Experience on Gathering Meaningful D
for Life Cycle Analyses

- Experience of the BASF Eco-Efficiency Tool in Indian Agri

Dirk Voeste
Head of Sustainability & Product Stewardship Crop Protec

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Samruddhi: Farmer Training Project in India

Benefits for farmers, society and environment

- Started in 2007 included over 100,000 farmers trained (2009)
- Better knowledge about farming
- Optimized disease management
- Better quality seeds
- Educate and demonstrate Good Ag Practices
- Increased productivity
- Improved prosperity
- Eco-Efficiency Analysis done for soybean farming (Guna region)

Farmer training project in India to improve sustainable production

BASF Eco-Efficiency Tool

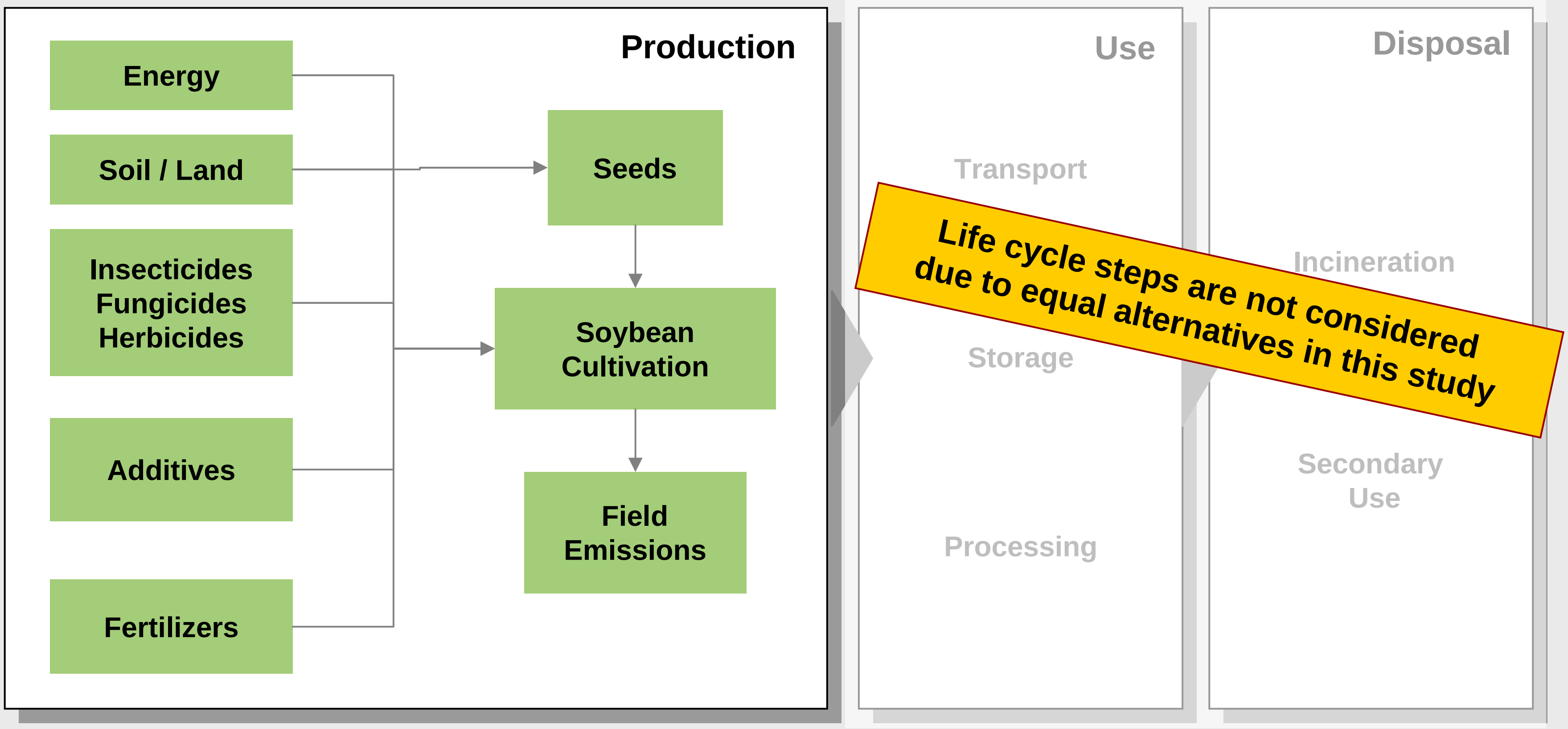
Measure sustainability performance in agriculture

