ILMASTOPOLITIIKKA JA HIILIKOMPENSAATIOIDEN POLITIIKKAHAASTEET

Jussi Lankoski

Carbon action - tiedetyöpaja

11.4. 2018 Ilmatieteen laitos

OECD

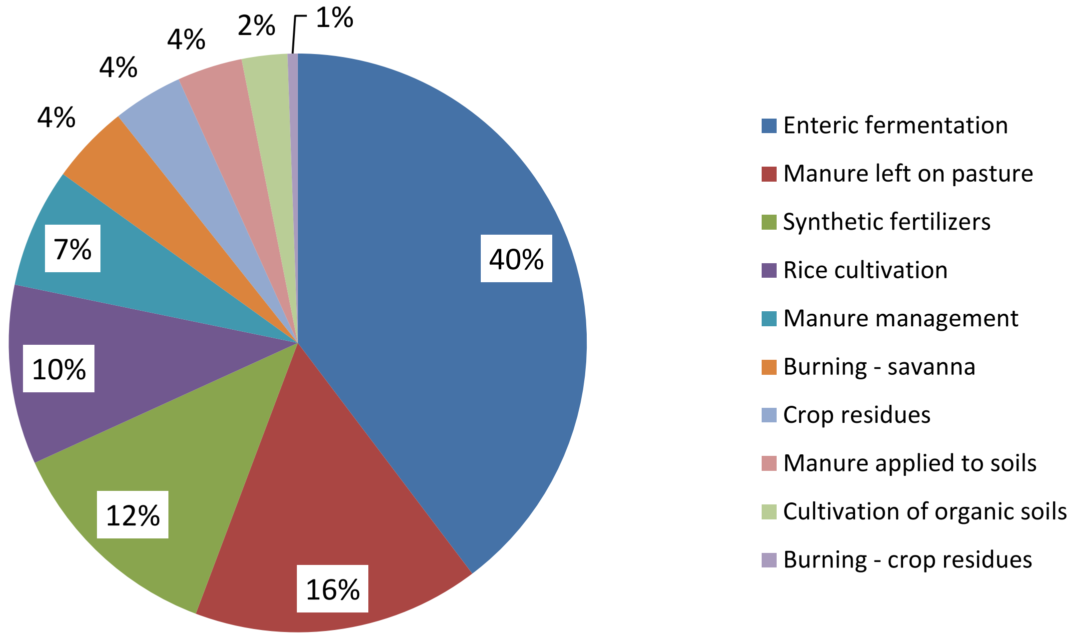
BETTER POLICIES FOR BETTER LIVES

Agriculture's role in GHG emissions

Agriculture contributes strongly to GHG emissions:

- Direct emissions 5.0- 5.8 $GtCO_2eq$ (10-12% of global anthropogenic emissions)
- Indirect emissions 4.3-5.5 $GtCO_2eq$ through land use and land use change
- Total AFOLU emissions 10-12 $GtCO_2eq$ (24% of global emissions)
- Largest contributor of non-CO_2 (nitrous oxide and methane) emissions (56% in 2005)
- Livestock contribute 80% of direct agr. emissions and ruminants 80% of livestock emissions

Global direct emissions from agriculture by source (average 2012-14)



Source: FAOStat data.

Agriculture's "fair" share of global mitigation responsibility?

- To meet below 2°C target, global emissions across all sectors in 2030 must fall by 26 $GtCO_2e$ per year

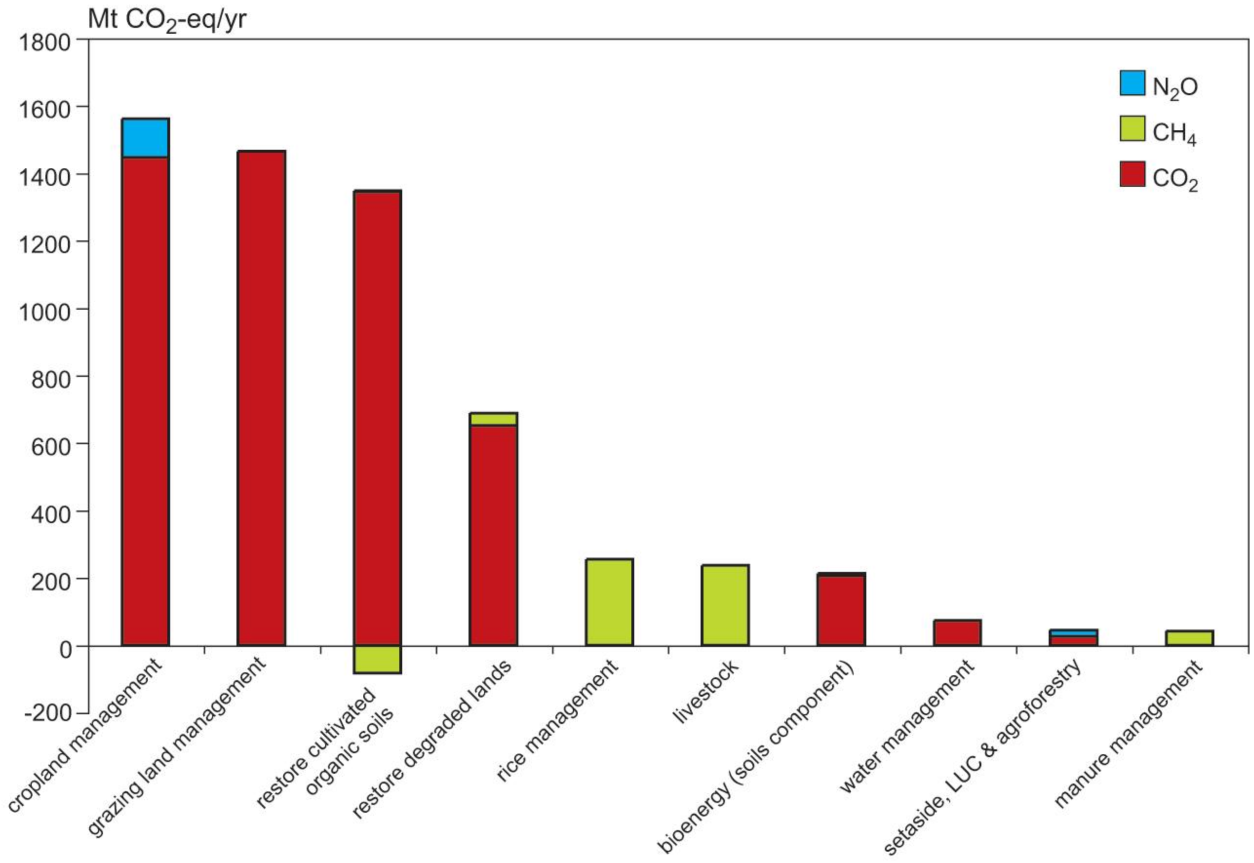
- With equi-proportional reduction by all sectors, agricultural emissions would need to decrease by two thirds, which is too high given the lack of low cost mitigation options for agriculture and food security concerns

- Considering agriculture's mitigation costs and maintenance of food security, Wollenberg *et al*. (2016) estimated the sector's contribution to be 1 $GtCO_2e$ yr^{-1} of non-CO_2 emissions (representing 4-5% of mitigation needed across all sectors)

- With current technology and C-price of \$20 tCO_2e^{-1}, non-CO_2 mitigation compatible with food security, will only achieve up to 0.4 $GtCO_2e$ yr^{-1}

- Therefore, other options needed (e.g. soil C sequestration)

Technical mitigation potential (AFOLU) by 2030



Source: Smith et al. (2014: 852).

Soil carbon sequestration measures and capacity

- Globally agricultural soils can offset 15% of global GHG emissions (Lal 2004)
- Biological carbon sequestration potential for EU-15 around 90-120 Mt C per year, but realistic potential only 20% of it (Smith 2004)
- Sequestration practices (t C per ha per year) (Smith 2004):
  - No-till (0.4) and reduced tillage (<0.4)
  - Conversion of cropland to grassland (1.2-1.7)
  - In addition afforestation, improved crop rotation, cereal straw and other organic amendments

Challenges in developing policy mechanisms for C sequestration (1)

Dynamics:

- Sequestration practice increases C storage with diminishing rate until it plateaus at new equilibrium (20-100 years)

Additionality:

- Policy needs to encourage sequestration practice that is additional (would not have happened without policy)
- Requires knowledge of "baseline practice" which may change over time and as a consequence also additionality
- "Common-practice" approach (e.g. if practice is only adopted by 5-20% of potential adopters then additional)

Challenges in developing policy mechanisms for C sequestration (2)

Heterogeneity:

- Vast heterogeneity in sequestration capacity and costs -> spatial targeting

Permanence:

- Some sequestration practices are relatively easily reversed (no-till adoption and green set-aside) and sequestration benefits lost
- Sequestration should be permanent, but some schemes use arbitrary periods (25-100 years) with possibility to opt-out (through purchase of additional abatement)

Leakage:

- If sequestration practice decreases commodity production then production and emissions are displaced to locations outside of "sequestration adoption region"

Carbon payments

Practice-based versus output-based payments:

- Due to heterogeneity in sequestration capacity and opportunity costs output-based payments more cost-efficient
- Output-based payments require detailed monitoring and thus involve relatively higher transaction costs (TCs)
- Antle et al. (2003): even with relatively high TCs output-based payments more cost-effective

Carbon offset markets

- Agriculture can provide voluntary offsets to regulated industries
- Due to uncertainty related to sequestered carbon under different practices in different locations *trading ratios* may be used to safeguard environmental integrity of markets
- Trading ratios secure the environmental performance of trading markets but may reduce willingness to participate in markets
- TCs related to participation increase threshold offset price after which offset supply becomes profitable

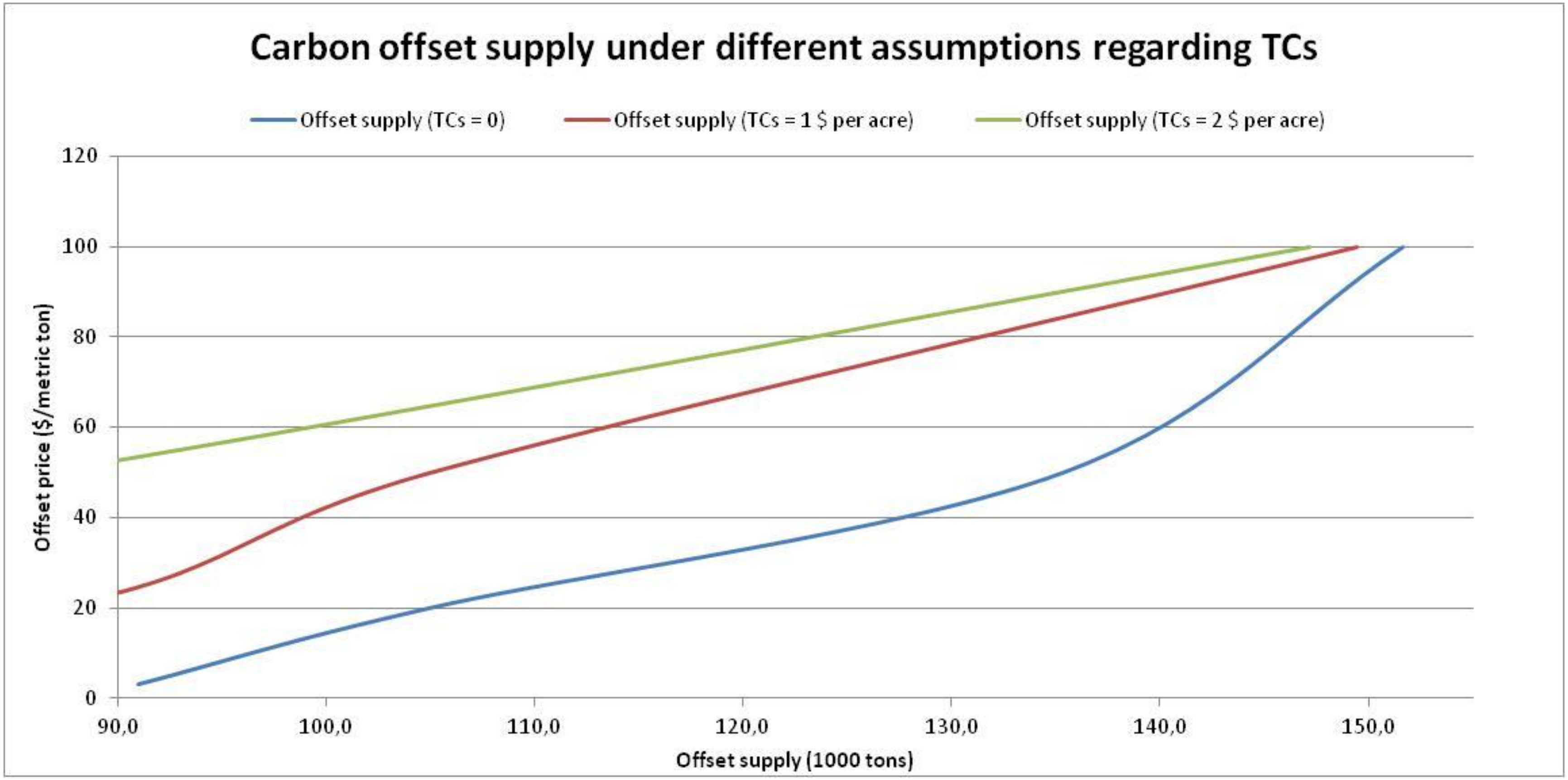
Environmental co-benefits and stacking of various credits

