Assessment of Biodiversity within the Holistic Sustainability Evaluation Method of AgBalance

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ABSTRACT

Biodiversity cannot scientifically be quantified in its totality. Absolute figures are highly variable. Some categories as systematic taxa etc. are not well established, and the functions and organisms depend on regional and local conditions. Therefore, any quantification of "biodiversity" is an approximation, requiring the relevant elements of biodiversity to be defined and the appropriate indicators used.

In AgBalance, the impact of agricultural activity on biodiversity is assessed as a relative function, constructed from the Biodiversity State Indicator and further indicators that have the potential to increase or decrease biodiversity. In AgBalance, a state indicator is included which allows a widely accepted quantification of the national or regional state of biodiversity. Changes of the state indicator due to influences which come from "driving force" or "response" category indicators provide a valuable tool to assess trends in the development of biodiversity".

Keywords: holistic LCA, biodiversity, AgBalance, sustainability

1. Introduction

The term "biodiversity" was in a widely accepted form defined at the Convention on Biological Diversity (CBD) 1992 as follows: "Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". According to this definition, biodiversity is encompassing all kinds of life forms, including genetic diversity and the levels of interaction between organisms including the ecosystems which they inhabit. This definition addresses issues that might not seem apparent at first glance. It raises problems on two levels, the level of complexity and data access, as well as on the normative level.

One element of the complexity is the huge range of living organisms and our limited knowledge about them – for example, the number of animal species in the world is estimated to be anywhere between 3 and 30 million. (WWF global, http://wwf.panda.org/about_our_earth/all_publications/living_planet): This is before gene diversity is added to the mix which factors in the huge variability within species and between individuals and populations (TEEB 2010). In addition tiny plants and microorganisms, which are not well known or hardly visible, are usually not included in biodiversity assessments (Reidsma 2006) (SRU 2009). Given the fact that they are responsible for delivering critically important ecosystem services of outstanding importance, like the creation of humus, CO_2-fixation and water balance, this omission is deeply flawed (Burel 1998) (European Union, 2011).

Finally, the quantification of biodiversity depends on a spatial and timely scale (Laurie 2010). The count of organisms under a footstep, in a field, a landscape, or in a larger spatial dimension will certainly result in different figures and data categories.

On the conceptual level, there are several challenges again. Mostly, debates on biodiversity include normative elements (Sarkar 2008) (Henle 2008) (Burkhard 2012). This is evident when studies focus on desirable organisms (in the sense of beneficial or attractive, rare or endangered species). Looking at ecosystem services, the concept of "benefit" implies that human interests are paramount. But, unwanted organisms like parasites, vectors and pathogens are all part of biodiversity, too, which includes organisms that cause damage in agriculture (FAO 2013) (FAO 2010). Animal pests, weeds and plant pathogenic fungi, bacteria, and viruses impact agriculture and reducing worldwide yields. The reality is that these organisms are hugely relevant to the economic, ecological and social pillar of sustainability (Charles 2010) (Karasakal 2009). The complex challenges which are part of the quantification of biodiversity can be summarized as shown in table1.

Table 1. Areas of normative tension when quantifying biodiversity

1. Focus on attractive animals or plants	Versus	Small organisms with often economic and ecological relevance are considered
2. Value-free quantification of biodiversity	Versus	Selection of positively or negatively valued elements of biodiversity
3. Quantification of biodiversity based on complete data sets	Versus	Extrapolation from a subset of data to the totality of biodiversity
4. Numerical quantification of biodiversity	Versus	Semi-quantitative or descriptive characterization of biodiversity
5. Quantification of biodiversity on a small-scale (regional, local, farm) level	Versus	Quantification of biodiversity in general or on a large-scale (national, EU, global) level

The sustainability evaluation method for agriculture and food supply chains "AgBalance™" is based on the principles of life cycle assessments which evaluate impacts which may contain conflicting objectives. For example, a definite farming activity may be positively rated for productivity, but it may be negatively rated for biodiversity development. The intention of AgBalance is to specify alternatives which allow decision makers to prioritize farm management strategies and to specify the respective strengths and weaknesses. Herewith, AgBalance follows the principles of the multi-attribute value theory (MAVT) which allows assessments on the basis of conflicting objectives (v. Witzke 2011).

