Towards an improved assessment of indirect land use change

Evaluating narratives, models and data for the U.S. 2005 - 2015

IEA Bioenergy ILUC webinar

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J.W.A. Langeveld, M. Chordia, K.L. Kline, V.H. Dale, G.A. Oladosu, A. Cowie

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- Analytical framework
- Description of narratives
  - Trade and market response
  - Internal adjustment response
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Modeling ILUC: extremely complex

- Lack of consensus and analytical framework
- Insufficient tools and data
- Quantifying indirect effects
  - Approaches and models are questioned
- Truncation error
  - Processed-based life cycle assessment (LCA) excludes indirect effects
- Inability to measure indirect land-use change

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Analytical framework

- Assess crop, food, and ethanol production and trade activities in US (biofuel policy) and Brazil (indirect effects)
- Direct effects in US
  - Corn production and crop prices
- Indirect effects in US
  - Livestock production, crop production, and agricultural commodity trade
- Indirect effects in Brazil
  - Corn production, crop exports, and changes in land use

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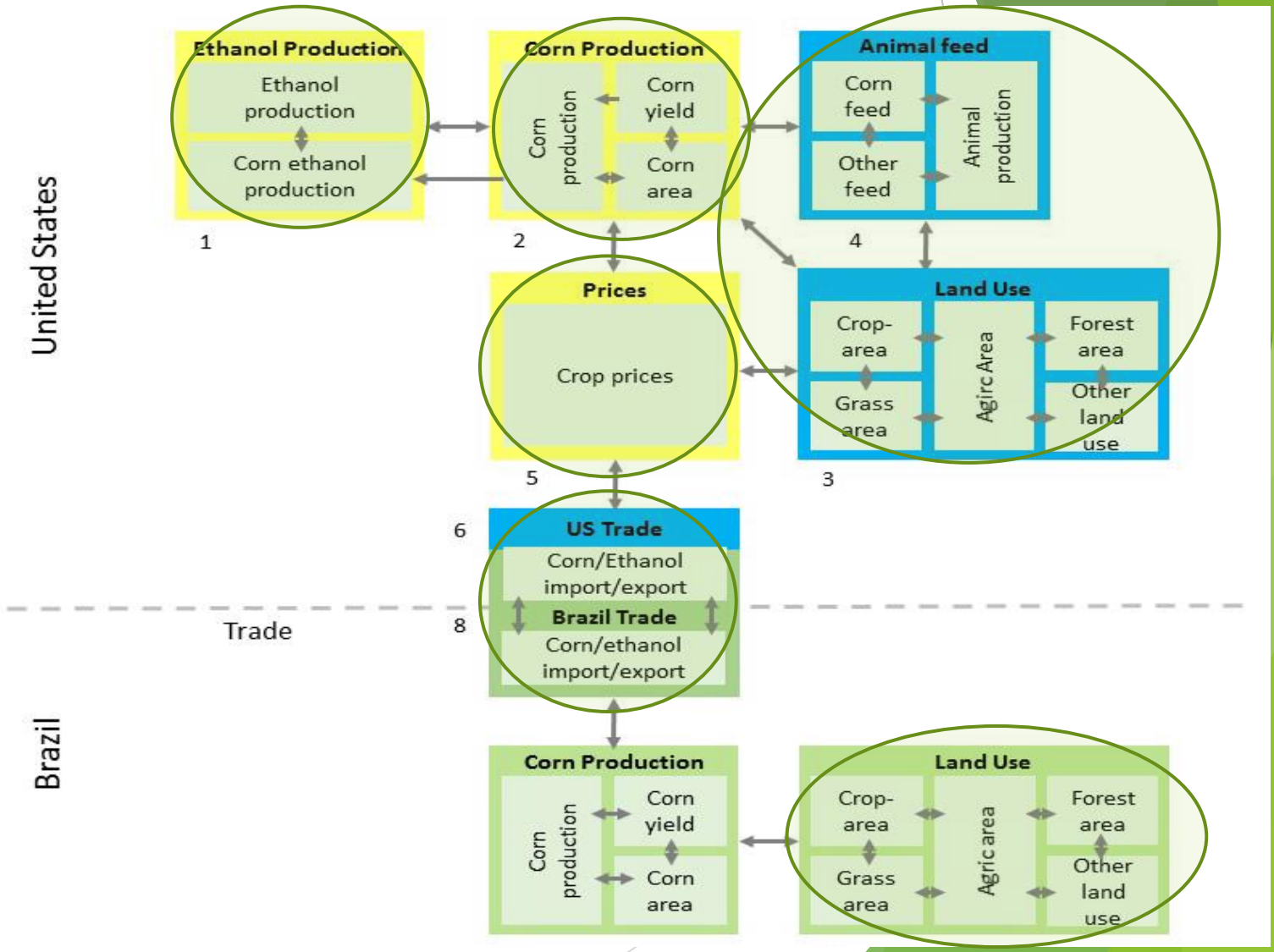
Analytical Framework



Source: IEA Bioenergy (2022)

Trade and market response narrative

- Biofuel markets create demand shock, affecting capital and land markets
- Higher U.S. biofuel production leads to deforestation in Brazil
  - elevated corn prices in the U.S., causing a decline in U.S. corn and meat exports
- Brazil expands production and exports in response

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Internal adjustment narrative

- Applies to various changing demands, including biofuel, population, and preferences
- Biofuel production increases based on the capacity of domestic suppliers
- Negligible impacts on international food and land markets
- Options to increase corn availability
  - Increased cropping intensity, infrastructure investment, and crop rotations
  - Market adjustments and improved agricultural efficiency

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Model projections compared to data

- Trade and Market Response Narrative:
  - High estimates of ethanol and corn demand expansion
  - Assumes an unanticipated shock in demand
  - Short-term price changes
  - Projected disruptions in markets and exports were not observed
- Internal Adjustment Response Narrative:
  - Accurately projected corn ethanol output expansion
  - Recognized flexibility in crop and livestock production
  - Predicted some land use changes, but not all

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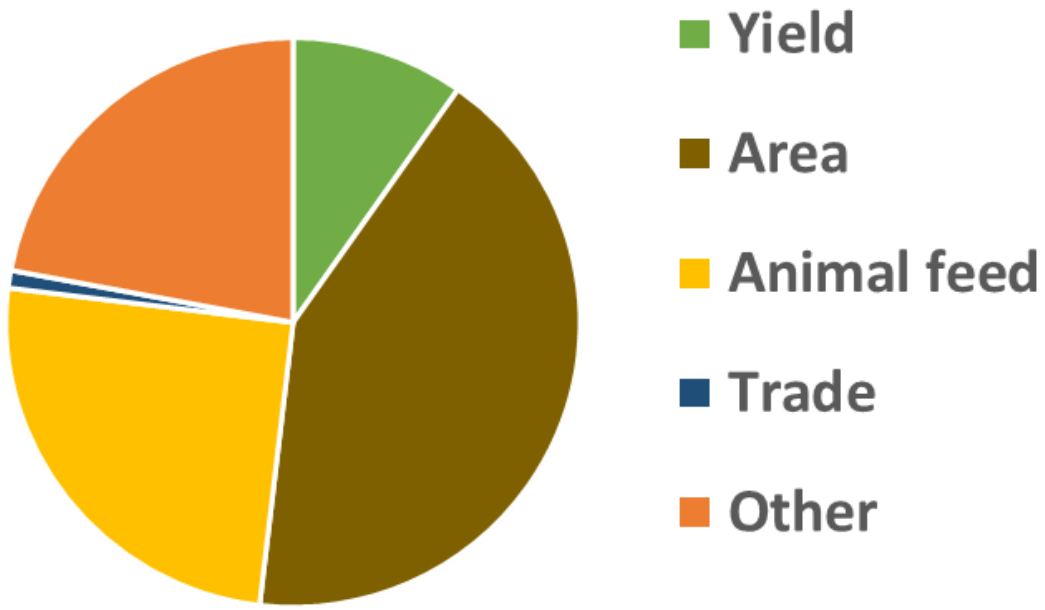
FAPRI-MU

