Criteria for sustainability assessment

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Working document 9 January 2009

Workpackage 1.1

Description in project proposal (p. 22): «Workpackage 1 will specify methods and key parameters and will develop assessment matrices to be used in the technology impact assessment. The sustainability criteria will include agro-ecology as well as economic parameters (yields, quality, profit margins)»

Scope (p. 17): «The proposed study will concentrate on the potential impact of varietal traits which are relevant for agricultural production techniques»

Document history: This report was prepared by an ad-hoc group of experts.

In a meeting on 3 March 2008, the content of this document was outlined. It was decided that:

- the matrix should closely follow the structure proposed by ACRE (2007)[1];
- the assessment should be a two-step process, where the first step is the assessment of each GM crop, and the second step is the assessment of a crop rotation / perennial system in the context of conventional, integrated or organic / low input agriculture;
- where possible, indicators should be harmonized with those used in other projects of NRP 59;
- special emphasis should be given to indicators which correspond to legal requirements in Switzerland;
- market prices for GM crops are assumed to be equal to non-GM crops (given equal quality);
- potential costs of co-existence are not considered;
- ethical aspects are not considered.

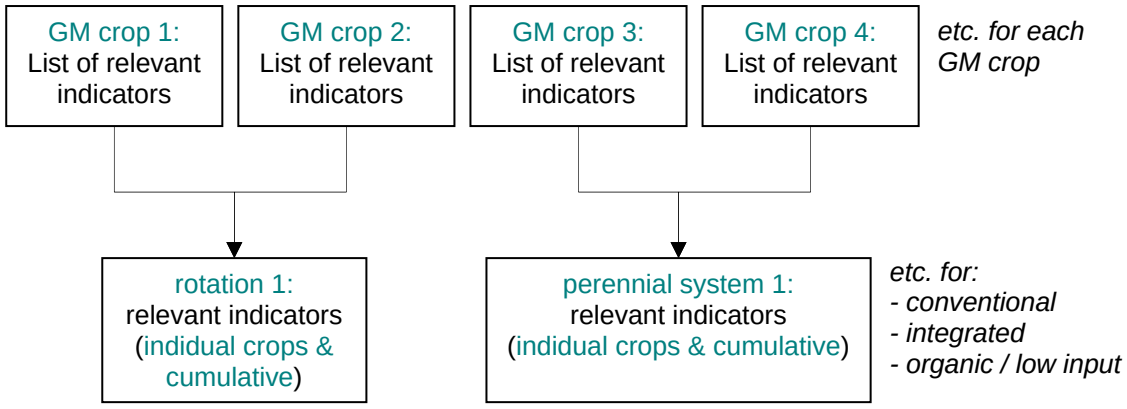
On 3 September 2008, the draft report was placed on the project website for commenting.

[1] Managing the footprint of agriculture: towards a comparative assessment of risks and benefits for novel agricultural systems. Report of the ACRE subgroup on wider issues raised by the farm-scale evaluations of herbicide tolerant GM crops, revised version, 3 May 2007. **Note:** Unlike the ACRE proposal, we do not assume, that our approach is superior to the environmental risk assessment, but see it as an addition to it.

1. Procedure

For the purpose of this project, the criteria for sustainability assessment will be arranged in a matrix. As a first step, a qualitative description of the benefits, negative impacts and potential for mitigation of negative impacts will be given for each selected GM crop. In addition, the impact of each described effect will be scored as low, medium or high. The outcome will be a list of those indicators which are affected by a given GM crop.

As a second step, the impact of scenarios will be analyzed. A scenario comprises the transition from a traditional to a novel crop rotation or management system. A rotation may include several GM crops, and a management system for perennial plants may also include several GM crops (e.g. rooting stock and apple tree). Scenarios are separate for conventional, integrated and organic/low input production systems. There will be at least one set of scenarios for annual arable crops and one for a perennial crop. If effects are discovered during the project, which are difficult to accommodate in the matrix, the matrix shall be refined accordingly.



2. Structure of the matrix

In table 1, the general structure of the proposed matrix is shown. The criteria in the matrix are arranged in five main headings. Most of the criteria, as well as the structure of the matrix, have been derived from the proforma given in Table 1 of ACRE (2007). The matrix is complemented with a few criteria proposed in the EU guidelines for impact assessment (2005). The criteria have been discussed during an expert meeting, but are expected to evolve during the project. The criteria shall be evaluated as a whole, and none has precedence over the others.

Table 1: Overview of criteria.

Criteria	Benefits		Negative impacts		Potential for mitigation
	description	magnitude	description	magnitude	description
1 Characterization of the GM crop					
• reversibility[1] / invasiveness[1] / latency[1]; • persistence[1]; • cumulative effects[1].					
2 Management system					
management system and inputs required[1]					
3 Environmental goods and services					
3.1 biodiversity[1,2]					
3.2 water[1,2]					
3.3 soil[1,2]					
3.4 air & climate[2]					
3.5 energy balance[1];					
3.6 landscape[2]					
4 Social factors					
social factors[1,2]					
5 Economic factors					
economic factors[1,2]					

[1]Criteria used in ACRE, 2007
[2]Criteria proposed the EU impact assessment guidelines (2005).

