RISE 3.0 - Manual

Sustainability themes and indicators

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Bern University of Applied Sciences

School of Agricultural, Forest and Food Sciences
RISE Response-Inducing Sustainability Evaluation

Helping farmers to measure, understand and implement sustainable development

"Everything which we do and accomplish, create and discover seems to me insignificant compared with what the farmer can produce. (…) The progress of the farmer alleviates the needs and cares of people and makes them receptive to the good and beautiful (…) and provides the foundation and blessing for our progress. A hungry man does not go to church, and no child goes to school if he does not have a piece of bread." (from a letter by Justus Liebig to Friedrich Wöhler, 1862)

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Contents

Important note on the contents of this manual

This version of the RISE 3.0 manual contains explanations on the background and philosophy (Chapters 1 and 2) of the RISE methodology, as well as on the goals, rationale and principles used to calculate all of the RISE 3.0 themes and indicators (Chapter 3). This is complemented by illustrations of some scoring functions and example calculations. The manual does not include either the complete set of questions in the RISE 3.0 questionnaire or the algorithms for calculating indicator and theme scores. The complete questionnaire is available online at www.farmrise.ch. Information on the algorithms can be provided on request by the RISE team at the School of Agricultural, Forest and Food Sciences (HAFL). A separate document describes how to use the RISE methodology.

Some of the topics and indicators in RISE 3.0 have several algorithm options for the user to choose from at the beginning of a project. These options are described in a separate document. For the time being, the RISE 2.0 algorithms are still available for use if required, for instance if a comparison of the same farm at different time points is planned. These algorithms are described in the previous version of this manual.

The HAFL RISE team welcomes any information from RISE users concerning possible inaccuracies or errors, as well as any images or written contributions for use in future versions of this manual.

Acknowledgements

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We wish to express our gratitude and appreciation for the patience and interest shown by all the farmers in Switzerland and elsewhere in the world who participated in RISE analyses and made important contributions to the methodology's development. We are grateful to all the funding partners of the RISE projects carried out since 2000, in particular the GEBERT RÜF Foundation, the Swiss Federal Office for Agriculture and the German Federal Office for Agriculture and Food, without whose support it would not have been possible to develop a modern and flexible software application. We thank Hans Jöhr of Nestlé, Dr. Alexander Schöning and Dr. Alberto Camacho of the German Gesellschaft für Internationale Zusammenarbeit (GIZ) and Robert Obrist of FiBL for their invaluable cooperation over many years.

Very special thanks go to our families and friends who tolerated our many hours of overtime during our work on RISE but also reminded us of their own right to social sustainability when it was necessary to do so. We are also very grateful to our former team members Dr. Christoph Studer, Hans Porsche, Andreas Stämpfli, Michael Schoch and Susanne Stalder. We owe a huge and special debt of gratitude to Dr. Fritz Häni who is and always will be the intellectual father of RISE. Finally, in my capacity as the RISE team coordinator, I should like to take the liberty of expressing my gratitude and appreciation to my RISE team colleagues Dr. Raphael Mainiero, Martina Graf, Dr. Firesenai Sereke and Dr. Christian Thalmann for their motivated and motivating commitment.

Zollikofen, February 2016

Dr. Jan Grenz

1. Introduction

1.1 RISE in brief

The vision of sustainable development that meets human needs in a fair and environmentally-friendly manner (WCED, 1987) has been globally recognized ever since 1992. In keeping with this vision, the importance of environmental and social goals for agriculture is growing steadily. The purely economic competition that has at times led to environmental and social dumping is being transformed into a more multi-dimensional competition where an agricultural enterprise's success is measured not only by its profitability but also by its accomplishment of social and environmental goals. While there is still demand for innovations that boost productivity and resource efficiency, growth that harms the health of humankind and nature is no longer considered acceptable.

The Response-Inducing Sustainability Evaluation (RISE) is an indicator-based methodology for the holistic assessment of agricultural production at farm level. The goal of RISE is to contribute to the dissemination and consolidation of the philosophy and practice of sustainable production. The target group of RISE comprises all the stakeholders in agriculture, society and business who share this vision. The use of RISE makes it easier to measure, understand and implement the vision of sustainable development. RISE quantifies and evaluates the farm's contribution to sustainable development, as well as the extent to which its production system complies with the principle of sustainability.

If land use is to become more sustainable, then practitioners need to acquire a common understanding of sustainable agriculture. Moreover, farmers must be motivated and supported in finding an approach that is suitable for their own farm. While control mechanisms may be necessary, they should not suppress farmers' self-motivation and creativity (Ostrom et al., 2007). Accordingly, rather than being a control or enforcement tool, RISE serves to holistically determine a farm's situation, providing a voluntary record of its performance. On the farm, as well as in training, consultancy and development programs, RISE aims to help make sustainable development a vision that can be implemented by farmers all over the world. RISE 3.0 provides a goal-oriented, individual assessment, since every farm can contribute to sustainable development in its own way (von Wirén-Lehr, 2001). RISE does not provide universal solutions, since these are not possible for complex and diverse socio-ecological systems like farms (Ostrom et al., 2007). RISE forgoes making a non-verifiable statement (Popper, 1935) about whether or not a farm operates sustainably, opting instead to determine the farm's position on the continuum between "optimal" and "unacceptable" for all the key spheres of activity. The RISE assessment is based on state-of-the-art knowledge concerning the environmental, economic and social impacts of agricultural production systems. It should always be interpreted against the backdrop of the farm's specific circumstances.

1.2 How was RISE developed?

RISE's development was triggered in 1999 by a request from a Brazilian farming business to what was then known as the Swiss College of Agriculture (SCA, former name of HAFL). The farmer wanted to scientifically record, evaluate and document the environmental and social performance of his business. Since no internationally applicable methodologies for assessing sustainability in agriculture existed at that time, RISE 0.0 was developed and used in a number of different projects. Version 1.0 was launched in 2004 (Häni et al., 2008a), followed by RISE 2.0 in 2011 and RISE 3.0 in 2015. Since the first assessments were carried out, RISE has been used by well over 2,000 farms in several different countries (Fig. 1). HAFL has continued to develop the RISE methodology with the cooperation and support of Nestlé, the GEBERT RÜF Foundation, the Research Institute of Organic Agriculture (FiBL), Syngenta, the Swiss Federal Office for Agriculture (BLW), the German Gesellschaft für Internationale Zusammenarbeit (GIZ), the German Federal Office for Agriculture and Food, Bioland Beratung GmbH and numerous other partners. The development and application of RISE have been the subject of more than 50 student projects, ranging from semester projects to PhD theses. The 2006 INFASA Symposium in Bern (Häni et al., 2008b) constituted a milestone on the way to establishing an international community of researchers working on holistic farm analysis.

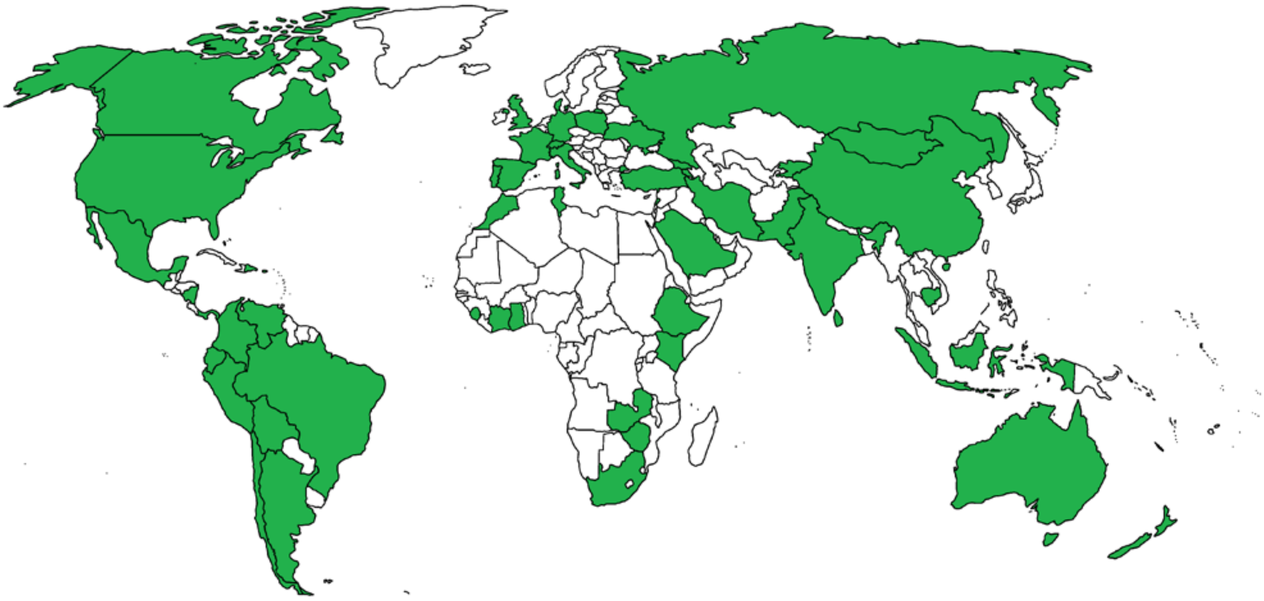


Figure 1. Countries (in green) where RISE was used on more than 2,400 farms between 2000 and 2015.

In the summer of 2008, an external evaluation was commissioned in which representatives of the authorities, science, agriculture and industry were asked about their expectations of RISE. Furthermore, RISE and two other indicator systems were assessed by the working group on "Farm evaluation systems" of Germany's KTBL (KTBL, 2009). Two consultations followed in 2009, during which experts discussed RISE 1.0 and suggested improvements. RISE 2.0 was developed between 2009 and 2011 with the support of the GEBERT RÜF Foundation. In 2010, a cross-comparison was carried out of the range of topics included in RISE compared to other indicator systems (OECD, 2004; GRI, 2006; ILO, 2008; Breitschuh et al., 2008; Zahm et al., 2008; Meul et al., 2008; Pretty et al., 2008; Hülsbergen, 2009). In RISE 2.0, the interpretation of sustainable development (SD) is in line with the definitions of the World Commission on Environment and Development (WCED, 1987) and Chapter 14 of Agenda 21[1] (UN, 1992). The overarching paradigm of SD is transformed into concrete principles and broken down into theme and indicator targets that were developed with reference to international agreements and

[1] "Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it (...) the concept of 'needs', in particular the essential needs of the world's poor (...) and the idea of limitations imposed (...) on the environment's ability to meet present and future needs." (www.un-documents.net/wced-ocf.htm)

standards. The move to RISE 3.0 in 2015 involved revising the content of most of the RISE themes based on feedback from extension agents and experts and academic research. Most importantly, it also involved the introduction of a more flexible set of topics and indicators. In addition to this greater flexibility, we have opened up RISE so that what has hitherto been a largely static methodology can become a set of sustainable agriculture indicators to which RISE network partners can contribute directly themselves.

1.3 Background and Motivation

Agriculture is not only the most important source of food for humankind. The sector also employs more than 1.3 billion people on more than 500 million farms and manages more than one third of the Earth's surface (FAOSTAT, 2009). Farmers are thus the custodians of much of our planet's usable land.

Farmers across many of the world's regions have been protecting land, water, forests and other resources for many years and continue to do so to this day. They have thus often developed well thought-out regulatory systems that enjoy the support of the local community (Ostrom et al., 2007). At the dawn of the modern age, European foresters started to become aware of the need to maintain and manage the productive potential of forests in order to prevent shortages of good quality wood, a principle that would be formally described as "sustainability" in the 18th century (Radkau, 2000; Grober, 2010). In contrast to this, the idea that farms should be managed solely according to economic principles became popular in agriculture from the 19th century onwards. At the same time, people started harnessing the growing potential of coal- and oil-fueled machines, selective crop and livestock breeding, irrigation, chemical plant protection and mineral fertilization. This approach brought great successes: life expectancy, literacy, income and food supply (Fig. 2), water, sanitation and infrastructure have all reached high levels in most regions of the globe and for most people (see e.g. Human Development Report/UNDP, State of Food and Agriculture/FAO, State of Food Insecurity in the World/FAO, World Development Report/World Bank).

This development is now in danger of reaching its natural and social limits. Global agricultural area has stagnated since 1993, despite the global population's continued growth (Fig. 3). It is true that the number of malnourished people as a percentage of the global population has declined, as has their absolute number, from 1.025 billion in 1994 to 805 million in 2014 (SOFI, 2014). However, the world population is expected to stabilize at around 9 billion by 2050, 34% more than in 2010. Due to urbanization and increasing affluence, food production will by that time need to have increased by 70% compared to 2000 levels, from 2.1 to 3 billion tons of grain and from 270 to 470 million tons of meat annually (Tilman et al., 2002; FAO, 2009).

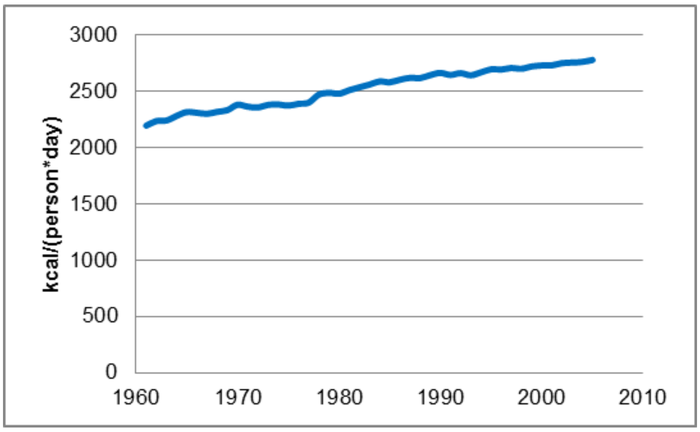


Figure 2. Development of the mean global per capita caloric provision originating from the agricultural sector. 2,500 kcal/day (and 75 g of protein) should suffice for an adult (data: FAOSTAT, 2009).

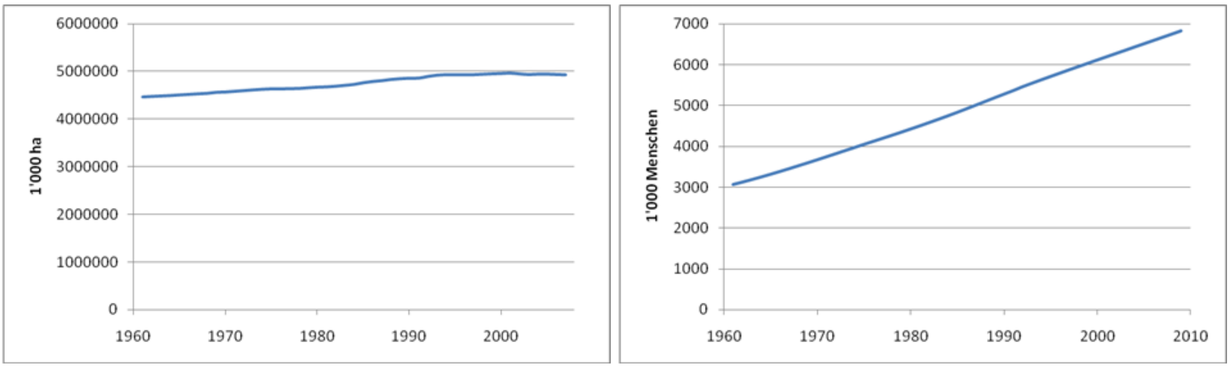


Figure 3. Development of global agricultural area (left) and world population (right) (data: FAOSTAT, 2009).

Due to the natural limitations on agricultural productivity and market structures that are unfavorable to farmers, hourly wages for agricultural workers are lower than in other sectors. Common responses to this situation include increasing productivity and thus decreasing unit costs through mechanization and increasing the size the farm (known as the "get big or get out" approach; Binswanger, 2009), sacrificing the needs of the farmer and their family and living off the farmer's equity (ART, 2007). The "agricultural treadmill" supplies society with cheap food but this success comes at the cost of social and economic problems within the agricultural sector, as well as wider environmental problems. Overuse of natural resources causes water scarcity and pollution, species and habitat loss, soil degradation and nutrient cycle disturbances. Fossil-based, energy-intensive production (IPCC 2007) and the expansion of agricultural area are reaching their natural limits (Tilman et al., 2002; WDR, 2008).

The realization that it is not only agricultural businesses that are being run in an increasingly unbalanced and short-sighted manner led to the understanding that economic and social development requires a more holistic development paradigm. The forestry term "sustainability" was discovered by politicians and developed into the principle of "sustainable development" (WCED, 1987). In 1992, this principle was adopted by representatives of 178 governments in the Rio Declaration and Agenda 21. Agenda 21 *"reflects a global consensus and political commitment at the highest level on development and environment cooperation"*. In Chapter 14 of Agenda 21, a sustainable increase in food production and improved food security are identified as the main goals of sustainable land use (UN, 1992). It is our intention that RISE should contribute to the achievement of these goals.

1.4 How is "sustainable development" interpreted in RISE?

An unambiguous definition of sustainable development and its translation into goals that can be implemented in practice are the foundations of any sound sustainability evaluation (von Wirén-Lehr, 2001). In RISE, this evaluation is achieved by comparing data collected on all the farm's spheres of activity against benchmarks derived from the definition of sustainability. Spheres of activity, sustainability goals, benchmarks and scoring functions constitute the building blocks of the RISE sustainability evaluation.

The vision of RISE is to contribute to sustainable development as defined by WCED (1987), i.e. a *"development which meets the needs of the present without compromising the ability of future generations to meet their own needs"*. Two notions central to this definition are (1) the limited carrying capacity of ecosystems and (2) the priority of meeting people's basic needs (UN, 1992). In RISE, "sustainable development" is interpreted from an anthropocentric, dynamic and holistic perspective in line with the "sensible sustainability" approach, and is recorded and assessed at the individual farm level.

Anthropocentric: The term "needs" primarily refers to basic needs. Once these needs have been met, everybody should have the opportunity to "satisfy their desire for a better life". Sustainable development is an anthropocentric concept centered on meeting the needs of present and future generations (Jörissen et al., 1999).

Dynamic: In keeping with the *development* component of the term "sustainable development", RISE adopts a dynamic approach. Rather than simply preserving certain goods and balances, it is also necessary to make sure that alternative strategies are in place and to make the most of development potential (Luks, 2002). Accordingly, RISE records and assesses developments and trends as well as the farm's current situation.

Holistic: While the sustainable development paradigm encompasses the economic, social and environmental dimensions, RISE is based on a holistic understanding of sustainability in which no separate dimensions are distinguished. The RISE indicator set is based on the following model: to meet the needs of the people on the farm (social), the farm uses human (social), financial (economic) and natural (environmental) resources to produce goods and services (economic), as well as emissions and waste (environmental). This model resembles the DFID "Sustainable Livelihoods Approach" (Fig. 4).

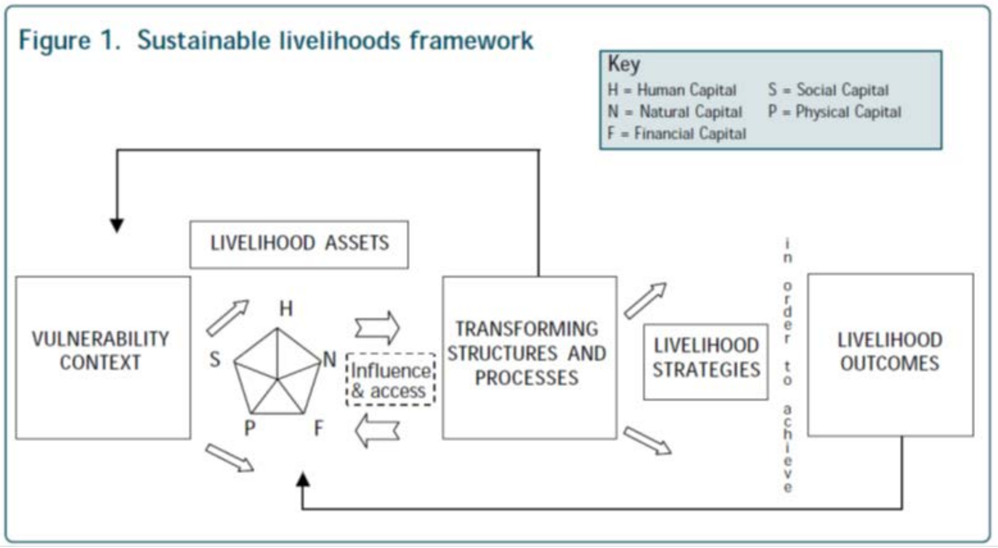


Figure 4. Interaction of capital stocks, context and strategies for livelihood creation. "Transforming structures" include the political and market environments (DFID, 1999).

Sensible sustainability: On a spectrum ranging from strong to weak sustainability or from full complementarity of natural and man-made resources to full substitutability of natural resources by man-made resources (Grunwald & Kopfmüller, 2006; Hediger, 2009), RISE adopts the middle position of "weak sustainability plus" as included in the Swiss Sustainability Strategy. This approach, which has also been described as "sensible sustainability" (Serageldin, 1996; ARE, 2008), argues that man-made capital can sustainably replace natural capital within certain well-defined boundaries.

RISE is intended to help make the paradigm of sustainable development easier to understand, measure and implement for individual farms. It records and assesses (1) the farm's contribution to sustainable global development and (2) the environmental, economic and social sustainability of production on the farm itself (i.e. the extent to which it contributes to the sustainable development of society). RISE makes it possible to establish where the farm is currently at in terms of all the relevant areas of sustainable development.

1.5 Postulates for Sustainable Development

Farm Management

1. Sustainable farm management involves managing a farm with the aim of maintaining and improving competitiveness in all areas (sales, procurement, personnel, finance). This is necessary in order to generate the profits that will secure the farm's long-term future. It is achieved through the efficient deployment of materials, personnel and capital and through the reduction of negative impacts and the promotion of positive impacts on society and the environment, based on an acceptance of the farm's responsibility towards man and nature.

Environment

To secure a natural environment that is conducive to human health and well-being (Hauff 1987) and to meet the paradigm of sensible sustainability, resource use on the farm must comply with the following ecological principles of sustainable development (expanded criteria based on Pearce & Turner, 1990; Daly, 1990; Enquête-Kommission, 1998; ARE, 2008; BFS, 2011):

2. Natural resources should be preserved and any existing damage repaired.
3. The consumption rate of renewable resources must not exceed their respective renewal rates.
4. Non-renewable resources should only be used if they are replaced by equivalent renewable resources and if higher resource productivity is delivered.
5. The input of substances into the environment should not exceed its absorptive capacity and resilience and should not pose a threat to human health.
6. The productivity and resilience of production systems should be maintained and enhanced.
7. Animals should be kept in a species-appropriate manner.

Economy

Economic activity involves the use of labor, land and capital to produce goods and services that meet peoples' material needs (Jörissen et al., 1999). It is thus directly linked to the fulfillment of needs as defined by the WCED (1987). Sustainable economic activity means that people's economic situation enables them to live with dignity. Their economic situation can be recorded in terms of solvency, stability and profitability (based on WCED 1987; Heissenhuber, 2000).

8. The farm enterprise must be capable of paying all its debts on time.
9. The cost-benefit ratio should make it possible to pay the people on the farm a wage that allows them to meet their basic needs and satisfy their desire for a good life. This entails the ability to invest in their own future and the future of the farm.
10. The farm enterprise must be able to remain solvent and profitable even in the event of unforeseen threats.

Man and Society

In the social domain, it is necessary to distinguish between the societal and individual levels. On a farm, the individual level features more prominently, since the main purpose of the business is to meet the individual needs of the people who live and work there. Binding social goals are prescribed by treaties and agreements governing nations and businesses, for example the Universal Declaration of Human Rights (UN, 1948) and the ILO guidelines on decent work (2008). The RISE postulates for human well-being that are key to social sustainability are as follows (UN, 1948; UN, 1992; SKOS, 2005; ARE, 2008):

11. The workload of the people working on the farm should not jeopardize their mental, physical and social health.
12. The standard of living enjoyed by workers and their families should guarantee their health and well-being, including food, water, clothing, housing, healthcare and essential social services.
13. Access to resources and education as well as unrestricted freedom to participate in economic and social life must be guaranteed.
14. All persons should be able to independently choose how they live and work and to implement this choice.
15. Protection against poverty must be guaranteed in the event of unemployment, illness, invalidity or loss of a spouse, during old age and in the event of any other loss of means of subsistence.
16. All of these conditions are applicable regardless of gender, age, religion, nationality, skin complexion and personal preferences or convictions.

1.6 What is Sustainable Agriculture?

At the farm level, “sustainable agriculture” means that (1) the farm contributes to sustainable global development and (2) the WCED sustainability postulate (1987) is met for the people making a living from the farm both now and in the future. The FAO (1991) describes “sustainable agriculture and rural development” as follows:

"It ensures that the basic qualitative and quantitative nutritional requirements of present and future generations are met while providing a number of other agricultural products;

- provides durable employment, sufficient income, and decent living and working conditions for all those engaged in agricultural production;

- maintains and, where possible, enhances the productive capacity of the natural resource base as a whole, and the regenerative capacity of renewable resources, without disrupting the functioning of basic ecological cycles and natural balances or destroying the socio-cultural attributes of rural communities, and

- reduces the vulnerability of the agricultural sector to adverse natural and socioeconomic factors and other risks, and strengthens self-reliance.”

A sustainable production system is extremely resilient, i.e. it can withstand disturbances such as droughts, storms or sudden price crashes (Walker et al., 2004). A system’s resilience is determined by its buffering capacity (soil organic matter content, owner’s equity and credit limit, social network) and its diversity (diverse crops, livestock breeds, products, suppliers, customers, landscape structures).

RISE’s definition of an ideal farm

The farm produces food, feed and other agricultural products and services in line with public and trade demand and in keeping with its potential as determined by the local climate, soils and socio-economic conditions. It creates and maintains an environmental, economic and social buffering capacity and maintains or increases the productivity of its natural, financial and human capital.

Non-renewable resources are only used if a physically and functionally equivalent renewable replacement can be made available and demand for non-renewables can be reduced through higher efficiency and lower resource intensity. The indirect use of non-renewable resources is steadily reduced. Soil and water use does not exceed their regeneration rate or irreversibly compromise their quality as a resource and habitat. Nutrient cycles are kept tight. The farm management employs knowledge and technology to improve resource efficiency. Production inputs are used as extensively as possible and only as intensively as is necessary. The farm’s production system helps to protect and promote the diversity and functionality of its ecosystems. No harmful substances are released into the soil, water or atmosphere in quantities that exceed their carrying capacity and resilience or that could pose a threat to human health. Indirect pollutant emissions are steadily reduced.

Livestock are kept in conditions that promote their health, meet their physiological requirements and, as far as possible, allow them to behave in a breed- and species-appropriate manner.

The people working on the farm are provided with decent and healthy working conditions that respect their human rights. This includes fair pay and treatment regardless of gender, age, religion, nationality, skin complexion or personal convictions. As long as they comply with the relevant safety and sustainability requirements, all people working on the farm are free to choose how they live and work. The farm environment provides everyone who works there with access to resources, education and participation in economic and social life. The wages paid allow the people on the farm and their families to enjoy a standard of living that guarantees their mental and physical health and well-being, including food, water, clothing, healthcare and essential social services.

The farm yields a revenue that allows the owner to pay their debts on time and invest in replacement or new sustainable production and farm management systems. The farm is buffered against natural and socio-economic turbulence. Its survival does not depend on single suppliers, customers, products or government subsidies. The farm and its people are protected through a network of formal and informal mechanisms.

2. The RISE Themes: Aspects of Sustainable Agriculture

The aspects that determine the sustainability of agricultural development and the goals for these aspects have been set out in Agenda 21, by the FAO (1991), in national sustainability strategies (e.g. ARE, 2008), in the development of different indicator systems and in a number of scientific publications.

Table 1. The 10 Themes and 46 indicators of RISE 3.0 (standard versions).

Topics	Indicators
Soil use	• Soil management • Crop productivity • Soil organic matter • Soil reaction • Soil erosion • Soil compaction
Animal husbandry	• Herd management • Livestock productivity • Opportunity for species-appropriate behavior • Living conditions • Animal health
Material use & environmental protection	• Material flows • Fertilization • Plant protection • Air pollution • Soil and water pollution
Water use	• Water management • Water supply • Water use intensity • Irrigation
Energy & Climate	• Energy management • Energy intensity • Greenhouse gas balance
Biodiversity	• Biodiversity management • Ecological infrastructures • Intensity of agricultural production • Distribution of ecological infrastructures • Diversity of agricultural production
Working conditions	• Personnel management • Working hours • Safety at work • Wage and income level
Quality of life	• Occupation and training • Financial situation • Social relations • Personal freedom and values • Health
Economic viability	• Liquidity • Stability • Profitability • Indebtedness • Livelihood security
Farm management	• Business goals, strategy and implementation • Availability of information • Risk management • Sustainable relationships

When selecting indicator topics, it is necessary to ensure coverage of the topics that are important to the public, government and academia. Farmers and extension agents must also be provided with new and relevant information that can be translated into sustainable farm development. The most important quality criteria for selecting the RISE topics and indicators are theoretical and practical relevance, cost-benefit ratio, methodological soundness and transparency (Pannell & Glenn, 2000; Christen & Halloran-Wietholtz, 2002; Isermeyer & Nieberg, 2003).

During the development of RISE 2.0, a cross-comparison of the indicator set was made against the following sources: Agenda 21 (UN, 1992); OECD (2003); Bylin et al (2004); GRI (2006); MOTIFS (Meul et al., 2008), KSNL (Breitschuh et al., 2008), Unilever (Pretty et al., 2008), ILO (2008), IDEA (Zahm et al., 2008), RISE expert consultation (2009), REPRO (Christen et al., 2009), SAFA (FAO, 2013). Table 1 shows the standard set of indicators used in RISE 3.0.

Selection of theme and indicator options

All of the questionnaires entered into the RISE database are assigned to a farm, and this farm is in turn clearly assigned to a project and a region. Users are also assigned to projects. This ensures that users have access to all the questionnaires in their project, but do not have access to user questionnaires from other projects.

Version 3.0 of RISE now has a flexible indicator set, in order to better reflect the diversity of production conditions in the agricultural sector and the different requirements of its users. Although the 10 RISE themes are fixed and all of them must be included in the analysis, the way that this is done (and in particular the level of detail) can be varied. This means that the use of indicators in RISE is now structured in accordance with the principles of the FAO's SAFA guidelines (2013).