General equilibrium model

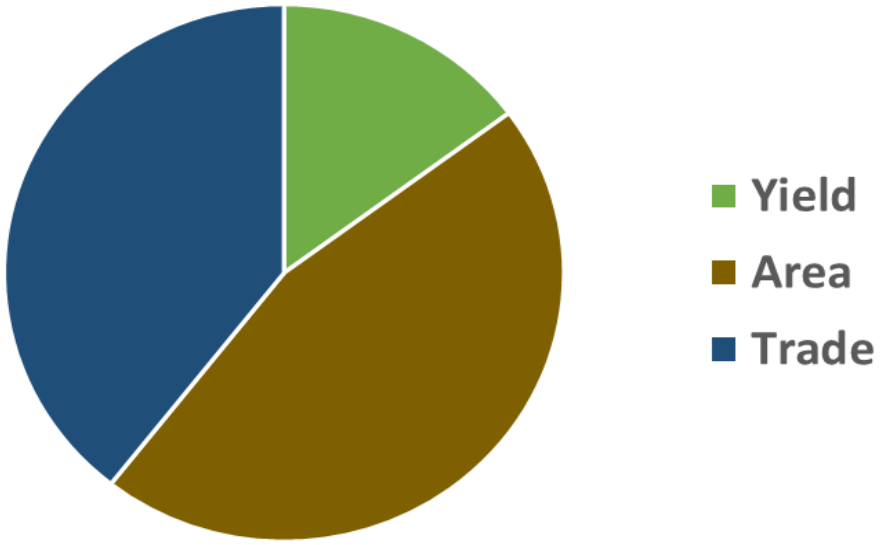
Trade and market response



Main results	FAPRI data related to corn ethanol (2005-2015)
U.S. corn ethanol production	Ethanol production up to 39.1 billion litres, virtually all from corn Corn demand increases to 95 mln tonnes; 42% of which covered by harvest area increase of 3.9 mln ha
Crop prices, livestock	Corn prices projected to double in comparison to 2005 levels Corn use in animal feed drops by 23.6 million tonnes; covering 25% of increased demand
U.S. trade	Corn exports projected to change slightly (+0.7 million tonnes in 2015)
Brazil	Not included in the analysis

Searchinger et al.(2008)

Trade and market response

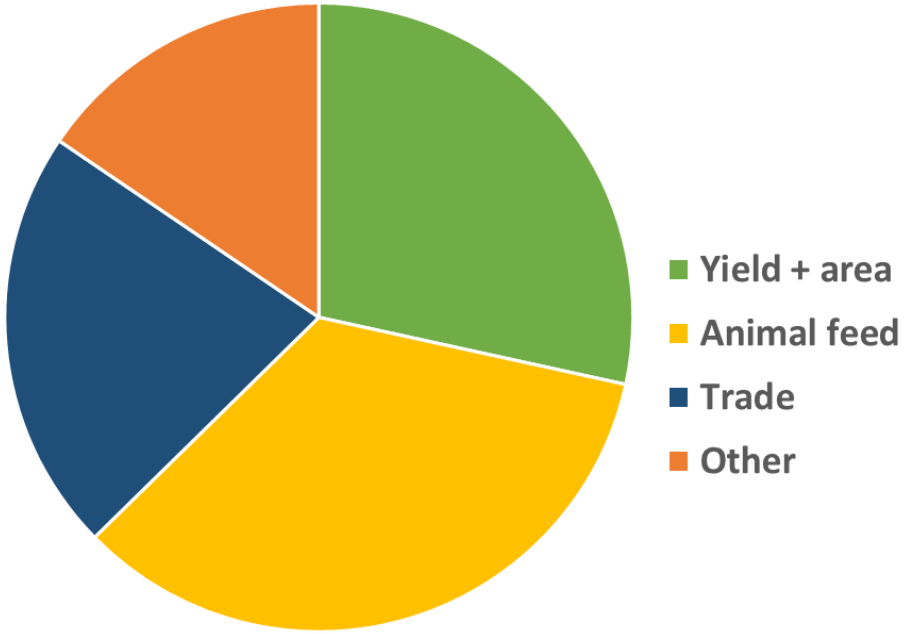


Main results	Searchinger et al. (2008)
U.S. corn ethanol production	Additional corn demand is 138 million tonnes; only 20% of which is covered by yield improvement. Corn area increases with 8.5 million ha. Increased ethanol production requires additional 12.8 million ha U.S. cropland
Crop prices, livestock	Increase of domestic prices with 62% by 2015
U.S. trade	Decline in exports (corn: -62%, wheat: -31%, soybeans: -28%, pork: -18%, chicken: -12%)
Brazil	increasing crop cultivation; conversion of 10.8 million ha of land: China and India (2.3 million ha), Brazil (2.8 million ha) and Africa (0.8 million ha)

