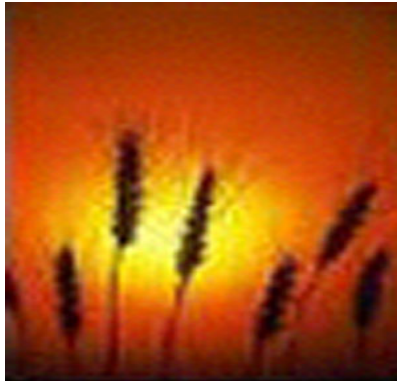




# IEF-LUC/IIASA

Kiev,  
28-30 May, 2007



## Biofuels for Europe – Ukrainian prospects

# LUC Research Framework

## *Global projects:*

- Food and Agriculture to 2100;  
Water and agriculture; Biofuels from agriculture; Agricultural production technologies and adaptation to global change; Livestock and environment; Future demand for land commodities and services.
- Water and Global Change

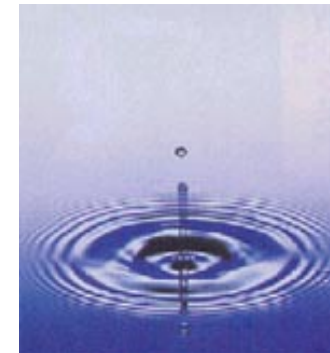
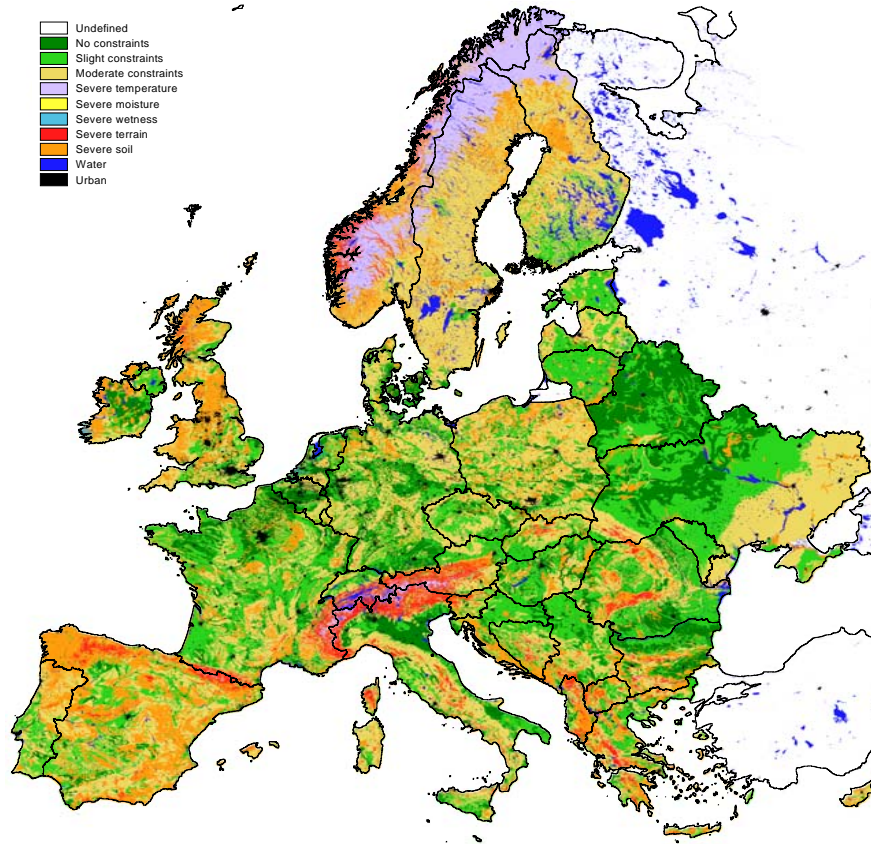
## *Policy support for sustainable development of regional agricultural and rural sectors:*

- Agriculture in Transition – A case study of Ukraine;
- Bio-fuel roadmap for Europe;
- Sustainable development strategy for Europe;
- China's agriculture in the 21<sup>st</sup> century

## *Methodology development:*

- Sequential rebalancing methods for spatial downscaling;
- Framework for spatial ecological-economic analysis.