- **Holistic:**
  - Life-cycle analysis
- **Scientific, objective:**
  - Quantitative
  - Reproducible
- **Cost effective:**
  - Affordable
  - Reasonable time effort
- **Decision oriented**

Use eco-efficiency to measure sustainability in Samruddhi programm

Initial Step

Setting the right system boundaries



System boundaries define scope of the life cycle assessment

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Inputs
Availability of farm-based data

Factor	Product	Volume	Farmers' Practice	Samruddhi Practice
Yield	Soybean	dt/ac	5,58	6,86
Fertilizer	Diammonium-P	kg/ac	16	12
	Super-single-P	kg/ac	47	93
Seed		kg/ac	29	36
Fungicide	Bavistin	g/kg seed	0	3
Herbicide	Pursuit	l/ac	0,27	0,3
Insecticide	Endosulphan	l/ac	0,5	0,45
	Triazophos	l/ac	0,4	0,375
PGR	Lihocin	l/ac	0	0,4

- Input data is calculated average data on the base farmers‘ surveys (2008 and 2009).

Input	Source	Year	Quality	Validity
Diammonium-P	Bousted	2010	High	World
Super-single-P	PROBAS	2010	High	World
Diesel	Bousted	1996	High	India
Carbendazim	BASF	1997	High, primary data	Europe
Imazethapyr	BASF	2009	Very high, primary data	USA
Endosulphan	EcoInvent	2008	High	Europe
Triazophos	EcoInvent	2008	High	Europe
Lihocin	BASF	2009	Very high, primary data	World

- Eco-profiles from either commercial databases or calculated from proprietary processes.
- Risk data (working accidents and occupational diseases from internet searches in publically available databases or publications).
- Toxicity and eco-toxicity data from MSDSs.

Robust and reliable data sources are essential

Correlation between Data and Indicators

Statistics and perception

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Air Emissions	Indien
CO_2 (1000 t/a)	1,5 E + 06
SO_X (1000 t/a)	7,9 E + 03
NO_X (1000 t/a)	6,6 E + 03
CH_4 (1000 t/a)	2,2 E + 04
HC (1000 t/a)	9,4 E + 03
Hal. HC	2,0 E + 00
NH_3 (1000 t/a)	3,83 E + 03
N_2O (1000 t/a)	1,0 E + 03
HCl (1000 t/a)	3,57 E + 02

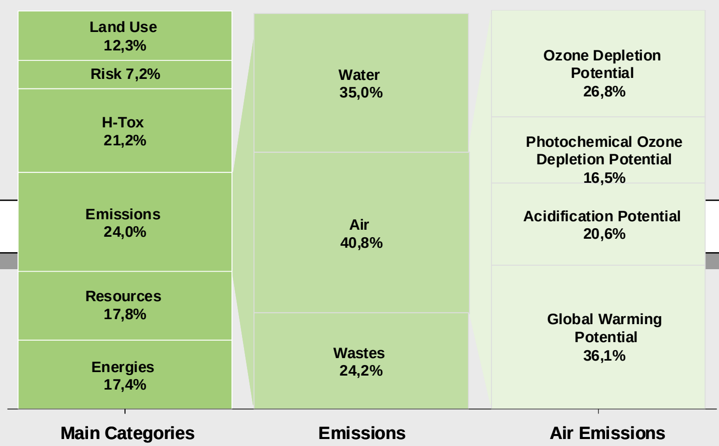
Energy	Indien
Energy (PJ)	1,8 E + 04

Water Emissions	Indien
COD (t/a)	2,53 E + 06
BOD (t/a)	5,5 E + 05
N-tot (t/a)	1,36 E + 06
NH_4N (t/a)	4,57 E + 05
P-tot (t/a)	2,50 E + 05
AOX (t/a)	3,75 E + 03
HM (t/a)	5,71 E + 02
HC (t/a)	1,14 E + 03
SO_4 (t/a)	1,43 E + 07
Cl^- (t/a)	2,86 E + 07

Use of Resources	Indien
Oil (Mio t)	2,7 E + 02
Gas (Mio t)	3,6 E + 01
Coal (Mio t)	5,0 E + 02
Lignite (Mio t)	3,5 E + 01
Limestone	4,1 E + 02
Iron	1,4 E + 02
Manganese	3,7 E + 00
Copper	1,5 E + 00
Bauxite	2,7 E + 00
Sulfur	3,3 E + 00
Stone	1,9 E + 02
Zinc	9,9 E - 01
Salt	0,0 E + 00

Relevance Factor

- Objective factor based on statistics.
- Data availability in publically available databases, e.g. UN-statistics, earthtrends.wri.org or national statistics.
- In case of no available data we estimate data on the base of the data from other countries (yellow box).



