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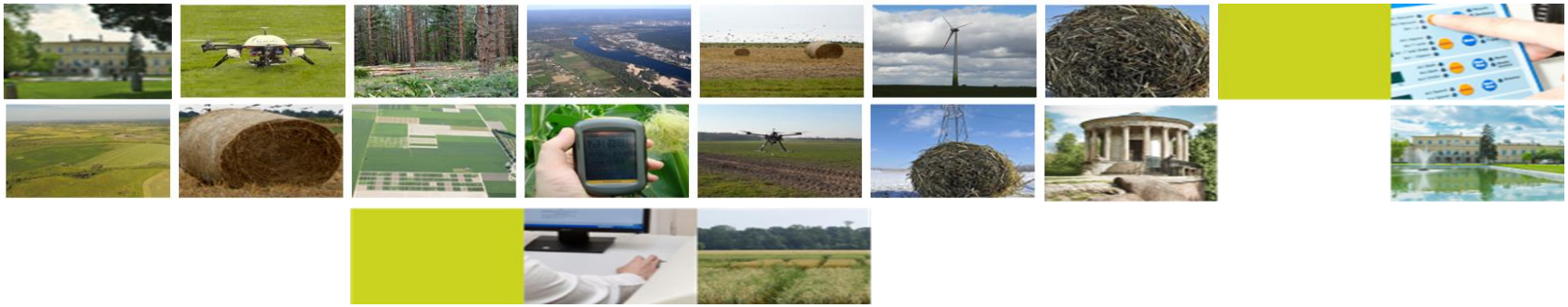

Contribution of agricultural systems to the bioeconomy in Poland: Integration of willow in the context of a stylised CAP diversification

Nosra Ben Fradj[1], Pierre Alain Jayet[2], Stelios Rozakis[3], Eleni Georganta[4], Anna Jędrejek[1]

[1] Dept. of Bioeconomy and Systems Analysis, Institute of Soil Science and Plant Cultivation, Pulawy, Poland
[2] UMR Economie Publique, INRA, AgroParisTech, Université Paris-Saclay, 78850 Thiverval-Grignon, France
[3] School of Environmental Engineering, Technical University of Crete, Akrotiri, Chania Crete, 73100, Greece
[4] International Hellenic University, 14th km Thessaloniki - Moudounia, 57001 Thermi, Greece

Department of Bioeconomy and Systems Analysis

Outline

1) Scientific context:
   - Synergies between bioeconomy and CAP
   - CAP and biomass production
   - SRC as real potential for decarbonisation of biorefinery and transport sector
   - Factors inhibiting the adoption of SRC
2) Study goals
3) Description of case study country
4) Methodology: MP modelling tool
5) Results
6) Conclusion

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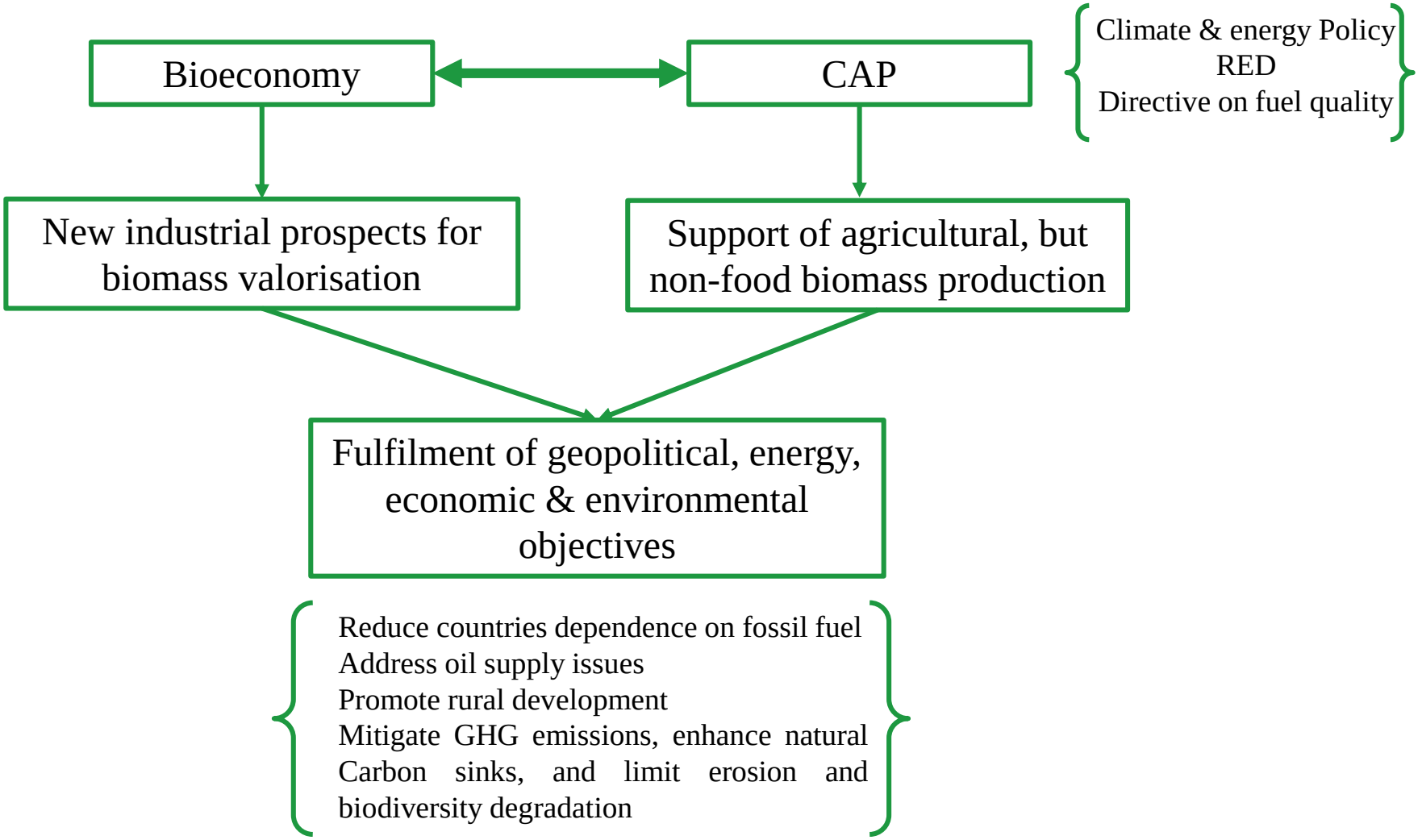
Synergies between bioeconomy and CAP