The need to describe quantitatively sustainability (or elements of sustainability which includes biodiversity) has led to develop AgBalance which is based on precursor systems. In building on the environmental impacts and economic costs assessed in the Eco-Efficiency Analysis (Saling 2005) and the additionally integrated social impact indicators in SEEBALANCE® (Schmidt 2004) (Kölsch 2008), AgBalance™ was designed as a specific type of a new LCA system to assess the sustainability performance of the production of agricultural goods. Therefore, AgBalance in addition to SEEBALANCE contains a range of new agriculture-specific indicators, namely biodiversity, soil health and land use which were identified and developed in a dialogue with various stakeholders. This holistic system allows assessing parameters which contribute to the development of sustainability in agriculture at several user categories:

(1) for the farmers, by assessing current practices and developing scenarios for improved processes,

(2) for the agri-food value chain, by assessing agriculture's contribution over the complete product life cycle and developing options for improvement, and

(3) for policy makers, by assessing the impact of legal bodies and regulations on products and farming practices. Depending on the level of assessment of a study, a "balance" between unequally or even controversially directed factors can be evaluated and assessed by the indicator system.

There are well established systems on the farm level like REPRO (Christen 2009) or KSNL (Breitschuh 2008), and there are systems which support primarily political decisions like SEBI (EEA 2012) or IRENA (EEA 2005). AgBalance was designed to analyze agricultural production including the industrial processes which are described since SEEBALANCE is an integral part of AgBalance. The method focuses on the supply chain level i.e. the crop respectively the cropping system. Indicators are preferably included which can be actively influenced by farmers, for instance properties of agricultural production processes.

In the context of AgBalance biodiversity indicators, several aspects need to be considered. What are the reasons for the selection of definite parameters as indicators, and the disregard of parameters which may be elements of other LCA systems? Firstly, the concept of AgBalance indicators requires numerical quantification of algorithms (Schoeneboom et al 2011). Secondly, AgBalance focuses on anthropogenic factors in general, and this concept is applied for biodiversity indicators, too. Thirdly, indicators are "indirect" in the sense that they do not require monitoring data of definite taxa – like birds, plants or mammals –; instead, parameters which can be regarded as accepted as biodiversity influencers are used as indicators. Obviously, feasibility and practicability play an important role for indicator selection, too. This may go on cost of scientific preciseness (which is, for instance, applied in the BioBio indicator system (Herzog, F. et al., 2012)). AgBalance has not the demand to quantify biodiversity in general, and the same is undoubtedly true for biodiversity assessments in other LCA systems (de Souza, M. et al, 2013; Curran, M. et al, 2011; de Baan, L. et al., 2013). Instead, the indicator set addresses a "biodiversity potential" in the sense that anthropogenic factors which relate to farming are quantified which impact biodiversity in regions where they are implemented. These conceptual elements and in addition the link of biodiversity in the overall concept of sustainability are conceptual characteristics of AgBalance and resulted in the selection of the indicators. Examples are described briefly here.

Subsequently with sustainability evaluation tools (Saling 2002) (Saling 2005) like AgBalance™ (Schoeneboom 2011) (Frank 2012) methodology, environmental, societal and economic impacts are assessed independently.

The environmental impact assessment use characterization factors (as in most LCIA methods) with the resulting impacts normalized to arrive at individual impact categories. The biodiversity results are integrated in the final evaluation as a single result. The normalized results for different environmental impact categories are represented as the environmental fingerprint for each alternative. Relative improvement in each impact is represented by smaller values on the respective axes; hence the smaller the fingerprint, the better the relative performance of the corresponding alternative. Finally, all results are expressed as an overall summary figure.

