MIND STEP

MODELLING INDIVIDUAL DECISIONS TO SUPPORT THE EUROPEAN POLICIES RELATED TO AGRICULTURE

AGRIMODELS Cluster: State of play regarding modelling of individual decision making

Marc Müller (Wageningen Economic Research)

AES

Agricultural Economics Society, 97th annual conference, 27.-29. March 2023, Warwick

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817566

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MODELLING INDIVIDUAL DECISIONS TO SUPPORT THE EUROPEAN POLICIES RELATED TO AGRICULTURE

Common challenges and joint activities within the AgriModels Cluster

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AgriModels Cluster (https://agrimodels-cluster.eu/)

agricore

The AGRICORE project proposes a novel tool for improving the current capacity to model policies dealing with agriculture by taking advantage of the latest progress in modelling approaches and ICT.

BESTMAP

BESTMAP will develop a new modelling framework using insights from behavioural theory, linking existing economic modelling with individual-farm Agent-Based Models.

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Making use of improved possibilities opened up by progress in the ICT area, MIND STEP will improve the exploitation of available agricultural and biophysical data and will include the individual decision making (IDM) unit in policy models.

IDM

- Individual Decision Making (IDM) at farm level is at center of all projects
- AGRICORE: New approaches for Agent-Based Models
- BESTMAP: Use of ABMs for impact assessment
- MIND STEP: Combine ABMs and farm-level simulation (optimization) models

- All projects rely on individual farm data: FADN
  - Application for EU-wide FADN was not always easy
  - Different solution strategies: Rely on national FADN, create pseudo-populations

Collaborative activities

- Organized sessions and workshops
  - EAAE Congress 2021
  - EAAE Seminar 2022
  - DG Agri Workshop 2022

- Joint modelling activities
  - Integration of AGRICORE farm model into MIND STEP toolbox (ongoing)

Today‘s talks

- AGRICORE:
  - PMP agent-based AGRICORE model for ex-ante assessment of regional agri-environmental schemes
  - Presented by: Lisa Baldi
- BESTMAP:
  - Benefits and challenges of the linking of general computable equilibrium (CGE) or partial equilibrium (PE) models with agent-based models (ABM)
  - Presented by: Alena Schmidt
- MIND STEP:
  - Analyses of Carbon and Nitrogen taxation scenarios in a multi-model framework.
  - Presented by: Marc Müller

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Analyses of Carbon and Nitrogen taxation scenarios in a multi-model framework

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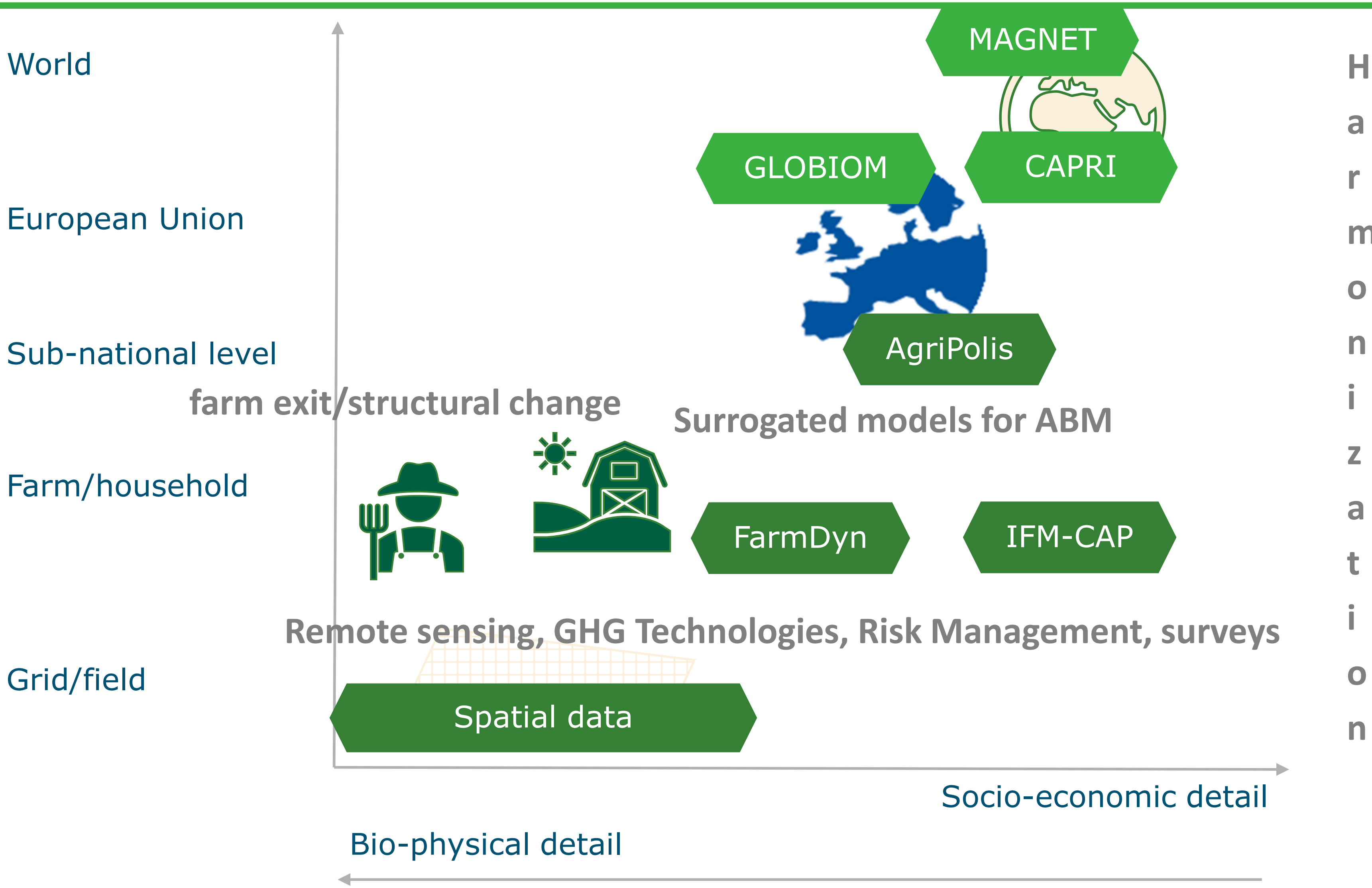
Project background: Working towards the end of the project

