Monitoring sustainability of Dutch agriculture

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Abstract

A more sustainable agriculture is widely used vocabulary to describe the main challenge of the agriculture sector. Sustainability is however a fuzzy concept. What does sustainable agriculture mean and how do we measure progress? This paper describes the process and results of a project to measure sustainability of the primary Dutch agricultural and horticultural sector. The project resulted in a report that describes the long term development of the performance of 7 farm types on about 25 sustainability themes (ranging from income to crop protection and animal welfare). A large number of indicators was based on the Dutch Farm Accountancy Data Network, a database that includes the individual data of 1500 farms representative for Dutch agriculture. This enables to look at averages scores for the sector. Moreover, variation in scores between farms can be identified. There are large differences among farms on the performance on nearly all sustainability themes. Furthermore, the usage of micro data offers the possibility to identify farms that are performing well on nearly all sustainability themes. These farms show that there is not necessarily a trade-off between environmental and societal performance on the one hand and economic performance on the other hand. An analysis on how these farms differ from other farms will help Dutch agriculture improve there level of sustainability.

1. Introduction

A more sustainable agriculture is often used as vocabulary to popular describe the main challenges within the agricultural sector. Governmental agencies, both national (i.e., Dutch ministry of Agriculture, Nature and Food quality (ANF) (2002, 2007)) as well as international (i.e., European Union (2001, 2010), set sustainability as a key-objective in its policy-description. Sustainability, however, is a fuzzy concept. Various definitions are used to define it. Moreover, a large number of methodologies and performance indicators are used to assess its development. What does sustainable agriculture mean and how do we measure progress? A long list of authors have already tried to translate this fuzzy concept of sustainability into meaningful indicators that can be used to measure progress. The Brundlandt commission (WCED, 1987) introduced the most general used definition of sustainability: meet the needs of the present without compromising the ability of future generations to meet their own needs. Both the OECD (1999) and EC (2001) developed already frameworks and indicators on sustainable agriculture. These frameworks and long lists of indicators, however, have never been put in practice, either by a lack of translation of frameworks into indicators, or a lack of representative data to calculate the indicators. For small number of case studies, sustainability assessment within agriculture has been put into practice, however, this cases often used small number of farms and never provided a representative overview for a farm type or country as a whole.
The Dutch ministry of ANF and the Dutch Environmental Assessment Agency (DEAA) requested to measure sustainability of the primary agricultural and horticultural sector in a quantitative way. Firstly, this means that all indicators should be measured preferably from 1990 onwards to see long term development and secondly, data should be representative.
This paper describes the process and results of a project to measure sustainability of the primary Dutch agricultural and horticultural sector. Next to the primary objective of a monitoring report on sustainability, the DEAA wanted to use the results for the

evaluation of the Dutch policy concerning the level of sustainability of animal husbandry.
Section two describes the method used, including the processes used to reach the project goals and the selection of themes and indicators. Section three describes a method to come to more integrated conclusions than just presenting scores on separate sustainability themes. The final section presents the lessons learned.

2. Method

In order to produce a consistent assessment of Dutch agricultural and horticultural sector, a model for developing performance measurement systems was applied. This model was based upon a general model developed by van Kerssens- van Drongelen (1999) and adjusted to Corporate Social Responsibility by Ten Pierick and Boone (2005). Within this model (table 1), 8 choices have to be made. For a detailed description of all choices, see Boone *et al.* (forthcoming).

