Sustainability in Horticultural Chains

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Abstract

Sustainability, people, planet and profit are currently modern issues. Our societies are asking for products and services that are produced and delivered in sustainable ways. However the concept of sustainability is very broad and has to be made more concrete at this time. With a top-down/bottom-up approach the concept of sustainability, a set of sustainability aspects can be identified that have the support of the various stakeholders and that can be determined with the use of indicators. The availability of information/data and the organisation of information to use indicators is a main aspect in the determination of sustainability aspects. Analyses of chain information systems showed that these systems provide several linkages that can be helpful in the assessment of sustainability. However, chain information systems are currently most applicable for determination of the environmental dimension of sustainability and readily linked to a product, much like an environmental Life Cycle Assessment. To realize such a combination, information in chain information systems have to be transformed, by model or database, to create the right information output. The social dimension is not very easily determined; it is more concerned with processes instead of products. As such the determination of social sustainability requires additional research.

INTRODUCTION

Climate change, biodiversity, economic growth, human rights, poverty, labor conditions, etc. are aspects which are judged to be important regarding a sustainable development of our society; to fulfil the needs of the present generation without endangering the fulfilment of needs of future generations (Brundland, 199?). Modern society demands products that are produced sustainably. Companies are entering a new era in which integrated responsibilities for humans, economy and environment are becoming a necessity of good entrepreneurship. In other words, sustainable within the dimension of people, planet and profit (triple P).

Indicators are a useful instrument to determine the level of sustainability of products or companies. While there is still no precise definition of sustainable development, indicators can help to show whether a society is moving in the right direction. A lot of international initiatives have been taken to operationalize sustainability in terms of the three P's. In most cases this is mainly restricted to corporations or particular economic sectors. The determination of the level of sustainability for agricultural companies or for (agricultural) chains is not developed or adjusted.

In this article a methodology is presented on how sustainability can be determined for agricultural companies and chain.

MATERIALS AND METHODS

To develop indicators for sustainable development is it necessary to have a structured approach. The methodological framework used in this research combines a top-down with a bottom-up approach. The top-down approach derives indicators from general principles regarding good entrepreneurship and from an analyses of literature on existing methodologies and developed indicators for sustainable development. The top-down approach results in a preliminary list of indicators. With the bottom-up approach, the opinions of stakeholders of a company or in a specific chain regarding sustainability are

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garnered. In this research the stakeholders in a rose chain are consulted about their vision toward sustainable rose chains. The bottom-up method can be seen as a first step to select criterion to create a more comprehensive set of indicators for the determination of sustainable development in companies and chains. After this initial selection a final set of indicators is established by using selection criteria for indicators for which the availability of data is the most important. To deal with aspects of data availability the possibilities of combining sustainability and chain information systems will be investigated.

RESULTS AND DISCUSSION

Top-down Approach

A major initiative on the development of indicators for sustainability is the Agri-Environmental indicators of the **Organisation for Economic Co-Operation and Development (OECD)**. OECD work on Agri-Environmental Indicators are primarily aimed at policy makers and the wider public interested in the development and use of agri-environmental indicators for policy making purposes. OECD agri-environmental indicators are directed at the national agricultural sector. The focus of the work is, in particular, related to indicator definitions, methodologies and calculation of indicators. The main objectives of agro-environmental indicator development are providing information on the current state and changes in the conditions of the environment in agriculture, assisting policy makers to better understand the linkages between caussation and impacts of agriculture, agricultural policy reform, trade liberalization and environmental measures on the environment, contributing to monitoring and evaluating the effectiveness of policies addressing agri-environmental concerns and promoting sustainable agriculture.

