Biodiversity impacts of energy crop production on agricultural land use and farmland habitats in Europe

Project overview and first results
May 2005

ALTERRA

Biodiversity impacts of energy crop production on agricultural land use and farmland habitats in Europe

Project for the
European Environment Agency,
2004-2005

ALTERRA

Project consortium

- Wageningen University & Research:
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- Berry Meuleman (ECOFYS)
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The conclusions and recommendations presented today do not necessarily reflect the views of the EEA, they are entirely the opinions of the researchers

Overall objective of study:

to assess the potential impact of agricultural biomass production on biodiversity, given a number of storylines within the EU wider renewable energy targets by 2010-2020

do's and don'ts in relation to biodiversity in energy crop production

Policy targets used:

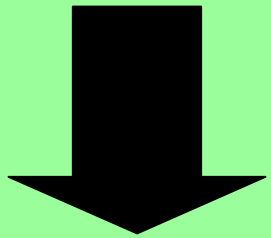
2010:

- EU White Paper on Renewable Energy Sources COM(97)599: *12% RES energy of total energy Consumption*
- Directive on Renewable Electricity (2001/77/EC):
  21% share of RES electricity in gross electricity consumption
- Transport Biofuel Directive (2003/30/EC): *Market shares in the European Union of 5,75% per MS*

2020:

- Transport fuels: *Market shares in the European Union of 5,75% per MS*
- Res-electricity and Heat: *the electricity produced from biomass sources (biomass, biogas and biowaste) in the EU25 will increase from 37 TWh in 2001 to 305 TWh in 2020.*

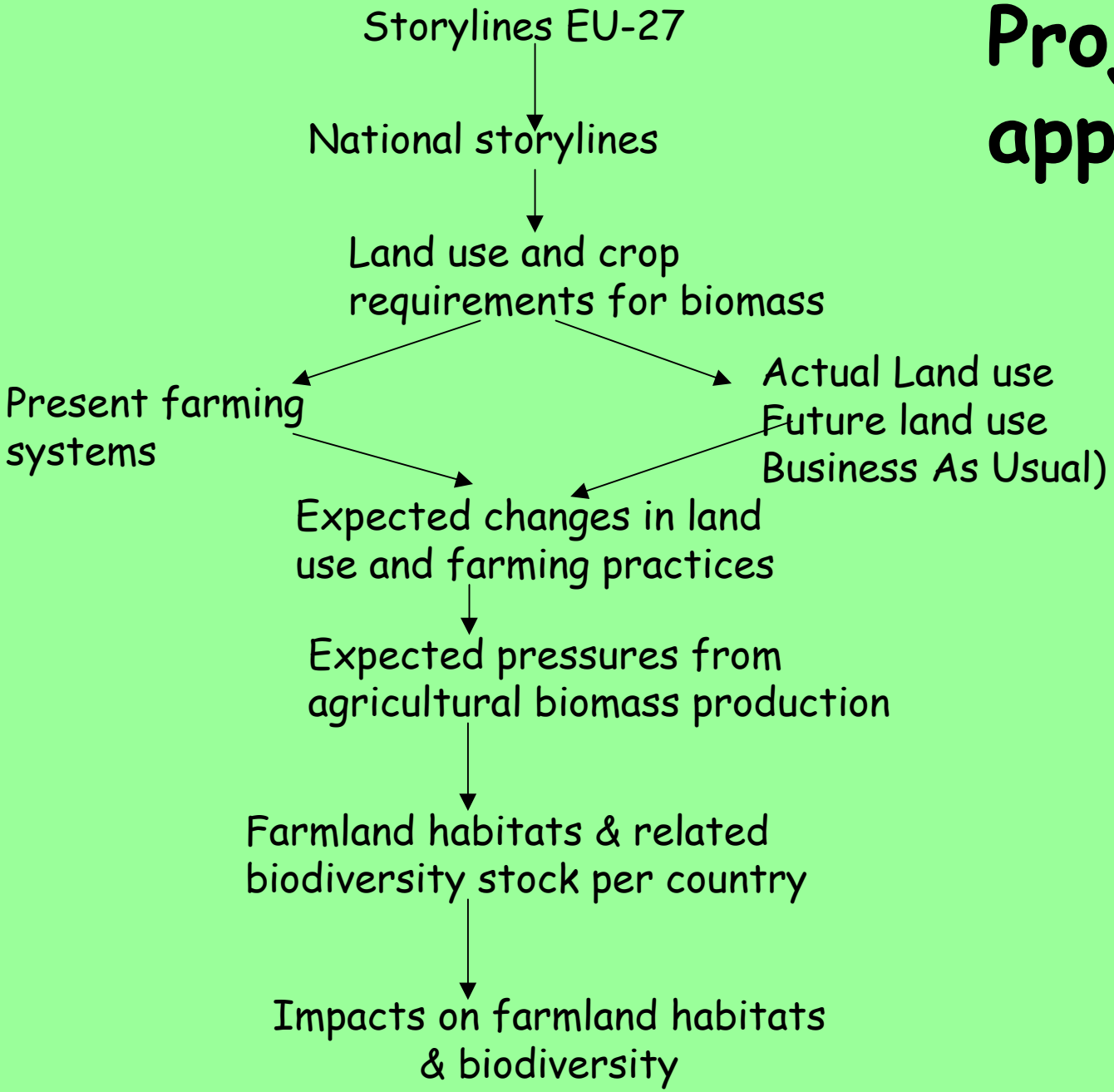
Future situation uncertain in 2010 and 2020 (How many ha?? Where? Which crops?)