- The MIND STEP project is now in its 4th year
- Database and model toolbox developed
- Common understanding of policy domains and –questions between modelling teams and stakeholders
- To improve stakeholder involvement, a test case for combined model use has been proposed (“putting the toolbox to work”)
- First results of simplified scenarios for policy evaluation

The MIND STEP Toolbox

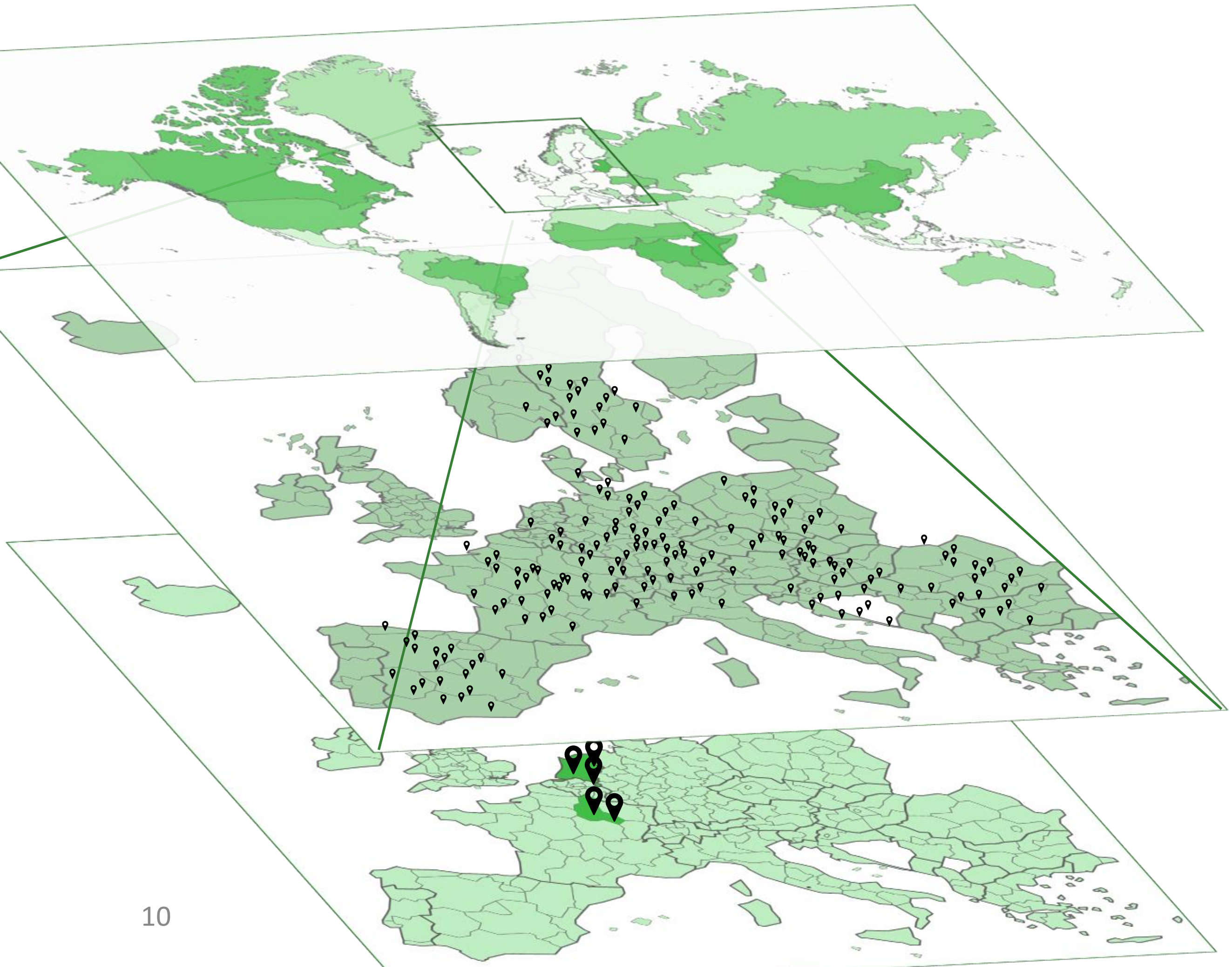


IDM Individual Decision Making models

RS = Remote Sensing data integration

Modules and Tools

Regional coverage of the models

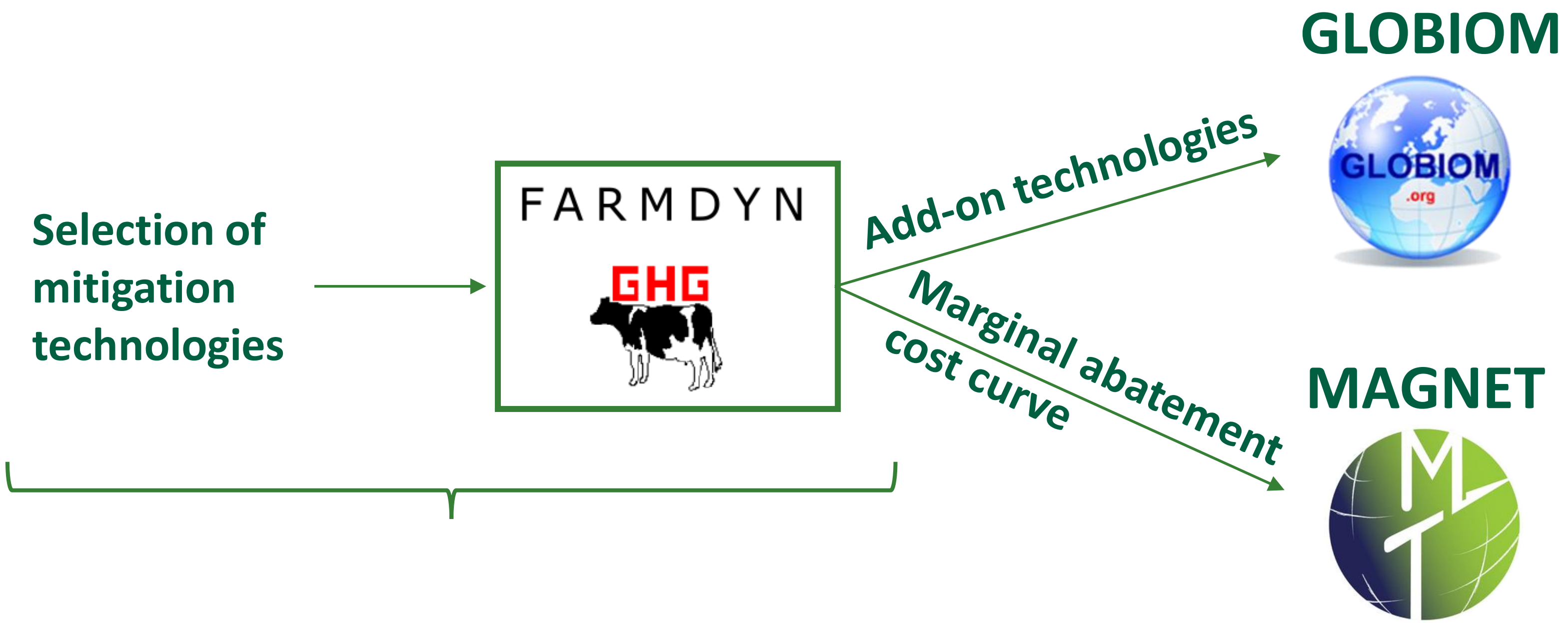


CAPRI & GLOBIOM
NUTS-2 and global regions

IFM-CAP
Individual farms across the EU

Empirical model & FarmDyn
Farms in FR, DE, and NL

Linking mitigation technologies adoption across scales



- Survey-based and impact-based selection of mitigation technologies
