Life Cycle Assessment towards a Sustainable Food Supply – A review of BASF's Strategy

Markus Frank[1,*], Peter Saling[2], Martijn Gipmans[3], Jan Schöneboom[2]

[1] BASF SE, Agricultural Center, Speyrer Strasse 2, 67117 Limburgerhof, Germany
[2] BASF SE, Sustainability Strategy, ZZS/S, 67056 Ludwigshafen, Germany
[3] Metanomics GmbH, Tegeler Weg 33, 10589 Berlin
[*] Corresponding author. E-mail: *markus.frank@basf.com*

ABSTRACT

Life Cycle Assessment (LCA) and approaches based thereon, e.g., Eco-Efficiency Analysis and SEEBALANCE, have proven useful tools for a quantitative sustainability assessment along value chains and across industry sectors. In order to holistically assess sustainability in agriculture, AgBalance™ combines LCA with environmental, economic and social impact indicators, generalized to varying spatial scales. The methodology comprises up to 70 sustainability indicators, which are grouped into the three dimensions "environment", "society" and "economy". Sensitivity and scenario analyses can be employed to study the robustness of the model results, and to investigate trade-offs or the response to external influences. In order to better translate findings from the socio-economic LCA studies to continuous improvement on farm, web-based crop management applications are developed. They interactively conduct scenario analysis for a set of sustainability indicators that were shown to be the most relevant ones in an AgBalance case study. This new strategy is designated "AgBalance Farm".

Keywords: Socio-economic LCA, agriculture, AgBalance, continuous improvement, AgBalance Farm

1. Introduction

1.1. Sustainability in the Food Chain

A focus on sustainability in the food value chain has become a basic prerequisite for suppliers and consumers. There is no other industry where so many product and production characteristics are marketed as "sustainable" as in food production (Frank et al. 2013). If sustainability is manifested and proven with different methods, varies widely in the different value chains of the food sector. Sustainability is mainly driven by the farming activities of the farmers who continuously implement new practices and improvements, in a challenging environment of weather, market needs and consumer expectations. Numerous existing sustainability programs often have their roots in Corporate Social Responsibility (CSR) activities, which are not integrated into the core business of the company (Porter and Kramer 2011). However, more and more companies recognize that these types of initiatives not only represent an investment in their brand and reputation, but they can also help to effectively resolve of one of their primary problem areas: supply chain security. Lawrence and Burch (2007) report that food producers and supermarkets increasingly rely on cooperation with suppliers and long term contacts for a secure supply of high quality products, particularly in product categories with high potential for differentiation. These contacts may include multiple layers of the value chain concerned, as they strive for considerably closer cooperation with the producers (Nestlé 2013).

1.2. Sustainability Assessment in BASF

Against this background, there is a demand to be able to map the whole food value chain with respect to the contribution of each stage to the sustainability footprint of the entire chain. BASF comprises one of the few companies being active on all different stages of the food value chain, starting from seed provision, plant protection and fertilizer additive manufacturing, provision of food ingredients, packaging and many more. Therefore, BASF has pioneered an array of LCA tools to capture the impacts on the various levels of the value chain. Tools such as Eco-Efficiency Analysis (Saling et al. 2002) and SEEBALANCE (Kölsch et al. 2008) are used by BASF and its customers to assist strategic decision-making, facilitate the identification of product and process improvements, enhance product differentiation as well as to support the dialogue with opinion makers, NGOs and politicians. Both Eco-Efficiency Analysis and SEEBALANCE analysis are comparative methods; the advantages and disadvantages of several alternatives are assessed according to a predefined customer benefit with a holistic approach. The analysis uses a Life Cycle Assessment approach with the whole life cycle of a product – from

cradle to grave – being considered. Next to the environmental impact, which is assessed based on ISO14040, ISO14044 and ISO 14045 norms, all economic factors are taken into account. The SEEBALANCE also considers social impacts of products and processes (Uhlman & Saling, 2010).

Both Eco-Efficiency-Analysis and SEEBALANCE have been employed in the food and feed value chains in order to assess the key drivers of sustainability in various production systems. It has been shown in various case studies that agriculture can have a large share of the entire sustainability profile of food and feed value chains. At the same time, logistics, transport, processing and, not least, consumption can play a substantial role as well. In 2012, for example, BASF analyzed the CO_2 balance for veal and beef products with the client Westfleisch, supporting them in improving the sustainability of their meat production along the whole value chain (Westfleisch 2010.).

