	5.59	6.45
	Lower and secondary	23.49	19.06	6.90	11.92	19.35
	Upper secondary education	34.86	28.09	52.41	37.06	35.48
	Post-secondary non-tertiary education	12.63	28.09	14.48	28.31	29.03
	First stage of tertiary education	7.72	12.04	24.14	16.57	9.68
	Second stage of tertiary education (PhD)	0.21	1.00	0.00	0.56	0.00
	Total	100.00	100.00	100.00	100.00	100.00
Agri-education	Yes	53.57	58.80	57.53	69.13	70.00
	No	46.43	41.20	42.47	30.87	30.00
	Total	100.00	100.00	100.00	100.00	100.00
Higher Educational level in household	None an primary	6.10	4.01	2.05	1.48	0.00
	Lower and secondary	9.00	10.03	4.11	3.88	10.00
	Upper secondary education	39.50	33.11	41.10	34.75	30.00
	Post-secondary non-tertiary education	20.17	31.10	19.18	29.57	40.00
	First stage of tertiary education	24.30	20.40	33.56	29.39	20.00
	Second stage of tertiary education (PhD)	0.93	1.34	0.00	0.92	0.00
	Total	100.00	100.00	100.00	100.00	100.00

In Table 19 the presence of agri-environmental schemes (AES) and organic production by clusters is reported. Only a low share of farms in the clusters adopts the AES, except for the "5 Dnk" cluster (51% of yes). The organic production is not frequent in all cluster but more than 10% of "1 Stable" and "4 Stable/Increase" are involved in such type of production.

Table 19 – AES and organic production by cluster

		CLUSTER				
		1 Stable	2 Stable/ Dnk	3 Increase	4 Stable/ Increase	5 Dnk
Presence of AES	Yes	22.76	37.12	23.97	33.02	51.72
	No	77.24	62.88	76.03	66.98	48.28
	Total	100.00	100.00	100.00	100.00	100.00
Organic production	Yes	12.80	8.58	6.21	10.43	6.45
	No	87.20	91.42	93.79	89.57	93.55

	Total	100.00	100.00	100.00	100.00	100.00

The use of internet for buying and/or selling (Table 20) presents relevant differences between clusters. Considering the input purchasing activity, only a small part of the cluster "1 Stable" (less than 10%) uses internet, while the other clusters show a much higher frequency of use (e.g. 26% for the group of "3 Increase"). Considering the selling, the group of "1 Stable" and "2 Stable/Dnk" are not frequent to sell (around 5%), but for the others this activity seems to gain more importance (e.g. 20% for the group of "3 Increase").

Table 20 – Use of internet by cluster

		CLUSTER				
		1 Stable	**2 Stable/ Dnk**	**3 Increase**	**4 Stable/ Increase**	**5 Dnk**
Use of internet to buy	Yes	9.38	18.87	26.39	29.21	25.81
	no	90.62	81.13	73.61	70.79	74.19
	Total	100.00	100.00	100.00	100.00	100.00
Use of internet to sell	yes	4.23	5.32	20.28	15.98	9.68
	no	95.77	94.68	79.72	84.02	90.32
	Total	100.00	100.00	100.00	100.00	100.00

4.3 Bayesian Networks (BNs)

The aim of this part is to respond to the aim to analyze the interconnections among WPs4-9 issues and to connect socio-economic (household) development and rural typologies based on the joint analysis of CAP, territorial and human interaction. We approach this issue here again based on stated intentions about future household and farm developments collected through survey A. In view of this aim, the main problems about an integrated analysis of the stated intention across the European countries can be grouped as follows: i) non-linear relation between variables, ii) too many variables should be consider in the analysis with respect to the dimension of available data, iii) high correlation among variables and multiple outcomes are to be taken into account to understand the process.

We try to manage these problems using the Bayesian networks tool. Bayesian networks were developed mostly in the last few decades. In particular, the last decade of the 20th century saw an improvement in instruments for learning Bayesian networks from data. From the first development in artificial intelligence field (NASA, NOKIA software applications), Bayesian networks are increasingly being used for issues in very different areas of research. Fields of applications regard sociology (Rhodes, 2006), medical diagnosis (Beinlich, 1989; Long, 1989) and environmental aspects (Marcot et al., 2006).

The methodology used in this work is based on Bayesian Networks (BNs) which "...capture the believed relation between a set of variables which are relevant to some problem" (Netica™). BNs are a graphical tools and they are defined as "Direct Acyclic Graphs (DAGs) where the nodes are random variables and certain independence assumption hold" (Charniak 1991). The BNs method offers some interesting advantages: a) the possibility to use incomplete and small data set avoiding dependence problems between variables because the dependencies are encoded; b) the possibility to learn from data: in fact when the causal relationships are expressed then the model can be used for an explanatory analysis; c) the possibility to combine Bayesian statistical techniques with the domain knowledge and data, so that it is possible to add some prior information that the researcher knows especially when data are insufficient or expensive; and d) the simplicity of interpretation due to the graphical tools Heckerman, 1996).

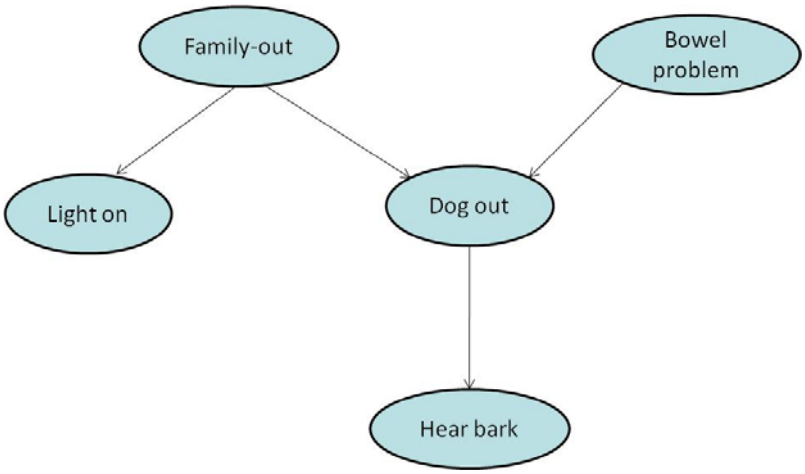
BNs, as the name calls to mind, are based on the Bayesian theorem and on the idea of a conditional dependence. The Bayes theorem permits to obtain the probability for an event B given event A. When the events are dependent, then the probability that event B depends on the event A can be expressed as:

$$P(B \mid A) = \frac{P(A \cap B)}{P(A)} = \frac{P(A \mid B)P(B)}{P(A)} \qquad (1)$$

The above relation can be applied in a generalized formulation when we have more than two events. A large number of variables increases the degree of complexity in relationships and the links between variables have to be defined using the principle of the conditional dependence. The conditional dependence consists in a selection of a subset of variables (parents) that influence other variables investigated (child).

In Figure 4, an example of conditional dependences is shown (see Charniak, 1991 for more details). In the figure the circles are called nodes and the arcs represent the dependence connection between the 'parent' and 'child'. A node is called 'parent' because of its influence on node called 'child' The example is important to clarify the idea of modelling a situation in which causality plays a role but where our understanding of what is actually going on is incomplete, so we need to describe things probabilistically. BNs allow to calculate the posterior probability distribution under conditional dependence of the nodes in the network given that the values of the nodes have been observed following the Bayes' rule.