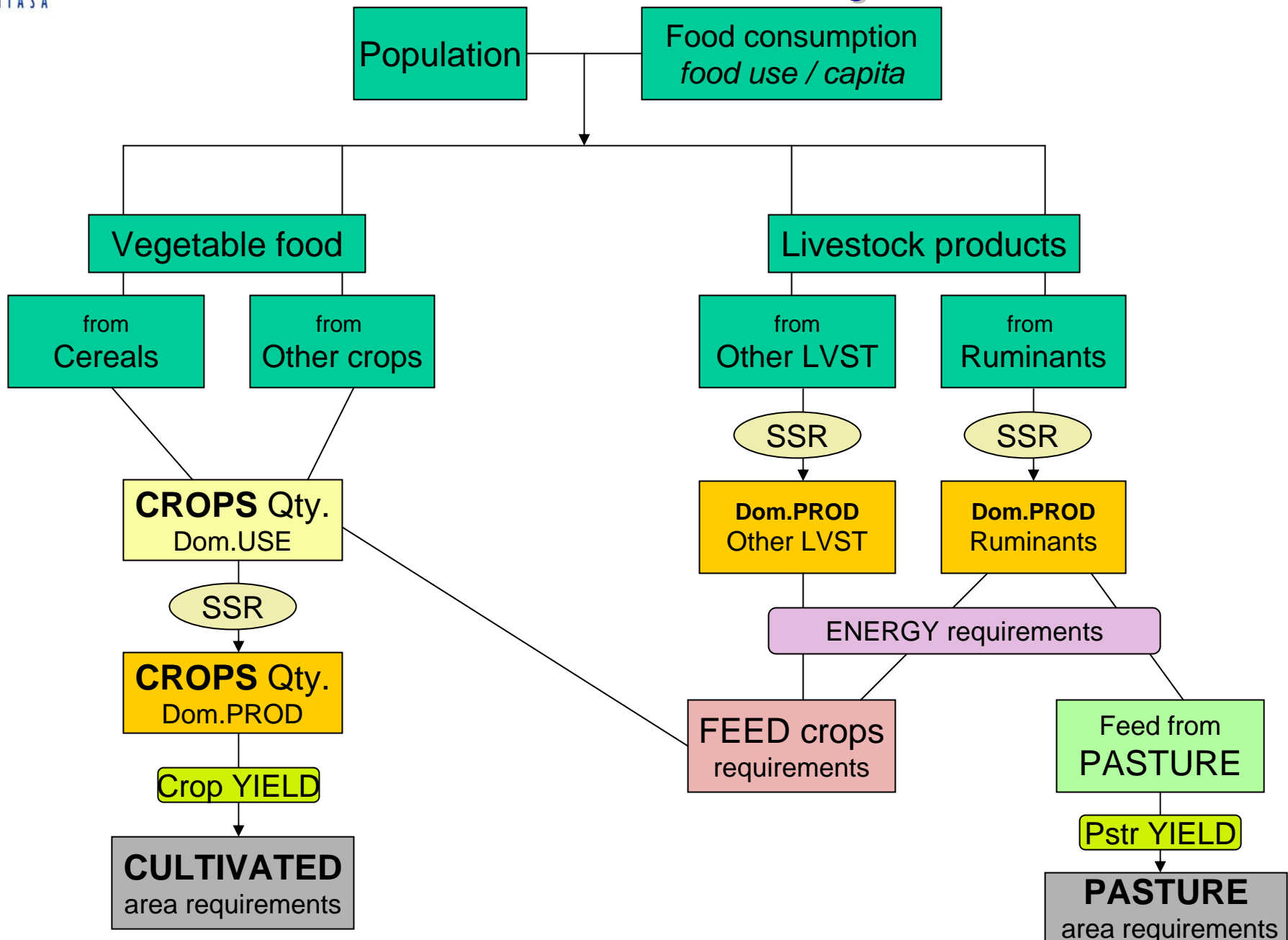
# BIOENERGY DEVELOPMENT



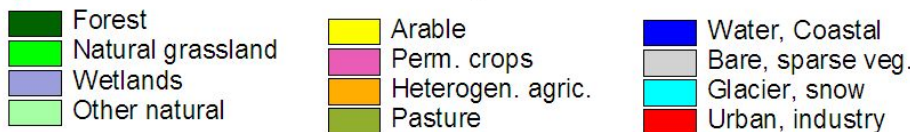
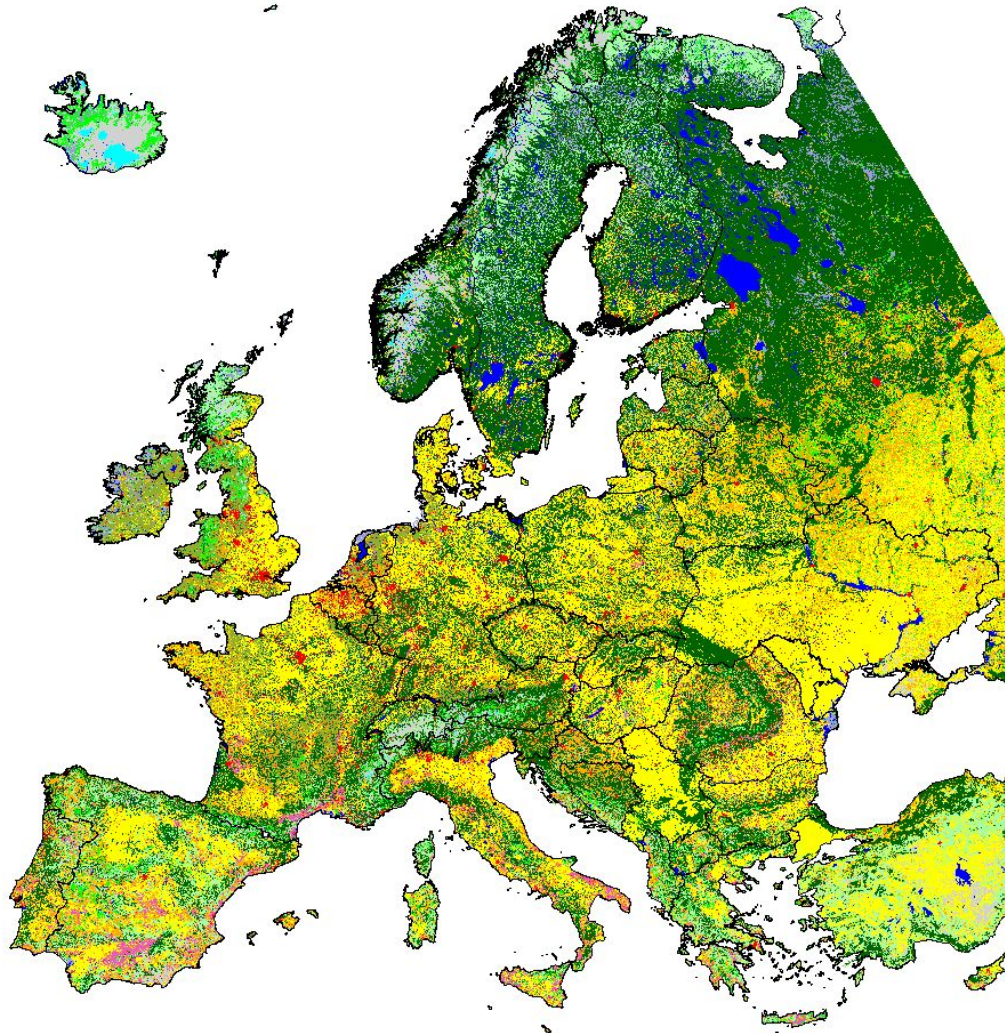
refuel



