# SAFE - a Tool for Assessing the Sustainability of Agricultural Systems: an Illustration

X. Sauvenier
*Laboratoire d'Ecologie des Prairies UCL, Belgium*

C. Bielders
*Unité de Génie Rural, UCL Belgium*

M. Hermy
*Laboratorium voor Bos, Natuur en Landschap, Belgium*

E. Mathijs
*KUL, Belgium*

B. Muys
*Laboratorium voor Bos, Natuur en Landschap, Belgium*

*See next page for additional authors*



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X. Sauvenier[1], C. Bielders[2], M. Hermy[3], E. Mathijs[4], B. Muys[3], J. Valckx[3], N. Van Cauwenbergh[2], M. Vanclooster[2], E. Wauters[4] and A. Peeters[1]
*[1]Laboratoire d'Ecologie des Prairies, UCL, Croix du Sud, 5 bte 1, 1348 Louvain-la-Neuve, Belgium, Email: sauvenier@ecop.ucl.ac.be, [2]Unité de Génie Rural, UCL, Croix du Sud, 2 bte 2, 1348 Louvain-la-Neuve, Belgium, [3]Laboratorium voor Bos, Natuur en Landschap, Vital Decosterstraat, 102, 3000 Leuven, Belgium, [4]Afdeling Landbouw- en Milieueconomie, KUL, Willem de Croylaan, 42, 3001 Leuven, Belgium*

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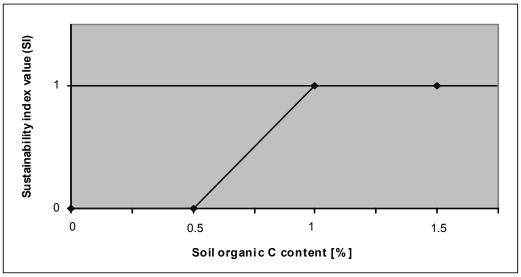
**Introduction** SAFE (Framework for Assessing Sustainability levels) is a tool for evaluating the sustainability of agricultural systems and uses a hierarchical framework populated with indicators objectively selected by multi-criteria evaluation. Indicators are measured at field, farm and landscape scales and progressively integrated into a global sustainability index (SI). SAFE is illustrated below with results on a field scale from a farm site.

**Results** The outcomes of this study are shown in Tables 1 and 2 and Figure 1.

**Table 1** Principles and criteria of the SAFE hierarchical framework for soil resources

| ENVIRONMENTAL PILLAR: soil resource | |
|---|---|
| Principles | Criteria |
| Soil regulation function shall be maintained or enhanced | Soil loss is minimised<br>Soil chemical quality is maintained or increased<br>Soil physical quality is maintained or increased |

**Table 2** Potential indicators, results of selection and 'fuzzification' of selected indicators

| e.g. criterion 'soil chemical quality is maintained or enhanced' | | | | |
|---|---|---|---|---|
| **Potential indicators** | | | **Selected indicators** | |
| Soil organic carbon content | % | ⇨ | i1. Soil organic C content: 0.75 % → $SI_{i1} = 0.5$ | $\omega_{i1} = 1/3$ |
| C/N | unitless | |  | |
| CEC | mmol/kg | | | |
| Total N | mg/kg | | | |
| Extractable K, Na, Ca, Mg | mmol/kg | | | |
| Soluble P | mg/kg | | | |
| Extractable P | mg/kg | | | |
| Micro-nutrients | ppm | Selection | | |
| Nitrogen balance | kg/ha | | | |
| P balance | kg/ha | | | |
| K | kg/ha | | | |
| pH | unitless | | | |
| Soil Al acidity | cmol/kg | | With : $SI_{i1}$ = 1/0 = desired/unacceptable level of sustainability | |
| Electrical conductivity | mS/m | | $\omega_{i1}$ = weight of the indicator within the given criterion | |
| Persistent organic pollutants | mg/kg | ⇨ | i2. Extractable phosphorus: 70 mg/kg → $SI_{i2} = 0,4$ | $\omega_{i2} = 1/3$ |
| Heavy metals in amendments | mg/kg | ⇨ | i3. Heavy metal in amendments : 0 mg/kg → $SI_{i3}=1$ | $\omega_{i3} = 1/3$ |



⇨ Integration of indicators at the 'criterion' level:

$$SI_{soil\ chemical\ quality} = SI_{i1}*\omega_{i1} + SI_{i2}*\omega_{i2} + SI_{i3}*\omega_{i3} = 0,63$$

Further integration (from the 'principle' to the 'global' level) requires weighing defined by the end's user. Results at the principle level are displayed with spider-web graphs in Figure 1

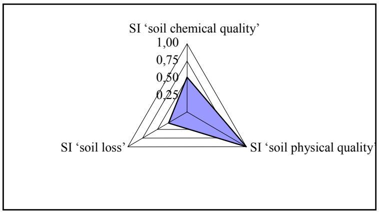



**Figure 1** Results of farm site of SI for each 'criterion' related to the 'principle' *soil regulation function*.

**Conclusions** The 'sustainability index' function related to an indicator is case specific: the shape is based on expertise and support points either as reference values, expertise or minimum/maximum/average values taken by the indicator in similar contexts. Indicator weightings (ω) within a given criterion are extrapolated from their respective 'relevance to sustainability' scores given by experts during the multi-criteria evaluation.