Product category range of environmental performance for EPDs: The example of Costa Rican pineapple

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Outline

I. Background
II. Sector characterization
III. LCA
IV. Communicating the results with an RoEP

Background

- LCAs are being used to create Environmental Product Declarations; they could be used to drive more sustainable production/consumption but need to be easier to interpret

- Background study of EPDs for Costa Rica (www.epdcostarica.info)

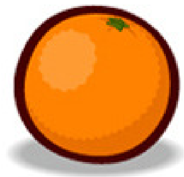
- Before you create an EPD, you have to write a Product Category Rule (a PCR), which specify among other things the rules for the LCA

Goals

- Conduct an LCA that can be used as a background document to developing a PCR with the intention of making the results comparable with all fruit-products
- Functional units: 1 serving at US supermarket
- Scope: Farm-to-shelf (for consumers)
- Use internationally recognized LCA methods but customized for the Costa Rican environment

Functional unit: Serving

- Use 1 USDA serving of fruit
- Servings in 1 kg fruit = % edible/USD serving size (kg)

					
Percent edible	51%	90%	73%	95%	69%
Serving size (kg)	0.165	0.109	0.18	0.152	0.165
Servings/kg	3.1	8.3	4.06	6.25	4.2

Study innovation:
Range of Environmental Performance

Rationale:

1. Variability of environmental performance within a product is as important as variability between products
2. Necessary for sector characterization and farm comparison

Solution: Use variation within and among producers to create a statistical *range of environmental performance* (RoEP) for each indicator for the sector

Range of Environmental Performance (RoEP)

Range for pineapple for an emission =

Variability in yield (within and between samples) +

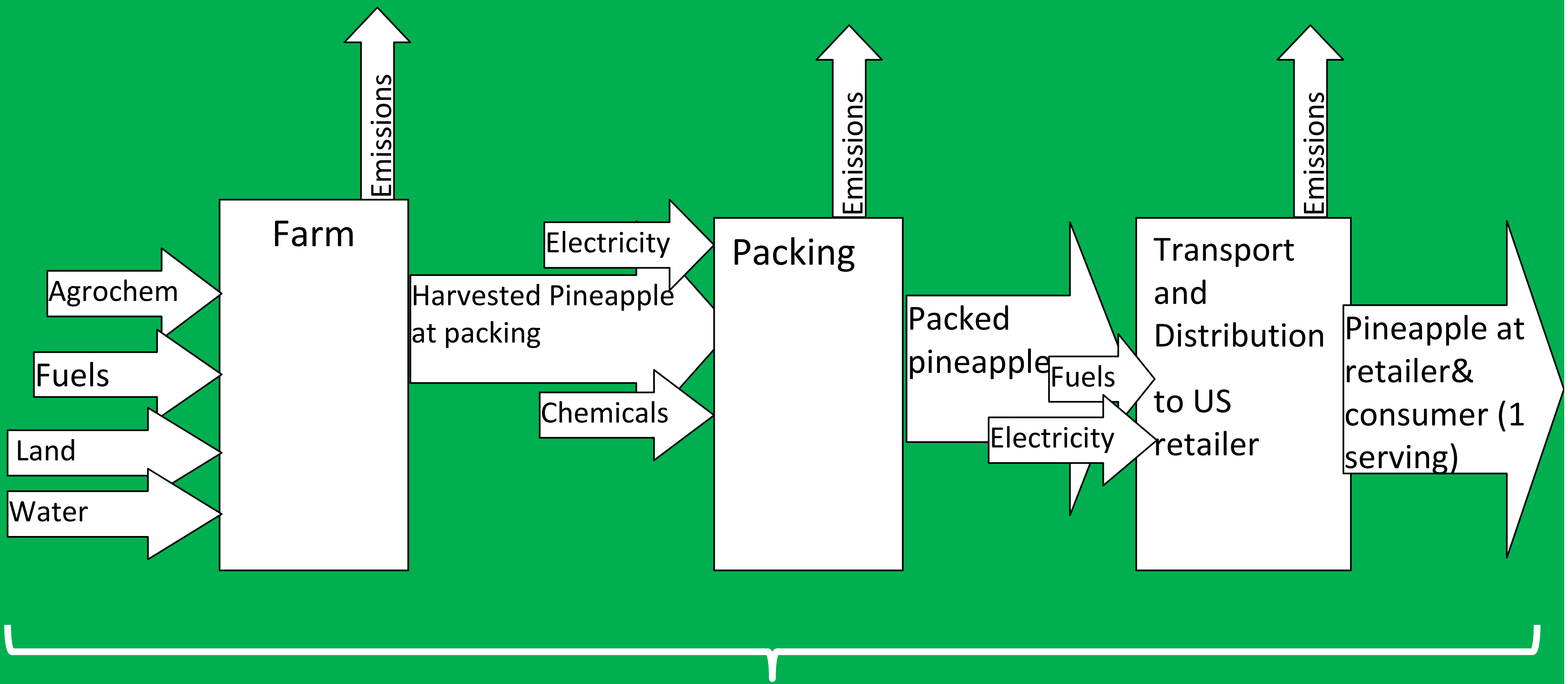
Variability in input (between farms) related to the emission +