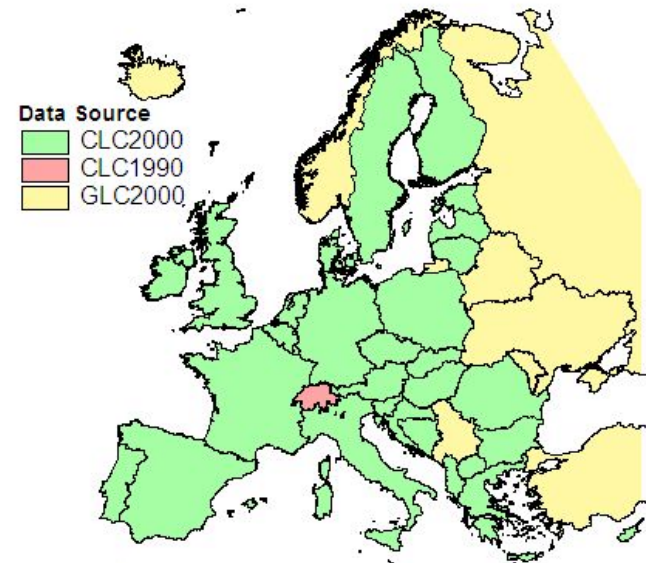
# REFUEL Scenario Projections



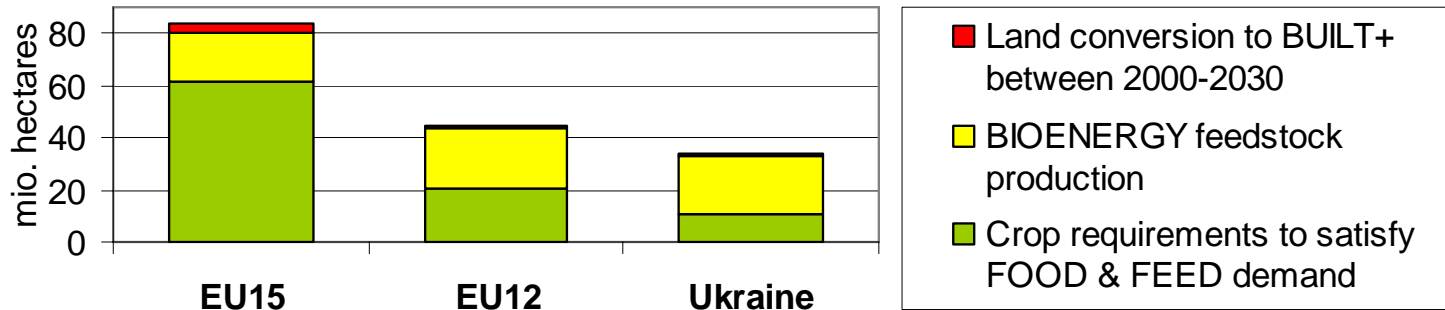
# Pan-European Land Use



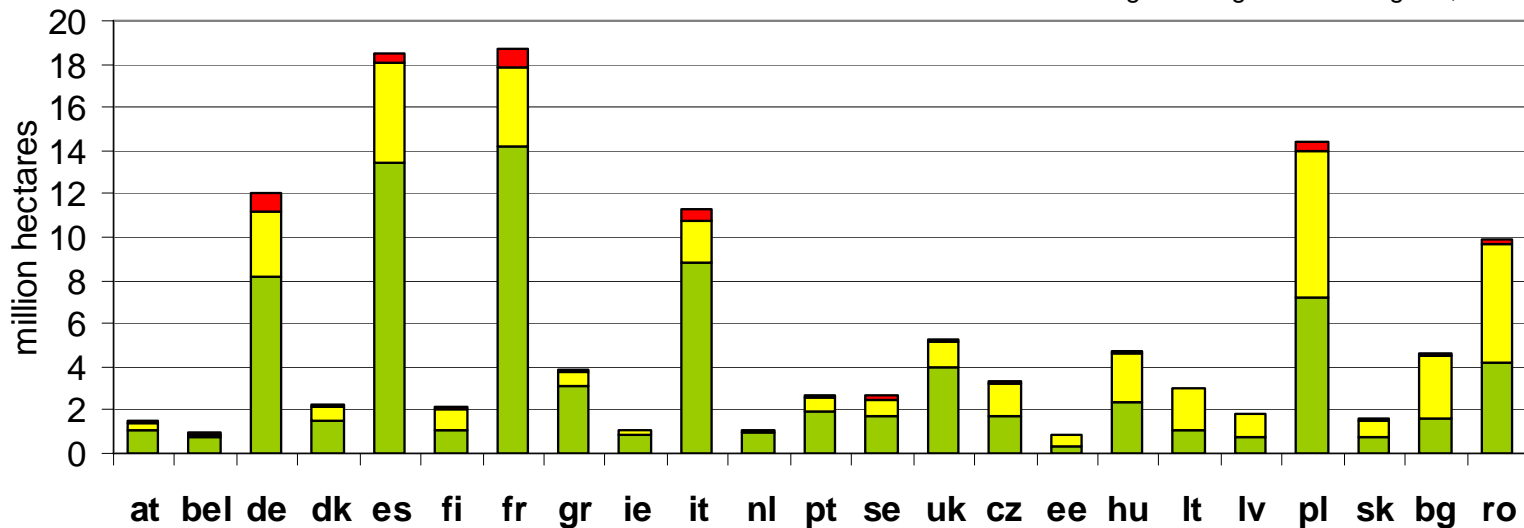
Three available European land cover databases (CORINE 2000, CORINE 1990, GLC2000 Europe) have been reclassified to twelve major land use classes for the purpose of determining spatial locations of arable land, grassland, forest and other areas. In this way a harmonized land use map was constructed for the Pan-European territory to permit spatially explicit estimation of land potentially available for bio-fuel production.



# Land required for food and feed and land potent. available for biofuel feedstocks, 2030



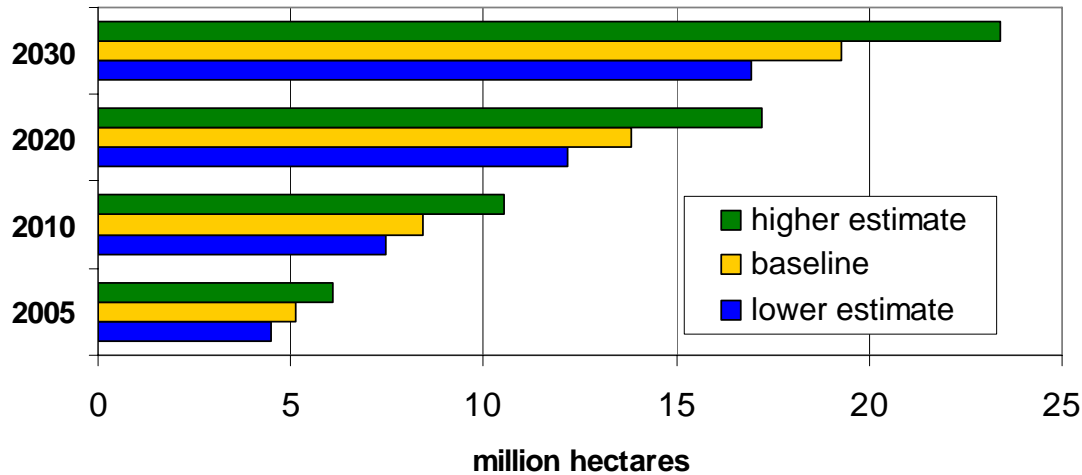
Source: Land Use Change and Agriculture Program, 2007



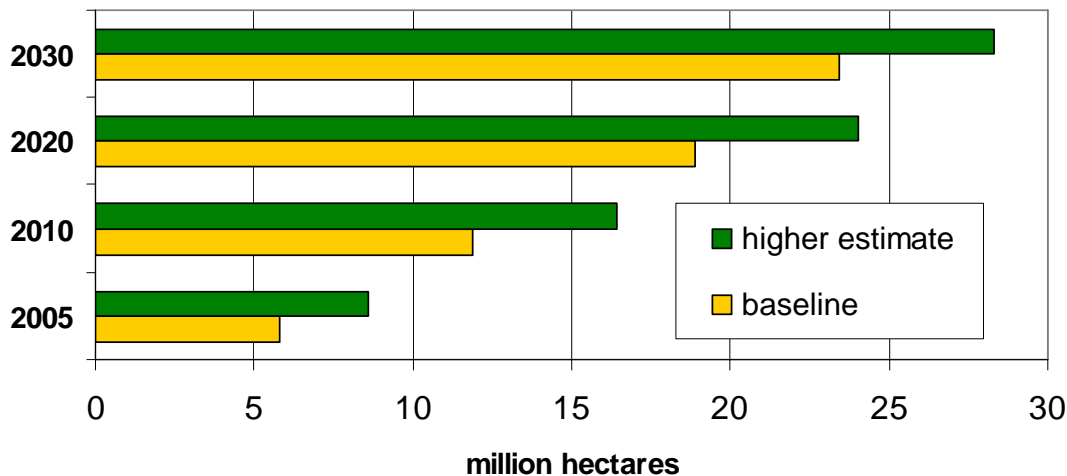
The graph shows the use of current stock of cultivated land in 2030 for EU15, EU12, Ukraine and selected European countries assuming projected food and feed demand would be satisfied from domestic production at current aggregate European self-reliance levels for cereals, other crops, ruminant livestock products as well as other meat (variant 'baseline' scenario).