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CAP and biomass production

Agenda 2000

Fostering the supply of 1G biofuel crops

↓

Ambiguous environmental & economic assessment

Food crisis

Food *vs* Fuel Debate

Greening

Favouring crop diversification, the maintenance of permanent grasslands and the conversion of 5% of ArL into EFA;

SRC, grassland, hedges, buffer-strips, and nitrogen-fixing crops, considered eligible EFA

Crop diversification options:

1. Farms with 10 <ArL<30 ha; at least two different crops where main crop area < 75% of ArL;
2. Farms with AtL >30 ha; at least three crops cultivated, where the area of two main crops < 95% of ArL.

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Short Rotation Coppice as real potential for decarbonisation of biorefinery and transport sector

- SRC plantations offer a wide range of greener, more sustainable and more cost-efficient production routes than those of conventional crops;
- Examples of SRC: willow, birch, and poplar.
- The integration of willow promotes the transition to a multi-functional agriculture reconciling economy with ecology (Monteleone et al., 2018).
- Being harvested in SRC system (every 3–5 up to 25–30 years), willow:
  - represents high yields according to management practices (Stolarski et al., 2019)
  - can prevent nitrate leaching (Schmidt-Walter and Lamersdorf, 2012).
- To meet the requirements of the development of a sustainable bioeconomy, willow must be sustainably grown with low or no nitrogen (N) fertilisers.

Source: www.geos.ed.ac.uk/

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Factors inhibiting the adoption of SRC

- Woody biomass from forest remains the main biomass energy source, representing more than 60% of the European domestic supply of energy from biomass (EC, 2016).
- The production of renewable energy, of which biomass represents the largest share, continues to increase.
- Several barriers that hinder the large-scale deployment of these crops:
  - lack of expertise and technical equipment (Lewandowski et al., 2016);
  - long rotation period and low productivity on less fertile land (Ben Fradj and Jayet, 2018; Mola-Yudego et al., 2014; Ostwald et al., 2013);
  - high establishment cost and delayed cash-flows (Mola-Yudego and Aronsson, 2008);
  - absence of a structured market (Schweier and Becker, 2013);
  - high risks related to energy market regulations (Sherrington and Moran, 2010);
  - uncertainty associated with the CAP's regulations and their direct impact on the establishment of new crops (Bartolini and Viaggi, 2012);

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Study goals

1. Investigating proactive greening mechanisms likely to enable a large-scale diffusion of willow plantation, including diversification schemes combined with incentives making willow plantation more attractive to farmers.
2. Assessing the economic and environmental impacts of greening measures, in particular when two commands of crop diversification options, namely the number of eligible crops and the amount of support, change.
3. Showing how promising candidates for the development of bio-based economy, such as willow, could be integrated into the Polish farming systems through this CAP option to manage the agricultural areas threatened by water erosion as well as to take advantage of the available large amounts of unutilised land dedicated to non-food crops.

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Poland – as a potential willow supply basin

- In 2017, the total UAA in Poland constituted 14.6 million ha with nearly 74% of arable land, 22% of permanent meadows and pastures (Statistics Poland, 2018).
- Formed on acidic rocks deposited by glaciers, dominant soils (46% of UAA) are of medium and poor quality and agricultural suitability.
- Large proportion of Polish soils are mostly characterised by sandy and light soils with low water content, thereby representing high risk of drought.
- 21% of UAA are threatened by water erosion, and consequently by mineral leaching (Krasowicz et al., 2012).
- To enhance crop diversification and climate change vulnerability, Poland applies a practice which requires a minimum of four eligible crops rather than of two or three (EEIG Alliance Environment, 2018).
- The Polish agricultural production has intensified, resulting in an increased N fertilisation (+4.7%) and GHG emissions (+4.1%) in 2017 compared with 2015 (Eurostat, 2019; European Environment Agency, 2019).

