Life Cycle Assessments of Palm Oil and Vegetable Oils

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Overview

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2. The Tool
   - Life Cycle Assessments (LCA's)
3. Environmental profile of vegetable oils
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1. Introduction

Environmental responsibility - historical perspective:

1. Energy costs (first fuel oil crisis in 70's)
2. Pollution costs (in 80's):
   - effluent
   - air (heavy fuel oil and acid rain)
3. The environmental impacts of our products and activities
4. Sustainable supply of our food raw materials
5. Corporate Social Responsibility (CSR)
6. (Renewable) Energy production and climate change (the Kyoto Protocol) and the Carbon Footprint

X. Growing stakeholder pressure (customers, consumers, governments, NGO's)

Unilever Environmental Policy (early 1990's)

Review and continuously improve the performance of our products, services and operations as measured by the environmental impact

Initiate projects to assess the environmental impact of the edible oil and fat based product range as one of our substantial businesses in Foods

→ First LCA's were carried out with the intention to apply the insights into the environmental impacts into optimisation programmes for our supply chain processes and product formulations

2. The Tool - LCA

- LCA is a technique for evaluating the environmental performance of products from ‘cradle to grave‘
- It allows to:
  - identify where impacts occur
  - assess impacts at each step
  - show where major improvements can be made

TheTool – Life Cycle Assessment:

Parameters used to measure the environmental profile:

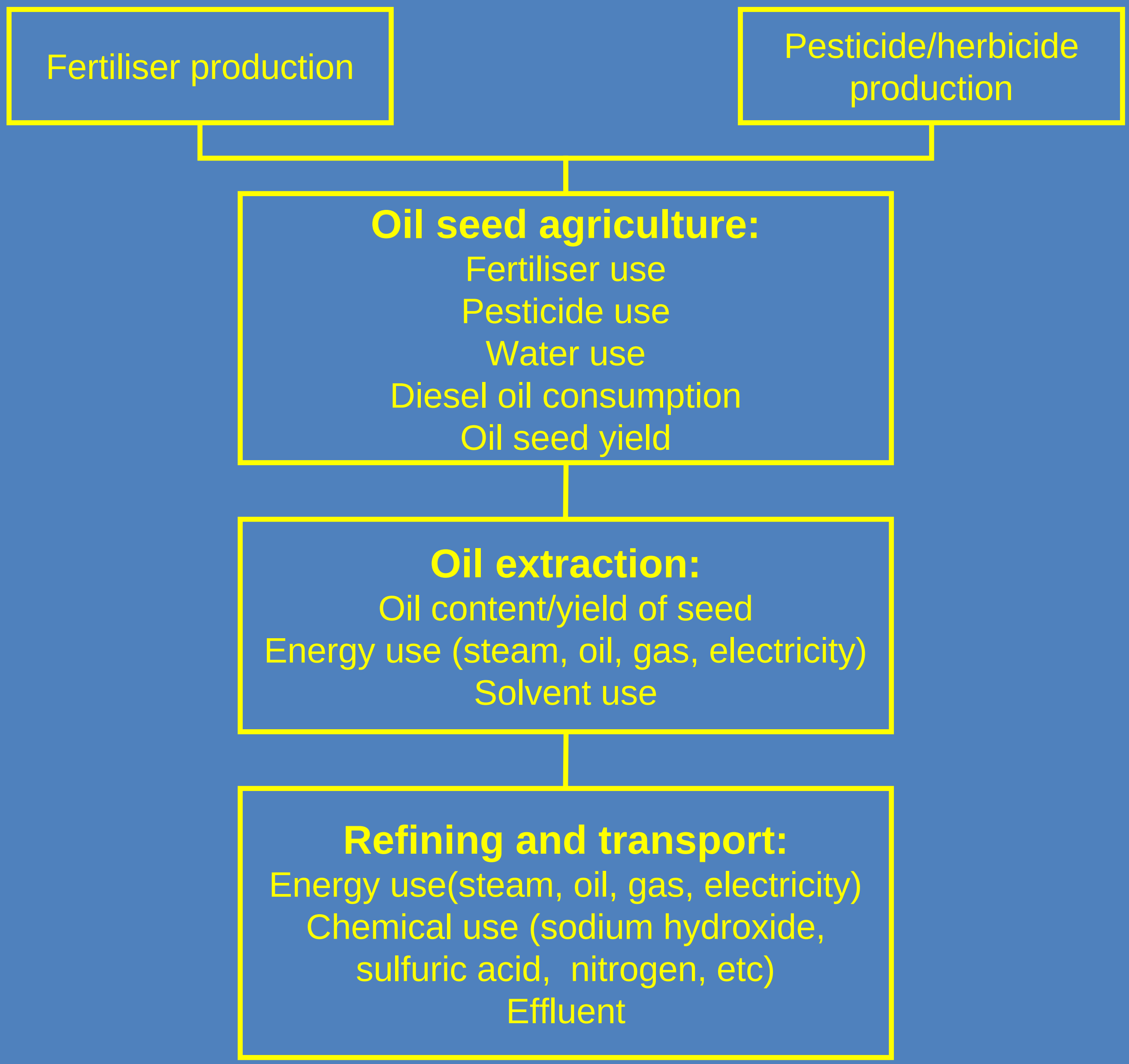
1. **Energy Consumption** – amount and source of energy used , expressed in MJ per ton of product/edible oil
2. **Global warming** – expressed in weight of kg CO_2 equiv. released
3. **Acidification** – Emission of nitrogen oxides (NO_x), sulphur oxides (SO_x) and ammonia (NH_3) leads to acidification of the environment and changes in the chemical composition of soil and surface waters in kg SO_2 eq.
4. **Eutrophication** – excessive plant nutrients due to run-off from agricultural land, leading to algal blooms & decay, oxygen depletion and resultant damage to aquatic ecosystems in kg PO_4 eq.
5. **Photochemical smog** – a measure of air pollutants released in terms of their potential to form ozone relative to that of ethylene / ethene in kg ethylene C_2H_6 eq.
6. **Land use** – area required in hectares per ton of product

(….. and others 'less defined' like ecotoxicity/biodiversity etc.)

