Life Cycle Assessment (LCA) of raw silk

Life cycle analysis of cumulative energy demand on sericulture in Karnataka, India.

Fritz Vollrath, Robin Carter, G. N. Rajesh, Gunnar Thalwitz, Miguel F. Astudillo
What is LCA?

- A standardised method to assess the environmental impact associated with the different stages of the life cycle of a product.

What is it used for?

- **In policy**: Consumer Information and policy development
- **In industry**: Identify environmental hotspots & best practices.

Different indicators: i.e. Carbon footprint (Global Warming potential)

- Biofuels?
- Organic food?
Why is it relevant for Silk?

- Policy makers & consumers are increasingly interested in environmental performance & life cycle thinking
- EU updating ecolabel criteria for textiles
- No baseline available for silk
- Identify ways to improve production performance (already done for other textiles).
First survey of raw silk production

Who?
20 reelers & 20 rearers

Where?
Karnataka, India. India is the second biggest silk producer. Karnataka is the most important sericulture region in India

When?
2011

What it was included?
Cocoon production (fertiliser use, pesticides…)
Reeling process (wood requirements, renditta…)

Environmental indicator used:
Cumulative energy demand (total amount of energy required to produce 1 kg of silk)
How do you do it?


Inventory of all the relevant **mass and energy flows** through the system.

Use of **impact assessment models** determine Environmental impact.
- Global Warming Potential
- Energy use
- Ecotoxicity
- etc
The energy flow of the mulberry rearing and cocoon drying system:

- **Mulberry Production**
  - Land
  - Water
  - Energy
  - Herbicides and Pesticides
  - Mineral Fertilisers
  - Farmyard Manure

- **Silkworm Rearing and Cocoon Drying**
  - Mulberry Leaves
  - Disinfectant
  - Consumable
  - Wood (firewood)
  - Leaves unsuitable for Worms
  - Runoff

- **Reeling**
  - Fresh Cocoons
  - Dry Cocoons
  - Energy
  - Water

- **Outside of System**
  - Animal Labour
  - Human Labour

- **Waste**
  - Rearing Waste
  - Runoff
  - Pupae
  - Waste Silk
  - Waste Water
  - Pupae

**Raw Silk**
Results: Hotspots: Where to focus

On a mass basis silk production is highly energy intensive compared with other fabrics:

Cumulative Energy Demand (MJ/kg)

- Jute yarn (India)
- Cotton yarn (global)
- Nylon
- Silk (Karnataka)
Results: Hotspots: Where to focus

Hotspots: Where to focus

Overfertilization & nutrient imbalance
- N fertiliser: 520 kg N/ha/y
- 50% more than the recommended dose

Fertiliser use (14%)

Electricity for irrigation (32%)
Results: Hotspots: Where to focus

Energy Use in Irrigation
- Furrow irrigation
- Not one farmer in sample has paid a bill
⇒ Distorted incentives

Fertiliser use (14%)
Electricity for irrigation (32%)

Boiling cocoons

Relevant Environmental Deficiency of water
Pfister et al. 2011
Inefficient use of wood
- Low efficiency boilers
- Higher wood use than reported in previous studies

Results: Hotspots: Where to focus

- Fertiliser use (14%)
- Electricity for irrigation (32%)
- Boiling cocoons (51%)

Hotspots: Where to focus
Inefficient use of wood
- Low efficiency boilers
- Higher wood use than reported in previous studies
Conclusion

- Indian silk production needs to improve its environmental performance to be sustainable

- There are possibilities for improvement:
  - Reeling sector: improved stoves
  - Cocoon production: fertiliser planning, irrigation optimization
  - Better use of co-products (pupae, sericin, waste silk)

- Subsidies of irrigation and agriculture can lead to distorted use of agricultural inputs
New Questions

Have we missed something important?
- infrastructure, field works, grainage …

How does it perform concerning other environmental indicators?
- greenhouse gases
- water use
- toxicity

How other countries perform?
China, Brazil, SE Asia

How other technologies /phases perform?
Multi-end reeling vs cottage basin

How sure we are about what we know?

Preliminary answers:

inclusion of capital goods and field works have small influence in energy requirements.

+ 10% of total energy requirements (aprox)
New Questions

Have we missed something important?
- infrastructure, field works, grainage...

How does it perform concerning other environmental indicators?
- greenhouse gases
- water use
- toxicity

How other countries perform?
China, Brazil, SE Asia

How other technologies/phases perform?
Multi-end reeling vs cottage basin

How sure we are about what we know?

Preliminary answers:
Carbon footprint is also high compared with other textiles

Global warming potential (kg CO2eq/kg)

Textile Jute, at plant (India)
Nylon
Yarn Cotton, at plant (Global)
Wool (At farm)
Reeled BV Raw Silk Karnataka*
New Questions

Have we missed something important?
- infrastructure, field works, grainage…

How does it perform concerning other environmental indicators?
- greenhouse gases
- water use
- toxicity

How other countries perform?
China, Brazil, SE Asia

How other technologies/phases perform?
Multi-end reeling vs cottage basin

How sure we are about what we know?

Preliminary answers:

Other production systems may have significantly different impact

Scope for Improvement

![Graph 1: Difference in GWP (preliminary)]

![Graph 2: Difference in energy demand (preliminary)]
New Questions

Have we missed something important?
- infrastructure, field works, grainage...

How does it perform concerning other environmental indicators?
- greenhouse gases
- water use
- toxicity

How other countries perform?
China, Brazil, SE Asia

How other technologies/phases perform?
Multi-end reeling vs cottage basin

Weaving?
Multi-end reeling?
Enzymatic or chemical degumming?

Industry needs?

How sure we are about what we know?
New Questions

Have we missed something important?
- infrastructure, field works, grainage...

How does it perform concerning other environmental indicators?
- greenhouse gases
- water use
- toxicity

How other countries perform?
China, Brazil, SE Asia

How other technologies/phases perform?
Multi-end reeling vs cottage basin

How sure we are about what we know?

Preliminary answers:

perform a sensitivity and uncertainty analysis (Monte Carlo simulation)
+ data => less uncertainty
Expanding the analysis

- Land use
- Other (positive) impacts
- Other producers
- Other technologies
- Multi-end reeling
- Wild Silk?
- SE Asia?
- China?
- Europe?
- Central Asia?
- Other parts of the cycle
- Weaving
- Dying
- Degumming - chemical? - Enzymatic?

- Erosion control
- Ecosystem services
- Employment generation
- Socio-economic aspects
- On and off-farm income generation
- Rural development potential
- Other (positive) impacts
- Other (positive) impacts
Thank You!

• Questions?

Funded by: