Factors affecting the implementation of measures for improving sustainability on farms following the RISE sustainability evaluation

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Abstract: *The Response-Inducing Sustainability Evaluation (RISE) is a method for rapid yet holistic sustainability assessment of agricultural production at farm level. Over 600 farms in 18 countries have been analysed using RISE. We report on lessons learned from RISE application, with a focus on practical impact. The analysis as such, despite being comparatively farmer-oriented and transparent, at best induces reflection. It can serve as a "door-opener" and an instrument to structure discussion where results are shared with farmers. Farmers will only engage for more sustainable production if the analysis is an integrated part of a process generating sustainable yet practicable solutions.*

Keywords: *RISE, sustainability evaluation, farm level, adoption, measures, participative*

Background

Sustainable agriculture (SA) is universally recognised as an indispensable component of sustainable development (UN, 1992; for one definition of SA, see FAO (1995)). Just like the targeted management of public and private enterprises depends on a reliable accountancy, targeted action towards SA requires relevant and tangible information on whether the farm or sector is heading in the "right" direction. An array of SA assessment tools have been developed for various scales (Zahm et al., 2008; Meul et al., 2008; Breitschuh et al., 2008; to cite just a few operating at the farm level). The practical implementation of these tools is in an early stage and will likely require further adaptation based on practical experience before unfolding its potential.

The RISE approach

RISE is a method for assessing agricultural production at farm level within one year (Häni et al., 2008). It starts with the collection of comprehensive information on ecological, economic and social aspects through a questionnaire-based interview with the farmer. A computer model uses this information to calculate 57 sustainability parameters, condensed into twelve indicators (Table 1). All RISE indicators are composed of state (current situation of the system) and driving force (pressures on the system) parameters. The indicator degrees of sustainability are calculated as the aggregate state minus the aggregate driving force. Indicators are rated on a scale from -100 to +100, where +100 indicates the optimum and -100 an intolerable situation. Benchmark values used for normalisation onto this scale are derived from published research, official statistics (e.g. FAOSTAT), (inter-)national agreements (e.g. ILO decent work standards) and expert knowledge. Some benchmarks can be regionally adapted. An optimum situation in the sense of farm sustainability is reflected by a broad bandwidth of positive indicator values rather than a maximisation of single indicators. Indicator scores are visualised as a polygon (see Tables 2, 3, 4). At parameter level, results are presented in tabular form to allow for a more detailed presentation. The RISE method has been developed iteratively through a sequence of development, application, evaluation and improvement phases since 2000. The current version 1.1 is being thoroughly revised based on the experiences described in this paper and in cooperation with extension and communication experts and farmers in order to optimise the indicator set, increase flexibility and user-friendliness of the software and facilitate the integration of RISE into a solution-oriented knowledge management system.

Table 1. Indicators and parameters of the RISE method for evaluating the sustainability of agricultural production.

Indicators	State Parameters	Driving Force Parameters
Energy	- Environmental effects of energy carriers used	- Energy input per unit agricultural land - Energy input per unit workforce
Water	- Water quantity and stability of the quantity - Water quality and stability of the quality	- Water quantity and productivity (crop & animal production) - Risks to water quality (manure, silage leachate, wastewater,…)
Soil	- Soil pH, salinisation, waterlogging, soil sampling - Erosion index	- Pollution by pesticides, acidifying fertilisers & fertilisers containing heavy metals - Tillage-related risks - Salinisation risk - Nutrient mining
Biodiversity	- Biodiversity-promoting practices	- Proportion of intensively used agricultural land - Plot size - Weed control
N&P emission potential	- N & P balance - Manure storage and application	- N & P from organic & inorganic fertilisers (imports / exports)
Plant protection	- Quality of the application - Eco- & human-toxicological risks	- Crop husbandry - Crop rotation
Waste	- Environmental hazard - Methods of waste disposal	- Type and quantity of waste
Economic stability	- Net debt service over change in owner's equity & interest paid - Equity ratio - Gross investment	- Cash flow/raw performance rate - Dynamic gearing - Condition of machines, buildings & perennial crops
Economic efficiency	- Return on assets - Return on equity - Total earned income	- Productivity
Local economy	- Share of regional workforce & salaries - Lowest salary on farm compared to average regional salary	- Raw performance per unit agricultural land
Working conditions	- Emergency/medical care - Provision of potable water - Accommodation & sanitary equipment - Working hours - Wage discrimination - Child labour - Forced labour - Gender	- Continuing education - Encumbering work - Working conditions - Income disparity - Working time to reach minimum salary
Social security	- Social security - Means of subsistence	- Potentially payable salary - Farm succession plan - Legality & documentation of employment

Previous applications of RISE

Up to now, RISE has been applied in a large variety of contexts: collaborative projects, education and training modules, research and development studies involving private industry, political and research institutions, producer organisations and farmers. The comprehensiveness of the sustainability evaluation varied depending on the objectives of the respective project: (i) Only the analysis was done (ii) The analysis was supplemented by a detailed feedback to the farmer and, finally, (iii) processes such as training programmes or the establishment of a platform for sustainable agriculture were initiated (Fig. 1).

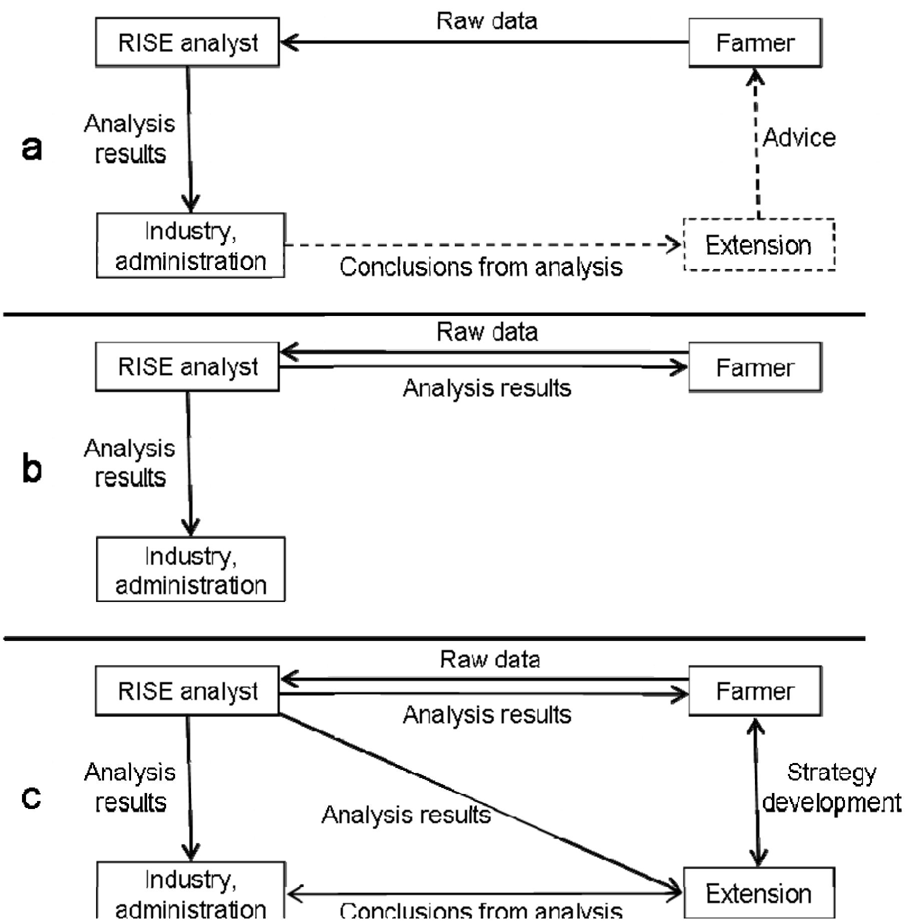


Figure 1. Typical contexts of RISE application: a) Analysis without feedback b) Analysis supplemented by a detailed feedback to the farmer c) Analysis, feedback and follow-up process, e.g. training programmes or the establishment of a platform for sustainable agriculture. Solid lines represent standard flow of information and actors in projects. Dashed lines represent optional flows of information and actors, which only existed in part of the projects.