Table 1 Model for developing performance measurement systems (Boone et al., forthcoming)

Choice	Description
1	Goals and functions
2	Scale level
3	Specification of preconditions and functional and user demands
4	Themes
5	Indicators, targets and measurement methods
6	Weighting and aggregation methods
7	Presentation format
8	Datasource

S*cale level*

The concept of sustainability implies that the scope of the study should be broad. However, for a practical assessment, the system and system boundaries need to be defined. The ministry of ANF wanted to use the results of the project to evaluate their policy. Therefore, this project focuses only on *Dutch* agricultural and horticultural sector. Direct impact occurring abroad of Dutch agriculture (e.g. deforestation and loss of biodiversity due to feed production in South America), is addressed however.
A focus on complete production chains have a preference from a theoretical viewpoint, since the sustainable behavior of one link can be out weighted by unsustainable behavior of the next link in the chain. On the other hand, Life Cycle Assessment studies show that for most agricultural products, the vast majority of the impact originates from primary agricultural production. Next to this, agriculture production chains are very difficult to define, while part of the agriculture product end up in a lot of different production chains. Furthermore, geographical definition of agricultural chains is difficult, while large companies in the processing industry operate all over the world. Due to this, data on sustainability indicators of agricultural production chains is hardly available. Therefore, we decided not to include the impact of other links in the Dutch production chain, like food processing and retail, and focus on the agricultural and horticultural sector itself.
Next to the delineation of the study, decisions are necessary how to aggregate and present results. Three options were identified: regional presentation, presentation per sustainability theme and presentation by farm type.
For local environmental issues, a regional split up has large advantages. Policy on nutrient management, for example, has regional aspect like soil and water quality. For several other environmental issues, however, no regional implementation is used, and

policy objective have a sector or thematic approach (e.g., climate change, animal welfare). Because the report should be used for policy evaluation, it is important to link the developments on the sustainability themes to the policies of the ministry of ANF. Furthermore, decisions on sustainable production are made by the manager of the farm and not on regional level, or thematic level. Farm level, therefore, is often used for policies to increase the sustainability. The fact that a farmer is the main decision maker to improve sustainability, was also the main reason not to choose for a thematic level. Another reason is that non agricultural actors might have a large impact on the thematic scores. Therefore, a split up into farm types was made.

Selection of themes per farm type

For the selection of themes, a group of 12 researchers and sector specialists were asked to lists the main sustainability themes that they identified in policy notes of the government, farm organizations and NGO's. In this way, the viewpoints of all stakeholders could be included. Secondly, scientific literature and other research reports were taken into account.

Based on the long list of themes and the size per farm type (i.e., number of farms and economic size), a proposition was made which farm types (or chapters) to include in the actual monitor, namely: arable farming, fruit and vegetable production in open ground, ornamental plant cultivation in open ground (bulb growing and tree nurseries), greenhouse farming and cattle, pig and poultry farming. Next to a presentation per farm type, it was proposed to present for the agricultural and horticultural as a whole, so mixed farms could be included as well and interaction between different farm types could be included (e.g., nutrients).

The long lists of relevant themes per farm types were discussed by a large group of specialists from the ministries of ANF and Housing Spatial Planning and the Environment (HSPE), researchers and DEAA. In a closing session with representatives from all groups, final decisions were made on which themes to include. The following criteria have been taken into account in the selection of the themes (based among others on GRI, 2006):

- Materiality
- Inclusiveness (viewpoints of all stakeholders should be included)
- Completeness
- Sustainability context (the context that is needed to understand the impact of the themes on sustainability should be described)
- Balance between themes
- Lack of overlap and interaction between themes
- Consistency of the list of themes.

Based on this process, it was decided to split the themes up into the most often used grouping of sustainability themes: profit, planet and people. Furthermore, each chapter should start with a description of the context. Therefore, a fourth group was added, namely context. Within this introduction of the sector, the relevance of both organic agriculture and multifunctional agriculture is described. These types of farming have an impact on several sustainability themes and, therefore, could better be described in an integral way. Not all themes are relevant for all farm types (e.g., crop protection for pig farming).

