Life Cycle Thinking for Sustainable Consumption and Production

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WHY LCA?
Six blind-folded men and the elephant

- It’s a Fan!
- It’s a Wall!
- It’s a Rope!
- It’s a Spear!
- It’s a Snake!
- It’s a Tree!
Why are biofuels considered green?

Solar Energy

Biomass production

Biomass harvesting

Biomass conversion to Biofuel

Distribution

Biofuel use

Land use change

CO₂e

CO₂e

CO₂e

CO₂e
Product life cycle

Impacts on:
- Human health
- Ecosystems
- Resources

- Emissions to air
- Emissions to water
- Use of resources

Adapted from UNEP (2012)
APPLICATIONS OF LCA FOR SCP IN THAILAND
Summary: Life Cycle Thinking - Pathway of Thailand

Technological Institute for LC Sustainability & Trade??

Cleaner Technology
1990

Life Cycle Thinking (Type I)
• Green label

Life Cycle Network
• Thai LCA Network
• LCA in academics

LCA/Eco-Design Capacity Building
• Supported by JP government.

1993

LCA Pilot Projects

1997

Government Green Procurement
• Sustainability Biofuel Study

Sustainable Development
2011

• National committee on SD
• Water Footprint
• Env. Footprint
• Green GDP, SAFA
• SCP/SD indicators

LCA Applications (+ in Policy)
• National Carbon Footprint
• Eco-Product Directory
• Thai Eco-Design Award

• Carbon Footprint Organization

2000

LCA Pilot Projects

2002

LCI Database Project
• Supported by MoI

2005

2007

National LCI Database
• Thai Green Design Network

2009

Eco-design excellent center

2012-2014-

Source: STI
Courtesy: Dr Thumrongrut Mungcharoen, NSTDA
LCA Applications & Initiatives

1. Carbon Footprint (since 2009)
   - GHG emission factors

2. EcoProducts Directory (since 2009)

3. Green Public Procurement (since 2012)

4. Sustainability assessment (Biofuels, AgriFood,..) (since 2006)

5. Policy Justification (since 2012)

6. Water/Environmental Footprint (since 2010)

7. SCP-SD Indicators/Institutional framework (since 2013)

- Food vs. Feed vs. Fuel?
- Green GDP/ Green Industry
- Eco-efficiency/ Factor X
- Adder/ Externalities?
- Env. Tax, etc.

Sugar cane/ Molasses/ Cassava/ Oil palm/ Jatropha

Courtesy: Dr Thumrongrut Mungcharoen, NSTDA
LCA-based labels in Thailand

Type 1

Ecolabel based on LCT

Type 3

Carbon footprint labels based on LCA

Green label: 460 products from 65 companies (117 product criteria valid)

Product carbon footprint label: About 1,800 products from 400 companies!
Progression of carbon labels

Carbon footprint reduction label:
GHG reduction = 880,000 t CO₂e
122 products from 32 companies

Carbon offset and neutral program:
GHG reduction – 12,000 t CO₂e

Personal carbon neutral program: GHG reduction – 325 persons / 1,600 t CO₂e
- Low carbon municipality program started since 2011.; 100 municipalities joined this program.
- total GHGs reduction is 12,000 t CO$_2$e, accounted from electricity and fuel saving, solid waste management, etc.
Product carbon footprinting and labeling in Thailand: experiences from an exporting nation

Shabbir H Gheewala*1,2 & Rattanawan Mungkung3

Product carbon footprinting has gained much attention in recent years as many national and international standards have been formulated as well as several carbon labeling schemes. Thailand has also made efforts in this direction over the past several years and is in fact the first country in the southeast Asian region to have developed national guidelines for carbon footprint calculation and labeling. During the process of conducting product carbon footprinting for pilot studies, many issues of concern were raised, some of which may be common to all countries, while others were more specific for tropical countries exporting agricultural products. Experiences are drawn from the study of several national (Publicly Available Specification 2050, Japanese and Thai national guidelines) and international (ISO14067) standards, including the application of some of these to several product carbon footprinting studies. Issues of data collection, grouping of products, co-product allocation, land-use change, product category rules, type of carbon label and consumer understanding have been discussed, with some possible solutions given to address these issues. The cost of carbon footprinting and labeling are also discussed, along with their implications on companies implementing carbon footprinting. Finally, suggestions are made for issues to be discussed at the international level with a view to harmonizing the carbon footprinting methodology, as well as to address the specific concerns of developing countries that have a large volume of agriculture-based exports.
The bioenergy and water nexus

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Abstract: Promotion of energy from biomass for reducing greenhouse gas emissions has led to increased usage of freshwater, especially during the cultivation of biomass. This has raised concerns about the increase in water stress, particularly in countries that are already facing water shortages. Attempts are being made to characterize the effect of water demand induced inter alia by increased bioenergy usage. Also, alternatives are being developed to mitigate such impacts by improved management so that bioenergy can be beneficially utilized. Future studies on bioenergy will need to take into consideration the water aspect so that the trade-offs between climate change mitigation and water stress are addressed. © 2011 Society of Chemical Industry and John Wiley & Sons, Ltd
Water requirement for crop cultivation
- crop water requirement (CWR)
  \[ \text{ET}_c = K_c \times \text{ET}_0 \]
- Effective rainfall