- Implementation of four “new” mitigation technologies into FarmDyn (feed additives (2x), management options, technology options)

Policy background

- MIND STEP should feed into current debates and policy programmes (Green deal, Farm 2 fork)
- Dedicated work package identified two most prominent domains with stakeholders:
  - Scenario 1: Climate change
    - Impact of different GHG mitigation measures (i.e. constraints on livestock numbers and/or on nutrient disposal).
    - Simulate the adoption of carbon taxes on agricultural production
  - Scenario 2: Mandatory reduction of input use
    - Farm-to-Fork strategy-type scenario
    - Impose a tax on mineral fertilizer

Scenario 1: Tax on CO_2-equivalent emission

- 20, 50, 100 and 150 euro per ton CO_2-equivalent
- Magnet, GLOBIOM, FarmDyn:
  - Carbon tax in Euro per ton on sum of CO_2 eq emissions from all sources/emission accounts (GLOBIOM)
  - Carbon tax in dollar/ tonne on input use of fossil fuels, land and fertilizer. Output tax on cattle sector (MAGNET)
  - Carbon subsidy in Euro per ton on reduction of CO_2-eq emission as compared to a base (Farmdyn)

Farm management measures

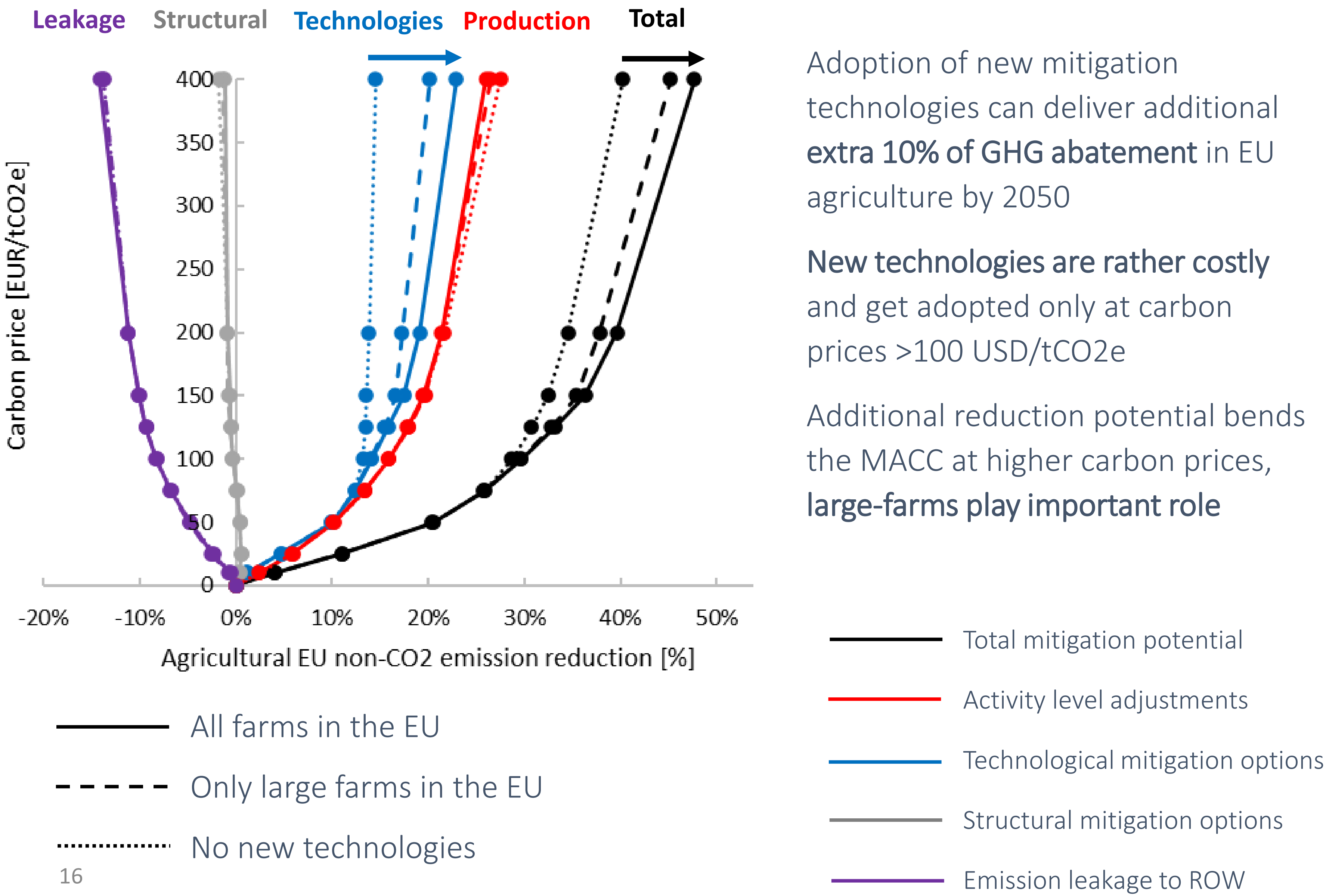
- Farmdyn and Globiom
  - Physical implementation of farm management measures in
    - feed ration adjustments
    - higher fat content in feed ration
    - lifespan expansion dairy cows
    - feed additives
    - N from mineral fertilizers
    - Manure and chemical fertilizer application techniques
    - herd size and composition
    - Carbon sequestration measures (Globiom)
- MAGNET:
  - Substitution between inputs and outputs at sector and national level