# Trajectories of cultivated land potentially available for biofuel feedstock production

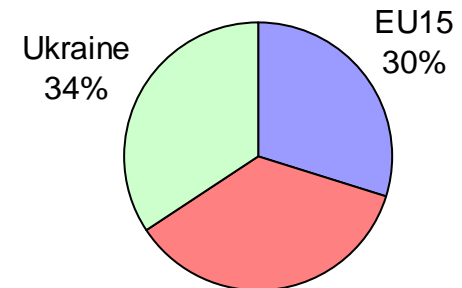
Potential area for growing BIO-CROPS in Western Europe



Potential area for growing BIO-CROPS in Eastern Europe



Source of potential cultivated land for growing BIO-CROPS in Europe, Baseline in 2030



Total = 65.1 million ha

Source: Land Use Change and Agriculture Program, 2007



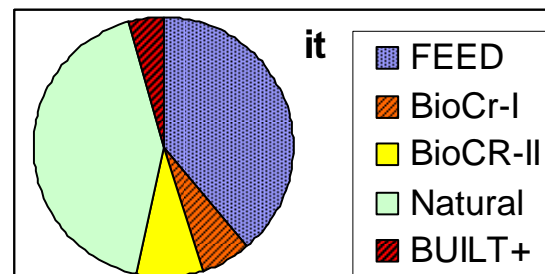
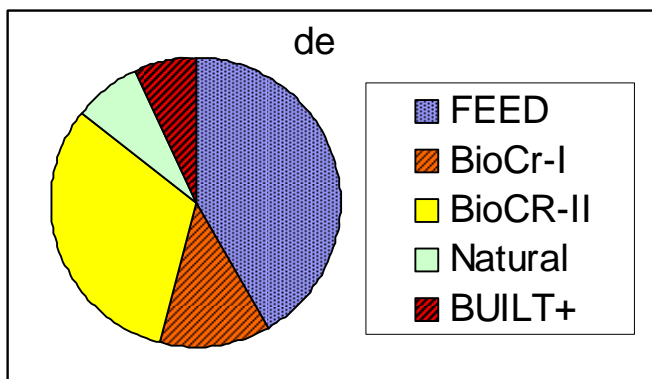
# Land for BIOENERGY crops – PASTURE

- **PASTURE**

Besides changes in feed area requirements, information on **land use** and **terrain** information from the **GIS** database was integrated to identify potential areas for harvesting bioenergy crops.

**BioCr-I:** Area gain due to technological progress (increased livestock intensity)

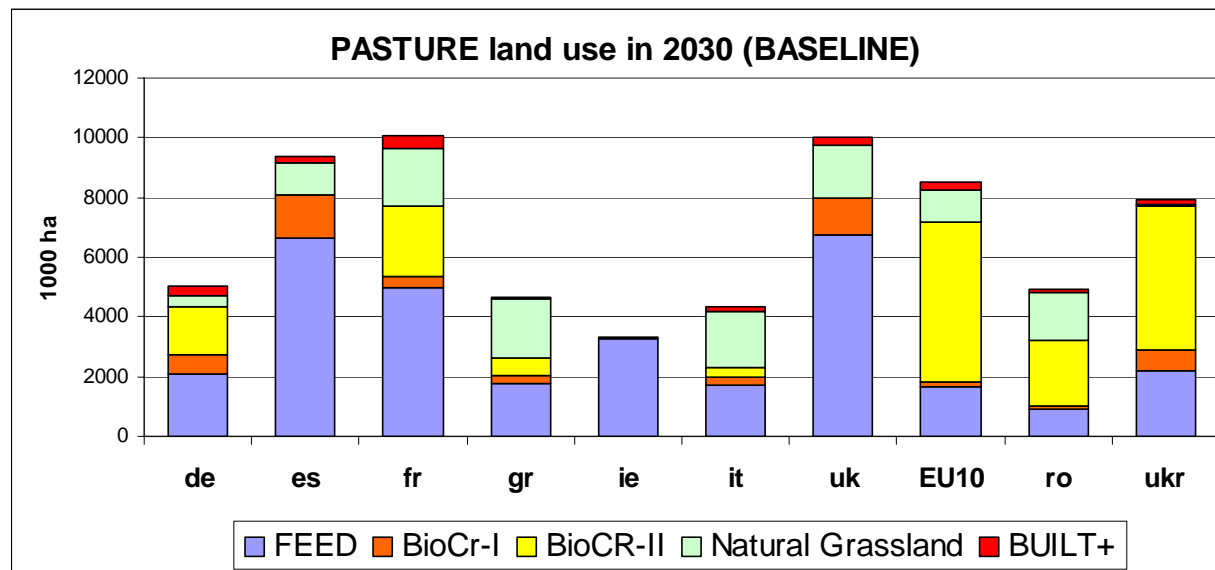
**BioCr-II:** “Surplus” pasture not restricted by slope or nature conservation (slope below 16% on grassland mask and not in land use class natural grassland)



