Market-Mediated Land Use Change & Biofuel Policy

Towards An Evaluation of Mitigation Options

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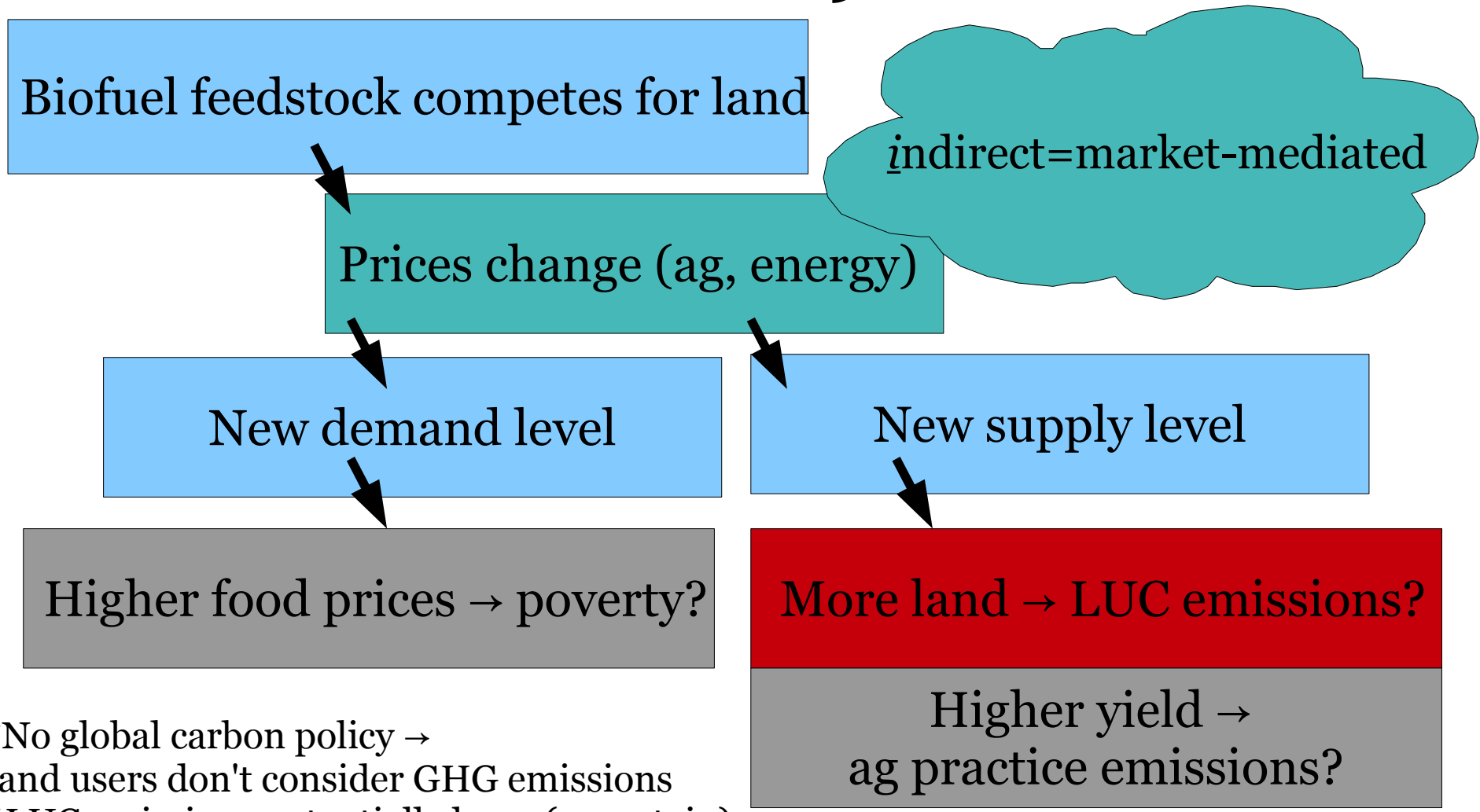
Biofuel LUC - why we care...