In order to demonstrate the practicability of AgBalance, a study about winter oilseed rape production in Germany was selected for a case study. Recent reports indicate that oilseed rape production has seen a substantial increase in productivity and profitability for the farmers over the last decade (BLE 2007). Whether or not this intensification has been sustainable in total, however, remained unclear as well as segmental calculations for biodiversity (Vié 2009). Therefore, oilseed rape production in Northern Germany from 1998 to 2008 was analyzed using the AgBalance methodology. In particular, the results and implications of applying the biodiversity indicator set of AgBalance will be discussed.

2. Material and Methods

AgBalance is a life-cycle assessment method for value chains focusing on primary agricultural production that integrates environmental, social and economic cost indicators. It is based on mandatory and optional parts of the ISO 14040 and 14044 standards for life cycle assessment. Furthermore, the developments of different working groups such as UNEP/SETAC for social LCA, the SA 8000 and ISO 26000SR standards were considered in the development of the methods. The results from the individual impact categories were aggregated as outlined (Saling 2002). The method received independent assurance of functionality and coherence from DNV Business Assurance, TÜV Süd and the National Sanitation Foundation (NSF).

Specific impacts of agriculture on the environment (biodiversity, soil health and land use etc.), the economy (total costs and profitability etc.), as well as to social (health and safety, gender equality, working conditions, training, fair trade etc.) aspects are assessed. In total up to 200 metrics are considered to evaluate up to 70 indicators in the three dimensions environment, society and economy. AgBalance offers the flexibility to assess production systems with different regional scope, from the farm level up to regional or even national level. Specific algorithms have been developed that can be operated with different databases, such as specific farm data as well as statistical, sectorial data or survey data. Preferably, publicly available data are used in order to give the system a high level of data transparency. AgBalance further allows for scenario analysis demonstrating interdependent variations of impact results as a function of changes to input parameters.

The set of AgBalance biodiversity indicators follows the "driving force – state – response" model which is proposed by OECD to structure the complex relationships between agriculture and biodiversity (OECD 2003). It is closely related to the "pressure – state – response" concept which can be regarded as largely accepted. Accordingly, the "pressure" component compiles factors which affect negatively biodiversity resulting in a decline of the state of biodiversity (what is reflected in a negative numerical factor on the state). The "state" indicator quantifies the status quo of biodiversity. Generally, organisms which are scientifically or politically accepted are selected for this purpose. "Response" indicators reflect activities which are able to promote or conserve biodiversity.

The indicators are linked with each other by calculation factors which are generated with indicator – specific algorithms. Quantitative ranges which are allowed for each indicator are specified in table 2. The selection of factors between 0.5 and 1.5 is based on bird data of different ecological groups (farmland birds, woodland birds, water and wetland birds, seabirds, butterflies) which show trend curves in this range and indicate herewith numerical realism of calculation factors (Bird indicators, BTO 2014). Maps showing bird populations in Europe as basis for the evaluation can be found at European Environmental Agency EEA under data and maps (EEA).

Table 2. Biodiversity indicators of AgBalance according to the pressure-state-response concept

Indicator	Calculation factor
Pressure indicators:	
Low cropping diversity	0.5 – 1
Nitrogen surplus	0.5 – 1
Ecotoxicity potential of pesticides	0.5 – 1
High farming intensity	0.5 – 1
Outcrossing potential	0.5 – 1
State indicator:	
IUCN assessment	(0,7)
Response indicators:	
High cropping diversity	1 – 1.5
Agri-environment schemes	1 – 1.5
Protected areas	1 – 1.5
Low farming intensity	1 – 1.5

2.1 Pressure indicators

"Low cropping diversity" is per se a reduction of agro-biodiversity and provides relatively poor plant-based resources to many animals (FAO 2004). In general, "agro-biodiversity" is more than the pure number of crops: according to FAO, "agrobiodiversity encompasses the variety and variability of animals, plants and micro-organisms that are necessary for sustaining key functions of the agro-ecosystems". The multitude of crops – i.e. the number of crop species, crop varieties, the number of crop rotation programs on a farm or in a region – are an important element of sustained management of biological resources. In AgBalance, the number of crop plants in a rotation was selected as indicator since the advanced standardization and reduction of complexity of crop rotation programs which is often seen as element of farming intensification has a double negative impact on biodiversity: firstly, it is per se a reduction of agro-biodiversity, and it secondly reduces the diversity of food sources for wild and domesticated animals. Accordingly, under-average numbers of crops in crop rotation programs are selected as pressure indicators in AgBalance. Cropping diversity enhancement is a target of European agricultural regulations with respect to biodiversity protection (summary paper IEEP 2014).