The flexible configuration of the indicator set is initially carried out at project level, where the project administrator can enable different topic options for each of the 10 RISE themes, so that they can be used in the project in question. A topic option contains a set of carefully aligned indicators that can also have different algorithm options. The RISE extension agents collecting farm data for this project can then select from among the enabled theme options. They may also choose qualitative options for some of the RISE indicators – these act as a "shortcut" for reducing the workload associated with indicators that the extension agents and farmers consider to be of limited relevance. RISE 3.0 offers the following options for adapting the indicator set to the needs of the extension agents and farmers:

- Theme sets are defined at the topic level. Each theme has at least one set, i.e. the standard theme set for RISE 3.0. For themes that have undergone a major revision since RISE 2.0, the old theme set from the previous version of the software continues to be available (this allows long-term comparisons on previously assessed farms). There are some significant differences between the RISE 2.0 and RISE 3.0 indicator sets – the indicators in the most recent version are not always an exact thematic match for those in the previous version.
- Algorithm options are defined at the indicator level. Each indicator has at least one algorithm option. The principal difference between the options concerns their level of detail. The available options range from purely qualitative sets of questions to detailed quantitative calculations.

Indicator and theme calculations

The farm data is compared against the benchmark data and normalized to a scale from 0 to 100 using a scoring function. 100 points represents an optimal result (a completely sustainable way of doing things), whereas 0 represents an unacceptable situation. In some instances, it is necessary to combine farm data and standard data, for example animal nutrient excretion is calculated using the average value for the animal category in question (benchmark data) together with the type and number of animals (farm data). The scores resulting from the normalization to this scale are referred to as indicator scores. A theme score is calculated using the arithmetic mean of several indicator scores, with all indicators being given equal weighting. All evaluated data are given a "traffic light" color code: red indicates problems, yellow means that further attention is recommended and green indicates good performance (Fig. 5).

Figure 5. Scores and color codes used in RISE. In this example, the farm has a score of 70 points and is thus rated as being on track to achieve sustainability for this theme.

The highest aggregation level for RISE results is the sustainability polygon, which shows the degree of sustainability for all the different topics at a glance (Fig. 6). As is the case with all indicator systems of this type – and in particular due to the diversity of agricultural production conditions and the aim of providing a globally applicable system – the benchmark data and scoring functions in RISE will never be able to meet the sustainable development requirements of all stakeholders equally well (Pretty et al., 2008), nor will they all be universally valid. Accordingly, they are partially adapted to regional conditions at the beginning of a project, e.g. by distinguishing between humid and arid climates. An interactive questionnaire is used for those benchmark values and weightings that can be influenced by the stakeholders themselves, thus responding to the demand for stakeholder involvement (Grunwald & Kopfmüller, 2006). This serves to mitigate the conflict between global applicability on the one hand and relevance to individual farms on the other (von Wirén-Lehr, 2001).

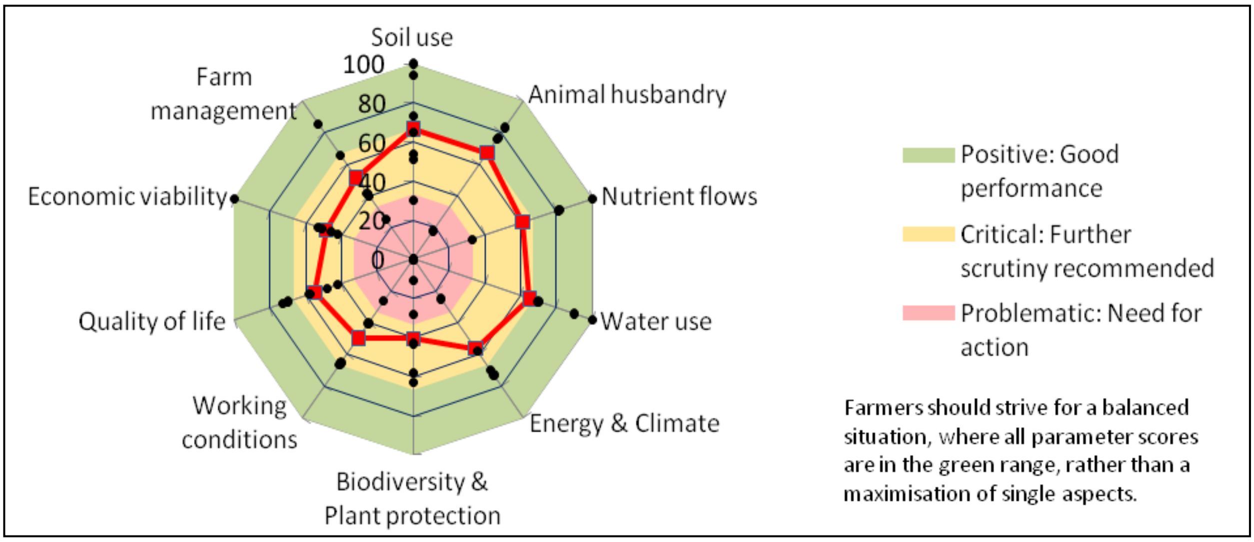


Figure 6. The RISE sustainability polygon (version from October, 2015).

3. The RISE Indicator Set

3.1 Theme: Soil Use (so)

“Prior to giving loans to farmers, bankers should in fact go out in their customers’ fields with a shovel. The soil and the number of earthworms would quickly show them how well the farm is being managed.”
Prof. Dr. Ludwig Volk, UAS South Westphalia

Theme

Fertile soils are a limited, easily degradable resource that is essential to both life and production. This topic reflects the state of the soil on the farm and how this state is affected by farming practices. The results for this topic answer the following questions for the farmer:

- How does the fertility of my soil rate?
- What impacts do my farming practices have on the fertility of my soil?

Relevance of the Theme

Soil is fundamental to virtually all life on the Earth’s continents, including human life. We use soil to grow food and fodder crops and renewable raw materials; it purifies our water; we use it to build on; we can obtain raw materials from it; it stores carbon and it acts as an archive of natural history (BMU, 2002). In ecosystems, it plays an indispensable role as a buffer, filter and habitat. Fertile soil provides plant roots with stable anchorage and a balanced supply of water, heat, air and nutrients, whilst at the same time preventing toxic accumulations of growth-inhibiting substances (Scheffer & Schachtschabel, 1989).

Soil fertility is determined by the quantity and quality of soil organic matter and clay minerals, texture and structure, soil pH and depth (Kuntze et al., 1994; Craswell & Lefroy, 2001; Table 2). While its quantity is hard to increase, fertile soil can be easily destroyed (European Soil Charter, 1972). On the majority of the global agricultural area, problem soils restrict plant growth (FAO, 2001). While these soils can often be improved, fertile soil can also be degraded. Although soil texture and clay mineral content are difficult to change in the short term, soil organic matter content can be modified within certain limits (Kuntze et al., 1994). Land use can have a more rapid impact on soil depth, structure, pH, nutrient content and pollutant content, and to some extent also on the quantity, diversity and activity of soil life (Candinas et al., 2002).

The point at which soil fertility is unacceptably impaired to the extent that its use has to be changed or ended cannot be universally defined for many soil properties, since the relationship between soil properties and fertility is affected e.g. by climatic conditions. For instance, sandy soils often provide a better water balance for plants than loamy soils in an arid climate, while the reverse is true for humid climates. Soil organic matter content is correlated with climatic humidity, but more organic matter does not automatically mean that soil fertility will also rise (Kuntze et al., 1994). Therefore, it is not possible to define optimal values for many soil properties. The figures in Table 3 serve as a rough guide.

According to Oldeman (1998), the productivity of global arable land and pastureland decreased by 13% and 4% respectively during the latter half of the 20th century. The most important soil degradation processes by surface area and impact are water erosion and wind erosion (Fig. 7), salinization, compaction and pollution (Oldeman et al., 1991; MEA, 2005). Soil sealing, soil organic matter loss, acidification, over-compaction and the formation or salt or metal oxide crusts are also problematic in some regions. Soil degradation causes problems off-site as well, including sedimentation and eutrophication of canals and waterbodies, dust emissions, flooding and emissions of greenhouse gases such as N_2O (Pimentel et al., 1995; MEA, 2005; van der Ploeg et al., 2006).

Table 2. Effect of soil properties on soil functions. 0 = massive modification of the property does not affect the function, 3 = massive modification of the property completely impairs the function (Candinas et al., 2002).

	SOIL FUNCTIONS													
	HABITAT				GENERAL ECOLOGY				BIODIVERSITY		AGRICULTURE		ECONOMY & SOCIETY	
SOIL PROPERTIES	Penetrable volume	Water storage	Gas exchange	Heat storage	pH buffer	storage	meta-bolism	filtra-tion	plants	soil organisms	crop growth	water balance	C sequestration	raw materials
Depth	3	3	0	3	3	3	1	3	0	0	3	3	2	3
Structure	3	3	3	2	0	1	2	3	0	0.5	3	3	2	0
Stability	2	2	2	2	0	0	1	1	0	0	2	2	1	0
Soil biodiversity	0	0	0	0	0	1	3	0	0	3	0	0	1	0
Biological activity	0	0	0	0	1	0	3	0	0	0	2	0	2	0
Soil organic C	1	2	1	2	1.5	2	1	1	0	2	2	2	2	0
Soil reaction	0	0	0	0	3	2	3	0	0	2	2	0	1	0
Storage capacity	0	0	0	0	2	2	1	0	0	0	1	0	0	0
Nutrients	0	0	0		0	0	1	0	3	0.5	3	0	0	0
Pollutant	0	0	0	0	0	0	2	0	2	1.5	2	0	2	0.5

Table 3. Value ranges of important soil properties.

Soil property	Measurement	Range	Optimum range	Problem range
Porosity	Total pore volume (TPV) as % of total soil volume (SV)	30 (compacted boulder clay) to 60 (Chernozem) or 80-90 (Andosol, raised bog) [1, 5]	45-50 [5, 6]	
Air capacity	Large pore volume (> 50 mm) as % of SV	<3 to >15	15 [3]	<3 [3] or <5 [8]
Bulk density	g/cm³	0.3 (waterlogged Andosol) to 2 (Durisol) [1], [2]		Compaction of >0.1 compared to optimum
Soil depth	Depth of root-penetrable soil in cm	<10 cm (Leptosol) to >1 m (Chernozem) [1]	>70 (deep)	<30 (shallow)
Soil reaction	pH value	3.0 (acidic sulfate soil) to >9.5 (Vertisol, Durisol, saline soil) [2]	Mineral soils: 5.5 (sand) to 7.0 (clay), or 6.5 to 7.2 [3, 4, 5]	<5.0 [5] and >8.0 [3]
Soil organic matter content	Organic matter by volume (%)	0 (sand) to 98 (raised bog). Arable soils: ca. 0.5 (Arenosol) to 10 (Chernozem) or 30 (Andosol) [1, 2]	No definite value.	>1 [7]
Erosion	Eroded soil in t per ha per year	0 to >30 [2]	0 [3]	>1 to 10 (depending on depth) [3]

Sources: [1]FAO (2001), [2]Kuntze et al. (1994), [3]Candinas et al. (2002), [4]VDLUFA (2004), [5]Scheffer & Schachtschabel (1989), [6]van der Ploeg et al. (2006), [7]Kolbe (2008), [8] Brunotte et al. (2008).

Figure 7. Water erosion: minor hillside slide in the Entlebuch region of Switzerland (left); erosion gullies in Ethiopia (right) (Photos: left Jan Grenz, right Christian Thalmann).

Indicator so_1: Soil Management

Sustainability goal

Knowledge and technology are actively employed to facilitate productive, site-adapted and soil-conserving soil use.

Content

An assessment is made of whether soil analyses, nutrient and soil organic matter balances and changes in soil C content are calculated and taken into account, and whether any agricultural area has been lost in the last ten years.

Scoring

100 points are awarded if all the relevant analyses are performed and no agricultural area has been lost.

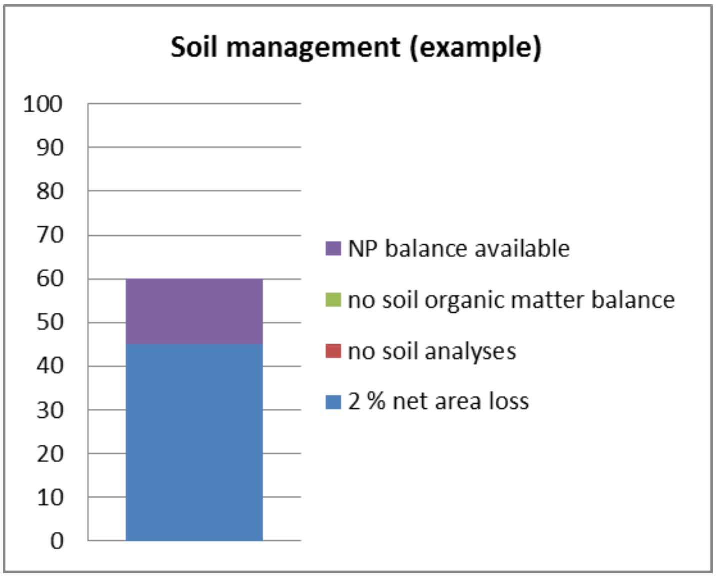


Figure 8. Example calculation of indicator so_1. The vertical axis shows the RISE score.

Explanation

Since soil forms the basis of almost all forms of agricultural production, good soil management is a key component of sustainable agriculture. This requires knowledge of and access to up-to-date information on soil fertility. Government and private sector monitoring systems such as those found in Switzerland, the EU and throughout the organic farming industry also adopt a knowledge-based, competent approach to soil management. This requires e.g. regular chemical soil analyses or the calculation of soil organic matter balances.

Indicator so_2: Crop Productivity

Sustainability goal

Through appropriate yields per unit area, the farm contributes in terms of both quantity and quality to satisfying the demand for agricultural products and ensures its own economic competitiveness.

Content

Yields per unit area of all crops grown on the farm are compared to the regional benchmarks for very high, average and very low yields. In addition, product quality is evaluated based on regional or farm-specific criteria.

Scoring

The three benchmark yields are equivalent to 100 RISE points (= very high yield), 67 RISE points (average yield for the region) and 34 RISE points (low yield), with 0 RISE points awarded for no yield, +/- a 20-point correction for product quality. Linear interpolation is used to fill in the gaps between the three defined points.

Explanation

The main purpose of agriculture is the production of food and raw materials. It produces 95% of the protein and 99% of the dietary energy consumed by humankind (WRI, 2000). The UN estimates that the global population will rise to somewhere between 7.8 and 11.9 billion by 2050 (UN, 2007). Changes in income levels and consumption habits mean that demand for agricultural products is set to grow even more rapidly than the global population. Chapter 14 of Agenda 21 calls for a sustainable increase of food production and for improved food security as the overarching goals of sustainable agriculture and rural development (UN, 1992). To calculate this indicator, all the crops on the farm and their main products are considered and weighted by the area on which they are grown. The scoring function takes account of regional yield variability, since yield can differ significantly between regions and crops, making a standard scoring system unsuitable. The way in which quality is defined also varies between different crops, regions and farm types. Consequently, a quality criterion (fat content, price, protein content, etc.) is defined for each crop at regional level, but can then be adapted at the level of the individual farm.

Indicator so_3: Soil Organic Matter

Sustainability goal

The arable soil on the farm is well supplied with organic matter, ensuring that the soil organic matter content in the topsoil at least remains stable.

Content

Either the arable soil organic matter content is directly evaluated or a simple soil organic matter balance is calculated and evaluated based on rotation and farming practices.

Scoring

In the interests of simplicity, RISE assumes a high and stable soil organic matter content for permanent grassland, permanent crops and woodland (Kuntze et al., 1994). There are two options for evaluating the situation on arable land (mineral soil). If reliable analysis data is available, the topsoil organic matter content is evaluated based on altitude and soil type. The benchmark data was provided by a comprehensive analysis of Bavarian farms (Capriel, 2010), although it is not valid for peaty soils and chernozems. If robust data is not available, a simple soil organic matter balance is calculated and evaluated, with a distinction being drawn between organic and conventional farms. The coefficients for the soil organic matter balance are taken from the STAND "site-adapted method" (Kolbe, 2008). The goal is a stable soil organic matter content capable of ensuring an adequate nutrient supply whilst preventing nutrient inefficiency and high greenhouse gas emissions (Kolbe, 2012). The scoring functions of both the procedures used in RISE are only valid for the temperate climate zone. For areas outside of this zone, RISE uses coefficients that have not yet been scientifically validated.

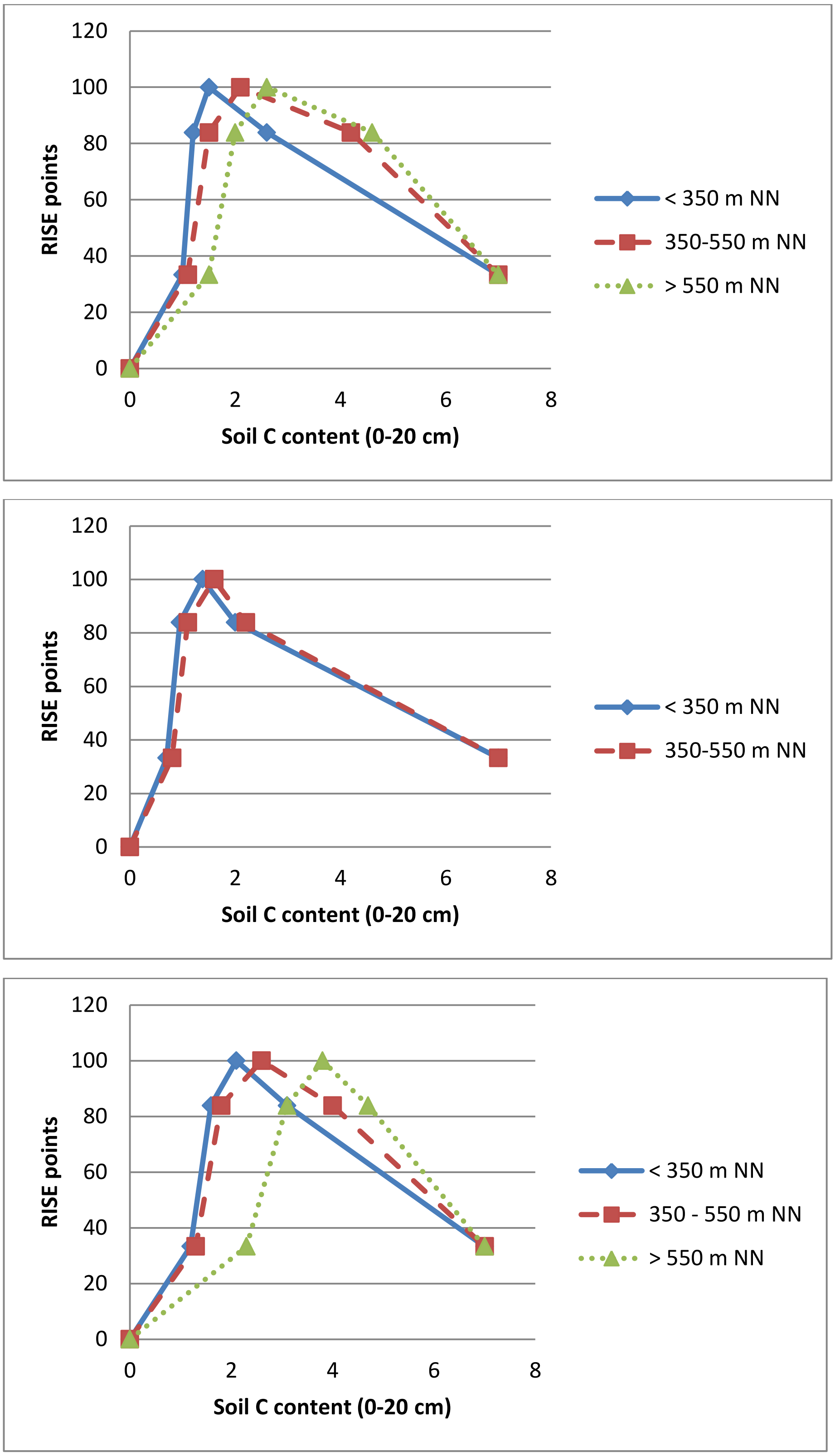
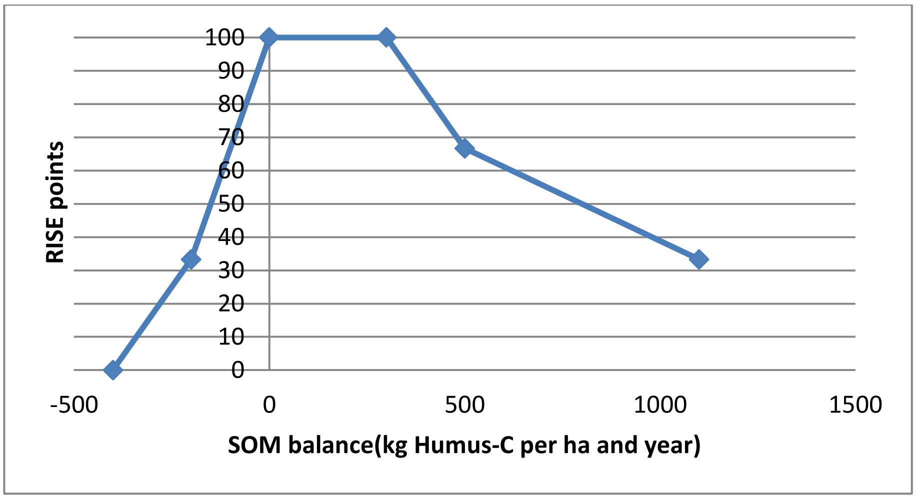


Figure 9. Evaluation of the topsoil organic matter content of arable land with sandy (top), clayey-loamy (center) and sandy-loamy (bottom) granularity. The assessment is based on the data in Capriel (2010). There is hardly any sandy soil in Central Europe at heights of more than 550 m above sea level.



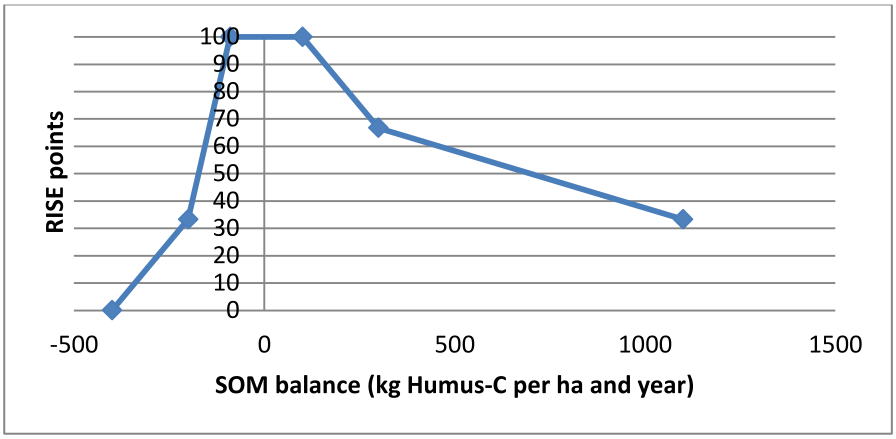


Figure 10. Evaluation of the soil organic matter balance of (mineral) arable land on organic farms (above) and "conventional" farms (below). Evaluation by supply category as per Kolbe (2008) and Kolbe (2015, personal comment).

Explanation

The quantity and quality of soil organic carbon affects the soil's biological and physical properties and in particular its filter and buffer properties (Kuntze et al., 1994; Candinas et al., 2002; Brock et al., 2008). Soil organic matter (SOM) content is influenced by the quantity and quality of any biomass that has been added to or left on the soil, site conditions (climate and soil) and tillage. A SOM balance can be calculated to provide a rough estimate of the organic matter supply based on location and management details (e.g. Kolbe 2012). Negative SOM balances should be avoided, since they result in a loss of soil organic matter. Excessively high SOM balances cause leaching and gaseous emissions that are harmful to the environment. However, the SOM balance does not in itself allow future soil organic matter content to be predicted. The heterogeneity of organic materials, plant productivity and soil and climate conditions means that significant errors can easily be made in the calculations for individual farms (Holenstein, 2010; Kolbe, 2012). Furthermore, SOM quality is very hard to estimate. Provided that reliable data is available, an evaluation of actual SOM content is clearly preferable to a SOM balance for farms in temperate regions. No proven calculation methods are available for areas with a tropical or subtropical climate (personal comment A. Gattinger/FibL, R. Oberholzer/ART). This also holds true also for carbon (C) accounting in the Clean Development Mechanism (www.v-c-s.org/afl.html).

If crop residues are removed or burned, the crop harvest index and the harvest residues' SOM coefficient are used to calculate how much soil organic matter carbon has been lost. The use of soil carbon simulation models that take additional site factors into account is recommended for a more in-depth analysis. Examples of such models include Roth-C (Smith et al., 1997; Holenstein, 2010) and SIMEOS-AMG (Saffih-Hdadi and Mary, 2008).

Indicator so_4: Soil Reaction

Sustainability goal

Soil reaction is within the optimal range for crop growth; soil use causes neither salinization nor acidification beyond this range.

Content

Soil pH is evaluated in terms of crop requirements and the risk of salinization or acidification is assessed (Fig. 11).

Scoring

Soil acidification and salinization are evaluated by a single indicator in RISE, since both are associated with soil pH. 100 points are awarded if all the soil on a farm has a pH of between 5.5 and 7.0. Points are deducted for higher or lower pH values. Further points are deducted if acidic fertilizers are used without the soil being properly limed. 25 points are deducted if more than 100 kg/ha per year (fertilizer quantity) of physiologically acidic fertilizers (e.g. urea, ammonium sulfate) are applied. In arid climates, adequate soil drainage is essential and soil pH should not exceed 7.0.

Explanation

Most plants require a soil reaction of between pH 5.5 and pH 7.0 for optimal nutrient uptake. At pH values below 5.0, mineralization is inhibited, the availability of toxic metal ions such as Al^{3+} increases and the availability of alkaline nutrients declines. Once soil pH rises significantly above 7.0, soil biological activity falls and the availability of metallic nutrients and phosphates becomes problematic (Scheffer & Schachtschabel, 1989). Very high pH values generally occur in connection with high ion contents in the soil solution which make it difficult for plants to absorb water through osmosis. Low pH values and soil acidification are typical of areas with a humid climate, while alkaline soils and salinization are widespread in arid climates (Fig. 11).

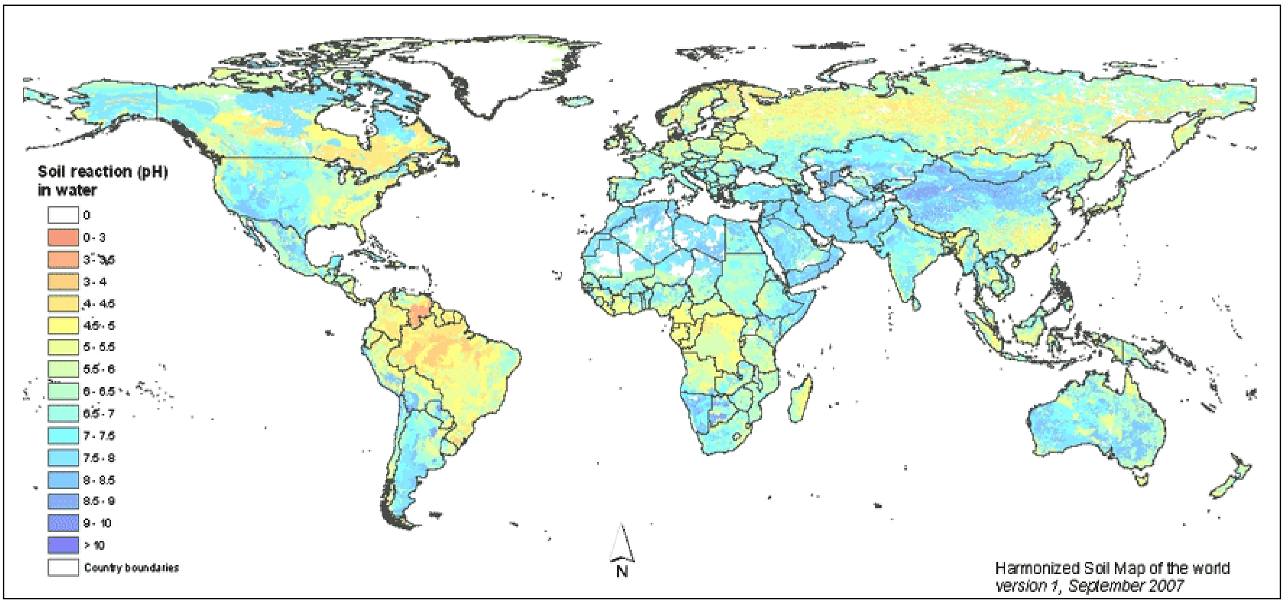


Figure 11. World map of topsoil pH values. Source: www.fao.org/nr/water/art/2008/soil_map5.html

Indicator so_5: Soil Erosion

Sustainability goal

The quantity of soil lost through water and wind erosion does not exceed tolerance levels even in the most threatened areas.

Content

Details are requested regarding the frequency and intensity of all erosion events to have occurred on the farm in the last 5 years. In addition, climate, slope gradients, soil type and cover and farming practices are used to calculate the risk of water and wind erosion for the highest-risk areas.

Scoring

100 points = no soil erosion observed; the risk of erosion does not exceed soil loss tolerance levels even in the highest-risk areas.

Explanation

The "soil erosion" indicator score is whichever is the lower out of the two scores for water and wind erosion. 50% of both the water and wind erosion scores is accounted for by an evaluation of observed erosion, while the remaining 50% is based on an evaluation of the erosion risk for the highest-risk area. Details are requested of observations during the last 5 years, including information about the frequency and intensity of erosion events.

Water erosion risk is only calculated if the farm makes use of areas with a slope gradient of more than 5% over a slope length of at least 15 meters. The risk of erosion is calculated using the American RUSLE method (Renard et al., 1997), which is an upgraded version of the Universal Soil Loss Equation (USLE, www.iwr.msu.edu/rusle; Wischmeyer & Smith, 1961). Rainfall erosivity is defined at regional level and can be obtained from maps (e.g. http://soils.usda.gov/use/worldsoils/mapindex). The steepest slope gradient is ascertained for the land used by each of the farm's different production systems. Soil cover during the period of maximum rainfall, the erodibility of each soil type (topsoil) and erosion prevention measures are also included in the evaluation. The evaluation system is based on RUSLE, while the soil loss tolerance level is derived from soil depth, as per the PC ABAG tool (www.lfl.bayern.de./appl/abag/web/). The standard value is 5 t per ha per year.

A similar approach is taken to calculating wind erosion. First of all, details are requested of erosion events during the last 5 years. If the farm has areas that are at risk from wind erosion due to exposure during periods when the soil is dry, the wind erosion risk is calculated for the highest-risk area. This is done using the method described in DIN 19706 (2002), where the input parameters are soil type, SOM content, average wind speed, soil cover (during the windiest period) and the presence, height and spacing of wind protection plants.