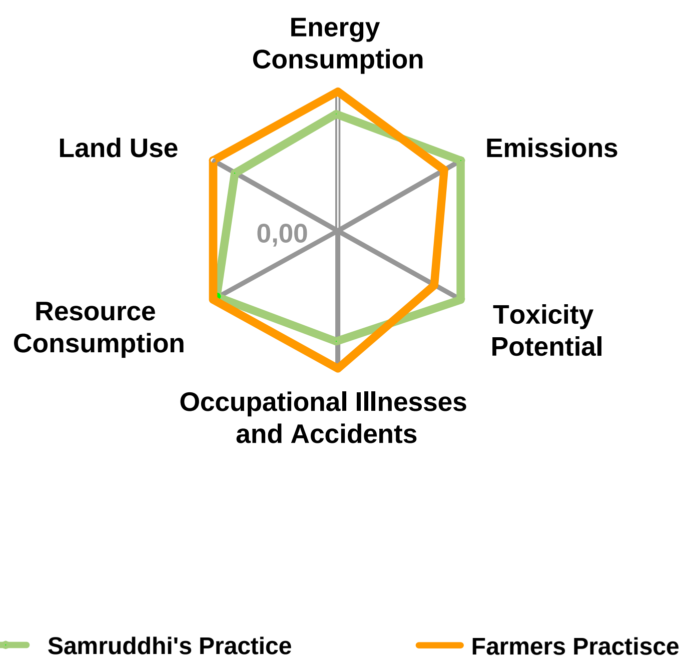
Societal Factor

- Subjective factor based on public polls/expert survey.
- Data provided by a survey of BASF Indian colleagues and external Indian persons (questionnaire based on a TNS survey for USA and Europe was used).

Weighing: $\text{Calculation Factor} = \sqrt{\text{Relevance Factor} * \text{Societal Factor}}$

Eco-Efficiency Analysis
Individual finger print

Samruddhi versus Farmer‘s Practice



Crucial Influence Factors

- Chosen indicators and categories are relevant contributors to the eco-efficiency results.
- Up to 100,000 data points and 11 categories and multiple indicators per study can be included depending on the system boundaries.
- Relative comparison of 2 scenarios per indicator set.
- Spider web diagram: value of ’0’ represents no and ‘1’ highest impact per indicator category (based on 1 MT soybean)

Key is a comprehensive set of robust and relevant indicators

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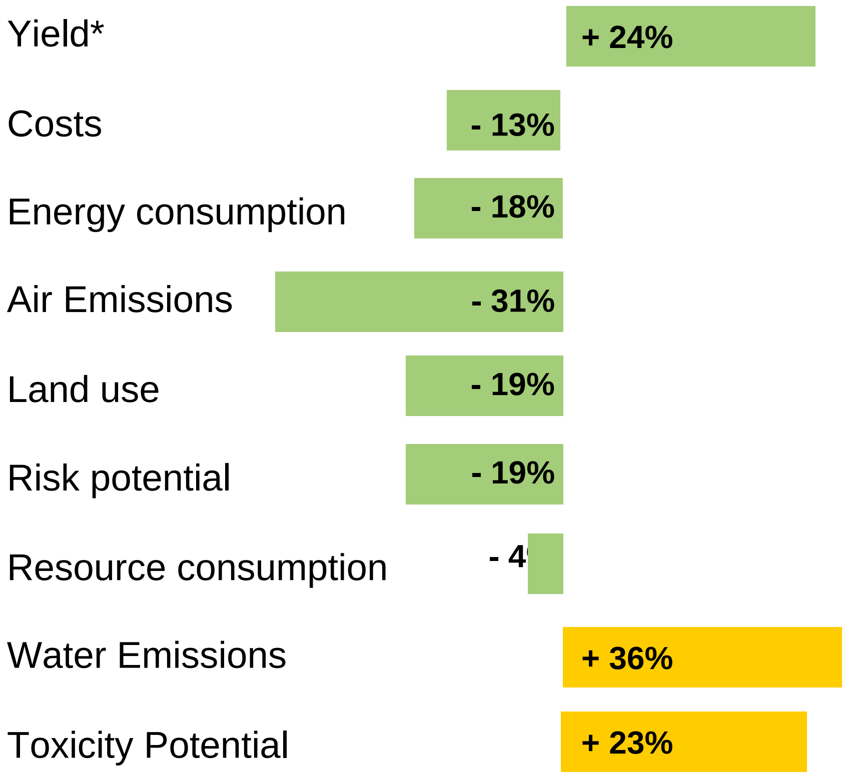
Farmer Training Project in India
Higher yield, lower costs and environmental impact



