Environmental performance management in bio-ethanol chains

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Preface

This thesis is conducted as part of the study Management, Economics and Consumer studies with the specialization „Management of Life Science'' at Wageningen University. I would like to gratefully thank all those who contributed to the completion of this thesis which was carried out at the Management Studies Group.

First of all I want to thank to my company supervisor Douwe Frits Broens of Beethanol BV. He has been very supportive throughout the whole project and have inspired and motivated me on the subject of bio ethanol and my personal development. Secondly I would like to thank my scientific advisor, Geoffrey Hagelaar. His vision was inspiring and his motivating feedback during the writing of this thesis was very usefull. I also want also like to thank Harry Bremmers, my second scientific advisor, for his constructive comments and help.

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Abstract

In the recent years, the use of bio fuels has increased considerably. Member states of the EU have the target that 10% of the transport fuels sold in 2020 have to be derived from renewable sources. This percentages includes biofuels, but also renewable electricity and hydrogen (Renewable Energy Directive (RED)). Nevertheless there is a growing concern regarding the sustainability and effectiveness of biofuels. Therefore several sustainability criteria are established by the EU (RED) and by the Netherlands (NTA-8080) which covers the whole production chain. The problem is however that it is not known how these criteria should be assured.

The objective of this research is to establish recommendations to Beethanol BV (decentralized bio ethanol production chain) concerning the assurance of the environmental criteria. This is done by the analysis of the Performance Measurement System (PMS) with key Environmental Performance Indicators (EPIs) and the associated co-operation between the chain actors in two other different bio ethanol production chains (Regionol and Van der Sluijs Groep).

Within the theoretical framework the concepts PMS and key EPIs are elaborated and the performance pyramid (Lynch and Cross, 1995 [21]) and the Plan-Do-Act-Check cycle of ISO are selected to evaluate the performance measurement in the cases. To analyze how the performance measurement in the chain is managed, associated supply chain literature is used including a managerial framework for networks (Hanf and Dautzenberg, 2007 [2]). This framework is used to evaluate the co-operation and co-ordination on three levels in the chain. The cases are analyzed by conducting in-depth qualitative interviews with respondents in the cases. In the report, first the chain is introduced together with the chain processes. Next, the performance pyramid together with the PDCA are used to assess the ambition level of the environmental performance in the cases. Finally the associated co-operation to achieve this level is evaluated with the manegerial framework for networks (Hanf and Dautzenberg, 2007 [2]).

In the analysis it is concluded that currently both chains do not have implemented a PMS with key EPIs yet. The cause is the chains are not insisted by the government yet and final consumers are not willing to pay a price premium for sustainable ethanol at this moment. However, both chains are organising a sustainability certification due to the developments of the government policy and the demand of business customers. After the analysis of both cases, the sustainable wood market is also analysed in this research. The sustainable wood market has faced the same problems regarding the implementation of certification standards in the past and therefore it provides several useful experiences. Besides the analysis of the sustainable wood market also additional literature about environmental care strategies is added to establish usefull recommendations for Beethanol BV.

The main result is that due to the developments in the EU policy, Beethanol BV should obtain a sustainability certification. The organisation of this certification does not require an intensive co-operation in the chain. However, a more intensive co-operation could be demanded to assure an efficient supply and reduce the investment risks in the chain.

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PDCA: Plan Do Check Act
RED: Renewable Energy Directive
NTA-8080: Nederlands Technische Afspraak-8080
PMS: Performance Measurement System
KPI: Key Performance Indicator
SCM: Supply Chain Management
GHG: Green House Gas
VSG: van der sluijs Groep
EPE: Environmental Performance Evaluation
EMAS: Eco-Management and Audit Scheme
ISCC: International Sustainability & Carbon Certification
E-85: A blend of 15% bio-ethanol and 85% fossil fuel
BSI: Better Sugarcane Initiative
ECS: Environmental Care Strategy
COC: Chain of Custody

