



How measures for greenhouse gas mitigation in agriculture are implemented strongly determines cost-effectiveness

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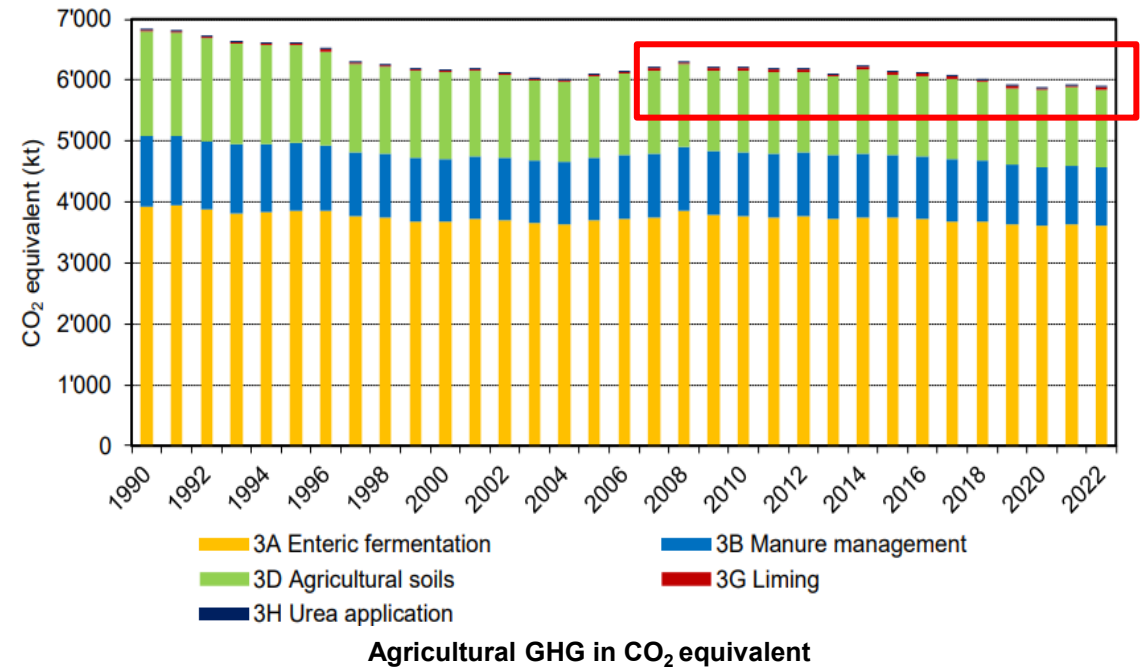
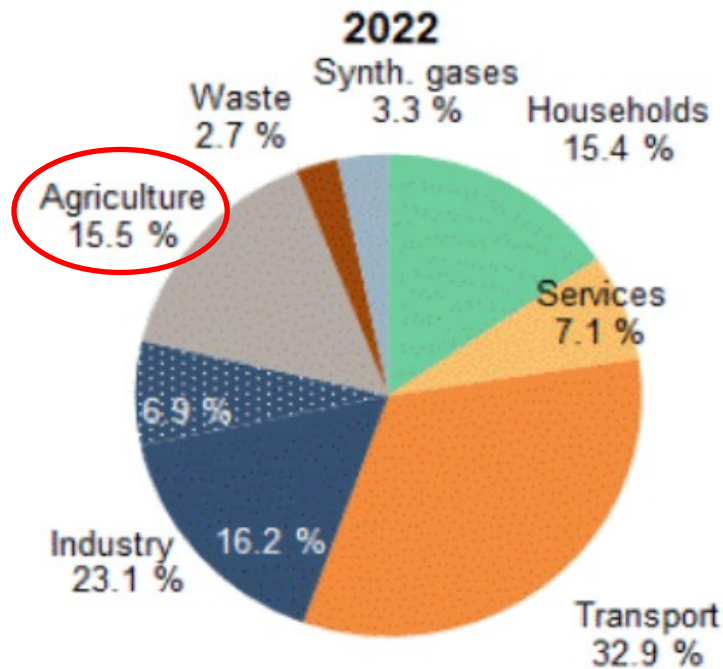
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Motivation

- Swiss agricultural greenhouse gas (GHG) emissions accounted for 15.5% of the total emissions (in 2022)
- Agricultural emissions have been reduced by 14% (in 2022), but the reduction is stagnating now