- Sequestration practices provide multiple environmental co-benefits (e.g. water quality and biodiversity)
- If several environmental markets exist (such as carbon offset, water quality trading, and biodiversity offsets) can credits be sold for different markets from the same practice adoption?
- Credits stacking = allows farmer to earn credits from several markets with one practice (such as no-till adoption)
- Stacking has pros and cons:
  - Increases participation and allows higher quality practice adoption
  - Complicates interpretation of additionality

Inter-market additionality

- If primary market (carbon offset) already incentivises practice adoption (e.g. switch from conventional tillage to no-till) what is the baseline for secondary market (water quality)? Current practice (conventional tillage) or no-till?
- If primary market (carbon offset) already compensates practice adoption then credits for water quality co-benefits are not additional from inter-market additionality viewpoint
- Additionality in water quality market would require either new practice adoption, such as green set-aside, or increased acreage under no-till

Credit stacking: US Corn Belt application (Lankoski et al. 2015)



US Corn Belt: consideration of co-benefits makes adoption more profitable

Offset scenario and environmental practice	Acreage response million acres	Carbon offsets, '000 tons	Nitrogen credits, tons	Phosphorus credits, tons	Farm profit increase, USD million
Carbon offsets: switch to no-till	0.8	44.4	-	-	18.4
Carbon offsets + water quality offsets: switch to no-till	1.0	49.4	23	83	20.4
Carbon offsets + water quality offsets: Green set-aside	0.05	20.7	1 251	102	1.6
Carbon offsets + water quality offsets: Vegetated field strips	0.6	6.5	5 140	58	12.4
Carbon offsets + water quality offsets: Reduced N fertilizer use	4.6	141.2	16 408	418	74.6

Carbon offsets

- Provision of CO_2-eq offsets through reduced nitrogen application or the establishment of green set-asides is not profitable without water quality offsets
- A conversion from conventional tillage to no-till is profitable in some cases
- Current low carbon offset prices and transaction costs have a significant negative impact on the number of participating parcels
- Current carbon offset prices do not provide incentives to participate in ecosystem service markets without the possibility of stacking water quality offsets

Stacking of water quality credits

- Allowing stacking increases the profitability of carbon sequestration practices
- Reduced nitrogen application becomes profitable and 21% of field parcels participate in the market with current water quality credit prices
- The establishment of green set-aside and streamside buffer strips becomes profitable in the lower productivity and highly erodible lands with current credit prices
- An oversupply of nutrient credits results in reduced credit prices and credit revenue to farmers

Conclusion from stacking

- Stacking provides additional environmental services
- Current CO_2-eq offset prices do not necessarily compensate profit foregone of adopting these practices
- Allowing stacking of water quality credits or government incentive payments makes adoption more profitable
- If environmental markets are local and small stacking may lead to oversupply of credits, reduced credit prices and thus credit revenue for farmers

Conclusion from policy challenges regarding soil carbon sequestration

Several policy design challenges: (i) vast heterogeneity in sequestration capacity and costs, (ii) dynamic features of sequestration benefits, (iii) additionality of practices, (iv) permanence, (v) leakage and (vi) farmers' risk aversion (long contracts and uncertain income with output-based payments)

Starting point:

- policy design should at least address heterogeneity and additionality for maximizing budgetary cost-effectiveness of sequestration policy
- develop scientifically sound, but relatively simple carbon sequestration capacity index (climate benefit index) to be applied at field parcel which considers both exogenous factors (soil type etc.) and endogenous factors (adopted practice and its capacity to sequester carbon)
- let farmers to offer their field parcels to program through auction (bidding)
- choose field parcels on the basis of benefit (index value) relative to cost (bid) and rank from highest to lowest ratio until budget is exhausted