Uncertainty in emission model for the emission

where, uncertainty in emission model estimated based on sensitivity analysis of the model

RoEP = 99% confidence interval from Monte Carlo simulation of each indicator

Pineapple system



"Farm to shelf"


1
2
3
TRITON
4
5

Inventory: Data sources

- Primary data provided by anonymous producers; secondary (background) data from the Ecoinvent database

- Anonymous participants represented from San Carlos, Limon, and Pacific pineapple regions; conventional and organic. Sample size of packing stage 2% of national export; farm stage < 2%; modeled range of environmental conditions that exist in all regions

Inventory for Sector Characterization: Inputs to 1 kg pineapple, delivered to packing facilit

Category	Input name	Country	Src	Unit	Amount	SD	Active Ing.
Energy	Diesel, at regional storage	RER	e	kg	7.29E-03	2.97E-03	n/a
	Petrol, unleaded, at regional storage	RER	e	kg	2.40E-04	2.20E-04	n/a
Fertilizer	Ammonium nitrate, as N, at regional storehouse	RER	e	kg	1.92E-03	1.08E-03	n/a
	Boric acid, anhydrous, powder, at plant	RER	e	kg	1.73E-04	1.89E-04	n/a
	Calcium nitrate, as N, at regional storehouse	RER	e	kg	1.72E-04	4.66E-05	n/a
	Compost, at plant	CH	e	kg	4.33E-03	2.43E-03	n/a
	Dolomite, at plant	RER	e	kg	2.03E-04	4.58E-05	n/a
	Fosfomax (0,30,0) fertilizer	CR	o	kg	4.51E-04	3.67E-04	n/a
	Iron sulphate, at plant	RER	e	kg	2.97E-04	2.45E-04	n/a
	Kaolin, at plant	RER	e	kg	8.20E-04	6.74E-0[illegible]	[illegible]
	Lime, hydrated, packed, at plant	CH	e	kg	1.63E-03	[illegible]	n/a
	Magnesium ammonium nitrate, (22,0,0,0,7)	RER	o	kg	2.11E-03	[illegible]9E-03	n/a
	Magnesium sulphate, at plant	RER	e	kg	2.03E-03	2.09E-03	n/a
	NPK (12,24,12) fertilizer	RER	e	kg	1.18E-02	9.63E-03	n/a
	NPK (18,5,15) fertilizer	RER	o	kg	2.11E-03	1.72E-03	n/a
	NPK (2,10,10) fertilizer	RER	o	kg	7.93E-05	6.46E-05	n/a
	Potassium chloride, as K2O, at regional storehouse	RER	e	kg	5.82E-03	4.74E-03	n/a
	Potassium sulphate, as K2O, at regional storehouse	RER	e	kg	4.33E-03	3.52E-03	n/a
	Single superphosphate, as P2O5, at regional storehouse	RER	e	kg	5.54E-05	4.51E-05	n/a
	Sugar, from sugarcane, at sugar refinery	BR	e	kg	2.51E-04	5.67E-05	n/a
	Urea, as N, at regional storehouse	RER	e	kg	3.62E-03	2.04E-03	n/a
	Zinc monosulphate, ZnSO4.H2O, at plant	RER	e	kg	2.74E-04	7.58E-05	n/a
fungicide	benzoic-compounds, at regional storehouse	RER	e	kg	5.63E-05	3.55E-05	Metalaxil
	pesticide unspecified, at regional storehouse	RER	e	kg	1.49E-04	9.40E-05	Fosetyl-aluminium
	triazine-compounds, at regional storehouse	RER	e	kg	1.20E-06	7.54E-07	Thiazole, 2-(thiocyanatemethylthio)benzo-
	triazine-compounds, at regional storehouse	RER	e	kg	6.58E-06	4.15E-06	Triadimefon
growth	organophosphorus-compounds, at regional storehouse	RER	e	kg	2.58E-05	3.69E-05	Ethephon
herbicide	diphenylether-compounds, at regional storehouse	RER	e	kg	6.58E-06	3.43E-06	Fluazifop-p-butyl
	diuron, at regional storehouse	RER	e	kg	1.12E-04	5.83E-05	Diuron
	glyphosate, at regional storehouse	RER	e	kg	3.76E-05	1.96E-05	Glyphosate
	pesticide unspecified, at regional storehouse	RER	e	kg	6.60E-05	3.44E-05	Bromacil
	phenoxy-compounds, at regional storehouse	RER	e	kg	1.38E-06	7.21E-07	Quizalofop-P
	triazine-compounds, at regional storehouse	RER	e	kg	7.90E-05	4.14E-05	Ametryn