If the RISE results indicate a risk of erosion, it is recommended that a more detailed analysis should be carried out using established GIS-based methods such as PC-ABAG, AVErosion or WEPS. A 2x2 m map of erosion risk in Switzerland is available at http://www.agri-gis.admin.ch/?initialState=ERK&reset_session&lang=de. Erosion registers are also available for Germany's federal states.

Indicator so_6: Soil Compaction

Sustainability goal

Crop growth and soil life are not impaired by over-compaction of the subsoil.

Content

The risk of excessive soil compaction is assessed based on risk factors (wheel load, soil moisture, soil type, tillage) and protection factors (pressure reduction, improvement of soil stability).

Scoring

100 points = no over-compaction observed. Soil is neither vulnerable to compaction nor tilled; maximum wheel load is 2.5 t or less.

Explanation

Naturally formed soils are porous structures in which large pores (≥ 0.05 mm diameter) are important for aeration, drainage and root penetrability. If the pressure on the soil exceeds its inherent stability, this results in soil compaction and loss of large pore volume (van der Ploeg et al., 2006). Livestock usually only causes compaction of the topsoil (personal comment Matthias Stettler, SCA; Oberholzer et al., 2006). Soils containing more than 25 mass % of clay are particularly prone to compaction (AG Boden, 1994). Several methods have been developed to calculate soil compaction risk, including Terranimo (www.terranimo.ch), TASC (Diserens & Spiess, 2005) and SALCA-SQ (Oberholzer et al., 2006). In RISE 3.0, the risk of over-compaction is assessed by (i) directly requesting details of observed signs of compaction and (ii) by calculating a risk index that incorporates risk factors (machinery weight, clay content, soil moisture when driven on by machines, tillage) and protection factors.

3.2 Theme: Animal husbandry (ah)

"The greatness of a nation and its moral progress can be judged by the way its animals are treated." (Mahatma Gandhi)

Theme

Animal husbandry is an integral part of many agricultural production systems. Livestock should be kept in a manner that ensures their welfare and does not harm the environment. Animal welfare-friendly practices encompass the "five freedoms": freedom from hunger or thirst, freedom from discomfort, freedom from pain, injury or disease, freedom to express normal behavior, and freedom from fear and distress (FAWC, 1979). At the same time, high performance and resource efficiency should also be pursued. This topic provides an indication of:

- whether livestock performance is at a high level,
- whether the husbandry system allows for species-appropriate behavior,
- whether the physiological needs of the animals are met and
- whether the animals are healthy.

Relevance of the Topic

Animal husbandry is a part of most agricultural production systems. Globally, 1.7 billion cattle and buffalos, 2.2 billion sheep and goats, 1 billion pigs and 21.7 billion chickens were kept in 2013 (FAOSTAT, 2015). These animals are kept for meat, milk and wool production, as a "living piggy bank", or for sociocultural reasons (Sambraus, 1991). The value of manure in crop production is another traditional reason for keeping animals that remains important today (Radkau, 2002). In many parts of Asia, dung is also an important heating fuel (Fig. 12). Moreover, there are many areas around the world, for example the savannas of the Sahel, the Central Asian steppes and Europe's alpine meadows, where an adapted pasture management system is the only way of putting the land to agricultural use. Permanent grassland covers 68% of the global agricultural area (FAOSTAT, 2010). Livestock production also has considerable economic significance, accounting for 56% of agricultural production value in Switzerland in 2014 and 32% globally in 2012 (BFS, 2015; FAOSTAT, 2015).

Figure 12. Cow dung being dried for use as heating fuel. Inner Mongolia, China (Photo: Jan Grenz).

The intensification and spread of livestock farming that has been occurring in more and more parts of the world in recent decades has been the subject of criticism due to its environmental impact:

- 20% of all pastureland is affected by soil degradation (Steinfeld et al., 2006). Particularly in the tropics, large tracts of land are being deforested in order to create new pastureland.
- Long-distance transportation of animal feed causes nutrient excesses in the importing regions and soil degradation in the exporting regions (Pengue, 2005; Grenz et al., 2007).

- Livestock production is a major source of man-made ammonia and methane emissions. Livestock-related greenhouse gas emissions account for 18% of mankind's total greenhouse gas emissions (Steinfeld et al., 2006).

- Close to one third of global arable land is used to grow animal feed (Steinfeld et al., 2006). Since the bulk of the energy contained in the crops is lost during their "conversion" into meat, these areas contribute less to global food security than they would if they were used e.g. to grow cereals for making bread.

- The use of antibiotics, hormones, painkillers, anesthetics and antiparasitic drugs has the potential to harm the environment (Boxall et al., 2003). Up to 90% of all antibiotics used in livestock fattening are excreted in urine and manure. These drugs and their metabolites find their way into the soil and water via animal excreta (Kools et al., 2005; Sattelberger et al., 2005; Helmholtz-Zentrum, 2007). Some antibiotics are toxic to aquatic organisms (e.g. Daphnia), soil organisms and plants, although the concentrations measured to date are not considered likely to cause acute environmental problems. Of far greater concern is the evolution of antibiotic-resistant pathogens (Boxall et al., 2003; Stoob et al., 2005; Helmholtz-Zentrum, 2007).

In spite of the threats that it poses to the environment, livestock production plays an important role in sustainable agriculture as long as stocking densities are adapted to farm size, nutrients are kept in tight cycles and housing, feeding and breeding take animal welfare into account (Postler & Bapst, 2000).

As sentient creatures with their own dignity, animals are protected by law in many countries[2]. For both ethical and agronomic reasons (the performance of healthy animals is usually better), they should be kept in a manner that ensures their well-being. Livestock should be kept in conditions that take account of their natural needs. The basic animal welfare criteria include the following:

- avoidance of thirst, hunger and malnutrition,

- adequate comfort and shelter,

- avoidance of pain, injury and parasites; prompt treatment of diseases,

- the right to species-appropriate behavior and

- avoidance of fear, stress and distress (Bartussek, 1999).

In order to ensure their usability in the field, it is important to draw a precise distinction between the concepts of enabling species-appropriate behavior on the one hand and keeping animals in welfare-friendly conditions on the other. Species-appropriate systems are those where the animals can live as they would in the wild. Welfare-friendly systems are those that meet the animals' needs as domesticated animals that have been bred as livestock. For instance, while it is not species-appropriate to feed a cow (e.g. maize- and soy-based) concentrate, doing so is nonetheless conducive to the animal's welfare in the case of a high milk-yielding Holstein cow. Polled cattle have a lower individual distance than horned cattle, meaning that a somewhat higher stocking density does not harm their welfare, whereas it would be harmful to the welfare of horned cattle. Production methods like the battery farming of egg-laying hens – in which many natural behaviors such as scratching the ground are impossible – are incompatible with sustainable agriculture. Conversely, programs such as RAUS and BTS[3] that require animals to spend more time out of doors, for example, are fundamentally beneficial to animal welfare (Danuser, 2005). However, it is recommended that a multi-faceted approach should always be taken to the evaluation of livestock production systems.

Even a species-appropriate livestock production system may come into conflict with other aspects of sustainability. For example, ensuring continuous availability of water can increase water consumption, free-ranging animals produce higher ammonia emissions (KTBL, 2006) and welfare-friendly livestock production systems often involve increased workloads and costs. Nevertheless, resource use, workload and costs should not be minimized at the expense of animal welfare.

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[2] Animal rights are enshrined in the constitutions of Switzerland, Austria and Germany.

[3] RAUS = Regelmässiger AUSlauf im Freien = regular time spent outdoors; BTS = Besonders Tierfreundliche Stallhaltungssystem = Especially animal-friendly housing system. Both are voluntary animal husbandry programs in Switzerland (www.blw.admin.ch/themen/00006/00053/index.html?lang=de).

Scoring methods

It is not possible to measure animal welfare directly, nor can it be extrapolated solely from animal performance and health. Consequently, a number of different indicator systems have been developed with the aim of providing information about livestock welfare. The EU research project "Welfare Quality" assessed animal welfare by looking at the aspects of feeding, housing, health and species-appropriate behavior. It defined between 30 and 50 parameters for each of 7 different animal species. These were assigned to 12 animal welfare criteria which were in turn consolidated into 4 animal welfare principles (www.welfarequality.net). The recording and evaluation of animal welfare has also been the subject of studies by Bartussek ("Animal Welfare Index"; 2001), Whay et al. (2003), KTBL (2006) and Winckler (2006). Most of these evaluation methods use information on animal condition, husbandry system and/or animal behavior. Animal condition can be captured based on pathological symptoms and zootechnical interventions such as docking, polling and castration. Husbandry systems can be assessed on the basis of livestock performance, housing (light, space, temperature, etc.), feeding and herd management. For most species, rating animal behavior is a lengthy process and may not even be possible due to a lack of sufficient time to carry out long-term observations.

RISE's scoring system for animal husbandry is based on information provided by the farmer, as well as a brief tour of the animal housing facilities and pastures. It focuses on easily recordable indicators such as lighting and air quality in animal housing and livestock mortality and performance. The scoring functions are based on Postler & Bapst (2000), KTBL (2006), BVET (2009), Welfare Quality (2009a, b, c) and the German organic farming associations' animal welfare handbook (2013) (Table 4). The RISE analysis also provides a first impression of animal welfare on the farm, allowing this to be considered in the context of the farm's overall sustainability. A detailed analysis, especially of animal behavior, would require more time. Such detailed analyses are recommended if the RISE analysis reveals possible problems or room for improvement.

Table 4. Comparison of the RISE 3.0 "Animal husbandry" topic indicators and the criteria[4] used by four established systems for recording and evaluating animal welfare.

"Animal Welfare Handbook" (Bioland NRW, 2013)	"Animal Needs Index 35/L" (Bartussek, 1995)	Welfare Quality® (Criteria, 2009)	BVET (2009)	RISE 3.0 Standard (2015)
3-level scoring system	*Up to 8-level scoring system*	*Mixed scoring system (max. 4 levels > 0-100 points)*	*No scoring system*	*Mixed scoring system (giving final score of 0-100 points)*
Information animal acquisition/breeding			Breeding	Ah_1 Herd management
Animal housing audits				Ah_1 Herd management
Product quality			Use	Ah_2 Livestock productivity
Housing climate (air quality)	Light, air and noise		Health	Ah_4 Living conditions
Panting (thermal stress), temperature; *shade and protection from wind*[5]		Thermal comfort	Health	Ah_4 Living conditions

[4] The table lists generic criteria that are relevant to several different species. Specific criteria such as "sitting pigs" are not included.
[5] Additions from the Animal Needs Index 35/L (Austria) are shown in italics.

Light			Health	Ah_4 Living conditions
Water supply		Absence of prolonged thirst	Drinking	Ah_4 Living conditions
Cleanliness of housing and waterers	Intensity of care	Absence of prolonged thirst	Drinking	Ah_4 Living conditions
Condition of housing fixtures, milking parlor, paths used by livestock			Health	Ah_4 Living conditions
Feed storage, quality and presentation		Absence of prolonged hunger	Feeding	Ah_4 Living conditions
Animal hygiene		Comfort around resting		Ah_5 Animal health
General state and physical condition (coat/skin, areas of feather loss, BCS)		Absence of injuries, Absence of disease, Absence of prolonged hunger (BCS)	Health	Ah_5 Animal health
Conditions caused by inadequate housing, scabs, sores (e.g. on joints), ailments (coughing, sneezing), parasites, abscesses on balls of feet		Absence of injuries, Absence of disease	Health	Ah_5 Animal health
Claw condition, lameness, foot rot, diarrhea		Absence of injuries, Absence of disease	Health	Ah_5 Animal health
Health status		Absence of injuries, Absence of disease	Health	Ah_5 Animal health
Animal mortality		Absence of disease	Health	Ah_5 Animal health
Polling, teeth grinding		Absence of pain induced by management procedures	Interventions	Ah_5 Animal health
Procedures for sick or fallen stock; quarantine		Absence of injuries, Absence of disease	Health	Ah_5 Animal health
Stocking density		Ease of movement	Movement	Ah_3 Opportunity for species-

	Freedom of movement			appropriate behavior
Lying down/standing up		Ease of movement		
Access to pasture, outdoor access		Ease of movement, Expression of other behaviors	Movement	Ah_3 Opportunity for species-appropriate behavior
Freedom of movement		Ease of movement	Movement, resting	Ah_3 Opportunity for species-appropriate behavior
Lying surfaces: composition and hardness, litter/perches	Flooring	Comfort around resting	Resting, health	Ah_3 Opportunity for species-appropriate behavior
Walking surfaces: condition/floor covering		Ease of movement	Health	
	Social contact	Expression of social behaviors	Social contact	Ah_3 Opportunity for species-appropriate behavior
Human-animal relationship		Good human-animal relationship, positive emotional state		

It is recommended that a lower threshold of 0.16 Large Animal Units (equivalent to one fattening pig) should be observed for the use of the RISE animal husbandry topic in the field. It is sufficient to make a qualitative assessment of conspicuous failings for animals that are kept in these kinds of numbers as a hobby or as pets. The RISE indicators for living conditions, opportunity for species-appropriate behavior and animal health are only applicable to mammals and birds – in their current form, they are not valid for e.g. bees, fish and silkworms.

Indicator ah_1: Herd Management

Sustainability goal

Livestock populations on the farm are managed in a long-term and site-adapted manner in order to optimize animal health, animal welfare and sustainability.

Content

An assessment is made of whether livestock-related information is collected and employed in a targeted manner in breeding and husbandry in order to improve animal welfare.

Scoring

100 points = systematic monitoring and documentation of animal husbandry (health and performance), balanced criteria for selection and breeding.

Explanation

Sustainable livestock production requires livestock farmers to be well informed about their animals' health and performance. Customers and government authorities are increasingly demanding detailed documentation in order to prevent outbreaks of animal epidemics and zoonotic diseases and to ensure product traceability. Various effective aids such as cow and sow breeding planners are available to supplement the essential practice of observing animal behavior. Breeding and selection also afford the farmer considerable influence over both livestock performance and welfare and environmental impacts. Breeding for performance and product quality alone is acceptable but cannot in itself be considered sustainable. These criteria may be replaced by others that have been chosen by the farmer. If this is done, however, the criteria should at least make agronomic and economic sense, e.g. longevity, life-long performance, disease resistance, robustness and good body shape (Postler & Bapst, 2000).

Indicator ah_2: Livestock Productivity

Sustainability goal

Appropriate livestock performance is achieved on the farm.

Content

Annual performance of all livestock categories on the farm is compared against regional benchmarks for very high, average and very low performance. Product quality is also rated based on regional or farm-specific criteria.

Scoring

The three benchmark performance values are worth 100 RISE points (= very high yield), 50 RISE points (average yield for the region) and 0 RISE points (very low yield), +/- a 20-point correction for product quality. Linear interpolation is used to fill in the gaps between the three defined points.

Explanation

Chapter 14 of Agenda 21 calls for a sustainable increase of food production and for improved food security as the overarching goals of sustainable agriculture and rural development (UN, 1992). Accordingly, in addition to the environmental and social impacts, RISE also evaluates livestock and crop productivity. All livestock categories with a quantifiable performance for which reliable information is available are assessed. Animal welfare, animal health and herd management are also assessed under this topic, meaning that a good topic score can only be achieved by farms with a high level of both productivity and animal welfare.

Indicator ah_3: Opportunity for Species-Appropriate Behavior

Sustainability goal

The animal husbandry system provides the animals with the freedom to express their natural social, movement, resting and sleeping, feeding, excretion, reproductive, comfort and exploring behaviors.

Content

An assessment is made of whether the animals enjoy sufficient time out of doors and contact with other members of the same species and of whether their environment permits them to behave as naturally as possible.

Scoring

100 points = based on current knowledge, the conditions in which the animals are kept allow species-appropriate behavior for all of the behavior categories included in RISE.

Explanation

The three-level qualitative assessment (optimal = 100 points, acceptable/room for improvement = 50 points, unacceptable = 0 points) follows the KTBL (2006) method for estimating the extent to which animal husbandry practices limit the animals' natural behavior. The score is based on the 20% of the relevant animal category stock that is kept in the least favorable conditions, with no weighting by Large

Animal Units. The three-level scoring system also draws on the animal welfare handbook of the German organic farming associations (2013). Six questions cover the three areas of freedom of movement (A), ground conditions (B) and social contact (C). These in turn influence the level of species-appropriateness in the behavioral areas of social behavior (C), movement (A, B), resting and sleeping (B), reproduction (A), comfort (A, B) and exploring (A, B). Table 5 provides an overview of the natural behaviors of cattle, pigs and poultry in the most important behavioral areas (KTBL, 2006).

Table 5. Overview of natural animal behaviors (based on KTBL, 2006).

Behavioral area	**Cattle**	**Pigs**	**Poultry**
Social behavior	• Herds of 20-30 animals, mother cows with their own offspring, bulls kept separately • Stable hierarchy that determines e.g. individual distance • Highly synchronous behavior	• Herds of 20-30 animals, sows and this year's young • Very pronounced social behavior, accounts for 10% of all activity. Extensive skin contact. • Relatively stable hierarchy, often violent fighting (flight and retreat important) • Newcomers only slowly integrated into group	• Social hierarchy very important and on occasion established by violent fighting • High-ranking animals have specific social functions, e.g. defense • Hierarchy is stable in flocks of up to 100, unstable in larger flocks • Highly synchronous behavior
Movement	• Plenty of movement, on pasture 1-13 km/day (depending on local environment) • Calves' playing behavior involves a lot of running around	• Change of activity generally involves change of location • Wild boars run 4-6 km/day	• Movement mainly associated with feeding, rate determined by light • Limited radius: 50-200 m for hens (depending on structure of local environment) • Ducks need waterbodies
Resting and sleeping	• Resting areas explored before the animals lie down • Resting also highly synchronized (space required!) • Rank influences order in which animals lie down • Animals need approx. 80 cm free space in front of them to stand up • 7-10 hrs/day spent resting	• Bedding of leaves, twigs, etc., changed daily • Lie down first on belly, then on side • Rest 11-15 hrs at night and up to 3 hrs during day	• Elevated, protected perches preferred, in close proximity to rest of flock
Feeding	• Graze by moving forward slowly (grazing gait), food must be at right height • Feeding for 8-12 hrs/day on pasture, 4-7 hrs/day in barn. Rumination for 5-9 hrs, mostly at night • Feeding takes place at characteristic times of day • Mouth submerged in water when drinking, intake of approx. 10 l/minute	• Very varied diet • 70-80% of activity time spent searching for food, esp. rooting and digging • Much less time spent on actual feeding • Large distance between animals while feeding because of competition for food • Drinking and eating usually in quick succession	• Food searched for and eaten by pecking (even when available ad libitum in trays). Ducks, however, may also graze. • 40-50% of day spent searching for and eating food

Excretion	• Back arched • Defecation 16-18x/day, no preferred location	• Defecation and urination 5-15 m away from resting area	
Reproduction	• Cow separates from herd before calving	• Sporadic contact with boars has positive impact on mating • Sow separates from herd before giving birth and builds a nest	• Hens separate from flock before egg laying and search for nest site • It is especially important for the nest floor to be made from a malleable material
Comfort	• Grooming performed by (also mutual) licking and rubbing • Tolerant of large temperature range, better at coping with cold than heat	• Pigs like to rub against objects, mutual grooming rare • Pigs cannot sweat and are well insulated, wallowing or showering therefore important	• A lot of time spent preening, esp. to maintain thermal insulation • Dust baths also part of this grooming behavior
Exploration	• Sight and smell are main senses used	• Most active during day • Hearing, smell and touch are main senses used	

Indicator ah_4: Living conditions

Sustainability goal

The physiological needs of the animals are met; they live in a species-appropriate environment.

Content

An assessment is made of whether temperature, lighting, air quality, noise level and feeding arrangements meet the needs of the species in question.

Scoring

100 points = all animals live in species-appropriate conditions.

Explanation

The requirements for animal health and welfare include clean water and air (sufficient oxygen content, few aerosols, low levels of dust and harmful gases such as ammonia), air temperatures within the species' comfort zone, light and noise levels that do not disturb the animals' senses and species-appropriate, welfare-friendly feeding arrangements (e.g. Algers et al., 2009). The housing system has a major influence on all of these indicators (Wechsler, 2005). Humans working with the animals also benefit from improved animal housing conditions: working in a species-appropriate structure is usually both more pleasant and healthier for humans, too. For this indicator, the scoring is once again based on the 20% of the relevant animal category that is kept in the worst conditions, with no weighting by Large Animal Units.

Indicator ah_5: Animal Health

Sustainability goal

The animals live free from pain and disease. The number of unintended losses is as small as possible.

Content

An assessment is made of the number of unintended losses, veterinary treatments, zootechnical interventions and the animals' external condition.

Scoring

100 points = no veterinary treatments necessary, no mortality due to disease, injury or accidents, no mutilated animals.

Explanation

The use of veterinary drugs may indicate failings in animal husbandry. Since current knowledge (2011) suggests that these substances do not cause major environmental damage, this issue is treated here rather than under any of the RISE topics connected with the environment. As with the previous two indicators, there is no weighting by Large Animal Unit factors. Homeopathic and natural substances (vitamins, minerals), vaccines and feed additives are regarded as non-toxic and are therefore not included in the RISE evaluation (Kools et al., 2008). Livestock mortality is evaluated using the system outlined in Table 6, which is itself based on sources such as Welfare Quality (2009). Zootechnical interventions like piglet tail docking or chicken beak trimming usually affect entire livestock categories and cause both pain and distress. In Switzerland, it is mandatory for most such interventions to be carried out under anesthetic to prevent the animals from suffering pain (BVET, 2005). While interventions such as piglet tail docking are carried out on the pig breeder's farm, they can nevertheless point to systematic failings on the farm where the pigs are fattened. The animals' external condition can provide clues about their health, standard of care and social stress. An assessment should be made of the appearance of the skin/coat, claws, joints, etc. of the 20% of the stock that is in the worst condition. Although the brief farm visits do not allow for a detailed evaluation of the animals' condition, the experience that we already have with RISE indicates that at least a rough assessment can be made in the short time available. If failings are uncovered during this assessment, the use of a more detailed system potentially also including animal behavior may be recommended.

Table 6. Threshold values for evaluating external damage in animals (top) and mortality (bottom) for different animal categories in RISE 3.0 (standard version).

Animal category	**Calves**	**Cows**	**Sheep, goats**	**Horses**	**Hogs**	**Mother sows**	**Laying hens**	**Broilers**
Damage	0 = 100 5 = 67 25 = 33 30 = 0							
Mortality	0 = 100 4 = 67 8 = 33 12 = 0	0 = 100 2 = 67 4 = 33 6 = 0	0 = 100 2 = 67 4 = 33 6 = 0	0 = 100 2 = 50 4 = 0	0 = 100 2 = 67 4 = 33 6 = 0	0 = 100 2 = 67 4 = 33 6 = 0	0 = 100 4 = 67 8 = 33 12 = 0	0 = 100 4 = 67 8 = 33 12 = 0

All figures in %. *Green = good, amber = average, red = poor. Animal Needs Index 35/L: Average to serious damage. RISE 3.0: The threshold values for 33 and 67 points are shown. Linear interpolation is used to fill in the gaps. 100 points equals 0% animal mortality. Damage: the wide spread in RISE is due to the fact that different types of damage are counted together, whereas the protocols count them separately.*

3.3 Theme: Materials use and environmental protection (nf)

Theme

Sustainable agricultural production makes use of natural nutrient cycles. It preserves a good nutrient balance even at high productivity levels, while minimizing environmental pollution and materials use. This topic provides an indication of:

- whether tight cycles and sustainable origins are taken into account by materials sourcing (fertilizer, feed, etc.);
- whether damage to the environment is avoided in the storage, use and disposal of materials.

Relevance of the theme

Humans have massively altered nutrient flows at regional and even global level. Approximately 20% of all biomass produced by ecosystems globally is extracted for human purposes (Imhoff et al., 2004). Many farms use large quantities of a wide range of materials. Today, virtually the only place where agricultural production still occurs without the use of external inputs that often originate from other countries or even other continents is in the developing world.

A 2014 study carried out on 10 farms in the Swiss Plateau region recorded an average annual N supply of 274 kg and a P supply of 59 kg per ha of agricultural area, annual food consumption of 5.7 tons of feed per Large Animal Unit and a water demand of 4,815 m^3 per ha of agricultural area. Products made on the farms and sold on to outside customers included 6,800 kg milk per lactating cow, 6.8 tons of wheat, 85 tons of sugar beet and 42 tons of potatoes per ha, as well as substantial quantities of meat and other products (Grenz & Thalmann, unpublished data). While these farms had an average of 1.8 plant protection product applications per ha per year, the norm for the Swiss apple industry is 39 applications per ha (Naef et al., 2011).

Unless these materials are used in a targeted and sparing manner, their environmental impacts can be significant. Nutrients that escape into the atmosphere can cause eutrophication of waterbodies and soil. Plant protection products pose a threat to life forms throughout the environment, while waste products can also cause contamination of soil, waterbodies and the air and poison the creatures that live there. The materials used on farms can also endanger the health of the people who make and use them.

Fertilizers

Nitrogen (N) and phosphorus (P) are the nutrients that are particularly important in the context of sustainability. Worldwide, these two chemical elements are the most frequently associated with reduced yields and also have the greatest impact on the environment. They are key drivers of both agricultural productivity and the environmental impact of farming. Of the yield increases achieved in cereals since the 1960s, some 40% can be attributed to improved crop N supply, primarily due to mineral fertilization (Brown, 1999). 187 million t of N are fixed from the atmosphere each year as a result of legume production and Haber-Bosch synthesis, which is more than the sum of all natural N fixation processes (Galloway et al., 2008; Fig. 13). Because nitrate, ammonia and nitrous oxide are highly mobile, crops can only absorb 50% or less of the applied N (Crews & Peoples, 2004). As a result, N flows from vegetation and soil into open water and groundwater have more than doubled as a result of human activity (Vitousek et al., 1997). The main sources of ammonia emissions are the storage and spreading of manure (UNECE, 2007). Globally, 64% of all anthropogenic ammonia emissions originate from livestock, while in Switzerland the figure is in excess of 90% (Steinfeld et al., 2006; Reidy et al., 2008). According to Galloway et al. (2004), global ammonia emissions from terrestrial ecosystems increased from 15 Tg to 53 Tg/year between 1860 and the 1990s. The N losses resulting from agriculture contribute to soil acidification, eutrophication of ecosystems, biodiversity loss, health problems in humans and animals and global warming (Crews & Peoples, 2004).

Unlike N, P is an element that is mainly made available for agricultural use through open pit mining. Phosphate rock is a non-renewable resource, meaning that global P stocks are limited. P flows from rock into plants and soil have increased by 75% compared to pre-industrial times, while flows from soil into the hydrosphere, predominantly via soil erosion, have risen by 70%. Each year, 10.5 to 15.5 million t of P accumulate in terrestrial ecosystems (MEA, 2005). The remaining P reserves are estimated at between

80 and 200 years (e.g. BGR, 2006). Ways of using P more efficiently and recycling it more effectively are the subject of intensive research efforts. The problems associated with nutrient overload are exacerbated by the importing of feedstuffs in areas with high livestock densities. Net imports of crude protein from South America to Germany alone came to 2.1 million t in 2005 (Grenz et al., 2007). On the other hand, large parts of sub-Saharan Africa lack sufficient nutrients, with arable land there having been depleted by an average of 700 kg N and 100 kg P per ha over a 30-year period (Stoorvogel & Smaling, 1990; Pieri & Steiner, 1996).

The keys to high nutrient efficiency are the maintenance of tight nutrient cycles, the avoidance of nutrient losses and the application of fertilizers at the right time and in the right proportion both to each other and to other growth factors such as water and temperature. Specific measures for reducing gaseous N losses include optimized livestock feeding and manure storage, letting animals spend more time on pasture and optimization of manure application timing and techniques. Nevertheless, it is still virtually impossible to avoid the loss of approximately 30% of the total N from housing, storage facilities and manure application (Fritsch, 2007; GruDAF, 2009).

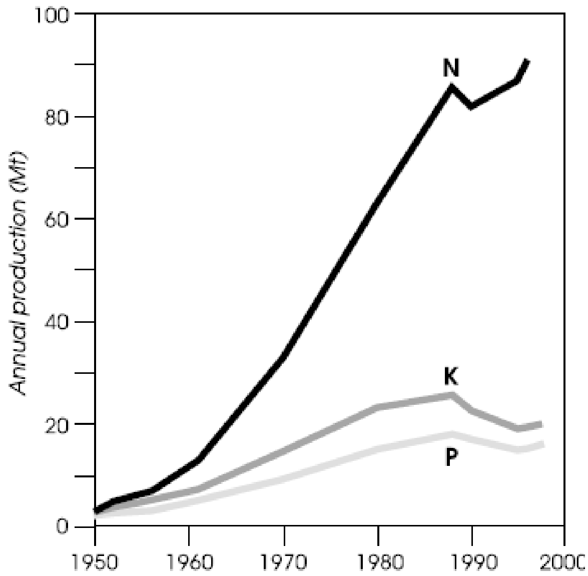

Figure 13. Global production of mineral fertilizers, in million t (Smil, 2001).

Many industrialized countries have reacted to the environmental damage caused by N and P emissions by introducing new legislation. Examples include Switzerland's "Proof of Ecological Performance" (PEP) and Water Protection Act, as well as the European Union's "cross compliance" rules (e.g. Oenema, 2004). The PEP obliges farmers receiving direct payments to maintain a stable N and P balance on their farms, with a margin of error of 10% over and above unavoidable N losses (BLW, 2009). A number of N and P cycle algorithms and models have also been developed to facilitate compliance with environmental regulations. The most widely established is the supply-demand or field-barn balance, which mainly focuses on nutrient flows between livestock and crop production. Another approach, known as the "farm gate balance", is based on the N and P exchange between the farm and the outside world (VDLUFA, 2007). In RISE, N and P balances are calculated for the farm as a whole using a method based on the "Suisse-Bilanz" (Swiss Balance), a mandatory system for recipients of direct payments in Switzerland. Ammonia emission estimates are based on UNECE (2007); the Agrammon model (http://agrammon.ch) can be used for precise ammonia emission calculations in Central Europe.

Plant protection products (PPP)

Agriculture suffers huge losses due to wild plants, wild animals and pathogens that eat, attack or compete with crops and livestock. Oerke & Dehne (2004) estimate that losses due to weeds, pests and pathogens in major crops[6] accounted for 26% to 40% of potential yields in the period 1996 to 1998. To prevent yield losses, 54.8 billion USD was spent on plant protection products (PPPs) in 2014

[6] Wheat, rice, corn, barley, potato, soybean, sugar beet and cotton.