MAGNET: Preliminary results

- Sample results for primary milk sector, EU28 REG, 2040 – percentage change compared to BAU.

Variable	Unit	BAU	CO2_50_WLD	CO2_100_WLD	CO2_100_EU
Land demand	1000 km2	540475	0.0%	0.4%	-0.1%
Production Prices	Index 2014 = 1	0.739	8.7%	16.9%	16.7%
Demand	Million $	90831	-1.2%	-2.1%	-6.9%
Export Volume	Million $	84.9	24.4%	66.2%	-52.1%
Feed input (compound	Million $	13535	0.1%	0.0%	-5.4%
Import Volume	Million $	662	-62.8%	-70.2%	101.4%
Production Volume	Million $	90254	-0.8%	-1.6%	-7.8%
Value added	Million $	41726	-0.3%	-0.8%	-6.7%
Emissions (total)	MtCO2e	117.4	-15.2%	-17.3%	-19.4%
Emissions CH4	MtCO2e	86.8	-15.6%	-17.9%	-19.9%
Emissions CO2	MtCO2e	1.7	-0.5%	-0.8%	-3.2%
Emissions N2O	MtCO2e	28.9	-14.8%	-16.8%	-18.8%

GLOBIOM: Preliminary results



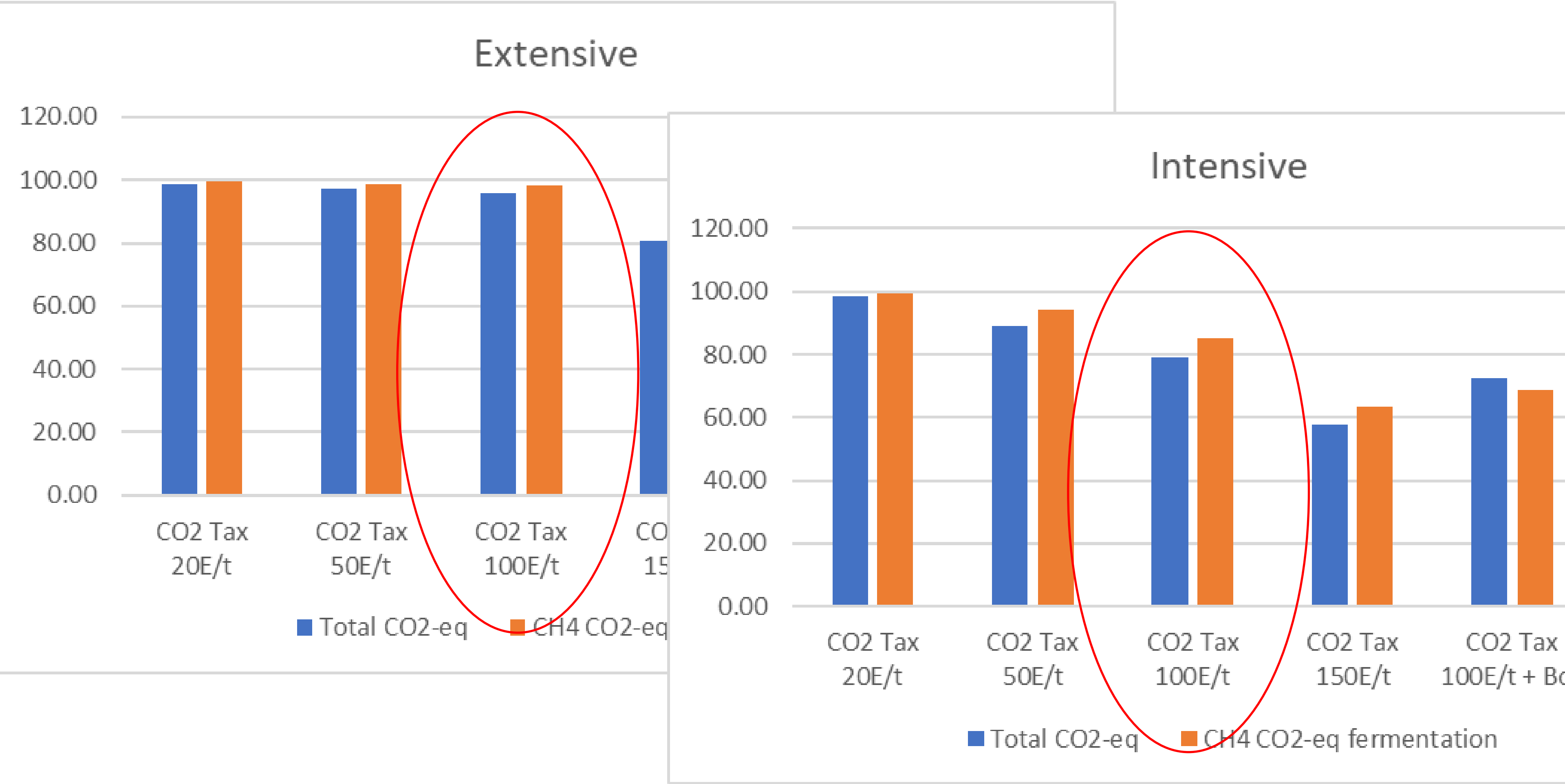
Adoption of new mitigation technologies can deliver additional **extra 10% of GHG abatement** in EU agriculture by 2050

New technologies are rather costly and get adopted only at carbon prices >100 USD/tCO2e

Additional reduction potential bends the MACC at higher carbon prices, **large-farms play important role**

FarmDyn: Preliminary Results