Figure 4 - Example of Bayesian Networks (nodes and parents)



In general, given a set of variable Xi, where i=1,…,N, it is possible to assume that X_i can be dependent on a subset of parents variables pa(X) such that $P(X_i|\ pa(X))$. So pa(X) includes only a specified subset of (X). The reduction to a subset of variables, caused by the conditional dependence relation, implies that the dimension of the model decreases (from the full model considering all the variables) so the inference results easier and simplified. When the complexity of the relationships between variables in a net (N) of data (D) increases (i.e. when the number of links imposed are large) it is not possible to directly apply the Bayes theorem but it is necessary to use the probabilistic inference which calculates the new beliefs for a set of variables, given some data.

The relation that identifies the probability to obtain that net given data is:

$$P(N \mid D) = \frac{P(D \mid N)P(N)}{P(D)} \qquad (2)$$

where P(N) is the prior probability to have that net, P(D) is the probability of data and P(D|N) is the likelihood which represents the probability to observe that data given a net.

The probabilistic inference is the process of finding a posterior distribution, given a prior distribution and observations then the Bayesian nets do probabilistic inference using the belief updating through the data learning (parameters learning).

There are several methods for the parameters learning which determine the Conditional Probability Tables (CPTs[1]) at each node, given the link structures and the data. Algorithms are based on the maximization of the term P(D|N)P(N), which is the same as maximizing its logarithm: log(P(D|N)) + log(P(N)). Since the term P(D) is constant for each net so the posterior probability depends on P(D|N) P(N) as:

$$P(N \mid D) \propto P(D \mid N)P(N) \tag{3}$$

Maximize the likelihood means to find the net which has most likely generated the data. The two terms, for the maximization, are dealing in a different way:

P(N), in this case is considered as if each net was equally likely, so the term can simply be ignored, since it will contribute the same amount for each candidate net;

P(D|N) (or logP(D|N) for simplifying computation) is the term to maximize using an iterative process. Starting with a candidate net and reporting its log-likelihood. Due to the nature of the algorithm the log-likelihood of the new net is always better than the previous then the process is repeated until the log-likelihood numbers are improved enough according to a specified tolerance level.

The result consists in the estimation of the posterior distribution for each variable defined as child. The posterior distribution is estimated considering the data evidence (likelihood).

In the analysis we use some selected variables (Table 21) as parent nodes to investigate what happens in the children nodes (Table 22). In the Table 21 the current characteristics used in the net building are shown. They represent the structural characteristics connected to the farm (as main specialisation, farm size, amount of SFP per ha) and the household (age of owner, education, % of household income derived by the farming activity, if the household lives on farm). In this set of variables also the policy scenario (CAP) and the Country (CSA) are considered.

[1] The CPT is the conditional probability table that reports the conditional probability for each child level given all the possible parents level combinations

Table 21 – Current characteristics used in the BNs

Variable	Label
CSA	Case study areas that identifies the country
HH_FULLTIME_NUMB	Number of household fulltime workers in the farm
AGE_CLASS	Age in class. Young less than 40 years old, adult from 41 to 65 years old and old more than 65 years old
IdAltitude	Location of the farm (plain, hill and mountain)
LIVE_ON_FARM	The household lives on the farm
spec_eurostat	Main specialisation of the farm
LAND_TOT_CLASS	Total land of the farm (owned + rent-in – rent-out)
INCOME_FROM_FARM	Percentage of the farm income over the household income
CAP	Hypothetical policy scenario
RENT	It represent the behaviour of the farmers in the rent land behaviour. It is divided in 4 categories: Both= the farmers both rent-in and rent-out, no_rent= the farmers no rent-in and rent-out, rent-in= only rent-in and rent_out=only rent out.
SFP_HA_CLASS	Amount of the SFP per ha divided in 4 classes
EDU	Educational level of the owner
ADVISORY_ASSISTANT	Use of advisory assistant

In the Table 22 the stated intentions used in the net building are shown. They represent the selected characteristics over which the responds state the intention of changing or not.

Table 22 – Stated intention used in the BNs

Variable	Label
INTENTION	Reaction to the hypothetical policy scenario
CHANGE_LEGAL_STATUS	Changing in the legal status
PESTICIDES	Changing in the use of pesticides
CHANGE_SELLOUTPUTS	Changing who sells output
LAND_OWNED	Changing farm size (land owned)
MACHINERY	Changing machinery
INNOVATION_01	Adoption of at least one innovation
CREDIT	Changing the use of credit
HH_LAB_IN	Changing the household labour on farm

In Figure 5, the net presents the linkages between nodes considering the relations within the current characteristics and between current characteristics and stated intentions. The variables structure depends on the cause-effect relation. The identification of relationships, some of them summerized in Table 4, are as an example:

- node intention that depends on the farm size (land owned and land rent), the percentage of income, age, members number of the family working in the farm, country and the policy scenario;
- node at least one innovation that depends on intention, SFP per ha, educational level, advisory assistant and age;
- node changing the amount of land that depends on intention, farm size, land rent, location of the farm (altitude), SFP per ha, members number of the family working in the farm.

The built net is quite small so it is not clear to see all the relationships between the variables, so the Figure 5 is divided in 3 boxes that try to explain the links. In particular the box 1(Figure 6) shows the relationships between farm characteristics in terms of land, specialisation and location; the box 2 (In the Figure 6 the section of the box 1 is shown. In particular the altitude and the farm size influence the main specialisation, the behaviour respect to the rent depends on the main specialisation, the farm size depends on the location where the household lives and on the income from farm

Figure 7 shows the relationships between farm and household characteristics in terms of amount of SFP per ha, advisory assistant, educational level, members of household working in the farms and age; the box 3 (

In Figure 7 the section of the box 2 is shown. In particular the distribution of the age and of the number of fulltime household members depend on the CSA. The educational level depends on the age and on the CSA. The SFP per ha divided in classes influences a large set of variables (almost all child nodes) presents in the box 3 (Figure 8).

Figure 8.) shows the child nodes and all the relationships imposed in the analysis.

For each hypothetical policy scenario, an unique net exists and it is obtained changing the finding in the parent node called CAP. In fact, in this way it is possible to consider the answers given only in one of the two scenario. In the Figure 5, the net in the Baseline scenario is given.