"**Nitrogen surplus"** reduces mostly plant diversity and, based on that, in addition diversity of animals. It is important to make clear that nitrogen is not per se negatively assessed in AgBalance: nitrogen fertilizer – it may be natural or synthetic – is essential for plants. In the context of sustainability, the surplus of nitrogen is critical of several reasons. In the biodiversity indicator set, it is not the potential risk for surface water or groundwater which may be primarily a risk for human health at excessive concentrations. For biodiversity, nitrogen surplus was selected as indicator since it deeply influences plant societies in agricultural landscapes; it often causes the reduction of flowering plants and stimulates grasses. This reduction of primary biodiversity has often indirect negative consequences for pollinating or plant-feeding animals, i.e. the higher levels of the food chain. Therefore, an algorithm for nitrogen surplus is chosen as an indicator for low biodiversity in AgBalance. Appropriate nutrient balances are elements of SAFA (FAO 2012) and IRENA (EEA 2005) indicator systems.

"Ecotoxicity potential of pesticides" is an influencing factor on organisms which are exposed to these compounds. Pesticides – or "plant protection products" – are biologically active compounds which are used by farmers to control weeds (herbicides), fungal diseases (fungicides) or animal pests (insecticides or acaricides). The compounds may have a risk potential, i.e. for unwanted side-effects on such organisms which are not the target of the application by the farmer. Although, registrations which are the precondition for any pesticide application require often a specific risk management by farmers, these products can be handled safely. For instance, buffer zones to surface water to protect aquatic organisms, the risk potential of definite products were selected in AgBalance as in indicator. Data for short-term (acute) and long-term (chronic) eco-toxicity of plant protection products on earthworms, honey bees, rodents, birds, water fleas and fish are therefore available from pesticide toxicity databases. This selection of test organisms follows the European regulations (regulation EC No 1107/2009). Very detailed data on these products can be reviewed and extracted from the European Commission and can be used as well for other regions (EU pesticides database).

“High farming intensity” is a descriptive summarizing parameter; there is scientific evidence that high yields are generally negatively correlated with reduced biodiversity (Geiger et al 2010). This indicator may be challenged since it raises some questions. Empirically, there is the trend that “intensive agriculture” and biodiversity reduction often go hand in hand, while farming practices with reduced productivity – like many organic farming practices, extensive or traditional farming practices – in general promote biodiversity. But, some questions remain open. Is lower productivity in one area (for instance, in Europe) translocating problems to other continents from which agricultural goods need to be imported? This indirect land use or in a more negative sense indirect land use change is often discussed and might be addressed more properly in consequential LCA. However, there is so far no common agreement how to do it. On the other hand a question is, if the negative effect which high productivity often has can be compensated by the generation of more diverse landscapes with hedges, trees and zones which are dedicated to biodiversity protection. Although these questions can be regarded as open, it was decided for the AgBalance indicator set to follow the empiric evidence for a negative correlation between farming intensity and biodiversity. The farming intensity is only one effect to assess the biodiversity; other positive effects from modern farming systems can balance them as well in a positive way.

“Outcrossing potential” means the potential of a crop for fertile reproduction with native wild plants and herewith the genetic infiltration of original biocenoses. Although it may be a numerical increase of biodiversity in natural habitats when outcrossing occurs, there may be competition between indigenous biodiversity and such elements of biodiversity which is introduced by humans. The outcrossing potential according to this indicator is crop specific: there are crops with high outcrossing potential due to parameters like pollen transfer potential, number of wild plants of the same biological taxon in the region (which facilitates inbreeding), seed persistence in soil. Accordingly, a ranking of crops is made which reflects in summary the outcrossing potential of a crop species. Outcrossing potential is in particular an element of political decision making and often controversial public debates in the context of genetically modified organisms (summary paper EFSA 2014).