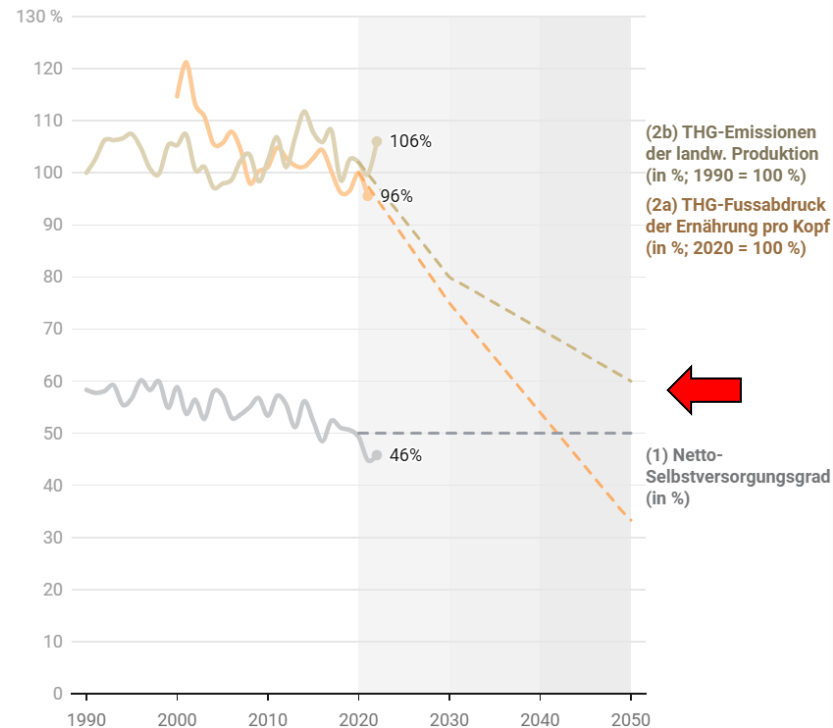


Motivation

- Swiss agricultural greenhouse gas (GHG) emissions accounted for 15.5% of the total emissions (in 2022)
- Agricultural emissions have been reduced by 14% (in 2022), but the reduction is stagnating now
- Reduction of GHG emissions from domestic agricultural production by 40% compared to 1990

Oberziele und bisherige Entwicklungen

Die Treibhausgasemissionen der landwirtschaftlichen Produktion entwickelten sich 2022 weg vom Zielpfad





Objectives

- Identify potential **measures** and up to three implementation **scenarios** (i.e., different assumptions for application of measures)
- Estimate the **cost** of each measure and scenario for farmers, and upscale to national-level
- Assess the **mitigation potential** of each measure at the national scale (Swiss National GHG-Inventory Model)
- **Integrate** costs and potentials of all measures in marginal abatement cost curves (**MACCs**). Group results by costs per ton of mitigated CO₂ and present them in three MACCs (i.e., for the most **probable** scenario, a **low-cost** and a **high-cost** scenario)



Identified measures

Function	Measures	Approach
<p>CH₄ reduction</p> <p>N₂O reduction</p> <p>CO₂ reduction</p> <p>C-sequestration</p> <p>CO₂e</p>	<ol style="list-style-type: none">1. Biogas plants (CH₄+N₂O)2. Increasing lactation number3. Methane-reducing feed additives4. Nitrification inhibitor5. Slurry covers6. More grain legumes7. Trailing hose/shoes for slurry spreading8. Precision nitrogen fertilization9. Nitrogen optimized feeding10. Rewetting organic soils (CO₂+N₂O)11. Biochar	<p>Technical approaches</p> <p>Structural approaches</p>



Example: Scenarios for measure “Grain Legumes”

