Asian Institute of Technology

Life cycle assessment of irrigation systems:

assessing regional and global potential environmental impacts

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LCA: purposes and concepts

- LCA approach widely spread and used in the industry worldwide; made commonly known through **carbon and water footprinting** and product eco-labeling; still new and developing in agriculture
- System oriented, and process oriented, integrated
- Classical approach: 1 given site / 1 given pollutant
- How about transfer of pollution source to another site? Contribution of production vs. contribution of inputs or past harvest phases? Regional and global potential impacts? Standard indicators, benchmarking, comparison, setting standards, process certification and product labeling?
- France and probably EC soon are introducing LCA-based ecolabeling on agrifood retail products

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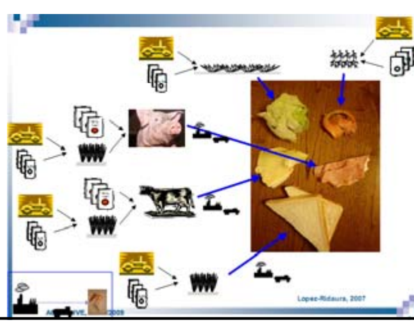
What is the environmental impact of a sandwich? The functional unit concept

Functional unit is a specific type of sandwich (mass, size, components), delivered at retail level

- Salad
- Tomato
- Ham
- Cheese
- Bread

(+Plastic)



The functional unit concept and system delineation

Functional unit may be a good (e.g. 1kg of dry paddy rice 14% wc, delivered at farm gate), or a service (e.g. 1km of transport for 1 person, 1cm of irrigation water delivered at root zone level)

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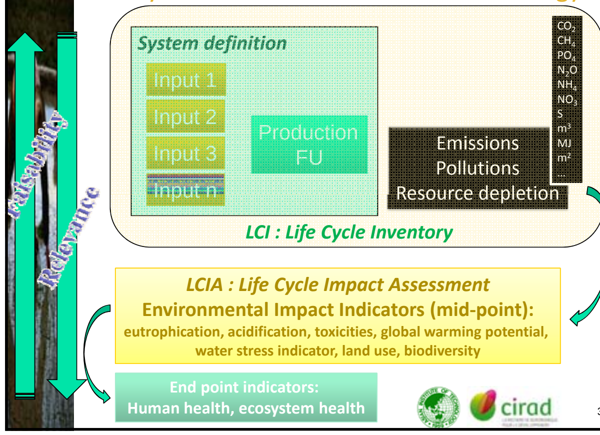
The functional unit concept and system delineation (2)

- Functional unit and system delineation are key elements
- LCA may allow comparison of different irrigated tomato production systems (FU may be 1kg –or 1ha, 1$ -of fresh tomato delivered at farm gate)
- LCA may allow comparison of different irrigation systems (FU may be 1 cm of water delivered at plot level under specific conditions)
- LCA of agrifood goods show that about 80% of all emissions, resource depletion, pollutions occur at the farm level (production)
- So, to compare cropping systems, irrigation management practices, irrigation systems, we may limit systems to farm (cradle to farm gate)
- LCA results are additive, so further investigations may touch on packaging, transport, processing, retail, even consumers (shopping habits)
- What is under scrutiny is « a way » of producing something, not any specific, localized site

Life Cycle Assessment: overall methodology

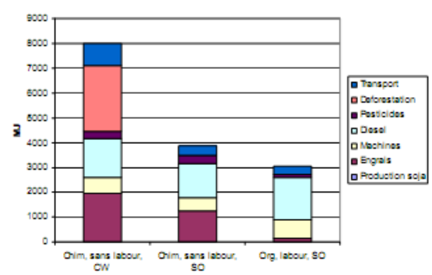


Strengths and limitations of LCA

- A robust conceptual and methodological framework
- Transparent, ISO standardized, internationally recognized
- Systemic, multicriteria-based, function-oriented, considers life cycle, may be combined with LC Cost / Value Assessment, Social LCA
- Databases and softwares are available for analysis

- Databases are only worth what's in them (EC, OECD references mostly on LCI, LCIA)
- Proper LCI requires intensive data collection effort
- What is evaluated is potential impacts; LCA not site-specific, not spatialized, not distributed
- Uncertainty and errors must be dealt with (error and sensitivity analysis)

Examples: soya bean systems in Brasil



1. Frontier agriculture, chemical fertilization, no tillage
2. Regular, chemical, no tillage
3. Organic, tillage

FU : 1 metric ton, soya beans, delivered at collection plant

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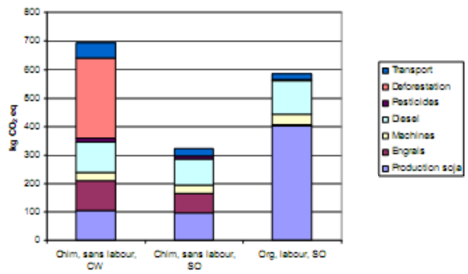

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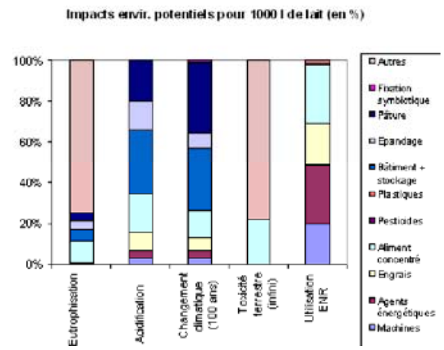
Examples: milk production in France



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- Paddy fields are contributors to methane and nitrogen oxydes emissions, water resource depletion, yet very few and incomplete LCA studies on rice production systems
- Research has long focused on field GHG emissions, then GWP, mostly in Japan
- Some recent attempts in Thailand (1st global exporter), Japan, Italy,

Recent works on paddy rice

(FU = 1kg paddy, farm gate)

Impact indicators, base on fertilizer application rate

	Unit	GAP	Min.	Max.	Avg.
Acidification	kg SO2-eq	0.00330	0.00337	0.00362	0.00353
Eutrophication	kg PO4-eq	0.05490	0.05487	0.05490	0.05490
Global Warming Potential	kg CO2-eq	2.14	2.17	2.23	2.21

Source: Rahatwal, 2010 *NB: Comparison between GAP and actual practices based upon fertilization only*

Impact indicators

Indicators	Unit	Environmental Load
Acidification	kg SO_2-eq.	0.00353
Eutrophication	kg PO_4-eq.	0.0549
Global Warming (GWP 100)	kg CO_2-eq.	2.2100
Water Use (irrigation eff. 60%)		
Blue Water	m^3	2 (Dry Season); 0.62 (Wet Season)
Green Water	m^3	1 (Dry Season); 1.2 (Wet Season)
Blue + Green Water	m^3	3 (Dry Season); 1.82 (Wet Season)
Energy Use	MJ	8.97

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Which research pathway to efficiency?

Actual practices
Recommendations (GAP…)
Alternative (organic, low input…)
Traditional, *etc.*

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Source: Rahatwal, 2010

Environmental impact indicators

Value of ecosystem services

Farmer income

Yield

What trade-offs towards efficiency? Which instrument to sway practices and enhance efficiency?

Synthesis: among 70 papers reviewed

- Very scarce LCA studies on tropical products : rice, palm oil, coffee, cocoa
- Most often driven by North countries interests and teams; Studied function = producing for North market
- Many partial LCA studies
- Lack of transparency in materials and methods
- Failure to consider farming systems diversity
- Lack of specific methods and data for their inventory
- Absence of several crucial indicators (biodiversity and water use)

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