1. Introduction

1.1. Problem description

In recent years, the use of bio fuels has increased considerably. This substitute of fossil fuels has a large potential to reduce greenhouse gas emissions, improve energy security and stimulate rural development [3]. Therefore, member states of the EU have the target which states that 10% of the transport fuels sold in 2020 have to be derived from renewable sources, including bio-fuels, renewable electricity and hydrogen [4]. Nevertheless there is a growing concern regarding the sustainability and effectiveness of bio-fuels [5]. Sustainability can be described as the maintenance and enhancement of environmental, social and economic resources, in order to meet the needs of current and future generations [6]. To prove the sustainability of the different aspects for bio fuels there is a great need for sustainability labelling and certification for the whole production chain.

In the European guideline for renewable energy (Renewable Energy Directive (RED)) several sustainability goals concerning greenhouse gas (GHG) emissions, land changes and deforestation are established. The bio-fuels that do not meet these criteria cannot be counted towards the national target and/or obligation for bio-fuels. Besides the European guideline, the Dutch government has formulated a test framework with criteria for the certification of the sustainability aspects of biomass, which is separated in several categories (Cramer criteria). This framework is recently ratified in the ''Nederlandse Technische Afspraak" (NTA-8080) [7] which forms the basis of the European guideline but is extended with several criteria. These extra criteria concern the competition with food production, local applications, environment, prosperity and welfare and are voluntary concerning the European policy. Nevertheless, they can be demanded by several market parties.

To certify sustainable bio-fuels, no clear procedures and methods are formulated in the NTA-8080 and the European guidelines besides the criteria. Therefore, the organisation of certifications is left to private initiatives. The large multinationals are establishing their own labels but for the small actors this is very difficult to organise [5]. To certify sustainable biomass, it is possible to use several existing standards like FSC and RSPO, which covers already a part of the sustainability criteria. With this method it is possible to establish a sustainability label with lower costs and efforts, but the main problem with this implementation is that the government also does not yet agree which standards are accepted for this method of certification.

Several small enterprises in the Netherlands and Germany which are producing and marketing their biofuels in the region are currently trying to co-operate and organise a format for an own sustainability label based on the sustainability criteria of the RED and NTA-8080 [5]. To establish this label, it is expected that an intensive co-operation between chain actors striving for continuous improvement (Deming cycle) [8] towards sustainability has to be organised within the whole supply chain. However, it is not known which method is most appropriate to meet the sustainability criteria. But it is expected that a chain-wide Performance Measurement System (PMS) is very useful to control if the chain is achieving the sustainability criteria. The basis of such a PMS exist of sustainability performance indicators which have to be identified across the whole chain.

This research will focus on the analysis of the PMS including the implemented key Environmental Performance Indicators (EPIs) and the associated co-operation between the different chain actors in two different cases (Regionol and Van der Sluijs Groep). This analysis should result in recommendations for a developing Dutch bio-ethanol supply chain (case 3) about the assurance of the environmental criteria and the associated co-operation between chain actors. The analysis of the two cases should result in the description of the chain processes, the elaboration of the co-operation between the chain actors and, the evaluation of the PMS by identifying the objectives and key EPIs. In this way the environmental ambition of the chain will be evaluated and it will be visual how environmental performance is incorporated in the whole chain.

The first case concerns an existing chain in Germany (Regionol) and the second case concerns an existing chain of imported bio-ethanol from Brazil (Van der Sluijs Groep). These cases are selected because it concerns two extremes regarding their production systems. Besides it is expected that both chains have established a good organisation to manage the sustainability issues. Therefore, the results of those cases are expected to be relevant for the establishment of recommendations for the third case. This case concerns a developing supply chain of decentral production of bio-ethanol in the Netherlands (Beethanol BV).

1.2. Research objective

For this project the following objective is formulated:

"To give recommendations to Beethanol BV concerning the assurance of the environmental criteria, by analyzing the Performance Measurement System with key EPIs and the associated co-operation between the chain actors in two other different cases".

1.3. Research framework

The nature of the research perspective is a combination between explorative- and design-oriented research and several sources will be used for this research which can be shown in the research framework in figure 1. The ingrediënts are theories on performance measurement, environmental peformance indicators and theory about supply chain management including models concerning the co-operation in supply chains. All theories which are used will be combined in the theoretical framework and used for analyzing the cases. For the analysis of the environmental performance and associated co-operation, the criteria of the Dutch NTA-8080 wil be used as a basis. The results of the analysis of Regionol and Van der Sluijs Groep will be used as an input for the analysis of Beethanol BV. At this stage it will be analyzed which aspects of the PMS, the implemented EPIs and the associated co-operation is relevant and can be recommended to Beethanol BV. The aim at this stage, is to produce recommendations regarding the EPIs which should be implemented in the chain and the associated co-operation between chain actors to manage these EPIs. It could also be concluded, that no EPIs can be recommended from the case analysis or that implementing EPIs is not relevant for assuring the environmental criteria due to specific reasons. In that case, it will be analyzed in the cases, which other methods or practices are used for assuring the environmental criteria and can which recommendations can be given to Beethanol BV. If it is concluded

after the analysis of both cases that unsufficient outputs are generated, other cases will be added or additional literature will be added to apply on the cases. Their could be insufficient output when no PMS and EPIs are implemented, the EPIs can not be implemented in the chain of Beethanol or the associated co-operation between the chain actors is missing. When an additional case is added, this could concern a similar case or a different case which could provide potential inputs for the establishment of recommendations for Beethanol BV. At the next stage, the Beethanol chain will be described and the recommendations for assuring the environmental peformances will be established based on the specific scenario's of the cases and the elaborated literature.

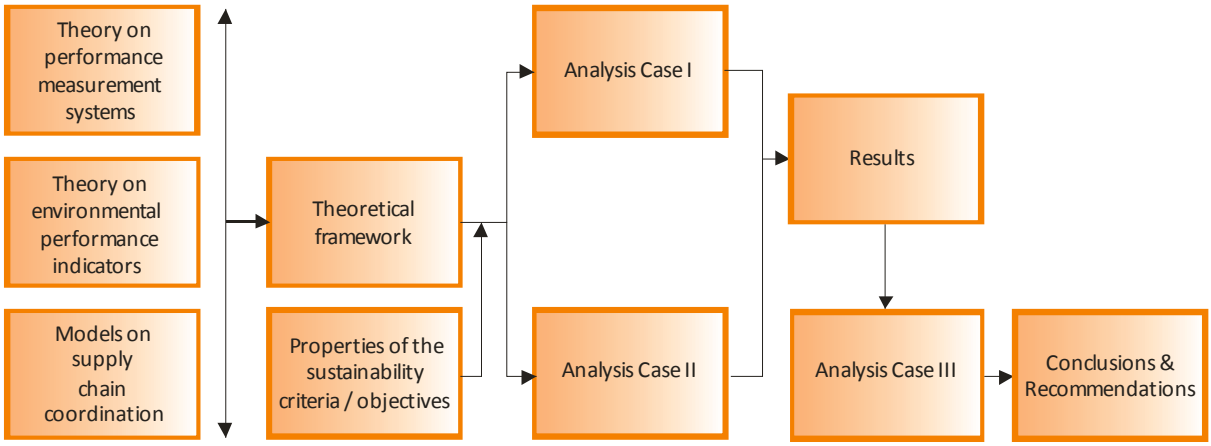

Figure 1: Research framework

1.4. Research issue

In this section, the aim of the research will be described by translating the research objective and research framework into an effective research issue which consists of a main research question and several sub-questions.

The main research question for this research is:

- What are the properties of the two cases concerning the environmental PMS including key EPIs and the associated co-operation between chain actors and which recommendations can be given to Beethanol BV to assure the environmental criteria.

Sub questions:

RQ 1: What is a PMS in theory and how can it be analysed in a chain?