Figure 5 – Bayesian Network in the Cap sceanario

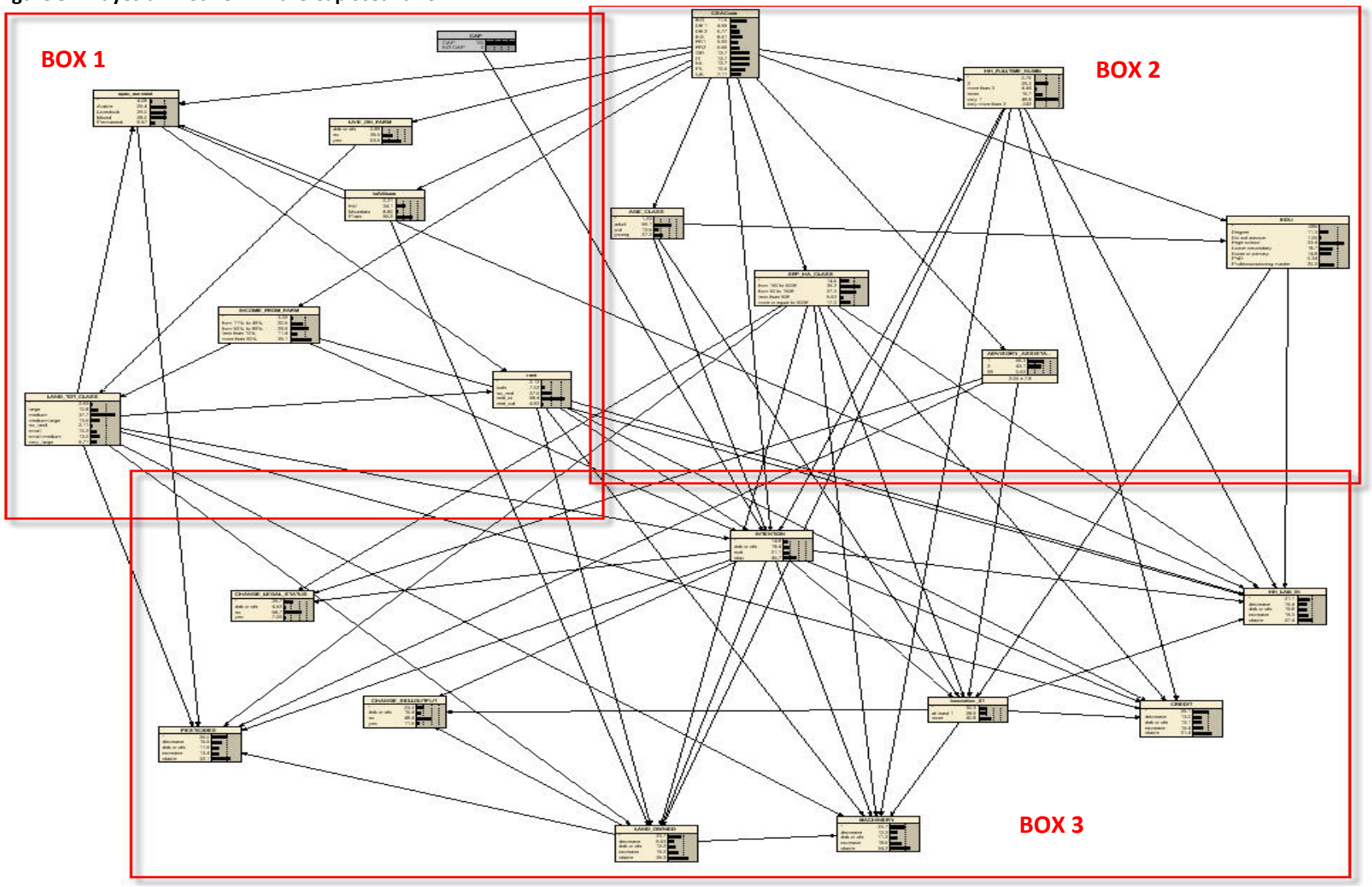
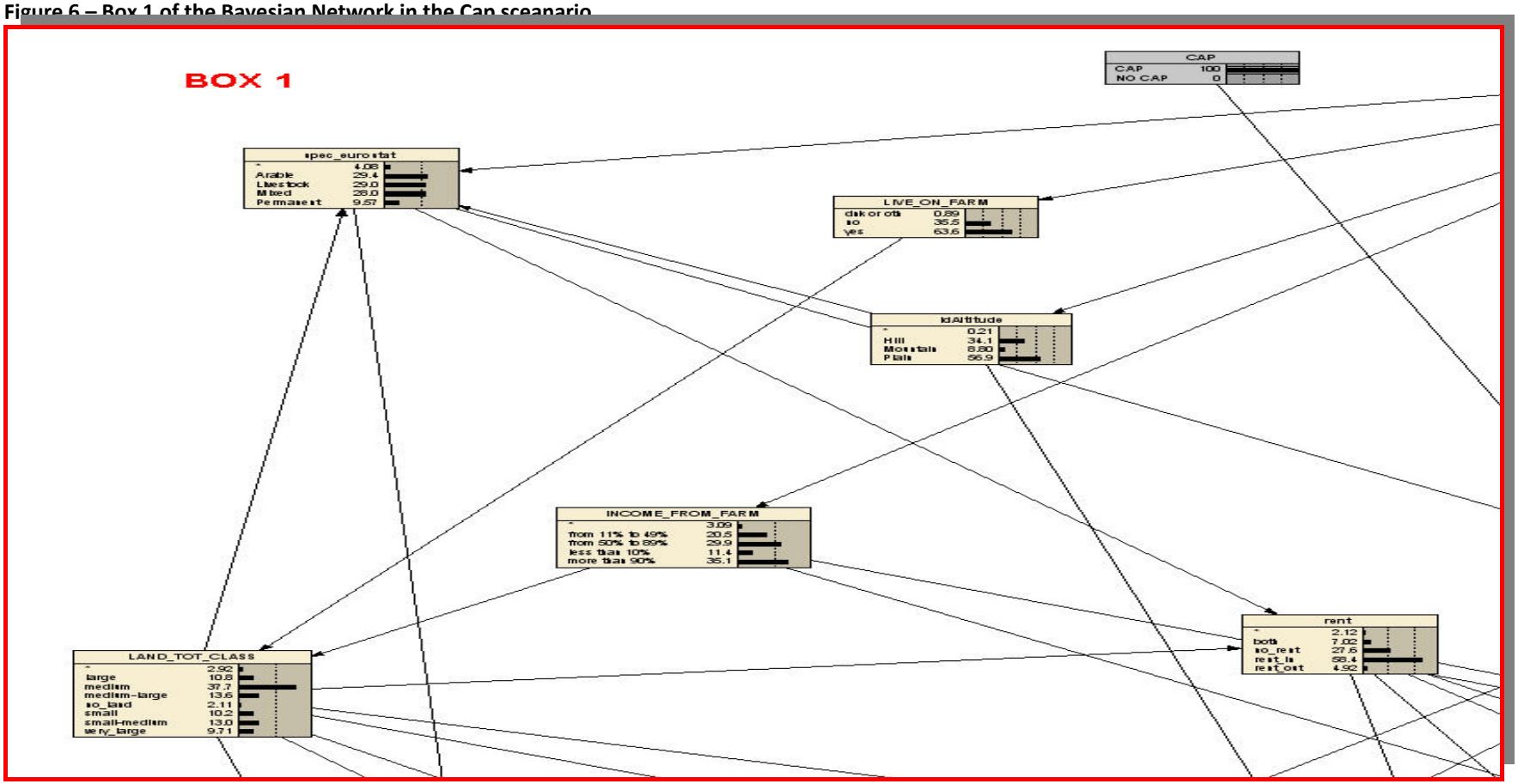
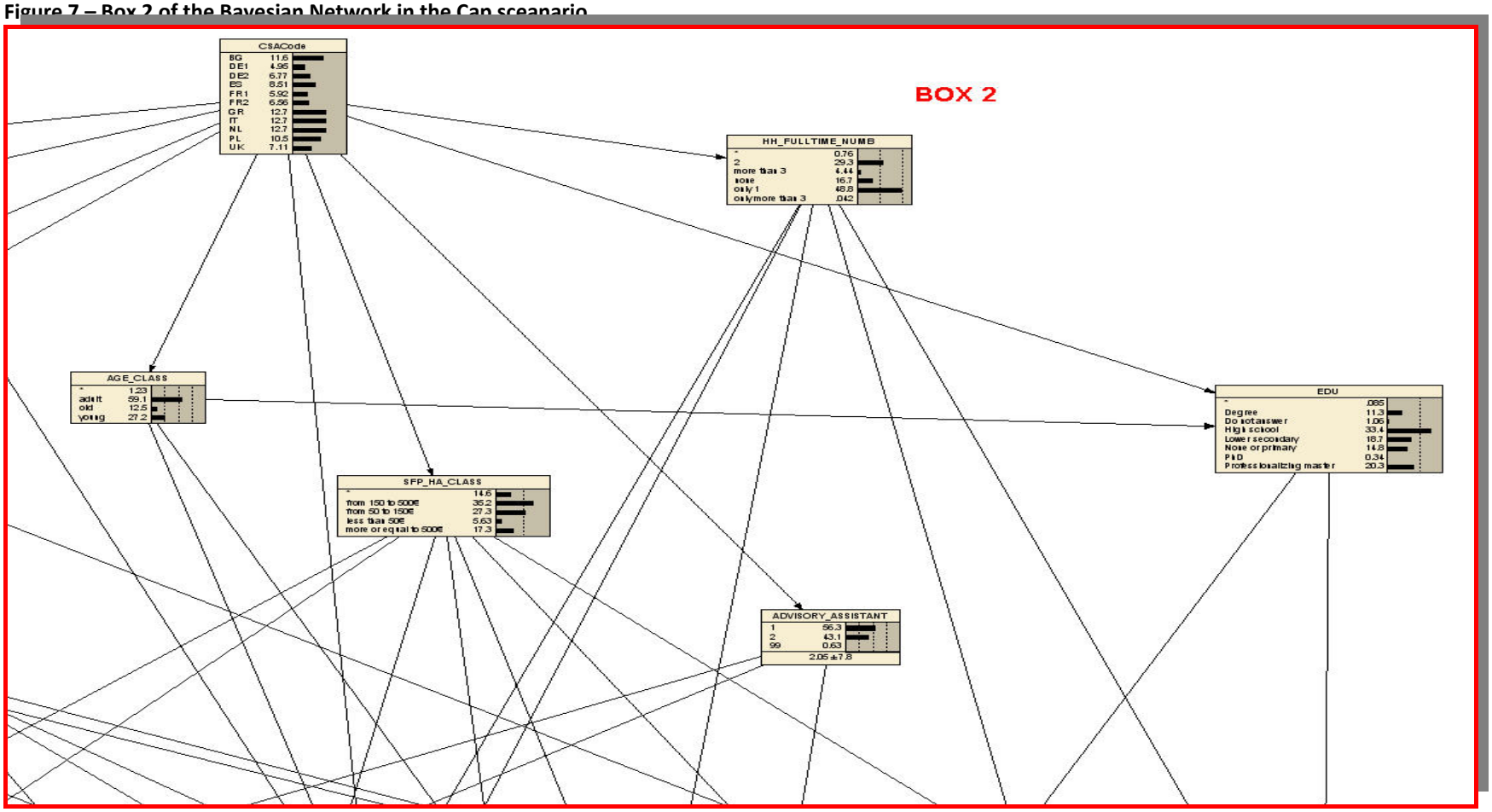