Production-weighte averages

Sector variation

Indicators: Emissions & impact models

Impact	Emissions model/standard	Impact model	Customized for Costa Rica?
Soil erosion	RUSLE2	N/A	Y
Carbon footprint	IPCC, Ecoinvent/PAS 2050	IPCC GWP 100	N (only land-use)
Virtual water/stress-weighted water footprint	CROPWAT/Water footprint standard	Riddout and Pfister (2010)	Y
Pesticide Toxicity	PestLCI	USETox	Y
Energy use	Ecoinvent	NR Cumulative Energy Demand	N
Eutrophication	Ecoinvent	TRACI (US EPA)	N
Acidification	Ecoinvent	TRACI (US EPA)	N
Smog formation	Ecoinvent	TRACI (US EPA)	N

Summary of results

Table 1: Ranges of performance for 1 serving* of fresh Costa Rican pineapple at a FL retailer.

No.	Category	Min (0.5%)	Max (99.5%)	Co. of Variation
1	NR fossil cumulative energy demand (MJ)	0.98	1.60	12.6%
2	Stress-weighted water footprint (L H_2O)	0.28	0.85	26.3%
3	Carbon footprint (kg CO_2-eq)	0.09	0.58	43.2%
4	Potential soil erosion (kg soil eroded)	0.0004	0.73	221.0%
5	Eutrophication potential (kg N-eq)	0.001	0.01	77.3%
6	Freshwater ecotoxicity (potentially affected fraction/m^3/day)	0.06	0.67	52.6%
7	Human toxicity (cases)	5.31E-11	5.82E-10	46.5%
8	Ozone depletion (kg CFC-11-eq.)	7.19E-09	2.24E-08	23.2%
9	Acidification (H+ moles-eq.)	0.032	0.051	11.1%
10	Smog formation (kg NOx-eq.)	0.0004	0.0008	13.9%

General LCA conclusions

- Wide performance variation across the sector; yield is a very important factor in environmental performance
- Regionalization of models was significant for results; in other words, estimation of regional impacts should use models that can be modified for the regional environment (e.g. RUSLE2, USETox, PestLCI, etc.)
- Conversion from forest could increase the carbon footprint by 5 times
- Only ≈25% of energy and carbon footprint from international transp.
- Pineapple is low in water use relative to other fruits; comparisons of eutrophication and toxicity are more tentative

Limitations of sector characterization

- Farm inputs based on Ecoinvent; most do not assume international transportation

- Organic pineapple effects cannot be well-quantified until data are available on biological inputs

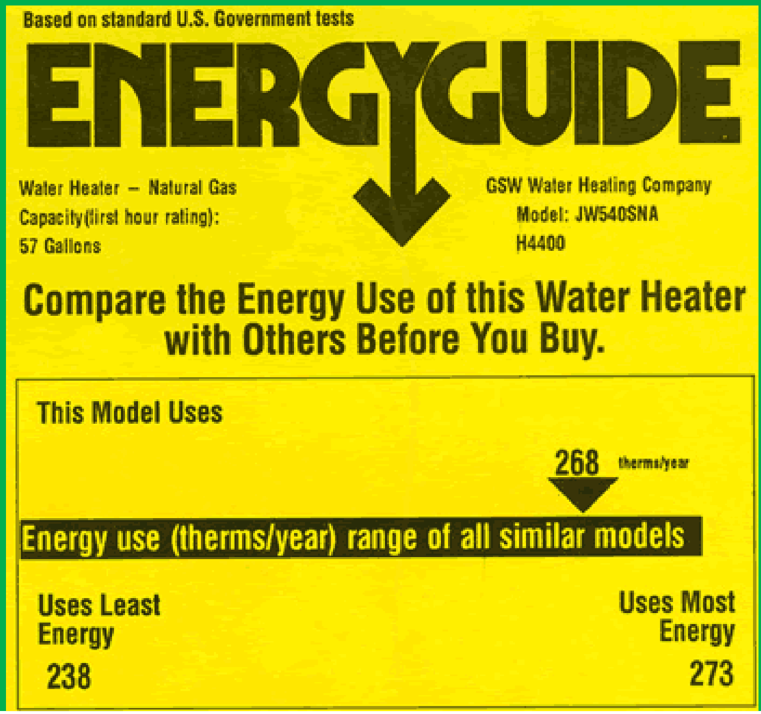
- Eutrophication effects need validation especially in humid tropical environments