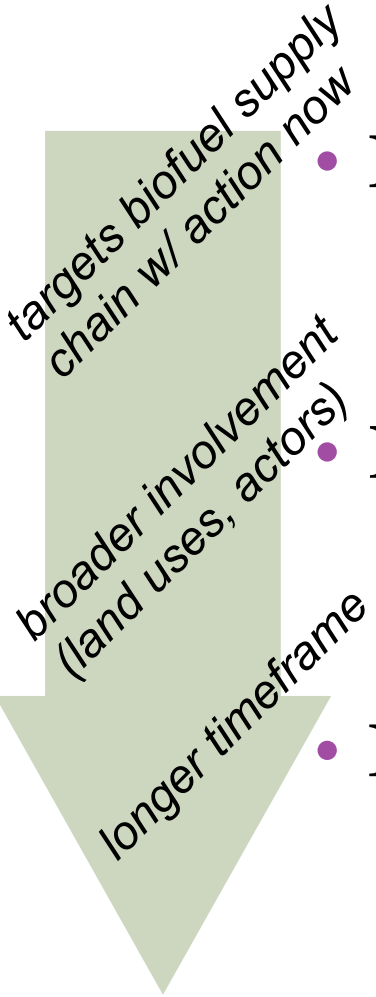
*No global carbon policy →
land users don't consider GHG emissions
*LUC emissions potentially large (uncertain);
can undermine GHG reduction goals of biofuel policy (1st gen & beyond)
*How to manage LUC risk for 21st c. given other policy objectives?

Witcover et al. Campinas 2011

Managing LUC Risk from Biofuel Policy: A Three-Pronged Approach

- Feedstock mix less reliant on land
  - promote low LUC-risk feedstocks (waste, residue, algae)
  - limit use/expansion of high LUC-risk (crop) feedstocks
- Lowered LUC risk for land-using feedstocks
  - reward feedstock-growing conditions that avert displacement or compensate for its effects
- Investments that reduce the scope for LUC
  - land productivity, environmental protection, carbon accounting

A 'Policy Menu' Approach: Cover Transition Timeframe, Both Sides of Productive Frontier



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- Investments that reduce the scope for LUC
  - land productivity, environmental protection, carbon accounting (short- and long-term)

Strategy List as Policy Design 'Menu'

Alter feedstock mix (inside supply chain)

Lower risk from ld-based sources (in/out)

Reduce LUC thru broader investm'ts (beyond)

1. Prioritize Low-Risk LUC Feedstocks: *waste, residue, algae*

- create incentives for low-risk LUC feedstocks (EU-RED double counting; R&D incentives)
- set targets for low-LUC biofuel volumes (US-RFS2 hi volumes for 'advanced' fuels & biodiesel)

2. Discourage Land-Using Feedstocks

- cap biofuel production volumes/feedstock production areas for higher risk feedstocks (US-RFS2 capped volumes for higher carbon 'renewable' fuels)
- exclude high-risk LUC feedstock pathways for meeting policy requirem'ts (regional US prop)
- create disincentives for high-risk feedstocks (via ILUC factor) (US-RFS2, CA-LCFS, 'quantitative' and 'uncertainty factor' proposals)

3. Limit LUC via Controls on Feedstock Production Conditions

- confine feedstock prod'n primarily to more 'marginal' land (little biomass or productive use) (some projections for cellulosics)
- promote use of more 'marginal' land (EU-RED CI bonus for severely degraded land, LIIB certification for 'non-provisioning' land)
- encourage 'additional' feedstock production from areas already under cultivation (LIIB certification for 'additional' output from higher yields or integration w/ existing prod'n systems)

4. Offset LUC with Credits

- allow emissions offsets for LUC effects (link to carbon credit programs – REDD, CDM)
- allow yield offsets for feedstock production (Virtual Yield Bubbles)

5. Take Pressure Off the Land Base

- create incentives for higher land productivity on cleared & 'marginal' land (map/target high-risk LUC areas, support defined local property rights, R&D, extension)
- reduce agricultural supply chain losses (harvest, storage, transport)
- generate land-saving co-products (encourage coproduct development from feedstock production & processing)
- ease demand thru energy efficiency gains (extract more energy from feedstock)

6. Protect Carbon Stocks/Encourage Carbon Sequestration

- target hi-carbon areas for protection (EU-RED 'no-go', US-RFS2 'go' areas, peatl'd, forests)
- promote GHG accounting in land use (EU-RED unilateral agreements)
- add carbon value for land use (carbon tax on ld, emissions tax on ld-based prod'ts, cap-&-trade for land-based emissions)
- add carbon value in all sectors (carbon tax, cap-&-trade)