Figure 6 – Box 1 of the Bayesian Network in the Cap sceanario



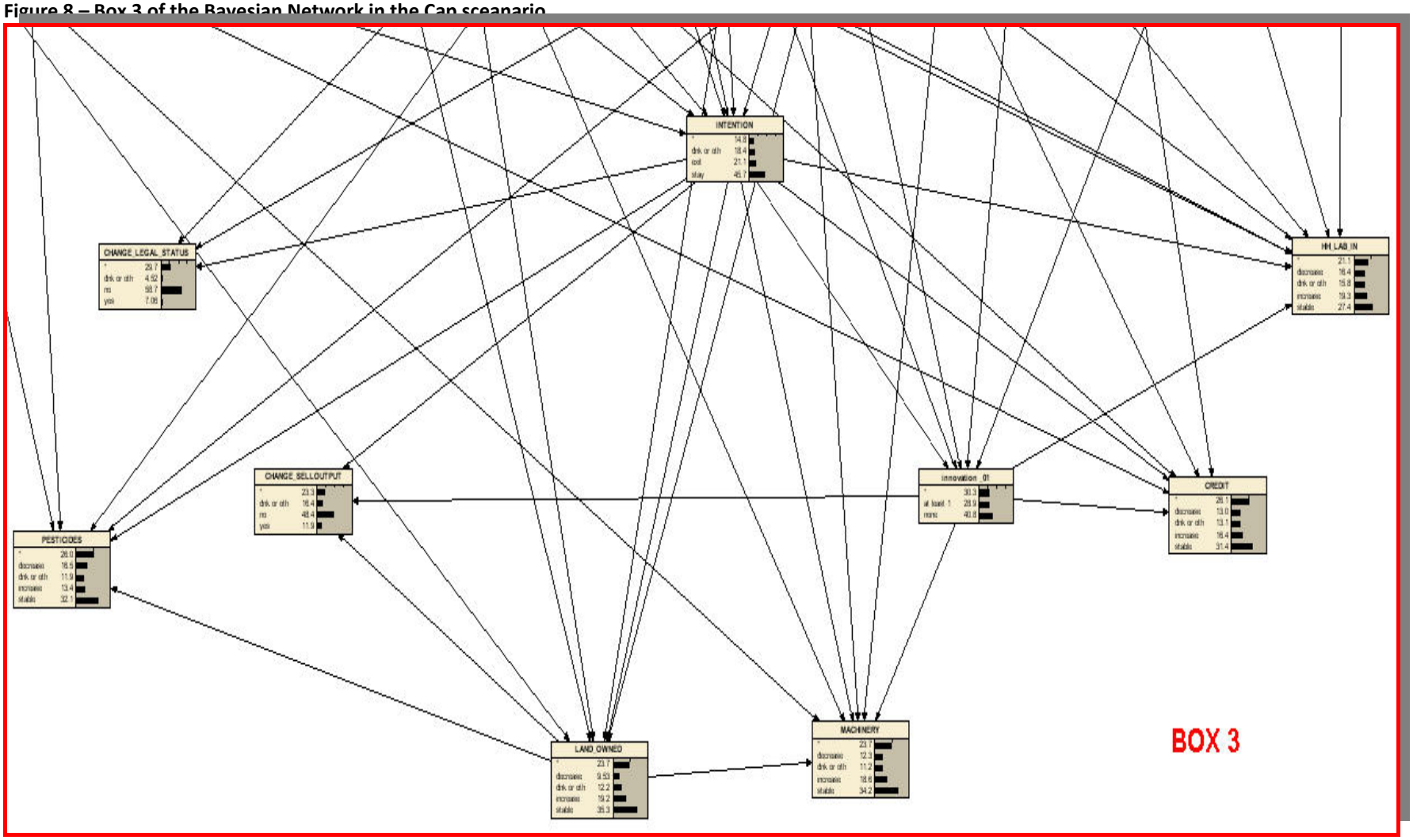
In the Figure 6 the section of the box 1 is shown. In particular the altitude and the farm size influence the main specialisation, the behaviour respect to the rent depends on the main specialisation, the farm size depends on the location where the household lives and on the income from farm

Figure 7 – Box 2 of the Bayesian Network in the Cap sceanario



In Figure 7 the section of the box 2 is shown. In particular the distribution of the age and of the number of fulltime household members depend on the CSA. The educational level depends on the age and on the CSA. The SFP per ha divided in classes influences a large set of variables (almost all child nodes) presents in the box 3 (Figure 8).

Figure 8 – Box 3 of the Bayesian Network in the Cap sceanario



In the Figure 8 the section of the box 3 is shown. This section reports the child nodes that are the output to be investigated and observed. The child nodes are connected to the a large set of parents. As an example, the node pesticides that describe the intention to change the use of pesticides depends on the farm size, farm specialisation, SFP per ha, advisory assistant, reaction to the policy and the intention of changing land.