(www.bccresearch.com/market-research/chemicals/biopesticides-chm029e.html). While pesticide sales have been falling for many years in industrialized countries, they continue to grow in emerging and developing economies (OECD, 2010; FAOSTAT, 2010). Combined with the increased potency of new active ingredients, this trend means that the potential biological impact is rising globally. Where no synthetic PPPs are available, significant quantities of work and effort are tied up in keeping weeds at bay. According to Lenné (2000), women in rural parts of Africa spend up to 80% of their working time on hoeing.

Inappropriate use of PPPs can cause them to accumulate in the soil, waterbodies and agricultural produce, damage the health of humans and ecosystems and eventually lose their effectiveness due to the evolution of resistance. In addition to the danger of acute poisoning, there is also a risk of chronic diseases and genetic damage, especially among people handling PPPs (McCauley et al., 2006). The production and use of particularly hazardous substances is restricted by international regulations such as the Stockholm Convention (Table 7).

Table 7. Chemicals whose production and use is restricted or prohibited by the Stockholm Convention of 22.5.2001. (Source: home.cc.umanitoba.ca/~umguerri/PLNT4600/mini2/2%20where%20are%20they%20from/dirty%20dozen.jpg).

The "Dirty Dozen"	
[1]Pesticide	[2]Industrial Chemical [3]Byproduct
aldrin[1]	hexachlorobenzene[1,2,3]
chlordane[1]	mirex[1]
DDT[1]	toxaphene[1]
dieldrin[1]	polychlorinated biphenyls (PCBs)[2,3]
endrin[1]	polychlorinated dibenzo-p-dioxins (dioxins)[3]
heptachlor[1]	polychlorinated dibenzo-p-furans (furans)[3]

RISE defines sustainable plant protection as a combination of measures that maximize natural regulation within the agro-ecosystem in order to minimize external interventions in general and the use of PPPs in particular. Synergies in the overall production system and the potential of agro-ecosystems for self-regulation can be used to achieve this aim (Boller et al. 2004). Typical measures are the choice of resistant crop cultivars, avoidance of excessive N fertilization, the optimization of sowing dates and diverse crop rotation (Häni et al. 1998).

To quantify the human toxicity and ecotoxicity of PPPs, tests are conducted prior to their registration. The results can be accessed in online databases (e.g. Extoxnet extoxnet.orst.edu, PAN Pesticide Database www.pesticideinfo.org, Pesticide Properties Database http://sitem.herts.ac.uk/aeru/footprint/index2.htm). Risk assessments are carried out based on these data, albeit not without considerable analytical and scientific effort (e.g. Chèvre & Escher, 2005). Indicator systems mostly evaluate the use of pesticides (and veterinary drugs) on farms on the basis of pesticide application method, quantity of active ingredient used, the area of the farm treated or the number of applications (e.g. Meul et al., 2008; Pretty et al., 2008; Vilain et al., 2008). The toxicity of the active ingredients is rarely considered. The scoring method used in RISE is a simplified version of the "Environmental Impact Quotient" (EIQ) proposed by Kovach et al. (1992). This method takes into account information on the persistence of active ingredients and their toxicity in several different groups of organisms, as well as human users and consumers (www.nysipm.cornell.edu/publications/eiq).

Waste and recycling

Farms produce large quantities of waste, ranging from recyclable materials such as manure, harvest residues, glass and metal to problematic waste such as chemical containers and waste oil[7].

[7] The appendices to the Basel Convention (2005) contain detailed lists of problematic waste products

Inappropriate waste management can endanger human, animal and environmental health. Legacy contamination can also harm future generations and therefore clearly violates the principle of sustainability. Waste management should follow the principles of the circular economy: (1) first and foremost, waste should be avoided by minimizing its quantity and hazardousness; (2) any waste that is produced should be recycled (including composting) or used as a source of energy (Krw-/AbfG, 1994). If the waste cannot be avoided or recycled, it should be disposed of in an environmentally-friendly manner. The eco-efficiency approach that dominates current environmental policy is based on less resource consumption, longer product lives, lower material toxicity and improved recyclability. The more radical "eco-efficacy" approach, on the other hand, postulates the need for a closed-loop economy that mimics natural ecosystems, where all the outputs of one process are recycled as inputs for the next process (Braungart et al., 2007).

Indicator nf_1: Material flows

Sustainability goal

The farm promotes sustainable production of consumables, machinery, infrastructure, feed and fertilizer through responsible sourcing. Targeted material selection and efficient resource utilization prevent waste.

Content

An assessment is made of (i) whether priority is attached to the use of nutrient sources (chiefly feed and fertilizers) either produced on the farm itself or at least sourced locally (within a region-specific radius), (ii) whether materials and equipment sourcing considers sustainability criteria and in particular the circular economy, (iii) whether unproductive losses are prevented.

This indicator integrates information on the following components:

(1) Self-sufficiency of feed supply (calculated): N-self-sufficiency, P-self-sufficiency.

(2) Self-sufficiency of fertilizer supply (calculated): N-self-sufficiency, P-self-sufficiency.

(3) Regionality of feed supply.

(4) Regionality of fertilizer supply.

(5) Losses from crop production („food loss").

(6) Degree of implementation of recycling potential.

Scoring

100 points = all materials are sourced locally, from sustainable sources. Unproductive losses are minimized.

Explanation

This RISE indicator assesses whether the farmer makes an active effort to minimize materials use on the farm, prevent unproductive losses and produce as little waste as possible. It also assesses whether sourcing of materials such as feed and fertilizers prioritizes the use of the farm's own resources, followed by locally sourced materials, with products only being sourced from further afield if there is no alternative.

Indicator nf_2: Fertilization

Sustainability goal

A balanced crop nutrient supply facilitates good yields while preventing damage to the environment and soil nutrient deficiencies. Optimal use is made of the nutrients available on the farm and these are only supplemented by externally sourced nutrients where necessary.

Content

Nitrogen and phosphorus balances are calculated at farm level (supply-demand balance, the benchmark values for the scoring function can be adjusted in the regional data. Nutrient surpluses are evaluated more critically than deficits in surplus areas. The tolerance limit for surpluses is only increased in the event of a poor P supply, but not for poor N supply). An assessment is also made of whether fertilizers are used sparingly in accordance with best practice.

This indicator integrates information on the following components:

1) Fertilization management = Fertilization planning (factors taken into consideration): crop nutrient demand (envisaged yield x quality), results of soil analyses (P and K content, texture, soil organic matter content…), atmospheric nitrogen immission, biological nitrogen fixation, available quantities of organic fertilizers (types, N and P contents, dilution factors), nutrient mobilization from crop residues, mulch and green manure; fertilizer application (factors taken into consideration): time and quantities (demand-specific application and release, type and formulation of fertilizer, dosability, precise dosage and distribution (application technology, wind speed).
2) Farm nitrogen balance.
3) Farm phosphorus balance.

Scoring

100 points = fertilizers are only employed where necessary, based on the relevant analysis results. The farm has stable N and P balances, i.e. the difference between supply and demand does not exceed 10%. The exact details of the scoring function can be defined regionally for both N and P. As a rule, more points will be deducted for surpluses than for equivalently-sized deficits. Figure 14 contains some examples of scoring functions.

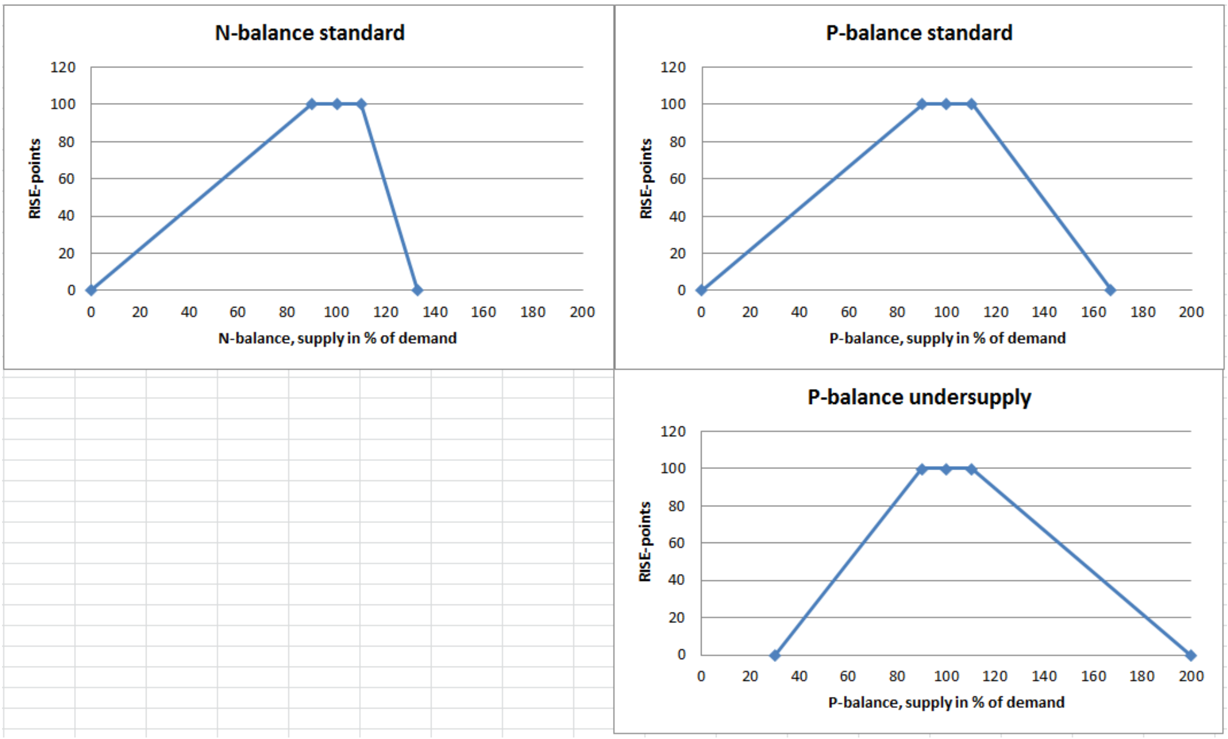

Figure 14. Standard scoring functions for farm nitrogen balance (left) and phosphorus balance (right). The functions' key parameters can be defined at regional level.

Explanation

Nitrogen and phosphorus can both contribute to eutrophication if they find their way into waterbodies. Since nitrogen compound emissions from agriculture are significantly more mobile than phosphorus compounds, nitrogen surpluses are likely to cause more rapid and extensive damage to the environment than phosphorus surpluses. In many countries, both of these nutrients are regulated by environmental and in particular water protection legislation.

Switzerland's Ordinance on Direct Payments in Agriculture makes the same provisions for both nutrients insofar as both are required to have a stable annual balance with a 10% margin of error. However, if an undersupply of phosphorus is documented, a higher demand for this element is permissible. The German Fertilizer Ordinance[8] states that a six-year average P surplus of more than 20 kg P_2O_5/ha*year is permissible if the soil P content is less than 20 mg P_2O_5/100 g soil[9] (CAL method). This is equivalent to Class D or below in the version of the German system with six soil content classes. The statutory regulations are aimed at avoiding environmental problems at local and regional level by preventing these nutrients from escaping into the environment as a result of nutrient surpluses and inadequate management practices.

Nutrient deficits, on the other hand, are a problem at farm and plot level. Although acute deficits of one or several elements can be detected through deficiency symptoms and reduced crop yields, in the case of structural undersupply of e.g. phosphorus it can be several years before the deficit becomes apparent, depending on the reserves present in the soil. In simple terms, it can be said that nutrient surpluses are a problem that affects society as a whole, while deficits are a private problem. The relative importance of surpluses and deficits varies significantly between countries and regions. In regions with high numbers of livestock and in industrialized nations in general, the bulk of the problems are caused by N and P surpluses. On the other hand, nutrient deficits are a problem in large parts of sub-Saharan Africa (with no access to fertilizer or low soil organic matter content) and some parts of South America (with phosphate-fixing soils or low soil organic matter content). This is why we have allowed the scoring functions in RISE 3.0 to be adjusted at regional level.

In addition to calculating the N and P balances, the following aspects of fertilization practice are also analyzed and evaluated:

- need-based fertilization (time and quantity),
- use of biological nitrogen fixation potential and consideration of nitrogen input from the air,
- ensuring full use of organic fertilizer potential.

Indicator nf_3: Plant Protection

Sustainability goal

Plant protection on the farm is based on the principles of integrated plant protection. Hazardous substances that are harmful to the environment are only used where strictly necessary and their impact on the environment is minimized through targeted selection and application.

Content

An assessment is made of (i) the extent to which plant protection problems are managed in accordance with the principles of integrated plant protection, (ii) the toxicity and persistence of any plant protection products used and (iii) whether measures are in place to minimize any unintended side-effects caused by the use of genetically modified organisms (GMOs).

This indicator integrates information on the following components:

(1) Management of plant protection challenges according to the principles of integrated plant protection: site-adapted production systems, variety selection based on resistance and tolerance to pests and diseases, reliable identification of species prior to chemical treatments, application of damage thresholds, use of biological and mechanical rather chemical means of plant protection, measures to keep the effectiveness of PPP (e.g. herbicide rotation).

(2) Due diligence in GMO cultivation: compliance with relevant legislation, measures to prevent unwanted spread or outcrossing of genes, conservation of specific GM properties (e.g. herbicide tolerance, resistance to pests), development of PPP use since GMO adoption.

Scoring

[8] www.landwirtschaft-bw.info/pb/site/lel/get/documents/MLR.LEL/PB5Documents/lrabb/ltz_Merkblatt%20zur%20D%C3%BCngeverordnung_080908.pdf
[9] www.lufa-nord-west.com/data/documents/Downloads/IFB/duengeempfehlunghauptnaehrstoffe.pdf

100 points = plant protection practices are completely in line with integrated principles, or no plant protection products or GMOs are used.

Explanation

The first step is to compare plant protection management practices on the farm against the principles of integrated plant protection:

- cultivation system design,
- selection of crop cultivars,
- identification of harmful organism presence prior to PPP use,
- use of the damage threshold approach,
- biological and mechanical methods preferred to synthetic chemicals,
- switching of active ingredient groups to prevent development of resistance,
- correct application of PPPs.

Points are not automatically deducted for the use of GMOs – this would not be justified by current evidence regarding the threat that they pose to humans and the environment. However, the unintended propagation or crossover of GMOs and/or the failure of the relevant preventive measures are scored negatively in RISE.

The third component of the indicator score assesses how PPPs are used on the farm. Persistence in the soil, acute and chronic toxicity to humans and ecotoxicity (risk-based, i.e. the toxicity for the most sensitive organism) are recorded for all PPPs used. Each of these criteria is captured using a three-level scale, e.g. “persistent” for a half-life of more than 3 months, “moderately persistent” for 1 to 3 months and “rapidly degradable” for less than 1 month. The scores are weighted by number of applications and treated area prior to being aggregated at the farm level.

Indicator nf_4: Air pollution

Sustainability goal

The storage, use and disposal of materials does not cause gaseous emissions that threaten or harm the health of humans, animals or the environment (air, soil, water and natural ecosystems).

Content

This indicator deals with gaseous emissions that can harm the health of humans or ecosystems. It integrates information on:

(1) Ammonia: risk of ammonia emissions from animal production (number of livestock per area, rating of grazing practice, slurry storage, spreading and incorporation into the soil), risk of ammonia emissions from imported organic fertilizers (spreading and incorporation into the soil),), risk of ammonia emissions from mineral fertilizers (type and quantity).

(2) Exhaust gases, smoke and odor: Burning of problem wastes (e.g. plastics), complaints from neighbors due to unpleasant smell (e.g. from stables, slurry application, sewage sludge, biogas fermentation or composting).

This indicator addresses the storage, use and disposal of toxic substances (plant protection products, veterinary drugs, dyes and colors, etc.), as well as other substances that could be harmful to humans, animals or the environment (effluent, waste, spillages from feed or fertilizer stores, etc.). Interviewees are questioned about actual soil and water pollution incidents (in the last 5 years) and the risk of such pollution incidents occurring in the future is also assessed.

Scoring

100 points = no pollution incidents and no risk of pollution incidents occurring.

Explanation

See the next indicator, “Soil and water pollution”.

Indicator nf_5: Soil and water pollution

Sustainability goal

The storage, use and disposal of materials does not cause liquid or solid emissions that threaten or harm the health of humans, animals or the environment (air, soil, water and natural ecosystems).

Content

This indicator deals with liquid and solid emissions that can harm the health of humans or ecosystems. It integrates information on:

(1) Nutrients (N and P): buffer strips for manure and slurry storage and spreading, silos, parcels with risks of nutrient leaching, temporary storage organic fertilizers on bare soil.

(2) Pollutants in fertilizer: heavy metals, radioactive isotopes, organic substances (compost, sewage sludge) that were not analyzed for pollutants, slurry and manure containing antibiotic residues.

(3) Plant protection products: buffer strips, water erosion (6 m wide vegetated buffer strip, permanent vegetation along field margins, prevention of siltation, maintenance of high water retention capacity = prevention of surface run-off)), prevention of drift, eco-toxicological characteristics of PPP (toxicity and persistence).

(4) Pollutants in wastes, residues and wastewater: storage and disposal of problematic materials, risks from household and farm wastewaters, share of adequately treated wastewaters, pollution caused by livestock entering into water, further risks of soil and water pollution.

This indicator addresses the storage, use and disposal of toxic substances (plant protection products, veterinary drugs, dyes and colors, etc.), as well as other substances that could be harmful to humans, animals or the environment (effluent, waste, spillages from feed or fertilizer stores, etc.). Interviewees are questioned about actual soil and water pollution incidents (in the last 5 years) and the risk of such pollution incidents occurring in the future is also assessed.

Scoring

100 points = no pollution incidents and no risk of pollution incidents occurring.

Explanation

Many farms use a wide variety of substances that can cause soil, water and air pollution as well as harming living organisms. For instance, the health of humans, animals and ecosystems can be endangered if the surface water or groundwater become overloaded with nutrients (eutrophication) or contaminated with pollutants or pathogens. Spillages from manure stores and silos and soil erosion are among the key ways in which P can enter waterbodies and the groundwater.

RISE 3.0 assesses the following substances: slurry, manure, feedstuffs (especially silage), effluent, contaminants such as oil, antibiotics, heavy metals, etc., all types of waste and other toxic substances (acids, alkalis, dyes, colors, etc.). The natural resources to be protected include water, soil, air, near-natural ecosystems, humans and animals. As with the “soil erosion” indicator, 50% of the indicator score is based on observations (in this case, pollution incidents in the last 5 years) and the remaining 50% is based on a risk assessment. The risk assessment takes into account how the abovementioned substances are stored, used and disposed of on the farm. Observations during the farm visit play an important role in this qualitative assessment. The other component of this indicator comprises the answers to 8 questions about the likelihood of pollution events occurring on the farm. These include the burning and dumping of e.g. silage wrap, animal carcasses or batteries, spillages from manure trays, slurry pits or bunker silos, and soil pollution caused by waste oil, battery acid or spray mixtures.

3.4 Theme: Water Use (wa)

Theme

Clean fresh water is indispensable both to human life, and to crop and livestock production. The production system employed by the farmer affects the amount and quality of the water available to other users. This topic addresses:

- how good the quality and quantity of the farm's water supply is,
- how intensively and efficiently water is used for production and
- how sustainable the farm's irrigation practices are.

Relevance of the Theme

Clean fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment ("Dublin Principles"; Global Water Partnership, 2000). In Chapter 18 of Agenda 21, the signatories commit to the aim of making "certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems (…)" (UN, 1992).

In those parts of the world with a permanently or seasonally arid climate (Fig.15), it is usually water availability that determines the productivity of natural and agricultural ecosystems. More than 900 million people live in watersheds with physical water scarcity, while areas with a further 700 million inhabitants are expected to be affected by water scarcity in the future (IWMI, 2006). According to Vörösmarty et al. (2000), more than one third of the global population lives in watersheds affected by water stress. Falling groundwater tables are a reality in e.g. northern China, northern India, Mexico, North Africa and West Asia (Araus, 2004; IWMI, 2006). Based on a minimum annual per-capita water demand of 900 m³, Falkenmark (1997) forecasts that virtually all of Africa, northern China, South Asia and West Asia will be incapable of achieving food self-sufficiency due to water scarcity by 2025. Even where water is not physically scarce, people may lack access to clean water for financial reasons.

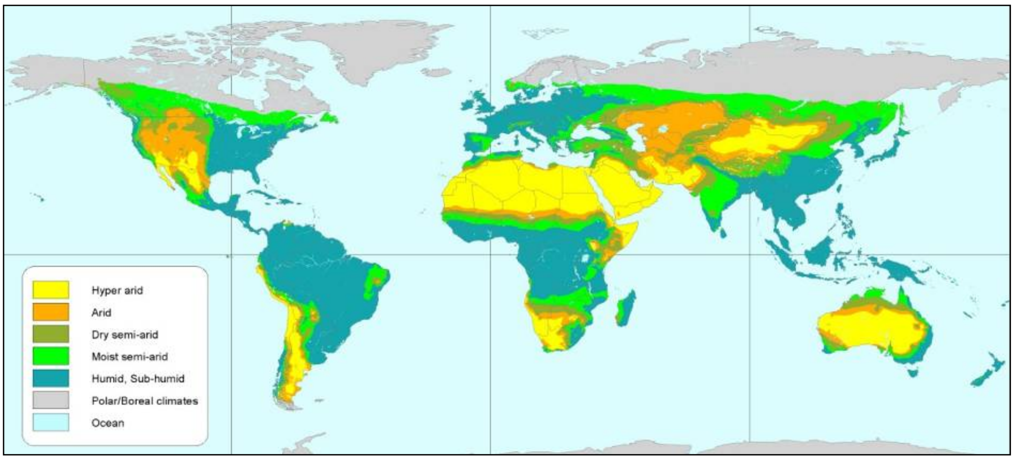

Figure 15. The Earth's drylands (http://lada.virtualcentre.org/eims/download.asp?pub_id=96700&app=0).

In many areas, contaminated drinking water is a major source of infectious diseases which claim some 6,000 human lives every day (UNESCO, 2003). Vegetable irrigation using unhygienic water can also cause intestinal worms, bacterial infections and diarrhea (Blumenthal & Peasey, 2002). Moreover, inappropriate water use contributes to soil degradation as a result of secondary soil salinization of large tracts of land (www.isric.org/UK/About+ISRIC/Projects/Track+Record/ GLASOD.htm; www.fao.org/ag/agl/agll/terrastat; Oldeman et al., 1991).

Of the 4,500 km³ of freshwater used by humans every year, nearly 70% is used in agriculture (Wolff, 1999). However, domestic, industrial and energy-related water demand is growing rapidly and could threaten the water supply of the often less profitable agricultural sector. While water is often reused several times, its quality usually deteriorates as a result (IWMI, 2006). The water used by the plants in rainfed crop production has the lowest opportunity cost, since there is virtually no drop-off in quality.

Contamination e.g. with toxic chemicals or fecal germs and inadequate water treatment can also cause more immediate harm to human and animal health, both on farms and in their vicinity. Over the longer term, quality problems may arise from the accumulation of toxic substances in the soil and in water pipes, as well as the contamination of water with chronically toxic chemicals. Overuse of water sources initially leads to increased costs associated with e.g. drilling and operating wells. Once this is no longer possible, the farm's very survival is threatened. If farms with privileged access to water (e.g. because they are situated on the upper reaches of a river) overuse their water resources, harm is caused to economically and politically weaker downstream riparians, as well as to natural ecosystems. One approach to preventing such conflicts is the introduction of an Integrated Water Resources Management system at watershed level (Integrated Water Resources Management; Global Water Partnership, 2000).

There are numerous technologies that enable substantial improvements in agricultural water use. Examples include water collection by rainwater harvesting and flash-flood irrigation, water storage in cisterns and water application through various types of drip and sprinkler irrigation systems (including measurement and control technologies). Water use efficiency can also be improved through methods such as deficit irrigation and alternate furrow irrigation (Kang et al., 2000). Water treatment and recycling methods include constructed wetlands, gravel filters (Bunch & Lopez, 2003) and the use of treated domestic and animal housing wastewater for irrigation. Overviews of traditional techniques such as *Tassa, Zaï* and stone walls can be found in Reij et al. (1996) and Cofie et al. (2004). More water-efficient cultivars are being developed in accordance with the "more crop per drop" principle (Passioura, 2004).

Indicator wa_1: Water Management

Sustainability goal

Knowledge and technology are actively employed to ensure efficient, site-adapted and resource-conserving utilization of water resources.

Content

This indicator is only calculated if "blue" water (taken from aquifers or surface waterbodies) is used on the farm (as opposed to only "green" water, i.e. rainwater naturally absorbed by the plants). Interviewees are questioned about whether water consumption is monitored, whether opportunities to collect rainwater are used where doing so is feasible, whether they are aware of the potential water-saving measures that could be implemented on the farm and the extent to which such measures have actually been introduced.

Scoring

100 points = water consumption is monitored, potential water-saving measures are known and fully implemented.

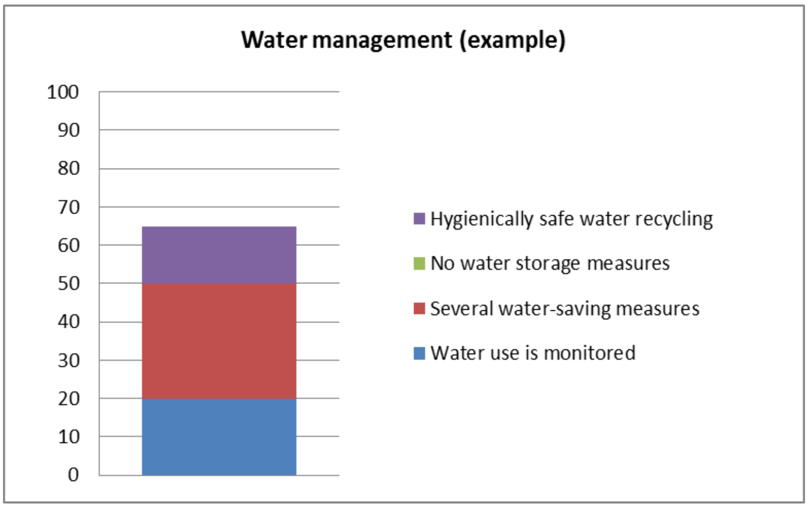

Figure 16. Example calculation of indicator wa_1.

Explanation

Water-saving measures can accumulate the most points, since a wider range of (low-tech and high-tech) technologies and measures exists for this purpose. It is thus also easier for the farmer to take active measures to save water. A farm where nothing is done to save water in production can only achieve a maximum of 50 points and will thus be given a "room for improvement" rating. The question relating to the use of information is also intended to raise awareness about the fact that such information is available and can be used. The questions are intended as examples and may be modified or expanded.

Indicator wa_2: Water Supply

Sustainability goal

The quantity and quality of the farm's water supply are secure in the short and long term.

Content

The current situation, trends and potential for conflicts concerning the quantity and quality of the water supply are recorded and assessed (Fig. 17).

Scoring

100 points = no problems on the farm (no need to increase depth of wells, no water-related conflicts, no deterioration in water quality, no decrease in water availability, no fall in the groundwater table), together with a low regional water stress level as defined by the WBCSD Global Water Tool.

Explanation

Water scarcity becomes a problem when it leads to water stress, i.e. sufficient water is not (or no longer) available. Since in some cases it may be some time before water stress at regional level affects the water supply on-farm, and since the farm itself can directly affect the availability of water to other users in the region, the watershed level is also taken into account in RISE 3.0. The intention is to raise the farmer's awareness of potential future water conflicts. The regional water stress index ("blue" water) is determined for the farm's coordinates using the Global Water Tool of the World Business Council for Sustainable Development (WBCSD)[10]. Moderate stress is defined as beginning at a value of 0.2 and high water stress starts at 0.4 (mean annual relative water stress index). The Global Water Tool levels of "low", "medium", "scarce" and "stress" translate into 100, 66, 33 and 0 RISE points respectively. Other information sources may also be used, for example the WWF's "Water Risk Filter"[11] or the map included in Pfister et al. (2009)[12].

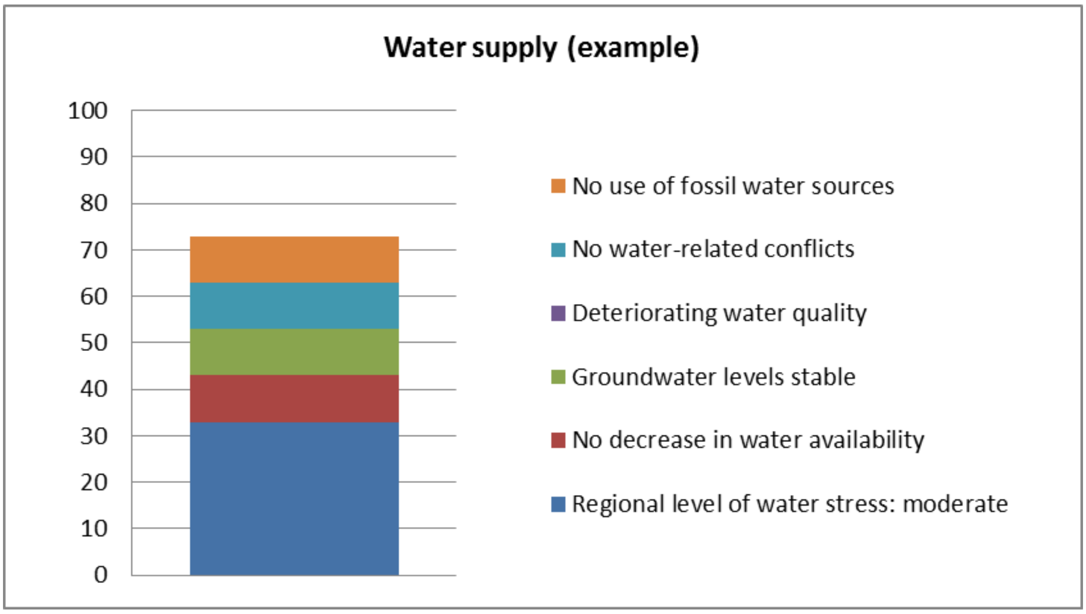

Figure 17. Example calculation of indicator wa_2.

