Dissertation Defense

Integrating Agriculture into Chinese Mitigation Policies

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Introduction

- **Research question**
  How to integrate agriculture into Chinese climate policies in an economic efficient way?
- **Status**
  - Agriculture is an important source of GHG emissions: 11% in 2005 with 820 $MtCO_2e$
  - but is not mobilized in national mitigation policies
- **Research methodology: Marginal Abatement Cost Curve(MACC)**
  - First attempt to construct a MACC for Chinese agriculture
  - Choice of bottom-up approach rather than top-down
- **Research focus**
  Croplands, especially N_2O emissions related to N fertilizer use

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Outline

Drivers of baseline emissions/activities

- **Priority of safeguarding food security in China**
  - ↗ Both baseline and mitigation scenarios should meet the national target of food production
  - ↗ All mitigation measures should not negatively affect yields
- **Agriculture policies and climate policies**
  - ↗ Climate-related policies indicate measure baseline application level (e.g. the conservation tillage program)
  - ↗ Synthetic N fertilizer use growth slows down
- **Changing diet for more animal protein**
  - ↗ Livestock emissions grow faster than croplands emissions
  - ↗ Higher demand for animal feed (soybean)

Baseline construction methodology

- Future agriculture activities data from CAPSiM models (endorsed by the Ministry of Agriculture)
- Projection of overall N fertilizer consumption based on historical growth rate and N rate of each crop
- China specific emission factors selected from domestic research
- Rice CH_4 emissions : direct projections from studies using CH4MOD model (endorsed in national inventory)

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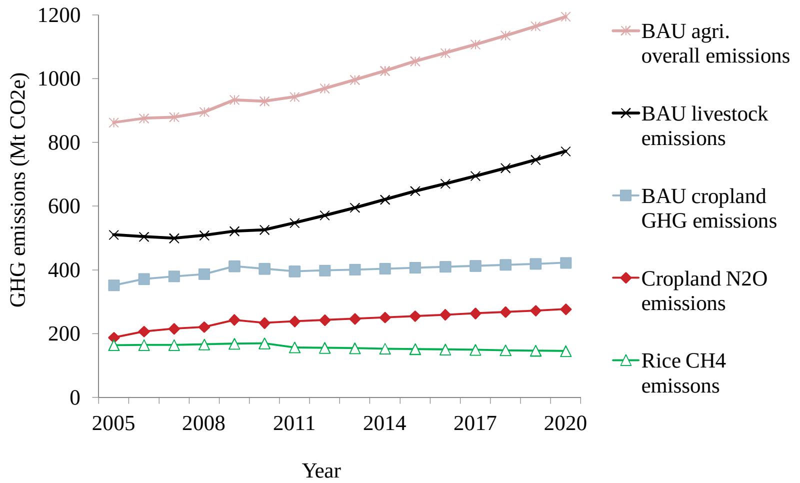
Baseline emission scenario to 2020



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Outline

I. Construction of baseline scenarios for agriculture

II. Technical mitigation potential from croplands

III. Economic mitigation potential from croplands

IV. Discussions on the economic incentives to trigger abatement in agriculture

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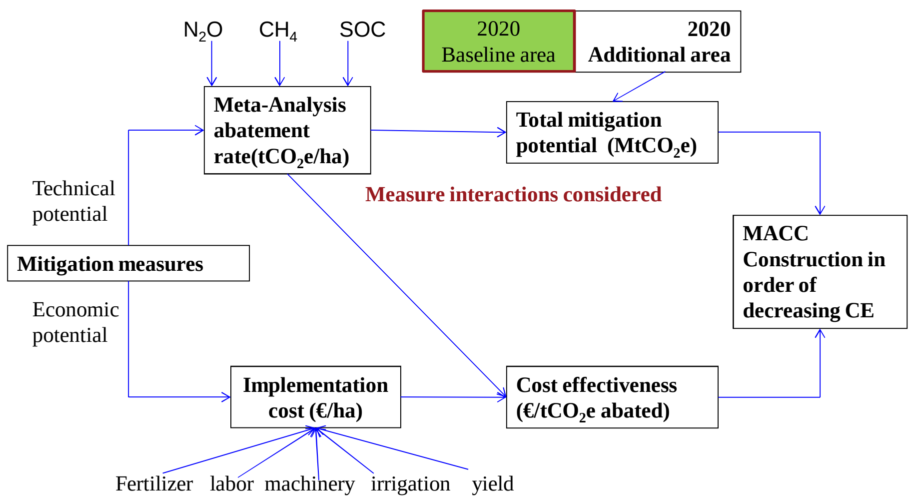
MACC construction steps
- China as one farm



Methodological approach is based on Moran et al. (2011) and adjusted to accommodate China's conditions.