The validation of the net is given by the error rates (Table 23) computed for each children node (output) are provided. These rated are computed as the rate of the observed misclassified over the total number of observations, assuming that all parent nodes are known. The errors are generally acceptable showing that the net works well.

Table 23 – Error rates

	Error rate
Intention	1.037
Land owned	8.019
Innovation	5.226
Pesticides	18.05
Machinery	14.85
Change_sell_output	22.37
Change_legal status	11.07
Credit	24.19
Hh_lab_in	10.33

However, the number of misclassification is rather different form different nodes and it is generally higher for those nodes that are less connected to parent nodes.

In Table 24 and Table 25 it is reported, as example, the observed and predicted distributions of node INTENTION in the two hypothetical policy scenario. The predicted distribution is quite far from the observed one even if the error rates are quite small. This depends on the relationships assumed in the net. In general, the tendency of the predicted values maintain the same rank/order of the observed ones.

Table 24 – Comparison between the distribution of observed and predicted in the node INTENTION in the Baseline scenario

		BG	DE1	DE2	ES	FR1	FR2	GR	IT	NL	PL	UK	Tot
*	obs.	0.37	7.69	4.38	0.00	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.76
	pred.	13.30	19.70	18.60	16.30	18.2	14.40	13.20	14.80	10.50	14.60	17.70	14.8
dnk or oth	obs.	9.89	1.71	0.63	5.47	10.00	17.42	3.00	8.67	20.67	0.00	8.33	8.17
	pred.	17.30	15.40	18.30	18.10	20.04	22.80	14.00	19.20	24.20	14.60	19.50	18.4
exit	obs.	13.55	14.53	11.88	22.39	12.14	18.06	9.00	15.33	35.67	3.61	6.55	15.36
	pred.	18.40	22.10	21.00	24.60	22.00	23.70	16.30	21.40	28.30	15.30	21.60	21.1
stay	obs.	76.19	76.07	83.13	72.14	77.14	64.52	88.00	76.00	43.67	96.39	85.12	75.71
	pred.	52.00	42.80	42.10	40.90	39.30	39.10	56.50	44.50	37.00	55.60	41.30	45.7

Table 25 – Comparison between the distribution of observed and predicted in the node INTENTION in the No-Cap scenario

		BG	DE1	DE2	ES	FR1	FR2	GR	IT	NL	PL	UK	Tot
*	obs.	1.10	14.53	5.63	0.00	2.14	0.65	0.00	0.00	0.00	0.00	0.00	1.40
	pred.	12.80	21.70	19.90	16.30	18.60	14.80	13.20	14.80	10.50	14.60	17.70	15.1
dnk or oth	obs.	12.82	1.71	2.50	9.45	17.86	27.10	3.67	14.00	23.00	0.80	34.52	13.08
	pred.	19.40	14.70	18.70	19.90	25.10	25.70	14.60	21.30	24.70	14.60	27.30	20.3
exit	obs.	36.63	61.54	55.00	56.72	32.86	36.13	65.33	29.00	40.00	14.86	20.83	40.25
	pred.	30.20	38.80	34.60	36.20	27.30	32.10	40.90	27.00	30.30	16.90	25.10	30.6
stay	obs.	49.45	22.22	36.88	33.83	47.14	36.13	31.00	57.00	37.00	84.34	44.64	45.28
	pred.	37.60	24.80	26.80	27.60	29.00	27.40	31.30	36.90	34.60	53.90	29.90	34.1

4.4 Intermediate discussion

The MCA allowed the identification of five main groups of farm-households based on stated intentions about the future and stated reactions to policy. This exercise allowed to identify in particular those farms willing to change in the next future by increasing in size and endowment of capital.

This exercise confirms on the aggregate the main insight from the thematic workpackages. In particular it hints at the idea that largest farms, with more educated and younger farmers are also those more willing to grow and innovate. In this farms, all components of farm structure tend to grow altogether, which is consistent with the expectation that thematic changes are connected into a whole farm and household strategy.

The BN exercise allowed to represent in a consistent framework the main interconnections identified by the thematic workpackages and to represent the effects of such interconnections on the final nodes (variables) with a satisfactory degree of credibility compared to the original data. In spite of the apparent complexity of the network, it shows that this can be obtained with a rather limited number of variables and connection compared with the sum of those entering the thematic analyses.

The tool is not used here for simulation purposes, except to show that it can catch the differential effects brought by the CAP and the adaptability of the tool to different case study areas. This hence offers the possibility of further research and policy evaluation using the developed tool.

5 SUMMARY OF MAIN OUTCOMES

A summary of the main insights of the project as derived from the main findings from individual workpackages and from the integrated analysis is presented in Table 26.

Table 26 – Main insights from the project

	Tendency	**Role of the CAP**	**Implications for policy design and implementation**	**Implication for further research**
Exit, land abandonment, farm typologies (WP3) (1,2)	Exit form agriculture continue at a high pace (average 25% in 10 years). However land abandonment is relevant only in disadvantaged areas.	The Cap would contrast exit (about 30% in the sample would continue farming only if the CAP stays in place). However the effect is very heterogeneous depending also on external factors (unemployment etc.)	Policy to contrast farm abandonment through income support would require more focus in specific areas and household features; policies would contrast land abandonment would also require more targeted action in disadvantaged areas	The process of exit rather than just the reduction of number of farmers would require more focus: is the land re-allocation a virtuous or vicious process? What are the complex grades of ownership and entrepreneurship connections with farming?
Structural change and innovation (WP4) (3)	Large farms tend to grow further. A relevant share of farms continuing their activity are also willing to innovate.	Relevant role in promoting further growth of large farms and innovation; first pillar policy, reducing uncertainty, contribute to earlier adoption of innovation and investment	Predictability is a key component of policy design.	Role of uncertainty and timing of technology adoption needs further study.
Chain interaction (WP5) (4)	Farm household have multiple linkages (production, labour markets, household consumption). Upstream and downstream connections are growing and changing their shape (e.g. internet for purchasing production means). Standard economic indicators (such as GDP) does	Changes in the CAP scenarios would have a minor effect on the overall regional economy and to remain focused on rural areas. Due to different linkages, impacts of policy change would be spatially very heterogenous across regions (e.g. very concentrated in	Need to take into account purchasing and selling flows in policy zoning	The results suggest that there may be a case for extending the existing FADN survey by adding additional questions on farm household purchasing and sales patterns, similar to that included in the USDA ARMS

	not account fully for the wide role and interconnections of agriculture in rural economy. Patterns of purchasing and selling are very heterogeneous. Locality of connections seems to be more dependent on attachment to local context than to other characteristics of the farm.	North east Scotland and very widespread in Podlaskie)		
Environmental sustainability (WP6) (5)	Farms are reducing their input use over time and are increasingly concerned about how resource scarcity would affect production. Farms are also increasingly engaged in policies concerning environmental protection and improvement (e.g. Agri-environmental schemes)	Removal of the CAP would provide a relevant reduction of input uses. However it would also cause abandonment of positive actions connected to payments. Present CAP seem to maintain some diversity of crops, but also obstacle the diffusion of new options, such as energy crops. Farmers with agri-environmental schemes or organic show a different pattern of change facing CAP removal (decrease use of input more than others, to be interpreted)	Take into ccount variables affecting also the environment, e.g. young farmers are more willing to change. Need of further targeting of environmental-related measures. Better accounting of self-selection issues in policy.	Need for a better understanding of the interplay of different components of the CAP towards the environment (e.g. positive effect of the CAP in supporting environmental friendly practice vs. Negative effects in stimulating the use of polluting inputs; unit reduction of pollution vs. Production increase due to support; interaction between cross-compliance and agri-environmental schemes, etc.)
Social sustainability (WP7) (6)	EU regions are very heterogeneous in terms of social features and sustainability. Farm exit also	Changes in CAP scenarios translate in minor changes in labour use (2-5% of farms affected), unless when it	In rural areas with high weight of agricultural employment, the CAP maintains its role as a major driver of labour market.	