Managing LUC Risk from Biofuel Policy: 'Menu' Item Promising Examples

targets biofuel supply chain w/ action now

broader involvement

longer timeframe

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Risk-based approach **e.g., 'ILUC Factor'**

e.g., 'Low Indirect Impact Fuels', offset schemes (need developm't, rigorous monitoring framework)

e.g., higher global yields, protected areas (uncertainty on magnitude/timing of payoff, scope w/in biofuel policy)

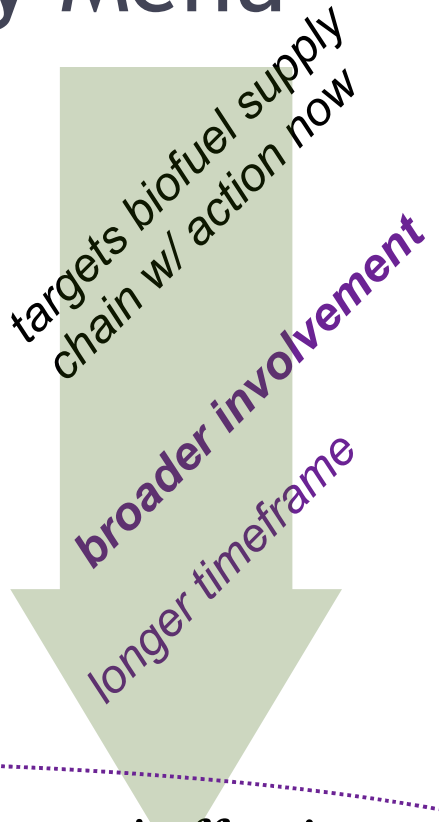
Source: Witcover & Yeh 2011 on LUC policy options for NLCFS

Moving from Concepts to Policy

- Evaluation Criteria
  - effectiveness (and robustness)
  - efficiency
  - implementability
  - enforceability
  - equity
- Evaluation Tools
  - modeling, data work to assess effectiveness, efficiency of outcomes, *unintended consequences (e.g., leakage)*
  - stakeholder participation and consultation (streamlined & workable processes, proper accountability)

Evaluation & 'Policy Menu'

- Evaluation Criteria
  - effectiveness (and robustness)
  - efficiency
  - **implementability**
  - **enforceability**
  - **equity**
- Evaluation Tools
  - modeling, data work to assess outcomes' effectiveness, efficiency, *unintended consequences (e.g., leakage)* as a valuable input for…
  - stakeholder participation and consultation (streamlined & workable processes, proper accountability)



Model-Based Evaluation of LUC *Policy Design*: An Illustration

- From collaborative research on a US National Low Carbon Fuel Standard (directed from ITS-UCDavis)
  - LCFS incentivizes alternative fuel use based on carbon intensities (v. volumetric mandates)
  - economic analysis for US (Madhu Khanna, Hayri Önal, Haixiao Huang, University of Illinois at Urbana-Champaign)
  - rest of world LUC effects (Siwa Msangi, Miroslav Batka, International Food Policy Research Institute)
- Approach – 'soft' link between 2 economic (partial) equilibrium models
  - BEPAM model responds to US biofuel policies by adjusting supply & demand in US ag, energy markets → SHIFTS in exports of key commodities (U of Illinois team)
  - IMPACT model depicts RoW response to US trade changes by adjusting production/consumption & **crop area** (IFPRI team)

Model-Based Evaluation of LUC Policy Design: Two Examples

targets biofuel supply chain w/ action now

broader involvement

longer timeframe

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1. LCFS, 'ILUC Factor' in US Policy