2.2 State indicator

“Farmland bird populations” are often used as indicators of species diversity (or biodiversity in general) since birds are on top of food chains and require for successful reproduction a diversity of biotic resources (like breeding habitats or different food sources).

In AgBalance, the status of biodiversity in a particular region is assessed by the number of species available that feature on the IUCN Red List for that region (IUCN 2008). The state indicator is calculated from the number of Red List species, according to a non-linear function. The function has the following range: the biodiversity state ranges from 1 (optimal) to 0 (worst); the slope is higher for smaller number of species, i.e., the differences are higher between regions with a smaller number of endangered species than those with higher number of endangered species. For Germany, the 632 Red List species were assigned a biodiversity state of 0.7. This definition is based on the published national biodiversity index of Germany. Other regions are assigned values by interpolation with zero Red List species corresponding to a biodiversity state indicator of 1, and 4000 Red List species to an indicator value of 0.1.

2.3 Response indicators

“High cropping diversity” is per se an increase of agro-biodiversity and provides diverse resources to animals in higher levels of the food chain. “High cropping diversity”, i.e. over-average number of crops in crop rotation programs as response indicator, responds to “Low cropping diversity” as pressure indicator (see above).

Cropping diversity is accordingly a bi-directional indicator in AgBalance, since high crop numbers are positively rated, low numbers negatively.

"**Agri-environment schemes"** are subsidies can be applied by farmers to increase elements of biodiversity. Although ARSes may be critically judged (Berendse et al 2004), they are regarded as a response indicator due to the positive effects on biodiversity which they have in total on biodiversity (European Commission 2014). AR-Ses are implemented on a local level, therefore, different measures may be funded which promote biodiversity: it may be extensive farming to promote definite birds species or the sowing of flower strips from which pollinating insects benefit. Two factors are considered in this AgBalance indicator algorithm: the level of funding which the farmer receives, and the acreage for which this funding is dedicated. Both figures and regional information as well can be used and quantified as additional indicators for the change of biodiversity after applying different subsidies.

"Protected areas" are a classical tool of nature conservation to increase elements of biodiversity. In general, there are many different categories of nature conservation territories which contribute to the increase of biodiversity**.** Farmland is often part of such protected areas, for instance in Natura 2000 territories which clearly contribute to the enhancement of biodiversity (European Commission 2014). Therefore, the local range of protected land is selected as an AgBalance indicator.

"Low farming intensity" practices describe in summarizing form the trend that low yields often promote elements of biodiversity (European commission 2014, Geiger et al. 2010). In AgBalance, farming intensity is (like cropping diversity) a bi-directional indicator: low farming intensity practices often contribute to biodiversity conservation, while high farming intensity has the opposite result (see above under pressure indicators). High nature value practices which contribute to biodiversity are mostly associated with lower productivity than conventional farming (BFN 2014).

The above mentioned indicators fulfill the requirement for indicators in the sense that they are influencing factors, which can be regarded as publicly and scientifically accepted. But, this does not allow the quantitative assessment of the biodiversity range which is relevant in anthropogenic landscapes. The concept of using bird population trend curves is applied in AgBalance as a data-based approximation for this quantification. In European countries (and globally) it is shown that the range of 0.5-1.5 gives a realistic dimension (Global wild bird index 2010; Bird indicators 2013; BLE 2007). Based on these data, the biodiversity indicators are connected by factors within a range between 0.5-1.0 for driving force indicators, 1.0-1.5 with response indicators, and a state indicator which is normally <1, for Europe it is 0.7 unless national data are available. This factor depends on the region and former losses of biodiversity to a defined status. A desired trend according to this concept is the positive shift of the state indicator; ideally the state indicator should reach 1.