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Poland – as a potential willow supply basin

- Being one of the largest coal-mining countries in Europe, Poland is highly dependent on coal for energy production.
- In 2017, Poland had the largest share (55.5%) of solid fossil fuels, i.e. hard and brown coal, in the gross inland energy consumption (Statistics Poland, 2019), compared with other EU countries.
- So far, biomass represents only 7% of the gross energy consumption, although it is claimed that the country represents a high biomass potential.
- Large proportion of unutilised agricultural area (UnAA) can be used for non-food purposes in Poland.
- Pudełko et al. (2018) show that almost 2.03 million ha of UnAA can be allocated to non-food crops, more than half of which are of medium quality on arable land (39%) and permanent grasslands (23%).

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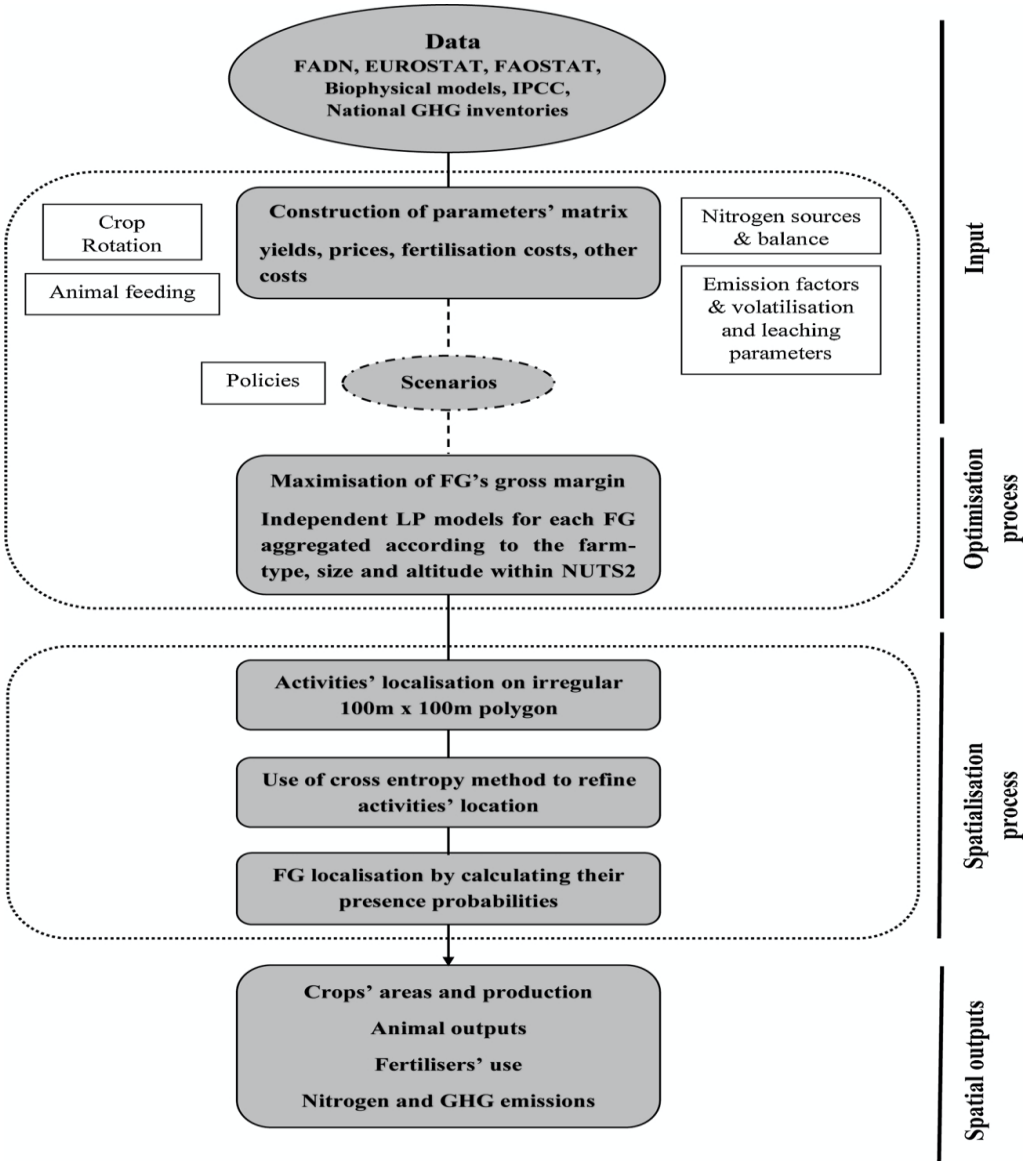
Modelling tool for assessment of crop diversification options: AROPAj



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Model Assumptions and Scenarios

i. Scanning different command variables and parameters:

- The lowest number of crop activities is about 2 recorded in Mazowsze and Podlasie, and Małopolska and Pogórze, and the highest is 15 in Wielkopolska and Śląsk.

  => The number of required crops is then varied from 2 to 16 crops.