Brandao (2022)

Consequential LCA

Trade and market response



Main results	Brandão (2022)
U.S. corn ethanol production	Increased demand for corn of 121 million tonnes, 56 million covered by domestic production. Growth of corn area by 5.2 million ha, release of 3.8 million ha of soybean land
Crop prices, livestock	Some 44 million tonnes of corn is derived from animal feed, 9 million tonnes from food. Corn ethanol generates 37 million tonnes of DDGS
U.S. trade	Export declines with 7 million tonnes
Brazil	

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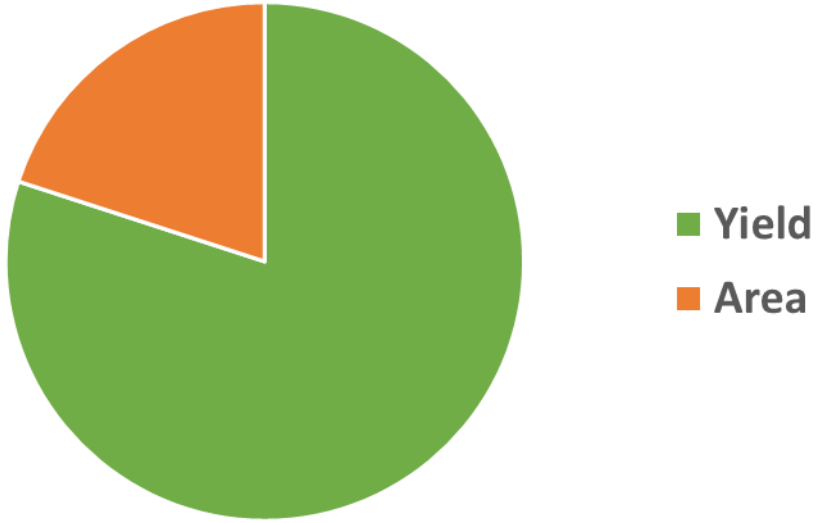
Flugge et al.(2017)

Consequential LCA

Trade and market response



Main results	Flugge et al. (2017)
U.S. corn ethanol production	Ethanol production up by 44 billion litres (2022), virtually all from corn. Additional corn demand 55 mln tonnes, covered by yield increase (44 mln tonnes) and improved corn-to-ethanol conversion. Corn area +2 million ha; cropland area does not change (0.05 m ha).
Crop prices, livestock	Reduction of poultry and dairy production, increase in beef cattle.
U.S. trade	Exports of distillers grains increased by 8.2 million tonnes (2008 to 2015); projected to continue
Brazil	Growth of harvested area is mostly met by increasing double cropping (76%. Also increased double cropping in China (29%) and India (100%)

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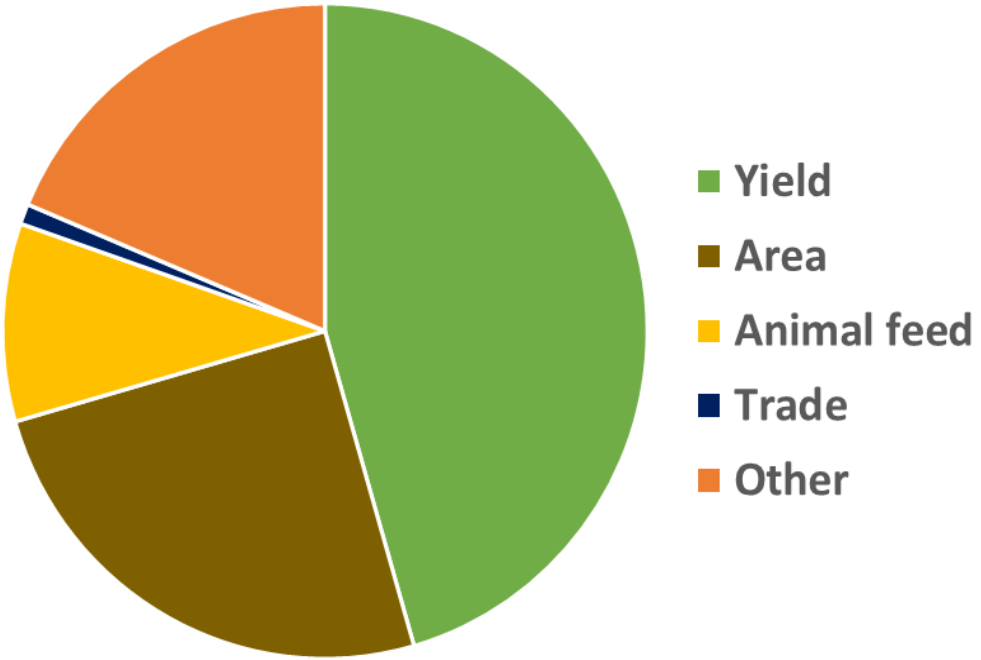
Data (2005-2015)