Table 2 Selected sustainability themes

Dimension	Theme
Context	Geographical distribution
	Structure (number of farms, area, animals)
	Organic agriculture
	Mulitfunctionallity
People	Spatial quality
	Image/reputation
	Labour
	Succession
	Animal welfare and health
	Food quality
Planet	Energy use
	Climate change
	Nutrients
	Water use
	Crop protection
	Biodiversity
	Animal feed
	Soil quality
	Plant health
	Fine particular matter
Profit	Income
	Financial position
	Investment
	Innovation
	Competitiveness

Selection of indicators per theme

After the identification of relevant farm types and themes, key-indicators were identified. A group of researchers started writing documents per theme using the following format:

- Why is the theme relevant for sustainability?
- Are goals set on this theme by government or farmers?
- Which indicators could be used to measure performance?
- Are indicators already measured or could they be measured at reasonable costs?
- Advantages and disadvantages of the most likely indicators
- Are (relative or absolute) benchmarks available for the indicator
- What is the best available indicator?

For the listing of advantages and disadvantages a checklist of criteria was developed (table 3).

Table 3 Criteria to select indicators

Selection criteria
Completeness
Structural availability
Representativity
Quantitativeness
Stakeholder support
Simplicity
Solidness (influence on score of external factors that are beyond farmers' control
Reliability
Costs
Comparability
Preciseness
Timeliness
Clarity
Availability at farm level (measure variation)
Availability per sector/farm type
Consistency (indicators over sector/farm type)
Reproducibility

Based on the format described above, for each theme one or several indicators were proposed. The outcome was again discussed and reviewed by a various experts. In total, about 50 specialist were involved in the process. Experts on farm types, sustainability themes, policy, performance indicators and databases were involved. Based on their comments, new documents were studied and new experts were consulted. During a workshop with all stakeholders, a final decision was made which indicators to include per theme and per farm type. More than 60 indicators were selected (see Annex 1). In some cases, no quantitative assessment was possible, either a suitable indicator was not available, or data to fill in this indicator was lacking. This resulted in a list of blank spots and recommendations to solve them.

3. Results and integrative conclusions

For the total agricultural and horticultural sector as a whole and each farm type, the performance on sustainability was presented. For each theme the following structure was used:

- Why is theme relevant for this farm type?
- Are goals set by government or farmers?
- Description of indicator used
- Development of the score of the indicator on the long term
- Explanations for the development of the score (with special focus on impact by government policy).

Interaction between themes

Apart from this long list of results per theme and sector, it is interesting to have more integrative results, for example, are there farms that do perform sustainable on nearly all themes and how those farms look like?

Since a large number of indicators are based on the Dutch Farm Accountancy Data Network, results are available at farm level for a large group of farms. This enables to compare the sustainability performance of organic farms and conventional farms. It also makes it possible to use indicators like the percentage of farms that have a total

household income that is persistently below the poverty threshold, or the percentage of farms that reached environmental goals.

Best performing farms

Based on three-year average results (2006-2008) the most sustainable dairy farms based on 10 themes were identified. The analysis is based only on the homogeneous group of dairy farms to prevent that scores are influenced by differences in crop plan or differences in animals kept. First, for every theme the 25% best performing and the 25% worst performing farms were identified. Secondly, farms were selected that ended up the most times in the best performing group and the less times in het worst performing group. These farms were labeled as the sustainable farms. Moreover, this group of farms is compared with the average farm (figure 1). The scores per theme in figure 1 are harmonized over the themes. A score of 100 means that a farm belongs to the 10% best performing farms. Subsequently, a score of 0 means that a farm belongs to the 10% of worse performing farms. The scores in between are set by linear regression (Stedula, 2006; Meul *et al.*, 2009). In figure 1, the scores of the sustainable farms are presented by the grey wedges. The scores of the average farm is presented by the thick black line.