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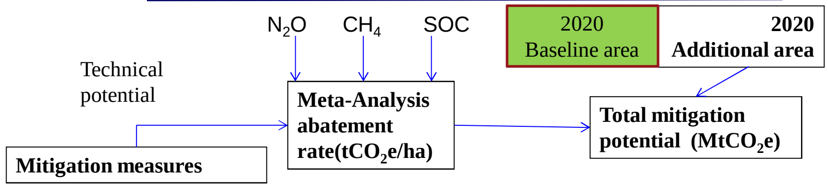
III. Technical mitigation potential

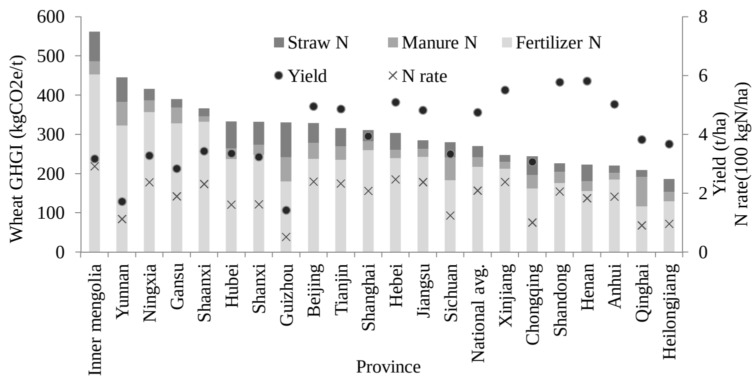


No.	Measure	Weighted abatement rate(tCO_2e/ha)	Additional application area (Mha)	Mitigation potential in 2020 ($MtCO_2e$)
C1	Fertilizer best management practices - Right rate	0.412	58.63	**30.65**
C2	Fertilizer best management practices (Wheat &Maize) - Right time and right placement	0.201	56.65	11.38
C3	Fertilizer and water best management in rice paddies	**1.337**	17.93	23.98
C4	Fertilizer best management practices (cash crops) - Right products, right time and right placement	**1.219**	17.94	21.86
C5	Enhanced-efficiency fertilizers	0.271	57.23	15.54
C6	More efficient recycling of organic manure	0.596	**120.11**	**40.19**
C7	Conservation tillage for upland crops	0.489	22.98	1.46
C8	Straw return in upland crops	0.210	30.06	0.95
C9	Biochar addition	0.329	9.90	3.26

Source：**Wang W** et al., 2014. **Greenhouse gas mitigation in Chinese agriculture: distinguishing technical and economic potentials**. Global Environmental Change 26:53–62.
Nayak DR, Saetnan ER, Cheng K, **Wang W,** et al., 2014. Management opportunities to mitigate greenhouse gas emissions from Chinese agriculture. Accepted by AEE, upcoming publication.

Regional disparities：
GHG intensity of cereal production

- **High geographic variations of baseline GHGI**
- **Regional variations of mitigation potential of N management practices**
- **Potential use as baseline/benchmark for offset/ETS programs**



Source: **Wang W** et al., 2015. **Greenhouse gas intensity of three main crops and implications for low-carbon agriculture in China**. Climatic Change 128: 57-70.

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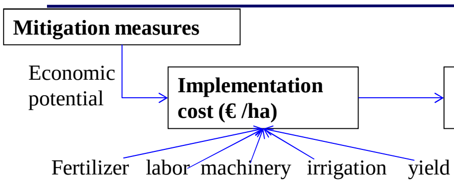
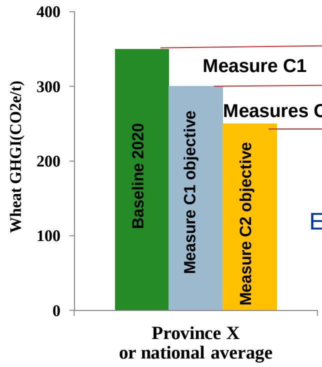
IV. Economic mitigation potential

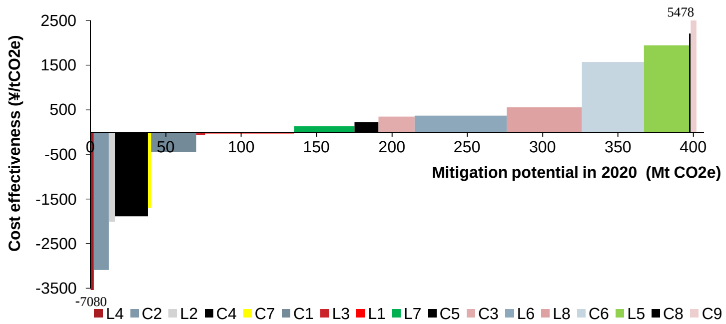




	N input	Labor	yield	Implementation cost	Cost-effectiveness
Measure C1	-31%			-15€/ha	**-260 €/tCO_2e**
Measures C2	-20%	+7.5 mandays/ha	+5%	30€/ha	**150€/tCO_2e**