10 www.wbcsd.org/work-program/sector-projects/water/global-water-tool.aspx
11 http://waterriskfilter.panda.org/
12 http://pubs.acs.org/doi/abs/10.1021/es802423e

Indicator wa_3: Water Use Intensity

Sustainability goal

The quantity of water used in agricultural production is adapted to local conditions through the choice of crops and timing of cultivation. The farm is not dependent on externally supplied water and its irrigation requirements are minimized.

Content

The water demand of the farm's crops and livestock is calculated based on standard regional coefficients and compared with the water supply as determined by climatic conditions over the course of the year in question. Water requirements are estimated taking the timing and duration of crop cultivation into account.

Scoring

100 points = the farm's total water requirements are less than the annual volume of rain that falls on its land. Crop selection and the time of year at which crops are grown ensure that irrigation requirements are minimized, thereby preventing a structural water deficit.

Explanation

The water intensity of sustainable production systems must be adapted to local conditions in order to prevent the risk of overexploitation of "blue" water at regional level.

The calculation of water consumption in RISE 3.0 is based on the FAO's CROPWAT model[13]. Crop water demand is calculated using the CROPWAT coefficients (Et0 * Kc = potential evapotranspiration * crop-specific coefficient). Regional water availability (calculated from effective rainfall and potential evapotranspiration) is input and considered on a monthly basis. This allows structural water deficits to be identified.

Indicator wa_4: Irrigation

Sustainability goal

Efficient irrigation methods enable high physical and financial yields.

Content

An assessment is made of whether (i) irrigation is carried out in a targeted and efficient manner, (ii) irrigation makes financial sense and (iii) there are any problems in connection with irrigation.

Scoring

100 points = irrigation is carried out in a targeted and efficient manner, as well as making financial sense and being problem-free.

Explanation

This indicator is only used if the farm has crops that are irrigated. Artificial irrigation may be rated as good (color-coded green) if it is carried out in a knowledge-based and targeted manner, if unproductive water loss is avoided insofar as this is possible using current technology and in view of the farm's financial situation (irrigation efficiency target of 85%) and if the use of irrigation makes financial sense. In addition, irrigation should not cause conflict with other water users or result in soil salinization (due to the use of excessively brackish water and/or inadequate drainage).

[13] http://cropwat.software.informer.com/download/

3.5 Theme: Energy and Climate (ec)

Theme

To be sustainable, agricultural production must be energy-efficient and not reliant on non-renewable, environmentally harmful energy carriers. This helps to protect the climate, which in turn has an impact on the health of plants, humans and animals. This topic addresses:

- the extent to which production on the farm is reliant on non-sustainable energy sources,
- which energy-saving measures have been implemented,
- the net volume of greenhouse gases (minus sequestration) emitted by the farm.

Relevance of the theme

In simple terms, energy is a system's ability to do work. One peculiarity of the primary sector is that it can produce more energy than it consumes. Prior to the age of fossil fuels, energy availability was determined by the area and productivity of vegetation (Radkau, 2002). The advent of fossil fuels made more energy-intensive practices feasible thanks to their high energy density (43 MJ/kg for gasoline/diesel vs. 15 MJ/kg for dry wood) and low price. Vegetated area and energy became largely decoupled as a result. Although "peak oil" is expected to occur before 2020 (Campbell et al., 2007), no such limitation of geological availability is expected in the next few decades for natural gas, coal and uranium (BGR, 2006). Barring a dramatic shift in the policy framework, the importance of fossil fuels is expected to decline gradually.

Statistically recorded annual average global per-capita energy consumption stood at 74 GJ in 2012 (IEA, 2013), while the corresponding figure for Switzerland was 144 GJ (BFE, 2013). The energetically utilizable productivity of vegetation in Central Europe amounts to between 20 and 250 GJ/ha per year. In the tropics, palm oil plantations can yield as much as 5,000 liters of oil per hectare, corresponding to more than 200 GJ/ha. Even with major improvements in energy efficiency (e.g. Weizsäcker et al., 1997), there is no prospect of a full return to a vegetation-based energy supply system.

Improvements in farm energy sustainability can be achieved by reducing energy consumption and using energy from renewable sources. Particularly energy-intensive processes include heating of buildings, milk cooling, barn ventilation, hay drying using fuel oil, feed distribution, tillage (plowing 1 ha to a depth of 25 cm requires approximately 25 liters of diesel), irrigation and greenhouse heating. Energy demand can be reduced by using heat exchangers and heat pumps and through better insulation (Agridea, 2010). Farms can also produce energy in the form of biogas, firewood, agro-fuels, solar power (electricity or heat) and wind and water power (Agridea, 2010).

Climate

Weather and climate conditions within the ecological tolerance of the regional flora and fauna are essential for the productivity and stability of natural and agricultural ecosystems. Weather records, data obtained from ice cores and sediments, observations of plant phenology and other evidence all indicate that the climate is warming in nearly every part of the globe. Increases in emissions and atmospheric concentrations of greenhouse gases (GHGs) that affect the climate such as carbon dioxide, methane and nitrous oxide have also been documented. It is thought to be highly likely that these increased concentrations are a cause of global warming (IPCC, 2007). Further increases of atmospheric GHG concentrations are expected in the future and it is predicted that these will cause a rise in mean global temperatures of at least 0.2°C per decade. Higher latitudes will probably experience even more pronounced warming (Fig. 18). Rainfall is forecast to become more variable overall (Dore, 2005). The predicted impacts of climate change on agriculture include yield gains at higher latitudes and losses at lower latitudes, more severe pest damage and increased soil erosion caused by torrential rain (Gregory et al., 2005; Weigel, 2005; Smith et al., 2007). The frequency of storms, heatwaves, flooding and landslides is forecast to rise, while the incidence of lightning increases exponentially in relation to rises in mean monthly temperature (Rosenzweig et al., 2001).

Methane emissions from livestock production, nitrous oxide and carbon dioxide released from arable land (due to N fertilization and from paddy rice production) and carbon dioxide emissions from the burning of fossil fuels contribute roughly 15% to the man-made component of the greenhouse effect

(Baumert et al., 2005; Smith et al., 2007; Fig. 19). Emissions of a similar magnitude are caused by the conversion of forests into agricultural land. Slash-and-burn practices, livestock farming and N fertilization are the principal sources of carbon dioxide, methane and nitrous oxide emissions (Steinfeld et al., 2006; Burney et al., 2010). Post-harvest burning of crop residues and the use of slash-and-burn on wasteland and woodland not only contributes to climate change but also harms human health and the economy, as well as potentially causing soil damage (Fig. 20).

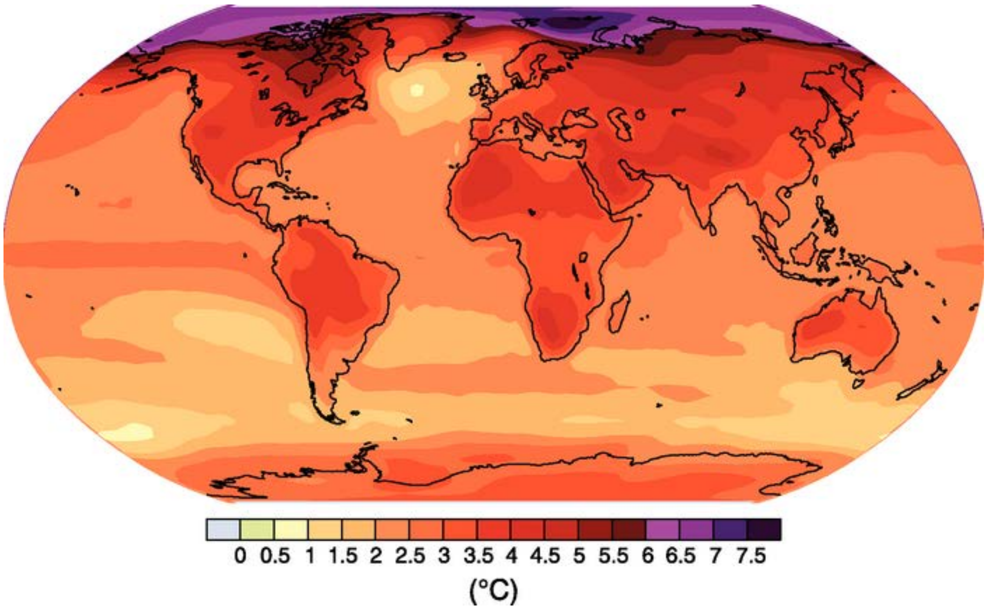

Figure 18. Projected temperature changes between 1980-1999 and 2090-2099 (Scenario A1B SRES; IPCC, 2007).

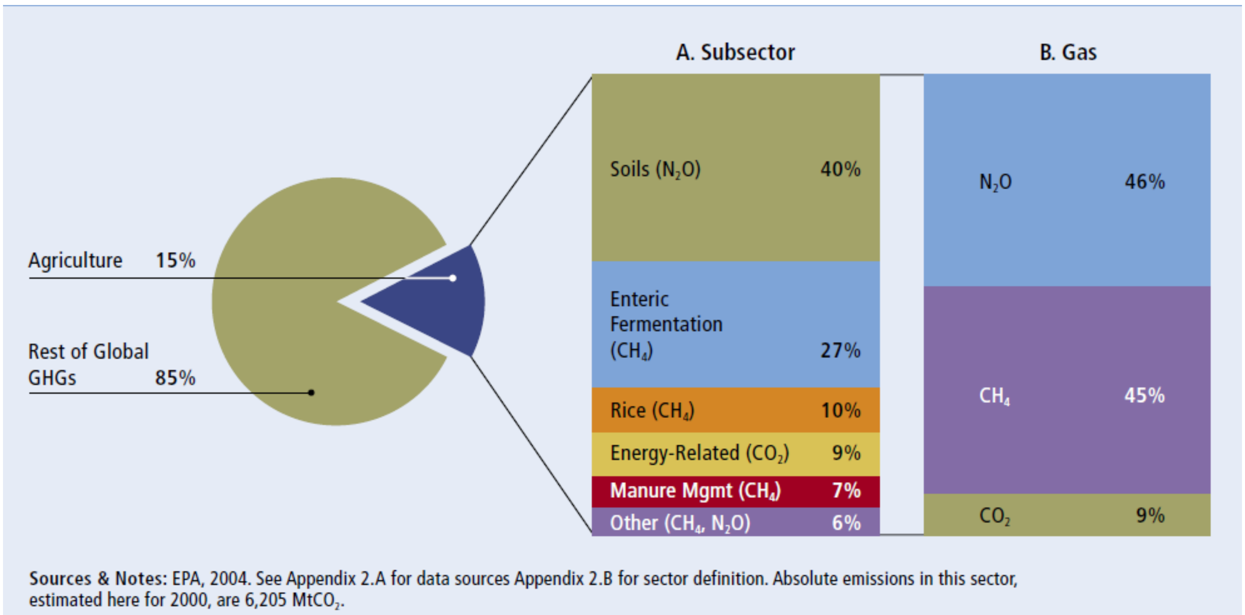

Figure 19. Man-made greenhouse gas emissions by source (Baumert et al., 2005).

Figure 20. Left: smoke clouds caused by slash-and-burn in South-East Asia, March 2010 (www.eosnap.com). Right: area cleared by slash-and-burn, Ntoaso, Ghana (photo: Jan Grenz).

During the last 300 years, approximately 170 Gt of carbon (C) have been released into the atmosphere through deforestation and tillage, a figure that continues to rise by 1.6 Gt each year (Hillel & Rosenzweig, 2009). According to Burney et al. (2010), emissions of 87 to 161 Gt C were prevented between 1961 and 2005 because higher yields meant that less new land was converted to agricultural use. Some of the GHG emissions could be sequestered through agricultural and forestry measures such as reduced tillage, measures to increase soil organic matter (SOM) content, more efficient use of N fertilizers, optimized irrigation practices in paddy rice cultivation, methane capture and use in biogas plants and, under certain circumstances, the production of biofuels (Reinhard & Zah, 2009; Schahczenski & Hill, 2009). In temperate climates, C sequestration rates of between 0.1 and 0.8 t per hectare per year have been measured following conversion to no-till drilling and improvements in crop rotation. However, this effect ceases when a stable site-specific SOM level is reached, typically within 20 to 50 years (Smith et al., 2007; Hillel & Rosenzweig, 2009). Larger amounts of C could be sequestered through afforestation and the conversion of arable land into grassland. The “Clean Development Mechanism” and “Joint Implementation” mechanism were established under the UN’s Kyoto Protocol as funding mechanisms for projects geared towards reducing GHG emissions and promoting C sequestration.

Scientific evidence suggests that the most we can now hope for is to mitigate climate change. Taken together with the variability in weather conditions that is already occurring, this means that it will be important for agricultural production systems to be sufficiently resilient. Potential measures include the establishment of buffers (SOM content, water storage and product storage facilities), protection against damage (measures to prevent erosion, flood defenses, hail netting, etc.), risk spreading through diversification (different crops, livestock genetic diversity, permanent crops, several different production sectors and potentially income from off-farm sources) and insurance against damage (hail insurance, livestock insurance, fire insurance and invalidity insurance).

Various indicator systems (e.g. Breitschuh et al., 2008; Christen et al., 2009) calculate energy balances by comparing the energy content of agricultural produce with that of the energy carriers and other inputs used in production. However, many agricultural products cannot be used as a source of energy. Products with low energy content such as cotton or ecological priority areas that are “unproductive” in terms of energy receive low ratings in these energy balances. The energy intensity of production by area and productivity by area (in kg of product/ha) are therefore calculated separately in RISE and not combined into a single figure. A similar approach was adopted by Vilain et al. (2008). The energy input for human and animal labor is not taken into account in RISE. Farm energy use is corrected for energy imports and exports resulting from contract work. In view of the fact that fossil fuel reserves are finite and given the impact that burning them has on the climate, farms should endeavor to switch over to sustainable, renewable energy sources. RISE therefore assesses the percentage of the farm’s total energy consumption that is accounted for by renewables.

Unlike life cycle assessments (LCAs) and related methods, RISE is not based on a life cycle approach. The energy use, emissions and resource consumption associated with the manufacture of production inputs and machinery are not included. The aspects that are relevant for inclusion depend on the factors that each stakeholder is able to influence – it is these factors that should determine their responsibilities. If at all possible, stakeholders should not be held responsible for factors that they cannot influence. Information on nutrient use efficiency is thus relevant to farmers so that they can minimize nitrogen loss to the environment, make the best use of manure and avoid buying in unnecessary mineral fertilizers. On the other hand, the energy intensity of fertilizer production is relevant to fertilizer manufacturers who want to minimize energy costs and threats to their business. Finally, the emissions and other environmental impacts resulting from energy production are relevant to politicians, consumers and energy providers, i.e. the stakeholders who shape and pay for the energy system.

The most authoritative means of calculating GHG emissions is the method developed by the IPCC (IPCC 2007) which links processes with specific emission factors (www.ipcc-nggip.iges.or.jp/EFDB/main.php). It is used as the basis for calculating the carbon footprints of people, enterprises and countries (Wiedmann & Minx, 2008). Agricultural emissions of CO_2, CH_4 and N_2O as well as C sequestration can be quantified using computer-based tools such as GAS-EM (Dämmgen et al., 2002), Holos (Janzen et al., 2005) and CALM (www.calm.cla.org.uk), all of which are calibrated for the temperate climate zone. The calculation of GHG balances in RISE is based on the FAO'S EX-ACT program (FAO, 2009) which is designed for global applications.

Indicator ec_1: Energy Management

Sustainability goal

Sustainable energy use is facilitated through the active deployment of knowledge and technology.

Content

This indicator is only calculated if energy is actually used on the farm (as opposed to only human and animal labor). Interviewees are questioned about whether energy consumption is monitored, whether the potential for producing renewable energy on the farm is being used, whether they are aware of the potential energy-saving measures that could be implemented on the farm and the extent to which such measures are actually being implemented.

Scoring

100 points = energy consumption is monitored, full use is made of the potential for producing renewable energy, there is an awareness of the potential energy-saving measures and these are fully implemented.

Explanation

If a farmer is already taking steps to reduce energy use and become less dependent on fossil fuels, this should be recognized and made visible by RISE. Conversely, the absence of such measures can be taken to indicate a need for advice in this area. Targeted measures require an awareness of the (quantitative) situation, i.e. dependencies, bottlenecks and the overall importance of the energy supply to the farm. The measures that have been implemented on the farm are selected from a list of potential energy-saving measures. A fixed scoring system awards points to all measures based on their effectiveness and these are then added up to give a final score.

Indicator ec_2: Energy Intensity

Sustainability goal

Agricultural production is not reliant on non-sustainable energy sources.

Content

The utilization intensity and the percentage of non-renewable energy carriers on the farm are calculated in a single indicator. This involves establishing the quantity and, where relevant, energy density of all energy carriers used. Only the farm's direct energy consumption is taken into account, while gray energy is not included (i.e. the energy "contained" in buildings, machinery and production inputs). Unlike in RISE 2.0, the term "renewable energy" is now preferred to "sustainable energy use", since there is no guarantee that even renewable energy can be used sustainably (Ellenberg, 1996; Anton & Steinicke, 2012).

Scoring

In RISE 3.0, energy intensity is scored using a sigmoid curve. The scoring function is based on the data gathered during 15 years of experience with RISE 1 and 2 and has been calibrated to be highly sensitive in terms of the scores awarded to energy-intensive farms in industrialized nations. The percentage of renewables has a modulating effect – a higher percentage of renewables leads to a higher score for the same energy intensity value (the curve shifts to the right) and a somewhat greater tolerance range up to the transition point (widening of the curve) (Fig. 21).

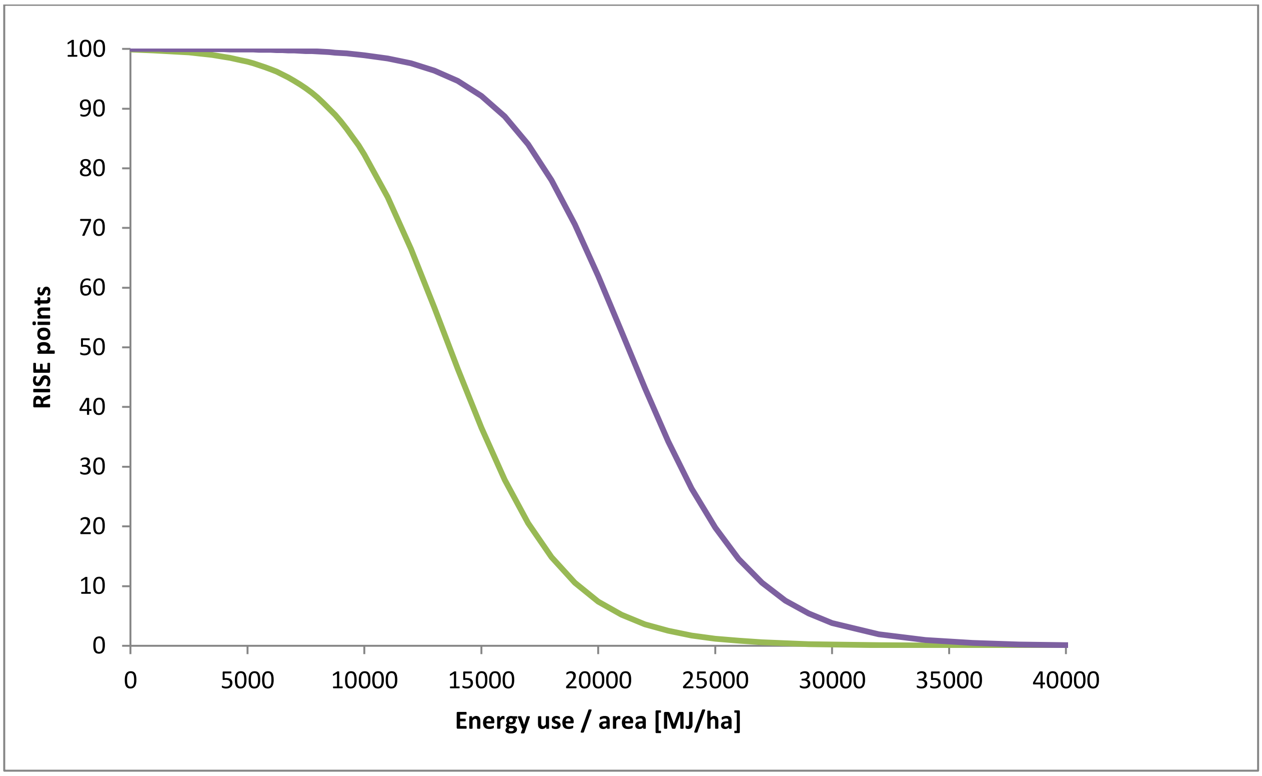

Figure 21: Example of the energy intensity scoring functions for 50% (green curve) and 100% (purple curve) renewables.

Explanation

Energy plays an extremely important role in farming. There is actually no shortage of energy on the Earth's surface – agricultural areas receive far more energy in the form of solar radiation than is required by agricultural production – and its use in farming need not necessarily be harmful to the environment. However, since the main energy sources currently used in agriculture – diesel and electricity – are mostly derived from fossil fuels, agricultural energy use is not presently sustainable.

Since the production of energy under the current energy system places high demands on land and resources and causes damage to ecosystems (Wackernagel & Rees, 1996; Gill, 2005; Hötker et al., 2006), the RISE scoring system penalizes very high energy intensities even if only renewable energy is used. The goal should be both to reduce energy intensity and to completely abandon the use of non-renewable energy sources (IPCC, 2013).

Indicator ec_3: Greenhouse Gas Balance

Sustainability goal

The annual net GHG emissions of the area of the farm used for production do not exceed the amount that it would need to emit in order to prevent a rise in the average global temperature of more than 2°C compared to pre-industrial levels.

Content

A GHG balance is calculated using data on land and energy use, production methods, animal husbandry and land use changes, and is then rated against global and/or EU benchmarks.

Scoring

The scoring function awards points as follows (Fig. 22): 100 points = 1.1 t CO_2 eq./ha (average global emissions in 1990), 67 points = 2.0 t CO_2 eq./ha (EU 15 average in 1990 minus 20%), 50 points = 2.5 t CO_2 eq./ha (EU 15 average in 1990), 0 points = 5 t CO_2 eq./ha (twice the EU 15 average in 1990). The benchmark values are based on data in Nabuurs et al. (2007), Smith et al. (2007), FAOSTAT (faostat.fao.org) and EEA (2013). Only a limited reduction of GHG emissions will be possible if demand for agricultural products remains unchanged. The estimated feasibility of reductions is based on data in Weiske et al. (2006).

Explanation

RISE 3.0 calculates GHG emissions/sequestration for the following processes: land use change, burning of biomass, use of production inputs (fossil fuels) and livestock production.

Direct methane (CH_4) emissions from ruminants are calculated using the method described by Mills et al. (2003), which calculates the quantity of CH_4 based on the amount of dry matter fed to ruminants. The equation used provides a sufficient degree of accuracy for individual projections (Mills et al. 2003).

Calculation of indirect CH_4 emissions resulting from slurry storage is based on the IPCC (Level II) approach (IPCC, 2006), which takes account of livestock species and number, ambient temperature and slurry management. Unlike the IPCC approach, however, RISE 3.0 uses linear interpolation to fill in the gaps between the extremes, resulting in some deviation from the original values. RISE 3.0 also differs from the IPCC (2006) tables in that interviewees are only asked for information about livestock farming intensity and slurry management and not about the region. The descriptions are based directly on the original IPCC criteria (1996). Nitrous oxide (N_2O) emissions produced by slurry storage or spreading are not included. CH_4 emissions resulting from slurry storage are rated as zero if the slurry is fermented in biogas plants.

The calculation of N_2O emissions resulting from nitrogen application is based on IPCC (2006) Level I. The total quantity of N applied/input is used to produce an FIE (fertilizer-induced emissions) estimate for 1% of the N total (IPCC, 2006). The N sources taken into account are livestock excreta minus gaseous losses during livestock production and application, mineral fertilizers, atmospheric N deposition and N fixation by legumes. It is assumed that there is no difference between N from organic and inorganic compounds (Stehfest & Bouwman, 2006). Nitrogen resulting from N fixation by legumes is included owing to the lack of information on this aspect (Rochette & Janzen, 2005).

The calculation of emissions from crop residue burning assumes that 80% of the dry matter is burned and that 0.07 kg N_2O and 2.7 kg CH_4 are produced per ton of dry matter. Fixed, region-specific (CO_2 eq.) values are used for the burning of grassland and woodland. The quantity of CO_2 fixed through afforestation is based on a region-specific time period and calculated in proportion to the time elapsed between the year of afforestation and the year of analysis. In accordance with the Kyoto Protocol rules, CO_2 emissions purely from livestock respiration and the burning of crop residues and grassland are not taken into account. In both cases, the same quantity of CO_2 was/continues to be fixed by plants.

RISE 3.0 permits the selection of certain individual land use measures that result in C fixation or release. Only those measures that do not go back more than 20 years and are implemented on a permanent basis are taken into account. The baseline figures are taken from Freibauer et al. (2004).

The calculation of methane emissions from paddy rice cultivation is based on the IPCC (2006) livestock Level I approach, which takes both irrigation (natural/artificial) and drying out frequency into account. The extremely high variability of methane emissions in wetlands (Frolking et al., 2011) is not considered, meaning that the calculation only provides a rough estimate.

In RISE 3.0, the global warming potential of methane and nitrous oxide is set at 28 and 298 CO_2 equivalent respectively (GWP_{100} in IPCC, 2013). As in the calculation of energy intensity, "gray" emissions from the production of inputs such as mineral fertilizers and pesticides are not taken into account.

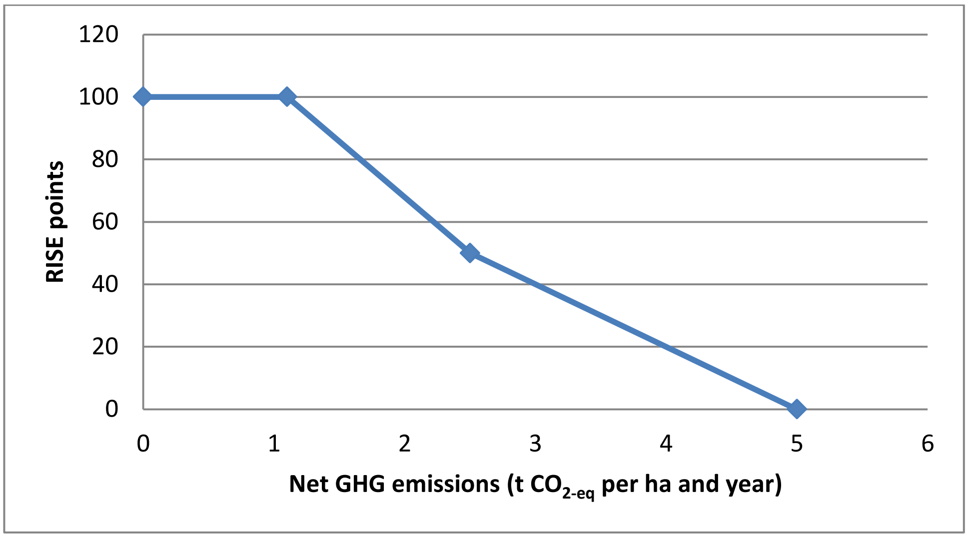

Figure 22. Scoring function of indicator ec_3.

In RISE, one global GHG scoring function is used for all farm types because, from an ecological point of view, there is no justification for using a different scoring method based on either the location or the source of the agricultural emissions.

3.6 Theme: Biodiversity (bp)

Theme

The diversity of living organisms and the health of ecosystems are closely connected. Indeed, agricultural production and human life itself are only possible at all thanks to the regulation of water, nutrient and gas balances, pollination, soil formation and other functions performed by ecosystems. This topic addresses:

- what is being done to promote the diversity of species, varieties and breeds on the farm,
- how well natural ecosystems are preserved and connected within the agricultural landscape,
- the quality of plant protection management and
- whether substances that are toxic to humans and nature are used for crop and livestock protection.

Relevance of the theme

Biodiversity is the diversity of ecosystems on Earth, the diversity of the species in these ecosystems and the diversity of the genome within these species (www.cbd.int). It is not only essential to humankind because we utilize a wide variety of different species – by providing services such as pollination, soil filter functions and nutrient cycle regulation, intact and diverse ecosystems in fact form the basis of life on Earth. The functioning of ecosystems and their ability to provide us with what we need to live is closely, albeit not always causally, linked to biodiversity (McCann, 2000; Loreau et al., 2001; Hooper et al., 2005; Lepš, 2005; Balvanera et al., 2006). To protect biodiversity, the Convention on Biological Diversity (CBD; www.cbd.int) was adopted at the UNCED summit in Rio de Janeiro in 1992.

The global economic value of ecosystem services was estimated at 16 to 54 trillion USD per year by Costanza et al. (1997), compared to a global GDP of 18 trillion USD at the time. The global value of pollination alone was estimated by Gallai et al. (2008) to be 240 billion CHF/year. One of the direct benefits that biodiversity provides to agriculture is pest control. For example, the introduction of the parasitoid *Epidinocarsis lopezi* 25 years ago in Africa in order to control the cassava mealybug prevented huge economic losses and possibly even famine (Neuenschwander et al., 2003). Similar projects have prevented major crop failures in California, Australia and Europe (Wood & Lenné, 1999). The returns of measures to protect biodiversity and ecosystems are estimated to exceed the associated costs by a factor of 10 to 100 (TEEB, 2009).

In recent decades, humans have profoundly altered the world's ecosystems across large parts of the world. Between 1950 and 1980 alone, more areas of natural ecosystems were transformed into agricultural land than between 1700 and 1850. Today, more than one quarter of the Earth's land is used as arable land or pasture (MEA, 2005). Intensive fertilization, plant protection and tillage create homogenous, eutrophic conditions across large areas. The consequences include species loss and damage to ecosystem services (Pimm & Raven, 2000; MEA, 2005). Land use change will continue to pose the greatest threat to biodiversity in the future (Sala et al., 2000).

Agriculture is a custodian of both wild and agricultural biodiversity in and around the areas it manages. It has several powerful means of influencing biodiversity at its disposal: allocation of land to different uses, crop rotation design, selection of species, varieties and breeds, and choice of farming practices. Both the landscape's structural variety and farming practices have an important influence on biodiversity in agricultural landscapes. According to Fischer et al. (2001), the sustainability principle requires that landscapes should be used efficiently and be pervaded by a network of regionally characteristic ecotone and biotope structures. Ecological infrastructures that play a valuable role in protecting biodiversity at farm level include e.g. stands of trees and bushes, hedgerows, field margins hosting a diversity of herbaceous plants, managed and unmanaged fallows and nutrient-poor grassland. A network of ecological infrastructures may consist of extensive protected areas interspersed with stepping-stone and corridor habitats. The quality of the network depends on the mutual proximity of similar habitats (Boller et al., 2004).