RQ 2: What are key EPIs and how can they be formulated?

RQ 3: Which model can be used to analyse the organisation of the chain actors regarding the PMS?

RQ 4: What are the properties of the cases regarding the implemented PMS including key EPIs and the associated environmental targets based on the environmental criteria?

RQ 5: How are the chain actors co-operating to assure the environmental performances?

RQ 6: Which recommendations can be given to Beethanol BV for assuring the environmental criteria and the associated co-operation.

1.5. Research material

Below, the research material will be determined in more detail in two steps:

1. Type of information
- Information about the bio ethanol sector and sustainability criteria
- Theories about (sustainable) performance measurement systems
- Theories about (key) environmental performance indicators
- Theories about supply chain (co-operation, process mapping)
- Properties of the three cases

2. Which sources
- Scientific articles (Library, digital sources)
- Qualitative face to face interviews with different actors in the cases and experts within the bio fuel market.
- Internet
- Books
- Media
- Project Files

1.6. Research strategy

This research consists of a desk research and a case studies. In this research, three cases (bio ethanol chains) will be explored. The research will start with a desk research to explore the theories available concerning performance measurement systems and supply chains which will result in the formulation of the theoretical framework. Secondly, in the case study, a combination of in-depth qualitative interviews and a document analysis of textual material of different sources will be used to apply the theoretical framework on the cases. The analysis will start with the first 2 cases. These cases will be analysed by elaborating the aspects from the theoretical framework. From this analysis it will be evaluated which aspects are relevant to recommend to Beethanol BV. When the analysis of the cased generates insufficient outputs to establish recommendations, additional cases or literature will be added. The aim is to create a list of recommendations (potential EPIs, associated co-operation or other aspects) which are relevant for assuring the environmental criteria.

1.7. Outline of the report

The first chapter of this report discusses the context of the research and provides the research problem, research objective, research questions, and the research strategy. In the second chapter, the theoretical framework is elaborated based on the theories and models about PMSs, key EPIs and supply chain management. The third chapter explains the methodology of the research including the selection of the case studies and the elaboration of the empirical part of the research. In chapter 4, th environmental criteria of the RED and NTA-8080 are stated. These criteria forms the basis on which the EPIs and

associated organisation wil get evaluated in the cases. In chapter 5 the cases will get evaluated based on the theoretical framework. First, the chain of Regionol and Van der Sluijs Groep are evaluated. With the analysis of these cases also a small case evaluation of the sustainable wood market is added due to limited results of the first two cases. Next, the case of Beethanol BV is described and analyzed wich aspects of the first cases are relevant to reccomend. After this analysis, additional literature about environmental care strategies is added to compare the different cases regarding their ambition and co-operation which was needed for establishing recommendations. The final chapter provides the conclusion of the research including the main recommendations for Beethanol, a critical review on this research in the discussion and recommendations on futher research.

2. Theoretical Framework

To answer the main research question several theories and literature need to be explored. In this chapter, section 2.1 will explain what a PMS is in theory and how it can be analysed (RQ 1). In section 2.2, specific literature about key EPIs and how they can be formulated will be elaborated (RQ 2). Finally, in section 2.3, the literature about supply chain organisation will be described concerning the co-operation between actors in the chain regarding the PMS (RQ 3).

2.1. Performance Measurement System

2.1.1. Introduction

In the last years, increasing attention is given to performance measurements systems (PMSs) within all kind of companies [9]. For the most part, this is due to the increasing requirements by the present competitive environment and customer demands [10].