	implies a reduction in labour used in agriculture.	causes exit form farming activity. This holds for all types of labour (household on-farm, household off-farm, hired) However the effects of the CAP changes can be important for specific categories (e.g. seasonal workers). In addition more detailed simulations confirm the relevance of labour connections with specific crops, driven by different policy scenarios.	Policies should be more flexible taking into account the particularities (economic, cultural, and social) affecting the specific contexts they are applied	
Connections with the rest of the word (WP8) (7)	The systems is widely affected by external scenarios (prices, etc.). Major visions of the future of farming in EU would shape also farming activities. Changes of household locations in the next years concern a minority of cases.	After 2003, the CAP lost its role as "interface" with outside the EU; however still protects incomes and affects production choices.		
Institutional dimension (WP9) (8)	Social and business networks are changing in rural areas. Farm and household are progressively disconnecting from each other; new forms of coordination in accessing resources (land) and connecting through the chain are getting more importance. Different governance structures may affect	Networks are important for farmers in their decision to continue their agricultural household facing different policy options. Business relations also changes as a consequence of the changing CAP.	Take into account governance structures. Stimulate diversity in regional economies to allow higher resilience to shocks.	

	resilience.			
Overall	Heteregeneity of farms and farm households seem to be growing also internally to each region.			

Sources: (1) Mishra et al., 2010; (2) Raggi et al., 2010; (3) Bartolini et al., 2010; (4) Roberts et al., 2010; (5) Giannoccaro and Berbel, 2010; (6) Manos et al., 2010; (7) Polman et al., 2010; (8) Sammeth and Gomez y Paloma, 2010.

The results of the project highlights once again the double dimension of heterogeneity in rural areas: on the one hand the heterogeneity of rural areas themselves, on the other hand the heterogeneity of farm households within each area. In spite of such heterogeneity, the project emphasises the existence of important common trends in farm-households and their connections with rural areas. These trends are driven by demographic and general economic factors and reflect in a relevant ongoing concentration of farming in less numerous but larger and more technologically advanced farms, a progressive disconnection between the farm (more and more managed as a legal entity rather than individually) and the household, an increased connectiveness between the farm-household and the outside world, also using innovative technologies such as the Internet.

One of the results of such trend, on the other hand, is the that heterogeneity of farm structures and households is further increasing and that a growing aspect of such heterogeneity is innovation in institution supporting rural governance.

Many of changes in the farming sector are connected to the choice of staying in farming or exiting, as exits represent a selection mechanism through which most of the other changes appear to happen. In addition, even if indirect adjustment effects are not directly dealt with in this project, exists would also likely contribute to modifications in the factor market in which farming continuing their activities play.

Also the CAP seem to have a stronger action through determining farmers' choice to continue farming rather than inducing changes of decisions within the farm. In spite of the potential for strategic answers due to the way the survey was carried out, the project clearly reveals that large number of farms would continue their activity only if the CAP remains in place.

The thematic analysis carried out reveals that the CAP, in spite of decoupling, maintains a number of roles as an component of income support, a driver of farm size expansion of middle-sized farms and innovation. Less evident effects are measured on the ground of labour use (basically determined by the exists rather than affecting farms continuing their activity) and environment (though with potentially high roles for specified technologies, such as organic farming).

The CAP also interact with institutional and organisational issues, which arrangements reveal to be rather CAP-dependent.

Finally spatial effects of the CAP reveals to be of special interest when also effects downstream and upstream are accounted for, due to the high concentration of linkages for input purchase and product selling in some areas.

The general policy insights derived from this exercise emphasise first of all the important role of the CAP in affecting changes in agriculture and in making it profitable to maintain agricultural activities in a large number o units. However the results also call for a number of potentially relevant adjustments in the current policy, particularly in the direction of making it less uncertain, more finalised to explicit targeted objectives, taking into account regional heterogeneity, but also accounting for farm

heterogeneity as an interesting policy objectives to ensure system's resilience in times of instability.

The results also call for attention to several further research areas. First of all the entry-exit mechanism requires more attention, with likely a higher attention to the entry of new farmers and a better understanding of the entrepreneurship dimension of agricultural activity. Dealing with uncertainty is a key element of this and other structural decisions and need further understanding. Environmental attention to the CAP calls for better study the interactions between different policy instruments, as well as the multiple environmental effects of the CAP.

The results can also be directed to more instrumental considerations, such as the emerging needs to revise the content of information collection in the direction of the explicit consideration of rural development and "functional" parameters, rather than focusing attention mainly on accounting data.

6 CONTEXTUALISING FINDINGS IN THE CURRENT POLICY DEBATE

6.1 Insights about current proposals for post-2013 CAP

When writing this report, the most recent view about the future CAP is given by the Communication from the European Commission 672/2010 "The CAP towards 2020:meeting the food, natural resources and territorial challenges of the future".

The document evaluates that the current debate agrees on the need of a strong common agricultural policy, structured around two pillars and having three main strategic aims:

- Objective 1: Viable food production
- Objective 2: Sustainable management of natural resources and climate action
- Objective 3: Balanced territorial development

In section 6 of the Communication, the reform orientation is explained, with reference to future instruments.

Three main policy options are envisaged:

- Enhanced status quo
- More balanced, targeted and sustainable support
- Abolished market and income support accompanied by payments for environmental public goods.

In the following we collect selected insights from the project related to the specific objectives listed in the document (Table 27).

Table 27 – Insights from the project concerning the COM 672 objectives for the future CAP

Objective	Insights from CAP-IRE
• Objective 1: Viable food production	
to contribute to **farm incomes** and limit farm income variability	The CAP seems to provide an important contribution to farm income as its removal is perceived as a major loss of profitability for many farms; there is also a risk reducing effect. This role is already played by the CAP in its present policy design
to improve the **competitiveness** of the agricultural sector and to enhance its value share in the **food chain**	The role of the Cap for competitiveness as it is presently designed is less clear. Even if there is a role in pursuing innovation, that is not dramatically

	different without the CAP, in the farms continuing their activity. This would rather call for improvement in instruments related to competitiveness if this objective is to be pursued
to compensate for production difficulties in areas with specific **natural constraints** because such regions are at increased risk of land abandonment	The project clearly shows very different pattern of reaction to CAP removal, which strengthen the feeling that important difference are in place between areas. However, in most thematic and in the overall analysis, belonging to a LFA does not appear as a major determinant of future trends and reaction to the CAP.
• Objective 2: Sustainable management of natural resources and climate action	
to guarantee sustainable production practices and secure the enhanced provision of **environmental public goods**	The results show that the Cap is required to maintain and strengthen the production of environmental public goods (e.g. organic, landscape). Some effect of general income support is also seen in maintaining higher use of polluting input. The need to jointly consider the different components of the CAP in their effects on public good provision is highlighted.
to foster **green growth** through **innovation** which requires adopting new technologies, developing new products, changing production processes, and supporting new patterns of demand, notably in the context of the emerging bioeconomy.	The effect of the CAP on technology adoption is relevant and mostly connected to profitability through income support and market instruments. A better knowledge of future policy would encourage early adoption of innovation. The use of advice is important to guarantee farm survival and development.
to pursue **climate change** mitigation and adaptation actions thus enabling agriculture to respond to climate change	The project does not address this issue directly. However insights relevant for public goods and innovation would be likely relevant for this issue as well.
Objective 3: Balanced territorial development	
	The project shows that the role of the