- Plant more legumes to reduce N₂O emissions through lower N fertilizer use



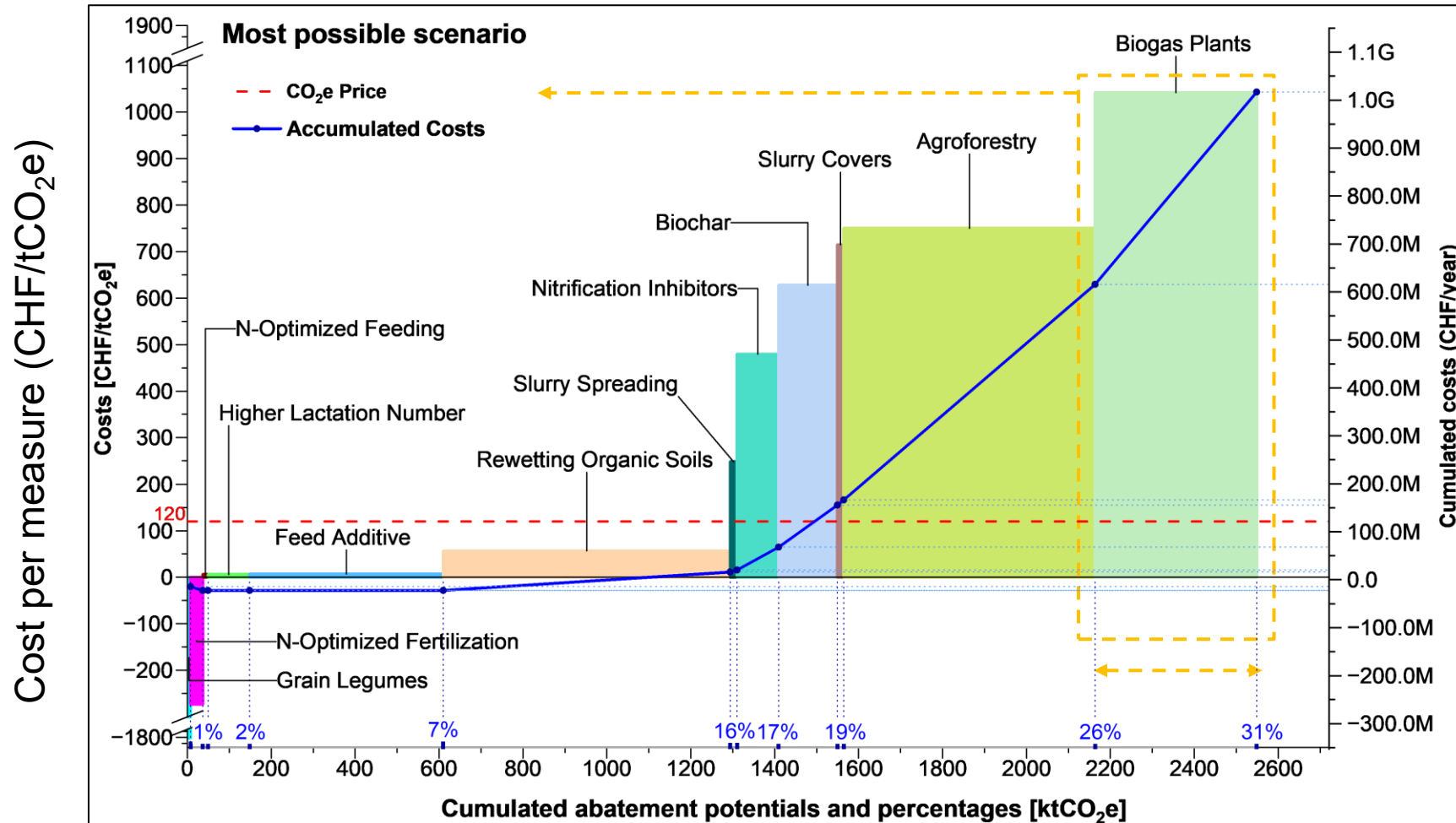
Assumptions

Scenario 1 (S1)	Expansion to meet agronomic potential (conventional farming)
Scenario 2 (S2)	Expansion to meet market demand (organic farming)
Scenario 3 (S3)	Expansion based on regional survey (organic farming)

References:
Keller et al., 2024;
Ramseyer et al., 2021



Results: MACCs with three scenarios



Cumulative cost per year

Example:

Measure of "Biogas Plants"