- A second scanning regarding one of willow parameters, i.e. subsidy, from 0 to €250 ha^{-1} by increments of 10.
- The parameters related to the crop's threshold area and the maximum area limit are set to 1 ha and 95% of UAA, respectively.
- Willow area is limited to 15% of UAA, its price is fixed at €77 tdm^{-1} and the annual costs are about €395 ha^{-1}.
- All these conditions were tested for a scenario in which the crop diversification subsidy is set around the current level (i.e. €75 ha^{-1})

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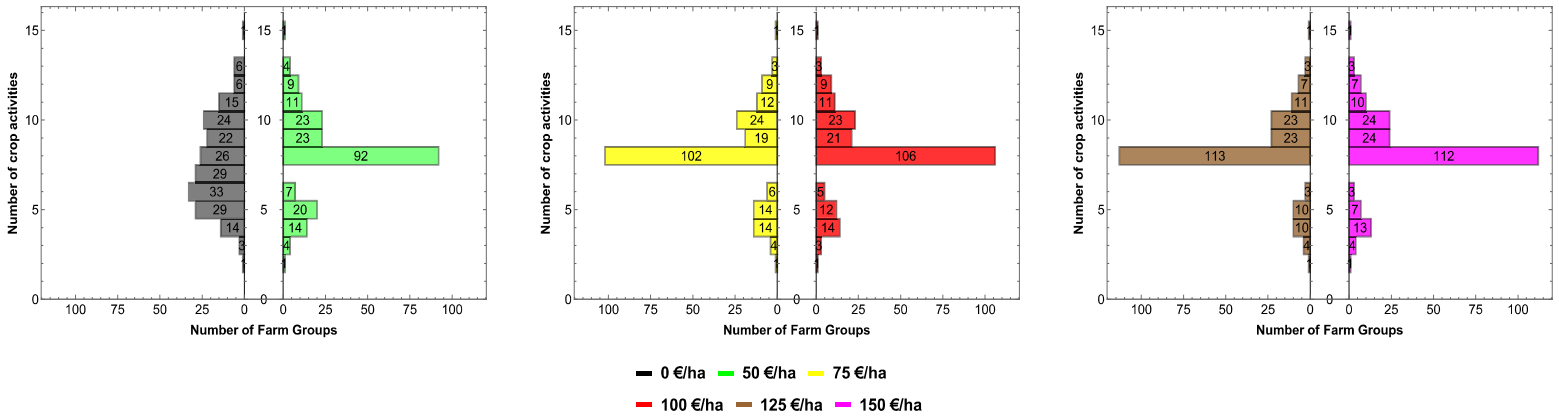
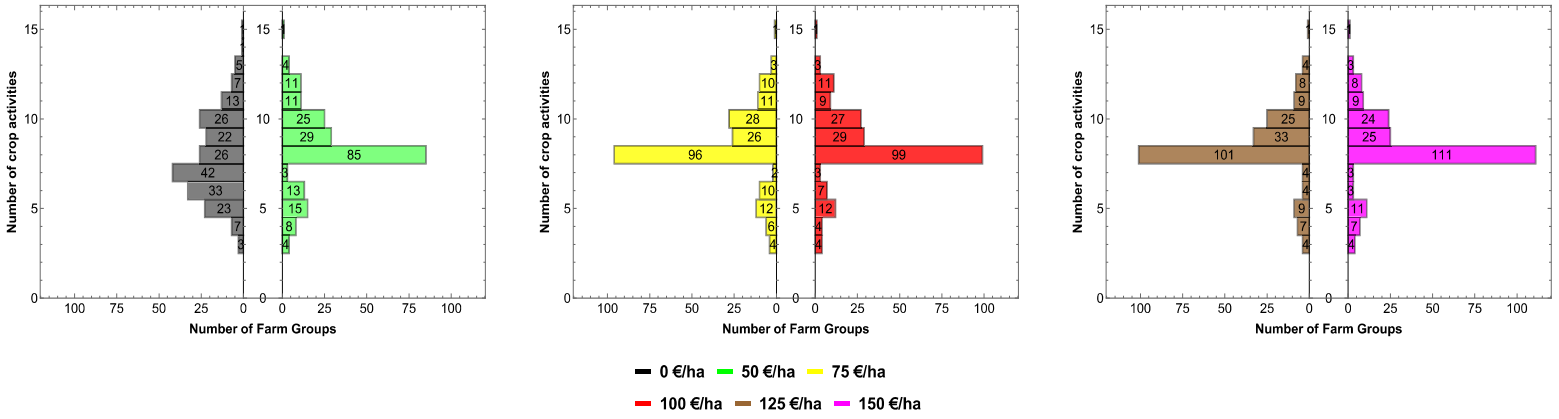
Impacts of a combined change in crop diversification support and subsidy on willow plantation



(a) $\text{Subsidy}_{willow} = €0\ \text{ha}^{-1}$



(b) $\text{Subsidy}_{willow} = €200\ \text{ha}^{-1}$

Distribution of number of crop activities over AROPAj farm groups in case of 8 crop requirement and five subsidy levels for crop diversification €0 ha^{-1} (Black), €50 ha^{-1} (Green), €75 ha^{-1} (Blue), €100 ha^{-1} (Red), €125 ha^{-1} (Brown), and €150 ha^{-1} (Magenta)

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Outcomes depending not only on the number of eligible crops, but also on regions, farming types, and economic sizes