Feed ingredients for a more sustainable aquaculture of salmon have been identified through Eco-efficiency Analysis in the collaboration with Biomar A/S (Saling et al. 2007). Three ways to produce astaxanthin as an ingredient of salmon diets were compared: chemical synthesis, fermentation and production via fermentation of algae. In this case study, the astaxanthin derived from chemical synthesis was the most eco-efficient product (Saling et al. 2007). Other examples comprise the production of beef with Cattlemen's Beef Board and National Cattlemen's Beef Association (NCBA 2014). The Eco-Efficiency Analysis portfolio shows that the present-day U.S. beef value chain is more sustainable than in 2005. While there was detected a 6 percent increase in the price of beef between 2005 and 2011, there was a simultaneous decrease in the overall environmental and social impacts from the U.S. beef value chain of approximately 7 percent.

Case studies were also performed on food packaging. In collaboration with the German dairy company Müllermilch, for instance, plastic cups made of polymers turned out to be the more sustainable option compared to returnable glass containers and composite cartons (BASF 2003). In a similar approach, various bottling alternatives for carbonated mineral water were compared. The customer benefit involved consumption of 1000 l mineral water at a distance of 300 km from the bottling plant. The disposable 'Office Line', a novel packaging method for office use, option outperformed the disposable PET or carton as well as the reusable glass bottle due to the favorable environmental footprint (Gerolsteiner 2005). The main sources of impacts are the material production, the cleaning steps and the recycling options for the different alternatives. Transportation plays a minor role. The relation of volume and packaging material and the reuse-cycles is very important for the position in the sustainability portfolio. The limitation of Eco-efficiency and SEEBALANCE to cover the agricultural production level is the lack of specific indicators, among others capturing the impacts on biodiversity, soil health and the agri-sociological context of production. For this reason, BASF has developed AgBalance^{TM}: a holistic method for assessing sustainability in agriculture and identifying key drivers for improvement.

2. AgBalance – Life-Cycle Assessment in Agriculture

AgBalance comprises a multi-criteria life cycle based approach in combination with a defined aggregation and summary of single results into a single sustainability score (Frank et al. 2012). AgBalance^{TM} delivers results that enable farmers, the food industry, politicians and society to objectively evaluate processes in terms of their sustainability profile. In doing so, a vast amount of information on individual factors can be ascertained in addition to overall statements on the sustainability of agricultural practices (e. g. ploughing). AgBalance was finalized in mid of 2011. In September 2011, the methodology was given independent assurance by the global expert agencies TÜV SÜD, DNV Business Assurance and NSF International. AgBalance^{TM} can be used to map an individual farm or the whole agricultural sector in one region, for example. The focus can either be on the agricultural production system alone or on the processes that have established themselves downstream in the value chain, such as logistics or processing.

A case study with the holding company SLC Agricola in Brazil involved an internal benchmarking of two large farms, each with over 10,000 hectares, to identify the central sustainability drivers for their crop rotation consisting of soya, maize and cotton and to derive follow-up opportunities for their continuous improvement. An average cultivated hectare for each of the two farms, Panorama (Bahia state) and Planalto (Mato Grosso do Sul state) were compared on the basis of the operation data from the 2009/2010 season. The indicators from all three sustainability dimensions – environment, economy and society – were investigated using a holistic approach over a section of the life-cycle that starts with the raw materials used in the production (the "cradle" of the process, for example phosphorus extraction or oil production) and ends with the delivery of the harvested goods at

the nearest port. The analysis revealed that the Planalto farm is substantially more sustainable than the Panorama farm (Fig 1), which is largely due to better results in the economy and environment dimensions.

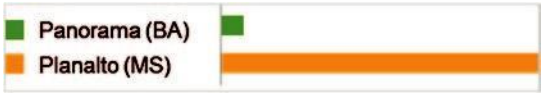

Figure.1. Relative sustainability index of the two farms Panorama and Planalto. Planalto achieved a 40% better result

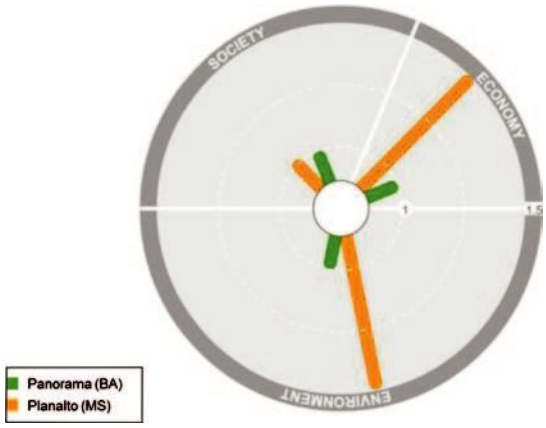

Figure 2. Representation of the sustainability index in terms of the three dimensions of sustainability. The length of the bar indicates higher sustainability. Each time the worse alternative is normalised to the value 1

Whereas the result in the social indicators did not exhibit significant differences (Fig. 2), the most important drivers in terms of economy turned out to be an improved cost situation and an increased profit of the Planalto farm. In terms of the environment, the key drivers turned out to be a predicted imbalance for nitrogen and above all, phosphorous in the soil as well the pesticide regime. According to initial calculations, the optimization of the fertilization regime in Panorama could lead to savings of almost 15 million kWh of energy (this corresponds to the energy use of roughly 2,000 households in Brazil) in addition to substantial cost savings. The CO2 equivalents saved using AgBalance™ amount to almost 8,000 tons per year. These results, together with the additional findings on pesticides, can serve as the starting point for a continuous improvement program at SLC Agricola. With its knowledge base, BASF supports a suitable product portfolio throughout the whole life-cycle and works towards creating common solutions towards greater sustainability.