“Pure analysis" (one-way flow of information)

In certain projects, the on-farm part of the RISE procedure was restricted to data collection (Fig. 1a). During the visit, the analyst conducted a standardised interview with the farmer, following a twenty-page questionnaire. The interview topics covered animal husbandry, the use of water, pesticide and fertiliser, plot-level information on topography, soils and biodiversity, the crop calendar, working conditions, social security and farm financials. The order of these topics in the interview followed the logic that less controversial topics like energy use were addressed earlier, sensitive topics towards the end of the questionnaire. This should give time to create an atmosphere of trust before turning to social and financial issues. The analyst had to be an expert in agronomy and command good knowledge of the local environmental, socio-cultural, economic and agronomic context. Particularly in Switzerland, farmers' willingness to actively contribute to the analysis was strongly tied to the perceived competence of the interviewer. When only a pure analysis was done, the results were solely presented to and discussed with the project sponsors which usually were private companies or administration, but not with the farmers themselves. This procedure was chosen when the focal point of the project was not the improvement of an individual farm but rather the quick capturing of the sustainability situation of a group of farms representative of a region, country or catchment area of a processing factory. Following this procedure, an implementation of measures at farm level as a direct consequence of the analysis could hardly be observed. However, project stakeholders tackled identified sustainability deficits by their own possibilities and means. For example, in northern China the installation of training programmes and strengthening of a regional extension service were implemented by a private company and government, following a RISE study (Table 2).

Table 2. Description of a RISE project in Heilongjiang province, China (2002, 2009).

Project description:
In a cooperative project of the Swiss College of Agriculture, a private food company, the regional Chinese Government and the Northeast Agricultural University of Harbin, RISE was used to assess the sustainability of dairy farms in north-eastern China. The aim was to identify key sustainability issues in the catchment area of a newly established dairy factory. Farmers did not receive a direct feedback of the RISE results, which were instead presented to and discussed with representatives of the government and private company.

Farm characterisation (average values):
Initial project 2002

Number of farms analysed	30
Agricultural area	1.46 ha
Work force	1.45
Large livestock units	4.8
Animals	dairy cows
Main crops	maize (fodder), vegetables
Equity ratio	0.96
Annual farm income	2681 US$
Calculatory profit	1377 US$

Major issues at parameter level: Remark: Indicator values (polygon) are aggregated parameter values (see Table 1).

- excessive stocking rates (*Biodiversity* indicator; see summary polygon below)
- use of mineral fertilisers in addition to an existing surplus of manure (*N&P Potential* indicator)
- improper manure storage (leaching) (*N&P Potential* indicator)
- inappropriate skills concerning application of plant protection products (*Plant Protection* indicator)
- insufficient social securities (*Social Situation* indicator)

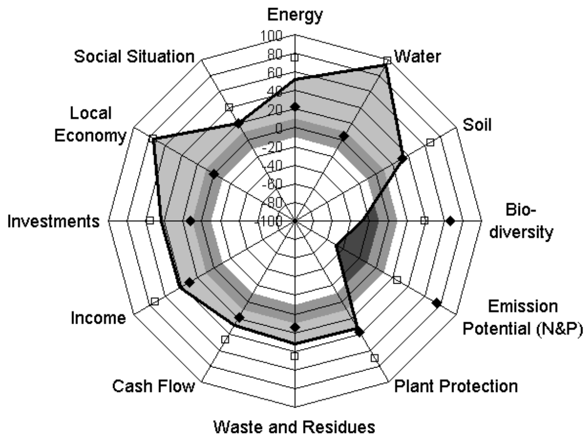


Photo: Cattle sheds and inappropriate manure management, 2002. Summary polygon with mean indicator degrees of sustainability of 30 dairy farms in China.
Legend: ☐ State (S): 0 pts = problematic situation, 100 pts = good situation; ◆ Driving force (D): 0 pts = low risk, 100 pts = high risk. ▬ Degree of sustainability, DS = S – D: ░ positive: 10 < x ≤ 100 pts; ▒ border area: -10 ≤ x ≤10 pts; █ negative: -100 ≤ x < -10 pts.