Cost: 1042 CHF/tCO₂e

Potential: 385 ktCO₂e/year

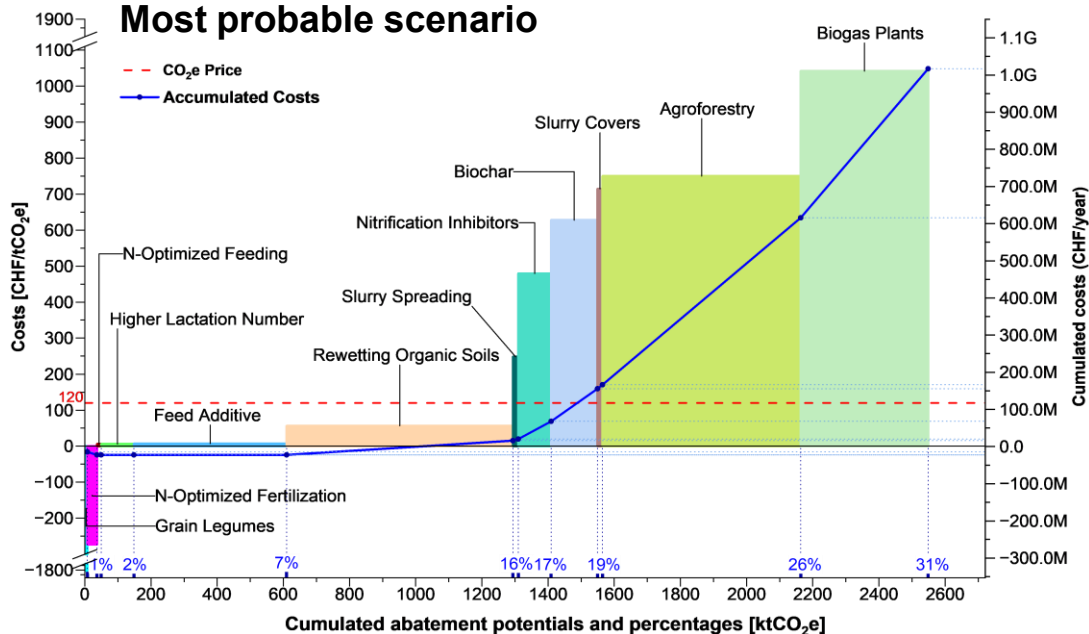
From left to right: Cumulative GHG emission reduction potential

From left to right: Cumulative GHG emission reduction percentage (% compared to 1990 level)