2. regional yield gains, protecting hi-Cstock areas

Witcover et al. Campinas 2011

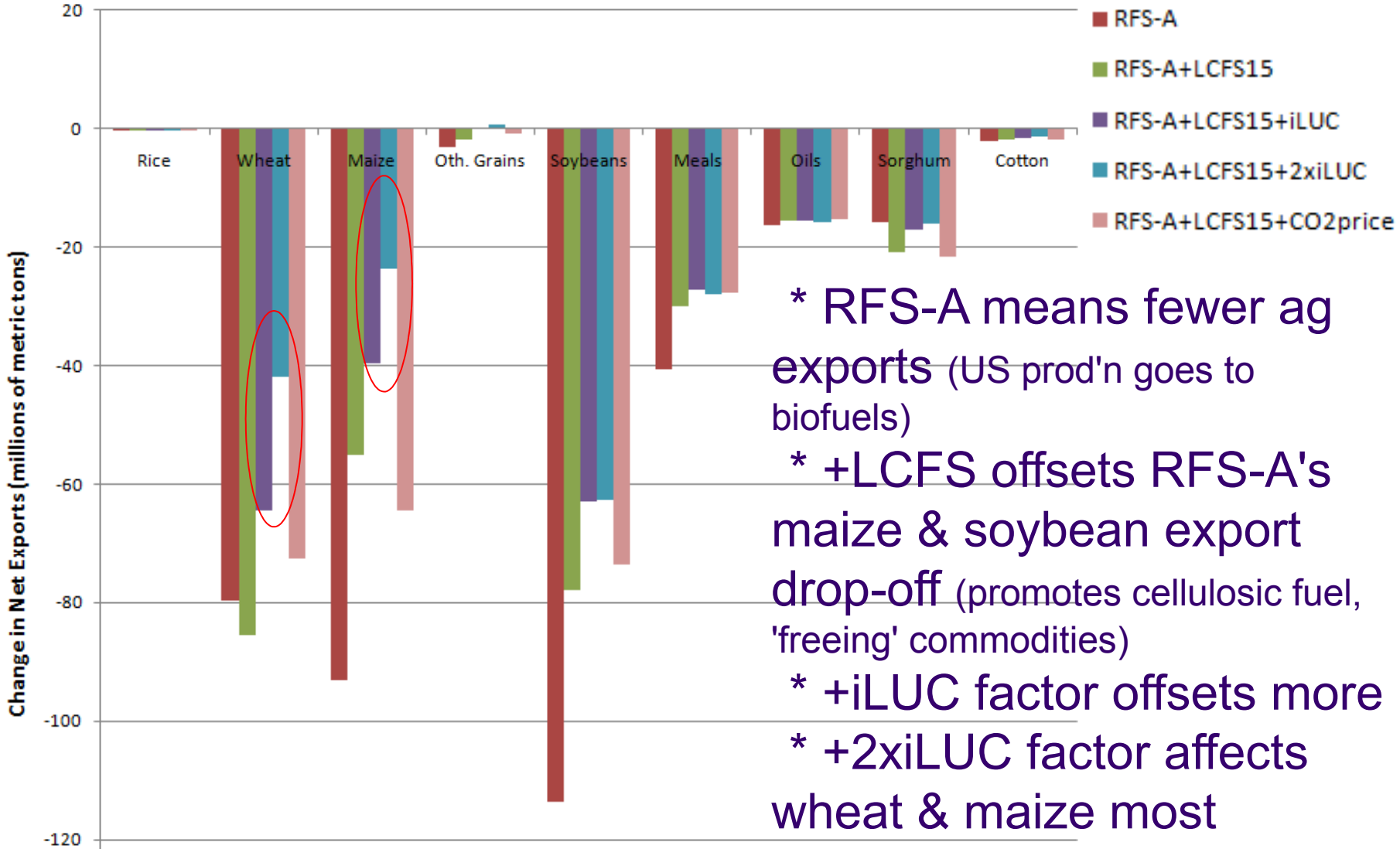
Modeling Example 1: US Policy Scenarios

(compared to BAU, no policy, AEO-informed, to 2030*)

RFS-A	RFS-AEO – RFS falls short of EISA blending goals (as per AEO 2010 outlook)
RFS-A+**LCFS15**	RFS-AEO + **LCFS requiring 15% decline in fuel carbon intensity**
RFS-A+LCFS15+**iLUC**	RFS-AEO with LCFS15 + EPA **'international LUC'** values
RFS-A+LCFS15+**2x**iLUC	RFS-AEO with LCFS15 + **2x**EPA 'international LUC' values
RFS-A+LCFS15+**CO2price**	RFS-AEO with LCFS+**CO2 price** (EIA assessment of US ACES cap-&-trade)

*details of BAU & scenarios in Khanna et al. (2011)

