How Much Should We Compensate Farmers in Global South To Mitigate Climate Change While Meeting Increasing Food Demand?

Suhyun Jung

Applied Economics, University of Minnesota

337K Ruttan Hall
1994 Buford Ave
Saint Paul, MN 55108
Jungx219@umn.edu

Selected Poster prepared for presentation at the
2015 Agricultural & Applied Economics Association and Western Agricultural Economics Association Joint Annual Meeting, San Francisco, CA, July 26-28

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Objective

Identify *regions with high priority for conservation to maximize net benefits* from agriculture and carbon, and generate a map indicating how much we should compensate farmers for their *loss of economic rent*

Motivation

- ❑ Increasing food demand: 70 % more food production required by 2050 compared to the level in 2009 (FAO 2011)
- ❑ Two sources of meeting increasing food demand
  - Intensification: closing "yield gaps" (80%)
  - Extensification: land clearing (20%)
- ❑ Effects of extensification: Tradeoff between economic rent (profit) for farmers and carbon sequestration

Literature

- ❑ Global tradeoff among ecosystem services including agricultural production, carbon sequestration, and water provision (e.g., Naidoo and Iwamura 2007; Naidoo et al. 2008; Johnston et al. 2014)
- ❑ Little information on true value of economic rent for farmers in developing countries: **No globally-consistent agricultural production cost dataset**

Scenario

Conservation Priority Regions

- ❑ Where should will conserve?
  Areas where value of carbon- return on agriculture is maximized

Return on Agriculture – Economic Rent (Profit)

→ How much should we compensate farmers?

Constraints

Biophysical Suitability

- ❑ Suitability index by crop : climate, soil , and slope condition (FAO – GAEZ)

Socioeconomic Suitability

- ❑ Profit >0: Constructed production cost and transportation cost using accessibility map (FAO – GAEZ)

Contribution

Methodology

- ❑ Construction and use of globally-consistent agricultural production cost data set

Implication

- ❑ Identification of high conservation priority area to increase net benefits from carbon and agriculture
- ❑ Quantitative estimation of farmers' welfare change in increasing net benefits
- ❑ Help inform land use decisions to secure environmental and social justice

Methods

Carbon Value Calculation

- ❑ Calculate the value of carbon storage for a given cell (10km by 10km)
  - Social cost of carbon from the literature: $137 per ton of carbon in 2010 US dollar assuming 3% discount rate (IWG 2015)
  - Spatially explicit global potential carbon storage dataset (West et al. 2010)
- ❑ Sensitivity check using different value of carbon under various discount rates

Methods - cont'd

Economic Rent (Profit) Calculation

- ❑ Calculate per hectare profit from major crop production (10 crops)
  - Price and yield from FAOSTAT
  - Costs: fertilizer, labor, machinery, and seed

For crop k in country i

$$FertCost_k^i = FertPrice_{nk}^i \, FertQuantity_{nk}^i$$

$$LaborCost_k^i = \sum_{type} Wage_{type}^i \times \frac{LaborHours_{type,k}^i}{ha}$$

$$type \in \{paid, unpaid\}$$

$$Low\_MachineCost_k^i = 0$$

$$High\_MachineCost_k^i = MachineCost_k^{US} \frac{ListPrice^i}{ListPrice^{US}}$$

$$Low\_SeedCost_k^i = SeedingRate_k^{US} P_k^i$$

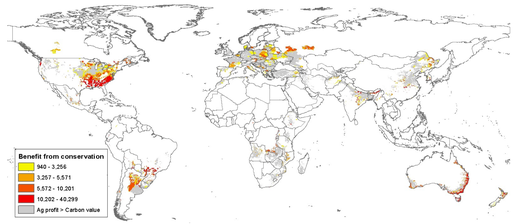
$$High\_SeedCost_k^i = SeedCost_k^{US} \frac{P_k^i}{P_k^{US}}$$

Caveat and Further Study

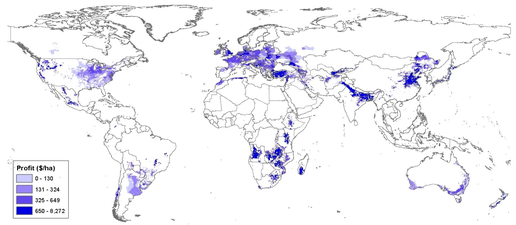
- ❑ Simplification of crop variety
  - Lack of production cost data for other crops
- ❑ Consideration of other ecosystem services such as water and habitat quality
- ❑ Intensification
  - Impact of intensification on economic rent and other ecosystem services

Preliminary Results (Wheat)

Conservation Priority Regions



Economic Rent (Profit)



→ Comparison of these two maps informs how much we should compensate farmers ($/ha) for optimization

References

1. Food and Agriculture Organization (FAO). 2011. The State of the World's Land and Water Resources for Food and Agriculture – Managing Systems at Risk.
2. IWG. 2015. Techinical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866. Interagency Working Group on Social Cost of Carbon, United States Government.
3. Johnston, J.A., C.F. Runge, B. Senauer, J. Foley, and S. Polasky. 2014. Global Agriculture and Carbon Trade-offs. Proceedings of the National Academy of Sciences 111(34): 12342-47.
4. Naidoo, R. and T. Iwamura. 2007. Global-scale Mapping of Economic Benefits from Agricultural Lands: Implications for Conservation Priorities. *Biological Conservation* 140: 40-49.
5. Naidoo, R., Balmford, A. Costanza, R., Fisher, B, Green, B., Lehner, B., Malcolm, T.R. and Ricketts, T.H. 2008. Global Mapping of Ecosystem Services and Conservation Priorities. *Proceedings of the National Academy of Sciences* 105(28): 9495-9500.
6. West, P.C., H.K. Gibbs, C. Monfreda, J. Wagner, C.C. Barford, S.R. Carpenter, and J.A. Foley. 2010. Trading carbon for food: Global comparison of carbon stocks vs. crop yields on agricultural land. *Proceedings of the National Academy of Sciences (PNAS)* 107(46), 19645–9648

Acknowledgement

This research was funded by two organizations at the University of Minnesota: Interdisciplinary Center for the study of Global Change and Consortium on Law and Values in Health, Environment & the Life Sciences.