The OECD agri-environmental indicators have been developed in four dimensions:

1. Agriculture in the broader economic, social and environmental context. One of the key contextual issues concerns farm financial resources (like net farm income, agri-environmental expenditures) and their relation to environmental outcomes in terms of farm level income and public and private agri–environmental expenditure.
2. Farm management and the environment. This dimension examines the relationship between different farming practices and systems and their impact on the environment. This issue covers aspects like nutrient, pest, soil and land management.
3. Use of farm inputs and natural resources. Indicators to track trends in the use of, among others, farm inputs such as nutrients, pesticides and water use.
4. Environmental impacts of agriculture. The extent of agriculture’s impact on the environment, including land conservation, greenhouse gases, biodiversity, wildlife habitats and landscape are monitored.

Besides this initiative there are several others that are designed to try to assess sustainable development. These initiatives and investigations have led to an overview (the top-down approach) of the various aspects of sustainable development and of the various indicators for sustainable development. This overview, which is very extensive, could be seen as an initial checklist for the determination of progress toward sustainable development in agricultural chains or of agricultural companies. The AKK/LEI-checklist was developed to evaluate project proposals within the framework of the co-innovation program Sustainable Agro Food Chain. The checklist could also serve as an instrument to make companies aware of (elements of) sustainable development (Meeusen and ten Pierick, 2002). Table 1 shows a small part of the result of the top-down approach; a part of the AKK/LEI sustainability checklist (Meeusen and ten Pierick, 2002). In the follow-up too this research the possibilities to determine sustainable development in agricultural chains and of agricultural companies are investigated, including the formulation of indicators for sustainable development.

Bottom-up Approach

With the bottom-up approach the checklist will be transformed to a more manageable set of aspects and indicators. The bottom-up approach consists of two directions; 1) a stakeholder consultation and 2) criteria based indicator selection.

1. Stakeholders. Consulting stakeholders results in a set of aspects and indicators that has the support of the stakeholders and fits the needs of the stakeholders.

Various techniques are available to carry out a bottom-up approach and consult the various participants regarding their opinion towards sustainable development in companies or in chains:

- Interviews- In discussions with various participants, the opinion towards the several sustainability issues from the checklist (for a specific company, product or production chains) are gathered.
- Questionnaire- Sending a questionnaire to the various participants, in which they indicate the relevance of aspects or themes of sustainability regarding a specific application.
- Group Discussions- Together with stakeholders or consumers, discussions can be conducted about ‘what is associated with sustainability and what is important’.

In a project "Sustainability as a competition factor in the rose chain", the instrument Group Decision Room (GDR), an electronic meeting system which promotes interactive communication, was used to gain additional insight into the opinions of stakeholders regarding rose chain sustainability. The participants of the GDR session represented the following aspects of the rose production chain: improvement and multiplication, growing, auction, transportation and trade. The GDR session consisted, in addition to others, the following two major discussion themes:

1. What is implicated with the notion of sustainability?
2. Which priorities can be given to aspects of sustainability?

The results of the GDR sessions regarding these two question or themes are presented briefly (Uffelen et al., 2002).

1. Together with the participants the concept of sustainability was made more concrete. Based on the extensive list of sustainability themes from the top-down approach (see table 2) a list of 23 themes were selected that had the support of the stakeholders.
2. The second question was about the importance of sustainability themes to create a competition advantage within 5 years. The participants could indicate the importance of several sustainability themes (resulting from question 1) by giving scores to the various themes, ranging from 1 (not important) to 10 (very important). Table 2 shows the scores for various sustainability themes. Five of the top-ten most important sustainability issues are related to environmental dimensions of sustainability. The aspects of costs, yield and productivity are all related to the economic dimension and indicate the economic continuation of the companies or of the entire chain. The social dimension is not represented in the top-10 issues. GDR session outcome indicates that environmental aspects are important to create a future competition factor based on sustainability in combination with the healthy economic performance of the companies. The GDR participants indicated that social dimension aspects of sustainability are supported, in the Netherlands, by the Collective Employment Agreements and by national laws regarding labour conditions. Social dimensions aspects are not seen by stakeholders to be of great importance in the creation of a sustainability competition factor.