to support rural employment and maintaining the social fabric of rural areas	CAP is important here. Present instruments however seems to work more through direct income support and exit avoidance, rather than promoting self-sustainable employment.
to improve the rural economy and promote **diversification**	Answers about this issue are not straightforward. In spite of the existing diversification measures, the prevailing effect seems to be rather that of a substitution between the CAP and non-conventional farming activities, which would encourage a reconsideration of appropriate instruments in the next reform.
to allow for **structural diversity** in the farming systems	The present CAP seems compatible with a structural diversity and to contribute to maintain it. However it seems a side effect, not explicitly promoted by the current policy.

Altogether, the project supports the position that "Achieving all these objectives will require that public support to the agricultural sector and rural areas be maintained."

In terms of policy instruments the project also provides for several insights (Table 28).

Table 28 - Insights from the project concerning the COM 672 instrument proposals for the future CAP

Instrument	Insights from CAP-IRE
• Direct payments	
The necessary adaptations of the direct payment system relate to the **redistribution**, **redesign** and better **targeting** of support	As expected from the present policy design the project supports the idea that the present CAP acts mainly though income support in an un-targeted way, which would encourage some reform if the policy is required to be more targeted to specific objectives.
The use of a single, flat rate direct payment was one of the proposals floated in the public debate. However, agricultural producers face very different economic and natural conditions across the EU which advocates for an equitable distribution of direct aids.	Differences among regions and farms are emphasised in the project, which seems to justify some differentiation of payments appropriate to contexts
Thus the question is how to reach an equitable distribution that reflects, in a	The project supports the idea that

pragmatic, economically and politically feasible manner, the declared objectives of this support, while avoiding major disruptive changes which could have far reaching economic and social consequences in some regions and/or production systems.	changes in the CAP bringing re-allocation of payments could have major effects for the agricultural economy, which calls for gradual change and corrective temporary measures. At the same time, the effect on the local economy and employment would be relevant only in the cases in which agriculture plays a major role in the economy and alternative income/employment opportunities are low.
Basic income support through the granting of a basic decoupled direct payment, providing a uniform level of obligatory support to all farmers in a Member State (or in a region) based on transferable entitlements that need to be activated by matching them with eligible agricultural land, plus fulfillment of cross-compliance requirements. Introducing an **upper ceiling** for direct payments received by large individual farms ("capping") should be considered to improve the distribution of payments between farmers.	This component is already in the policy. Some upper ceiling seems to be justified as larger farms are less sensible to policy changes. However, the project emphasises the trend in the disconnection between household and farm which also highlights the need to consider more directly household-specific information if income support is directed to household (legal status of the farm, share of income from agriculture in the household, etc.). Connection/complementarities with social policies may be relevant here.
Enhancement of environmental performance of the CAP through a mandatory "**greening**" component of direct payments	This would be needed to provide positive environmental public goods from the first pillar. However, it should be clear that if such payments compensate for additional costs there will be anyway a trade off with income supporting measures (i.e. money used for compensate higher farming costs due to environmental constraints cannot be expected at the same time to contribute to income support).
Promotion of the sustainable development of agriculture in areas with **specific natural constraints** by providing an additional income support to farmers in such areas in the form of an area-based payment	This could be well justified by the diversity of farming conditions emphasised by the project.
	This is also corroborated by the project,

In order to take account of specific problems in certain regions where particular types of farming are considered particularly important for economic and/or social reasons, voluntary **coupled** support, may continue to be granted	through the attention to locally-specific productions that are sought to be kept competitive. As witnessed by the project, this seems rather an issue for a regional level rather than national one.
A simple and specific support scheme for **small farmers** should replace the current regime in order to enhance the competitiveness and the contribution to the vitality of rural areas and to cut the red tape.	This would be supported by the project as small farmers show to be the most affected by policy changes and those for which staying in farming would be more difficult. Current income support however does not seem to contribute to self-sustainable competitiveness, which would call for considering devising new instruments if the objectives of this support scheme are to be met. Also the definition of small would be very relevant as it is rather specialisation-dependent. In addition, below some threshold, small farms cannot be expected to become competitive or to play any role top meet society objectives on rural/agricultural economy. Finally the issue of size should be considered in a different way when considering Western Europe conditions vs. New member states.
Simplification of **cross compliance** rules by providing farmers and administrations with a simpler and more comprehensive set of rules	This is not clearly addressed by the project. In fact, the kind of reaction to policy scenarios seems to hint at the fact that cross-compliance is not very constraining for farmers, which suggest paying further attention to compliance and effectiveness issues.
These changes in the design of direct payments should go hand in hand with a better definition and targeting of support to **active farmers** only	Though the definition of active farmers is still unclear, this idea is supported by the project results, as long as less active farmers are also likely to exit whatever the policy conditions or to carry out agricultural activity as a non-economic activity. Active farmers would be those more reactive to policy and more prone to change to react to incentives towards CAP objectives.

Market measures	This issue is marginally addressed by the project. Reactions to crisis and price volatility emphasise the needs to control market risk. Embedding in the chain seems to be growing as a mean to increase stability more than as a means to attract higher value added.
Rural development	
Within this framework, **environment, climate change** and **innovation** should be guiding themes that steer the policy more than ever before.	This is consistent with the project's result that such effects are not delivered as by products of first pillar measures, and deserve dedicated instruments.
For the policy objectives to translate into results on the ground, **effective delivery mechanisms** are of paramount importance.	This is confirmed by both the innovation simulations calling for well anticipated incentives and minimising uncertainty about future policy, and the issue of under-spending and excessive constraints attached to second pillar measures that were raised during the LPNs.
For the sake of efficiency, it will be essential to strengthen the **coherence** between rural development policy and other EU policies, while also simplifying and cutting red tape where possible.	This again was a raised as a key issue in some LPNs, particularly related to environmental policies; coordination between first and second pillar could also require more attention.
In addition, a **risk management toolkit** should be included to deal more effectively with income uncertainties and market volatility that hamper the agricultural sector's possibility to invest in staying competitive.	This orientation is supported by the project results derived from the effects of prices volatility and reasons to exit if the CAP was removed. The income support itself has an effect of risk protection that should not be overlooked. The project also calls for risk taking pushed by the policy, for example through support to investment.
It is also essential to further strengthen and simplify the **quality** (including organic farming) and **promotion** policies in order to enhance the competitiveness of the agricultural sector.	This is a relevant point coming also from the project. Organic farming emerges as a relevant determinant of farm stability in future scenarios. Quality is a relevant focus particularly for some areas (e.g. Italy).
The instruments of the future CAP should continue to be structured around two pillars	The project shows that there remain some issues (e.g. equity) that would be

	better dealt with at a an aggregate level, while others would imply decision at the local level. Specificities such as environmental goods are difficult to grasp at an aggregate level and reflect local priorities. This also would contribute to support the proposal of a continuation of the present structure into two pillars, with different territorial levels in charge of their management.