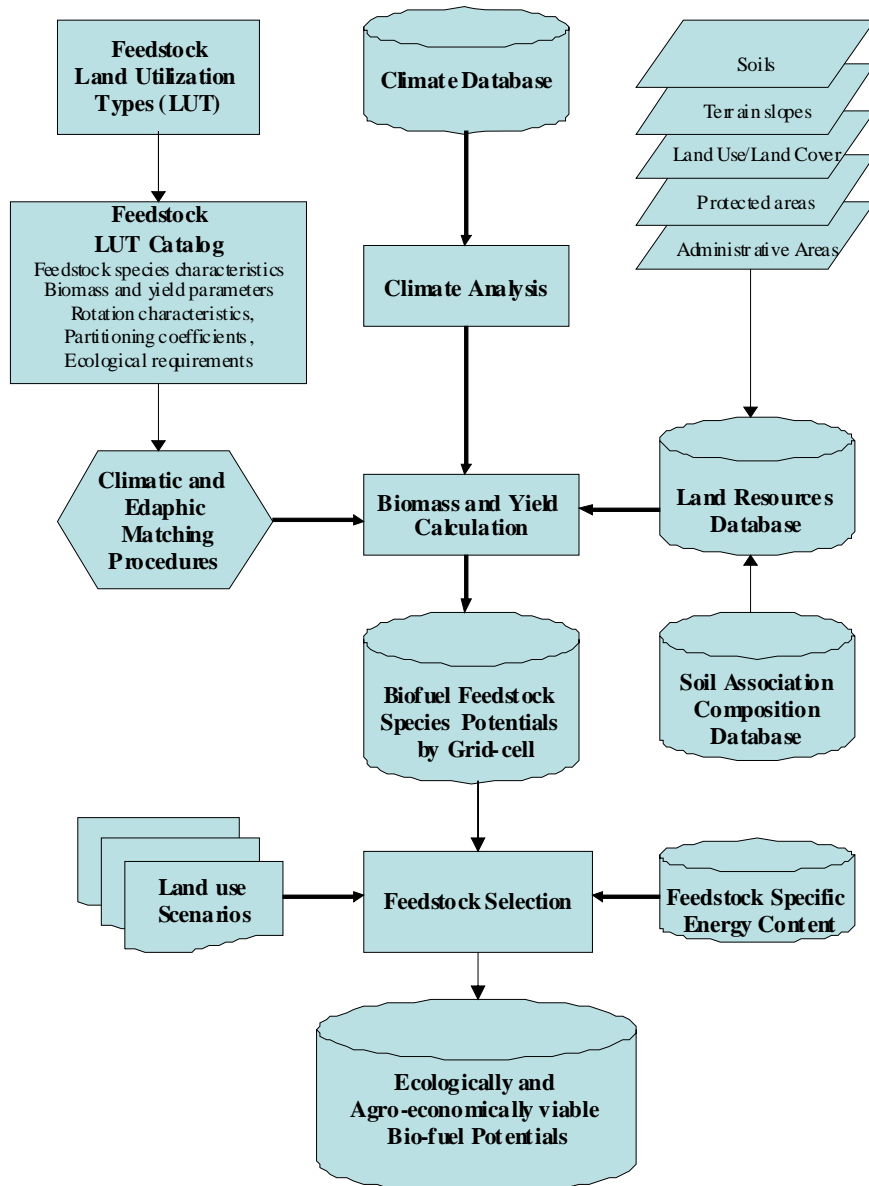


# Land for BIOENERGY crops – PASTURE

	FEED	BioCr-I	BioCR-II	Natural Grassland	BUILT+	SUM*
<b>EU25</b>	32382	4907	10564	11078	2075	61006
<b>EU15</b>	30700	4767	5210	9993	1835	52504
<b>EU10</b>	1682	140	5354	1085	240	8502
<b>ro+bg</b>	1077	187	2736	2433	132	6565
<b>ukr</b>	2183	706	4819	85	132	7924



# Methodology for assessment of biofuel feedstock potentials



## Biofuel feedstocks considered:

(1) Woody ligno-cellulosic plants – (2nd generation biofuels): Short rotation forestry management systems. Tree species considered include poplars, willows and eucalypts covering a wide range of ecological regions of Europe.

(2) Herbaceous ligno-cellulosic plants - (2nd generation biofuels): Herbaceous plants selected included miscanthus, switchgrass and reed canary grass.

(3) Oil crops – (1st generation biofuel for biodiesel production): The two selected oil crops are widely grown in Europe: rapeseed, sunflower.

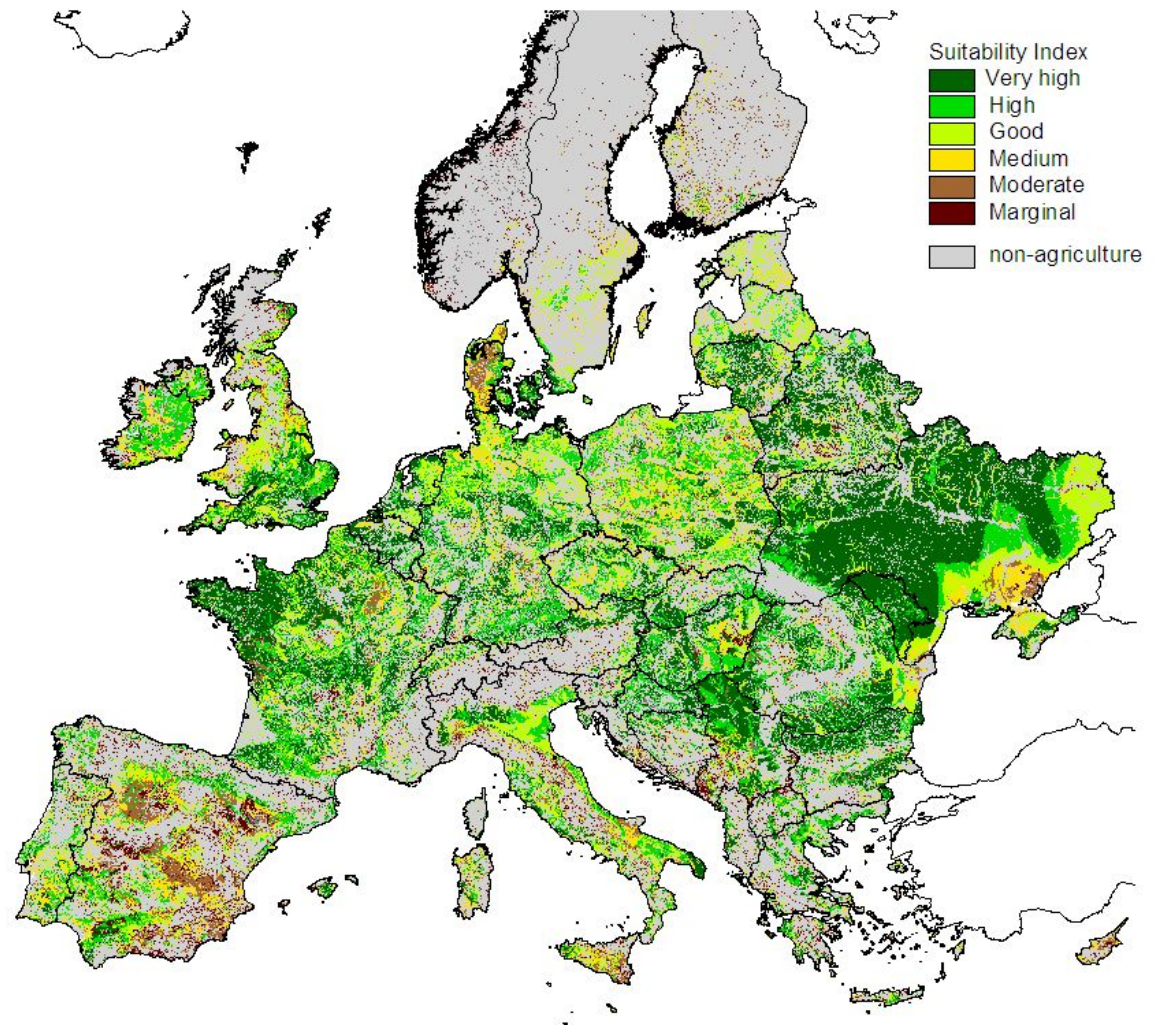
(4) Starch crops - (1st Generation biofuel for bioethanol production): Selected starchy crops are wheat, maize, rye and triticale.