Numerous approaches and methods have been developed for quantifying biodiversity (Magurran, 1988; Krebs, 2001; Buckland et al., 2005). The fundamental problem is that even incomplete biodiversity recording is extremely costly. Some approaches therefore only consider selected taxa that are taken to be representative of particular functional groups of organisms. However, for many landscapes there is insufficient knowledge about which species are best suited to this approach. The methods used to evaluate agricultural practices include criteria lists and points systems. The system developed by IP Suisse (www.ipsuisse.ch/?id=143&fid=4271), for example, includes lists of crop-specific measures to promote biodiversity, including rotation breaks, green manure, "skip-row" seeding of cereals, mowing of grass at staggered intervals and the establishment and management of ecological compensation areas and structural diversity (IP-Suisse, 2009).

RISE also assesses biodiversity indirectly based on the diversity of the wild and farmed plant and animal species on the farm and the ecological quality of the landscape. Indirect indicators include the percentage of land that is ecologically valuable or important to local culture (stands of trees and bushes, hedgerows, uncultivated field margins, etc.), participation in agri-environment schemes, number of crop species and varieties and livestock breeds, mixed cropping, conservation of regional varieties and breeds and plot size (Christen & O'Halloran-Wietholtz, 2002; Oppermann, 2003; Breitschuh et al., 2008; Pretty et al., 2008; Vilain et al., 2008). These indicators are captured partly at the farm level and partly at the landscape level.

Where an assessment of biodiversity is required, it is necessary to establish what the goal is. Should biodiversity in the landscape be as high as possible? Or should the ecosystem approximate its natural state as closely as possible? Since RISE considers agricultural landscapes, we have opted for a compromise between these two goals: natural ecosystems should be provided with the space needed for their preservation, while the farmed areas should host a region-specific minimum level of biodiversity.

RISE land category definitions

The RISE analysis records and assesses the land used by the farm separately according to its type and use. This is necessary in order to ensure that RISE adequately reflects the diversity of the land on the farm in terms of its ecological characteristics and habitat potential. Figure 23 provides a breakdown of the land categories used in RISE. The land category hierarchy goes from left to right.

Farmland	Farmable areas	Production-oriented areas	Grassland
			Arable land
			Permanent crops
		Ecological infrastructures	Planar →e.g. extensive grass
			Linear →e.g. hedgerows, banks
			Dotted →e.g. individual trees, rock piles
	Areas of land that cannot be used for agriculture	Area with buildings, sealed land → e.g. farmyard, buildings, paths	
		Other → e.g. waterbodies, quarries, gravel pits, rocky ground, reserves	
	Woodland → no/extensive exploitation		
Common land			

Figure 23. Breakdown of land categories in RISE 3.0

Indicator bp_1: Biodiversity Management

Sustainability goal

The farm has a biodiversity management system that incorporates a strategic and systematic approach to planning, decision-making, implementation and monitoring of activities geared towards species protection and ecosystem conservation.

Content

The farm should either be receiving comprehensive advice on biodiversity or have a knowledge of the current situation. There should also be planning and implementation of species and habitat protection measures and monitoring of the success of any measures implemented. A variety of farming measures to promote biodiversity should be implemented in the agricultural area (and optionally also unproductive land, woodland).

Scoring

100 points for comprehensive advice on biodiversity or a knowledge of the current situation, planning and implementation of species and habitat protection measures and monitoring of the success of any measures implemented. In addition, a variety of farming measures to promote biodiversity should be implemented in the agricultural area (and also optionally unproductive land, woodland).

Explanation

"Conscious" management: Sustainable agricultural production requires conscious management of the different natural resources that a farm uses and influences. As one of these resources, biodiversity is strongly affected by the methods used in production (see sources for the "intensity of agricultural production" indicator). Farmers thus have a responsibility to protect and promote biodiversity and to make sure that they do not harm it.

In order to ensure that a given site's biodiversity is maintained and is not damaged as a result of unintended impacts or changes in farming practices, the farmer must have a fundamental sensitivity to and knowledge of this subject and its context (Hungerfold & Volk, 1990). Active biodiversity management may then involve farmers obtaining external advice and support in order to develop decision-making guidelines and potentially also help with the implementation of measures, although this may also be done by the farmers themselves. In order to ensure a systematic approach to management, it is recommended that the "plan, do, check, act" management cycle should be adhered to – this approach is also used in the Eco-Management and Audit Scheme (EMAS) and ISO 14000. As far as rare species or protected habitats are concerned, the first step of this approach is for the farmer to be informed about the actual and potential presence of such species/habitats on the farm. The next step is to use this information to develop and implement specific individual measures. The third step is to monitor the success of the measures that have been implemented and the final step is to carry out any necessary amendments to the measures.

<table>
<tr><th>Indicator</th><th>Sub-indicator</th><th></th><th>Affected biodiversity level</th></tr>
<tr><td rowspan="6">Biodiversity management</td><td rowspan="2">"Conscious" management</td><td>Protected species</td><td>Wild plant and animal species</td></tr>
<tr><td>Protected habitats</td><td>Cultivated areas (e.g. species-rich grassland), biotopes not used for agriculture (e.g. stands of trees/bushes, waterbodies) and intermediate areas (e.g. hedgerows)</td></tr>
<tr><td rowspan="4">Measures to promote biodiversity</td><td>Crop production</td><td rowspan="4">Direct impact (impact of mowing technique on insects and small animals) and indirect impact (presence of more cultivated species creates conditions for more wild species) on wild species diversity</td></tr>
<tr><td>Grassland</td></tr>
<tr><td>Permanent crops</td></tr>
<tr><td>Woodland (optional)</td></tr>
</table>

Figure 24: Content of biodiversity management indicator

For reasons of efficiency, in this component of the indicator RISE concentrates on selected areas of biodiversity and selected steps in the management cycle. It therefore focuses on the management of protected and wild plant and animal species where the first three steps in the cycle are selected and on the management of protected habitats (e.g. dry grassland, reed beds, natural hedgerows, wetlands) where the first two steps are selected. Most of these habitats are affected by human activity and can include both cultivated land (e.g. species-rich grassland) and biotopes not used for agriculture (e.g. stands of trees/bushes, waterbodies). The management cycle should ideally incorporate all four steps and all aspects of biodiversity for every area. This means that a comprehensive biodiversity management system would include the conservation and promotion of genetic diversity.

Measures to promote biodiversity: In addition to the planning aspects covered by the first component of the indicator, biodiversity management also includes concrete farming measures. It has been shown that different farming practices have different impacts on biodiversity. For instance, the extent to which insects and other small animals are harmed varies depending on which mowing technique is used. Scythes and sickle bar mowers are relatively low-impact techniques, whereas mortalities of up to 80%

can be expected if rotary mowers with conditioners are used (Humbert et al., 2009; Fluri et al., 2011). RISE has one list with a selection of corresponding measures for each different type of land use. There is also always an open-ended category for measures not contained in the list.

Crop production measures:

- Undersown crops in crop production
- No use of insecticides, fungicides or growth regulators
- No use of herbicides
- No use of mechanical weed control (without seedbed preparation)
- Other measures (e.g. mixed cropping of cereals and vegetables, winter planting with intercrop or green manure during winter months, measures to promote soil organisms: use of manure compost, soil-friendly crop production: no plowing, no-till drilling and rotary band seeding, higher percentage of leys in rotation, diversity of botanical families in vegetable cultivation)

Measures for grassland:

- Use of sickle bar mowers
- No use of mower conditioners
- Mowing at staggered intervals
- Delayed mowing (after main flowering season)
- No silage
- No use of PPPs on grassland
- Other grassland measures (e.g. strips of grassland left unmown as cover for small animals)

Permanent crop measures

- Ecologically valuable margins, e.g. hedgerows, hedgerows and bushes in fruit cultivation, extensive grass and wild herb strips along orchard margins
- No clearing or burning (e.g. removal of standard fruit trees)
- Ground cover managed to promote biodiversity, e.g. greened driving lines, no herbicides, alternate mowing/mulching of driving lines
- Significant proportion of extensive/unused species (e.g. shade trees, dead wood, plants that are not fertilized or treated with PPPs)
- No PPP use
- Other measures (e.g. cultivation of resistant fruit varieties, reduced use and use of nature-friendly plant protection products in fruit cultivation, leaving brush piles, rock piles, wood piles, wild bee hotels and lacewing boxes)

Measures for woodland (optional)

- Ecologically valuable forest margins
- Graduated, improved woodland margins with adjacent biodiversity areas
- No (unsustainable) clearing or burning
- No PPP use
- Other measures

Since the impact on biodiversity depends on the type of land that is being managed in one or other of the ways listed above, the percentage of each land type is estimated on a five-level scale, with the points totals being weighted by land type before being added together to give a final score.

A variety of methods are used in practice to assess the impact of management on biodiversity. Examples from Switzerland include the IP-Suisse points system and the list of measures developed by Bio-Suisse. The points from these other systems can be input into RISE which then directly converts them into the corresponding RISE score. This is done on the following basis:

Table 8: IP-Suisse biodiversity points/number of measures and corresponding RISE points.

IP-Suisse points	Number of measures (Bio-Suisse)	RISE points	Impact on biodiversity
0	0	0	Very negative
9	6	33	Negative
13	9	50	Average
17	12	67	Positive
≥23	≥17	100	Optimal

Indicator bp_2: Ecological Infrastructures

Sustainability goal

The farm hosts several areas with high biodiversity potential that provide a habitat for rare and specialized plants and animals.

Content

An assessment is made of the percentage of the agricultural area that has a high ecological value (planar, linear and dotted structures). The area being assessed can be optionally extended to the entire farm area.

Scoring

100 points are awarded if 17% of the farm has high biodiversity potential. This figure is based on the UN Convention on Biological Diversity (Nagoya, Aichi), which states that 17% of terrestrial areas should be managed for nature. This threshold may be adjusted at regional level.

Explanation

Many plant and animal species require ecologically valuable habitats for their survival. The extreme changes in the cultivated landscape and the intensification of agriculture that have occurred over the past 50 years have led to a reduction in biodiversity. The experts agree that areas managed for nature are required if biodiversity is to be preserved. In addition to nature reserves, these may also include areas in forests and on cultivated land, since many species require extensively managed land. Research into the ecological effects of government agri-environment schemes in Switzerland reported positive impacts for most groups of organisms. However, the programs' effectiveness was highly dependent on the ecological quality of the areas, e.g. their structural diversity (Knop et al., 2006).

This indicator reflects the percentage of the farm area that has a high ecological value. By default, only the area used for agriculture is assessed. The RISE extension agent may broaden the scope of the assessment to include the land use types "farmyard, buildings and roads", "unproductive areas" and "woodland". The ecological value of the various areas is estimated by the farmer. Protected status (per nature conservation agreements), participation in agri-environment schemes (CH: ÖQV-Q[14], IPS[15]: areas meeting project standard) and comparisons with reference photos can yield useful information about whether an area is ecologically valuable.

The targets proposed by the experts for the proportion of ecologically valuable land range between 15% and 20% (IOBC, 2004; UN, 2010). The UN's Nagoya Protocol on the conservation of biodiversity calls for 17% of all terrestrial areas (not just agricultural areas) to be managed for nature. Accordingly, the standard optimal percentage of ecological priority areas (worth 100 points) has been set at 17%. In other words, this indicator measures the farm's contribution to the achievement of the UN conservation target. Where sound reasons exist, this target may be altered at regional level by the RISE extension agent.

[14] CH: Ordinance on Ecological Quality: Quality Scheme
[15] IPS: IP-Suisse

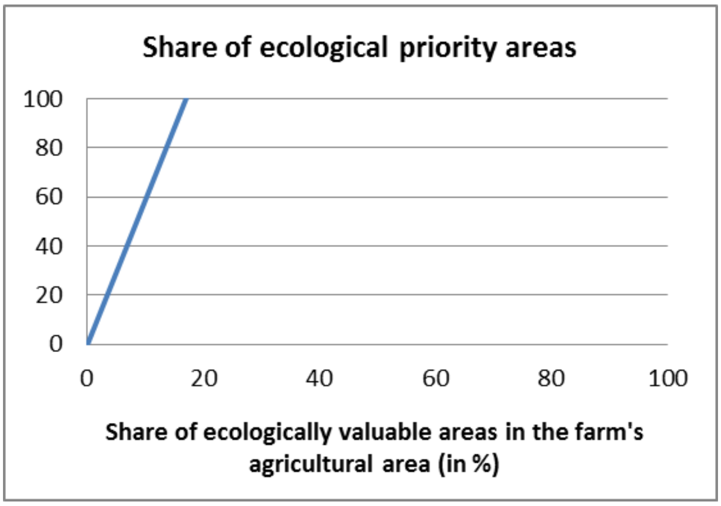

Figure 25. Scoring function for indicator bp_2. In this instance, the regional target for ecologically valuable areas has been set at 17%.

Indicator bp_3: Intensity of Agricultural Production

Sustainability goal

Production intensity is low enough to provide habitat for a diverse flora and fauna.

Content

The intensity of fertilization, PPP use and livestock production (stocking density) is calculated on an area basis and the measures taken to foster biodiversity in the agricultural area are recorded. Both aspects are then scored.

Scoring

100 points = no nitrogen fertilization (0 kg N per ha), no PPP use, low stocking density (1 Large Animal Unit per ha). These values may be adjusted at regional level. Any sprays used should have only a low level of toxicity for non-target organisms (including beneficial insects and aquatic organisms) and low persistence (half-life <1 month).

Explanation

The intensity of agricultural production strongly affects species diversity (Donald et al., 2001; Marshall et al., 2003; Green et al., 2005; Kleijn et al., 2009) as well as ecosystem functions such as biological pest control (Tscharntke et al., 2005; Geiger et al., 2010), crop pollination (Biesmeijer et al., 2006) and the conservation of soil fertility (Brussaard et al., 1997). Excessive nitrogen application substantially alters the competitive balance in plant communities, favoring fast-growing species and impoverishing species diversity (Grime & Hunt, 1975, Hawes et al., 2010).

Table 9. Breakdown of RISE indicator for assessing the intensity of agricultural production. PPP = plant protection product; AA = agricultural area.

Indicator	Sub-indicator	Assessment basis	
Total intensity	PPP	No. of PPP applications/ha Thresholds may be adapted regionally	On entire AA →Total intensity for farm. Compensation possible
			On production-oriented areas →Intensity for production areas. Limited compensation possible
		PPPs applied (harmfulness weighted by land type)	Toxicity to beneficial insects and non-target organisms →Potential to cause harm
			Degradability →Persistence in the environment
	Livestock production	Large Animal Units/ha Thresholds may be adapted regionally	On entire AA
			On production-oriented areas
	Fertilization	kg N/ha	On entire AA
			On production-oriented areas

Potential measures of intensity include productive output (e.g. yields per unit area) and the intensity of agricultural input use and management interventions (Donald et al. 2001). This RISE indicator largely follows the approach proposed by Herzog et al. (2006) for assessing intensity, in which the intensity of fertilization, PPP use and livestock production is evaluated.

As far as fertilization intensity is concerned, high levels of nitrogen application cause soil eutrophication, alter and impoverish the composition of plant communities and lead to an increased risk of nitrate leaching into the groundwater and harming aquatic ecosystems.

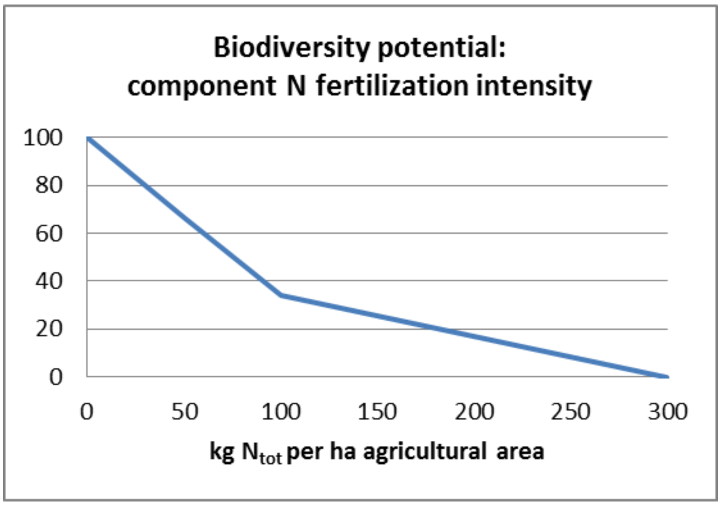

Figure 26. Scoring function for the N fertilization intensity component, one of the three components of indicator bp_3. This function may not be adapted at regional level.

As far as the intensity of PPP use is concerned, the number of PPP applications per unit area and the toxicity and persistence of the substances used are assessed. The latter are not included in the approach proposed by Herzog et al. (2006). However, toxicity and persistence are both important factors for evaluating environmental impacts (Kovach et al. 1992). In principle, the harm caused to biodiversity will increase with the number of PPP applications. The RISE scoring function can be adapted to local conditions using regional data. Split PPP treatments (splitting a single PPP application into several applications) have the advantage of enabling the quantity used to be reduced, meaning that a lower overall amount of the substance enters the environment. However, multiple PPP applications increase the amount of time that organisms are exposed to the substance, which in turn increases the amount of harm caused to them. It is therefore justified to treat individual split applications as "fully-fledged" PPP applications.

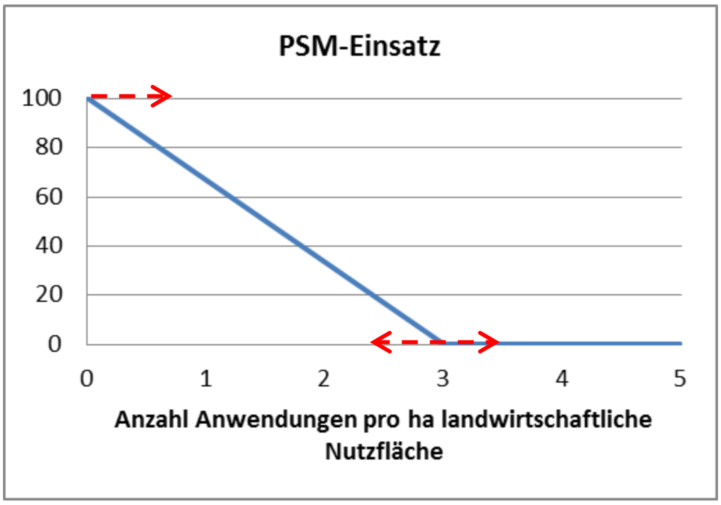

Figure 27: Scoring function for PPP use intensity. The two endpoints on the scale can be adapted to local conditions using regional data.

As far as livestock production intensity is concerned, high stocking densities result in high levels of nitrogen entering the environment, altering the composition of plant communities and potentially causing high ammonia emissions. Although stocking density is to some extent correlated with fertilization intensity, on many farms stocking density still provides a good measure of the intensity of use of pastureland and land used for fodder crop production (Herzog et al., 2006).

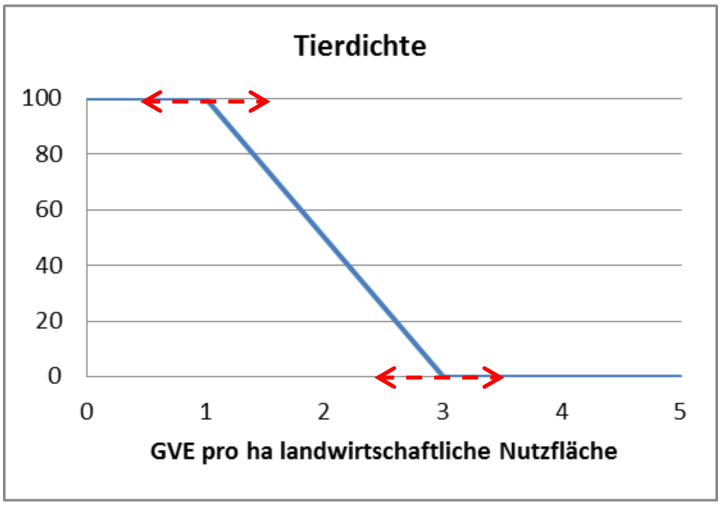

Figure 28: Scoring function for livestock production intensity. The two endpoints on the scale can be adapted to local conditions using regional data.

For all three components of this indicator (fertilization, PPP use and stocking density), the first assessment basis considers intensity across the whole of the agricultural area. This provides a measure of the overall intensity of the farm in each of these three areas. Extensively used areas compensate for the substances used on the production-oriented areas. However, in order to obtain a measure of the intensity of production-oriented areas alone, the second assessment basis only assesses the intensity of these areas. The same scoring functions are used so that the degree of compensation can be ascertained.

Production-oriented areas are defined as all agricultural areas minus any ecological infrastructures (see the RISE definitions; extensively used grassland and pastureland, hedgerows, reed beds, etc.).

Indicator bp_4: Distribution of Ecological Infrastructures

Sustainability goal

The landscape is well connected, allowing mobile animal species to move from one ecological stepping stone to another. There is no "erosion" of ecological structures.

Content

An assessment is made of the interconnectedness of ecologically valuable structures in the landscape as well as of how the proportion of these structures has evolved over the last 10 years (Fig. 29).

Scoring

100 points awarded if 100% of the arable land contains or is in close proximity (< 50 m) to ecologically valuable structures and if these structures' development has followed a positive trend (+/- 20 points). The optimal value for the ecological quality of the landscape may be adjusted at regional level.

Explanation

In addition to the percentage of the total area containing ecologically valuable structures, one measure of a landscape's ecological quality is how well these structures are interconnected. What matters is not just whether there is enough habitat to sustain healthy populations but also the spatial distribution of these habitats and whether exchanges can occur between the populations present in different locations. Sustaining stable populations can also serve the interests of agriculture, since highly fragmented landscapes have been shown by Kruess & Tscharntke (1994) to have less potential for natural pest control.

RISE establishes whether a habitat can be considered to be well connected through the use of remote sensing images (e.g. satellite images from Google Earth), maps, or visual inspection in the field. A 50 m buffer zone is mapped out around all the relevant landscape elements (hedgerows, trees, rock piles, etc.). The percentage of the farm's agricultural area that falls within 50 m of a landscape element so that it is still accessible to many organisms is then calculated. In this RISE indicator, "well connected" is thus taken to mean that several landscape elements are distributed all over the farm. If this is the case, it is assumed to be highly likely that an exchange of populations between elements will be possible, meaning that they are interconnected in the classical sense. The percentage of interconnected habitats is directly translated into a RISE score. If aerial photographs are unavailable, an assessment can be made using photographs of "reference landscapes".

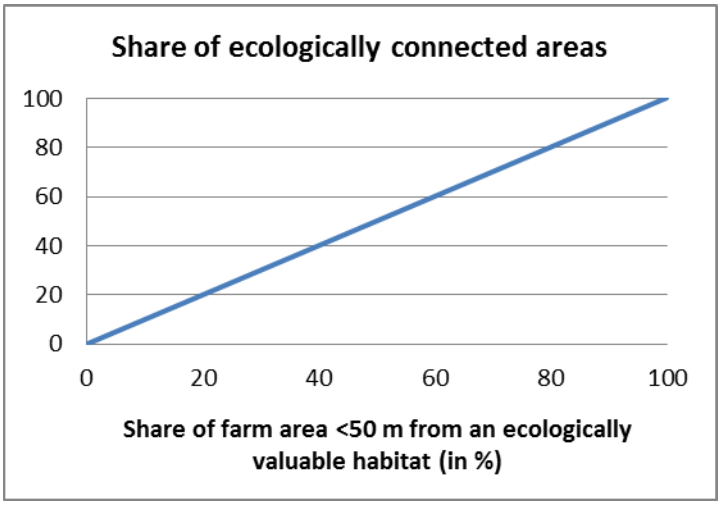

Figure 29. Scoring function for indicator bp_4.

Indicator bp_5: Diversity of Agricultural Production

Sustainability goal

Through diverse agricultural production and on-farm use of genetically diverse crops and livestock, the farm contributes to the survival and development of plant and animal genetic resources. This helps to ensure that a wide diversity of primary genetic material will still be available to future generations for breeding purposes. By growing different types of crops, the farm helps to create a more diverse cultivated landscape.

Content

An assessment is made of various aspects of production diversity: the number of different land use types, the number of arable and permanent crops grown, the number of livestock breeds on the farm (with bonus points awarded for old or endangered varieties and breeds); for permanent grassland, frequency of use and yields are evaluated; beekeeping is rated positively.

Scoring

100 points = 5 different land use types (this figure may be adjusted at regional level), 6 different livestock breeds, 3 rare and/or old breeds or varieties and bees kept on the farm, high percentage of diverse permanent grassland (assessment based on frequency of use and yield), 10 different arable and permanent crops (for >10 ha of arable and permanent crops, max. 10 crops; for under 10 ha of arable and permanent crops, 1 crop per ha).

Table 10: Content of diversity of agricultural production indicator.

Indicator	Sub-indicators	Impacted biodiversity level
	Number of **land use types**[16] (minimum area >8% AA)	Diversity of cultivated landscape

[16] **Land use types:** arable crops with no vegetable cultivation, vegetable crops, paddy rice, other arable crops, hayfields, pastureland, litter areas, unproductive arable (e.g. fallow land), unproductive permanent crops (e.g.

Diversity of agricultural production	Number of **arable and permanent crops**	Species diversity of crop types Diversity of cultivated landscape
	Diversity of **permanent grassland**	Species diversity Genetic diversity of crops and wild species
	Number of **old/rare crop varieties**	Genetic diversity of crop types Conservation of cultural heritage
	Number of **livestock breeds** on the farm	Genetic diversity of livestock
	Number of **old/rare livestock breeds**	Genetic diversity of livestock Conservation of cultural heritage
	Beekeeping	Pollination of wild species and crops Conservation of cultural heritage

Table 11: Biodiversity score based on frequency of use and yield.

Description	Typical yield [t DM/ha per year]	Biodiversity score 0-100
Unused permanent grassland	0	50
Extensive mountain pasture	1	100
Permanent grassland without legumes	2	100
Permanent pasture, 1 grazing/year (extensive use)	2	100
Permanent pasture, 2 grazings/year (low-intensity use)	3 (– 4.5)	80
Permanent pasture, 3 grazings/year (medium-intensive use)	4 (– 6.8)	50
Permanent pasture, 4 grazings/year (intensive use)	6.5 (– 9.5)	25

hedgerows), permanent crops. Extensively used woodland is not included in this assessment. Intensively used woodland usually take the form of plantations and should thus be recorded under permanent crops.

Permanent pasture, 5 grazings/year	8.5	20
Permanent pasture, 6 grazings/year	10	20
Permanent pasture tropics, artificial mix (50% legumes)	12	25
Permanent pasture tropics, artificial mix (without legumes)	12	20
Litter area (1 cut for litter)	0	100
Natural meadow, 1 cut/year (extensive use)	2.5	100
Natural meadow, 2 cuts/year (low-intensity use)	5 (– 4.5)	80
Natural meadow, 3 cuts/year (medium-intensive use)	7.5 (– 6.8)	50
Natural meadow, 4 cuts/year (intensive use)	10 (– 9.5)	25
Natural meadow, 5 cuts/year	11.5	20
Elephant grass (*Pennisetum purpureum*)	20	50
Permanent grass tropics, intensively mown (50% legumes)	25	25
Permanent grass tropics, intensively mown (without legumes)	25	20

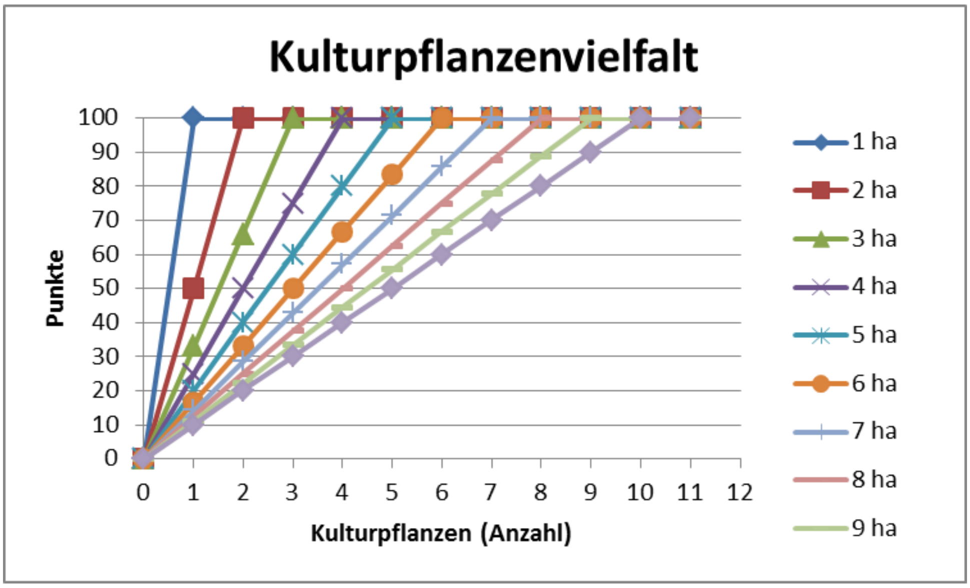

Figure 30: RISE points for number of crop types in relation to area of arable and permanent crops.

Explanation

In modern agriculture, the diversity of ancient, locally adapted or resistant crop varieties and livestock breeds has been replaced by a handful of high-performance cultivars and breeds. While this has led to improved yields and performance, it has also eroded the genetic basis of resilient production systems in many parts of the world (IÖW, 2004). The concentration on a small number of high-performance breeds, species and cultivars entails a number of risks for yields resulting from e.g. reduced disease resistance and adaptability to changing environmental conditions, as well as the danger of inbreeding depression. Where genetic diversity declines, opportunities for future breeding programs are irretrievably lost, impairing adaptability to unforeseen disease threats or changing environmental conditions (BfN, 2010). Declines in genetic diversity also result in loss of cultural heritage, since many native breeds and varieties are of cultural and historical importance. Examples include the Hérens cattle used in cow fighting in the Swiss canton of Valais and the Rheinthaler Ribelmais ancient corn variety or Swabian lentils that are an important part of local recipes and customs.

The conservation of livestock breeds and crop varieties through their use on farms makes an important contribution to the protection of genetic resources and provides an opportunity to safeguard, maintain and develop valuable cultivated landscapes (BfN, 2010). This can in turn provide both agronomic (rotation, pest control, soil conservation) and economic (risk spreading) benefits. Diversification can also be advantageous in terms of workload and is often socially desirable, since it enriches the landscape.