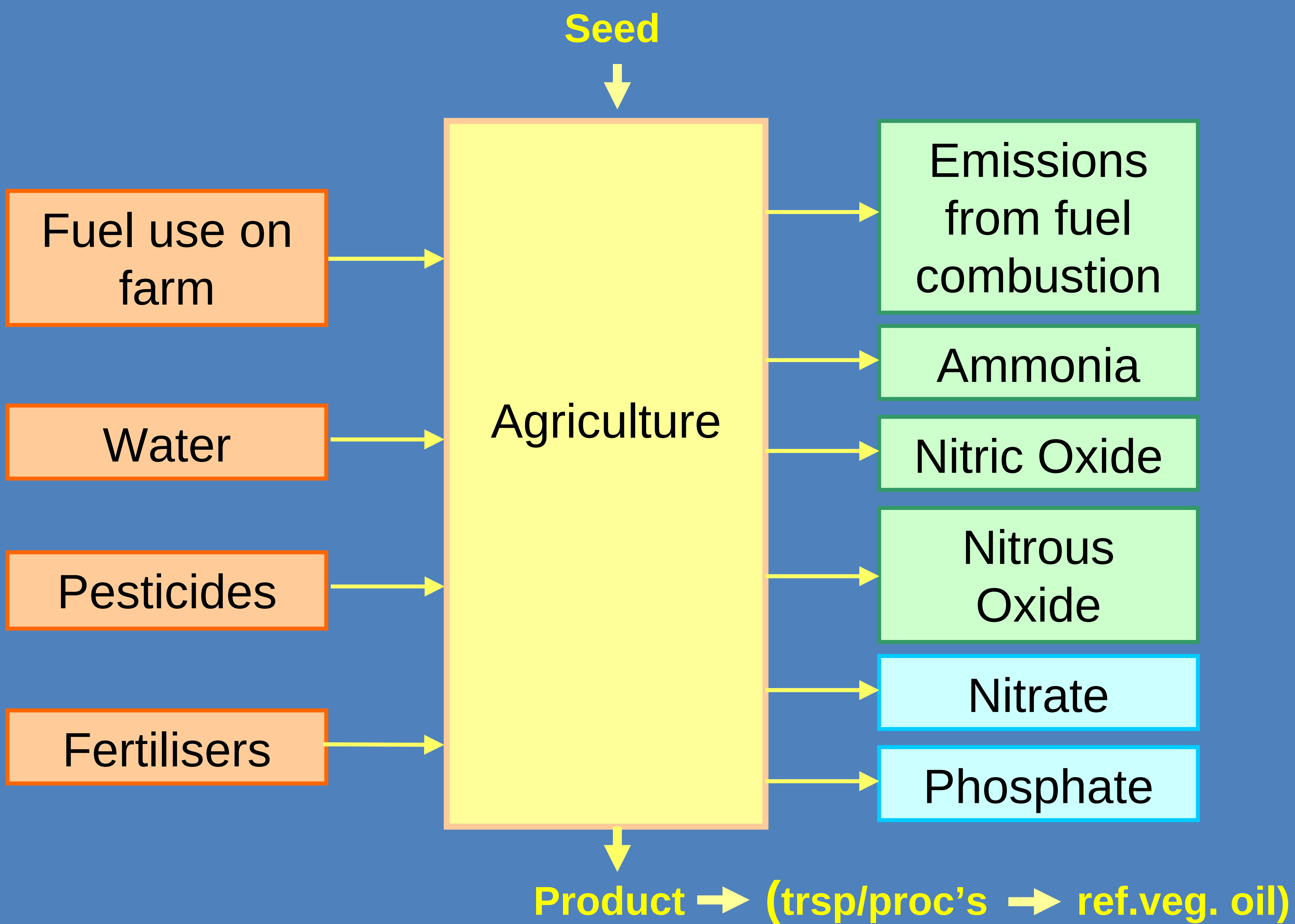
Environmental Profile of Vegetable Oils

- System boundaries
- Key process stages
- In- and outputs
- ‘Assumptions’

Simplified System Boundary, Key Process Stages and Elements included in the Life Cycle of Vegetable Oils



In- & Output – Agricultural System



Agricultural Systems:
The Problem of Variability

- What is an “average” farm?

  There are variations in:
  - Technology
  - Mechanisation
  - Crop variety
- External factors:
  - Prevailing climate (& yearly variations)
  - Soil quality
  - Indigenous pests

→ LCA of the same crop grown in different parts of the world may show greater differences than different crops grown in the same area !

Agricultural Systems:
The Problem of Complexity

- Emissions of ammonia, nitrous oxide & nitric oxide from the use of fertilisers are affected by:
  - Soil condition (pH, SOC, CEC, drainage, texture)
  - Climate
  - Crop type
  - Fertiliser type and mode of application
- Nitrogen/phosphorus not taken up by plant or emitted to atmosphere is assumed to be lost as nitrate/phosphate in runoff & leachate

Assumptions

- **Agriculture**
  - Focus on areas where Unilever sources oils
  - Collect data on specific production systems/agricultural practices
  - Use site specific data on soil quality
- **Extraction**
  - Solvent for soy, rapeseed and sunflower
- **Refining**
  - Physical for tropical oils
  - assumed to take place at a GMP factory in Europe (The Netherlands)
- **Transport**
  - distance and mode dependent upon plantation/farm location

Agricultural Inputs and Outputs for Oil seeds

	Oil yield t/ha	Fertiliser input (kg/t oil)			Pesticide (kg/t oil)
		N	P_2O_5	K_2O	
Plantation crops					
Palm fruit (1)	5.5	19	3	29	0.01
Coconut (1)	0.7	62	62	104	0
Olive (2)	0.9	231	82	69	7.8
Annual crops					
Rape seed (3)	1.4	183	65	260	35
Sunflower (4)	1.3	120	45	303	37
Soybean (5)	0.6	0	136	136	21