Outcome and follow-up process:
Following the RISE study, the regional government and the private company fostered activities in the identified priority domains. The development of a consulting team, as well as the construction of biogas digesters and the production of corn silage and lucerne were some of these actions. A a team of a private agricultural service in the district provided technical assistance. A training video was produced that informed farmers about proper feeding, hoof treatment, silage production and general hygiene. Brochures with further information for farmers were developed. Additionally, posters with information on feeding and other aspects were hung up in the milk collection centres. In 2009, some of the farmers were re-assessed with RISE in order to monitor the development of the farms. Most farmers mentioned not having implemented any changes after the first RISE analysis. However, partly as a consequence of the RISE analysis several measures had been proposed by the extension services and local government to these farmers.

One important issue was that many interview questions did not allow the farmer to draw direct conclusions about the outcome of the analysis. They rather induced reflection, as confirmed by a survey among Swiss farmers who had previously participated in RISE studies. From the experiences made we induce that in settings without comprehensive follow-up to the sustainability analysis, (i) all questions asked should be clearly linked to sustainability topics, (ii) the reason for asking these questions should be explained to the farmer, (iii) preliminary results should be shared with the farmer during the first visit, (iv) farmers have to be informed about their role in the project and the objectives of the latter.

Analysis and feedback (two-way flow of information)

The full procedure of a RISE analysis consisted of two visits to the same farm (Fig. 1b). The second visit served the presentation of the analysis results to the farmer, the joint control of the plausibility of results and the discussion of possible further steps. RISE results were compiled and presented in a feedback booklet at different levels of detail.

This allowed the communication of results to the farmer to be flexibly adapted as the feedback discussion unfolded. However, according to feedbacks from farmers there was a rather poor implementation rate of sustainable agricultural practices following the analysis cum feedback procedure, at least within the first years after the analysis (Table 3). This observation was supported by a small study with Swiss farmers on the implementation of measures following a RISE analysis. Of ten surveyed farmers who had participated in RISE studies in the previous three years, eight had not changed anything on their farm. They do “keep the RISE information in mind” and “might take the results into consideration” in specific situations e.g. when a new farming strategy would be needed due to changes on markets or of the family situation or when a major investment would be considered. Developers and users of indicator-based holistic farm analyses hence should be clear about the importance of adjusting the timing of interventions to farmers' needs.

Table 3. Description of RISE project in four regions in the Swiss Alps (cantons of Grisons, Bern, St. Gallen, Lucerne), 2006.

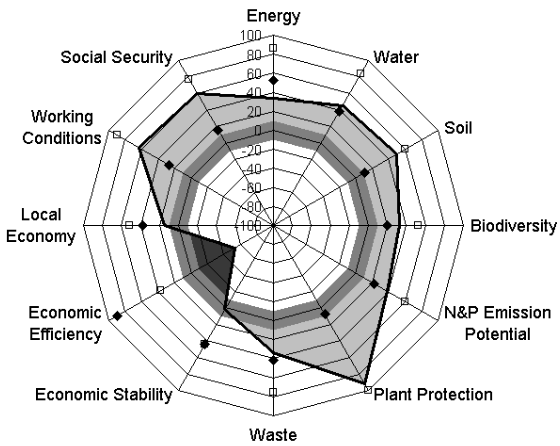
Project description:
In the “Mountain Dairy Project”, strategies for commercial dairy manufacturing plants in mountainous areas and for dairy milk producers were developed in order to improve competitiveness of the dairy sector in an expected deregulated cheese market.
RISE was used to holistically assess farm situations and to validate the individual farm development strategies developed by another project group (economists). The RISE analyst visited the farm twice; once for collecting data for the sustainability analysis and once to provide an individual feedback. There was no consistent follow-up process after the feedback.