Storylines (scenarios)

Not describe most likely future, but rather describe storylines which have diverging implications for future land use

Project approach



6 Storylines

Low impact 2010

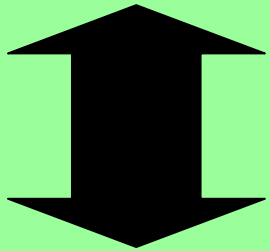
Medium impact 2010

High impact 2010

Low impact 2020

Medium impact 2020

High impact 2020



Net Effect

Business as Usual Storyline

- No EU biomass directives

-Only CAP: Mit Term Reform

Biofuels storyline specifications (I)

Endogenous factors (varying with storylines)		***Storylines (impact)***		
Variable	***Index***	***Low***	***Medium***	***High***
Targets Biofuels Directive		Targets will be met (5.75%)		
import from outside EU	Depending on UAA per inhabitant (low UAA/ha more import allowed)	20-50%	10-40%	0-30%
Cross border export within EU 27	Depending on UAA per inhabitant (high UAA/ha more export allowed)	0%	0%	0-10%

Biofuels storyline specifications (II)

Endogenous factors (varying with storylines)		***Storylines (impact)***		
Variable	***Index***	***Low***	***Medium***	***High***
(i) Transport fuel mix	Dependent on present (bio)fuel mix	= reference is a combination of present biofuel mix, and fuel mix (petrol-diesel)		
(ii)Transport fuel mix	More biodiesel than in reference			+10%
	More bioethanol than in reference	+10%		
(i) Crop mix	Biodiesel/bioethanol	present share of crops potentially used for conversion into biodiesel (oilseed crops) bioethanol (starch and sugar crops)		
Crop productivity		(For low yield countries high increase rate/ for high yield countries low increase rate)		

Biofuels storyline specifications (IV)

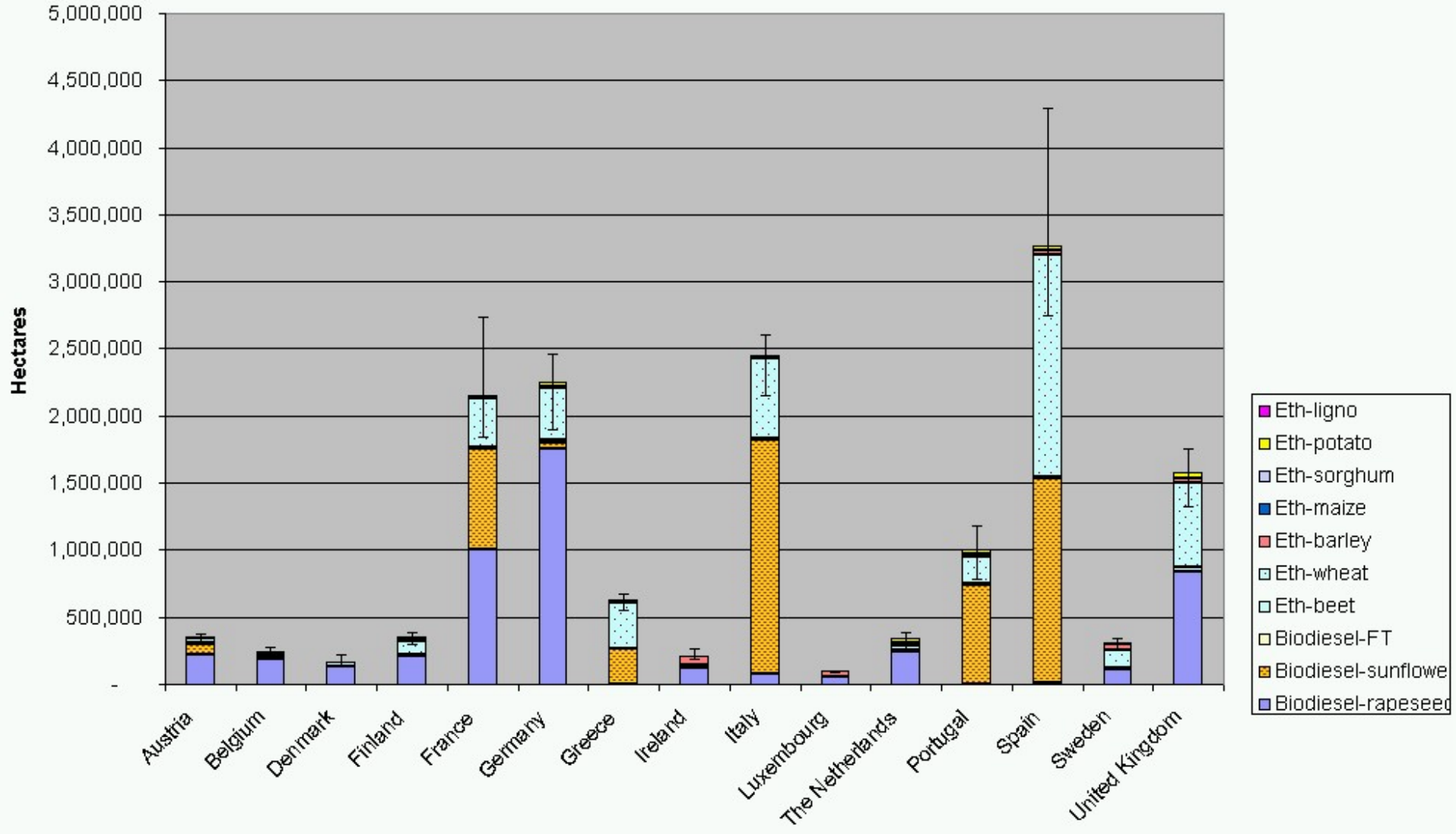
Endogenous factors (varying with storylines)		***Storylines (impact)***
Differences between 2010 and 2020 storyline specifications		
	2010	and 2020
(H) Conversion technology	5% from lignocellulose	30% from lignocellulose
(J) Conversion efficiency		+ 5%