(5) Sugar crops - (1st Generation biofuel for bioethanol): Sugar beet is a widely grown crop in Europe, while sweet sorghum is regarded as a potential energy crop for the sugar to energy production pathway.

# BIOFUEL FEEDSTOCK POTENTIALS

## Suitability Index for biofuel feedstocks on agricultural land

The map shows results for the best feedstock in terms of biofuel energy equivalent.

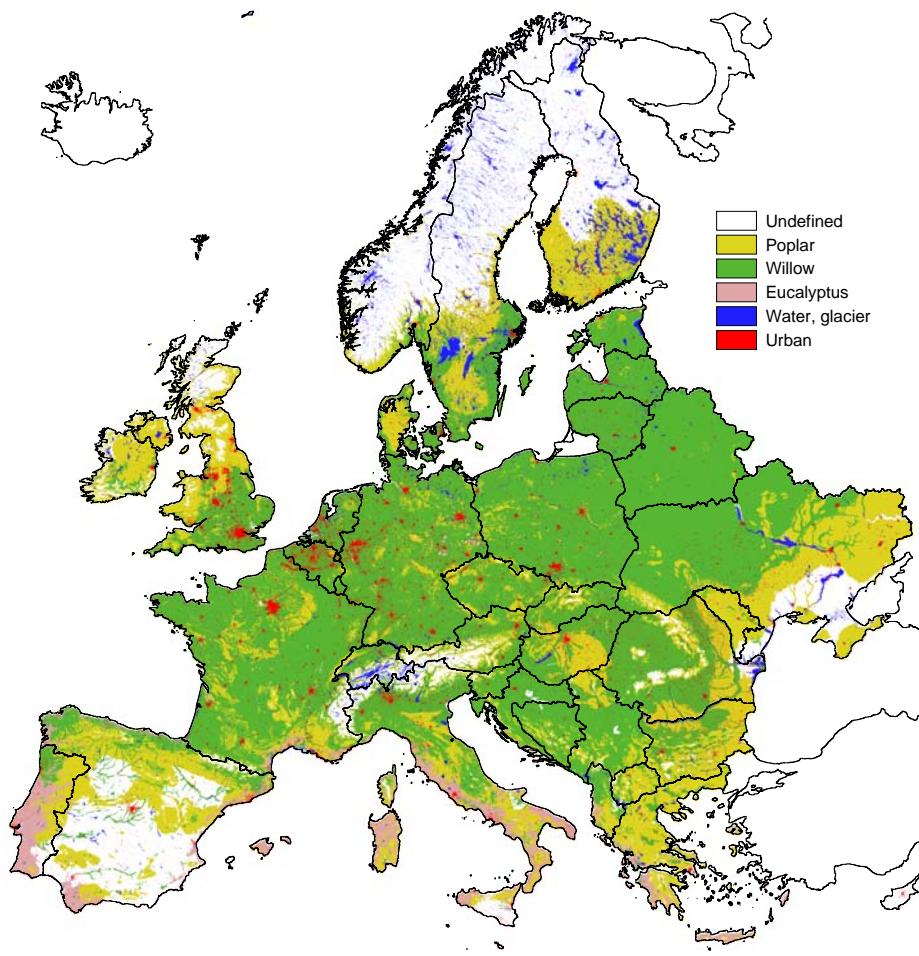
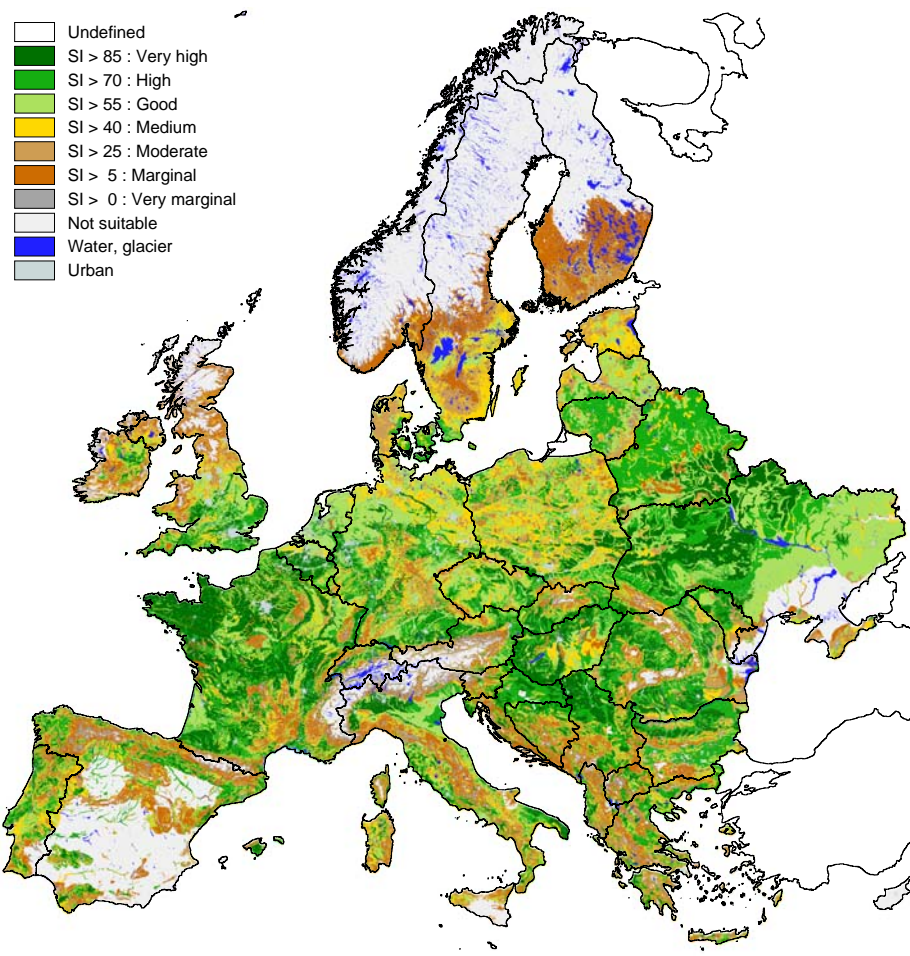




# Suitability of woody ligno-cellulosic feedstocks

(a) Land suitability index for woody ligno-cellulosic (2<sup>nd</sup> generation) biofuel feedstocks