Farm characterisation (average values):

Number of farms analysed	10
Agricultural area	30.3 ha
Work force	1.8
Number of large livestock units	27.4
Animals	dairy cows
Main crops	pastures, meadows
Equity ratio	0.49
Farm income	66600 US$
Calculatory loss	16246 US$

Major issues at parameter level: Remark: Indicator values (polygon) are aggregated parameter values (see Table 1).

- critical water availability, due to dry climatic conditions in some locations (*Water* indicator)
- high energy consumption (*Energy* indicator)
- high production costs (high labour costs) and low profitability (*Economic Efficiency* indicator)
- ammonia evaporation due to problematic manure application practices (*N&P Emission Potential* indicator)



Photograph: Liquid manure application with splash plate on a dairy farm in the Swiss Alps. Summary polygon with mean indicator degrees of sustainability of 10 mountain dairy farms in the Swiss alps, 2006.
Legend: ☐ State (S): 0 pts = problematic situation, 100 pts = good situation; ◆ Driving force (D): 0 pts = low risk, 100 pts = high risk. ▬ Degree of sustainability, DS = S – D: positive: 10 < x ≤ 100 pts; border area: -10 ≤ x ≤10 pts; negative: -100 ≤ x < -10 pts.

Outcome and follow-up process:
The farm strategies developed in this project were mainly oriented towards economic aspects and generally suggested an intensification of production (e.g. by increasing the number of dairy cows). Off-farm income was to be increased. The independent, holistic RISE evaluation provided a complementary picture and triggered discussion about otherwise ignored aspects of sustainability. Examples of issues that were brought up were workload, ecological aspects of irrigation, cross-subsidisation of agricultural production by off-farm activities. Within the frame of this project it was not possible to develop viable strategy alternatives, since limited resources made the required in-depth analysis impossible. For an optimal consideration of sustainability issues in farm strategy planning, it would be essential to consider a holistic baseline analysis at an earlier stage of the process. Sufficient resources should be reserved for the complex and time-consuming development of alternatives.

Analysis, feedback and follow-up process (three-way flows of information)

In projects aiming at the practical implementation of measures fostering agricultural sustainability, the RISE analysis set off a process involving experts with local knowledge (Fig. 1c). The RISE analyst completed the analysis, verified the results with the farmer and provided information about the sustainability situation to an extension service. The latter merged the RISE information with local knowledge and provided specific, solution-oriented advice to farmers. A structure of this type was implemented in a collaborative project in Kenya (Table 4). The overall goal was to contribute to improving the situation of smallholder farmers by making agricultural production more sustainable. RISE was used (1) for a holistic analysis, to prioritise issues and identify entry points for concrete measures and (2) to monitor the impact of training measures over time (2009 versus 2006).

Together with local agronomists and institutions, training modules on priority domains such as record keeping, soil conservation and manure management were developed and training courses accomplished, to which 240 farmers attended. Demonstration plots were established and regular follow-up meetings and trainings organised to foster long-term relationships between the regional extension team and the farmers. The RISE results offered a comprehensive basis for a data-based dialogue on sustainability issues. The 2009 re-evaluation of the 30 farms analysed in 2006 revealed good adoption of SA practices with immediate and visible effects that either alleviated workload (use of herbicides instead of hand weeding) or mitigated the risks of crop failure in this drought-prone region (water harvesting, irrigation, no/reduced tillage). Measures with rather diffuse cause-effect relations (e.g. manure management, record keeping) were virtually not adapted.