These two questions reduced the preliminary list of sustainability aspects. Then a list of aspects was formulated based on the opinions of the various stakeholders in the rose chain. So, selection of sustainability aspects had the support of those involved in the rose chain. A tailor-made set of sustainability aspects was defined.

2. Indicator Selection. The next step in the bottom-up approach is the selection of indicators for the various sustainability themes. With several selection criteria appropriate indicators for sustainable rose chains could be formulated. Selection criteria for good indicators are, among others, scientific validity, communication quality, availability of

data, representative, reproductive, etc. In a LEI project after the development of indicators for sustainability, several possible indicators are judged with the help of several selection criteria. For the aspect of data availability the possible indicators are judged on the information in the Farm Accountancy Data Network (BIN). Various data from a random sample of agricultural and horticultural holdings are stored in the network. Most aspects belonging to the economic dimension of sustainability, can be assessed, sometimes with additional calculation, with the information in BIN.

Possible indicators within the economic dimension are: number of jobs, financial outcome, investments in capital, R&D, human capital and certification.

Possible indicators in the social dimension are number of registered complaints, amount of days of illness (%), education/courses of employees, contribution to local economies and nature conservation.

The BIN network also has information that could be used to assess some environmental aspects of sustainability, such as total use of energy, mineral leaching, toxic emissions, waste and land use. For most of these environmental aspects the information in BIN must first be transformed to create information about the environmental sustainability (more about this topic in subsequent discussion). This kind of transformation also takes place in an environmental Life Cycle Assessment (LCA). In an LCA study of a product or service, flows in the economic systems and flows out of the economic systems (extractions of resources from the environment and emissions to the environment) into the environment are determined, when possible, in a quantitative way. Based on these data the potential impacts posed on the natural resources, on the environment and on human health are assessed. BIN data serves as an input to carry out LCAs (Vrolijk et al., 2002). Besides information for the determination of environmental and economic sustainability BIN and other systems contain less information to assess social aspects of agricultural holdings or chains sustainability.

An Example

In a research carried out by the Research Station for Floriculture and Glasshouse Vegetables an economic and environmental assessment was made for several glasshouse crops. The effect of options to reduce the environmental impacts of glasshouse cultivation was determined in two dimensions; environmental and economic. The environmental impacts of glasshouse cultivations were determined with help of a LCA. That LCA (Figure 1- derived from Raaphorst et al., 2001) shows that the use of energy is dominant in the total environmental impact of rose production. Other important indicators are emissions contributing to acidification, eutrophication, ozone depletion and toxification. Scenario options to reduce the use of energy in 2010, such as the application of fuel cell technology, in combination with electricity delivery, and new construction materials will lower the environmental impact of 1 m^2 rose. However, through investments in new construction materials and new energy conversion techniques, the economic results will be lower (Raaphorst et al., 2001). For decision-making the results of these two analyses have to be weighted against each other, which requires additional research and even more when social sustainability is incorporated. A stakeholder review can be used to carry out such a weighting analysis.

Agricultural Chains

With the BIN network several aspects of environmental and economic sustainability can be determined. But these aspects could only be determined for agricultural holdings. To create a complete view of the state of sustainability, including the social dimension, is it important to take the entire life cycle of agricultural products into account This is necessary in order to avoid not accounting for their effects when undertaking measures to make an of agricultural product chain more sustainable. But taking the entire chain into account requires more information. The system to determine the level or state of sustainability is more complex. For the environmental aspects of sustainability the methodology of LCA could be used. For economic and social

dimensions of sustainability there are not such methodologies available. To determine the social and economic sustainability of agricultural chains a great deal of information is required.