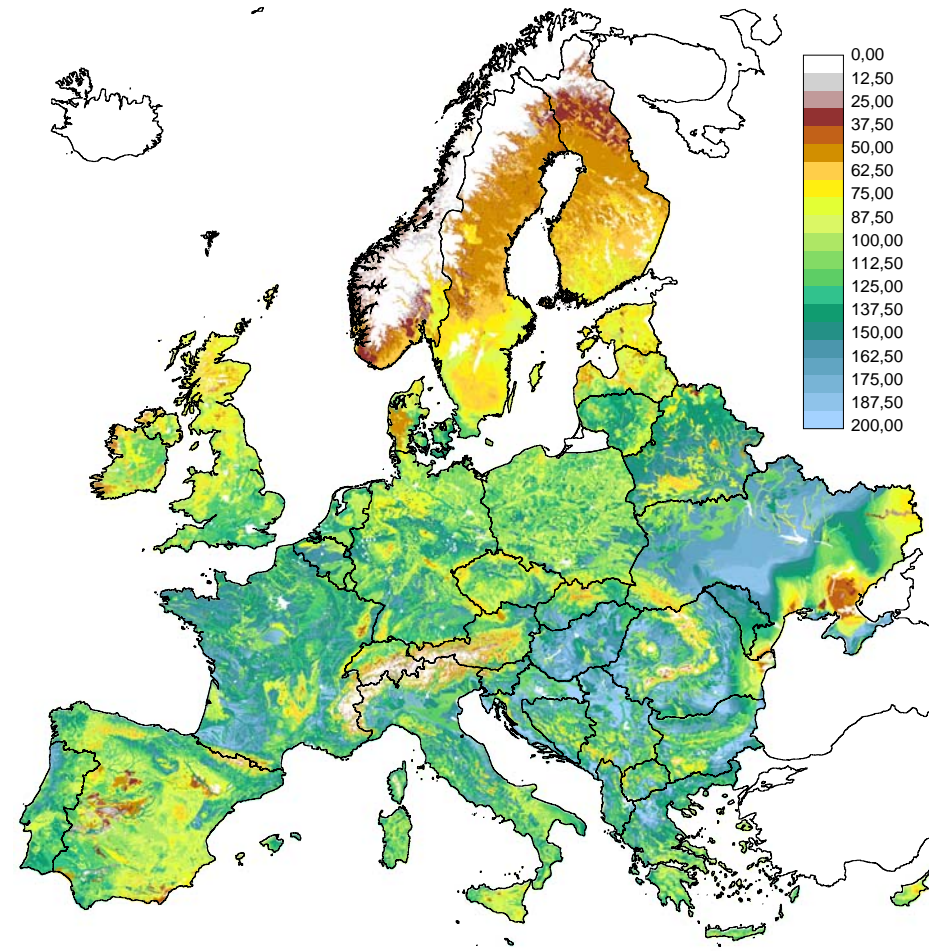
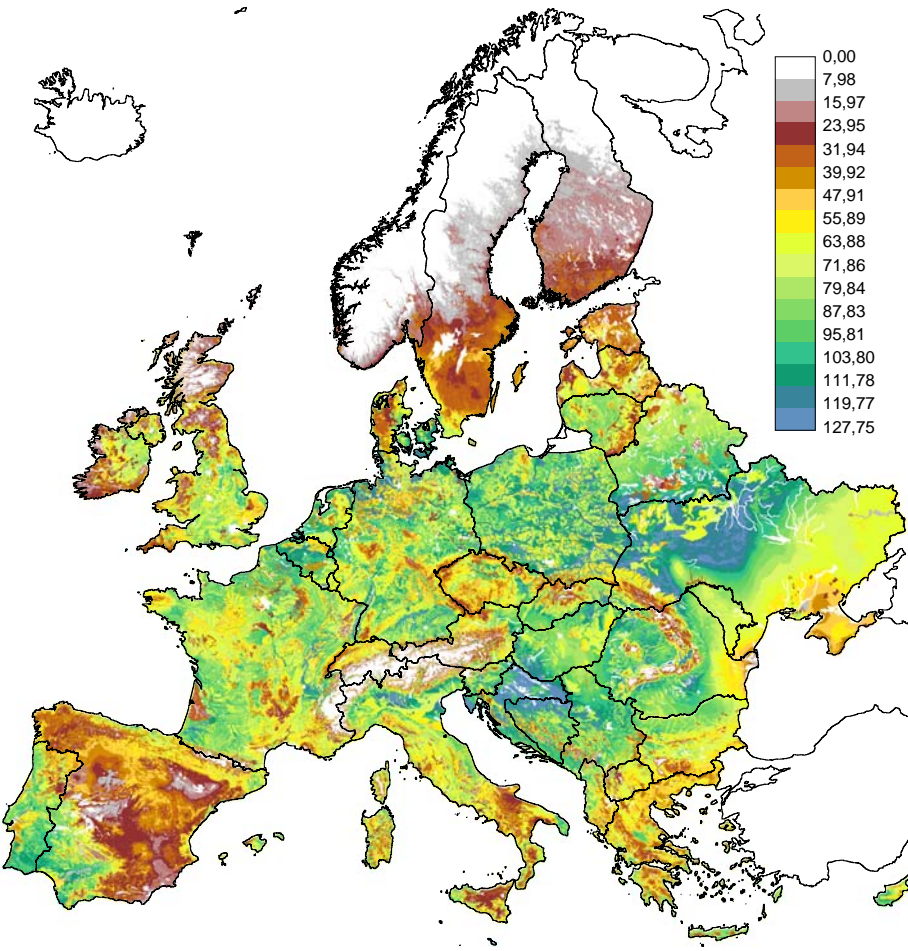
(b) Best yielding species for biofuel production from woody ligno-cellulosic feedstocks



# Biofuel Feedstock Yield Potential

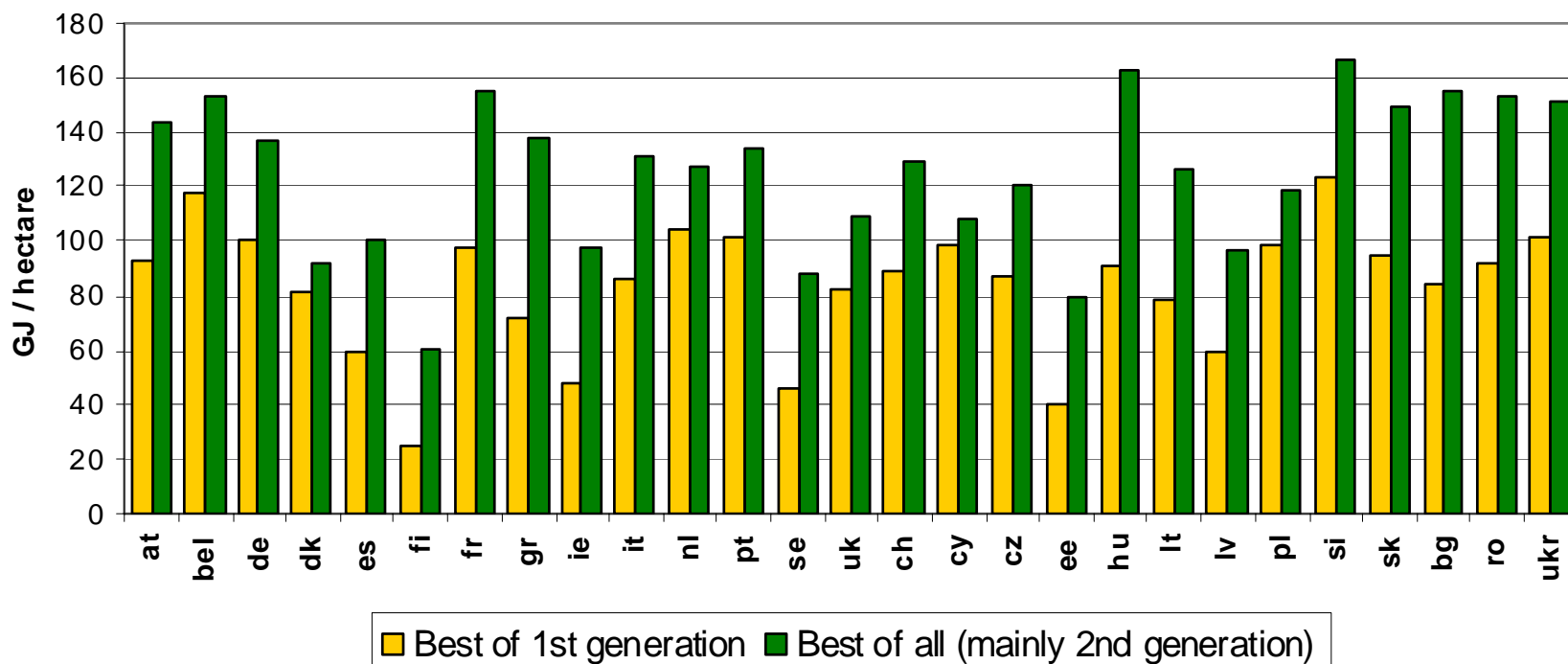
(a) Attainable energy yields of (1<sup>st</sup> generation) starch crops, sugar crops and oil crops (GJ/ha, biofuel equiv.)

(b) Attainable energy yields of (2<sup>nd</sup> generation) woody and herbaceous ligno-cellulosic feedstocks (GJ/ha, biofuel equiv.)





# Average potential biofuel energy yields for 1st and 2nd generation biofuel feedstocks on cultivated land for European countries (GJ/ha biofuel equivalent)

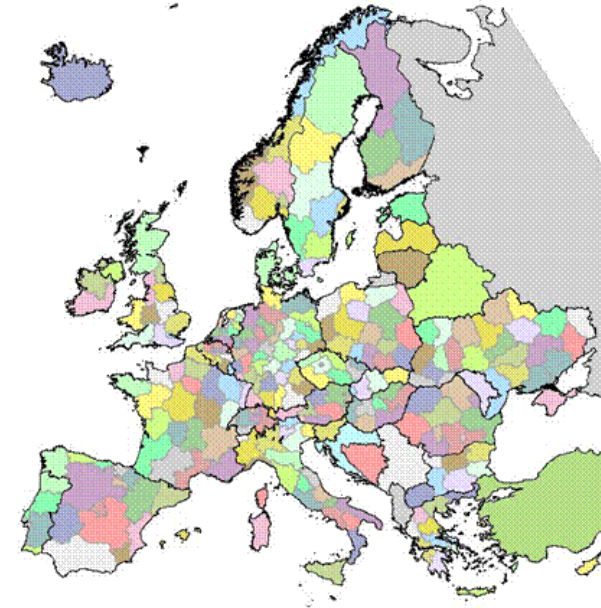


Note: 1<sup>st</sup> generation biofuel feedstocks include starchy crops (wheat, maize, rye, triticale), sugar crops (sugar beet, sweet sorghum) and oil crops (rapeseed, sunflower). 2<sup>nd</sup> generation ligno-cellulosic feedstocks comprise of woody species (willow, poplar, eucalyptus) and herbaceous species (switch grass, miscanthus, canary reed grass). In each grid-cell with cultivated land the best-performing species is selected (in terms of biofuel equivalent).



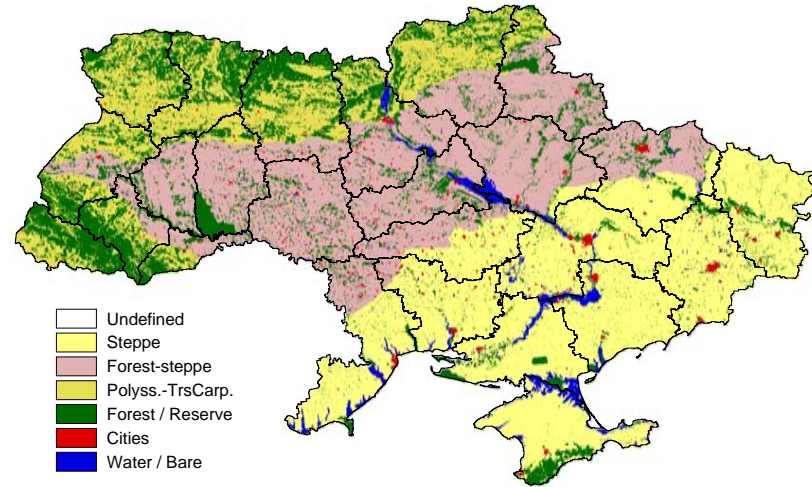
# Summary and conclusions

- Detailed resource database available for assessing suitability of alternative biofuel feedstocks;
- CLC2000 land cover grid (at 100 m) used to determine current use of land potentially suitable for biofuel feedstock production;
- Suitability and bio-productivity assessment with AEZ model operating at 1 km resolution database;
- Aggregation of individual feedstock potentials to national or sub-national administrative units by major land cover class;
- Availability of land was assessed assuming (a) scenarios of demographic change and per capita consumption, (b) convergence of yields for WEU and CEEC, and (c) maintaining of current European levels of self-reliance for food and feed.



# Conclusions

- Ambitious renewables/biofuel targets (20% share of renewables in total energy; 10% share of biofuels in petrol and diesel) are proposed for 2020, with possible strong impacts on land use, commodity markets and the environment.
- Scenario analysis suggests that by 2030 as much as 65 million ha of cultivated land could be available for bioenergy feedstock production in Europe; of this amount roughly 1/3 each could come from EU15 countries, New Member States, and Ukraine.
- Policies are needed to:
  - (a) achieve minimum greenhouse gas savings,
  - (b) avoid/limit negative environmental impacts, and
  - (c) promote bioenergy systems that can make a positive contribution to rural welfare and development.





# THANK YOU!

<http://www.iiasa.ac.at/Research/LUC>