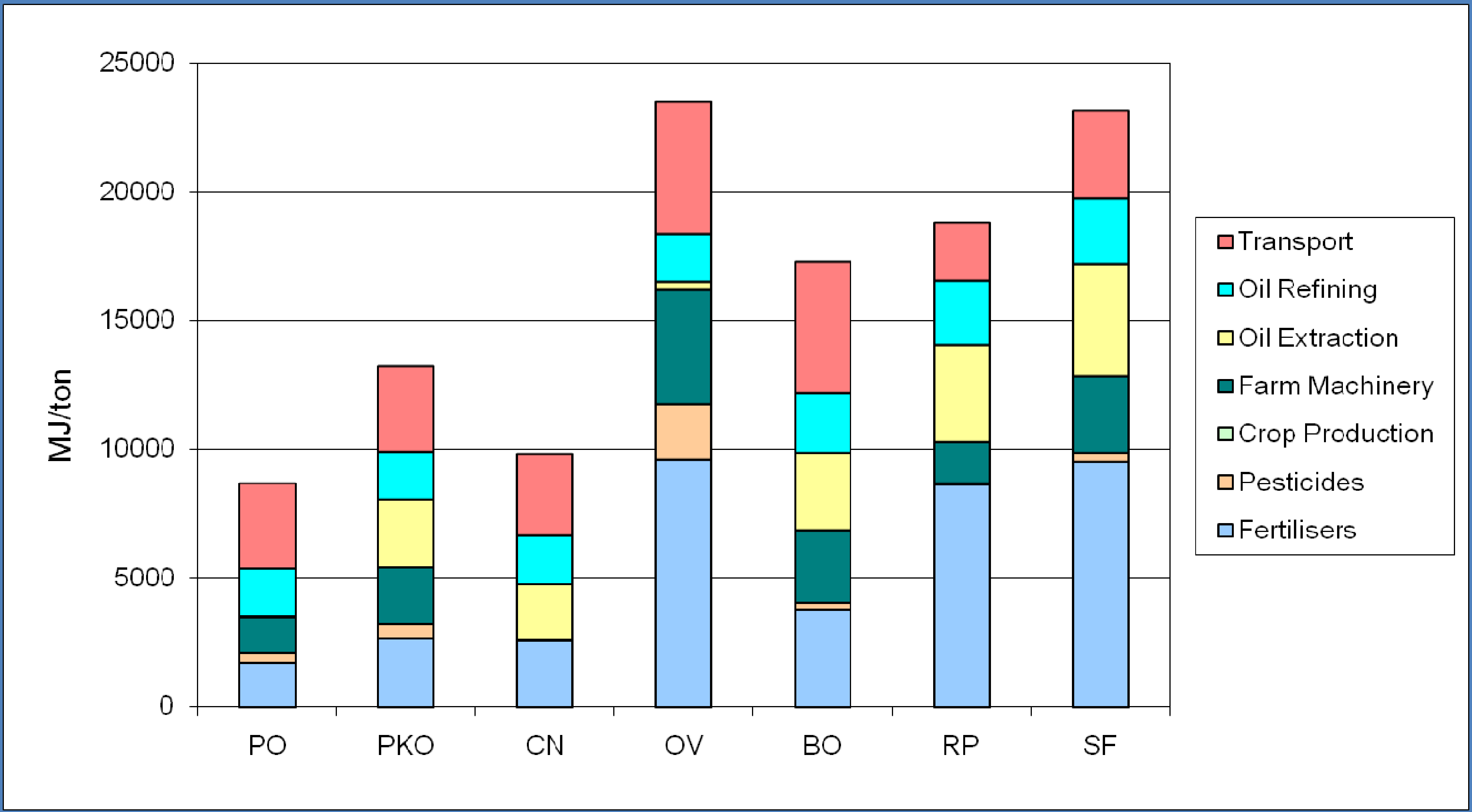
Notes:

1. Data from Malaysia. Oil yield is combined for palm and palm kernel oil (ca. 22.5/2.5% FFB yield)
2. Data from Spain
3. Data from Germany
4. Data from France
5. Data from Brazil