Farms that grow ancient, local, endangered and/or disease-resistant fruit, vegetable or cereal varieties make an important contribution to crop genetic diversity conservation. This may involve arboretums (orchards with several different local varieties) or the cultivation of ancient vegetable or cereal varieties. By allowing farmers to preserve their independence and combat monopolies, it can also have a positive impact on costs over the longer term.

Honey bees and other insects contribute to the value of farm harvests by pollinating crops and wild plants. In addition to the direct benefits of pollination, beekeeping can also be expected to provide indirect benefits, since bees require a continuous supply of flowering plants, something that is more commonly found in small-scale landscapes. The presence of honey bees also requires farmers to take particular care over which plant protection products they use, and this in turn benefits wild pollinators, other insects and the subsequent parts of the food chain.

3.7 Theme: Working Conditions (wc)

Theme

A committed and productive labor force is a basic requirement for a successful farm. Both of these traits are strongly influenced by on-farm working conditions. This indicator assesses the objective working conditions for farm employees and self-employed farm labor. The following aspects are addressed:

- occupational health and safety/physical working conditions,
- work organization,
- respect of basic rights,
- remuneration,
- justice.

Relevance of the theme

Since poor working conditions result in employees having to take time off work, dissatisfaction and reduced productivity, they are directly linked to economic success (Antle & Pingali, 1994; Bronnum-Hansen, 2000; Shikdar & Das, 2003). Specifically, long working hours increase the risk of accidents, (Härmä, 2006), contact with chemicals and pesticides can lead to acute or chronic diseases (Dich et al., 1997; Gorell et al., 1998; Bin Nordin et al., 2002; McCormick et al., 2002) and the inhalation of dust can cause lung damage (Thaon et al., 2006).

Work-related accidents and diseases result in high economic costs that affect both regional and national development. The negative repercussions include the impact on the social networks that have to support the victims, as well as reduced tax revenue and lower productivity. In addition to economic arguments, there are also ethical reasons for why good working conditions are indispensable to sustainable development. A variety of national and international regulations set out standards for healthy and humane working conditions (UN human rights, ILO, SUVA Guidelines, Swiss federal laws, etc.).

Problematic working conditions are widespread in agriculture. Far more (self-employed) people report long working hours in agriculture than in any other sector (EWCS, 2007). In Switzerland, the number of occupational accidents in the agricultural sector is second only to the construction industry. The low profit margins of the primary sector and the widespread employment of low-skilled workers lead to low wage and income levels (Worldwatch Institute, 2003; EWCS, 2007), in spite of the fact that the work is often hard and sometimes dangerous. According to the Job Stress – Health model of Hurrell and McLaney (1988) (Fig. 31), work-related stressors can cause both acute psychological, physiological or behavioral reactions (low motivation, dissatisfaction, physical ailments, accidents and employees taking time off work) and chronic illness. The effects of the job stressors are influenced by individual, personal factors. Non-work stressors and buffer factors also affect the severity of the impacts.

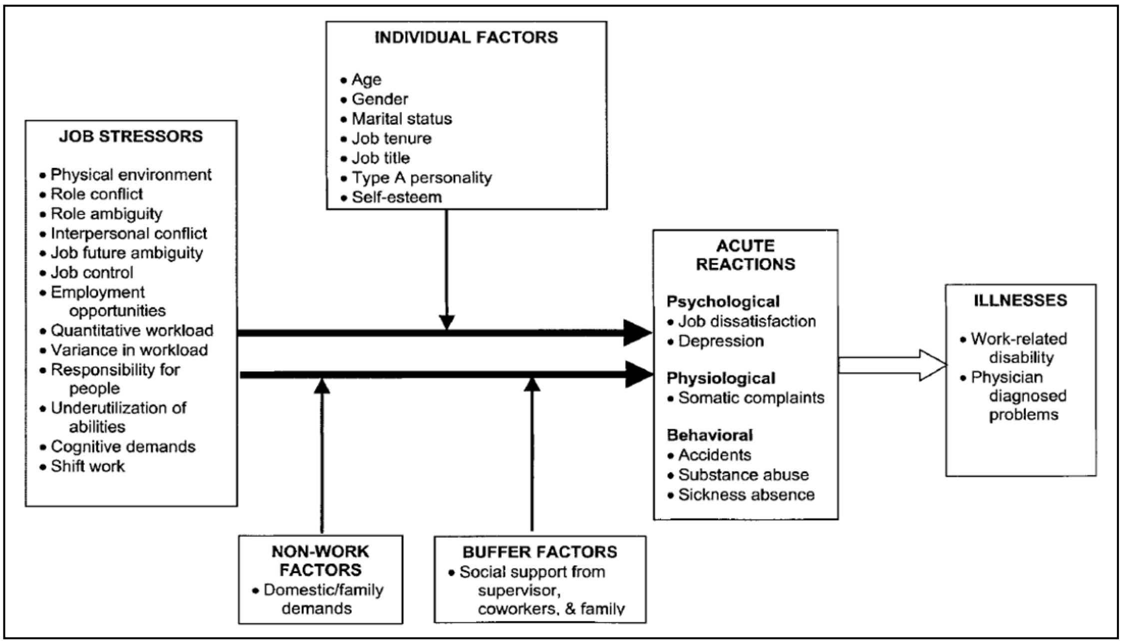

Figure 31. Job Stress – Health Model of Hurrell & McLaney (1988).

In the Effort-Reward Imbalance (ERI) model of Siegrist (1998) (Fig. 32), commitment and motivation are determined, at the extrinsic level, by the relationship between the effort a person is required to make and the rewards they receive for doing so. These rewards may be both tangible and intangible – feeling that your work is appreciated or being held in high esteem within a group can be very strong motivational factors. A person's commitment to their work is also influenced by intrinsic factors. Work-related stress comes about as a result of all the activities that a person engages in (Melin & Lundberg, 1997). In addition to stress in a person's main place of paid employment, unpaid household and family-related work, sideline activities and even leisure activities can all act as sources of stress.

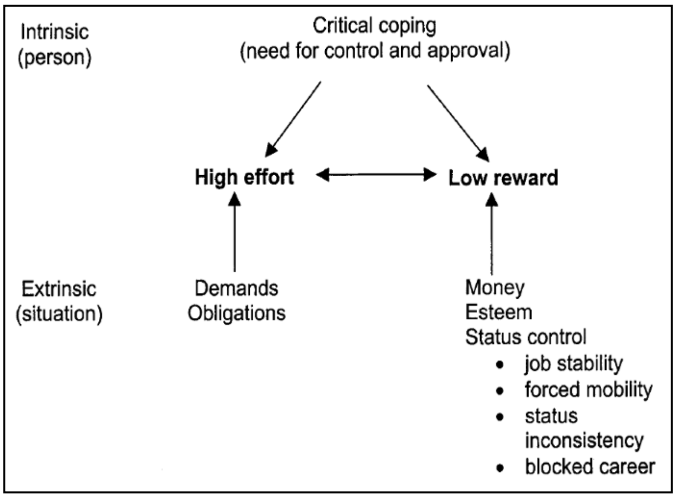

Figure 32. Effort-Reward Imbalance Model (Siegrist, 1998).

Working conditions are affected by a variety of factors. These can be grouped into the following areas: (Pfeuffer, 2003):

- physical work factors (e.g. how physically demanding the work is, exposure to chemicals),
- work organization (e.g. type of work, working time),
- social and psychosocial environment (e.g. high work intensity, time pressure, lack of support, monotonous activities),
- human resource management factors (e.g. ongoing training, appropriate allocation of work, remuneration).

The Working Conditions topic focuses on the objectively measurable properties of the workplace. The subjective evaluation of working conditions (job satisfaction and motivation) is covered under the Quality of Life topic. The results of both topics should be considered together, not least because this can sometimes reveal paradoxical findings such as good working conditions but low quality of life or vice versa. Job stressors and their impacts on health are evaluated using a method akin to the Job Stress – Health Model of Hurrell and McLaney (1988). The stressors are determined by the physical and mental stresses on the workforce and are evaluated by examining which safety and damage prevention measures are in place. Each indicator also takes other aspects and sources of stress into account. For instance, the work-related stress of working children is recorded using the ILO definitions.

Wherever possible, data should be collected for everyone working on the farm. The score awarded for some indicators is based on the person with the highest level of stress, since it is important for all workers to be protected against excessive stress levels. If only the average stress level of the workforce was recorded, this would mask individual sustainability risks.

Indicator wc_1: Personnel Management

Sustainability goal

Good personnel management ensures that the farm has a sufficient short-, medium- and long-term supply of satisfied, motivated and adequately trained personnel. There is little potential for conflict thanks to transparent and fair terms and conditions of employment.

Content

An assessment is made of whether the farm has a professional, forward-looking personnel management system in place and whether working conditions comply with the decent work standards established in the relevant human rights conventions and agreements.

Scoring

100 points = personnel requirements are known / arrangements are in place for replacing workers leaving the farm for age-related reasons / an apprenticeship program is in place / written employment contracts / pay stubs resp. payslips/ work permits for all personnel / measures are taken to motivate the workforce (e.g. incentive systems, praise) / protection against unfair dismissal / adequate income protection in the event of accidents, sickness, maternity, etc. / no discrimination / no forced labor of any kind / freedom to form labor unions.

Explanation

Although personnel management is not often specified as a direct component of working conditions, it actually has a substantial influence on them. RISE's scoring of the questions about residence and employment assesses the legality and documentation of farm workers' employment. It is assumed that the absence of residence and work permits, employment contracts and wage stubs reduces an employee's ability to demand their social and financial rights.

The questions concerning child labor, other problematic working conditions such as bonded labor and discrimination are based on the human rights of freedom, self-determination and physical integrity enshrined in the Universal Declaration of Human Rights (UN, 1948). Article 2.1 of the International Labor Organization's (ILO) Convention concerning Forced or Compulsory Labor defines forced labor as involuntary work or service which is exacted from any person under the menace of any penalty. A representative sample of personnel from different job categories on the farm should be interviewed, with the most negative responses for each category being scored. All members of the labor force have the right to form, join and organize the labor unions of their choice and for these labor unions to engage in collective bargaining with the farm management on their behalf; see ILO Conventions 11, 87, 98, 135 and 154.

Indicator wc_2: Working Hours

Sustainability goal

Each person working on the farm has enough free time to recover physically and mentally, so that they can remain healthy and productive in the long run.

Content

Daily, weekly and annual working hours and annual vacation are recorded and evaluated against the regional standard.

Scoring

100 points = 5 days a week, 40 hours a week, 6 weeks' paid vacation a year, overtime remunerated. These values may be adjusted at regional level.

Explanation

Working time is a key factor in the assessment of working conditions. Excessive working hours can damage workers' health by depriving them of the time needed to recover both physically and mentally (Ala-Mursula et al., 2006; Härmä, 2006). Exhaustion and stress are often important causes of people taking time off work because of illness and accidents, and this can in turn lead to personnel shortages. Moreover, even when it does not cause people to be absent from work, being required to work excessive hours on a permanent basis still has a negative impact on workers' productivity and quality of life.

In RISE, working time is calculated differently for different types of employment. Part-time work is adjusted to a full-time equivalent basis and compared against a reference scale. Workers on an hourly wage are fully compensated for all the work they perform, allowing their hourly rate to be compared directly against the reference scale. In the case of piece workers, it is necessary to record the amount of time taken to perform the task they are paid for. The assessments of working time are based on the ILO's international conventions. These standards are also used by various certification schemes (e.g. BSCI, 2009). Although agricultural work is consistently excluded from these agreements, to our knowledge there are no medical grounds for treating agriculture differently to any other industry. On the contrary, the statistics show that agricultural workers are in fact subject to above-average physical demands and have above-average working hours (BFS, 2010; EWCS, 2007). The working times specified in the ILO conventions are regarded as minimum values and are awarded 34 points in the RISE evaluation (33 points or less indicates a need for action).

In order to allow the differences between self-employed workers and employees to be analyzed, the results for both categories are presented separately. To ensure that the personal circumstances of every individual are equally accurately recorded and are given the same weight in the evaluation, an average score is computed for all workers without any weighting based on annual working hours. It is therefore important to take a close look at the scores of individual workers when analyzing the results, in order to ensure that people working very long hours are identified.

The individual thresholds are as follows:

> - Working hours per week: The working hours of persons employed in any public or private industrial undertaking or in any branch thereof shall not exceed eight in the day and forty-eight in the week (ILO Convention 1, Art. 2).
>
> Excessively long working hours are rated as problematic (<34 points = color-coded red). However, the threshold value in RISE is 4 hours a week higher than the ILO figure, since the latter relates to jobs where employees usually have to commute to and from work. On average, these people spend around 50 minutes a day traveling to and from their workplace. This unproductive but nevertheless stressful time is not an issue for the majority of agricultural workers.
>
> A weekly working time of 44 hours or less is rated as optimal (100 points). This is arrived at by taking the 40-hour figure for non-agricultural professions (based on five eight-hour days) and adding four hours to compensate for commuting time.

- Working days per week: The whole of the staff employed in any industrial undertaking, public or private, or in any branch thereof shall, except as otherwise provided for by the following Articles, enjoy in every period of seven days a period of rest comprising at least twenty-four consecutive hours (ILO Convention 14, Art. 2).

In accordance with this principle, working arrangements providing less than one day off per week are rated as problematic (<34 points = color-coded red). The curve has been drawn in such a way as to give a 33 point difference for every half day. Accordingly, two days off per week is regarded as the optimal recovery time for workers.

- Vacation: Workers employed in agricultural undertakings and related occupations shall be granted an annual holiday with pay after a period of continuous service with the same employer (ILO Convention 101, Art. 1). The holiday shall in no case be less than three working weeks for one year of service (ILO Convention 132, Art. 3). If the period of employment is less than one year, vacation entitlement is reduced accordingly. Cases where less than 3 weeks' paid vacation is provided or taken are rated as problematic.

- Overtime compensation: All hours worked in excess of the normal hours should be deemed to be overtime, unless they are taken into account in fixing remuneration in accordance with custom. (…) Overtime work should be remunerated at a higher rate or rates than normal hours of work (ILO Recommendation 116).

Indicator wc_3: Safety at Work

Sustainability goal

Appropriate measures are taken to ensure that the number of work-related accidents and cases of illness on the farm are minimized. Children are not harmed by any work they do on the farm.

Content

An assessment is made of the frequency of work-related accidents and cases of illness on the farm, the measures taken to prevent them and whether there is a risk of illegal child labor (Fig. 33).

Scoring

100 points = no work-related accidents and/or illnesses in the last 5 years / safety strategy implemented / safe storage and application of PPPs / only low-toxicity PPPs used / no problematic child labor.

Explanation

Strenuous manual labor and exposure to harmful substances such as chemicals, pesticides and dust can lead to health problems and employees having to take time off work. Compared to other sectors, the health impacts of agricultural work are very high (EWCS, 2007). 62% of active agricultural workers report work-related health issues. The most common health problems include back pain, muscular pain, fatigue, stress, headaches, irritability, eye, hearing, skin and respiratory problems and allergies. The protection of children from exploitation is a pressing social problem. To determine which forms of on-farm labor are acceptable for children and which are not, we have adopted the definition used by the UN (Grimsrud, 2001).

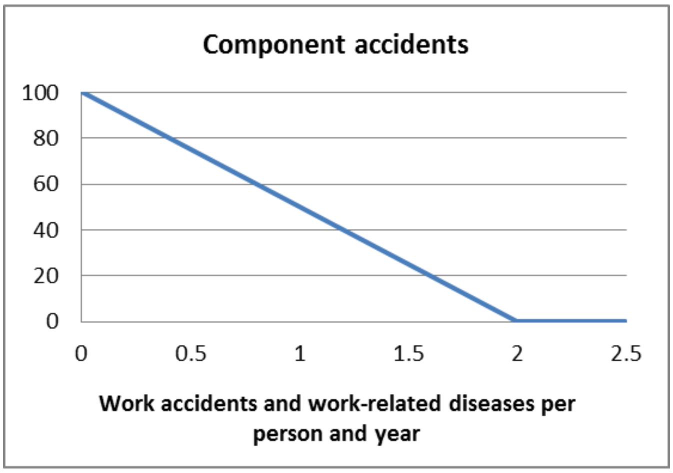

Figure 33. Scoring function for the "accidents" component of indicator wc_3.

Indicator wc_4: Wage and Income Level

Sustainability goal

The people employed to work on the farm earn an hourly wage that allows them to live comfortably above the minimum subsistence level when working normal hours.

Self-employed workers (mainly family members who are not paid a wage) also receive appropriate hourly compensation (private consumption and non-monetary benefits) and the farm delivers a very positive financial return.

Content

The income of the people working on the farm is compared against their financial needs. Self-employed workers are also asked about the farm's financial results (e.g. how the value of the business has changed, private account deposits/withdrawals, building up of reserves, equity capital formation), since it is possible that other assets may have been accumulated on the farm in addition to those used for private consumption.

Scoring

34 points = the people employed to work on the farm earn an hourly wage that allows them to live on the subsistence level when working normal hours. 100 points = the hourly wage is double the minimum subsistence level for an average household. For self-employed people (unpaid family members working on the farm), the same calculation is carried out based on the figure obtained by dividing private consumption plus all the non-monetary benefits enjoyed by the household by the total number of hours worked by all self-employed workers. The relevant threshold values (minimum subsistence level, factor for 100 points, household size, normal working hours) can be adjusted at regional level. Additional points are awarded or deducted (+/- 50) based on the farm's financial results.

Explanation

The remuneration and/or income that workers receive for their work is a central aspect of the working conditions in any business (EWCS, 2007). This indicator evaluates the level of income received for the number of hours worked and provides a measure of the financial attractiveness of working on the farm. To this end, a worker's hourly wage is compared against the benchmark hourly wage of a job with standard working hours. This standardization is particularly important for part-time and temporary work. The benchmark wage and standard working hours are defined in advance in consultation with local experts and are verified in the field.

According to the scoring function a score of 34 points (the bottom of the amber range) represents the minimum subsistence level. This is defined based on a consumer basket that is sufficient to meet basic subsistence requirements (food, clothing, housing, basic healthcare) and provide social security coverage (pension, disability, accidents, death) (SKOS, 2005). The results for a worker who receives a low hourly wage will thus appear in the red zone. The maximum score is awarded for people whose hourly wage is three times higher than the minimum subsistence level. The calculation of the minimum subsistence level for employees is based on the needs of an average family and the assumption of fair and transparent personnel management that provides full compensation for the work performed. It is important to ensure that e.g. single people do not receive lower wages than people with a family for doing the same work.

In the case of family members who work on the farm, the monetary standard of living is calculated on the basis of effective expenditure, since no wages are received. In order to determine the minimum subsistence level, basic needs are adjusted based on family size and composition. A comparison then shows whether the family is able to achieve a living standard above this minimum subsistence level when working normal hours. A low monetary standard of living per hour worked could be due to low farm profitability or the excessive and inefficient deployment of labor, but may also be caused by the farm management attaching a lower priority to this area (investment in the farm rather than in the well-being of the family). The assessment of whether a household is living in absolute poverty (despite possibly having a high standard of living per hour) is made using indicator ev_5 (Livelihood Security) under the Economic Viability topic.

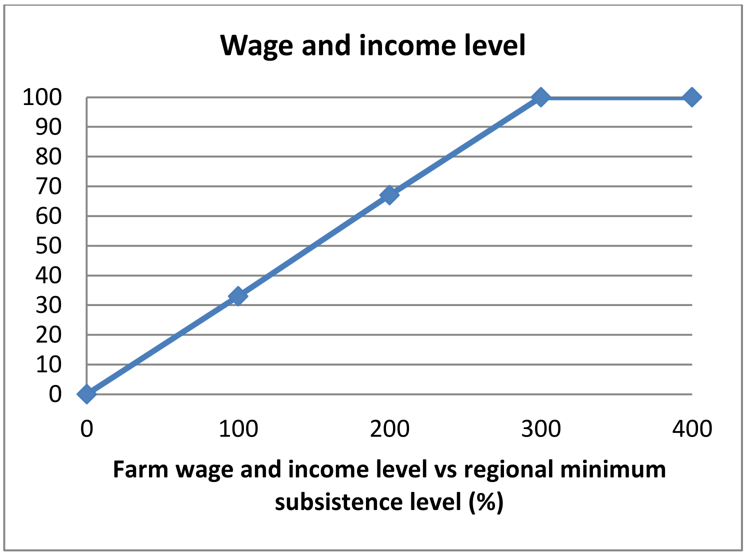

Figure 34. Scoring function for indicator wc_4. In this case, the target value was set at 300% of the regional minimum subsistence level.

3.8 Theme: Quality of Life (ql)

Theme

A high level of satisfaction with their work and their life in general is important for the physical, mental and social well-being of the people living on the farm. Quality of life, satisfaction and happiness are important indicators of successful sustainable development. Quality of life is achieved when individual goals are currently being met.

Relevance of the theme

Quality of life is the physical, mental and social well-being of an individual. It involves the desire of every person to lead a life in which they are able to meet not only their basic needs but also their social, cultural and societal needs (Diener et al., 1998; King & Napa, 1998). Quality of life, satisfaction and happiness are important indicators of successful sustainable development (Gowdy, 2005; Binswanger, 2006).

The quality of life experienced at any given moment is determined by a variety of factors. Different studies classify these factors in different ways and give them different names. The most frequently cited factors include interpersonal relations, social integration, personal development, physical health, self-determination, material wealth, emotional well-being, rights, environment, family and leisure (Schalock, 2004; Verdugo et al., 2005). Reactions to a poor quality of life include low motivation and commitment, burn-out, simmering conflicts and health problems. Indications of a high quality of life on the farm may include increased commitment and satisfaction, greater well-being and fewer instances of people having to take time off work (Diener et al., 2008).

A number of challenges arise when assessing quality of life: (1) Quality of life is a cross-cutting issue and is determined by several very different aspects of a person's life. (2) How a person evaluates their quality of life depends on their individual goals. Both the relevant areas of their life and their individual goals are shaped by their environment, culture, experience and personal preferences (Carr et al., 2001; Wirtz et al., 2009). This means that quality of life assessments must adopt a flexible and participatory approach to defining the relevant areas of life, together with personalized weighting of the individual factors (Radlinsky et al., 2000). (3) Sustainability requires intergenerational justice. This is achieved when the opportunities for future generations to meet their own (quality of life) needs are at least as great as those of the present generation.

RISE essentially follows the approach used for quality of life reporting in the United States as described by Campbell et al. (1976). This method has also been used in Switzerland for social reporting in the agricultural sector by the Federal Office for Agriculture (BLW) (Radlinsky et al., 2000). In the interests of simplicity and clarity, the 13 areas of life about which interviewees are questioned have been combined into six groups of similar themes, once again following the approach of Campbell et al. (1976). Quality of life for all areas is determined using a two-step approach. The weighting of areas of life carried out in RISE 2.0 provided very little additional information of value and has therefore been dispensed with in RISE 3.0. Interviewees now directly rate their satisfaction with the different areas of their lives. Their ratings are then converted into a score of between 0 and 100. The following satisfaction ratings are allowed: very satisfied (100 points), satisfied (75 points), partly satisfied (50 points), dissatisfied (25 points), and extremely dissatisfied (0 points). Other permitted answers are "don't know" (no score) and "no answer" (no score).

Indicator ql_1: Occupation and Training

Sustainability goal

All farm personnel are satisfied with their occupation and their initial and ongoing training.

Content

An assessment is made for all interviewees of how important their occupation and initial and ongoing training are to them and how satisfied they are with their current situation in this regard.

Scoring

100 points = very satisfied with current occupation (on-farm, sideline activities, household work, etc.: type of work, working hours, workload, relationship with employees, authorities, customers, etc.; satisfaction, motivation), initial training (duration, type and level of training, etc.) and ongoing training (courses, self-study, study groups, etc.).

Indicator ql_2: Financial Situation

Sustainability goal

All on-farm personnel are satisfied with their financial situation.

Content

All interviewees are asked how important their financial situation is to them and how satisfied they are with it.

Scoring

100 points = very satisfied with current earnings (from agricultural work, sideline activities, other sources, etc.) and standard of living (housing, opportunities, consumption, training, vacations, leisure, pension, etc.).

Indicator ql_3: Social Relations

Sustainability goal

All on-farm personnel are satisfied with their social relations.

Content

All interviewees are asked how important social relations are to them and how satisfied they are with their current situation in this regard.

Scoring

100 points = very satisfied with family situation (relationship with partner, life together, communication, consideration, interaction, etc.) and social environment (friends, colleagues, neighbors, etc.; help, support, friendliness, trust).

Indicator ql_4: Personal Freedom and Values

Sustainability goal

All on-farm personnel are satisfied with their personal freedoms and their ability to live by their personal values.

Content

All interviewees are asked how important personal freedoms and the ability to live by their personal values are to them and how satisfied they are with their current situation in this regard.

Scoring

100 points = very satisfied with the stability of the overall political and economic situation (security, peace, corruption, inflation, prices, employment, etc.), personal freedoms (hobbies, relaxation, activities, contacts) and cultural and spiritual life (music, dance, local culture and traditions, theater, film, literature, visual arts, etc.; religion, spirituality, etc.).

Indicator ql_5: Health

Sustainability goal

On-farm personnel are satisfied with their health situation.

Content

All interviewees are asked how important their health (including time management) is to them and how satisfied they are with their current situation in this regard.

Scoring

100 points = very satisfied with (physical and mental) health and time management (pressure to meet deadlines, stress).

Indicator ql_6: Other Areas of Life

Sustainability goal

All on-farm personnel are satisfied with the situation in the other areas of their lives.

Content

All interviewees are asked how important the other areas of their lives are to them and how satisfied they are with their current situation in this regard.

Scoring

100 points = very satisfied with the other areas of life mentioned by the interviewee (e.g. access to resources, participation and involvement in economic life, ability to choose how they want to live their lives and implement these choices, ability to choose how they work and implement these choices).

3.9 Theme: Economic Viability (ev)

Theme

A farm is first and foremost a business that needs to deliver economic goals whilst working within the relevant environmental and social constraints. The aim is to ensure the short- and long-term profitability of the business and to maintain or even improve productivity so that the business can develop in a stable and self-determined manner that guarantees the livelihood of the farmer's family and the income of the people employed on the farm. This topic addresses the following aspects of a farm's economic viability:

- liquidity
- stability,
- profitability,
- indebtedness,
- livelihood security

Relevance of the theme

Profitability

The economic dimension of sustainability is typically determined through the aspects of profitability, liquidity and stability (e.g. Heissenhuber, 2000; Breitschuh et al., 2008). There are three main reasons why it is in practice difficult to determine what a sustainable profitability level is for an agricultural business: (1) The widely pursued goal of maximizing returns requires capital to be invested in the investment that promises the highest yield (interest) and most reliable returns. This places sustainable forms of investment at a disadvantage, since they usually have lower financial returns. (2) Returns can only be maximized if there is sufficient capital mobility. However, the bulk of the capital in an agricultural operation is usually tied up in land, fixed assets and livestock. To divest these assets would be at odds with the business philosophy of most farmers. (3) The exact values used as the basis for calculating rates of return are often almost impossible to determine in the agricultural sector. For instance, the book value of land seldom corresponds to a realistic market price. In many countries, land prices are subject to special regulations that prevent them from being set freely.

During the RISE expert workshops held between 2008 and 2010, consultants and farmers alike questioned whether traditional profitability indicators such as return on equity and total productivity are relevant for measuring the sustainability of farms. Moreover, if the indicators are taken from "tax-optimized" financial accounting standards, as is the case in many OECD countries, the interpretation of the resulting indicator scores can be misleading. Accordingly, RISE does not calculate return on capital employed. It would in any case be methodologically incorrect to calculate it for the whole enterprise rather than just the agricultural part of the business. The same applies to return on sales – off-farm employment income and private consumption should not be included in the accounts (personal comment Steingruber; Raaflaub, 2010). Furthermore, the enterprise's capital would need to be broken down into private and business capital. This would be beyond the scope of a quick analysis tool like RISE. RISE therefore expresses economic viability primarily through liquidity and stability indicators. Because RISE is designed to be as widely usable as possible, and since double-entry bookkeeping is not used on most farms around the world, RISE confines itself to using cash flow statements, which are easier to produce and compare.

Liquidity and Stability

All over the world, access to money (equity and borrowed capital) is one of the factors that act as a constraint on sustainable socioeconomic development. Even in Switzerland, insufficient liquidity threatens the livelihood of a significant number of farms whose cash flow is lower than the minimum amount of cash needed to ensure their medium- to long-term survival (Meierhofer, 2008). Farms will often use wage dumping (among members of the farmer's own family) so that they can continue to invest and maintain their production systems. This results in low wages and long working hours for farm employees and reduced spending power for self-employed farm workers, all of which ultimately has a negative impact on the farm's social sustainability.

When banks make credit checks, they enquire about liquidity before financial profitability and stability. When the medium-term sustainability of a business is investigated for a credit application, the business has to produce an operating budget based on the farm's past performance but also taking likely future economic developments into account. The business has a high chance of remaining viable if the routine expenses of the farm and farmer's family are covered, the repayments and interest payments due on any loans can be made, any necessary future investments can be carried out and the farm remains solvent[17]. RISE 3.0's assessment of farms' economic sustainability follows the standard creditworthiness criteria of lending institutions as closely as possible.

Cash flow statements provide a more realistic picture of a farm's financial situation than profit and loss accounts (personal comment Tüscher, 2010; Steingruber, 2010). Cash flow statements for self-employed farmers only include the cash operations of the farm and household, i.e. the cash inflows (income) and outflows (expenditure). These operations have a direct impact on the household's liquid assets. It is also easy to calculate household income based on cash flow (Fluder et al., 2009). Furthermore, it is easier to make comparisons, since no calculated values or estimates (e.g. of land value) are involved. The same argument is put forward by Meier (2004) in connection with international comparisons of the financial situation of farmer households: "Major obstacles to comparability are depreciation, valuation of stock and livestock and calculated values for payment in kind, non-cash rents, etc. Looking at cash flow indicators, one does not have to tackle these problems".

While the worldwide trend towards specialization and ever larger production units has contributed to increased efficiency, it has also made businesses more vulnerable to market fluctuations, which are likely to become more frequent as a result of market globalization. Professional farm management is becoming increasingly important in all parts of the globe in order to ensure that opportunities and threats are identified and the appropriate measures taken in good time.

Conclusion: Insolvency poses an acute threat to the sustainable operation of an agricultural business. Due to the limited time and budget available for data collection and analysis in a RISE farm assessment, we have elected to dispense with the costly and time-consuming development and recording of profitability and productivity indicators. RISE 3.0 places strong emphasis on cash flow analysis, both to determine the farm's current situation and in connection with investment planning. Since RISE addresses the business as a whole, it does not calculate unit costs. If RISE identifies a weakness in the area of liquidity planning and/or cash reserves, unit costs should be analyzed in a more detailed investigation (RISE follow-up process).