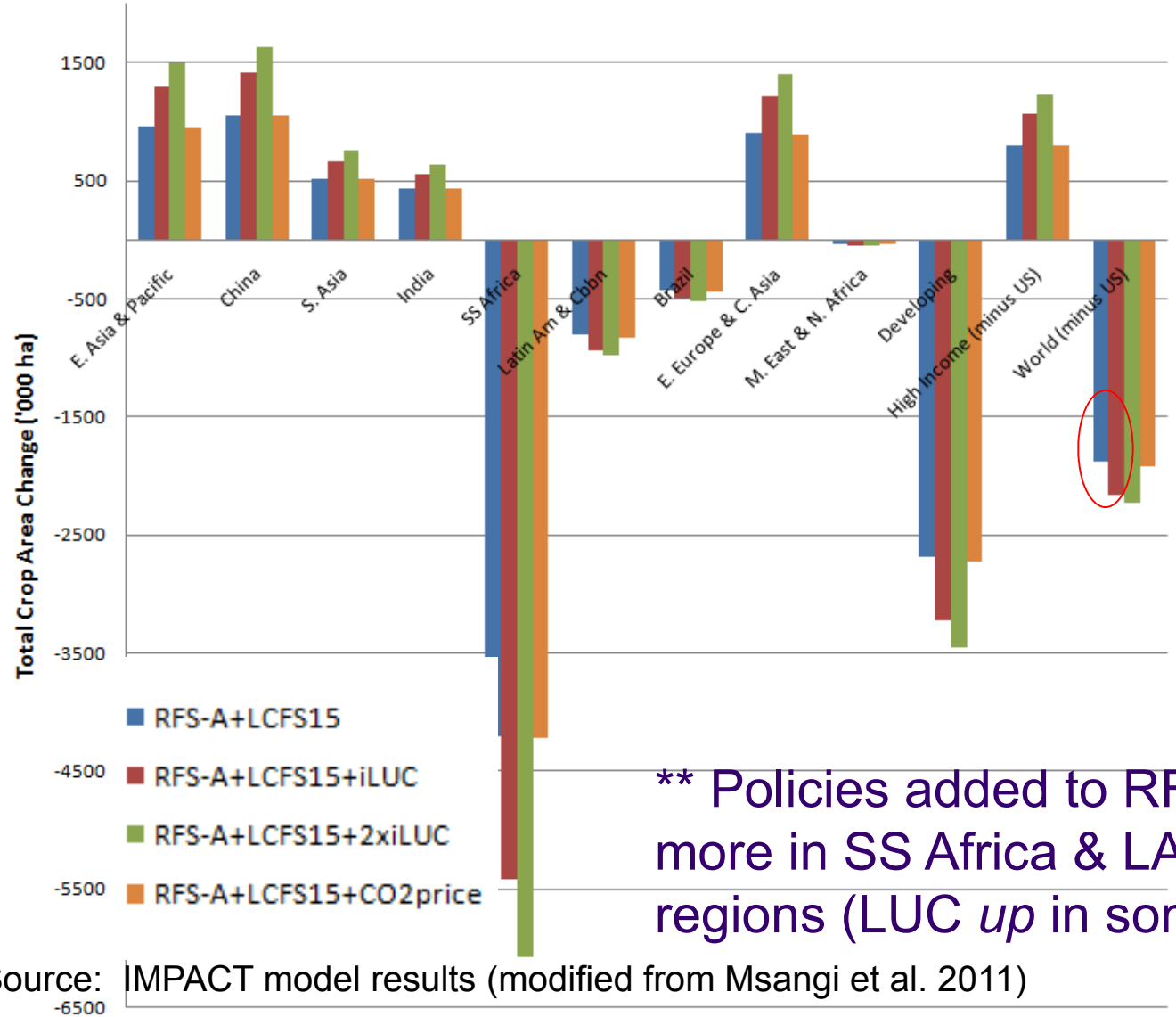
Ex 1: US Policies change US exports relative to BAU (2030)



* RFS-A means fewer ag exports (US prod'n goes to biofuels)
* +LCFS offsets RFS-A's maize & soybean export drop-off (promotes cellulosic fuel, 'freeing' commodities)
* +iLUC factor offsets more
* +2xiLUC factor affects wheat & maize most

Source: BEPAM model results

Ex 1: Policies change non-US LUC relative to RFS-AEO (net, by 2030)



* RFS-A prompts LUC outside US

* Adding LCFS lowers LUC (by ~ half)

* Adding iLUC factor lowers LUC more (smaller effect)

* 2xiLUC factor lowers LUC more (smaller incremental effect)

