CAP greening measures:
Modelling challenges and first results

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Introduction

- Key change of the 2013 CAP reform relative to previous reforms: **CAP greening**

- Challenges
  - Different to standard polices (coupled/decoupled direct payments, MPS)
  - It links direct payments to of environmental performance of farms
  - How to capture the effect of CAP greening?

- In this presentation we focus on economic impacts

Content

- Greening measures
- Models
  - CAPRI
  - IFM-CAP
- Preliminary simulation results
  - CAPRI
  - IFM-CAP

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CAP greening measures

- Crop diversification
- Permanent grassland
- Ecological focus area (EFA)

CAP greening

Crop diversification:

- Regulates crop diversity on arable land
- Stricter requirements for larger farms than small ones
- Farms with an arable area smaller than 10 hectares are excluded

Minimum number of crops:

- Farms with 10-30 hectares : at least 2 crops
- Farms greater than 30 hectares : at least 3 crops

Maximum crop area share thresholds:

- Main crop should not cover more than 75% of arable area
- Two main crops should not cover more than 95% of arable area

Exemptions for crop diversification measure

- Farms with more than 75 % of arable land covered by grassland or other herbaceous forage or land lying fallow (or combination of three) (rest of arable area not more than 30 ha)

- Farms with 75 % of their eligible agricultural area cultivated with forage or crop under water (or combination) (rest of arable area not more than 30 ha)

- Area situated in the north of 62nd parallel or certain adjacent areas have less strict requirements

CAP greening

Permanent grassland:

- Aims to prevent grassland conversion to arable land
- The **ratio of grassland to total agricultural area should not decrease by more than 5%** compared to the reference ratio in **reference period**
- The obligation can be applied at national, regional or sub-regional level
  - **23 MS apply at national level, 4 MS at regional level, 1 MS at sub-regional level, 1 MS without permanent grassland (Malta)**
- If the ratio has decreased by more than 5 % at national or regional level, the obligation needs to be imposed at farm level

Exemption:

- If grassland decreased due to afforestation

CAP greening

Ecological focus area (EFA):

- Aims to allocate land to environmentally friendly practices: **5% of arable land**
- Applicable only for **farms larger than 15 ha** of arable land

- The rate might be increased to 7% subject to new legislation after 2017

- **Eligible area:** fallow land, terraces, landscape features, buffer strips, catch crops or green cover, nitrogen-fixing crops, etc.

- Exemptions
  - more than 75% of arable land is forage, grassland or fallow land
  - more than 75% eligible land is forage, grassland or crop under water

Ecological focus area (EFA):

- To account of the characteristics of the types of EFA: conversion (c) and weighting factors (w)
  - Eg: fallow land (c=1, w=1) ; buffer strips (c=6, w=1.5),
- MS can choose which elements they want to integrate in their EFAs lists
  - 18 EFA measures in HU,FR,IT *vs.* 2 measures in LT
  - Most applied measure is fallow land (26 MS); least applied is stone walls (7 MS) and strips along forest edges (with production) (6 MS)
- MS can impose restrictions on application of plant protection and fertilisers
- 4 MS activated the forest exemption (EE,FI,LV,SE)
- 2 MS activated the collective implementation of EFA (NL,PL)

Implementation of EFA

Number of EFA per MS or region	Number of MS
2	1
3	1
4	3
5	3
6	5
7	1
8	3
9	1
10	1
11	2
13	2
14	3
15	2
17	1
18	3

Eligible area	No of MS	C	W
Fallow land	26		
Terraces	8	2	1
Hedges or wooded strips	13	5	2
Isolated trees	13	20	1.5
Trees in line	16	5	1.5
Trees in groups	17		1.5
Field margins	16	6	1.5
Ponds	12		1.5
Ditches	15	3	2
Traditional stone walls	7	1	1
Other landscape features under GAEC or SMR	11		
Buffer strips	17	6	1.5
Agroforestry	11	0	0
Strips along forest edges (no production)	9	6	1.5
Strips along forest edges (with production)	6	6	0.3
Areas with short rotation	20		
Afforested areas	14		
Catch crops or green cover	19		
Nitrogen fixing crops	27		

CAP greening

Equivalent practices:

- Farms adopting equivalent practices do not need to implement (replace) the three measures
- Equivalent practices refer to those which yield equivalent or higher level of climate and environmental benefits
- E.g.: national or regional environmental certification schemes and (3 MS=FR,NL,AT) agri-environment-climate measures from Pillar 2 (2 MS=IR,PL)

Exemptions (all greening):

- Farmers participation in small farmer scheme
- Organic farming

CAP greening

Non-complying farms are subject to payment reduction:

Two components:

- Reduction of greening payment depending on the amount of non-complying area

- Administrative penalty: additional payment reduction depending on the share of non-complying area

- Non-complying farms' direct payments are reduced corresponding to the level of greening and administrative penalties are imposed

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Modelling CAP greening

- Modelling CAP greening is challenging:
  - It is implemented at farm level
  - **Application depends on individual farm characteristics**
  - It induces farm-specific effects
  - Heterogeneous impact across farms, regions and MS

- Given that CAP greening is implemented at farm level, one needs to use a model able to capture **farm behavior and farm heterogeneity**

- The only available models that can model CAP greening at EU level:
  - **CAPRI**
  - **IFM-CAP**

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Other studies on CAP greening

- **Mahy et al. (2015)**: crop diversification, non-parametric simulation model, Flanders (Belgium)
- **Brown and Jones (2013)**: three measures, qualitative based on survey, North Cornwall (England)
- **Czekaj, Majewski and Was (2013)**: three measures, LP FADN data, Poland
- **Patton et al. (2013)**: CAP greening, FAPRI-UK PE model, UK
- **Schouten, Polman and Westerhof (2013)**: EFA, agent-based model (SERA), The Netherlands
- **Gigante, Arfini and Donati (2014)**: CAP greening, PMP model, FADN and Administratieve data, Emilia-Romagna (Italy)
- **Vanni and Cardillo (2013)**: three measures, Census data, statistical analysis, Italy
- Etc.

Model description

- CAPRI
- IFM-CAP

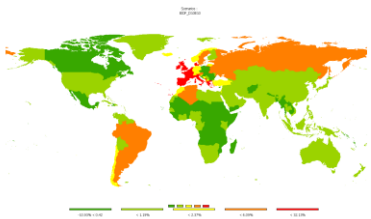
CAPRI model

- CAPRI is a spatial agro-economic model of agricultural commodity markets at the global and EU level

- Two interlinked modules:
  - **Market module**: A globally closed model for production, demand and trade in primary and secondary agricultural products. **Captures interaction between EU and global markets**.
  - **Supply module**: regional (NUTS2) simulation models for EU which capture in detail farming decisions (farm types) (crop shares, animal herds, yields, fertilizer use ..)
  - Indicator calculators for production and market balances, land use, farm income, prices, nutrient balances, GHG emissions etc.

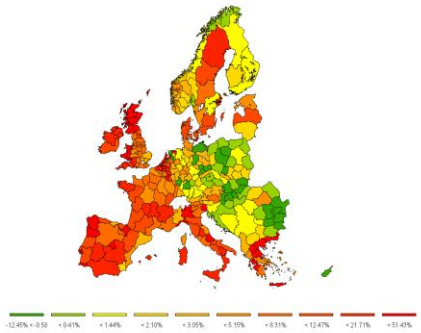
CAPRI modelling system

Two interlinked modules:



Market module

- 60 countries in 28 trade blocks
- 50 primary and secondary agri. products,
- Agricultural and trade policy measures



EU supply module

- 250 NUTS2 regions for EU + Norway +Western Balkans
- Detailed representation of farming decisions: **NUTS2 regions split in 2500 farm types**
- CAP policy

Indicators calculators

Production and market balances, land use, income, prices, nutrient balances, GHG budgets, etc.

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Relevance of CAPRI for CAP greening

- The key advantage: CAPRI models farm types at NUTS2 level for the whole EU which allows to capture CAP greening measures
- CAPRI disaggregates NUTS2 supply modules to farm types (around 2500 farm types).
- Farm types are constructed based on FSS and FADN data.
- Each farm type is distinguished by production specialization (13) and the economic size (ESU) (3).