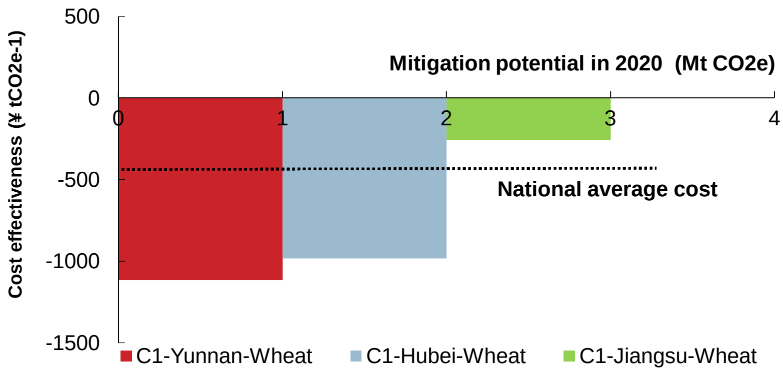
Example: C1 synthetic N management practices for wheat

MACC results- national level



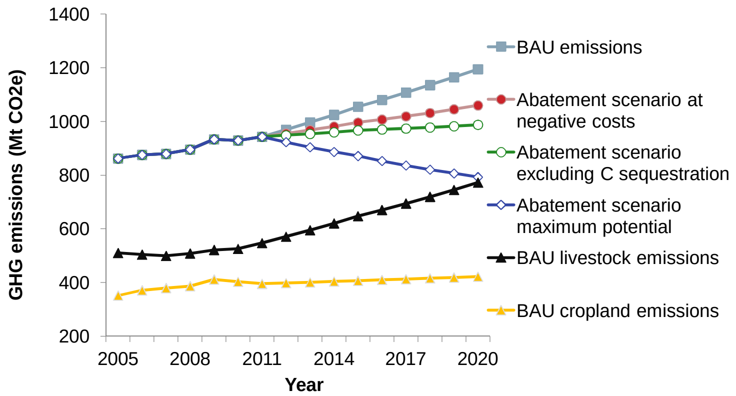
- **Maximum feasible technical potential in 2020: 402 $MtCO_2e$ (207Mt emission reduction +195Mt carbon sequestration)**
- **Importance of negative-cost mitigation potentials (common in all bottom-up MACCs)**
- **Relative cost effectiveness of N fertilizer and manure best management practices**

MACC results- regional disparities



C1 synthetic N fertilizer best management practices
- right rate for wheat production

Emission and mitigation scenarios



↗ **Maximum mitigation potential: 34% of baseline emissions**

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Carbon pricing progress in China

Pricing carbon to internalize negative externality of excessive GHG emissions; emission trading and carbon tax are the two major economic instruments.

- Cap & Trade: agriculture is excluded from the sectors covered by the 7 Chinese ETS pilots
- Offset programs: agriculture will have limited potential due to high transaction costs and problem of aggregation
- Carbon tax: subsidy for N fertilizer producers and farmers could be considered an equivalent negative carbon tax at a rate of € 4.2 /tCO_2e (author's calculation)

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Difficulties of pricing carbon in agriculture

The high transaction costs

- Diffuse nature of agriculture emissions and mitigation actions calls for aggregator: example of NZ scheme
- Difficulties in accurate measurement and verification of emissions and abatements
- The specialty of soil carbon storage and reversal risk

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Implications of research outcome on pricing carbon in Chinese agriculture

- **Restructure N fertilizer subsidies**
  - Send a clear signal to farmers on reasonable fertilization
  - Redistribute public funds to improve the infrastructure, extension services and professional service groups, subsidy organic fertilizers and finance agriculture offsets/ETS programs.
- **Up-scaling carbon crediting schemes**
  - Refer to CDM PoA procedures
  - **Use regional GHG intensity as standardized baseline**
- **ETS pilot covering the agricultural sector**
  - Accelerate financial flows from industry and energy sectors to agriculture/countryside
  - **Use GHGI as benchmark for allowance allocation**

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Summary and further research

- **Major research contribution**
  - Quantify mitigation potentials available in agriculture
  - Estimate cost-effectiveness of agriculture abatement options
  - Provide pointers for both policy and research to realize the indicated potentials
- **Limits and further research**
  - Requirement on more detailed regional analysis (except for cereal N fertilizer management measures)
  - Barriers to the realization of win-win options: needs to consider wider social costs and farmers' behaviors
  - An holistic approach to integrate land cultivation and livestock activities
  - Detailed uncertainty analysis

Publications during the PHD

- **Wang W**, Koslowski F, Nayak DR et al., 2014. Greenhouse gas mitigation in Chinese agriculture: distinguishing technical and economic potentials. Global Environmental Change 26:53–62.

- **Wang W**, Guo LP, Li YC et al., 2014. Greenhouse gas intensity of three main crops and implications for low-carbon agriculture in China. Climatic Change, 128: 57–70.

- Quemin S, **Wang W**, 2014**.** Overview of climate change policies and development of emissions trading in China**,** Series Information and Debates n° 30 of Climate Economics Chair.

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- Li YC, Xiong W, Hu W, Berry P, Hu J, Lin ED, **Wang W**, et al., 2014. Integrated assessment of China's agricultural vulnerability to climate change: a multi-indicator approach. Climatic Change 1–12.

- Quemin S, Madelenat J, Elbeze J, **Wang W,** 2013. Carbon Markets and Prices Around the World, in Climate Economics in Progress 2013, Chapter 2, Climate Economics Chair, Paris.

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Thanks!

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