6.2 Other selected agricultural policy issues

New member states

Location appears as a major determinant throughout the analysis carried out in the project. Location in new member states in particular appears as an important determinant of innovation and input use. This is driven by a mix of context variables (lower standards of life but higher growth rates, high unemployment) different policy in place (growing area payments) and different starting conditions of local markets and farms.

The discussion in the project was driven by the contrast between request of equal treatment raised by e.g. farmers in new member states, and the evidence of different conditions that would affect choices in case more targeted policy would be the chosen approach.

Agriculture vs. rural areas

The project was built on the issue of the role of the CAP in rural areas. The focus was then devoted mainly to CAP and agriculture, as this remain the main focus of the policy. However, interactions with wider issues was explored on different grounds.

The main message is that the role of agriculture in rural economies depends on it economic relevance. However in terms of policy impact, the changes in agriculture have proportionally larger effects compared to other sectors, thanks to the embeddednes of the sector.

Small farms

The issue of small farms emerges from the project as a rather articulated one and to be read also in connection to the emerging issue of active farmers.

Very small farms often are found to be willing to quit agriculture anyway, particularly when associated to old farmers. This would likely show that farms below some thresholds would not deserve investment as they would no yield any results.

However, above such threshold, there seems to be a very relevant sector of small farms that are policy dependent and rather fragile, and would justify attention and support. It seems however that generic support does not imply development of

autonomous livelihoods in these farms. As a consequence, likely different instruments are required if the policy objective is to promote growth of small into larger farms, or to sustain the small farms as such.

Organic

Organic farming as an explanatory variable seems to be in many cases a relevant driver for continuation of farming, even when the CAP is removed. At the same time, the keeping of organic production is rather dependent on the CAP. The likely explanation of this is to be find in the distinction between a market oriented organic farming and a policy driven organic farming, that would not be profitable without policy support.

7 DISCUSSION AND OVERALL CONCLUSIONS

The economic, social and economic impact of agricultural policy is a well established issue in the literature. However, instruments providing a comprehensive view of rural economies and related policy effects are not common.
The project CAP-IRE addresses the issue of the role of the CAP in rural economies with a focus on (farm-)households.

This comes at a time of dramatic changes in agriculture, including structural change, increasing rural-non-rural interaction, development of innovative connections between rural households and farming.
The need to address complex policy questions is also expressed by the problems raised by the AB and the LPN about the future of rural areas, where different and evolving economic agents and institutions are envisaged.
As a result, a number of research questions emerge, enquiring into: a) the evaluation of the real effects of policies; b) the understanding of background changes in rural areas and the understanding of mechanisms of change; c) the search for improved policies; and d) the effects of scenarios. This includes a very wide-ranging analysis of the role of policy in rural areas, as well as detailed considerations of the performance of specific policy instruments.

The project CAP-IRE addresses the complexity of these issues through the view of six thematic WPs, related to:
A- farm structural adjustments, investment and innovation
B - chain interactions between agriculture and related economic sectors
C - environmental sustainability
D - social sustainability
E - interactions between rural communities and the rest of the world
F - governance issues
For each of them, specific methodological proposals have been developed, in order to address specific issues in a multi-level perspective.

The specific objective of WP3 is to develop an analysis of the inter-linkages between these issues, building both on the surveys expected in the project, and the intermediate and final outcomes of the thematic WPs.

The overall conclusions derived by the project can be summarised as follows.
In terms of need and relevance of agricultural policies, the project shows that, while the overall economic contribution of farm-households in rural areas depends on the weight of agriculture in each area, the CAP continues to play a major role in affecting agriculture and agricultural production, and the farming population.

However, the project also highlights the need to re-specifying policy objectives and roles, in particular:

- more attention may be given to measures targeted at innovation and support of entrepreneurship, additionally to income support;
- there is a need to strengthen the connection between productive agriculture and the environmental/social dimension of agriculture: the growing attention to competitiveness requires potentially a reallocation of environmental concerns on farms and potential specialisation of areas/farm typologies in producing environmental public goods; the key question is to identify those situations in which environmental protection is actually synergic with competitive sustainable production;
- it is necessary to take more explicitly into account the non-agriculture related contributions that farm-household members make to local economies through, for example, off-farm employment and on-farm diversification activities.

A major issue highlighted by the project is the need of accounting for regional or farm differences, in particular by:

- further integrating differentiated regional and farm needs with respect to agriculture, i.e. measures addressing farm abandonment through income support may require more focus in specific areas and household features; more targeted measures with respect to land abandonment in less favoured areas is required;
- considering differences in social indicators among rural areas, including labour allocation in farming and off-farm activities; long-term unemployment and low education levels in some rural areas;
- taking into account differences in governance structures of farm households, governing input and output, the role of networks, and the institutional environment of regions when designing policies;
- considering the importance of farm household governance, including input and output governance, for the resilience of farm households to disturbances such as the financial crisis;
- recognising the spatial concentration of agriculture-related businesses in some (but not all) rural areas and the associated vulnerability of some rural towns should there be a decline in farm production.

The needs expressed above also reflect in suggestions to address key variables in policy design; in particular

- time frame, policy predictability and coordination over different policy objectives remain key issues in policy effectiveness;
- there is a need to take into account the flows of goods and services and their spatial dimensions, including the key nodes (firms, locations) through which such goods and services are exchanged, in targeting policy measures, particularly those related to investment and innovation;
- there is a need for further targeting of environmental, rural development and socially focused measures and for better accounting of self-selection issues in policy

design, i.e. taking into account that not all farmers/farms are the same and they would participate differently to the same policy; higher attention should be paid to the connection between environmental behaviour and other variables (e.g. farmers' age);
- the role of farm governance structures should be more explicitly taken into account. A relevant policy aim could be to stimulate diversity in regional economies to make farm households more resilient to shocks.

Improving policy evaluation remains a need; the project suggest focusing on the following policy evaluation issues:
- a significant number of farmers state the intention to abandon farming if CAP is abolished. The dramatic structural changes that would arise from the abandonment require improved tools for ex ante policy analyses;
- CAP effects change radically depending on other forces, such as an increase in productivity or changes in the world markets, which require specific attention to context scenarios.

The project also highlights that further scientific evidence is needed on the following:
- the project has shown once again how difficult it is to understand the links between farms and rural areas, in particular due to the lack of available data regarding the economic environment of farms, and the difficulties in modelling such links, even when data is collected through surveys. Accordingly, the study of the interplay between farms, farm-households and rural areas through their multiple social and economic connections remains a key issue in supporting evidence-based policy for agriculture and rural areas. The process of farm exit is a complex issue which needs to be understood beyond the mere reduction in the number of farms, and requires a more focused analysis. Is land re-allocation a virtuous or vicious process? What are the complex modes of farm governance, including ownership, and the role of entrepreneurship connected to farming? How can we improve the resilience of farm households and rural areas to changes in the social and business environment?
- the results suggest that there is a case for extending the existing FADN (Farm Accountancy Data Network, the EU-wide network collecting accounting information on farming) survey by adding additional questions on farm household purchasing and sales decisions, similar to those included in the USDA ARMS (the Agricultural Resource Management Survey carried out regularly in the USA).
- there is a need for a better understanding of the interplay between the different components of the CAP with respect to the environment, e.g. the positive effect of the CAP in supporting environmentally friendly practices vs. the negative effect of stimulating the use of polluting inputs; the unit reduction of pollution vs. production increases due to support; the interaction between cross-compliance (environmental requirements to which CAP payments are conditioned since 2005) and agri-environmental schemes.

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