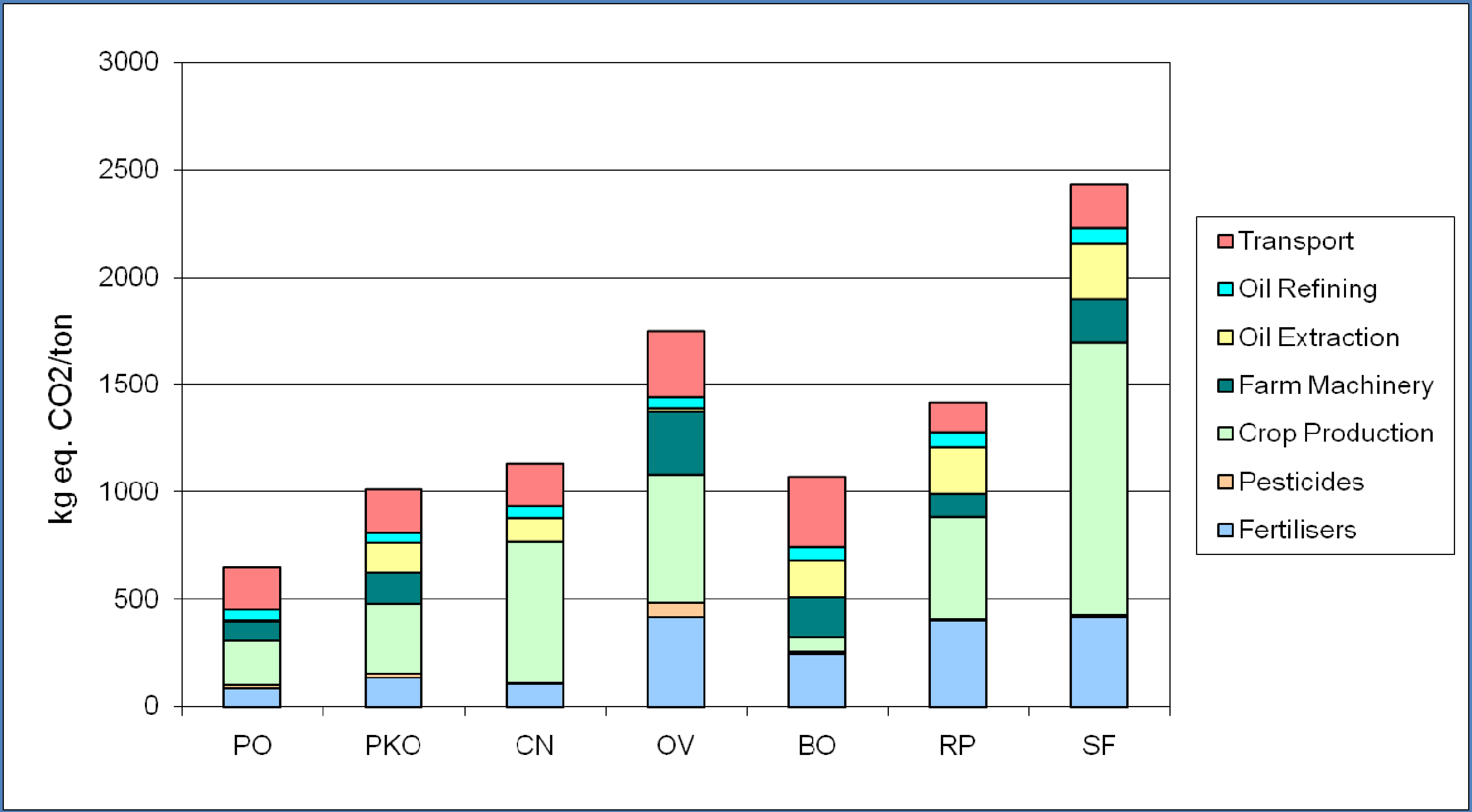
Environmental Profile of Vegetable Oils

Results

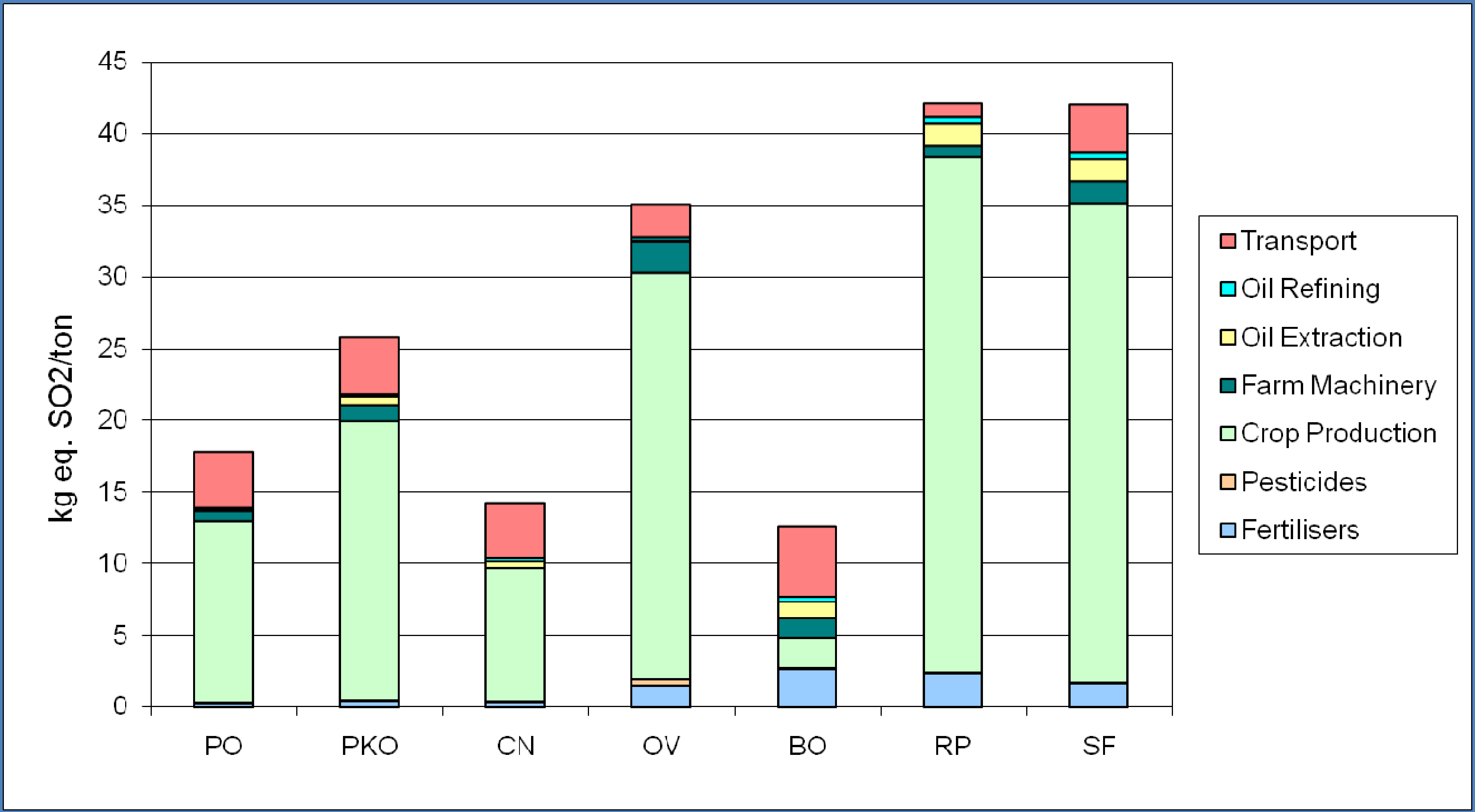
Environmental Profiling: **Energy Consumption**