	Margin (€ 1000 ha^{-1})	Variation rate (%)											
	Baseline Scenario	Eligible crops	6			8			10			12		
		Willow subsidy (€ ha^{-1})	0	100	200	0	100	200	0	100	200	0	100	200
Regions														
Pomorze & Mazury	0.8		19.8	19.9	20.2	18.1	18.3	18.8	16.7	16.8	17.2	15.3	15.6	16.0
Wielkopolska & Śląsk	0.9		0.2	0.1	0.1	−0.8	−0.6	−0.4	−0.7	−0.6	−0.3	−1.4	−1.3	−1.0
Mazowsze & Podlasie	1.0		7.4	8.0	9.2	0.5	1.5	2.7	−4.3	−4.2	−2.8	−4.9	−4.8	−3.4
Małopolska & Pogórze	0.9		−3.3	−3.0	−2.6	−4.9	−4.8	−4.4	−5.8	−5.7	−5.4	−6.8	−6.7	−6.3
Farming Type														
FT1	0.9		9.9	9.9	9.9	8.8	8.9	9.0	7.2	7.2	7.4	6.0	6.1	6.2
FT2	1.1		−2.9	−2.8	−2.6	−4.0	−3.8	−3.5	−5.4	−5.2	−4.9	−6.3	−6.2	−5.8
FT3	1.2		5.4	5.6	5.9	4.4	4.6	5.0	3.1	3.3	3.8	2.3	2.5	3.2
FT4	0.4		12.8	13.4	15.2	0.5	2.2	4.0	−4.0	−4.0	−2.2	−4.0	−4.0	−2.1
FT5	1.0		3.1	3.2	3.5	1.9	1.9	2.3	0.4	0.5	1.1	−0.5	−0.4	0.2
FT6	0.7		3.5	3.6	4.0	1.7	1.9	2.2	0.1	0.3	0.6	−1.5	−1.3	−0.8
Economic size														
ES1	0.8		−6.9	−6.5	−5.8	−10.0	−9.6	−8.7	−11.7	−11.4	−10.6	−12.1	−11.9	−11.1
ES2	0.8		2.2	2.1	2.2	0.2	0.4	0.9	−2.4	−2.2	−1.6	−3.6	−3.4	−2.8
ES3	0.9		23.0	23.6	25.1	13.6	14.9	16.4	6.7	6.9	8.4	5.2	5.4	7.0
ES4	1.0		−1.6	−1.6	−1.5	−0.5	−0.6	−0.7	2.0	2.0	2.2	0.3	0.5	0.6
ES5	0.9		4.7	4.7	4.7	4.6	4.6	4.6	5.4	5.4	5.3	6.1	6.0	6.0

➔ Mixed impacts due to the farming structure (farm type and economic size) and specialisation defining each region.

➔ Small- sized FG (ES1) record a consequent loss in their income, compared to middle and high-sized FG (ES3, ES4 and ES5) <= specialisation of FG, according to their production factors.

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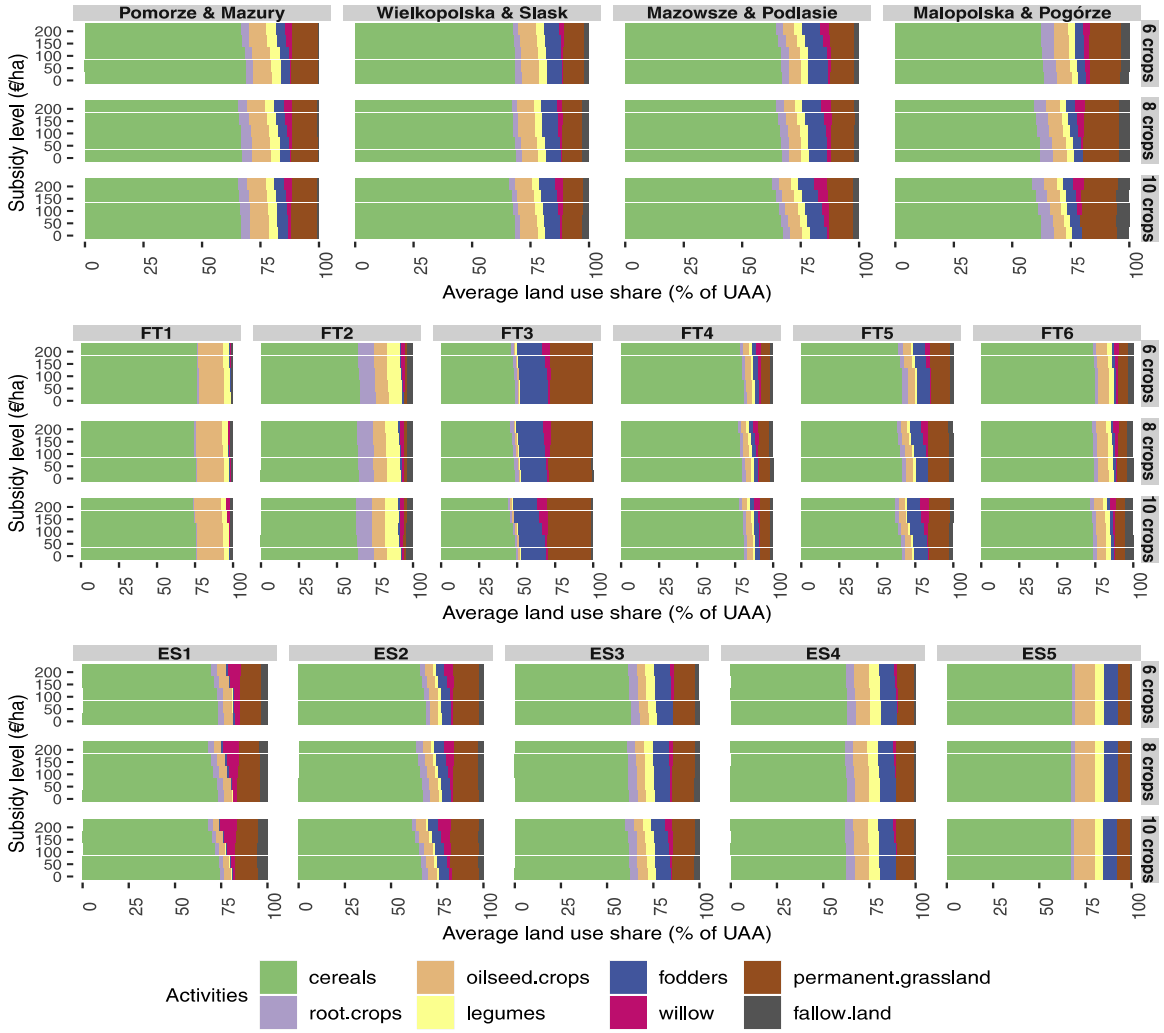
Reflection of LU choices to comply with crop diversification