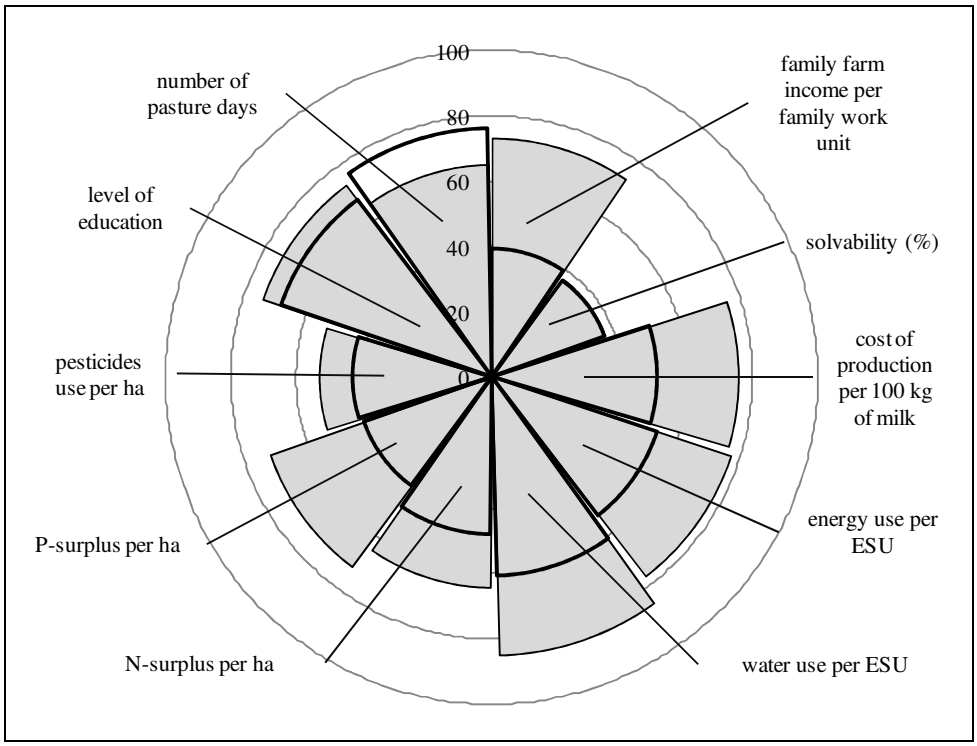

Figure 1 Comparison of the scores of the most sustainable farms (grey wedges) with the average farm (thick black line) 2006-2008

Figure 1 shows that farms do exist that outperform on 9 of the 10 themes. They only perform worse than the average farm on number of pasture days. Large differences exist between the two groups of farms on the performance on family farm income, cost of production, water and energy use and use of nutrients. These farms show that there is not necessarily a trade-off between environmental on the one hand and economic performance on the other hand. There seems to be large potential for improvement in sustainability by bringing the average farm on the level of the best

performing farm. In the report the characteristics of the more sustainable farms are compared with the average farm. This kind of analysis will help to improve the performance of the less sustainable farms and in that way make Dutch agriculture more sustainable.

4. Lessons learned

The current project resulted in a 350 page report. One of the disadvantages of a report is that some of the data are soon outdated, either because some of the data becomes only available quite some time after the reporting period of the data, or the time span between production and publication process. Therefore, a website that is updated as soon as new data is available is recommended. Moreover, this gives the possibility to make available more detailed data and links with additional information on data, methodology, used databases and relevant policy documents.

The project-management was quite complex, while so many specialist were involved. The involvement of these specialist, however, resulted in a broadly accepted set of indicators. To end up with the best indicator, detailed knowledge was needed about sustainability themes and indicators, policy and datasets. Most recent developments on these fields are not documented yet and can only be assembled by involving those specialists.

For some indicators it was difficult to judge the actual performance of Dutch agriculture, while a clear benchmark does not exist. A possibility to compare the data with other countries, therefore, would deliver added value.