Storyline specifications RES electricity and Heat

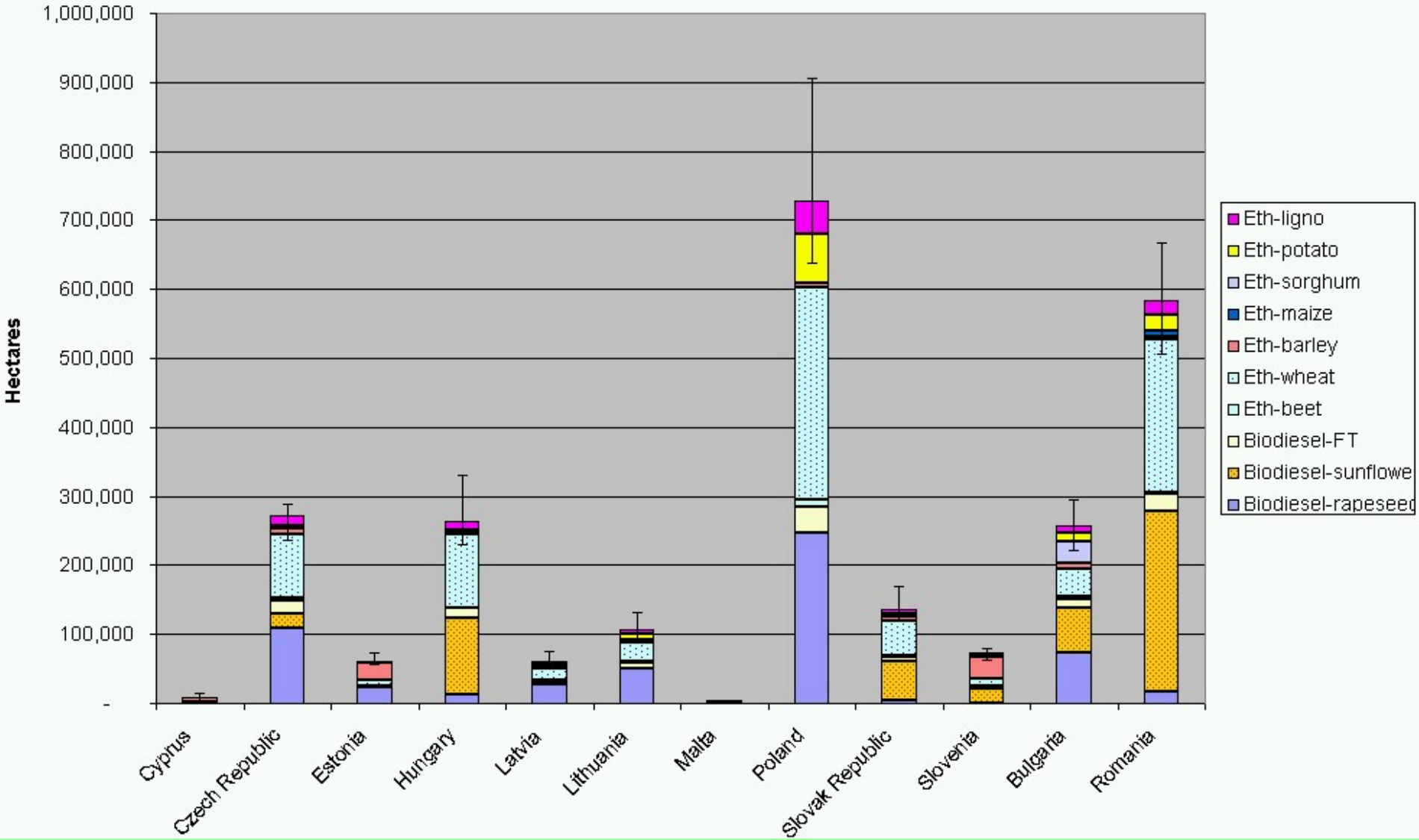
agricultural residues are not expected to require additional arable land

- energy crops are expected to remain the most expensive biomass source and therefore the least attractive option in the biomass supply curve of each MS

Results:
Land requirement for the medium impact storyline for Biomass crops in the EU15 (2010).