Changes in land use allocation in percent of arable land for different number of eligible crops and according to Polish FADN regions, farming type and economic size classes.

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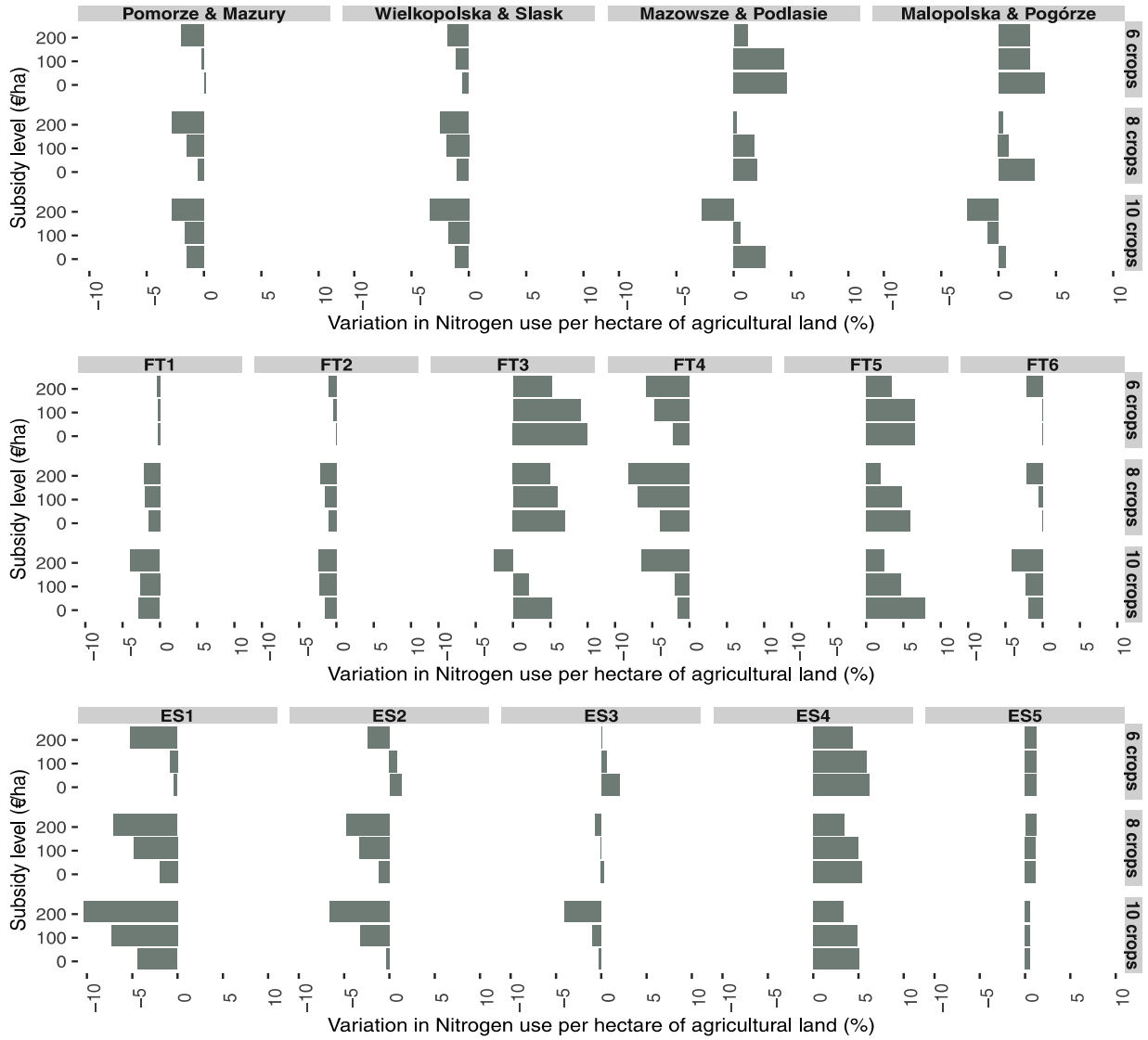
N fertilisation triggered by a complex double effect of crop diversification