Indicator ev_1: Liquidity

Sustainability goal

The farm's liquid assets are sufficient to meet its financial obligations at all times.

Content

An assessment is made of the ratio of cash reserves (liquid assets plus available credit lines) to average weekly expenditure (annual expenditure divided by 52 weeks), i.e. the number of weeks that the farm can live off its cash reserves. The farm's reserves are deemed to be sufficient if, at any time in its production cycles, it is able to pay wages and salaries, accounts payable to suppliers, loan repayments and interest payments out of its own reserves.

Scoring

100 points = 40 weeks of cash reserves. 0 points = 0 weeks of cash reserves. These values may be adjusted at regional level.

Explanation

A farm is considered to be liquid (solvent) if it is able to meet its financial obligations at all times. Liquidity is an indicator that expresses the ability of a business to pay any money that it may owe. Liquidity constraints can threaten the survival of the operation (Kutter & Langhoff, 2004). If we know the farm's cash reserves, we can calculate how long the financial resources available for paying the

[17] www.nw.ch/dl.php/de/20070727145945/Merkblatt_soziale_Begleitmassnahmen_01012010.pdf

money owed by the business will last. These cash reserves are made up of the farm's liquid assets plus credit lines obtained from lending institutions.

The ratio of cash reserves to payments due can be calculated and expressed in terms of how long the reserves will last. Figure 35 provides an example of a time-based assessment of a farm's liquidity.

Figure 35. Assessment of a farm's liquidity based on how long its cash reserves will last ("reach").

The measurements provided and their classification on a scale ranging from good to unsatisfactory are empirical in nature. As such, they will not always reflect the specific characteristics of a particular farm (Kutter & Langhoff, 2004). In Switzerland, farms' cash reserves should be enough to last for 6 months (24 weeks), since they receive their direct payments twice a year (personal comment Steingruber, 2010).

In RISE, the farm's total annual expenditure is divided by 52 weeks. If liquid assets plus available credit lines are enough for 15 weeks or less, a maximum of 33 points is awarded and the cash reserves are rated as clearly unsatisfactory (red). Cash reserves lasting more than 25 weeks are rated as sustainable (green). A more detailed investigation is recommended for anything falling in the uncertain range between these two cut-off points.

Indicator ev_2: Profitability

Sustainability goal

The farm is financially profitable on both a short- and long-term basis. In other words, its earnings allow it to meet its financial obligations, make investments and earn a profit that adequately recompenses the equity invested in the business.

Content

The operating cash flow to sales ratio is assessed. If the relevant accounting data is available, return on equity is also assessed, i.e. the ratio of profits (cash flow minus depreciation) to invested equity capital.

Scoring

Cash flow to sales ratio: 20% = 100 points / 10% = 67 points / 0% = 0 points

Return on equity: 5% = 100 points / 0% = 0 points

If both figures can be calculated and awarded a score, the average score is taken.

The benchmark scores may be adjusted at regional level.

Explanation

The farm's income is sufficient to pay for ordinary upkeep costs, production inputs, staff expenditure in the case of paid employees and the private expenditure of family members who are not paid a wage. Enough is left over to produce a positive operating cash flow that allows the farm to make investments, repay any debts and earn a profit that recompenses the equity invested in the business. Farms that keep accounts enter depreciation of invested capital in their books, ensuring that they will be able to keep producing and thus remain profitable on a long-term basis.

Indicator ev_3: Stability

Sustainability goal

The farm is financially stable. This means that it is regularly able to break even over a period of several years with a normal level of household consumption, and that the long-term future of production on the farm is secure.

Content

The farm has several strings to its bow, maintains a modern infrastructure and is thus not wholly dependent on market price trends or individual customers. Guaranteed land access means that it is possible to plan and ensure the continuation of production on a long-term basis, whilst a high equity ratio allows the farmer to make their own decisions about how the business evolves.

Scoring

100 points = the farm's infrastructure is in good condition, the farm has several customers in all of its key areas of activity, its main income source accounts for less than 20% of total business revenue (no concentration risk), long-term access to all land is guaranteed and it has a high equity ratio.

Explanation

Stronger market fluctuations can be expected as agricultural markets become increasingly globalized. The resulting financial pressures are forcing agricultural businesses to lower their costs (i.e. become more efficient). Many businesses are turning to specialization (expansion of one area of the business at the expense of others) in order to differentiate themselves from their competitors and obtain a cost advantage. However, this also causes them to become more dependent on individual markets and customers, potentially posing a threat to their survival in the worst-case scenario.

Indicator ev_4: Indebtedness

Sustainability goal

The farm's level of indebtedness is not problematic and is in keeping with its financial resources. There is leeway for it to take on more debt if necessary, e.g. to see it through a period when it is short of funds.

Content

Debt-to-equity ratio: gearing is calculated as the ratio between net debt and operating cash flow. This allows a figure to be calculated for the number of years that would be required to fully repay the farm's debts with its current cash flow.

Short-term debt service coverage ratio: this is the ratio between mandatory debt service (interest and mandatory amortization) and cash flow. It expresses the percentage of cash flow that is currently used to service debts and whether there is any leeway to take on more debt in the short term, e.g. to get through a period when the market is unfavorable or to make investments.

The indicator score is calculated as the average of the two components.

Scoring

Debt-to-equity ratio: 100 points if the farm would require 5 years to repay its debts with its operating cash flow / 0 points for 20 years.

Debt service coverage ratio: 100 points for 0% debt service coverage ratio / 67 points for 50% / 0 points if 100% of cash flow is used to service debts.

These thresholds may be adjusted at regional level. The indicator score is the average of the two components.

Explanation

Debt-to-equity ratio

The debt ratio expresses the relationship between income and level of indebtedness. An operation with a high income can take on and service more debt. First of all, net debt is calculated as third-party debt minus cash. The resulting figure is then divided by the cash flow, which is itself composed of owner's equity plus booked depreciation. The debt ratio calculated using this method expresses the number of years that the farm would need to repay its debts if the entire annual cash flow was used for this purpose. It should be noted that the calculation is based on the assumption that future business results will remain constant. If the debt ratio is 15 years or more, the bank will classify the farm as a risk, demand that it takes certain actions and, under certain circumstances, stop lending it money. A high level of debt often has a negative impact on the farm's ability to repay its debts and can mean that there is no longer any financial leeway if no additional credit can be obtained during a liquidity crisis, for example. The debt ratio is a very powerful indicator of financial security when compared over several years, since if a company's exposure increases, the numerator (net debt) normally increases while the denominator (cash flow) decreases. Farms with a low level of debt are far better placed to react to current market trends requiring investment. New business activities or the expansion of existing activities tie up cash, causing a leverage effect that exacerbates the adverse financial trend. This single indicator thus provides a clear indication of both the farm's potential performance and its level of indebtedness (Kamber, 2009).

Debt service coverage ratio

The vast majority of the world's poor live in rural areas. The economic development of these areas is therefore key to poverty eradication. One of the key requirements for this to be possible is a financial system tailored to the needs of farmers and small producers as well as non-agricultural businesses such as intermediaries and tradesmen. Access to secure savings arrangements is extremely important to households with small and irregular incomes and in particular to women, in order to provide cover for emergency situations or the money needed for their children's education and other long-term investments. In addition to savings, loans can also facilitate participation in economic activity by allowing business opportunities to be realized and existing commercial activities to be expanded. Access to financial services can pave the way towards a financially independent, self-determined life. While the calculation of credit limits in developed countries is usually very complicated (in Switzerland, for instance, it is based on the lending limit, which in turn depends on the enterprise's earning power), in developing countries it is often much simpler, since small producers are simply refused credit due to their lack of security and insufficient cash flow. This means that they are unable to invest and thus also unable to increase their well-being.

Indicator ev_5: Livelihood security

Sustainability goal

The farm's income is sufficient to secure the economic livelihood of the household (family members who are not paid a wage).

Content

An evaluation is made of the ratio between private spending and a corrected minimum subsistence level. The minimum subsistence level is corrected for the size of the farmer's family and any payments in kind received by the farm are deducted. The private spending of family members who are not paid a wage (farmer's family) should clearly exceed the minimum subsistence level.

Scoring

Between 34 and a maximum of 66 points may be awarded for household spending amounting to between 100% and 200% of the minimum subsistence level (amber, critical). If household income is between two and a maximum of three times higher than the minimum subsistence level, the farm is awarded between 67 and a maximum of 100 points (green, sustainable).

Explanation

The assessment of household income in relation to the minimum subsistence level is absolutely key to small producers. The eradication of poverty is the first of the UN's Millennium Development Goals (www.un.org/millenniumgoals). The UN defines “absolute poverty” as a per-capita income of 2 USD a day. The same goal also calls for full employment.

The RISE topic “Economic Viability” assesses the family’s livelihood security based on its absolute private household spending, regardless of its level of employment. Only real spending is evaluated. This means that if the family lives on the farm and no actual rent is paid, then rent is not included in the calculation. Household consumption of farm-produced goods is also deducted from the regional basic needs figure, since the farm does not spend any money on buying these goods. This indicator addresses the question of whether the farm makes enough money (from its main and supplementary income sources) to keep its absolute and effective household spending above the regional minimum (subsistence level) for a comparable family.

In combination with the “profitability” indicator (ev_2), it is possible to assess whether the farm has enough financial leeway to increase its household spending (i.e. the family is living well within its means, household spending is not a priority for the farmer) or whether the family has insufficient income to cover its private spending. Indicator wc_4 under the “Working Conditions” topic compares household spending against the number of hours worked by family members on the farm (hourly wage comparison). This allows the attractiveness of working on the farm to be determined: can family members live above the minimum subsistence level, assuming that they work normal hours? If a worker does not work full-time on the farm – and their paid employment is therefore not sufficient to secure their livelihood despite the fact that they receive a relatively good hourly wage – this is not considered to be problematic by the Working Conditions indicator.

3.10 Theme: Farm Management (fm)

"I am noticing … an inevitable development: our traditional understanding of farm management – focused narrowly on short-term growth – has become outdated. Sustainability will be the new measure of success." (C.K. Prahalad, University of Michigan, 2010)

Theme

It may be perfectly viable to run a farm using traditional methods, even over the longer term. However, changes will need to be made if a poorly designed management process coincides with manifestly unresolved challenges. Where this occurs, it is necessary to modify the farm's strategy by implementing measures that incorporate sustainability into management systems, processes and culture.

Sustainable farm management

- pursues goals and strategies that are in tune with the stakeholders' personal values and take into account the natural limitations of people, animals, the environment, finances and society;
- has access to the knowledge needed to make informed decisions;
- regularly assesses internal and external risks so that proactive measures can be taken and resources can be employed productively, safely and profitably;
- cultivates sustainable relationships, ensuring that dealings with people and stakeholders both on and off the farm are characterized by respect and fairness.

Relevance of the theme

The part of the survey that deals with the "meta-topic" of sustainable farm management – which falls under the "governance" sustainability dimension of the SAFA guidelines – adopts a less formal approach than the other RISE topics. The main aim is to understand how the farm is managed. The farm's sustainability and the results for the other RISE topics are heavily dependent on the approach and quality of the farm's management. Sustainable farm management places particularly high demands on those responsible for running the farm. Some of the most successful pioneers have managed to achieve a lasting improvement in the performance and competitiveness of their business by combining the commercial side of the operation with the provision of a service to society (Porter & Kramer, 2011; Anker, 2014).

Farm management

Producers, agribusiness, scientists and governments are increasingly recognizing the need for an entrepreneurial culture in agriculture (de Lauwere et al., 2002). The development of the relevant management and entrepreneurial competencies is an important task that should be addressed by all the stakeholders in the agricultural system (McElwee, 2005). The findings of the international studies cited above are consistent with the practical experience gained during the use of RISE 1.0 and 2.0, as well as the personal comments of extension agents and farmers. Since the person responsible for running the farm often lacks the full range of key skills or the necessary time, certain managerial functions are either outsourced to third parties or neglected entirely. Sooner or later, this is likely to cause problems (personal comment Flückiger, 2010). Many farms lack specific strategies (personal comment Obrist, 2009) e.g. to address falls in the price of their products (Fig. 36). As the number of agricultural support and development programs grows, extension agents are receiving more and more questions from confused farm managers who no longer have a clear overview of the situation (personal comment Marthaler, 2010).

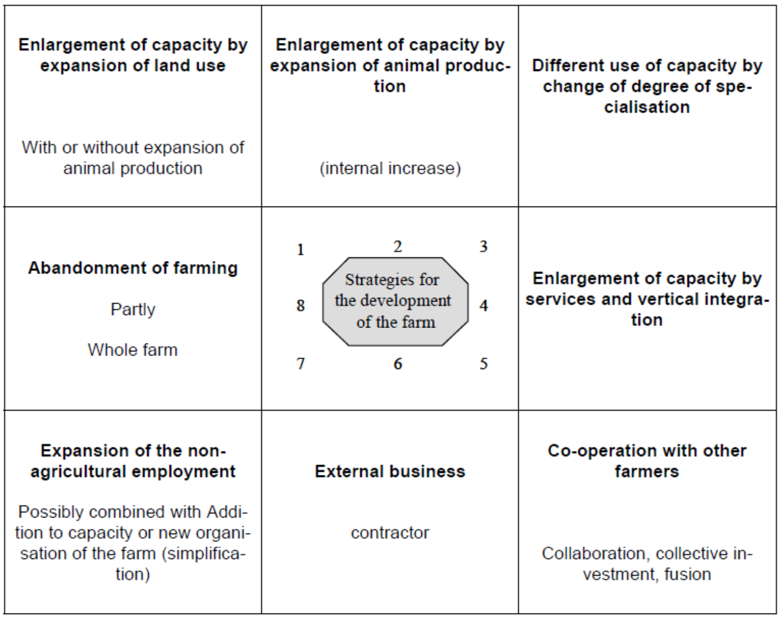

Figure 36. Development strategies for securing farm income (McElwee, 2005). There are eight basic development strategies that an agricultural business can implement in response to falling prices for agricultural produce.

Sustainable farm management

Studies of agricultural business strategies often adopt a purely economic approach that confines itself to asking how farms can successfully adapt to the globalization of agricultural markets. This approach is unsuitable for agricultural businesses, since non-monetary factors also play an important role in farmers' decisions (Sereke et al., 2015). The Sustainable Farm Management topic in RISE 3.0 asks farmers about their values, since these form the basis of strategy development and implementation. It is only possible to capture an accurate picture of the situation on a farm if the values of those responsible for running it are taken into account (Brodt et al., 2004).

A farm's business goals are the overarching principles that guide how the business develops and should therefore be consistent with the principle of sustainability. The aim should be to strike a balance between economic development, social justice and environmental sustainability. The goal of "prosperity through growth" is re-interpreted as "prosperity through the avoidance of damage to the environment and through more justice in the distribution of limited resources" (Müller & Hennicke, 1995). In a sustainable business strategy, these environmental and social innovations can act as drivers of economic success (Porter & Kramer, 2011). Environmental and social efficiency are two key principles of sustainable farm management. Environmental efficiency is a principle geared towards the protection of the environment. By improving the input-output balance (which represents the results of the material flow and energy analyses), raw materials use and the environmental impacts of emissions and waste (on the atmosphere, groundwater, open water, soil, flora and fauna) are both reduced. Environmental efficiency seeks to achieve relative improvements in products or production, e.g. though energy savings, lower CO_2 emissions, better use of raw materials or reduced waste production. Social efficiency aims to increase the positive impacts of management actions in terms of economic value added and reduce the negative social effects. The aim is to achieve a relative improvement in the social conditions on the farm and to cultivate sustainable relationships with off-farm actors.

In order to achieve the goal of sustainable farm management, farm managers must follow the principles of sustainable development. In other words, the farm's development goals must be based on economic, social and environmental criteria and the corresponding measures taken. Figure 37 provides an overview of the areas of sustainable farm management and their interactions.

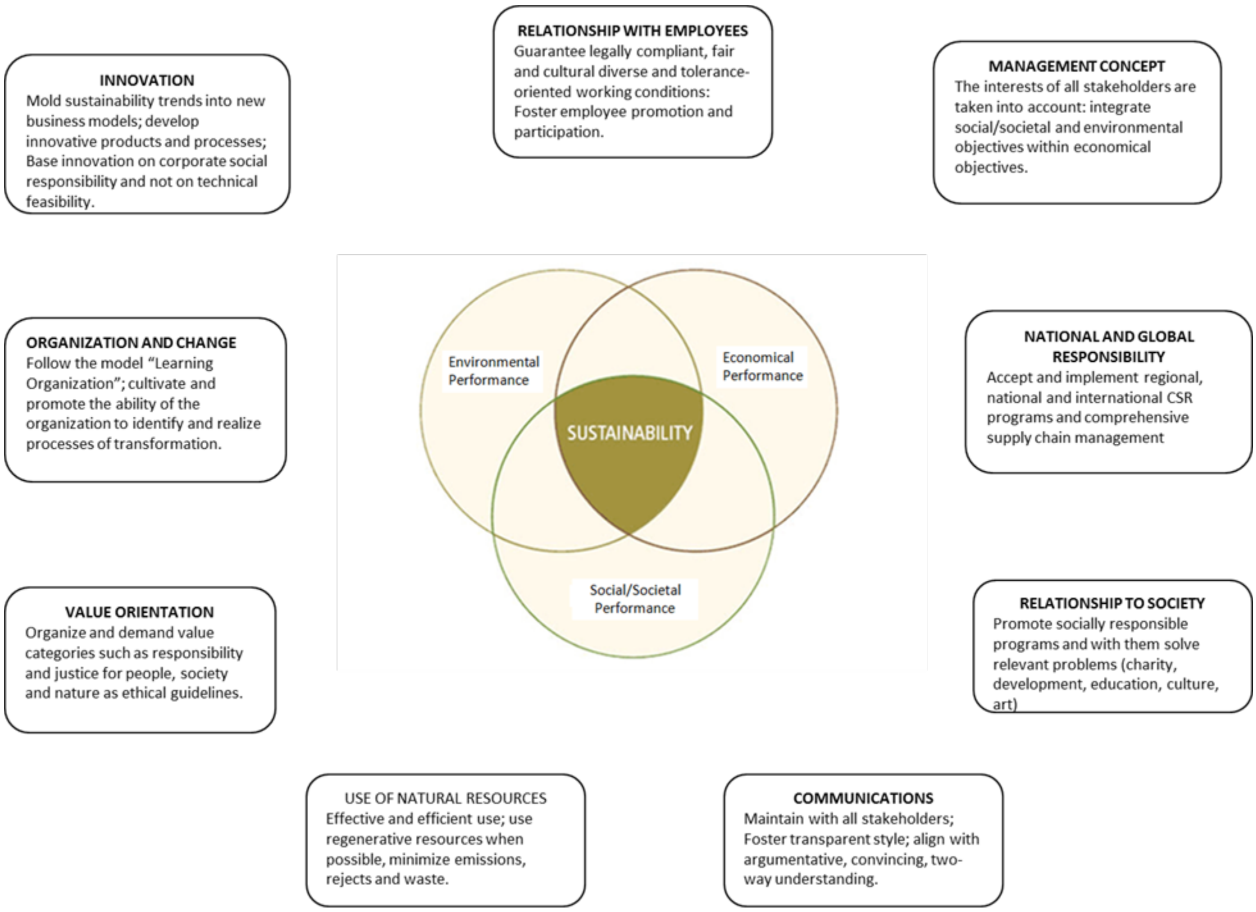

Figure 37. Areas of sustainable farm management and their interactions (files.steuerfachschule.de/AMN-Daten/beschreibung-AMN.pdf).

Developing a sustainable farm management approach

Once the RISE interview has been completed, the results of the sustainability analysis and the pros and cons of the farm's strategy are discussed with the farm management. In many cases, the established way of doing things may be perfectly sustainable even over the longer term. However, this will cease to apply if the farm management is unable to cope with external (extreme climate events, economic crises) or internal circumstances (overwhelmed by excessive workload, personal conflicts). The extent to which a farm is managed sustainably is revealed by its ability to successfully overcome such difficulties.

The individual development of adaptation strategies should be carried out in close consultation with farm employees and, if necessary, consultants. The outcomes should be continuously monitored to ensure that they are meeting the farm's business objectives and are in tune with people's personal values and life goals. This process defines the farm's unique identity as perceived by the outside world.

Accordingly, it is important that the process of strategic development and identifying values and goals should be carried out in a conscious manner. It may be worthwhile employing an experienced coach to assist with this process. Rather than a typical arrangement where the consultant shares their expertise, in this case their role would simply be to support the process. RISE itself does not have the funding to provide the relevant coaching. However, if a need for strategic action is identified or if there are concerns that the farmer is unable to cope, the RISE feedback procedure can provide details of available coaching services.

SWOT analyses (Strengths Weaknesses Opportunities Threats; Schreyögg & Koch, 2010) remain a popular tool for analyzing an enterprise's situation in order to provide a starting point for developing a business strategy. The strategic planning process carries out an internal and external analysis with a view to identifying strategic conclusions about how to deliver the project or business goals. The process asks the following questions: How can we make use of our strengths? How can we address our weaknesses? How can we make the most of our potential? How can we avoid threats?

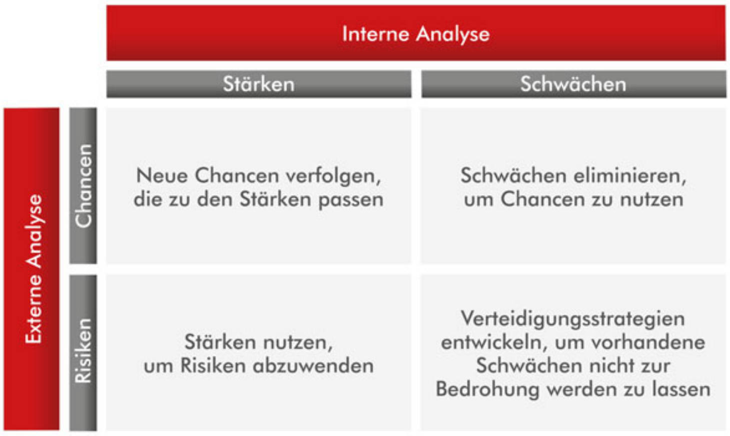

Figure 38: The four components of a SWOT analysis (Schreyögg & Koch, 2010).

Indicator fm_1: Business Goals, strategy and implementation

Sustainability goal

The people responsible for managing the farm consciously set goals, develop strategies to deliver these goals and implement the relevant measures. In this context, "conscious" means compatible with people's personal values and the conditions on and around the farm. The chosen strategy should have a positive impact on economic, social and environmental sustainability.

Content

This indicator covers both the rational (planning and forecasting) and subjective (values) aspects of the farmer's strategic development process. The goals, strategy and implementation challenges are analyzed and the business objectives are checked for compatibility with sustainability goals.

Scoring

100 points = The farmer has well thought-out goals and an appropriate strategy for the farm and implements them systematically. These aspects are evaluated both by the farmer (satisfaction with how he/she manages the farm) and the extension agent (how complete and well thought-out the strategy is and how successfully it is implemented). The strategy is also assessed in terms of how holistic it is, i.e. whether it takes social and environmental aspects into account as well as economic aspects.

Explanation

A sustainably managed farm tries to find its own answers to the question of which goals should be pursued through which strategies under the farm's own particular set of circumstances. Sustainable farm management requires a conscious approach to developing business goals and strategies. These should be based on the farmer's own values and life goals and on the farm's key strengths.

Sustainable farm management is the outward expression of values and life goals that are consciously or unconsciously influenced by all the stakeholders (Sereke et al., 2015). Family, tradition, political structures, property ownership, market conditions and competition all have an impact on how a farm is managed. If a farm has coherent goals, values and strategies, it is able to achieve a balance that affords it a degree of resilience against unforeseen external changes (Darnhofer, 2010). A farm's strategy will either be consistent with its goals or not. Similarly, the business goals or vision may or may not be consistent with people's personal values and life goals. A high level of awareness of values and goals enables the farmer to focus better on what they are trying to achieve, making it easier to spot problems and facilitating the participatory identification of adaptation strategies.

The strategy also needs to be coherent with the external context in which the farm exists. This requires an ongoing analysis of the external circumstances. What are the farm's strengths? What is unique about it (USP)? Where are the best market opportunities to be found? Analyzing these aspects helps to organize work on the farm in a targeted manner so that individual strengths can be built on. The farm's processes should be continuously reviewed to see whether they can be improved in order to prevent disruption, quality issues or delays.

Many farms lack an explicit long-term strategy. And even when they have one, it is often exclusively geared towards economic and/or agronomic performance indicators. The potential impacts of the chosen strategy on economic performance are relatively simple to measure and assess, e.g. cost reduction, increasing revenue through partnerships or contract farming. On the other hand, social and environmental sustainability are much harder to assess. Potential indicators of social sustainability include the social and gender-specific impacts of the chosen strategy and the existence of participatory processes involving both farm workers and the local community. The most effective way of preventing threats to the environment is by ensuring the sustainability of the agroecosystem by employing agricultural methods that maintain or increase productivity whilst at the same time helping to reduce emissions. Examples include agroecological approaches such as integrated soil fertility management, adapted crop rotation and diversified farming systems such as agroforestry (Wojtkowski, 2002; Altieri et al., 2015).

Indicator fm_2: Availability of information

Sustainability goal

Where necessary, the people responsible for managing the farm have access to adequate information and reliable planning tools so that they are able to manage the farm systematically and professionally.

Content

An assessment is made of whether the farm has access to adequate information and the reliable planning tools needed to manage the farm systematically and whether these are actually used if required.

Scoring

100 points = The farmer has access to all the necessary information and reliable planning tools and employs them as and when required in order to facilitate sustainable farm management.

Explanation

Reliable information, adapted planning tools and comprehensible documentation all help to achieve targeted and transparent farm management based on best agricultural practice. These aspects are gaining in importance around the world as a result of globalized trade and increasing regulatory requirements.

The information required for sustainable farm management includes technical information relating to agricultural production and data on prices and markets. The availability of adequate information is particularly crucial to successful adaptation strategy planning, e.g. the decision to invest in renewable energy systems. Accurate bookkeeping is also a key planning and control tool.

In the case of the small producers found predominantly in developing countries, there is an increasing emphasis on the availability of information sources and planning tools that have been adapted to local conditions (Wettasinha & Waters-Bayer, 2010).

Indicator fm_3: Risk Management

Sustainability goal

The people responsible for managing the farm are aware of the risks and dependencies that could pose a threat to the farm’s livelihood. They do everything in their power to minimize these risks.

Content

This indicator assesses how the people responsible for managing the farm deal with risks that pose a threat to its livelihood. An assessment is made of how much room for maneuver the farm management has internally, particularly in terms of risk prevention but also in terms of minimizing the negative impacts of any adverse events. The implementation of quality assurance measures is key to guaranteeing healthy and marketable produce.

Scoring

100 points = All risks posing a threat to the farm's livelihood are known and adequate measures are in place to protect against them.

Explanation

Stable yields are essential for ensuring food self-sufficiency, while production surpluses are key to farming families' economic well-being. There are different reasons in different parts of the world for unstable yields, including a lack of knowledge, a lack of access to financial or natural resources and marginal site conditions. Crop failures are particularly serious in regions affected by poverty, since they can often result in famine.

In addition to crop failure, there are a number of other risks that can determine whether a farm succeeds or fails. It is therefore important to regularly review the internal and external risks to the business and implement risk minimization measures in order to guard against adverse events. On a social level, cooperation between farms can play an important part in risk management (Pulfer & Lips, 2010). The cultivation of stable relationships can lead to the establishment of a social network that helps farms to jointly overcome crises that threaten their livelihood (or prevents the crisis from occurring in the first place). At an agroecological level, the risk of total failures can be reduced by employing a higher number of different livestock and plant species, since every species responds differently to (generally species-specific) pests, adverse weather events or shortages.

Indicator fm_4: Sustainable Relationships

Sustainability goal

The farm's internal and external relationships are managed in such a way as to provide a sound basis for its long-term success. The farm cooperates with colleagues and neighbors wherever it makes sense to do so. Conflicts are resolved by consensus and not by coercion.

Content

The stability of the farm's internal and external relationships and partnerships is assessed.

Scoring

100 points = Stable relationships are successfully cultivated on and off the farm and provide a sound basis for its success. The farm engages in sensible, productive cooperation with other farms and individuals. Conflicts on or involving the farm are solved by consensus rather than through coercion.

Explanation

Responsible behavior towards employees and society as a whole is a key attribute of businesses that achieve long-term success (William et al., 2003). This is the corporate culture described in the "co-evolution" approach where, rather than self-interest, the primary motivation is a willingness to cooperate and achieve meaningful collective added value (Anker, 2015).

This approach is extremely important in agriculture, where cooperation between farms is especially critical (Pulfer & Lips, 2010). The importance of cooperation between farms has grown as a result of increasing and ever more expensive mechanization across the globe and because of the growing economic pressures in the agricultural sector. Growth is not an option for many family-run farms with limited land of their own and scant financial resources. Consequently, cooperation between farms is often the only way of reducing workload and lowering unit costs. If this potential for cooperation between farms is not already being exploited, professional consultants and coaches should encourage farmers to tap into it.

All farms are embedded in a social and societal context characterized by numerous different relationships and dependencies. Stable relationships are important to a farm's long-term success. It is therefore necessary to ensure that all the relevant stakeholder groups are included in the strategic development process (Schaltegger & Figge, 1999). Farms' social exposure is recorded using the following groups: internal stakeholders (workers, management); access to resources (land rights, water rights, etc.) and finance (lenders, etc.); value chain (customers, suppliers, consumers, etc.); the farm's local environment (neighbors, local community, etc.); and the societal context (professional organizations, NGOs, media, etc.). It is essential for farmers to be self-critical about how they manage their farms. This includes the need to be aware of positive and negative external effects. For this to be possible, it is necessary to ensure the ongoing participation and inclusion of both employees and external stakeholders.

Within the farm, it is important to have clear rules so that decisions are communicated clearly and all members of the farm's workforce are treated fairly and with respect. Employees' commitment to their work is strongly influenced by whether they believe that what they are doing has a purpose and whether they feel that they are valued as a person (Anker, 2012). It is therefore recommended that workers should be given meaningful tasks to perform and shown appreciation for their efforts. Conflicts should be resolved by consensus and not by coercion. Management should encourage workers to admit their mistakes without fear of punishment. The idea is to foster a learning process focused on finding solutions rather than apportioning blame. Process consultants can help people to recognize and understand their own situation and to develop new solutions. Farmers who are able to obtain new insights by looking at problems and their causes objectively and critically will find it easier to modify their way of doing business should this be necessary.

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