Farm types in the CAPRI-FARM

Type of farming	abbr.	Economic size class	abbr.
Specialist cereals, oilseed and protein crops	13	< 16 ESU	ESC 1
General field cropping + Mixed cropping	14 60	≥ 16 ≤ 100 ESU	ESC 2
Specialist horticulture	20	> 100 ESU	ESC 3
Specialist vineyards	31		
Specialist fruit and citrus fruit	32		
Specialist olives	33		
Various permanent crops combined	34		
Specialist dairying	41		
Specialist cattle + dairying rearing, fattening	42 43		
Sheep, goats and other grazing livestock	44		
Specialist granivores	50		
Mixed livestock holdings	70		
Mixed crops-livestock	80		

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IFM-CAP model

- **Models individual farms** in the EU
  - Covers all farms from FADN data (about 60 000 farms)
- **Full farm heterogeneity** in term of policy representation (e.g. CAP greening) and impacts (e.g. small versus big farms).
- Detailed **socio-economic results** (i.e. average and distribution)
- **Flexibility in aggregating results** by farm type and EU regions (NUTS-2 & MS)

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IFM-CAP model

- Comparative static & non-linear optimisation model
- Calibrated for the three-year average around 2008
- **Objective function**: maximization of farm level profit function:
  Revenues from selling products + Pillar I subsidies – Accounting costs – PMP terms
- **Constraints**: land (arable & grassland), policy requirements/constraints (e.g. quotas, CAP greening) and animal feeding at farm level
- **Full use of FADN data**, completed by Eurostat data, CAPRI, etc. when needed

Model parameterization

DATA

- **FADN data**
  - Utilized Agricultural Area (arable & grassland)
  - Obligatory set-aside rate
  - Milk quota right
  - Set of crop and livestock activities
  - Yields, Prices & Subsidies
  - Observed activity levels
  - Farm level feed costs
  - Farm weighting factor
  - Land rental prices (prior)
- **EUROSTAT data**
  - Yields for fodder crops at MS level
  - Carcass weights
- **CAPRI data**
  - Prices for fodder crops at MS level
  - Feed prices at MS level
  - Feed nutrient content
  - Prices and Yields trend
  - Animal feed requirement functions (prior)
  - Elasticities for feed demand at NUTS2 level (prior)
- **Others data (prior)**
  - Out-of quota prices for sugar beet (Agrosynergie, 2011)
  - Share of in-quota production on total production at MS level for sugar beet (DG-AGRI)
  - In- quota prices for sugar beet (Agrosynergie, 2011)
  - Share of in-quota production on total production at MS level for sugar beet (DG-AGRI)
  - Supply elasticities at NUTS2 level (Jansson and Heckelei, 2011)

MODEL

- **Optimize farm's objectives:** profit maximisation = linear gross margin - quadratic behavioural function
- **Subject to:**
- Land constraints (arable & grassland)
- Policy constraints (CAP 1 pillar - decoupling, quotas, seta-side, greening)
- Feeding constraints (feed availability vs. feed requirement, max share of roughage & concentrates)

OUTPUTS

- Activity levels (ha & head)
- Production (Tons)
- Land use (ha)
- Input use
- Farm profit (€)
- Shannon index
- ...

ESTIMATION

- **Accounting unit costs for crops**
- **Behavioural function's parameters**
- **Animal feed requirement & costs**
- **Sugar beet quota & prices**

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CAPRI *versus* IFM-CAP

- Each model has its strengths and weaknesses in modelling CAP greening

- **CAPRI**:
  - Provides detailed economic and environmental impacts across farm-types
  - **Can capture market effects of CAP greening** (e.g. price changes)
  - Interlinkage between market module (price changes) and farm behaviour

  but
  - Aggregation bias because aggregated (representative farms) types are modelled (e.g. by construction the crop allocation is much more diversified for the aggregated farm than for the individual farms).
  - Certain assumptions need to be made to model some greening measures

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CAPRI *versus* IFM-CAP (cont.)

- **IFM-CAP**:
  - Provides detailed CAP greening impacts across individual farms
  - Can model **farm specific implementation of greening measures**: no (minimal) aggregation bias
  - Provides very detailed impacts: distribution across farms and average by farm type, region, etc.

  but
  - No interlinkage between market module (price changes) and farm behaviour
  - Cannot capture market effects of CAP greening (ongoing work)

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Simulated scenarios

- Baseline
- Greening scenarios

Baseline

CAPRI and IFM-CAP:

- Baseline is the reference scenario used as benchmark for comparing greening scenarios
- Baseline – 2020
- CAPRI baseline is calibrated to Aglink-COSIMO baseline of the DG AGRI outlook.
- IFM-CAP uses CAPRI data (yield and price trends) to generate baseline

CAP greening scenarios in CAPRI

Scenarios for individual greening measures:

- Crop diversification
- Permanent grasslands
- Ecological focus area

Scenario combining all three greening measures

- All greening measures

Modeling Crop diversification

- Most challenging to model because it is implemented at farm level and impacts are farm specific.
- CAPRI does not have individual farms, only farm types
- We **combine individual FADN data with CAPRI farm types**
- The link between CAPRI farm types and FADN is done through **Shannon index**
- Shannon index measures the level of crop diversity (the index increases in more diversified crop structure and more even distribution of crop area)

Modeling Crop diversification (cont.)

- Shannon index with and without crop diversification measure calculated from FADN.
- The difference between the actual and the simulated Shannon index was introduced as a land use constraint for farm types in CAPRI.
- For each farm type in CAPRI, the crop diversity measure is introduced as an adjustment of arable crop area by conditioning land allocation to be in line with the crop diversity as given by the Shannon index.

Modeling Permanent grasslands

- Challenge: to get reference period for grassland area
- Land area to be maintained as grassland was set at average between the base year (average for 2007-2009) and the 2020 baseline
- Farm type implementation of the measure is assumed => **over-estimated effects** which in reality will most likely not occur (see further)

Modeling ecological focus area (EFA)

- 5% EFA rate
- Only fallow land considered for the ecological focus areas
- Other landscape element not considered in this presentation (on-going work) => **over-estimated effects**
- This is a test exercise => we get upper bound effects which in reality will not occur (see further)

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CAPRI scenario results

- We compare percentage changes relative to 2020 baseline for four simulated greening scenarios

Area, EU
(% change relative to 2020 baseline)

	Crop diver.	Grassland	EFA	Greening all
Cereals	0.06	-0.88	-2.55	-3.66
Oilseeds	0.11	-0.56	-1.7	-2.43
Other cereals	0.69	-1.59	-4.34	-6.11
Other arab. crops	0.54	-0.4	-1.5	-1.69
Set aside & fallow land	-0.55	-3.87	49.2	44.09
Grassland	-0.03	2.08	-1.58	1.23
Arable land	-0.03	-0.94	0.78	-0.42
UAA	-0.03	0.00	0.05	0.09

Area by farm type
(% change relative to 2020 baseline)

	Crop diver.		Grassland		EFA		Greening all	
	Grassl.	Arable	Grassl.	Arable	Grassl.	Arable	Grassl.	Arable
EU	-0.03	-0.03	2.08	-0.94	-1.58	0.78	1.23	-0.42
Granivores	0.03	-0.03	3.96	-0.67	-1.76	0.32	3.77	-0.60
Mixed livestock	0.03	-0.05	3.22	-1.72	-1.59	0.82	2.59	-1.28
Mixed crops-livestock	-0.06	0.01	4.06	-1.29	-1.97	0.62	3.32	-1.02
General field cropping	-0.05	-0.01	4.33	-0.62	-3.05	0.44	3.29	-0.44
Cereals, oilseed	-0.18	0.00	3.64	-0.43	-2.50	0.30	3.11	-0.35
Sheep, goats	0.02	-0.13	0.58	-2.20	-0.87	4.35	-0.07	1.53
Cattle rearing/fattening	-0.04	0.05	1.00	-1.97	-1.23	2.54	0.04	0.22
Specialist dairying	-0.05	0.02	1.98	-1.69	-1.72	1.55	0.76	-0.34
Various permanent crops combined	0.23	-0.14	6.60	-0.28	-2.55	0.26	6.20	0.00
Specialist olives	1.11	-0.44	4.11	-0.28	-1.24	0.21	4.06	-0.21
Fruit and citrus fruit	0.18	-0.07	2.13	-0.10	-7.15	0.70	-1.48	0.58
Specialist vineyards	0.05	-0.05	4.00	-0.21	-2.50	0.45	3.55	0.20
Specialist horticulture	-0.33	0.00	2.27	-0.07	-1.36	0.05	1.84	-0.01
ESU 0-16	-0.04	-0.02	1.66	-1.02	-1.62	1.18	0.76	-0.16
ESU 16-100	-0.03	-0.02	1.80	-0.96	-1.31	0.73	1.02	-0.45
ESU above 100	0.00	-0.02	2.76	-0.74	-1.88	0.52	1.96	-0.48
Residual farms	-0.03	-0.04	3.07	-1.25	-1.93	0.81	2.13	-0.74