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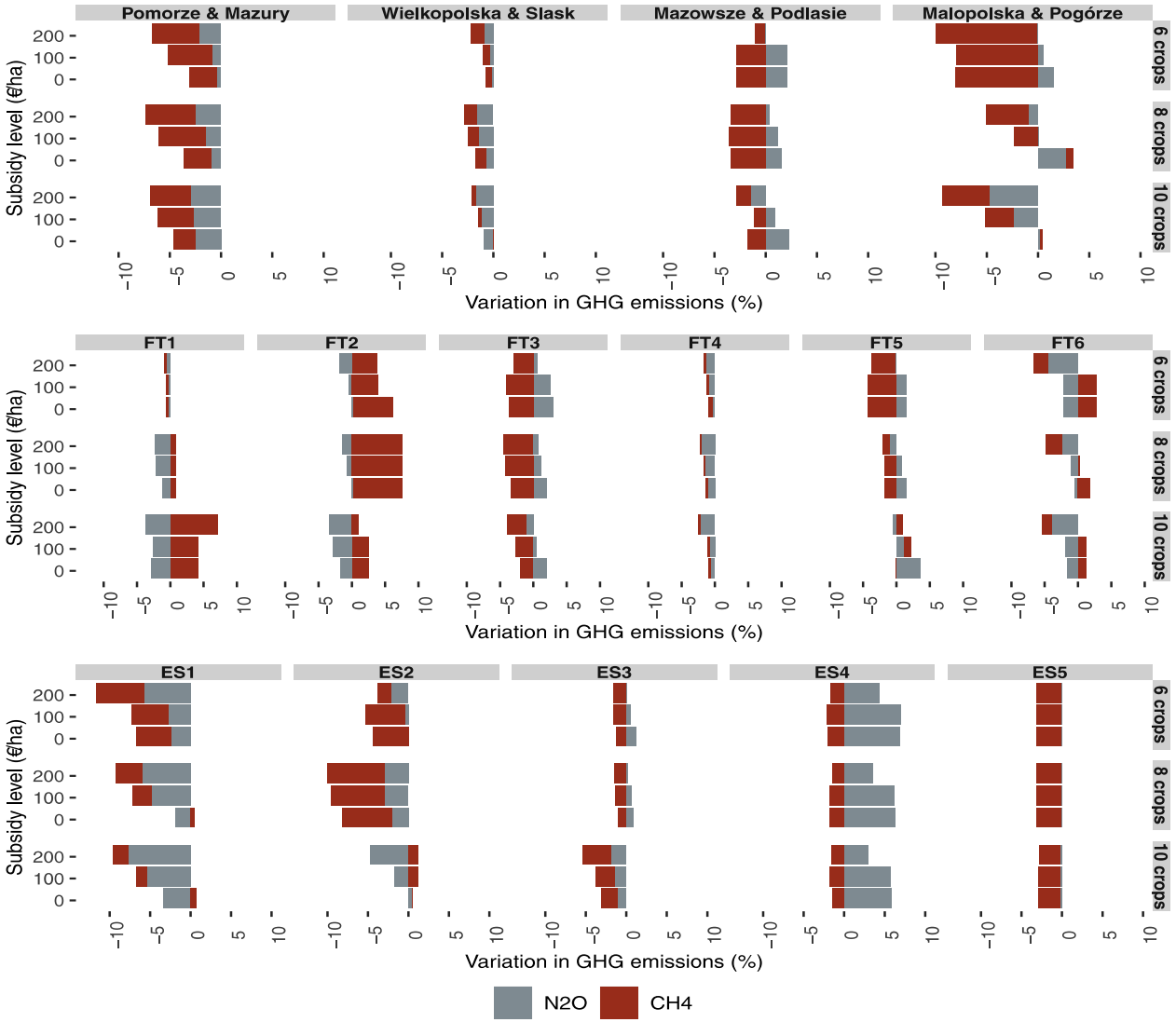
The more binding crop number requirement the lower CH_4 emission decrease



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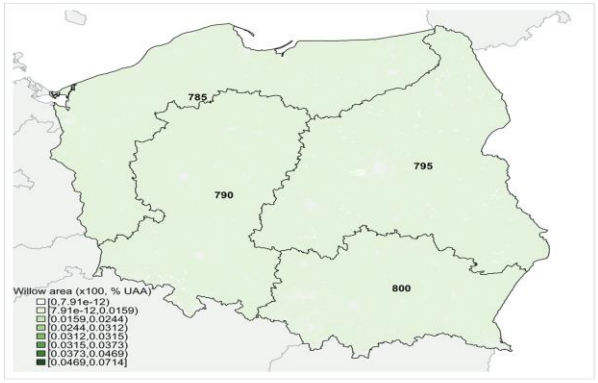
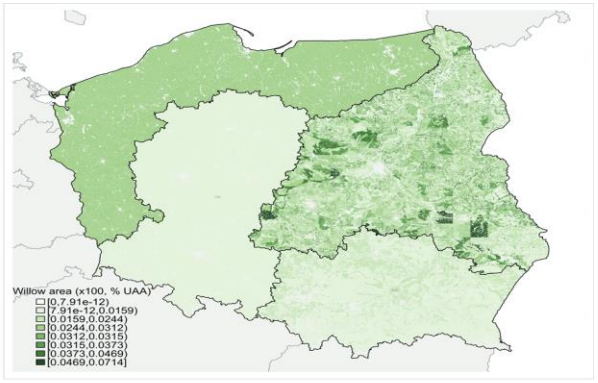
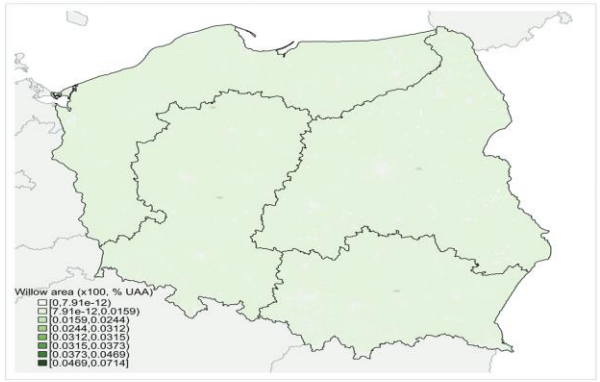
Spatial distribution stemming from urbanisation and historical factors