Change in total GHG output per farm, selected components. Average per farm type **(index, base =100)**



FarmDyn: Preliminary Results

Change in total feed use and N from mineral fertilizer per average farm (**index, base =100, Bovaer in kg/farm**)

		CO_2 Tax 20E/t	CO_2 Tax 50E/t	CO_2 Tax 100E/t	CO_2 Tax 150E/t	CO_2 Tax 100E/t + Bov	CO_2 Tax 150E/t + Bov
Number of cows	Base=100	99.62	96.67	91.01	71.21	91.41	75.50
Fresh grass	Base=100	99.71	98.48	93.80	73.11	94.14	77.88
Grass silage	Base=100	100.24	99.93	101.37	93.49	100.99	96.88
Maize silage	Base=100	99.14	92.64	73.18	44.13	75.15	47.73
Standard concentrate	Base=100	100.62	0.00	0.00	0.00	0.00	0.00
Concentrate, EF CH_4 low	t dm/farm/year		149	164	127	163	138
Soybean Meal	Base=100	92.73	59.91	32.81	22.04	34.14	22.17
FeedAdd Bovaer	kg dm/farm/year					360	300
Mineral Fertilizer N	Base=100	98.63	96.67	95.47	85.54	95.43	87.64
Total Feed	Base=100	99.72	97.96	98.65	100.35	98.23	99.51

Scenario 2: Mandatory input reduction

- 20% reduction of mineral fertilizer uses in agriculture,
- with the goal to reduce nutrient losses at sector level by 50%.
- (Farm2Fork strategy foresees reduction by 50% in the use and risk of chemical pesticides by 2030)