The LEI is conducting research on the possibilities of combining sustainability and chain information systems (Kramer et al., 2002). How could chain information systems be used for the determination of sustainability? A chain information system is defined as the way the chain participants share information. Two different systems could be distinguished: a system in which information is transferred by the various participants in a chain and a system which is placed outside the chain and is acting like a certain type of database. In the latter system all the participants in the chain have access to the system. Most current chain information systems are developed to trace and/or track products. Tracking provides information about a product's current position in the chain. Tracing provides information where a product has been and under which circumstances. Food safety and legislation are important driver in the growing interest in tracing and tracking and chain information systems in general. Until now the most important reasons for companies to pay attention to tracing and tracking was to abide by the law and to limit damage claims. There are some expectations that companies will use tracing and tracking in a more positive way such as better control of the production processes.

In this research the possibilities for a combination of sustainability and chain information systems was investigated. This was carried out with the help of two case studies. Two existing chain information systems are investigated in more detail including what kind of information is gathered in these systems and their links with sustainability.

Case Study Vegetables, Groeinet Information System

Groeinet develops registration programmes for environmental registrations, product registrations, and logistics. Agricultural companies can register the use of pesticides, fertilizers and yields for a crop. While the information system of Groeinet is not developed for assessment of sustainability per se, the information system has some aspects that can be used for the determination of sustainability. Recorded information about pesticides and fertilizers could be used to assist determination of environmental impacts. For example production of these inputs are accompanied with the use of energy, which could be very high. The fertilizer Calcium Ammonium Nitrate (CAN) is produced from natural gas in the Netherlands utilizing $0.7m^3$ natural gas for 1 kg CAN. However, databases with information about the energy contents of inputs are necessary to determine the total energy use. The use of pesticides leads to emissions of toxic compounds into water, soil and air. With information about the (eco)toxic effects of pesticide use the recorded information regarding pesticides can be used to determine sustainability in regard to water, soil and air quality.

Case studies showed that the Groeinet information system indicates points of impact for sustainability. However, this requires additional information, to translate the inputs used into useful information about sustainability. For some aspects of sustainability this can be done easily. The case studies showed this as far as environmental sustainability aspects. The determination of aspects of social sustainability is more difficult. This is accentuated by the fact that chain information systems focus on products. Environmental aspects could also be related to product, much like in an LCA. Aspects of social and economical sustainability are more related to processes rather than to products. However, there are possibilities to relate social aspects to product, for example the number of hour's labour or labour happiness to produce a certain amount of product. But additional research is required to elaborate on this (Kramer et al, 2002)

CONCLUSIONS

The LEI research showed that the concept of sustainability is a still developing. It involves environmental, economic and social aspects. Attention to sustainability is mostly restricted to economic sectors or to nations. The current challenge is to make the concept of sustainability more concrete; delineate what is it and how can it be assessed. The

bottom-up/top-down approach offers possibilities to define indicators for sustainability. For this method to provide a comprehensive view of sustainability it is necessary to examine complete production chains including all associated activities in order to avoid missing negative impacts of other these elements. Chain information systems gather large quantities of information. These systems were developed for tracing and tracking food products in order to guarantee food safety. But these systems also contain information to assess some aspects of sustainability. However, to obtain information about sustainability the collected data must be transformed with the use of databases or models. This results in a dynamic determination of the level of sustainability of production chains. Until now chain information systems have been most suitable for the determination environmental sustainability. This is mainly because chain information systems are related to products and that economic and social performance aspects are more related to processes and companies. But possibilities exist to assess social and economic sustainability with indicators such as number of labor hours or the number of employee accidents per production unit. Additional research on this topic is recommended.

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Tables

Table 1. (Parts of) the LEI/AKK Sustainability checklist (Meeusen and ten Pierick, 2002).