3. Indicators used to assess criteria

In table 2, the indicators are described which will be used to assess the criteria for each scenario. A scenario comprises the transition from a traditional to a novel crop rotation or management system. To assessments these transitions, it will be determined whether each indicator changes or remains unchanged. For changing indicators, it will be noted in which direction it will change (positive or negative impact), and whether this change will be large or small (magnitude of effect). Where possible, semi-quantitative or quantitative assessments will be made (e.g. yield, profitability).

Table2: Indicators to be used in this project.

Criteria	Indicators
1 Characterization of the GM crop	
reversibility / invasiveness / latency	• potential of the GMO to establish in nature and to outcompete native plants; • speed of dispersal of seeds; • potential of the GMO to cross out with wild plants.
persistence	• persistence of GMO as rhizomes; • persistence of GMO in seed bank; • environmental fate and persistence of gene product(s).
cumulative effects	combined effects arising from: • combinations of management practices and/or inputs and/or gene product(s); • the use of several GMOs in a crop rotation; • changes in crop rotations;
2 Management system	
management system and inputs required	• necessary management practices; • necessary plant protection products, fertilizers & other inputs; • crop growth and vegetation period; • stress tolerance of crop;

	• durability of resistances; • aptitude of crop to be integrated in a crop rotation; • yield; • management flexibility (=convenience for farmer) (e.g. number and timing of management practices; coincidence with labour peaks; planning and organization; stress associated with severe crop diseases etc.).
3 Environmental goods and services	
3.1 biodiversity	Effects of the crop and its management system, and of the gene product(s): • on native flora; • on non-target arthropods; • on native wildlife. with special emphasis on extinction of species and changes in population size.
3.2 water	• quantitative water use of crop and management system; • water balance in relation to soil structure; • pollution of water through the use of fertilizers, plant protection products or gene product(s).
3.3 soil	• soil erosion; soil cover over entire rotation; • soil compaction: use of machinery; • fate of fertilizers, plant protection products and gene product(s) in soil, and toxicity to soil organisms.
3.4 air & climate	air pollution, with special emphasis on greenhouse gases: • use of machinery; • spraying of pesticides; • evaporation of ammonia (e.g. from manure).
3.5 energy balance	energy balance of agricultural system, and type of energy source (renewable / non-renevable) • energy needed for machinery and for input manufacture (kind & quantity); • energy output (for energy crops).
3.6 landscape	Changes of visual aspects of the traditional, regional agricultural landscape. • diversity of crops (rotation); • new crops; • field & farm size; • natural habitats (hedges etc.); • novel management practices with relevance for visual aspects.
4 Social factors	
social factors	Non-pecuniary social effects, such as: • employment (including seasonal aspects); • job quality • requirements for education, information, vocational and continuing training; • effects on health, safety and dignity of farm family and labourers (e.g. in relation to pesticide spraying); • social and economic protection of the farm family and labourers; • social well-being.
5 Economic factors	
economic factors	economic impacts to be assessed are: • operating costs (inputs, labour, economics of scale etc.); • administrative costs on business; • conduct of farm business; • competitiveness (income, profitability, viability); • property rights on land (tenure); • impact on investment and access to finance; • consequences for specific regions and/or sectors; • specialisation and diversification; • eligibility for policy support.

	The following variables are required for the calculations: • Description of management practices: management activities, inputs, machinery, labour; • yields. • conflicts and synergies with other crops in the rotation or farm activities

4. Impact assessment

The impact of scenarios will be assessed as follows:

4.1 Description of scenarios

For **arable crops**, describe the traditional rotation (=baseline data) and the novel rotation which includes all selected GMOs. For **perennial crops**, describe the traditional and the novel management system. For conventional, integrated and organic / low input farming, separate scenarios have to be elaborated. If negative impacts can be mitigated, it needs to be determined whether the practices for mitigation are likely to be performed in the conventional, integrated and organic / low input farming.

Table 3: Matrix for description of scenarios.

	Conventional	**Integrated**	**Organic / low input**
Traditional rotation or management system	*describe*	*describe*	*describe*
Novel rotation or management system, including measures for mitigation	*describe*	*describe*	*describe*

4.2. Assessment of scenarios

Each scenario (=transition from a traditional to a novel crop rotation or management system) is assessed with the indicators given in table 2. The indicators will be considered in a tiered approach.

4.2.1: First, it will be determined whether an indicator will be affected by the transition, or remain unchanged.

4.2.2: If an indicator is found to change, the effect is described qualitatively (positive or negative impact). Where possible, semi-quantitative or quantitative assessments will be made (e.g. yield, profitability). In all cases, the magnitude of the effect (large, medium or small) is described.

Table 4: Tiered approach for assessment of scenarios.

	Is the indicator affected?	**if yes, give details**	**if yes, specify magnitude of effect**
indicator 1	*yes / no*	*describe*	*low / medium / high*
etc. for <u>all</u> indicators given in table 2	*etc.*	*etc.*	*etc.*

5. Acknowledgements

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