Competition between agricultural landscapes and natural areas is an important factor in the context of global biodiversity development. It is specified in the "environmental pillar" section, as part of the indicator "land use". It is not an element of the set of biodiversity indicators described here, but a standard element of each study since "land use indicators" are obligatorily used.

Each AgBalance study requires the assessment of all indicators in all three pillars – ecology, economy, social. Herewith, it is avoided that a targeted selection of indicators results in an unbalanced or biased assessment. A study result cannot be exclusively driven only by biodiversity or social or soil indicators or any other selected set of indicators even when the study question refers to elements of sustainability. All single results are displayed and shown separately in the study report. Finally they will be aggregated to an overall result.

3. Results and Discussion

For the showcase study on winter oilseed rape production in the Northern German state Mecklenburg-West Pomerania, the main data sources were from the German "reference farm network", the German annual agricultural report and interviews conducted on five farms, each with 100 – 500 ha of agricultural area planted with winter oilseed rape. The general study's scope was the sustainability performance of winter oilseed-rape production in the study region in 2008 in comparison to production ten years before. The customer benefit was defined as the 'production of 1 ton of oilseed rape, cradle to field border, in Mecklenburg-Vorpommern, Germany, product water content below 9%, data from 2008 and 1998.

Biodiversity indicators are shown in table 3. The indicator results of the two alternatives 1998 and 2008 can be compared with numerical results and have been calculated from single impact categories. The indicators

"Ecotoxicity potential", "Nitrogen surplus" and "Protected areas" show quite good improvements in the 10 years period, the others are constant but not negative. Only the Biodiversity state indicator was reduced which can be linked to other agricultural or industrial processes and the reduction of species in that region. Although the absolute number of pesticides which were used in the standard application schemes increased (5 in 1998 comparing to 9 in 2008), the ecotoxicity potential showed a positive trend due to more favorable ecotoxicity profiles of the new products.

Table 3. Overview on biodiversity impact categories for 1998-2008 comparison for the winter oilseed rape production

		2008 Standard	1998 Standard
Biodiversity	Biodiversity state indicator	0,69	0,70
	Agri-environmental schemes	1,00	1,00
	Protected areas	1,28	1,09
	Crop rotation	1,00	1,00
	Ecotox potential	0,91	0,88
	Farming intensity	0,60	0,60
	Intermixing potential	0,65	0,65
	Nitrogen Surplus	0,75	0,69
	Result biodiversity	0,24	0,18

The protected area coverage evaluates the coverage of Natura2000 and FFH areas in the study region (in this case, the federal state) against a given target value, as well as the fraction of area enrolled in agri-environmental schemes.

The results of the evaluation of the Biodiversity Potential can be linked afterwards with results from other environmental indicators to come to conclusions which are easy to understand, consider the whole life cycle and are holistically done. With the final results, further decision-making can be initiated and can be used for further improvements of the agricultural processes.

The highest aggregated assessment of all sustainability indicators showed a substantial improvement of sustainability score throughout all dimensions ("Economy", "Environment" and "Society") when comparing the good agricultural practice "Standard 1998" to "Standard 2008" practice. It is evident that ecological indicators contributed significantly to this difference since they exhibit clear differences between 1998 and 2008. In Figure 1 it is shown, in which environmental indicators, the alternatives differ and where improvements happened during the time period of 10 years. As more outside an alternative is located for the specific indicators, as more this alternative have benefits in the defined categories. The figure shows that in 2008 compared to 1998 all indicators have been improved; just the soil indicator showed the same result.