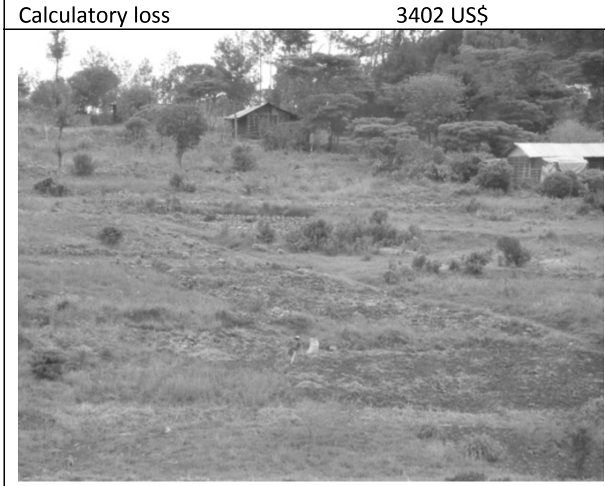
Table 4. Description of RISE project in Nanyuki (Laikipia district), Kenya, 2006 and 2009.

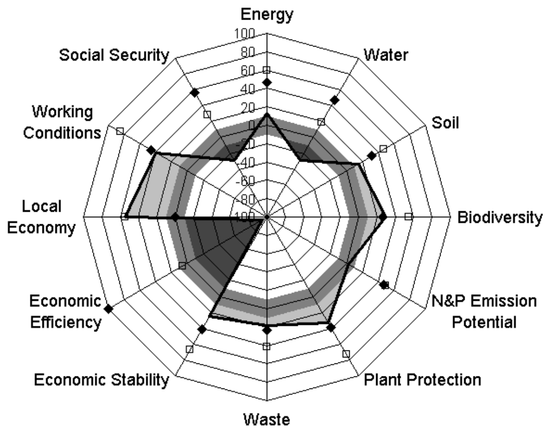
Project description:
In a collaborative project of SHL, CETRAD (Centre for Training and Integrated Research in Arid and Semi-arid Lands Development), and Syngenta, key sustainability deficits of smallholder agriculture in the Laikipia district of Kenya were identified through RISE assessments and tackled through targeted training modules. The overall goal of the project was to improve the situation of smallholder farmers by enhancing the sustainability of their agricultural production.
Those findings applying to all farms were brought up in group feedback discussions. Farmers were invited to a farmer’s site, a community hall or church and results of general interest, like crop rotation, or water use, were presented. Individual feedback on specific and more sensitive issues, like profitability or social security, was also provided to all interviewed farmers.

Farm characterization (average values):
Initial project 2006

Number of farms analyzed	30
Agricultural area	3.21 ha
Work forces	2.8
Number of large animal units	3.98
Type of animals	(dairy) cattle, goats, poultry
Crops	Maize, potatoes beans, wheat
Equity ratio	0.98
Farm income	1604 US$
Calculatory loss	3402 US$

Major issues at parameter level: Remark: Indicator values (polygon) are aggregated parameter values (see Table 1).
- lack of water due to extreme climatic conditions and overuse of water resources (*Water* indicator)
- poverty and even malnutrition prevail due to low crop yields and crop failure (*Water* indicator)
- production techniques that enhance soil water evaporation (*Soil* indicator)
- inappropriate manure management (*N&P Emission Potential* indicator)
- inappropriate skills concerning application of plant protection products (*Plant Protection* indicator)
- insufficient social securities (*Social Security* indicator)





Photograph: Smallholder farms with small plots in Kenya, 2009. Summary polygon with mean indicator degrees of sustainability of 30 smallholder farms in the Laikipia district, Kenya.
Legend: ☐ State (S): 0 pts = problematic situation, 100 pts = good situation; ◆ Driving force (D): 0 pts = low risk, 100 pts = high risk. ▬ Degree of sustainability, DS = S – D: positive: 10 < x ≤ 100 pts; border area: -10 ≤ x ≤10 pts; negative: -100 ≤ x < -10 pts.