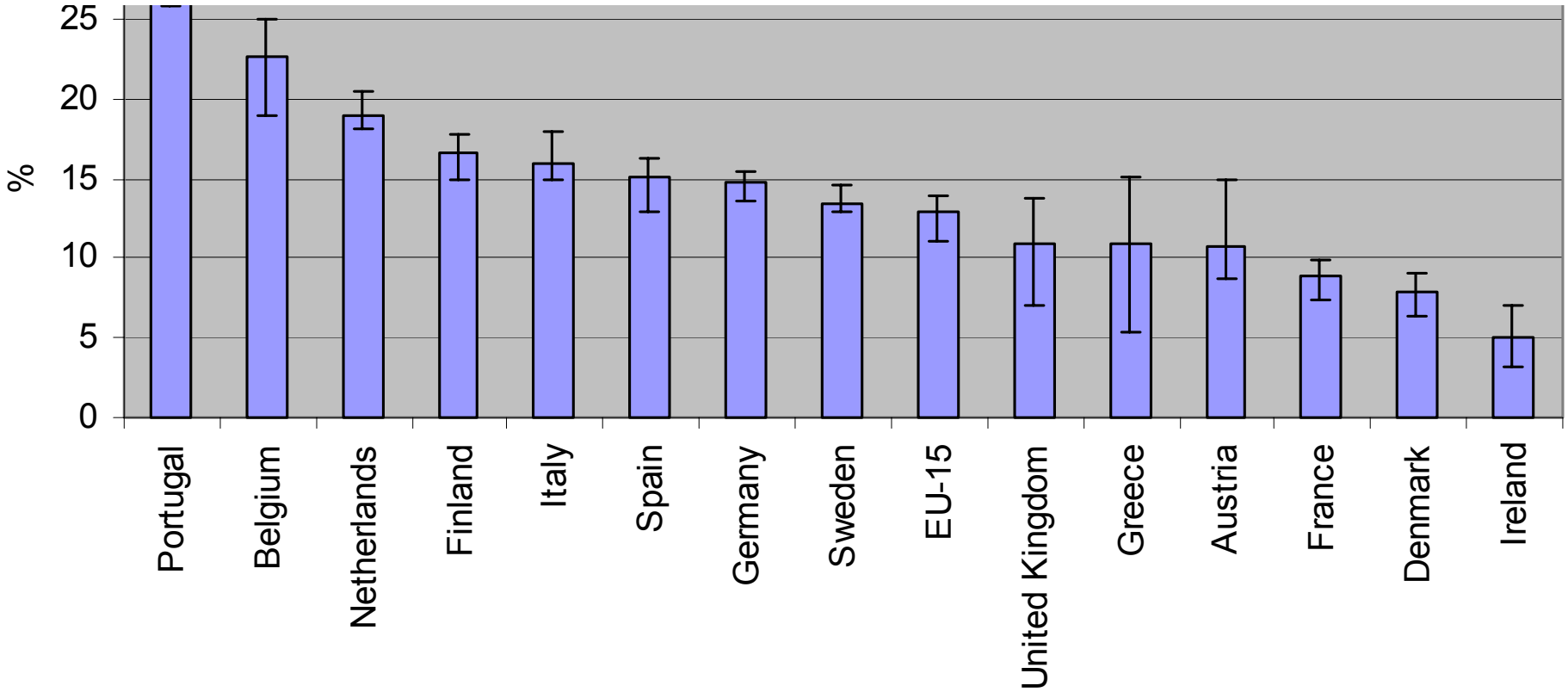
Results:
Land requirement for the medium impact storyline for Biomass crops in the EU10+Bulgaria&Romania (2020)



Linking storylines to land use

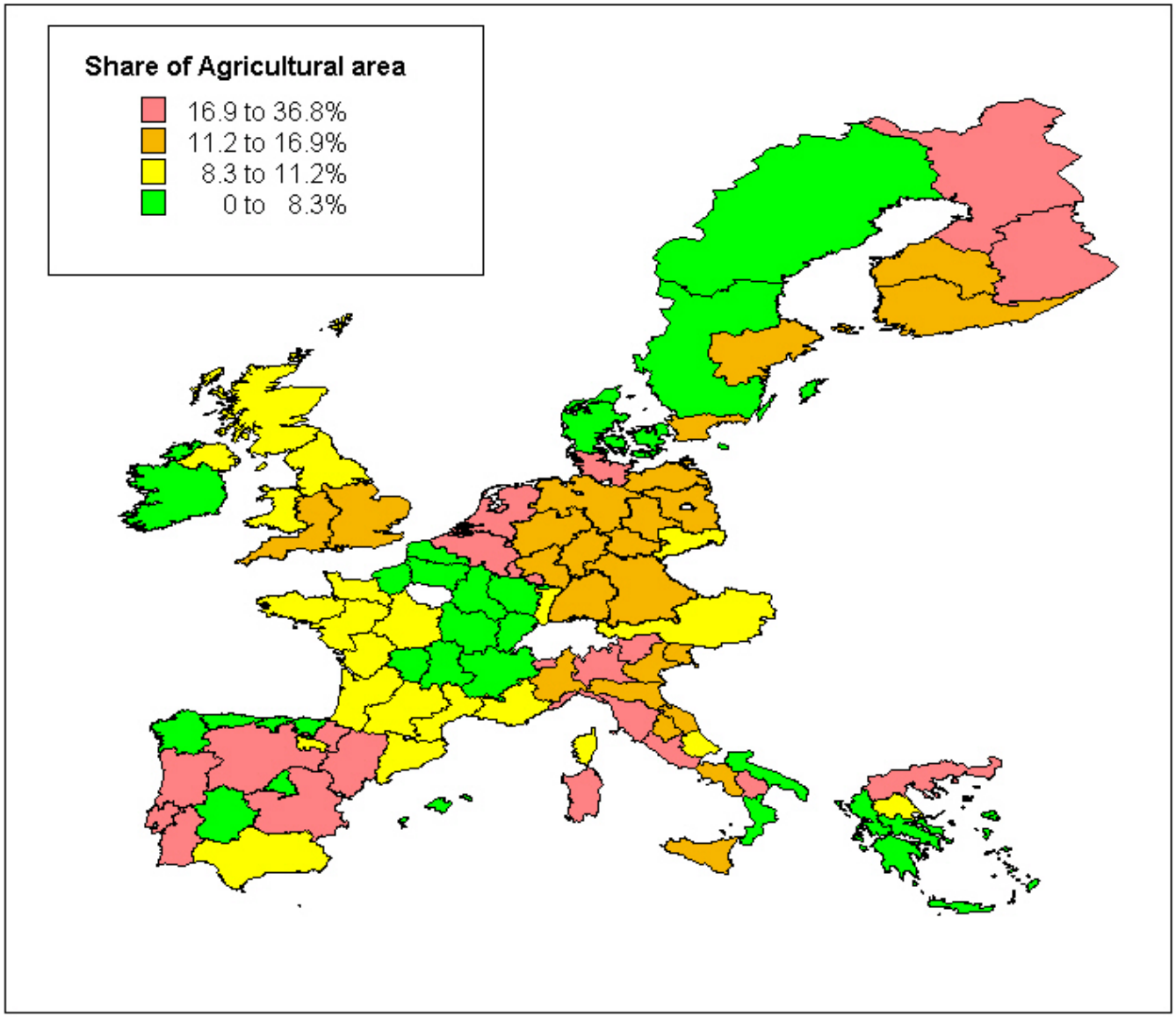
The share of the agricultural area projected to be used for biomass crops in 2010 in EU-15 according to the storylines.