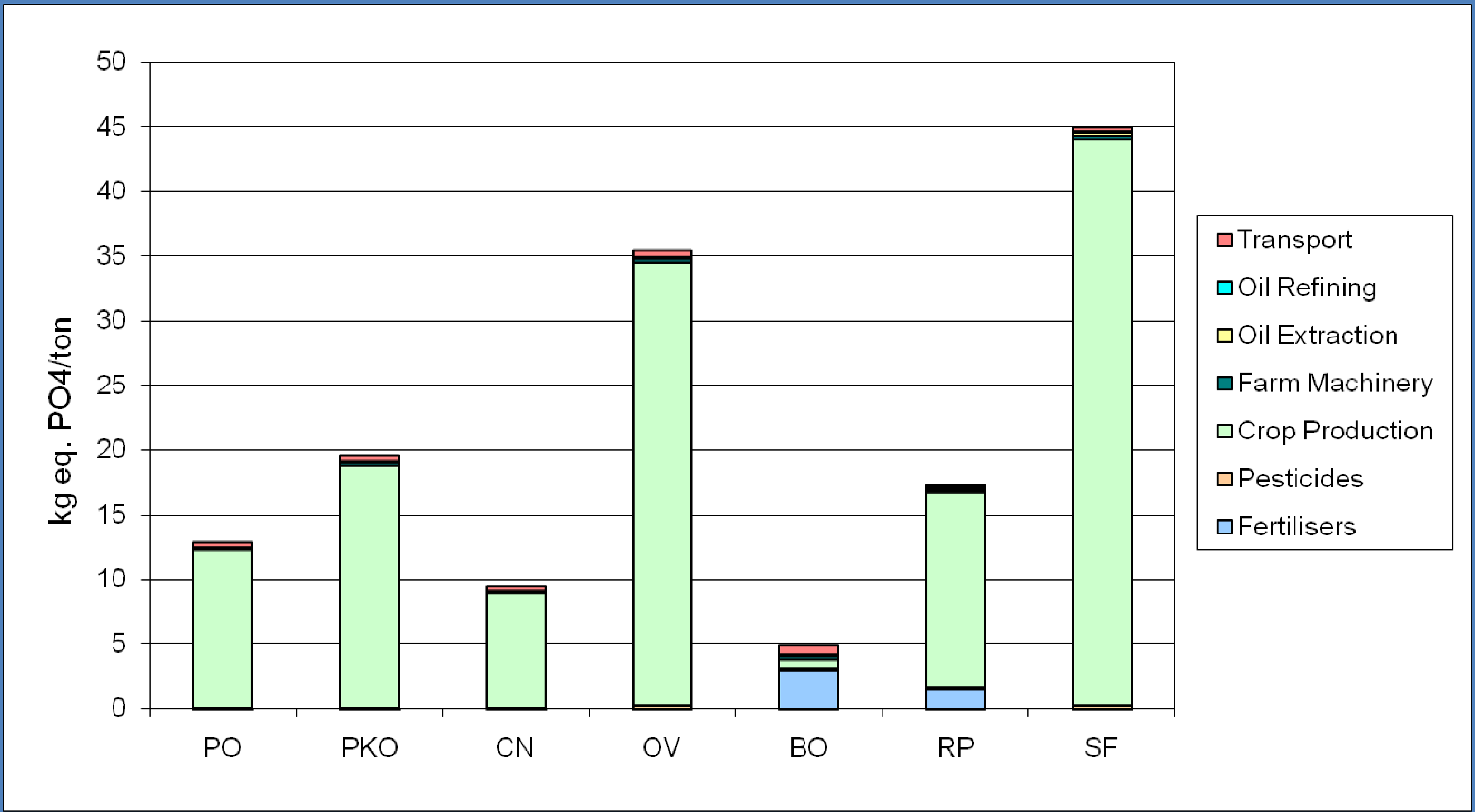
Environmental Profiling:
Global Warming



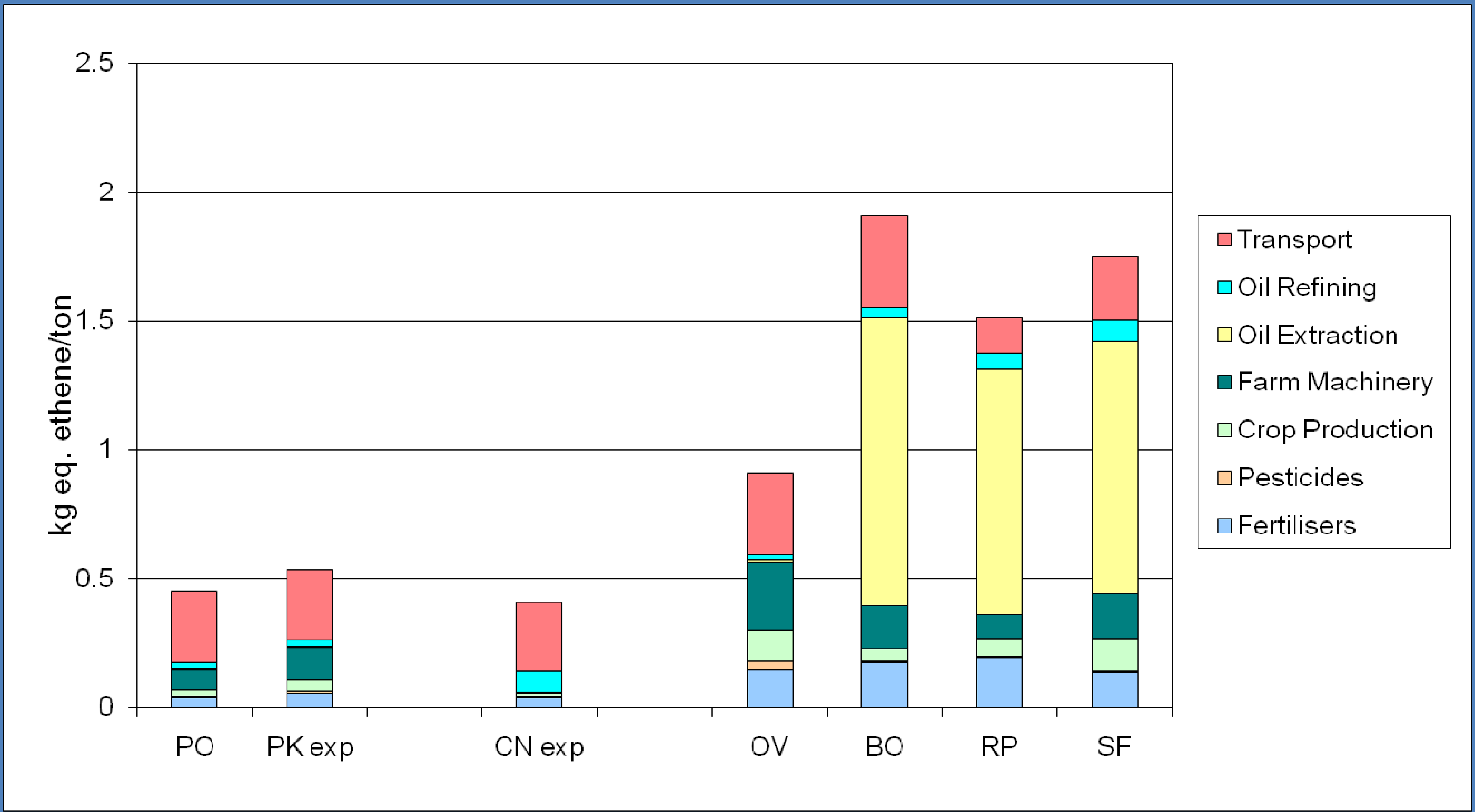
Environmental Profiling: **Acidification**