Outcome and follow-up process:
In a follow-up process an extension service team was established and trainings on selected topics were offered. Farmers throughout appreciated the holistic ”portfolio” of their operation presented in the feedback. In contrast to precedent trainings that focused on the most common issues, the feedbacks allowed for thematically open discussions. Advantages of working in groups were the lively discussions and the exchange of experience and knowledge that promoted collaborations among the participants.
In 2009 the farms were re-evaluated by the same RISE-analyst. Several farmers had adopted conservation agricultural (CA) techniques on their farm or participated in trainings for safe use of chemicals. Repeated crop failure due to drought motivated several farmers to try new techniques like no-till, reduced tillage or water harvesting. Demonstration plots and farms and repeated visits of extension officers supported adoption. However, for many farmers it was difficult to transfer innovations presented e.g. on field days or demo farms onto their own farm. The challenge is to join the new elements with the existing farm strategy. For example, farmers who want to produce crops with CA techniques should cover the soil with mulch to prevent unproductive evaporation. Some farmers did use mulch on their plots, but did not adjust the number of livestock to the reduced amount of biomass available. The consequence was that not enough mulch was available for an effective soil cover and the fodder for livestock became critical. Optimally the extension service individually assists implementation of measures at each farm.

Key factors for an efficient implementation of measures

The implementation of measures varied considerably between projects depending on context and procedure of the RISE application:

- Generally, farmers only got involved in SA if the sustainability analysis was an integrated part of a process generating sustainable yet practicable solutions. Some of the re-evaluated Swiss farmers stated that the RISE analysis alone was biased e.g. due to the system boundary's excluding off-farm income and some of the economic parameters being based on tax accounting (which usually is "tax-optimised" and hence based on a too low revenue). The trade-off between fast and broad applicability of the tool and specific relevance of the results affects all known comparable indicator systems (von Wirén-Lehr, 2001). Neither the sustainability parameters, nor the benchmark values used in RISE will equally satisfy the demands of all the various actors with a stake in SA (Pretty et al., 2008). As a consequence, the next RISE version will keep a universal set of indicators and parameters, but allow for a higher degree of benchmark adaptation according to user requirements. Particularly in the socio-economic domain, farmers' perceptions e.g. on the relative importance of farm and off-farm income should be reflected in the weighting of parameters. Implementation of this participatory approach to benchmark selection should alleviate the outlined dilemma of applicability and specifity (von Wirén-Lehr, 2001; Grunwald & Kopfmüller, 2006).
- Farmers should have the chance to develop genuine interest for a sustainable development in general and SA in particular. A transparent definition of SA is necessary, translated into practically implementable goals (von Wirén-Lehr, 2001). Valuation algorithms must be directly related to these goals. Since sustainable development is a normative concept, definition and goal system of SA are necessarily subjective to a considerable extent (Christen, 1999). Environmental limits, such as the tolerable atmospheric greenhouse gas concentration, can be considered absolute, albeit difficult to determine. Yet, in the socio-economic domain, subjective concepts and value systems stand in the center of human behavior. It is important to transparently present the values on which an indicator system is based and the limitations of the evaluation, as well as to periodically review these values together with the concerned stakeholders.
- Farmer's involvement in the follow-up process and the search for practical solutions should be actively encouraged. Techniques e.g. from the empirical social sciences, such as participatory rural appraisal, may prove useful in this regard (e.g. Chambers, 1994). Combined approaches involving "hard science" and "soft communication" seem favourable: scientific knowledge adapted to the specific situation (Stähli & Egli-Schaft, 2008).
- Projects involving sustainability analysis resp. targeting SA implementation should be more systematically evaluated with respect to their defined goals. These goals should be formulated together with the concerned stakeholders and considering established standards and methods (e.g. IFAD, 2009).

Establishment of a knowledge platform

The availability of user- and solution-oriented information proved an important factor in the adoption of SA techniques (see also Rodriguez et al., 2009). A central challenge in making sustainability-relevant knowledge effective is to bring the rather abstract concept of sustainable development to the ground. For this purpose, the RISE team is working on a project aiming at developing a knowledge management system that identifies sustainability deficits and connects people, knowledge and technologies for practicable SA solutions. This knowledge management system shall neither be a decision support system, nor an expert model, given the often limited consideration of field reality and farmer's knowledge and experience by such systems. It rather will be a knowledge and communication platform of a knowledge community linking farmers and other stakeholders.

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