- The policy instrument we consider to achieve is a carbon tax on GHG emissions from mineral fertilizer in the EU 27 at production and/or application

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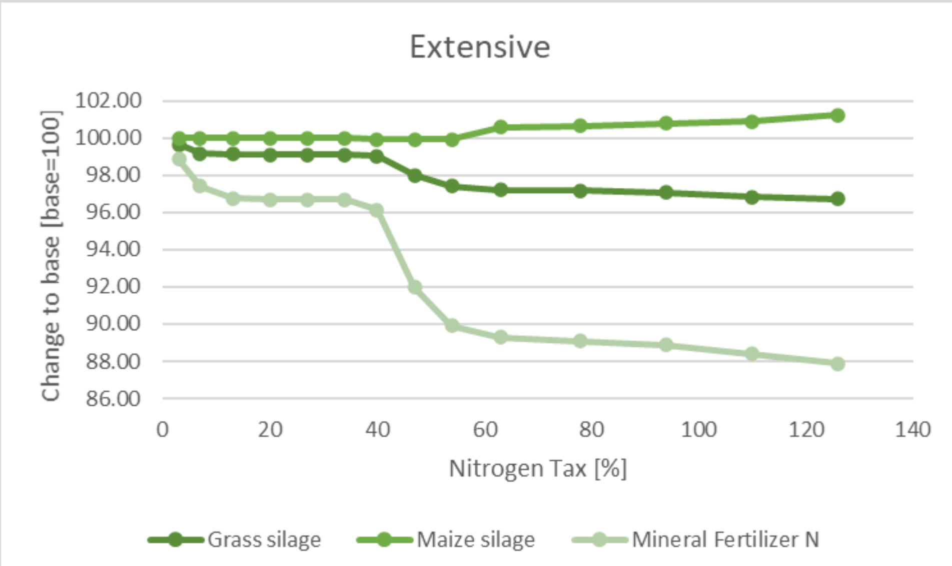
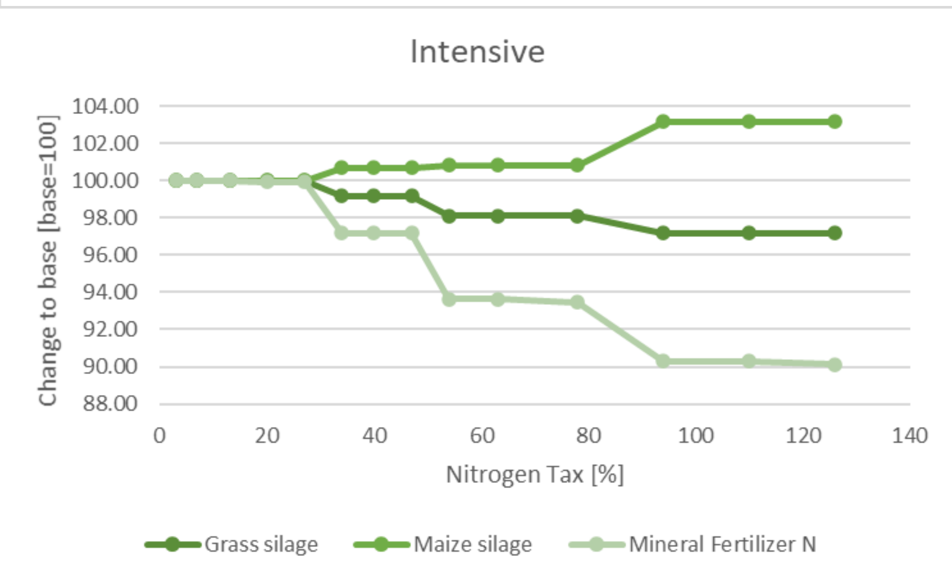
Mandatory input reduction N-taxation rates

CO2 Tax (Euro/tCO2eq)	CO2 Tax (Euro/kgCO2eq)	N-Tax - Upstream (Euro/kgN)	N-Tax (Euro/kgN) - Application	N-Tax multiplier - Upstream	N-Tax multiplier - Application
10	0.01	0.04	0.03	1.04	1.03
25	0.03	0.09	0.07	1.09	1.07
50	0.05	0.18	0.13	1.18	1.13
75	0.08	0.26	0.20	1.27	1.20
100	0.10	0.35	0.27	1.36	1.27
125	0.13	0.44	0.33	1.45	1.34
150	0.15	0.53	0.40	1.54	1.40
175	0.18	0.62	0.46	1.63	1.47
200	0.20	0.70	0.53	1.72	1.54