Dimension	Category	Aspect	Explanation
Planet	Transportation	Reduction freight transport	Reduction of freight transport
	Energy	Reduction energy use	
		Renewable energy	The use of renewable energy sources
	Materials	Re-use materials	
	Water	Quality water surfaces	
	Air	Air quality	Reduction emissions
	Fauna	Biodiversity	To prevent the reduction in diversity of sorts and types of animals
Profit	Costs and efficiency	Price/quality ratio	Increasing the price/quality ratio of the products and service
	Ethic in business-to-business context	Control and certification	The control of whether demands made in advance have been met
	Employment	Quantity of employment	The increase in the number of jobs
People			
	Working conditions	Workplace	The improvement of the location, interior (ergonomic) and safety
	Food safety		Reduction of food-pollution components
	Norm and values	Emancipation	The stimulation of integration of the elderly, handicapped, immigrants, women etc.
	Social responsibility	Welfare	Contribution to health, housing, safety, education etc. of the community

Table 2. Sustainability themes and the importance of these themes in the rose chain (Uffelen et al., 2002).

Environmental dimension	Ranking	Economic dimension (following)	Ranking
Energy use	1	Capital investments	13
Pesticide use	2	Investments in Human Resource Management	15
Water and minerals	5	Investments in Research &Development	10
Material use	11	**Social dimension**	
Emissions to air, soil and water	5	Labour conditions	14
Disturbance (noise and light)	19	Labour circumstances	12
Landscape and nature conservation	18	Relations	15
Waste	8	Relation to local communities	20
Genetic modification	17	Gifts	22
Economic dimension		Human rights	21
Costs	8	Governmental influence	7
Yield	6	Market influences/market orientated	3
Productivity	3		

Figures

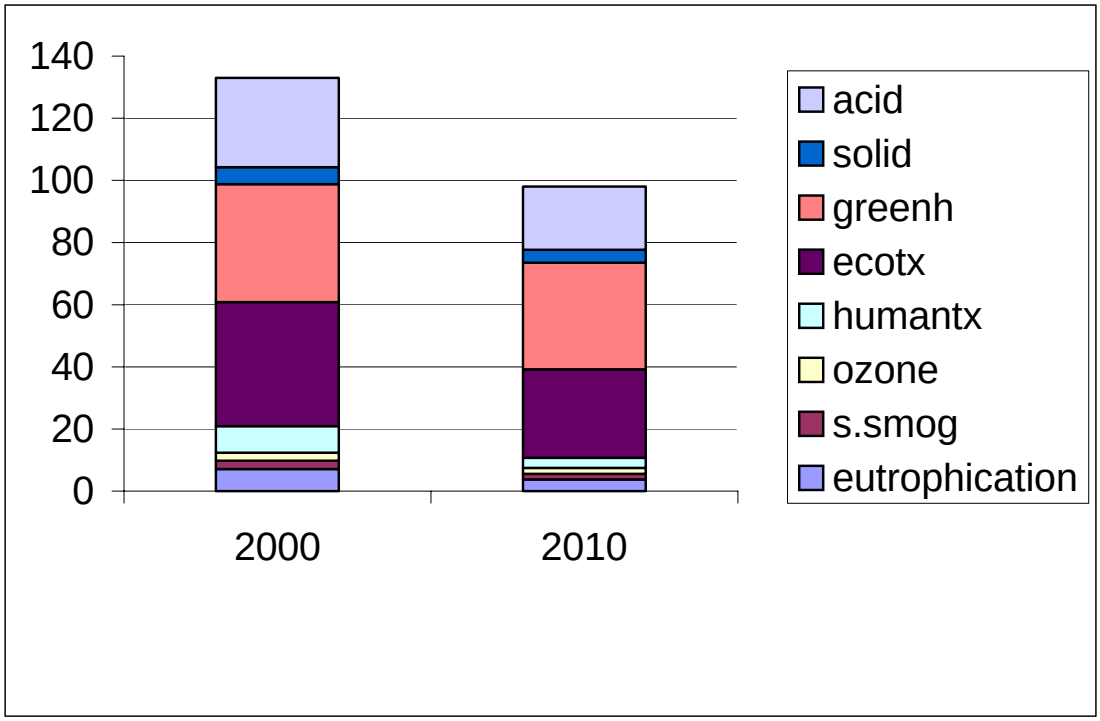

Fig. 1. Relative Environmental impact of 1 m^2 in 2000 and 2010.