Production, EU-27
(% change relative to 2020 baseline)

	Crop diver.	Grassland	EFA	Greening all
Cereals	-0.06	-0.6	-1.72	-2.5
Oilseeds	0.04	-0.51	-1.65	-2.38
Fodder	-0.1	0.62	-1.58	-0.75
Potatoes	0.05	-0.1	-0.38	-0.5
Sugar beet	0.17	-0.35	-1.7	-2.19
Meat	-0.03	-0.05	-0.39	-0.44
Milk	0.05	0.05	-0.17	-0.19

Prices, EU
(% change relative to 2020 baseline)

	Crop diver.	Grassland	EFA	Greening all
Cereals	0.02	0.45	1.91	2.74
Wheat	0.09	0.41	1.72	2.48
Barley	-0.02	0.46	1.99	2.86
Grain maize	0	0.43	1.91	2.75
Oilseeds	-0.06	0.55	2.32	3.22
Rape seed	-0.03	0.53	2.51	3.43
Sunflower	-0.16	0.69	1.94	2.86
Potatoes	-0.03	0.12	0.46	0.65
Meat	0.17	0.18	1.08	1.17
Milk	-0.18	-0.13	1.19	1.32
Sugar	0	0.02	0.04	0.07

Income per ha (% change relative to 2020 baseline)

	Crop diver.	Grassland	EFA	Greening all
EU	0.13	0.30	1.74	2.04
Granivores	0.58	-0.93	17.60	16.01
Mixed livestock	0.44	0.76	4.41	4.83
Mixed crops-livestock	0.17	0.70	4.06	4.91
General field cropping	0.01	0.25	1.18	1.57
Cereals, oilseed and protein	0.03	0.71	3.01	4.28
Sheep, goats	0.29	0.24	1.49	1.38
Cattle rearing/fattening	0.93	0.90	3.66	3.52
Specialist dairying	0.26	0.38	3.28	3.24
Various permanent crops combined	0.10	0.06	0.24	0.36
Specialist olives	0.34	0.13	0.68	1.11
Fruit and citrus fruit	0.06	0.01	-0.29	-0.40
Specialist vineyards	0.05	0.03	-0.02	-0.03
Specialist horticulture	-0.03	0.02	0.20	0.18
ESU 0-16	0.12	0.27	1.40	1.60
ESU 16-100	0.26	0.45	2.20	2.56
ESU above 100	0.08	0.41	2.71	3.27
Residual farms	0.04	0.08	0.63	0.67

On-going improvements

- Update of data linked to greening measures (e.g. grassland, EFA elements)
- Update of MS specific CAP implementation based on latest available information

On-going improvements

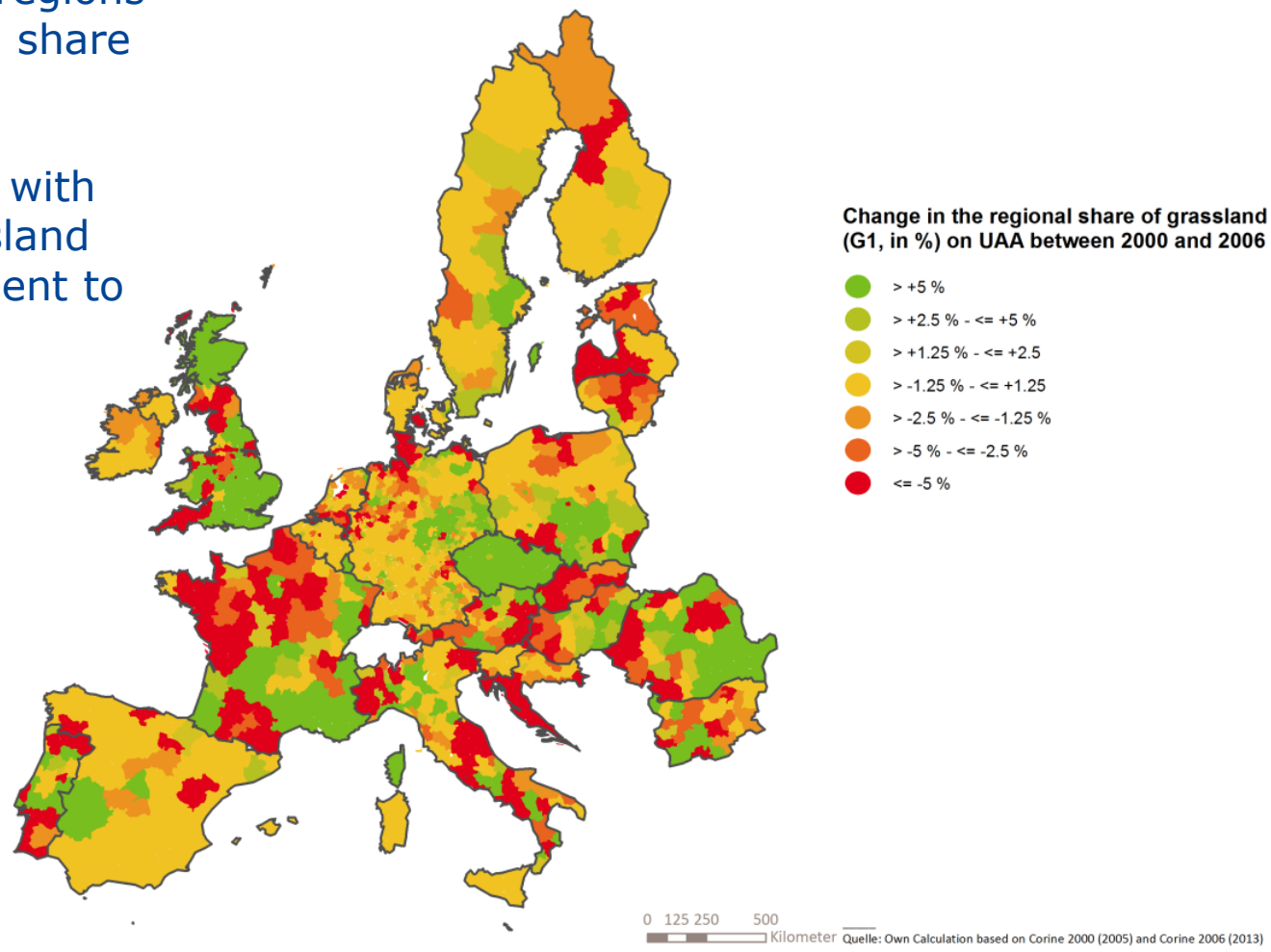
Maintenance of permanent grassland

- Grassland data problematic (particularly regional data): different sources have different values
- Update of grassland regional data from CORINE land cover (CLC)
- Identification of **dynamics of grassland use**
- CORINE based info should allow to determine potential area that need to be reconverted to grassland
- Use this information to **derive grassland conversion dynamics for the baseline**
- Translate derived spatial CORINE data to farm types in CAPRI

Spatial distribution of the development of grassland (G1) share on UAA between 2000 and 2006

-In one third of NUTS3 regions the change in grassland share is less than 1%.

-The number of regions with an increase in the grassland share is roughly equivalent to the ones with a decline.