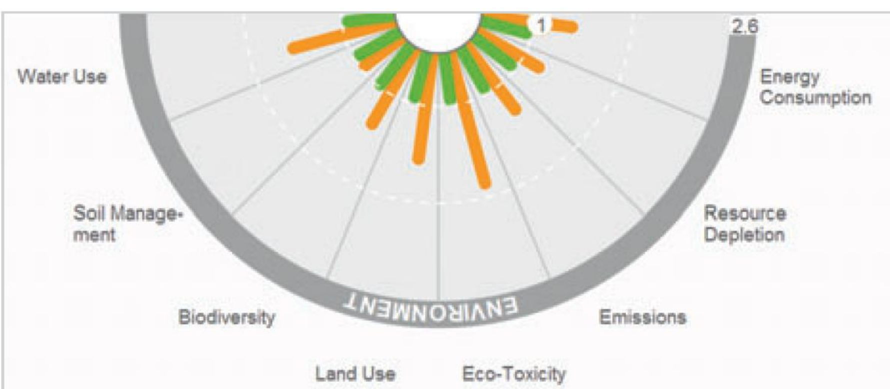

Fig. 1 Assessment results of biodiversity in total in the context of the other indicator sets of the environmental pillar (Green petals reflect the values for 1998, orange petals represent 2008).

The overall results can be shown in a similar way, covering all types of indicators to get a good overview, were improvements have been made over the last 10 years and where further activities or changes needed to have a more sustainable solution. Figure 2 shows all the impacts and allows specialists together with farmers the development of strategies for higher sustainability in the sector. In all main categories, the 2008 technology is more sustainable compared to 1998. It can be shown with the AgBalance methodology and can be quantified, that the sustainability in the defined type of agriculture was improved over the last 10 years. A common opinion in the society that the biodiversity was reduced if the situation today is compared to the situation 10 years ago, can be refuted.

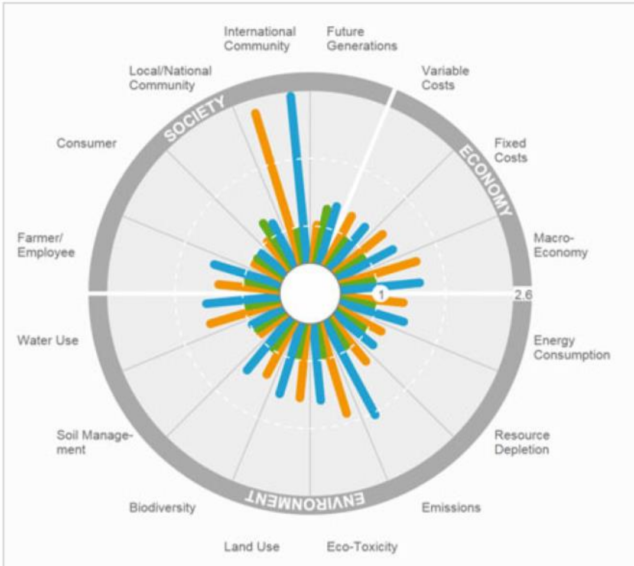

Fig. 2 Assessment results of all indicators in total (Blue petals reflects the values for modified fertilizer regime, based on Good Agricultural Practice in 2008, Green petals reflect the values for 1998, orange petals represent 2008).

4. Conclusion

The indicator set which is used to assess biodiversity in AgBalance has definite properties which become particularly visible with the showcase study. The concept implements that agriculture is not „good“ or „bad“ for biodiversity in general, instead, specific agricultural measures may promote or reduce biodiversity. A “state indicator” is a valid tool to make assumptions about biodiversity in general, based on drawing extrapolations from organisms of a select group to describe the state of biodiversity in total at a definite time and at a definite place. The amount of detailed information on various aspects of the sustainability performance of the production system together with scenario analysis makes AgBalance a powerful tool to derive recommendations for optimized crop production protocols.

Several examples show, that this kind of information is very helpful for farmers and other members of the whole supply chain, to develop more sustainable processes and to support a more sustainable agriculture. The quantification of sustainability indicators show very clearly optimization potentials and can be used for further improvement of processes. It can support the positioning of farmers in the society and increase the acceptance of products in the market following general principles of sustainability as a market trend. In particular the biodiversity facts of an agricultural process are in the focus of different stakeholders and needs to be improved to reach the goals of generating higher state indicators of a certain time period. The methods shown in this article are bale to measure and assess these effects and giving clear directions for the improvement of biodiversity.

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