Time series analysis

No narrative



Main results	Statitstics
U.S. corn ethanol production	Increase in corn use by 92 million tonnes.
Crop prices, livestock	Corn price went up by 75% Corn feed use declined by 20 million tonnes but DDGS output increased by 29 million tonnes (feed availability increased by 9 mln tonnes)
U.S. trade	Corn export declined with 0.7 million tonne.
Brazil	Corn production has gone up by 50 million tonnes.

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Limitations

- US 2005-2015 data
- National annual statistics
- Crop prices
- Trade flow projections assume global markets are working
- Causality

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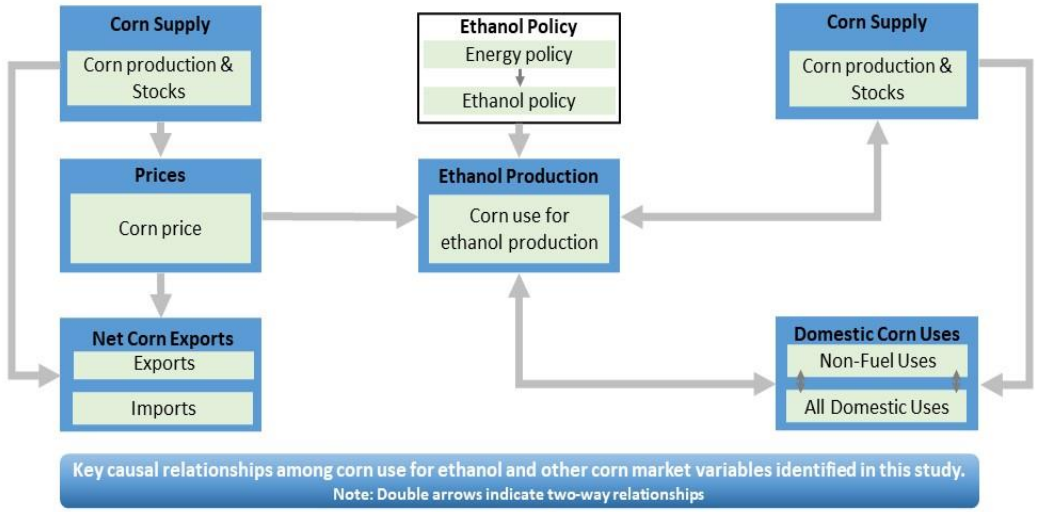
Oladosu et al.(2021)

Causal analysis of quarterly data

Granger-causality evaluation of multivariate data



Key causal relationships among corn use for ethanol and other corn market variables identified in this study.
Note: Double arrows indicate two-way relationships

Main results	Study
U.S. corn ethanol production	Structural breaks corn use linke to policy, corn price, and drought High ethanol production is linked to increases in corn supply
Crop prices, livestock	High corn ethanol use linked to reduced feed corn use No impact from ethanol production on crop prices
U.S. trade	No causal relation between corn ethanol use and corn trade (exports)
Brazil	Not included

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Discussion

- Evaluation of model projections gives conflicting results
  - Two main narratives that lead to contradictory findings
- Questioned relationships
  - As more data becomes available since the implementation of the U.S. biofuels policy, evidence challenges assumed relationships in Trade and Market Response models
  - Recent analyses indicate a lack of statistical evidence supporting the notion that U.S. ethanol production expansion directly caused changes in corn prices, U.S. corn exports, or deforestation (Brazil)