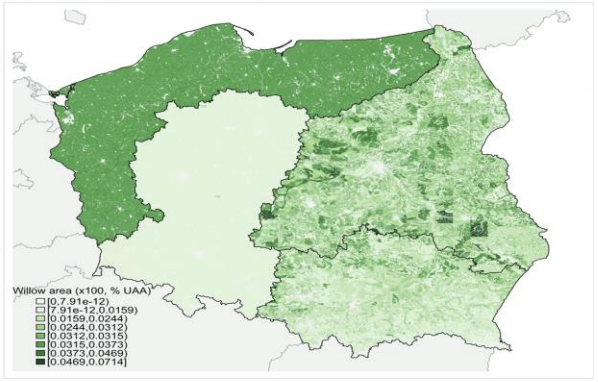
(a) 6 crop requirement - Subsidy$_{willow}$ = €0 ha^{-1}



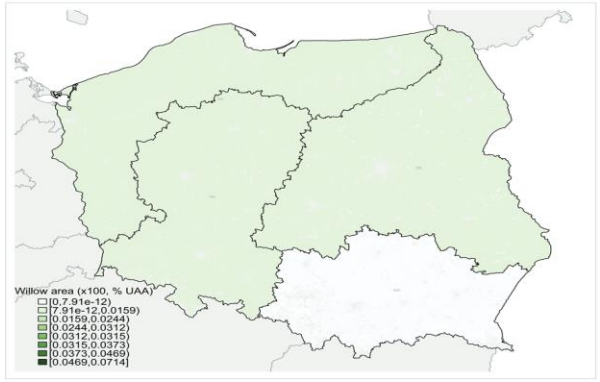
(b) 6 crop requirement - Subsidy$_{willow}$ = €200 ha^{-1}



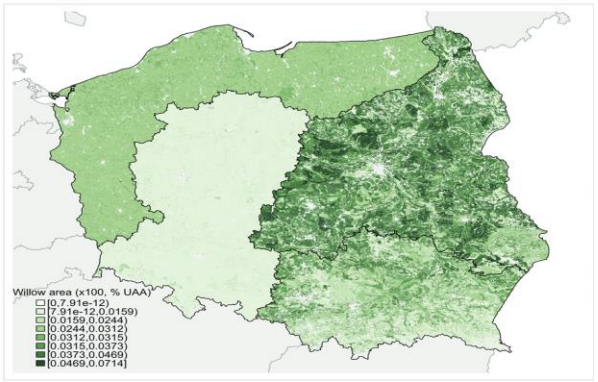
(c) 8 crop requirement - Subsidy$_{willow}$ = €0 ha^{-1}



(d) 8 crop requirement - Subsidy$_{willow}$ = €200 ha^{-1}



(e) 10 crop requirement - Subsidy$_{willow}$ = €0 ha^{-1}



(f) 10 crop requirement - Subsidy$_{willow}$ = €200 ha^{-1}

Conclusion 1

- The Polish agriculture presents high production potential of willow, the supply varying between 1 and 6.2 million tons with respect to the diversification measures and the amount of support on willow.

- This is contrary to what is actually observed, few farmers opting for willow plantation.

- Several barriers can explain this gap, in particular, the lack of support. As a matter of fact, only 9% of FG, i.e. small and middle-sized FG specialising in cereals, oilseeds and protein crops, and in grazing livestock, opt for willow, benefiting from a basic diversification support (€75 ha^{-1}).

- In addition to this payment, subsidising willow plantation up to €100 ha^{-1} and €200 ha^{-1} results in an increase of 20% and 45% of FG opting for willow, respectively.

⇒ The latter support option constitutes a proactive approach to promoting PEC cultivation within Polish farmers thereby coping with liquidity risks and uncertainties associated with agricultural and energy policies.

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Conclusion 2

- Future CAP instruments have to be consistent with the current European policies, for instance Nitrates and Water Framework Directives, and respect the new *'good agricultural and environmental conditions'* and cross compliance requirements.

  ⇒ The new CAP model should enhance the implementation of innovative and sustainable cropping and agroforestry systems combining arable crops and SR woody plantations for better valuation of the agricultural production and efficient management of the environment.

  ⇒ An increased support towards SRC is therefore required to ensure an effective large-scale deployment of these promising bioeconomy careers.

  ⇒ willow can be grown on areas representing high risk of organic matter decline, water erosion and drought as well as on areas of protected water resources under the Nitrate and Water Directives.

  ⇒ The CAP schemes should be backed up with an enhanced support from regional authorities and a better articulation between industry and biomass producers in order to make farmers less reluctant to adopt this relatively new and economically unattractive crop

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