In average 13% of the Utilised Agricultural area is expected to be used for biomass crops production by 2010

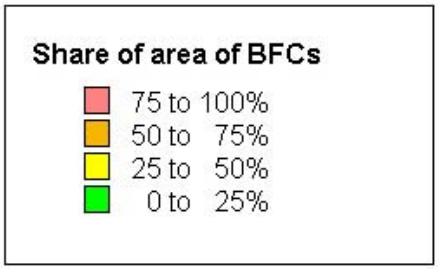


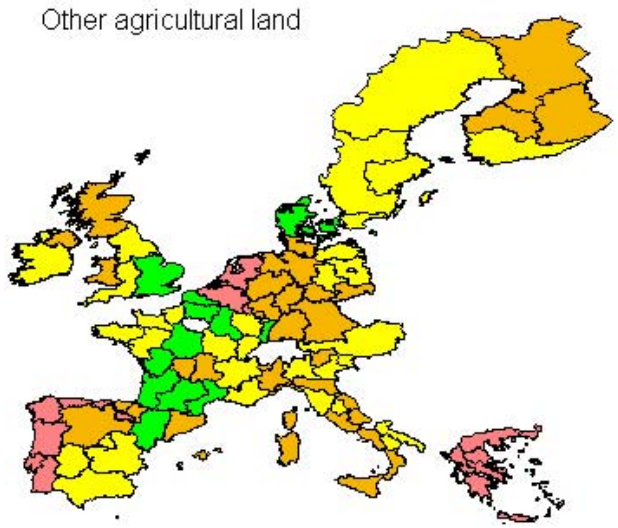
Error bars show land requirements for low and high storyline results

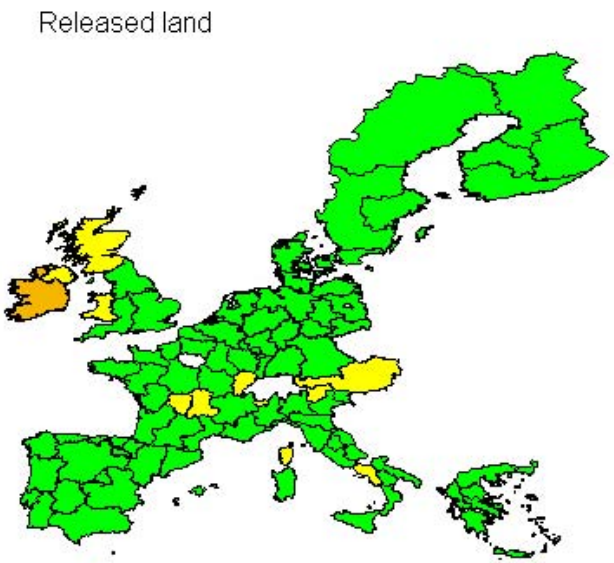
% UAA per region expected to be used for biomass crops 2010 EU-15 (medium impact storyline)