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Conclusion

- Modelling Indirect Land Use Change is complex
  - Need for verifiable data that provide basis for a fair comparison
- Research to improve and test validity of analytical tools to
  - Measure effects of policy on land cover and land management
  - Measure effects biofuel production on land cover and management

    (clarify these are separate variables)
- More consistent and transparent approach is required to
  - Develop and apply standard terms and definitions
  - Agree on standard baselines and reference scenarios
  - Quantify actual effects of specific variables on land management, land cover, carbon cycles, and climate forcing

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Contact

Biomass Research

Hans Langeveld
hans@biomassresearch.eu

Shifting cultivation

Allan's land use factor

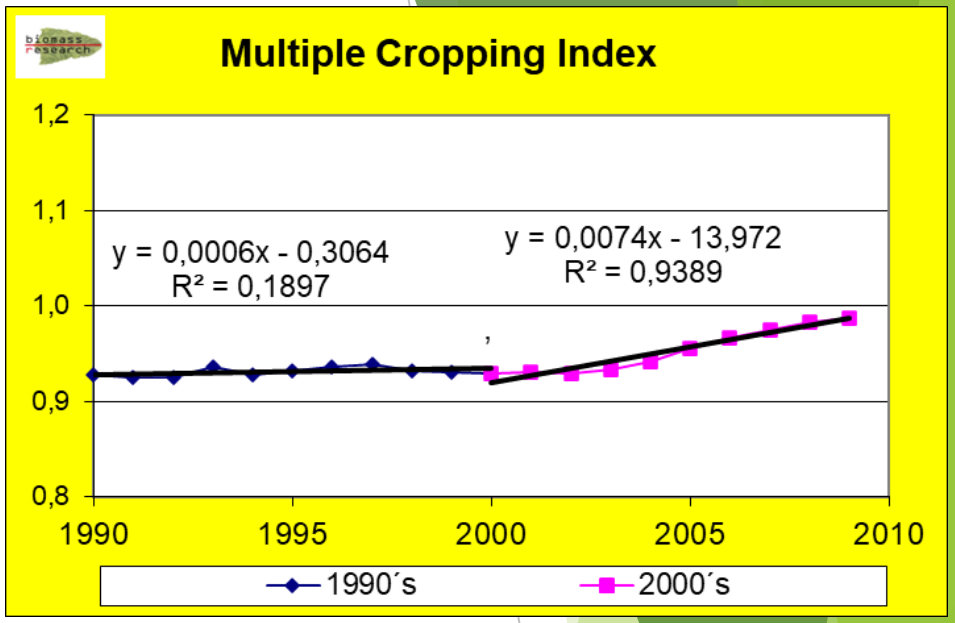
- L = (C+F)/C
  - C= length of cropping, F=length of fallow period (https://edepot.wur.nl/132865)

Multiple Cropping Index

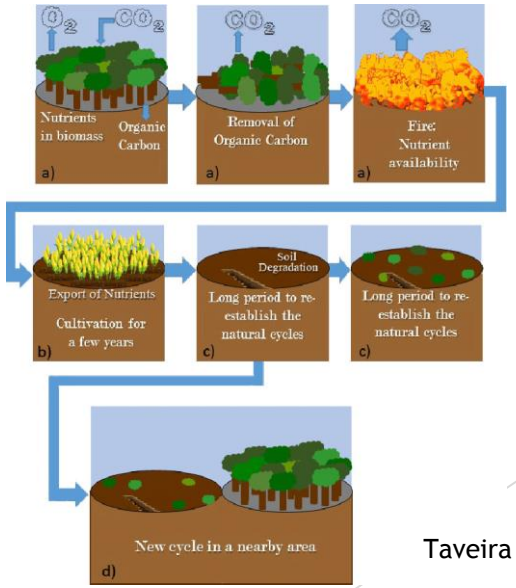
- Harvested area / crop area

Shifting cultivation

- a) opening of clearings in the forest, burning plant residues (slash and burn)
- b) cultivation of small subsistence plots for a limited number of years
- c) long fallow for ecosystem restoration
- d) new cycle (shifting cultivation) in a nearby area



Langeveld et al., (2014)



Taveira et al., (2019)