Source: own calculations based on CORINE

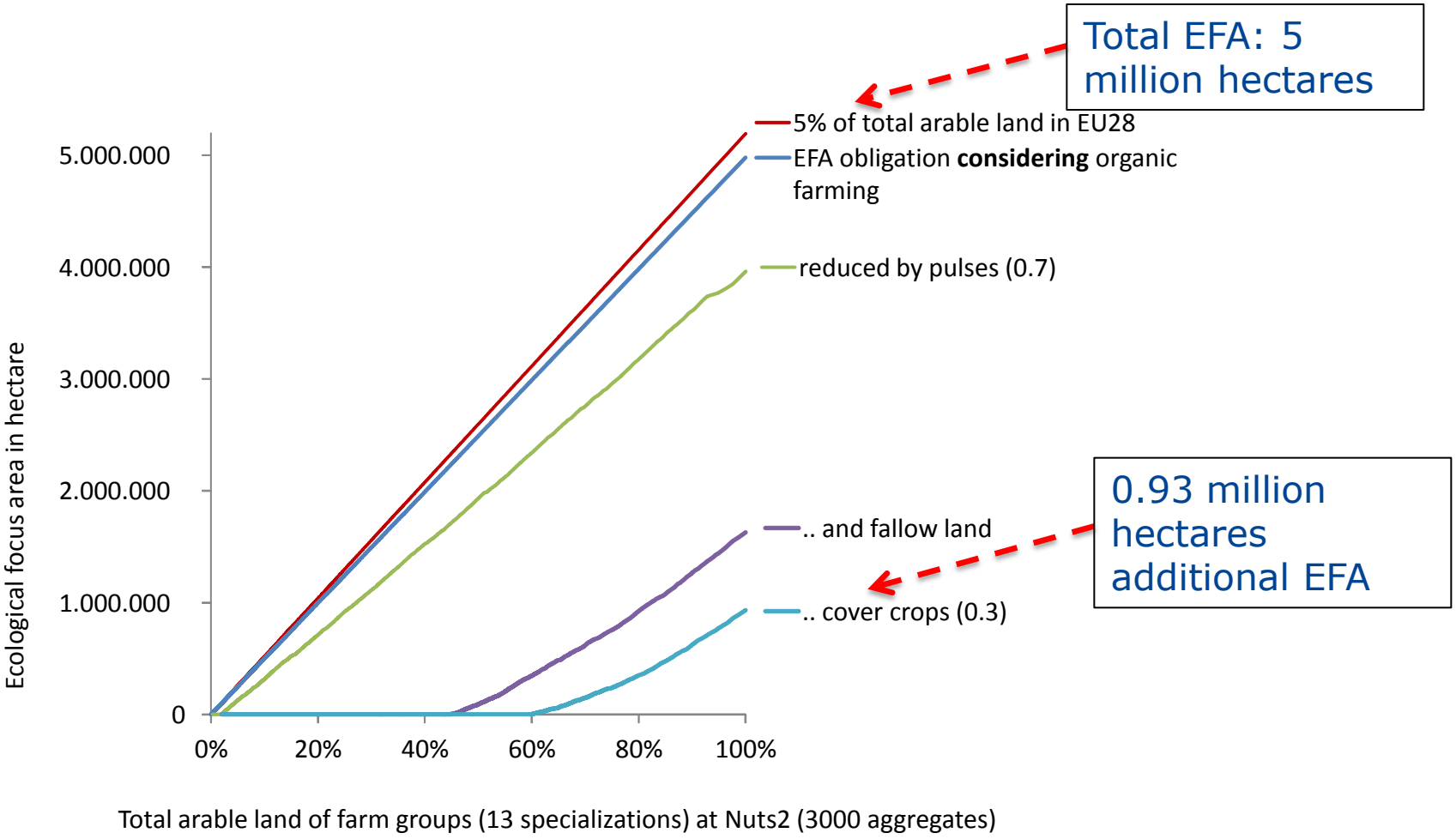
On-going improvements (cont.)

Ecological focus area (EFA)

- The presented EFA impacts were over-estimated
- Collecting data to account for area already complying with EFA (for baseline): fallow, areas with nitrogen fixing crops (protein crops), cover crops, landscape features, etc.
- Use EUROSTAT for cover crops (intermediate crops) and landscape features – FSS, Agricultural production methods (SAPM)
- Investigate the possibility to use LUCAS (Land Use/Cover Statistical Area Frame Survey) for landscape features

EFA distribution by farm type in 2010

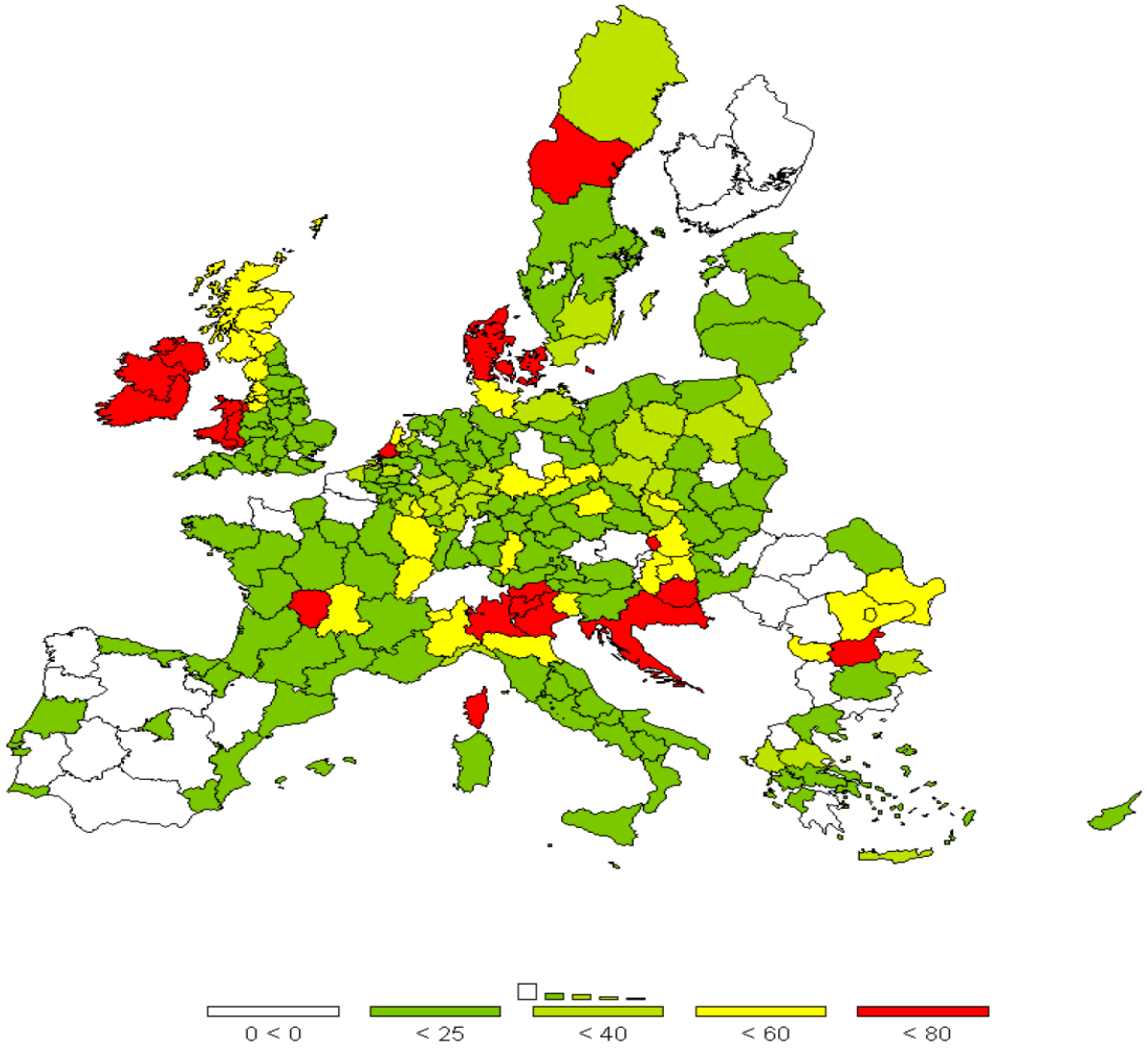
after accounting for organic farms (1), protein crops (0.7), fallow land (1), cover crops (0.3) (weighting factors in brackets)



Source: EUROSTAT, FSS and SAPM (2010)

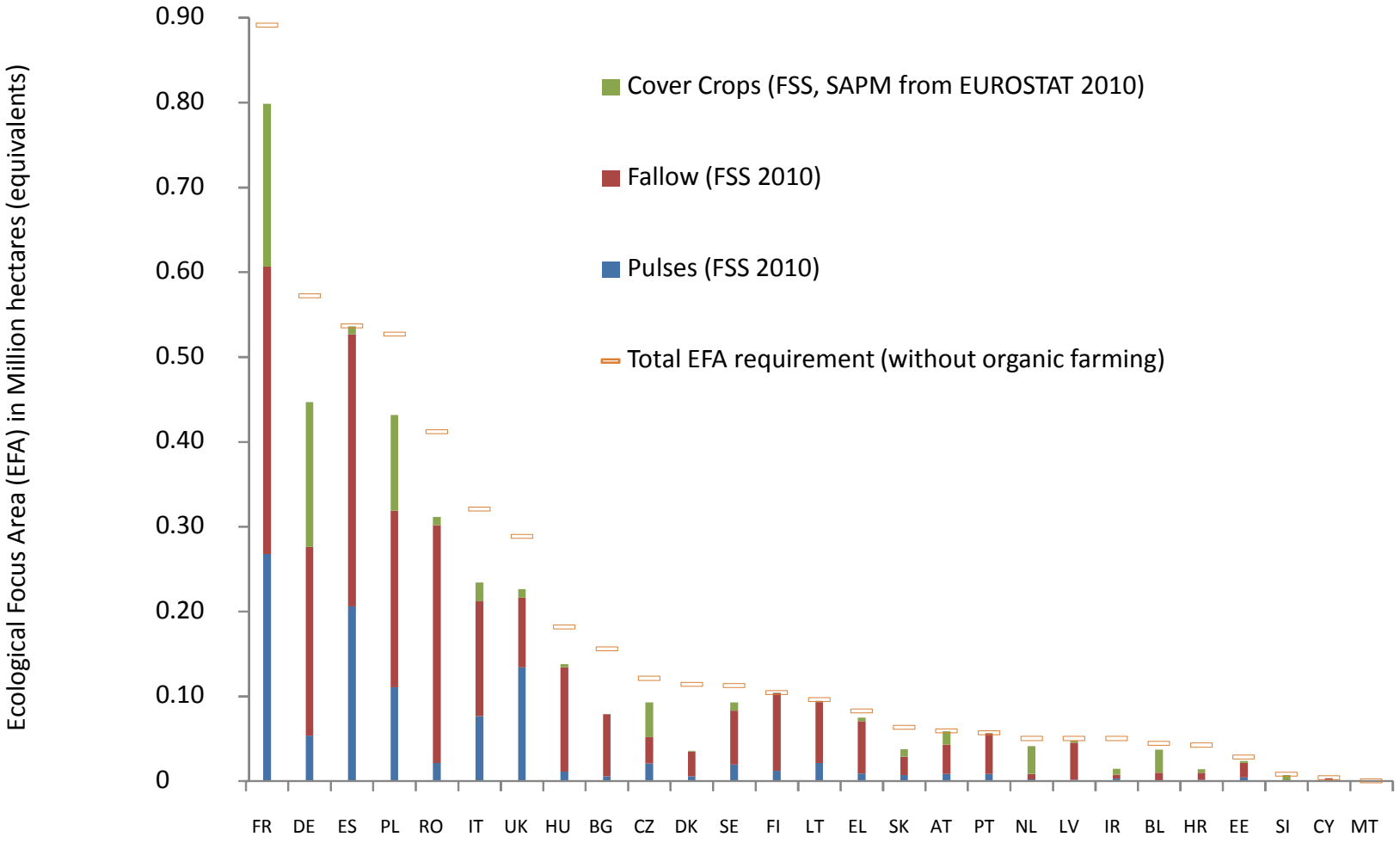
Non-complying EFA in 2010 (percentage of the 5% obligation)

after accounting for fallow land (1), protein crops (0.7), cover crops (0.3)



EFA by MS in 2010 (ha)

after accounting for fallow land (1), protein crops (0.7), cover crops (0.3)



Source: EUROSTAT, FSS and SAPM (2010)

On-going improvements (cont.)

Crop diversification

- Endogenization of the link between CAPRI farm types and Shannon index calculated based on individual farms
- Introduction of additional restrictions in the FADN micro simulation to account for price responses
- Iteration until the both models convert

CAP greening scenarios in IFM-CAP

Two scenarios

- **Crop diversification: full enforcement**
  - Farmers fully comply with the requirements

- **Crop diversification: hypothetical**
  - Farmers take into account the costs (administrative and greening penalty, profit loss) of not complying, and may decide on the level of compliance
  - Farmers may choose to be fully or partially non-compliant with requirements

Penalty scheme in the hypothetical scenario

	Exempt	Group 1	Group 2
Arable land (*AL*)	< 10 ha	10–30 ha	≥ 30 ha
Minimum number of cultivated crops	–	2	3
Maximum proportion of main crop in *AL* (%)	–	75%	
Maximum proportion of two main crops in *AL* (%)	–	–	95%
Non-compliant area (*W*)	–	$W = 0.50 \times AL \times r$	
Ratio of difference (r)	–	$r = \min(1, X75/25\% + X95/5\%)$	
Proportion of non-compliant area (*sh*)		$sh = W/(EL - W)$	
Penalty (*P*)	–	$sh \leq 3\% \Rightarrow P = 0$ $3\% < sh \leq 20\% \Rightarrow P = (2 \times W)/4$ $20\% > sh < 50\% \Rightarrow P = (EL\text{-}W)/4$ $sh > 50\% \Rightarrow P = EL/4$	
Area eligible for receiving the greening payment (*GP*)	–	$GP = EL - W - P$	

X75: percentage area of main crop going beyond the 75 % threshold;
X95: percentage area of two main crops going beyond the 95 % threshold;
EL = Eligible land

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IFM-CAP scenario results

- Out of **5 million commercial farms** represented in IFM-CAP for the EU-27:
  - **31%** are subject to the crop diversification measure (i.e. concerned farms)
  - the remainder (**69%**) are exempted from the measure

Affected farms by MS (% of total farms)

	Exempt farms	Concerned farms
BL	35.6	64.4
DK	9.8	90.1
DE	26.1	73.4
EL	86.2	13.8
ES	71.8	28.2
FR	39.8	60.2
IR	93.2	6.8
IT	79.4	20.6
NL	70.8	29.2
AT	51.1	48.9
PT	87.5	12.5
SE	27.8	72.2
FI	23.3	69.7
UK	55.8	44.1
CY	86.7	13.3
CZ	32.7	67.2
EE	46.7	53.3
HU	50.1	49.8
LT	38.9	61.1
LV	61.0	38.8
MT	99.0	1.0
PL	59.9	40.1
SI	90.3	9.7
SK	9.8	88.4
BG	87.4	12.6
RO	87.6	12.4
EU-27	**68.9**	**31.0**