As shown in figure 2, a PMS is a part of the performance management process which manages its performance in line with its corporate and functional strategies and objectives. The objective of this process is to provide a control system, which deploys corporate and functional strategies to all business processes, activities, tasks and personnel [11]. The process defines how an organisation uses various systems to manage its performance and can serve for example, the process of a quality certification. At the heart of the process, the PMS is used as an information system which enables the deployment of the strategic and tactical objectives of the business as well as providing a structured framework for collecting, analysing and reporting to facilitate the decision and control processes ([11]; [12]). It can be defined as *"the set of performance measures used to quantify both the efficiency and effectiveness of actions" [13].* The main purpose of a PMS is to provide reliable and valid information on performance which can be used to evaluate, control, budget, motivate, promote, celebrate, learn and improve [14]. A PMS also improves communications internally among employees, as well as externally between the organisation and its customers and stakeholders. The system can create a new climate, affecting all the organisation's aspects by measuring and improving performance.

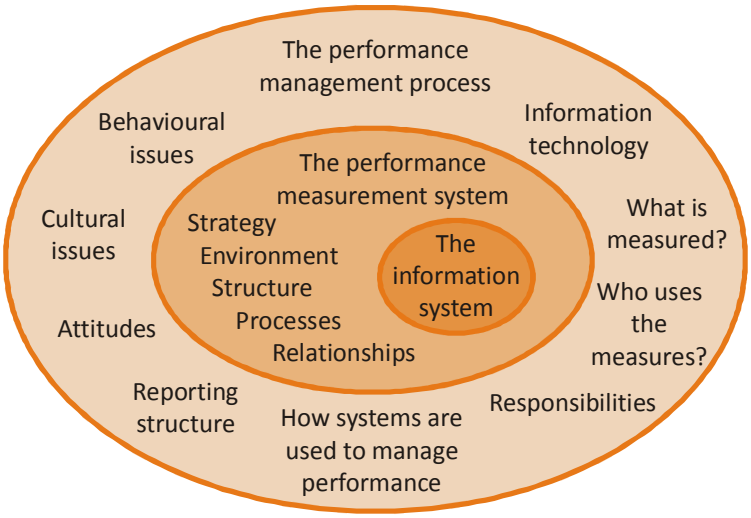

Figure 2: Position of the PMS[11].

With the help of the performance measures, an organisation should be able to understand [12]:

- *How well the organisation is doing (correct process representation);*
- *If the organisation is meeting its goals (identification of the goals and the reference standards);*
- *If the customers are satisfied (control of the process development)*
- *If the processes are in control (control organisation effectiveness and efficiency parameters);*
- *If and where process improvements are necessary (identification and correction of problems).*

The traditional PMSs are mainly focused on financial measures but in the last years, many research is carried out to create multidimensional and balanced models to support increasing complexity of organisations and management of companies [15]. New models are created and traditional models, for example, are extended to focus on measuring sustainability aspects or to extend the system for a whole supply chain.

Simply, the development of a PMS can be separated into phases of design, implementation, use and maintenance. In the design phase, the key objectives are formulated and the measures are designed. Afterwards, the systems and procedures are put in place in the implementation phase, to collect and process the data that enable the measurements to be made regularly. In the use phase, managers will review the measurement results to assess whether operations are efficient and effective, and the strategy is successfully implemented. Finally, in the maintenance phase, the system will be reviewed continuously to make sure the measures are still in line with the actual strategy [16].

Especially at the implementing face, many organisations are facing a lot of problems. The main problem is that many organisations fail to take the internal and external environment into account when the measures are designed. Therefore, it is very important to integrate the four different phases with the people, processes, infrastructure and culture issues associated with them when developing a PMS (figure 3) [12, 17].