** Policies added to RFS lower LUC more in SS Africa & LAC than in other regions (LUC *up* in some places)

Source: IMPACT model results (modified from Msangi et al. 2011)

Witcover et al. Campinas 2011

Ex 1: US biofuel policy design matters to LUC in RoW

- Adding LCFS to RFS (encouraging lower carbon intensities in US) lowers LUC in RoW, especially SSAfrica and Latin America/Caribbean
- Adding an iLUC factor on top of an LCFS further reduces LUC in RoW, again with strongest effects in SSAfrica and LAC
- A higher iLUC factor continues to reduce LUC, but at a declining rate

Modeling Example 2: Productivity gain scenarios for SSA & LAC

selected crop	productivity gain (additional percent gain per year)	Target region
soybeans	0.15 %	Latin America
cereals/grains[1]	0.10 %	Sub-Saharan Africa
cotton	0.20 %	Sub-Saharan Africa
roots & tuber crops[2]	0.25 %	Sub-Saharan Africa

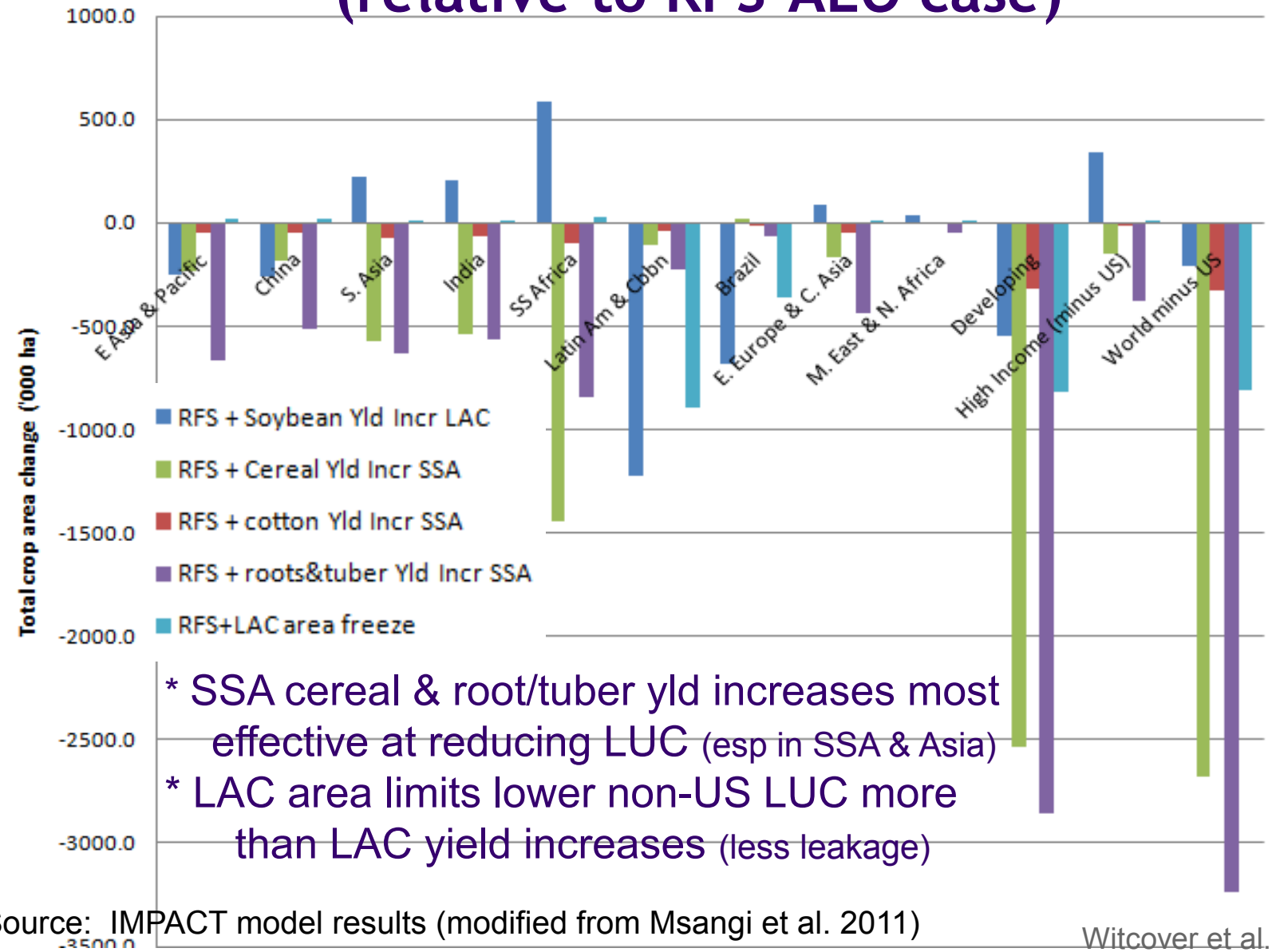
Note: (1) including rice, wheat, maize, sorghum, millet and other coarse grains; (2) including potatoes, sweet potatoes, yams and cassava