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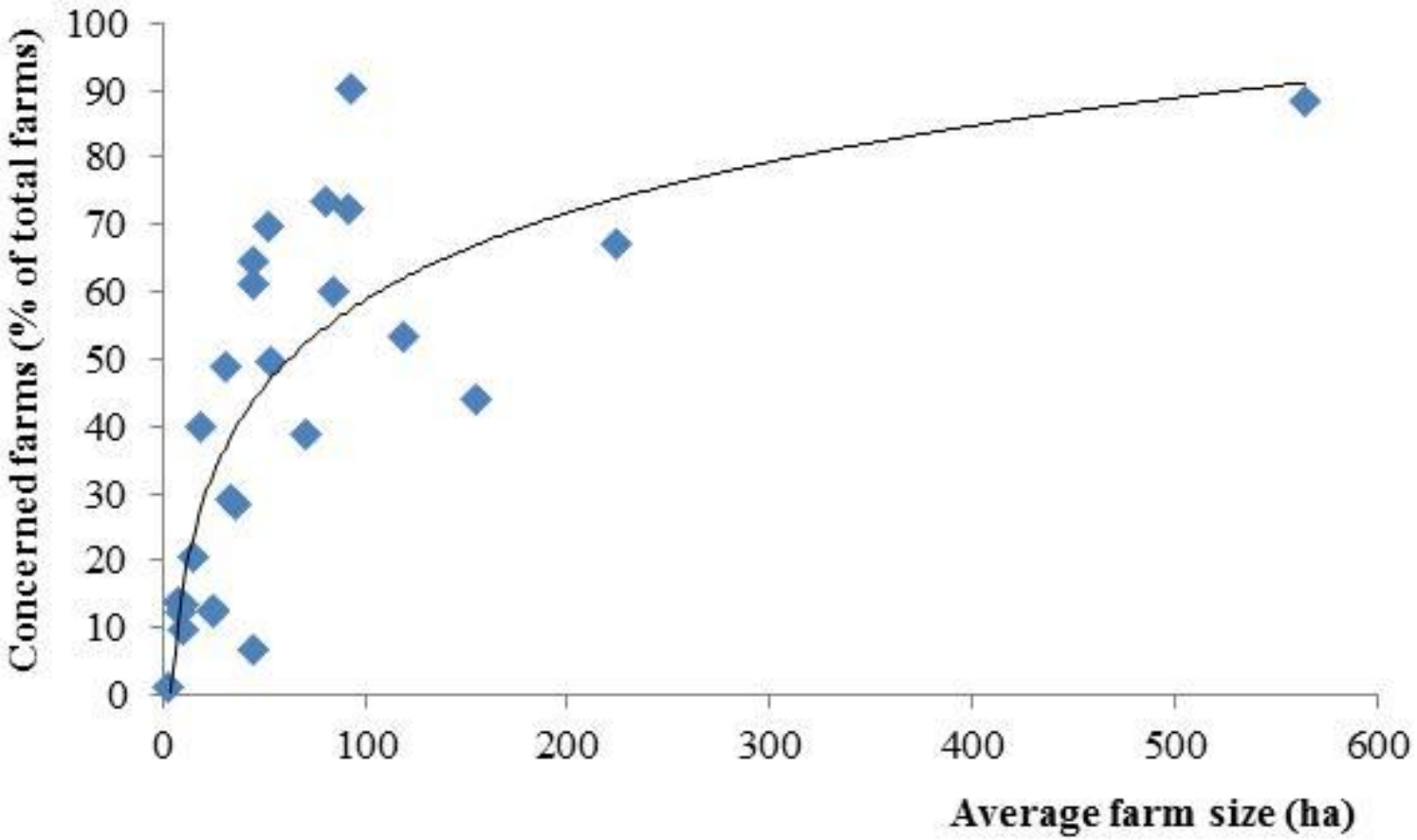
Correlation: Farm size and the share of concerned farms



Compliant and non-compliant farms by MS (% of concerned farms)

	Baseline		Full enforc.	Hypothetical scenario		
	Compliant	Non-compliant	Compliant	Fully compliant	Non-compliant	
					All	Increased compl.
BL	88.6	11.4	100	91.1	8.9	7.9
DK	85.6	14.4	100	90.2	9.8	8.2
DE	92.7	7.3	100	97.2	2.8	2.4
EL	74.7	25.3	100	79.9	20.1	13.5
ES	63.8	36.2	100	75.2	24.8	16.2
FR	93.1	6.9	100	96.3	3.7	3.5
IR	54	46	100	72.6	27.4	24.9
IT	79.5	20.5	100	88	12	9.4
NL	64.5	35.5	100	72.2	27.8	20.2
AT	95.3	4.7	100	98.2	1.8	1.8
PT	74.4	25.6	100	82.9	17.1	14.2
SE	90.7	9.3	100	95.9	4.1	3.5
FI	80.4	19.6	100	92.5	7.5	7.1
UK	84.7	15.3	100	92.2	7.8	6.2
CY	48.8	51.2	100	70.2	29.8	16.6
CZ	95.7	4.3	100	96.9	3.1	2.5
EE	92.9	7.1	100	96.9	3.1	3.1
HU	90	10	100	92	8	7.4
LT	96.5	3.5	100	98.6	1.4	1.2
LV	93.4	6.6	100	94.7	5.3	4.3
MT	100	0	100	100	0	0
PL	86.7	13.3	100	90.1	9.9	8.6
SI	96	4	100	98.2	1.8	1.8
SK	94.9	5.1	100	94.9	5.1	1.9
BG	75.1	24.9	100	82.6	17.4	4.6
RO	97.6	2.4	100	97.8	2.2	1.9
EU-27	**84.7**	**15.3**	**100**	**90.1**	**9.9**	**7.6**

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Simulation Results: income

- Income effect is relatively small (outcome of the profit maximization behaviour)
  - Average income declines less than 5% at MS level
  - For some farm specializations and farm sizes income effects are somewhat larger
  - Only around 5% of the total farm population experiences a negative income effect

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Reallocated area

Reallocated area:

- Share in total UAA
  - full enforcement scenario: 0.63%
  - hypothetical scenario: 0.32%

- Share in arable area
  - full enforcement scenario: 0.98%
  - hypothetical scenario: 0.51%

- Share of individual farms (in total farms) that reallocate area
  - full enforcement scenario: 5%
  - hypothetical scenario: 4%

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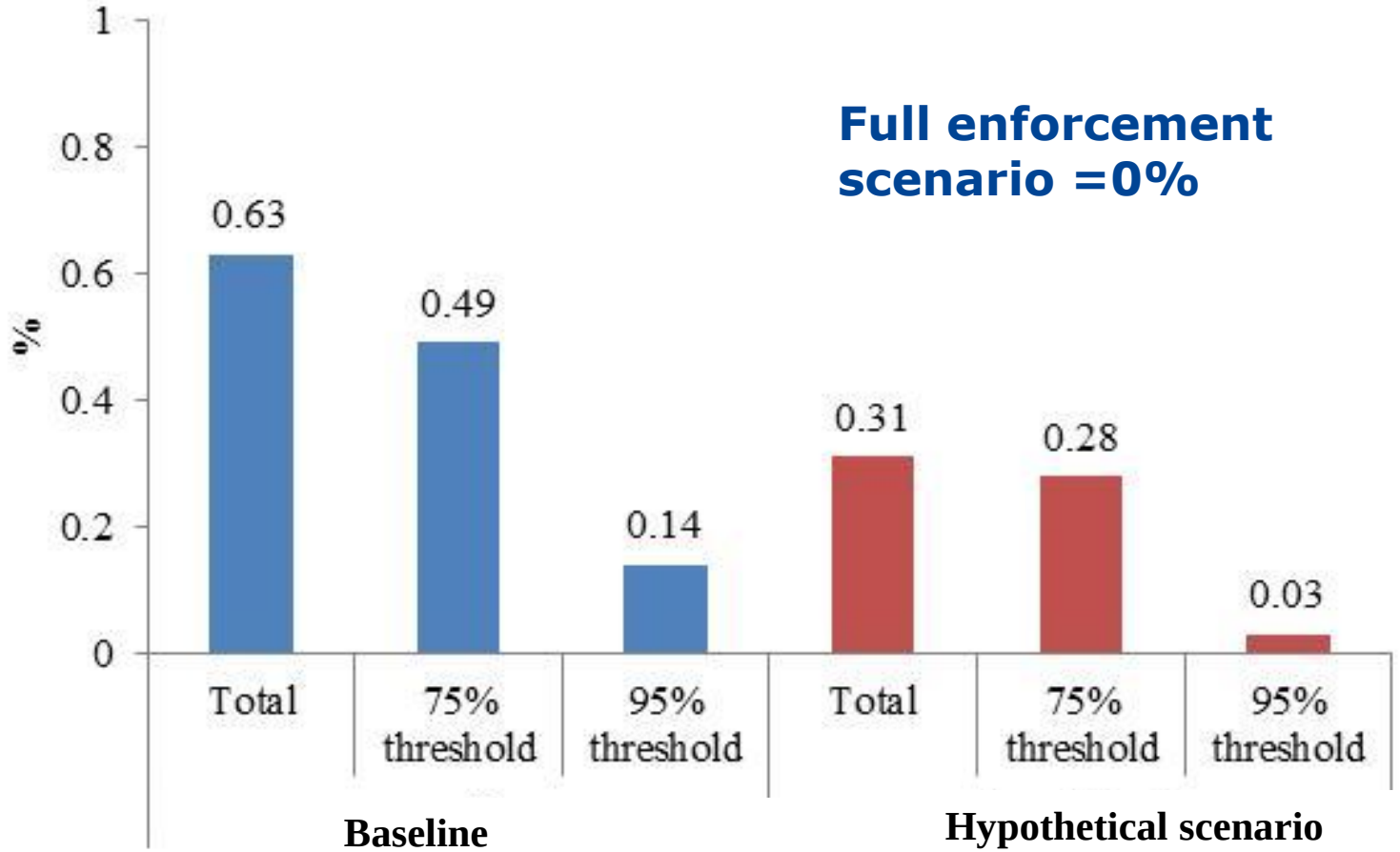
Area not complying with the diversification measure, EU-27 (% of UAA)