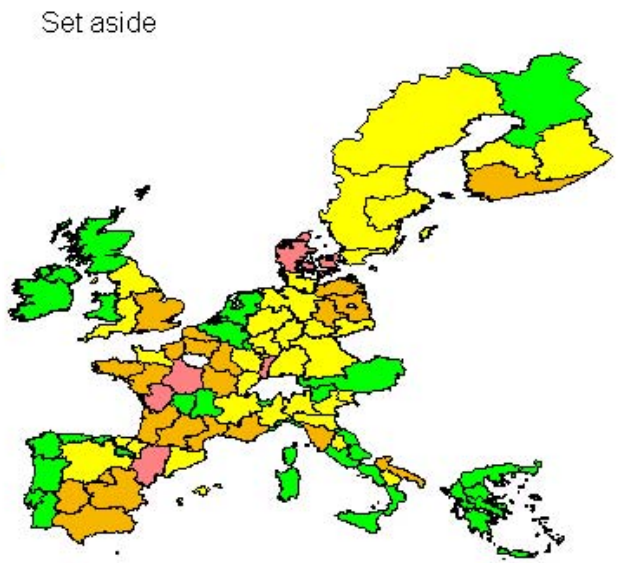


Types of land use conversions expected for biomass crop production



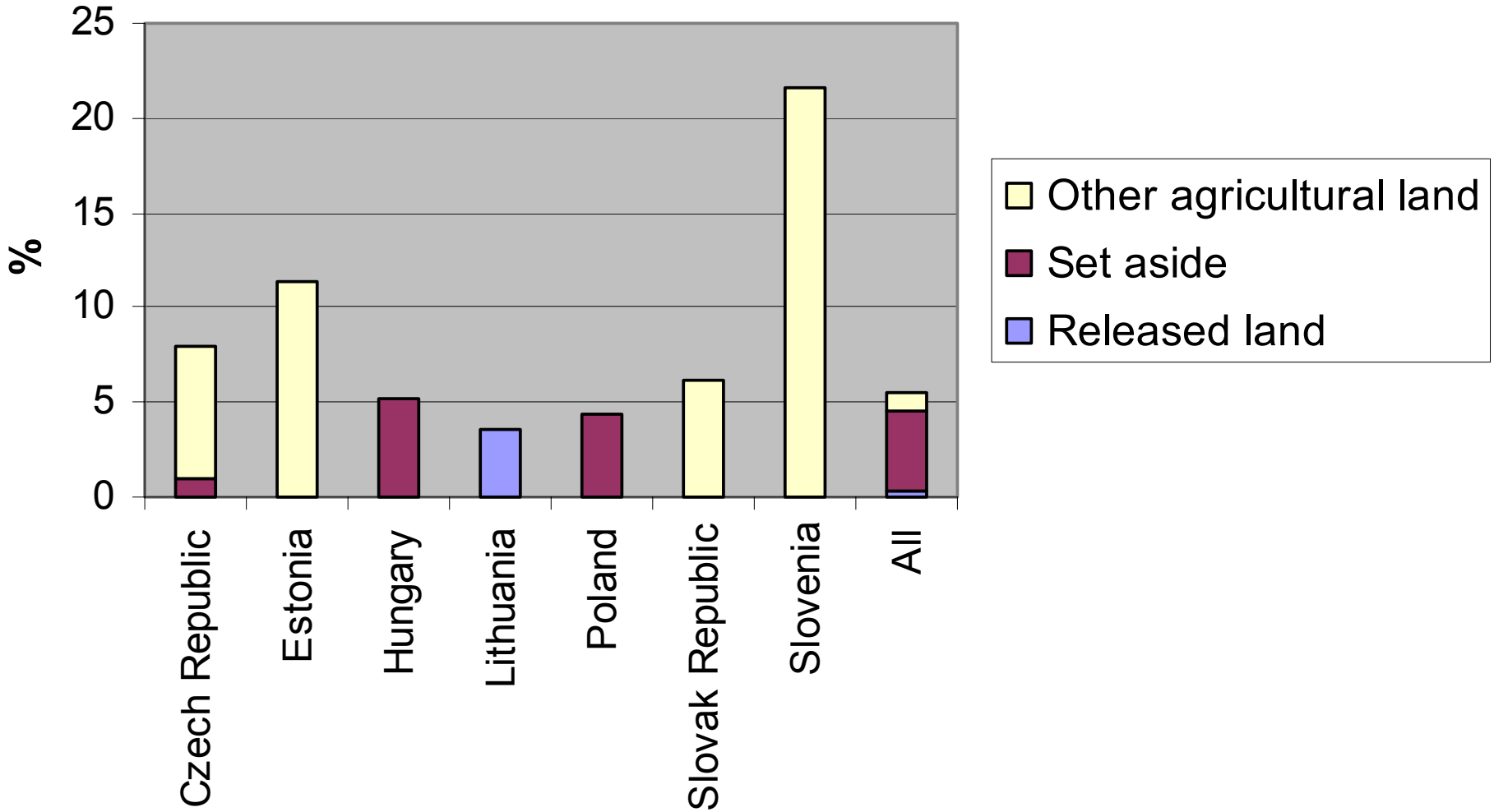




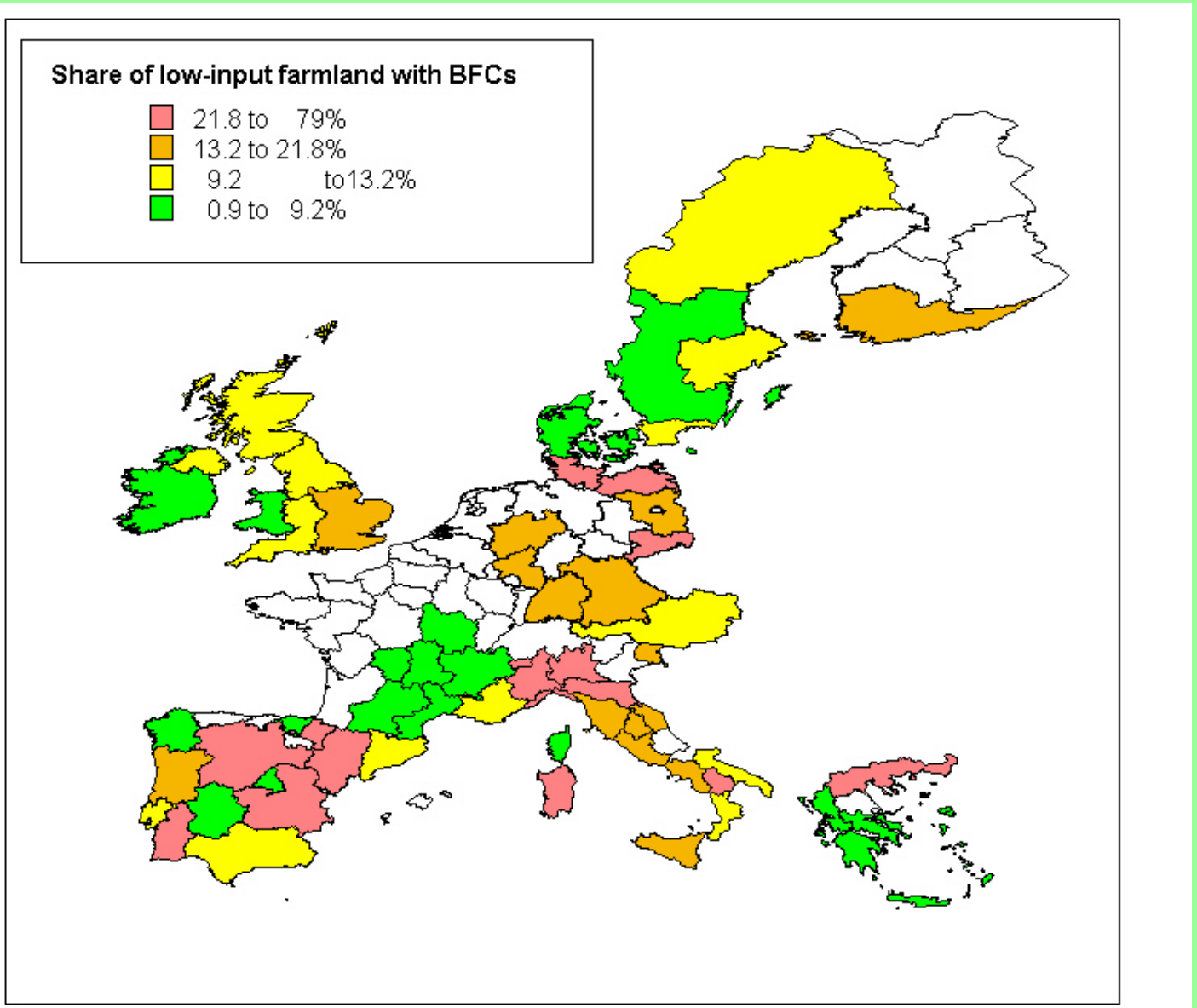


The maps show the % of the area substituted by Biomass Crops that otherwise (BAU storyline) would be set aside, released from agricultural production or other agricultural land

Types of land projected to be substituted by biomass crops in EU10



% of (former) low-input farmland that is likely to be used for biomass crops 2010



Effects on biodiversity

Biodiversity impacts depend on:

- Extent of land use requirements?
- Types of biomass crops?
- Types of land use conversions?
- Effects on types of biodiversity (Soil organisms, birds, mammals, invertebrates and plants)
- Effects on water and soil quality
- Effects on landscape diversity and habitat fragmentation

Three groups of biomass crops

Biofuel energy crops:

1) Sugar/starch: sugar beet and potatoes

2) Oil-starch: sun-flower, Rape, cereals, sorghum

Ligno-cellulose crops:

3) Short Rotation Coppice and perennial biomass grasses (myscanthus, Switchgrass, Reed Canary grass)

Effects of these 3 groups of biomass crops on biodiversity are different!

Three groups of biomass crops

Biofuel energy crops:

1) Sugar/starch: sugar beet and potatoes, fodder maize

Similar to conventional crops: higher input use

2) Oil-starch: sun-flower, Rape, cereals, sorghum, corn maize

Similar to conventional crops: lower input use

Ligno-cellulose crops:

3) Short Rotation Coppice and perennial biomass grasses (myscanthus, Switchgrass, Reed Canary grass)

Low input use, low mechanisation

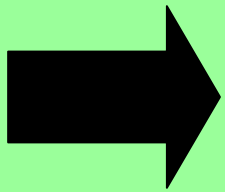
Types of land use conversions most likely to affect biodiversity in either positive or negative way

- Conversion of extensive land use categories to arable land. e.g.
  - Fallow/set-aside → arable
  - Permanent grass → arable
  - Dehesa/montado → arable
  - Abandoned land → arable
  - Wetland → Drained arable land
- Changes within arable land e.g.
  - Intensive crops → extensive biomass crops (SRC)
  - Extensive crops (spring cereals) → intensive biomass crop (e.g. root crops)
  - Intensive crops → intensive crops
  - Decreased/increased crop diversity