Source: Vosti *et al.* (2011)

Area Targeted for Halt on Agricultural Area Expansion

Ex 2: We also impose a halt to crop area expansion in tropical regions of LAC

Ex 2: LUC from interventions in LAC/SSA (relative to RFS-AEO case)



* SSA cereal & root/tuber yld increases most effective at reducing LUC (esp in SSA & Asia)
* LAC area limits lower non-US LUC more than LAC yield increases (less leakage)

Source: IMPACT model results (modified from Msangi et al. 2011)

Ex 2: Effects of policies to reduce the scope for biofuel LUC vary by region

- Boosting staple yields in SSAfrica has high payoffs in lowering biofuel policy-induced LUC, with contributions from most regions ('low-hanging' fruit in terms of relatively low yields → avoided land expansion, SSA net importer → 'transmits' land-saving elsewhere)

- Limiting tropical Latin American land expansion is a better option than higher LAC yields for reducing LUC, but not as good as adjusting SSA yields (adjusting yields in exporting region → offsetting land expansion elsewhere; less leakage with land limits)

- Challenges – uncertain location of LUC? enforcing land expansion limits? yield investment mechanisms & timing /magnitude of payoffs? (can biofuel policy design contribute?)

Recap: Strategy List & Evaluation Structure

- Three-pronged approach → fleshed out strategy list → policy menu
  - less land-reliant feedstock mix, lower risk from land-based feedstocks, broader investments to reduce the scope for LUC
  - grouping strategies by policy targets vis-à-vis biofuel supply chain highlights combinations to cover transition timeframe and both sides of productive frontier (ease of implementation/enforcement; need for greater coordination; longer timeframes; choice of evaluation tools)
- Model-based evaluation (examples)
  - LUC *outcomes* varied by region, magnitude due to policy design choices for LUC strategies from two 'prongs'
    - 'ILUC factor' (*inside* US biofuel policy) strengthens move toward cellulosics of an LCFS, reducing LUC outside US
    - yield improvements targeted toward staples in SSAfrica outperform LAC-directed strategies in terms of non-US LUC reductions (difficult to incentivise within US biofuel policy)
- From here: more systematic evaluation framework, mix of qualitative & quantitative tools needed for policy design and monitoring (effective LUC policy *combinations* for 21st c. needs)

Thank You!

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References

- Khanna, M., H. Önal, H. Huang. 2011. *Economic and Greenhouse Gas Reduction Implications of a National Low Carbon Fuel Standard*. Discussion draft (prepared for a National LCFS project). University of Illinois, Urbana-Champaign.
- Msangi, S., M. Batka, J. Witcover, S. Yeh. 2011. *Global Land Use Change and Finding Effective Mitigation Strategies*. Discussion draft (prepared for a National LCFS project). International Food Policy Research Institute (IFPRI), Washington, DC.
  - Note: simulation results presented here differ slightly (but policy messages do not) from those in the draft due to recent modifications to align IMPACT GDP growth assumptions with those in the BEPAM model.
- Vosti, S., S. Msangi, E. Lima, R. Quiroga, M. Batka, C. Zanocco. 2011. *Agricultural Greenhouse Gas Emissions in Latin America and the Caribbean: Current Situation, Future Trends and One Policy Experiment*. IDB Infrastructure and Development Discussion Paper no. IDB-DP-167. Inter-American Development Bank, Washington, DC.
- Witcover, J., S. Yeh. 2011. *Policy Options for Addressing Global Land Use Change Associated with Biofuel Policy*. Discussion draft (prepared for the National LCFS project. Institute for Transportation Studies, University of California-Davis.