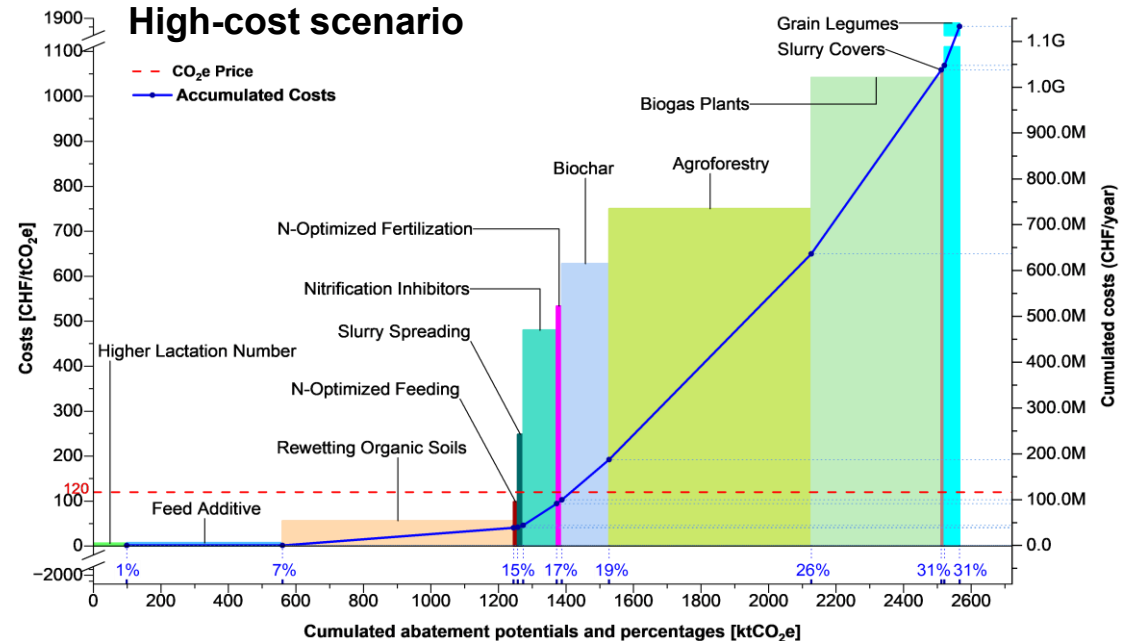
Results: MACCs with three scenarios



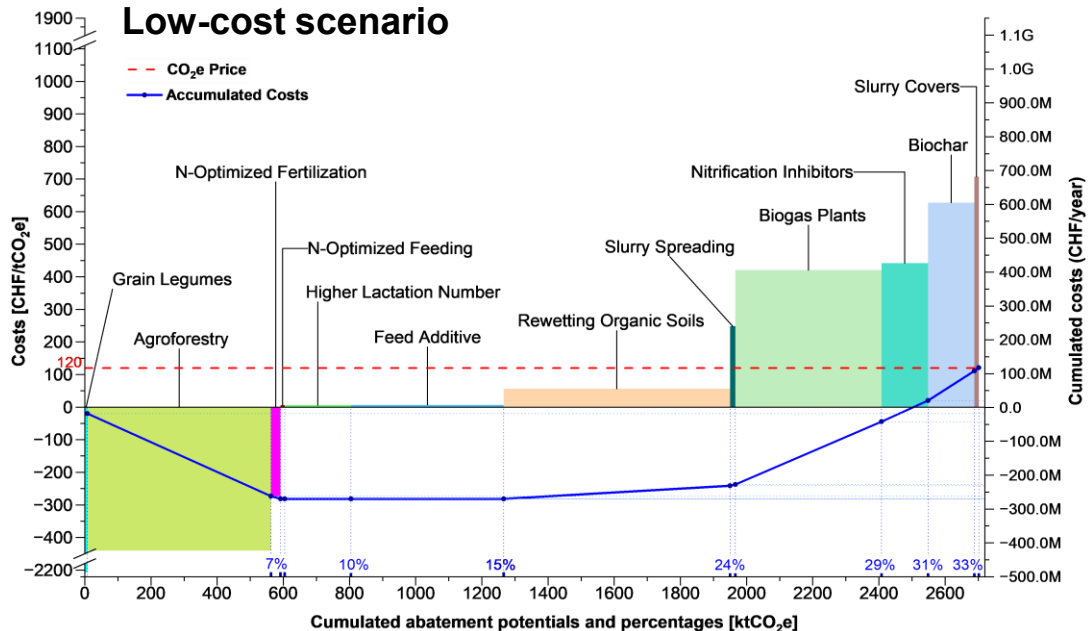
Most probable scenario



High-cost scenario



Low-cost scenario

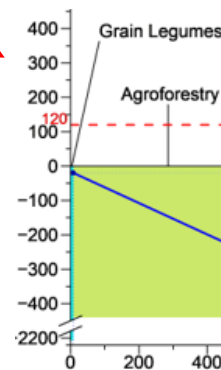
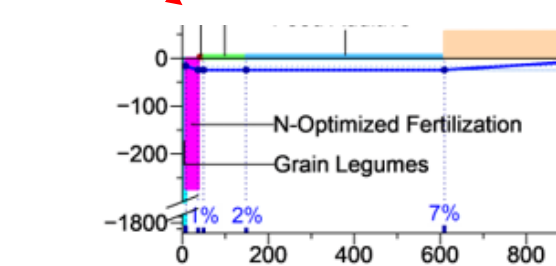
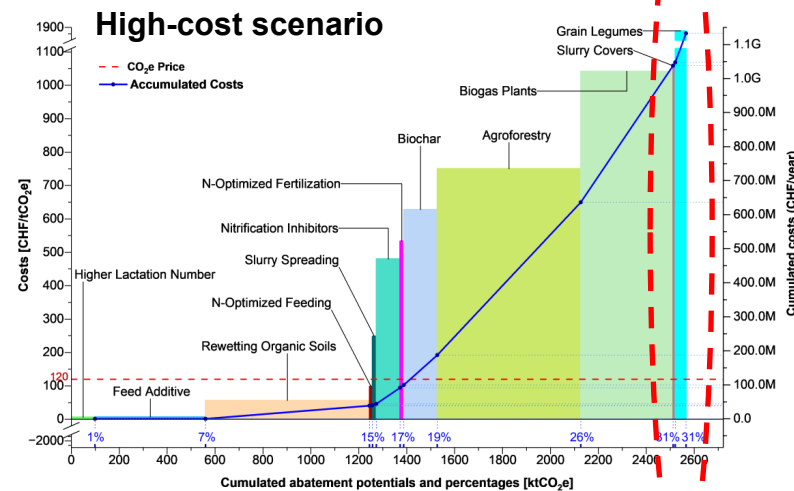
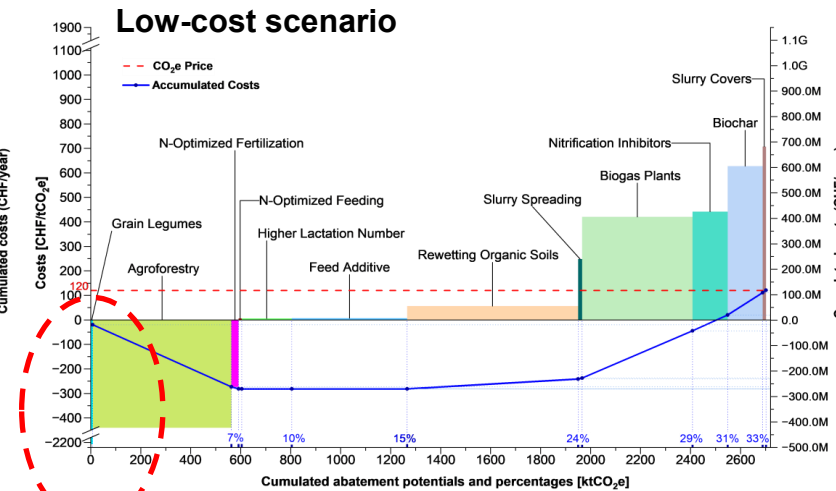
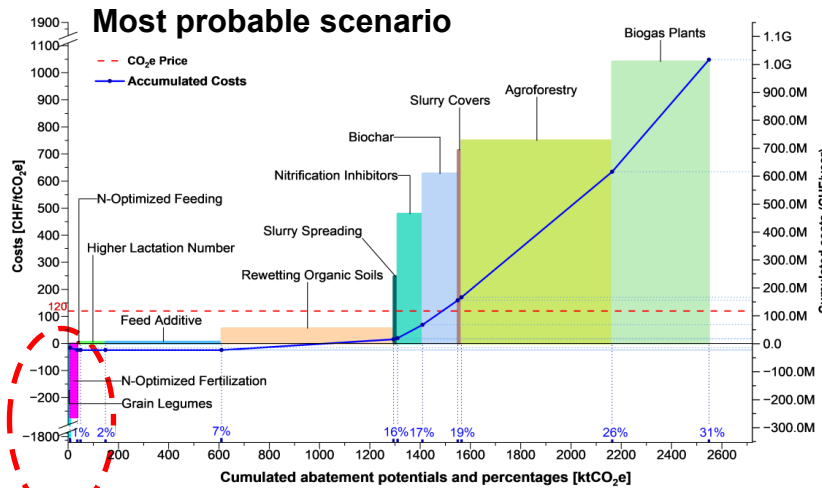


Results from MACCs		Probable scenario	Low-cost scenario	High-cost scenario
All twelve measures	Emission reductions (kt CO2e)	2548 (31%)	2701 (33%)	2566 (31%)
	Costs (Mio CHF)	1017	118	1133
Cost-effective measures	Number of measures	6	7	4
	Emission reductions (kt CO2e)	1294 (16%)	1950 (24%)	1257 (15%)
Neutral-cost measures	Costs (Mio CHF)	16	-231	40
	Number	2	2	1
Negative-cost measures	Emission reductions (kt CO2e)	112 (1%)	213 (3%)	99 (1%)
	Number	2	3	0
Negative-cost measures	Emission reductions (kt CO2e)	37 (0,45%)	592 (7%)	0 (0%)
	Number	2	3	0



Assumptions change the ranking of measures in MACCs and need to be transparently communicated

Example: Grain Legumes (Represented bar colour:)





Conclusions

- A 31-33% emission reduction could be reached with a cost of 118-1,133 Mio CHF per year. Cost-effective measures can achieve a 15%-24% emission reduction.
- How measures are implemented leads to strong uncertainty in MACCs, especially regarding the costs. Transparent communication is important for policy makers.
- The existence of cost neutral and cost negative measures suggests that there are other barriers that currently prevent the uptake of measures.



Thank you for your attention

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