Measuring sustainability can be a central key to steady improvements towards sustainable agriculture. It is therefore an essential requirement that it succeeds in translating results from complicated life-cycle analyses into farmers' everyday reality and to derive specific recommendations for action. However, agricultural production globally is strongly dependent upon smallholder farming, which is not easily accessible by complex and expert-based LCA approaches. Novel IT solutions are required in order to make use of LCA-based knowledge for a more sustainable crop management on-farm. This is the basic idea of the concept "AgBalance Farm".

3. AgBalance Farm - From LCA to Farm Management

Global food security and sustainability stands and falls with the adoption of sustainable crop management practices by millions of smallholders in developing countries. As outlined above, Life Cycle Assessment has proved capable to reveal the key drivers of sustainable agriculture and thus to serve as a guardrail for improvement strategies (Frank et al. 2012). However, the translation of the results of LCA studies into on-farm decision support has mostly failed. Here, we present a strategy designated "AgBalance Farm" that uses key learnings of Socio-Economic LCA studies for the development web-based crop management support applications for farm-

ers. This strategy is based upon BASF's experience with the Eco-efficiency Analysis manager as outlined in Saling (2013). India is the fifth largest producer of soybean in the world but soybean yields currently reach only half the global average of 2.4mt/ha. Lack of knowledge about good farming practices comprises the key reasons for the low productivity. Through the training program 'Samruddhi' (Sanskrit for 'prosperity'), farmers are educated not only on the timely usage of crop protection inputs, but also about correct fertilization, seed rate and spacing to enable higher yields (GIZ 2013). A group of self-reliant farmers, the so-called 'Margdarshaks', are trained by BASF's technical advisors and are entrusted to promote 'Samruddhi' in their village and to help other these farmers to adopt the best practices. While the contribution of Samruddhi to the profitability of the Indian soybean farmers had been shown (PWC 2013), its contribution to the sustainability of the production was largely unknown (Voeste 2012). Against this background, a holistic socio-economic life cycle assessment using AgBalance^{TM} methodology was conducted. As a test case, soybean production under 'Samruddhi' and 'non-Samruddhi' in the state of Madhya Pradesh were compared. The AgBalance^{TM} revealed that the 'Samruddhi' production practice outperfomed 'non-Samruddhi' in all three dimensions of sustainability. In the economic dimension, a better cost position (fixed & variable) and higher profits per ton of soybean resulted in a better score. In the social dimension, a stronger emphasis on professional training favoured the 'Samruddhi' practice. In the environmental dimension, the better performance of the 'Samruddhi' practice in some LCA impact categories was accompanied by the inferior scores in categories such as soil health, biodiversity potential and emissions. As the key driver for this, the fertilizer regime of 'Samruddhi' was identified (PWC 2013). Based upon this AgBalance^{TM} study, 12 sustainability indicators with a big impact on the study result were selected. Through regression analysis of data sets of approx. 100 individual farmers, mathematical functions describing the interdependencies between the respective indicators were derived, e.g. between yield and nutrient management. A web-based application was generated that can be used e.g. by 'Margdarshaks' to help soybean farmers in their villages optimizing their production protocol towards higher yield, profitability and sustainability. It basically conducts scenario analysis interactively, as demonstrated for the concept of the Eco-efficiency Analysis manager. With this "AgBalance Farm" strategy, we aim to effectively use the potential of socio-economic LCA to support crop management decisions of individual farmers.

4. Summary

Sustainability is becoming increasingly important as a key factor for growth and value creation. Customers along supply chains want more sustainable products and system solutions. There is a need to integrate sustainability much more closely into businesses and decision-making processes. To manage this in an effective way and to support decision-making processes, a sustainability evaluation toolbox is needed which can be applied to assess products and processes in a holistic manner. Both detailed in-depth results of individual impact indicators, as well as aggregated results and a single sustainability evaluation score are output of the sustainability Evaluation methods. Different types of footprinting in combination with other information can support decision-making efficiently. The communication of the results is a key aspect of this type of studies, especially in the food supply chains, where also end consumers are involved. Holistic, LCA-based and scientific sound methods to measure sustainability are key success factors for the realization of more sustainable production systems. Nutrition of human beings will be one of the key challenges of the future and can only be realized in a more sustainable manner. BASF cooperates with all players and producers in the supply chain, from basic production and farming via processing, packaging, transportation and preparation of foodstuffs.