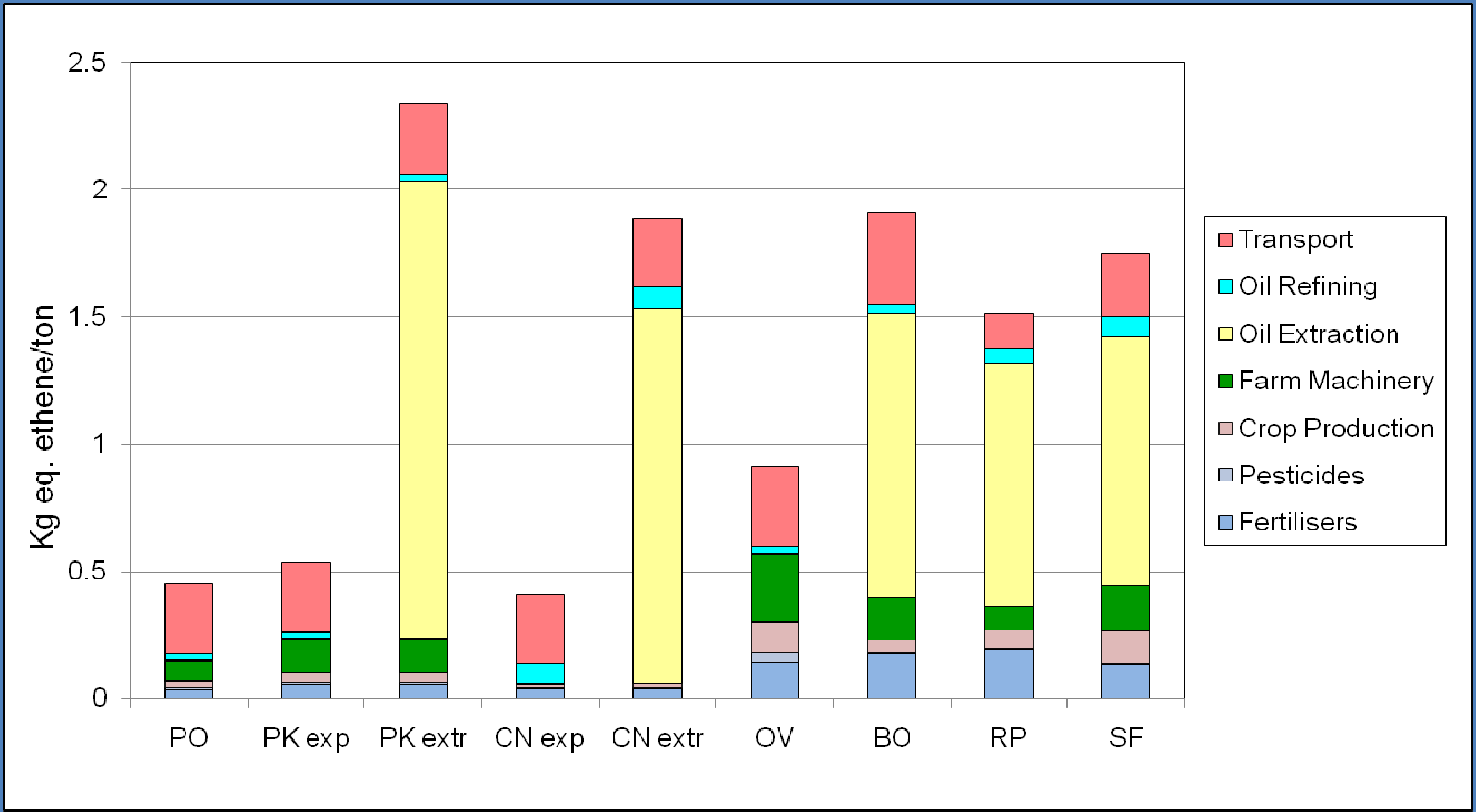
Environmental Profiling: **Eutrophication**