Drivers:	*Pressures:*	Water	Soil	Soil organism	Birds	Mammals	Inverts	Plants
rotation widening/ less pesticides/ less fertilisers	extensification	+	+	+	+	+	+	+
clearing abandoned land	Re-using abandoned land, increase landscape diversity	-	-	-	+	+/-	+/-	+/-
drain land/ bring land under irrigation	Drainage/ irrigation	-	-	-	-	-	-	-
enlarging plots/ remove hedges, tree lines etc	Habitat fragmentation	0	0	0	-	-	-	-
more tillage/ploughing removal biomass	Erosion/ disturbance	-	-	-	-	-	-	-
More N-application	Eutrophication, Acidification	-	-	-	+/-	0	-	-
More pesticides	pollution	-	-	-	-	-	-	-
Ploughing-up of perm. grassland/Dehesas	Habitat destruction	-	-	-	-	-	-	-

Land uses that can be converted to biomass crops

- Horticulture (open air)
- Root crops
- Horticulture (under glass)
- Intensive winter weeds
- Maize (grain/forage)
- Intensive permanent grass
- Intensive permanent Crops
- Fodder crops
- Short-term set aside
- Extensive arable
- Short-term fallow
- Mediterranean scrub
- Long-term set aside
- Long term fallow
- Extensive permanent grass
- Wetlands



Biomass crops:

Biofuel energy crops:

1) Sugar/starch: sugar beet and potatoes

2) Oil-starch: sun-flower, Rape, cereals, sorghum

Ligno-cellulose crops:

3) Short Rotation Coppice and perennial biomass grasses

For 128 combinations of land use changes (16*8) the directions of impacts on biodiversity were determined and expressed in indexes

e.g. Switch from intensive winter wheat to <u>Sugar/Starch biofuel</u> crops:

Pressure	Water	Soil	Soil Organisms	Birds	Mammals	Inverts	Plants
Landscape diversity				+	+	+	+
Inputs (fertilisers)	-	-	--	-	-	-	--
Inputs (Pesticides, Herbicides)	-	-	-	--	-	-	--
Irrigation							
Tillage							
Drainage							
Habitat fragmentation							
Mechanisation							

For 128 combinations of land use changes (16*8) the directions of impacts on biodiversity were determined and expressed in an index

e.g.Switch from intensive winter wheat to Switchgrass:

Pressure	Water	Soil	Soil Organisms	Birds	Mammals	Inverts	Plants
Landscape diversity	+	+	+	++	++	+	
Fertiliser	+	+	+	+	+	+	+
Pesticides	+	+	+	+	+	+	+
Herbicides	+	+	+	+	+	+	+
Irrigation	+	+	+	+	+	+	+
Tillage	+	+	+	+	+	+	+
Drainage	+	+	+	+	+	+	+
Habitat fragmentation							-
Mechanisation	+	+	+	+	+	+	+

Estimation of biodiversity effects

Combining:

- Indexes
- With land requirements (Storylines)
- Expected land use changes
  - Types of land use released in Business as usual storyline
    - Set aside/fallow
    - Land released from agriculture
    - Arable land (food/feed→ biomass crop)
- Expected % of low input farmland potentially used for biomass crop production

Results:
Estimation of % of Utilised Agricultural Area converted to biomass crops per country with a positive, negative and neutral effect on biodiversity

Results

- In Portugal, Italy, Spain, Slovenia, Estonia and Bulgaria largest % of UAA at risk of a loss in biodiversity.
- because:
  - Large % of set aside/fallow converted to biomass crops
  - Large % of low input farmland
  - Large % of UAA required for Biomass crop production

Initial conclusions (I)

- Pressures for change from increased biomass demand on land use are not equally distributed over EU27
- More pressure on land in Portugal, Belgium, The Netherlands, Italy and in New MS: Malta and Slovenia.
- Overall however, changes in land use for satisfying demand for biomass from agriculture are expected mainly in intensive farming areas

Initial conclusions (II)

- Biodiversity impacts from increased biomass demand are likely to be relatively small except in countries where there is large proportion of Low intensity farmland
- Therefore; possible negative effects on biodiversity are larger in Southern Europe (Portugal) and some CEEC.
- Also: in countries with large share of high intensity farmland increased biomass demand can provide opportunities to increase biodiversity

Initial conclusions (III)

- In CEEC biomass demand impact is not as important as the expected impact on farmland biodiversity from the present intensification of agriculture (autonomous process)
- Abandoned grasslands in CEE an opportunity for nature conservation/bio-energy synergy by harvesting of grass for biofuel production
- In this study the effects were determined following the storyline assumptions! From these assumptions possible effects were investigated to identify the 'do's and don'ts'.

Do's and don'ts (I)

- Choose the right biomass crop→ depends on what land is being converted
  - Do not choose a more intensive crop (so oil crop above root crop, Perennial biomass grass/SRC above arable crop)
- Avoid monotonisation of the landscape
  - Try to introduce a mix of biomass crops (landscape diversity)
- Avoid converting low intensity farmland to biomass crops
- Possible gain for biodiversity in intensive arable land
- Explore win-win solutions for grassland management
- For choice of crops need to take local biodiversity stock into account (what biodiversity value can be reached?)