Communicating results: Representation of RoEP

To show how relatively important the different impacts are , there are normally two ways to go about it:

1.Put impacts in context of all impacts of an entire population or region

2.Put them in context of the same product or product serving the same function …an example is the EnergyGuide example on appliances in the US

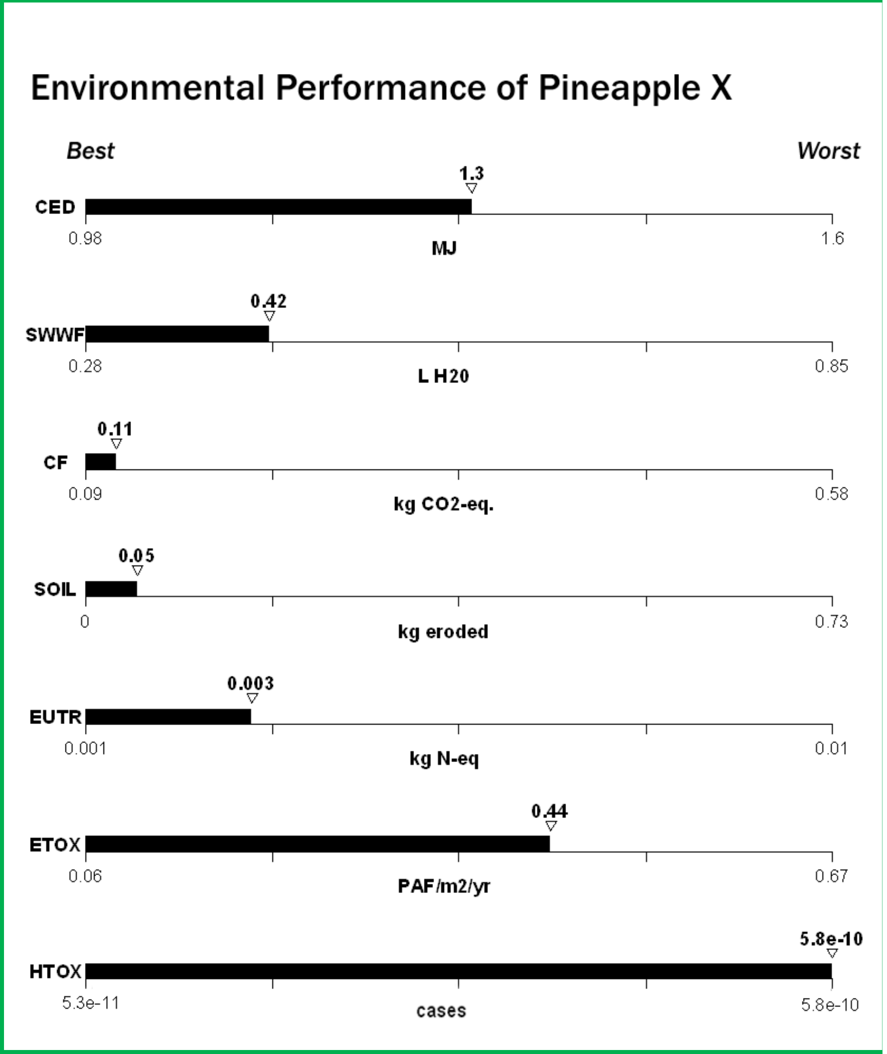


Using RoEP to present results of an example pineapple

- ‘Best’ and ‘worst’ represents 0.5% and 99.5% of Range of Environmental Performance

- This range can be used to compare with other pineapples or expanded to include the performance of all fruits performing the same function (providing 1 serving of fruit)

•This range can be approximated statistically with a representative sample LCA



Potential future development

- The RoEP concept could be used for a pineapple EPD or as a model for other agricultural products
- EPDs could be published domestically (farm-to-port) or as a part of an existing EPD program in importing country
- Aside from the labels, LCA could be used for management purposes

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