* - kg/ha, all other factors per 1 MT

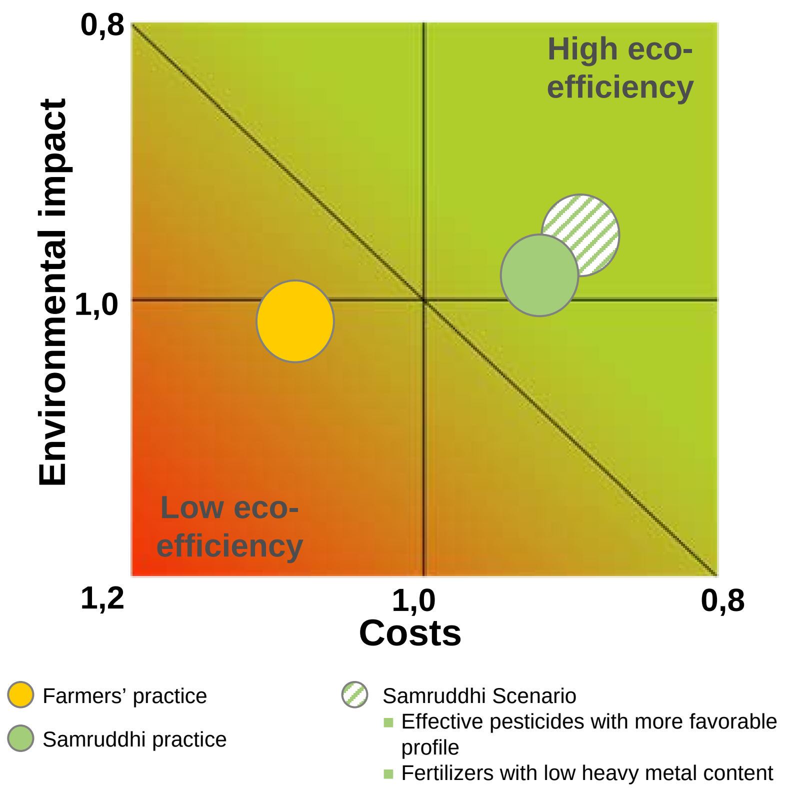
Crucial Influence Factors

- Yield
- Land use for soybean cultivation
- Fertilizer type and fertilizer amounts (energy consumption, P-consumption and heavy metals)
- Occupational diseases and working accidents in agriculture
- Total cultivation cost:
  - reduced due to higher yield
  - higher yield overcompensates for add. expenses, e.g. fungicides.

Holistic approach helping farmers to improve productivity and sustainability

Scenario Analysis
Tool to identify improvement potential

Production of 1 MT soybeans



Conclusion

- Samruddhi's cultivation schedule is significantly more eco-efficient than farmers' practice (> 5 %).
- Fertilizer and crop protection have a very strong impact on the result: the fertilizer amounts and type and their heavy metal content are relevant.
- Scenario analysis demonstrates improvement potential.
- Lacking of unique indicators for agricultural production systems.

Tool supports decision making to improve productivity in a sustainable way

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What can we learn from the case study?

- Need for a holistic approach to demonstrate impact on all pillars of sustainability (no single indicator)
- Robust and relevant indicators are essential to substantiate conclusion
- Input with significant and reliable data (statistics, survey)
- Weighing factors publically accepted
- Validation of tool via stakeholder and recognized institutes
- Scenarios needed to support political decision making
- Need for more specific indicators for agricultural processes and food security

BASF develops AgBalance with specific indicators for agricultural production

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