- Nitrogen tax mark-ups are calculated based on different levels of CO2 taxation
- Based on average N contents of fertilizers and emissions factors for application and production (upstream emissions)
- Tax mark-up distinguish between application and production (and combinations)

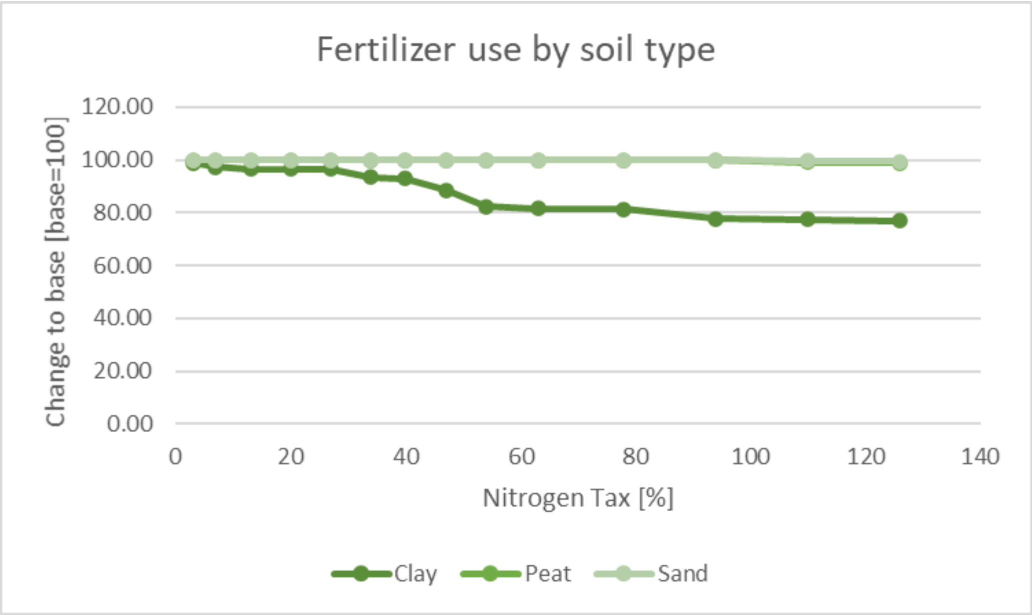
Management effects – Extensive and Intensive





- Substitution of grass silage with maize silage in animal ration
- Effect is more pronounced with intensive farms
- Reduction of mineral fertilizer noticeable above taxation rates of 50%
- Reduction of mineral fertilizer use stronger on extensive farms

Fertilizer use – Soil types



- Fertilizer use not changing on farms with peat and sandy soils due to limited possibilities to substitute mineral N with alternative management practices
- On farms with clay soils, reduction of 20% realized with taxation rates above 50%

Summary: Ensemble use of models

- Common storyline
- Comparable scenario settings
- Identification of indicators and models
- Harmonization of technology representation across models
- Standardized reporting
  - AgMIP table and indicator formats
  - MIND STEP specific indicators
- => “Factsheets” for communication with stakeholders

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Stakeholder involvement

- Scenario assumptions and results
  - Workshops, survey
  - Agreement on storyline and relevant policies
  - Early sharing of model results (“fast track”) to get feedback and refine scenarios

- Management and technology
  - Indentification of technology options
  - Iterative process between stakeholders and modellers

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Outlook

- Further refinement and addition of policy scenarios
  - Use of tax revenues within the sector, e.g. for financing of mitigation technologies
- Improve the complementary use of the models
  - Technology-rich <-> wide geographical coverage
  - Temporal resolution (target year, dynamic vs comparative static)
- Strengthen the collaboration between modelling teams
  - Standardized I/O between models is only starting point
  - Ensemble use requires constant communication between modelling teams
  - In particular farm-level models are not yet integrated in a network

Proposal: Network of farm modelers

- Networks for sector/market/gnereal equilibrium models are well established
- Possible activities for a farm-level modelling network:
  - Identify the thematic domain of the network
  - give directions to what enhancements are best suited to the farm models in the network,
  - accumulate and share knowledge in building, parameterizing, and applying farm models
  - bring together networks of farm level model and tool developers and users from different institutes and with different backgrounds, objectives, programming languages and IT solutions
  - broaden the use of the models in the network by re-using existing tools and to exploit the potentials of harmonisation of data and modules and shared maintenance and development of new modules within a larger user community.
  - Create opportunities for joint publications.

Many thanks! Any questions?

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