Full enforcement scenario =0%

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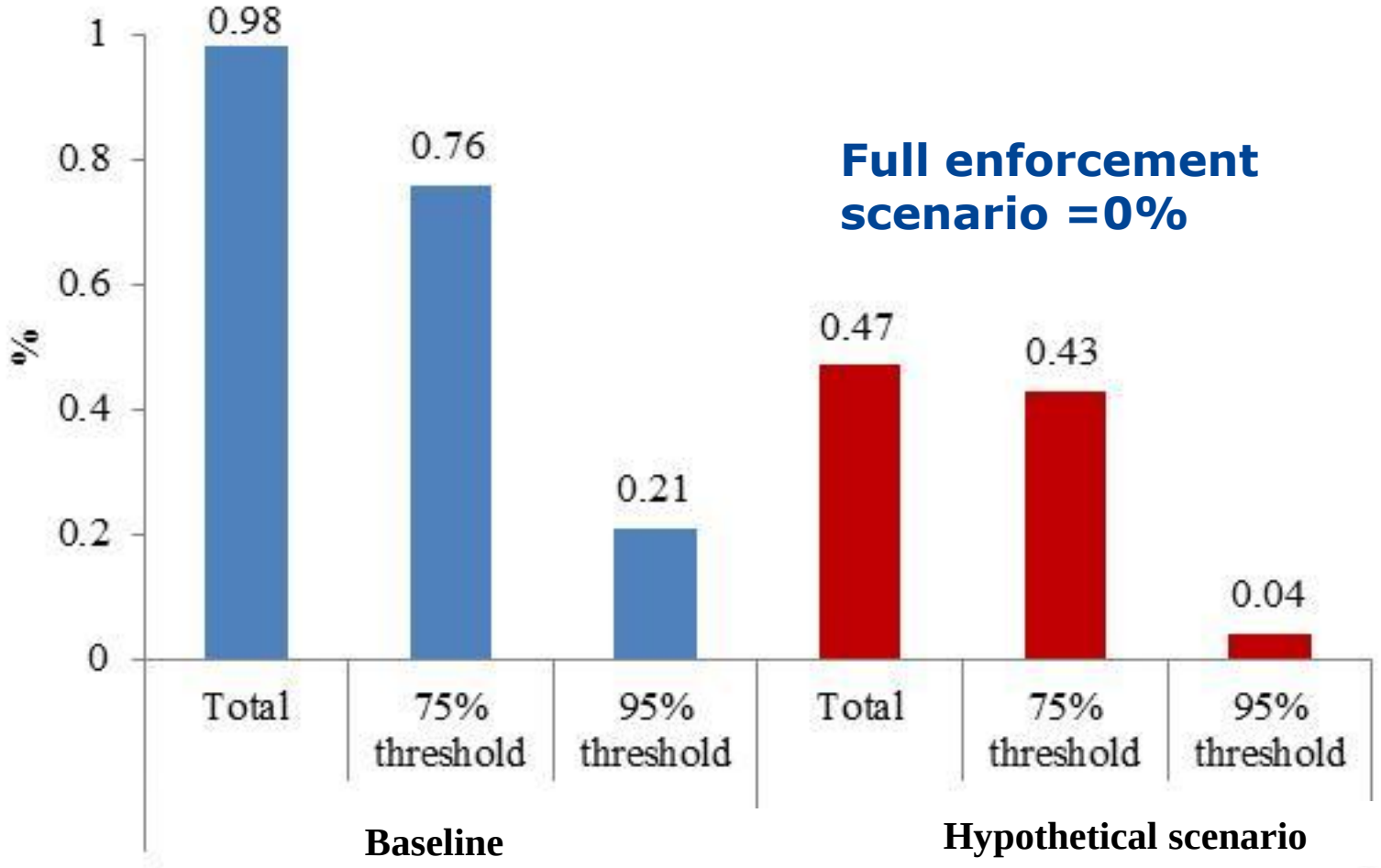
IFM-CAP Results

European Commission

Area not complying with the diversification measure, EU-27 (% in the concerned arable area)



Full enforcement scenario =0%

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Area not complying with the diversification measure by farm specialization, EU-27 (% in the concerned arable area)

	Baseline			Full enforc.	Hypothetical scenario		
	Averg.	Min.	Max.		**Averg.**	Min.	Max.
Cereals, oilseeds and protein crops	**1.0**	0.0	16	**0**	**0.5**	0.0	12
General field cropping	**0.8**	0.0	4	**0**	**0.4**	0.0	2
Horticulture	**2.9**	0.6	17	**0**	**1.9**	0.1	15
Vineyards	**1.5**	0.4	8	**0**	**0.9**	0.2	6
Fruit	**1.1**	0.3	23	**0**	**0.7**	0.0	11
Olives	**1.5**	0.2	3	**0**	**1.2**	0.7	2
Permanent crops	**2.7**	0.0	23	**0**	**1.5**	0.4	6
Dairy farms	**0.9**	0.0	7	**0**	**0.3**	0.0	4
Sheep and goats	**1.4**	0.2	12	**0**	**0.5**	0.0	9
Cattle rearing and fattening	**0.8**	0.1	15	**0**	**0.2**	0.0	3
Pigs and poultry	**2.5**	0.8	15	**0**	**1.2**	0.1	15
Mixed crops	**1.5**	0.0	5	**0**	**1.0**	0.0	3
Mixed livestock	**1.0**	0.1	8	**0**	**0.5**	0.0	5
Mixed crops and livestock	**0.6**	0.0	10	**0**	**0.2**	0.0	7

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Area not complying with the diversification measure by farm size, EU-27 (% in n the concerned arable area)

	Baseline			Diver-full	Diver-hypothetical		
	Average	Min.	Max.		**Average**	Min.	Max.
< 2 ESU	**0.1**	1.3	1	**0**	**0.1**	1.3	1
2 to < 4 ESU	**0.3**	0.1	4	**0**	**0.3**	0.2	4
4 to < 6 ESU	**0.7**	0.0	5	**0**	**0.5**	0.0	4
6 to < 8 ESU	**1.7**	0.2	12	**0**	**1.2**	0.1	11
8 to < 12 ESU	**1.4**	0.1	4	**0**	**0.9**	0.1	3
12 to < 16 ESU	**1.6**	0.0	10	**0**	**0.9**	0.0	10
16 to < 40 ESU	**1.3**	0.1	8	**0**	**0.6**	0.0	4
40 to < 100 ESU	**0.9**	0.0	5	**0**	**0.4**	0.0	2
100 to < 250 ESU	**1.0**	0.1	10	**0**	**0.3**	0.1	8
≥ 250 ESU	**0.7**	0.0	3	**0**	**0.4**	0.0	3