When results are presented for all individual sustainability themes, it is complex to draw integral conclusions. Having a large group of indicators from one micro economic databases enables to go more into detail on trade-offs between sustainability themes and secondly, provides insight in farm characteristics of integral sustainable farms. This gives both the ministry of ANF and individual farmers action items to make Dutch agricultural more sustainable. The project could deliver even more added value, if the results of the report could be discussed with all stakeholders. In this way more background information could be assembled about the reasons behind the current trends and obstacles that prevent the Dutch agriculture to become more sustainable.

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Annex 1 List of themes and indicators

Theme	Indicator	Chapter
Context		
Geographical distribution	ESU per ha (graphical)	all
Structure	Number of (specialized) farms	all
	Number of production factors (area, animals)	all
Organic agriculture	Number of farms	all
	Number of production factors (area, animals)	all
	Integral sustainability comparison with conventional farming	2,6
Multifunctionallity	Turnover	1
	Activity per farm type	1
	Proportion of revenues from multifunctional activities	2,6
People		
Spatial quality	Number of persons with odeur discomfort as a result from agricultural practices	2
	Regional clustering	4,5,6,7,8
Image/reputation	Reputation of agriculture, distributed to the average degree of familiarity with agriculture	1
Labour	Quantity (FTE) of paid labour and family labour	all
	Level of education	all
	Number of students relating to primary agricultural production	1
	Absenteeism in agriculture	1
	Violation of law foreign labour	1
Succession	Number of farms with a successor	all
	Education level of the successor	all
Animal welfare and health	Number of sustainable housing systems	6,7,8
	Use of antibiotics	6,7,8
	Mortality rate	7,8
	Average age of milking herd	6
	Incidence of farm practice related health problems	6
Food quality	Salmonelloses in poultry herds	8
	Rapid Alert System for Food and Feed (RASFF) violations	1
	Violation of maximal residual limits found in agricultural products	1,2,3
Planet		
Energy use	Absolute energy use	all
	Energy-Efficiency	all
	Proportion green energy	4,5
Climate change	Absolute accumulated greenhouse gas emissions	1
	CO2-emissions	5
	CH4-emissions	6,7
Nutrients	Nutrient balance	1
	Soil balance	2,6
	Nutrient use	4,5
	Quantity of manure applied (artificial and organic)	2,6
	NH3 emissions	6,7,8
	Nitrate concentration in upper groundwater per soil type	1
Water use	Absolute water use	all
	Water use for irrigation	1,2,6
Crop protection	Pesticides use	1,2,3,4,5, 6
	Environmental impact points of pesticides	1,2,3,4,5, 6
	Norm violation of pesticides and biocides use in superficial waters (graphical)	1

Theme	Indicator	Chapter
Biodiversity	Percentage of nature conservation combined with agricultural practices	1
	Bird species index	1
Animal feed	Nitrogen and phosphorus flow in Dutch agriculture	7
	Composition and origin of animal feed	7
Soil	Organic matter content	6
	Biological soil characterization per soil type	2,6
Plant health	Q-organisms in import and export controls	2,4,5
	Incidence of most important plant diseases	2,3
Fine particular matter	Absolute fine particular matter emission per farm type	1
	Regional fine particular matter emission (graphical)	8
Profit		
Income	Value added in the Dutch agricultural production chain	1
	Average farm income per family labour unit	2,3,4,5,6, 7,8
	Percentage of farms with total income (including off farm) below the poverty threshold	2,3,4,5,6, 7,8
Financial position	Percentage of farms with solvability (net worth/total capital) below 50%	2,3,4,5,6, 7,8
Investment	Net-investments (investment minus depreciation) level	2,3,4,5,6, 7,8
Innovation	Percentage of innovations and innovators	2,3,5,6,7, 8
Competitiveness	Economic value of import and export per product	all
	International cost of production comparison	6,7,8

a). 1. total agricultural and horticultural sector; 2. field cropping; 3. fruit and vegetable production in open ground; 4. ornamental plant cultivation in open ground (bulb growing and tree nurseries); 5. greenhouse farming; 6. cattle farming; 7. pig farming; 8 poultry farming