5. References

BASF (2003) Environmentally friendly even without a deposit. BASF'S eco-efficiency analysis looks at packaging systems for milk-based drinks. Press Release and Information. http://www.basf.com/group/corporate/de_DE/news-and-media-relations/science-around-us/eco-efficiency/index

Frank M, Fischer K & Voeste D (2013) BASF: Measurability of shared value creation in agriculture. *In:* Michael D'Heur (ed.) "CSR und Value Chain Management"(2014); SpringerGabler, p. 217-236

Frank M, Schöneboom J, Gipmans M & Saling P (2012) Holistic sustainability assessment of winter oilseed rape production using the AgBalance^{TM} method – an example of 'sustainable intensification'?, *in:* Corson, M.S.,

van der Werf, H.M.G. (eds.), Proceedings of the 8th International Conference on Life Cycle Assessment in the Agri-Food Sector (LCA Food 2012), 1-4 October 2012, Saint Malo, France. INRA, Rennes, France, p. 58-64.

GIZ (2013) Partnering Progress. BASF's Samruddhi Project. *In:* Responsible Corporate Investment in Rural India, pp. 11-17. http://de.scribd.com/doc/183777721/Responsible-Corporate-Engagement-in-Rural-India-A-Compendium-of-Good-Practices. [Accessed: Feb. 10, 2014].

Kölsch D, Saling P, Kicherer A, Grosse-Sommer A & Schmidt I (2008) How to measure social impacts? A socio-eco-efficiency analysis by the SEEBALANCE®method. Int. J. Sustainable Development 11 (1),

Lawrence G & Burch D (2007)Understanding Supermarkets and Agri-food Supply Chains. *In* Supermarkets and Agri-food Supply Chains. Transformation in the Production and Consumption of Foods, Burch and Lawrence (eds.), p. 1-28. Cheltenham: Edward Elgar Publishing Limited.

NCBA (2014) Cattlemen's Beef Board and National Cattlemen's Beef Association; Sustainability, 2014

Nestlé (20013) Nestlé in society: Creating Shared Value and meeting our commitments. 2013. http://www.nestle.com/csv (Accessed 23 April 2013).

Porter M & Kramer MR (2011) The Big Idea: Creating Shared Value: Rethinking Capitalism. Harvard Business Review, Januar-Februar 2011,1-17.

PWC (2013) Price Waterhouse Coopers Evaluation of Financial Impact of Samruddhi Programme on Soybean Farmers.

Saling, P, Becker, M, Hens, T , Jakoby, H (2005), Ökoeffizienzanalyse Mineralwasser-verpackungen, 2005, Gerolsteiner, http://www.gerolsteiner.de/fileadmin/Homepage/_koeffizienzanalyse.pdf

Saling P (2013) User handbook for Web-based Eco-Efficiency Analysis.

Saling P, Kicherer A, Dittrich-Krämer B, Wittlinger R, Zombik W, Schmidt I, Schrott W & Schmidt S (2002) Eco-efficiency Analysis by BASF: The Method. Int J LCA 7 (4), 203-218.

Saling P, Grosse-Sommer A, Alba-Perez A & Kölsch D (2007) Using Eco-efficiency analysis and SEEBalance in the Sustainability Assessment of Products and Processes. *In:* Sustainable neighbourhood – from Lisbon to Leipzig through Research (L2L). https://www.bmbf.de/pub/l2l_conference.pdf

Uhlman B & Saling P (2010) Measurnig and communicating sustainability through Eco-efficiency-Analysis. Chemical Engineering Progress December 2010, 17-26

Voeste D. (2012) Experience on gathering meaningful data for life cycle analyses: BASF'S ecoefficiency tool in Indian agriculture. *In:* A Sustainability Challenge: Food Security for all. National Academies Press, pp 46-48.

Westfleisch (2010) Annual sustainability report 2010, page 22

This paper is from:

Proceedings of the 9th International Conference on Life Cycle Assessment in the Agri-Food Sector

8-10 October 2014 - San Francisco

Rita Schenck and Douglas Huizenga, Editors
American Center for Life Cycle Assessment

The full proceedings document can be found here:
http://lcacenter.org/lcafood2014/proceedings/LCA_Food_2014_Proceedings.pdf

It should be cited as:

Schenck, R., Huizenga, D. (Eds.), 2014. Proceedings of the 9th International Conference on Life Cycle Assessment in the Agri-Food Sector (LCA Food 2014), 8-10 October 2014, San Francisco, USA. ACLCA, Vashon, WA, USA.

Questions and comments can be addressed to: staff@lcacenter.org

ISBN: 978-0-9882145-7-6