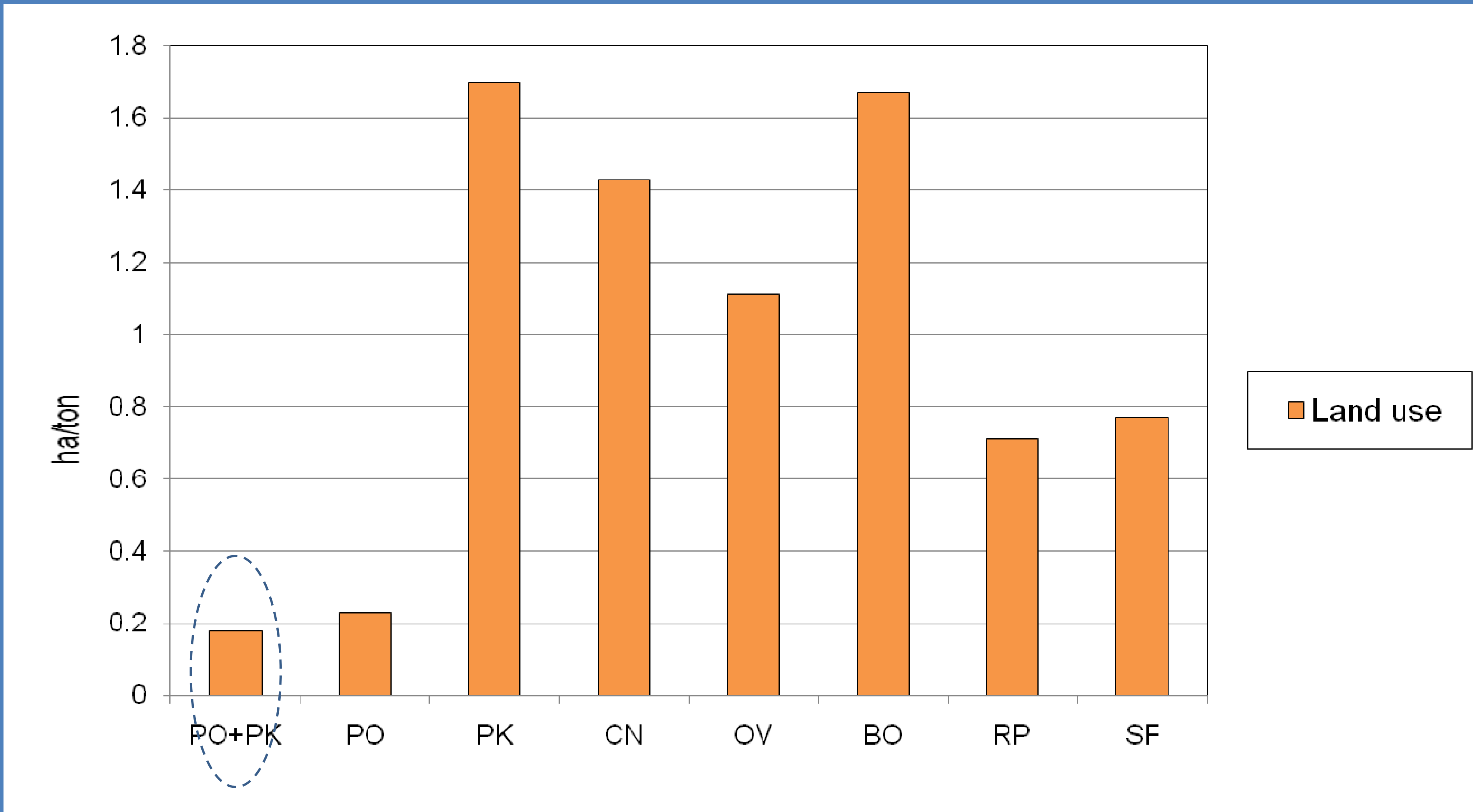
Environmental Profiling:
Photochemical Smog



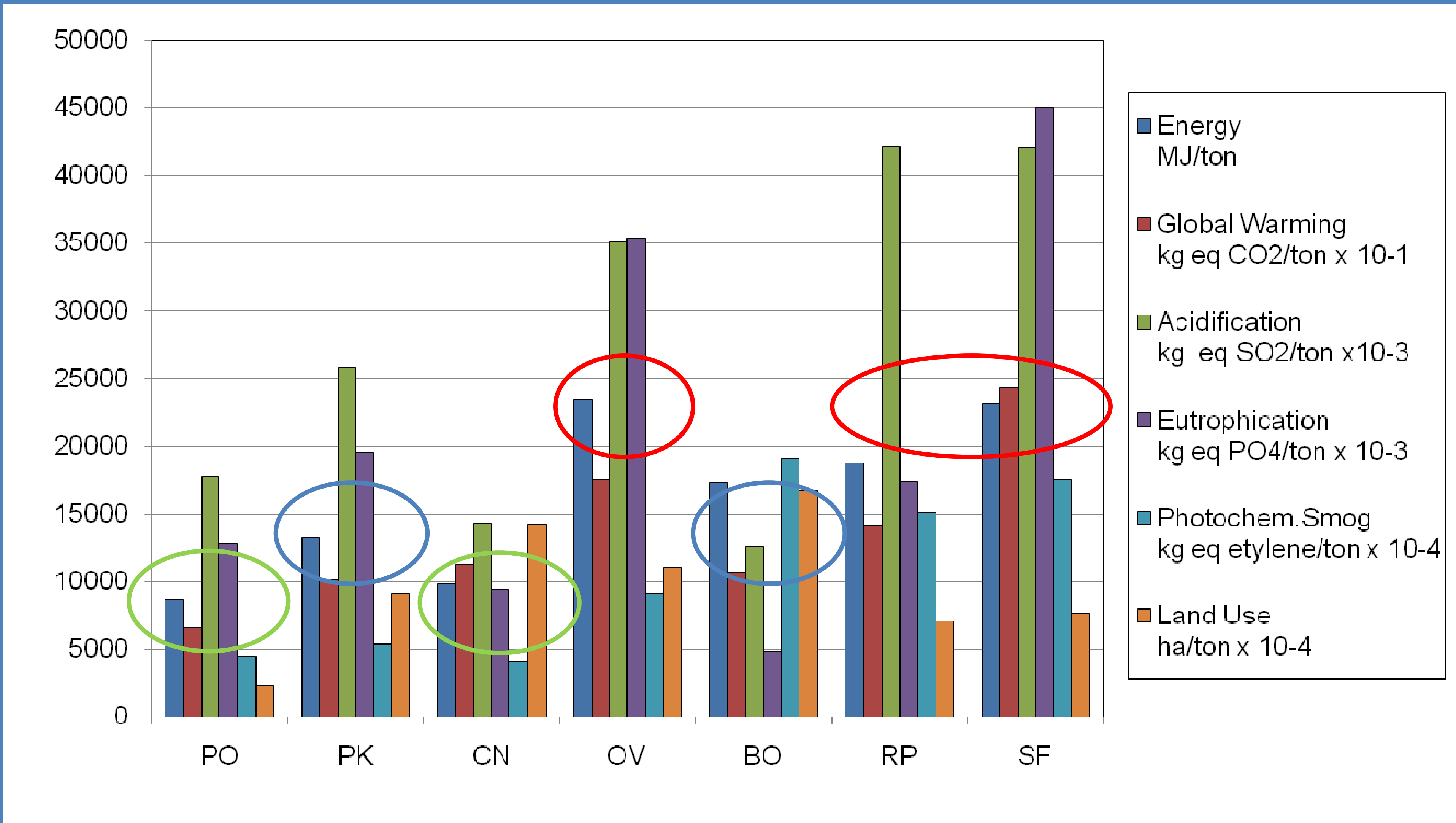
Environmental Profiling: **Photochemical Smog**



Environmental Profiling:
Land Use



Summary Environmental Profiles



Discussion of the Environmental Profiles of Refined Vegetable Oils

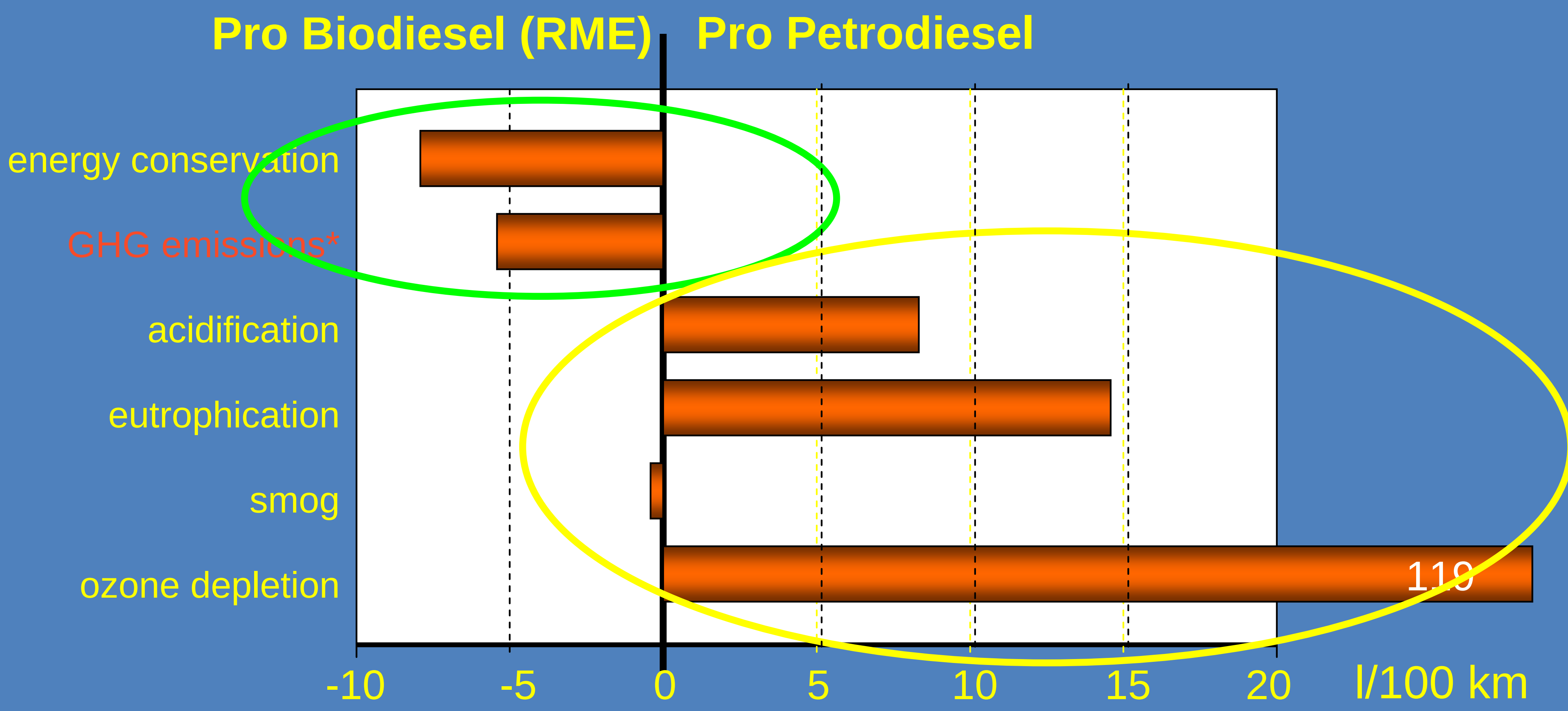
- Agriculture has biggest impacts — mostly due to production and fate of fertilisers (impact of pesticide use not included!)
- Followed by transportation, oil extraction and refining
- Photochemical smog as the exception, as the biggest impacts occur during the solvent extraction stage of the oils (as in BO, RP and SF)
- In general:
  - SF, OV, RP **++++** impacts
  - BO, PK **++** impacts
  - CN, PO **+** impacts

Strengths and Weaknesses of LCA‘s

- Strengths:
  - Allows assessing against a benchmark, between different options or continous improvements
  - Allows to show effects of single steps on the total supply chain
  - Allows to assess a product, production or application process based on a limited number of impact themes

- Weaknesses:
  - Not all environmental impacts are included, such as issues relating to biodiversity, soil quality and effects of pesticides (ecotoxicity)
  - Allows ‘cherry picking‘
  - Impact of land conversion not included

‘Cherry picking’: Positive and Negative Environmental Effects of Rape-seed Oil derived Biodiesel (there is more than GHG only!)



All in all: “The Net Environmental Benefit remains unclear” (IFEU)

*** Land use change and soil conversion effect not included !**

Source: IFEU 2003

‘Land conversion’: Landclearing and the biofuel carbon debt

(Fargione et al., Scienceexpress, 7 Feb 2008, page 1)’

	Land type	Carbon debt (t CO2/ha)	Debt allocated to biofuel (%)	Annual repayment (t CO2/ha/yr)	Time to repay biofuel carbon debt (yr)
Palm oil biodiesel	Tropical rainforest	702	87	7.1	86
	Peat land rainforest	3452			423
Soybean biodiesel	Tropical rainforest	737	39	0.9	319
	Cerrado wooded	85			37

Summary and conclusion

- Large environmental impact of agricultural stage of oil crops relative to extraction, refining and transport

- Perennial, tropical crops with lower impact because of lower agricultural input and mechanisation (PO - higher yield)

- Ability to choose alternative materials (e.g. veg. oils in foods) and processes to produce “greener” products is often constrained by other factors:
  - Nutrition
  - Product functionality
  - Sensory qualities
  - (Cost)

- Planet is not the only criteria!

  ➡ Triggered start of sustainability initiative with the objective to incorporate and balance all the impacts of the 3 P’s (Profit – Planet – People) in the sourcing, manufacturing and distribution of our raw materials and products.