Potential impact on water use
- water stress index (WSI)
  \[ WSI = \frac{1}{1 + e^{-6.4*WTA^* \left( \frac{1}{0.001} - 1 \right)}} \]
- Water deprivation

Water deprivation (m$^3$H$_2$O$_{eq}$ unit$^{-1}$) = Water deficit (m$^3$ unit$^{-1}$) × WSI

Gheewala et al. (2014), Water 6(6): 1698-1718
Multiple impacts in Life Cycle Assessment
Life Cycle Environmental Sustainability Assessment of Oil Palm Plantations in Thailand

**Life Cycle Inventory Data Collection**
- Independent Smallholders
- Group of Smallholders
- Mini Estates
- Mills with plantation

**Sustainability Assessment**
- Life cycle inventory
  - LC-GHG emissions (Carbon Footprint)
- Water requirement, footprint and impact potential
- Water requirement, footprint and impact potential
- Land use and HCV areas

**Outputs**
- Identification of environmental hotspots and recommendations for supporting sustainable oil palm production

Data for supporting Thailand National LCI Database of Oil palm plantations (Province/Region levels)

Environmental sustainability indicators and baseline data for oil palm plantation in Thailand for supporting certification of RSPO and/or other sustainability standards
Sustainability Assessment of Sugarcane Complex for Enhancing Competitiveness of Thai Sugarcane Industry

Life cycle of sugarcane systems

1. Land use for sugarcane plantation
2. Sugarcane cultivation & Harvesting
3. Sugarcane complex
   - Sugar milling
     - Agr. residues
     - Bagasse
     - Cane juice
     - Filter cake
     - Wastewater
   - Bio-electricity generation
   - Sugar processing
   - Waste/By-products utilizations
   - Bio-ethanol production
     - Molasses
   - Spent wash
   - Bio-electricity
   - Sugar
   - Bio-ethanol
   - Value-added products

Scenarios for sustainability assessment

1. GIS data/Statistic
2. Field data
3. LUC scenarios for sugarcane plantation in Thailand
   - Comparative assessment for different agricultural practices, varieties, yields
4. Comparative assessment for different production systems and different by-products utilization systems. The scope of impact assessment includes:
   - GHG emissions
   - Water use
   - Eutrophication
   - Acidification
   - Eco-toxicity
   - Human-toxicity
   - Photo-chemical oxidation
   - Socio-economic impact
   - Other aspects related to BSI, GBEP

(1) Sustainability indicators & Baseline data for Thai sugarcane industry
(2) Life cycle GHG emission method and GHG emission factors for the Thai sugarcane industry
(3) Roadmap for sustainable sugarcane bioenergy production in Thailand
## Sustainability Assessment of Sugarcane Complex for Enhancing Competitiveness of Thai Sugarcane Industry

<table>
<thead>
<tr>
<th>Environment</th>
<th>Economic</th>
<th>Social</th>
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</thead>
<tbody>
<tr>
<td>1. Climate change</td>
<td>1. Sugarcane productivity</td>
<td>1. Wages paid in sugarcane system</td>
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<tr>
<td>2. Acidification</td>
<td>2. Processing efficiency</td>
<td>2. Income from selling products</td>
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<td>5. Photo-oxidant formation</td>
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<td>5. Land tenure of farmers</td>
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<td>6. PM formation</td>
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<td>7. Ecotoxicity</td>
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<td>8. Fossil depletion</td>
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<tr>
<td>9. Water consumption</td>
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<td>10. Chemicals used</td>
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</tbody>
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Research Network for LCA and Policy on Food, Fuel and Climate Change

- Development of capacity and human resources for LCA in Thailand
- Policy recommendations on food and fuel issues vis-à-vis climate change
- Commitment to continue activities on LCA of the researchers and partners

**Production Systems**

**Resources**
- Land
- Energy
- Chemical
- Water

**Feedstocks**
- Rice
- Cassava
- Sugar cane
- Oil palm
- Rubber

**Products**
- Food
- Fuel
- Bio-refinery products

**Policies**
- Climate change mitigation
- Efficient resources use
- Ensuring food security
- Enhancing energy security
- Towards Green Economy & Poverty reduction
- Support country’s SCP

**Tools used**

Life Cycle Assessment, Carbon Footprint, Water Footprint, Ecological Footprint, Biodiversity Footprint, Material Flow Analysis. Consequential LCA, Social LCA, Cost Benefit Analysis
Research Network for LCA and Policy on Food, Fuel and Climate Change

Mahidol U
CLCA (biomass)

U Phayao
MFA (cassava)

Mahasarakham U
SLCA (sugarcane)

Prince of Songkla U
CF, WF, EF (oil palm, rubber)

Kasetsart U
CF, WF, BDF (rice)
Green GDP

Hybrid LCA approach: Applied National Life Cycle Inventory (LCI) incorporated with I/O table to assess the environmental impacts by LCA to quantify environmental damage cost.

- Convert environmental impact in physical unit to monetary unit by valuation technique.
- Develop environmentally extended input-output analysis (EEIOA).
- Done in broadly economic sectors, 16x16 and elaborating in detail of major industrial sectors and agriculture sectors i.e. petrochemical, paper, stable crops, livestock, etc.
Advantages of life cycle thinking

» Prevents problem shifting
  – to other life cycle stages
  – to other environmental problems
  – to other sustainability pillars
  – to other countries
  – to the future generations
THANK YOU