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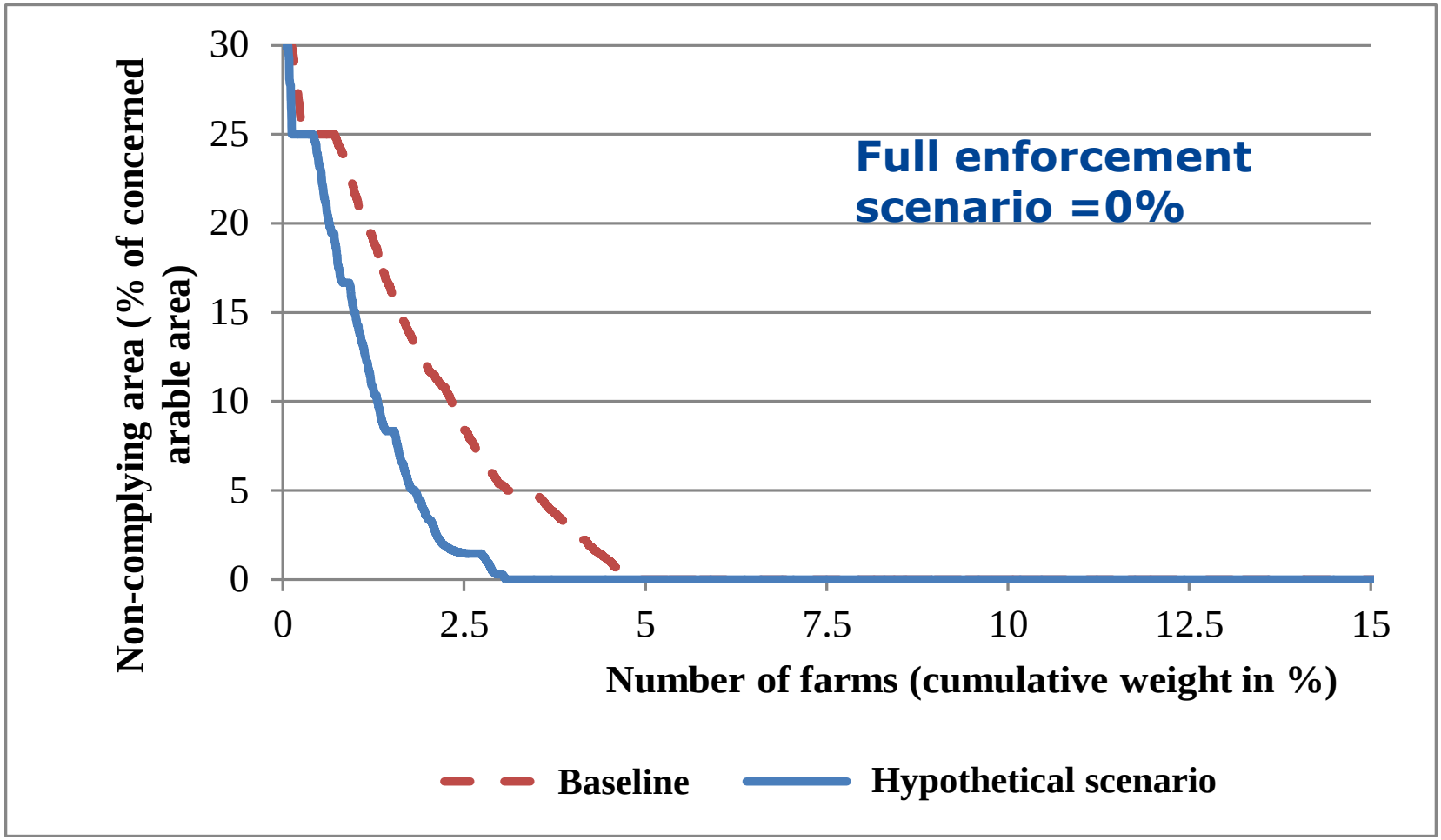
The distribution of non-compliant area by individual farm (% of concerned arable area)



Conclusions

- CAPRI and IFM-CAP are unique in the literature in being able to model CAP greening at EU level
- Complementarities between models:
  - CAPRI can capture market impacts
  - IFM-CAP can model farm specific implementation and impacts of policies
- Overall impacts are small
  - Out of 5 million farms around 5% of farms are affected
  - The reallocated area due to the measure represents less than 0.5 % of UAA
  - Market impacts small

Limitations

- Results presented here are preliminary
- The models are calibrated on the average 2007-2009 instead of single year data => some aggregation bias
- Aggregated crop activities in the models
- Not all implementation specificities are considered in the model (e.g. organic producers, 'small farmers' scheme)
- In the hypothetical scenarios we do not account for the fact that the penalty is harsher if a farm is non-compliant for three years => hence we underestimate the penalty
- Some aggregation bias in CAPRI as it uses farm types not individual farms
- Higher substitution between land use categories within farm types in CAPRI

Thank you for your attention

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Annexes

Modeling Crop diversity in CAPRI

Shannon Index:

$$\text{Shannon Index} = -\sum_i sh_i \ln(sh_i)$$

sh_i is share of crop *i* in arable land.

- Higher value implies more crops and/or more diversified crop structure on farm, e.g.
  - farm with 1 crop, Shannon index = 0
  - if area is split equally between 2 crops, Shannon index = 0.7
  - if area is split 80-20% between 2 crops, Shannon index = 0.50
  - if area is split equally between 8 crops, Shannon index = 2.08

Income per ha (% change relative to baseline)

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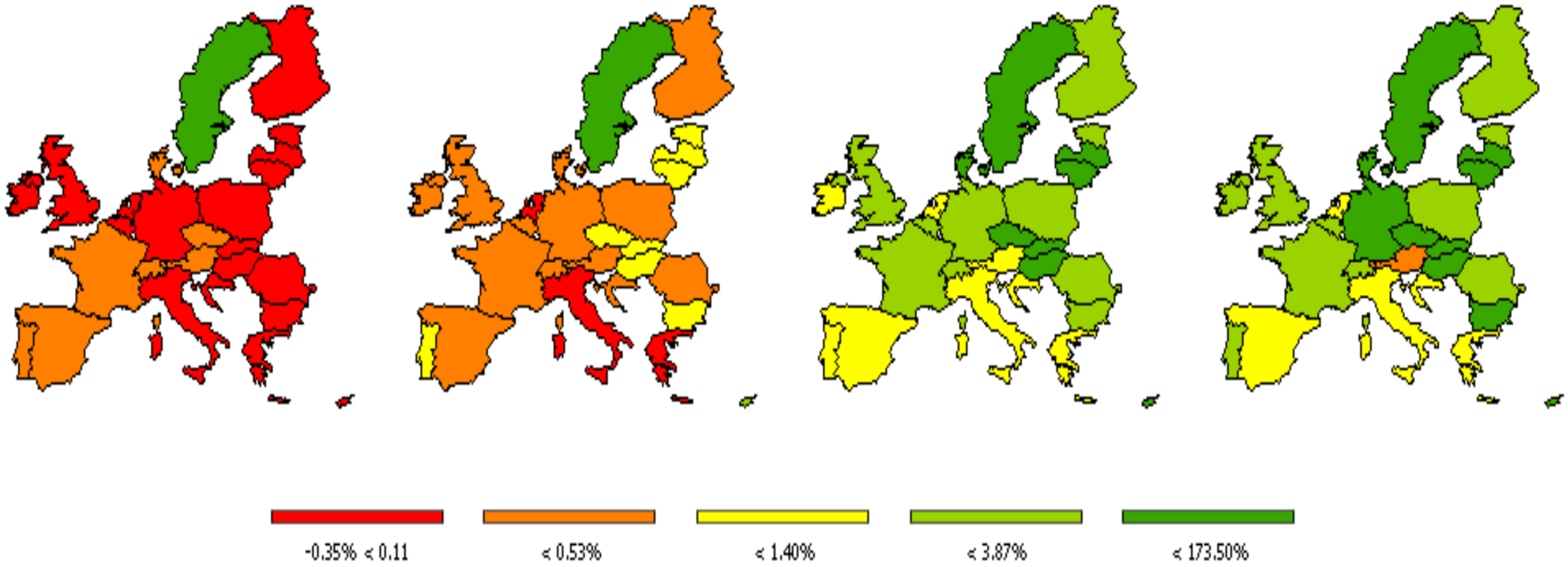
Crop diver. **Grassland** **Set-aside** **Greening all**



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