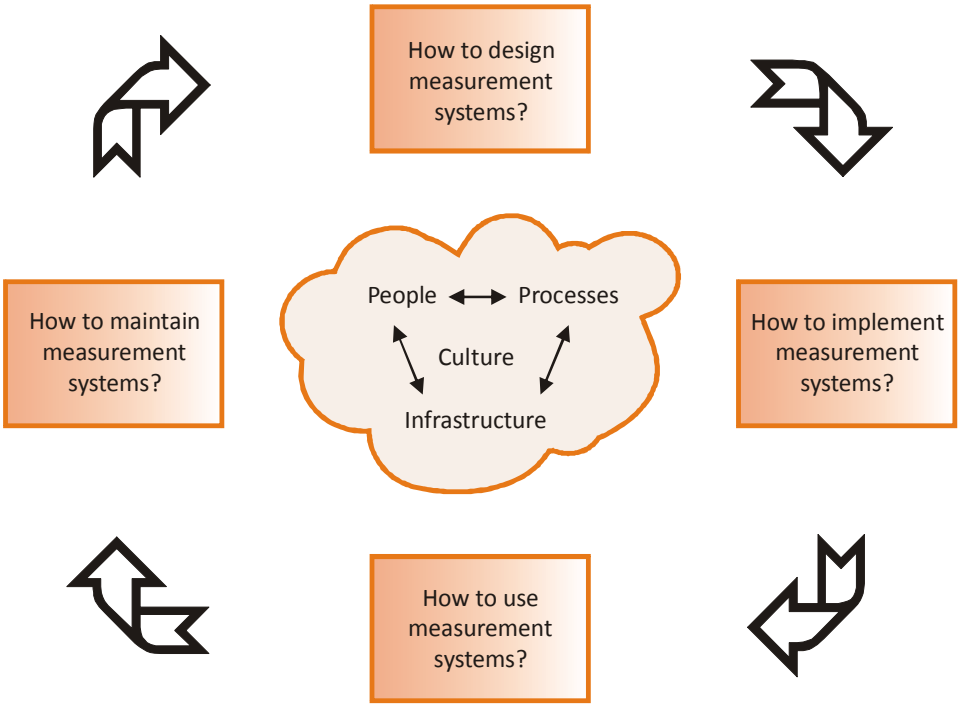

Figure 3: PMS, emerging research themes [17]

2.1.2. Establishing performance measurement systems

As mentioned in the previous section, the process of establishing a PMS can be divided in different stages as shown in figure 3. In a model of Ten Pierick (figure 4), 5 different phases are described which should result in the application and maintenance of a well-functioning PMS[1].

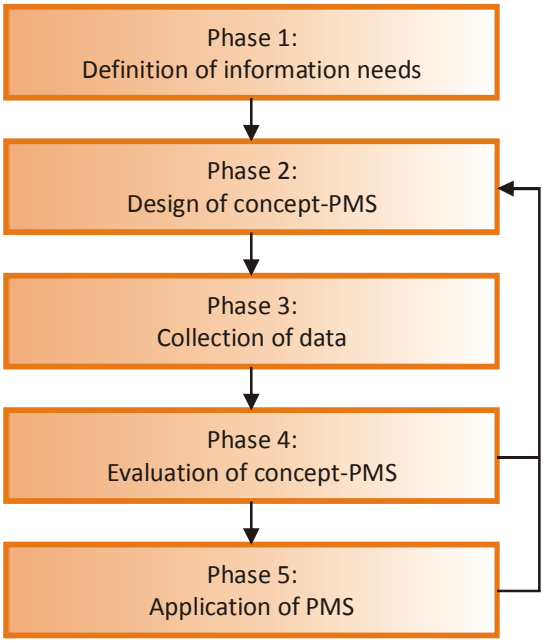

Figure 4: Phases of establishing a PMS [1]

In the first phase, the information needs will have to be analysed. Within this stage, the targets and functions of the PMS should be elaborated and the level of analysis should be clarified. This analysis level could be distinguished on basis of the geographical area, sector level or organisation entity. On basis of the organisation entity, the following levels can be classified [1]:

- *Chain level*
- *Company level*
- *Business-unit level*
- *Establishment level*

For each of these analysis levels, different targets and functions will be arranged and different constraints and user requirements will be appropriate. When the analysis level is clarified and the functions and targets are elaborated, a strategic plan should be formulated. The strategic plan forms the basis of an effective PMS. If an organisation is focusing on the wrong set of performance measures, the organisation's strategic mission can be undermined. To start the formulation of a PMS, a well-developed strategic plan should contain the basic information necessary [1].

The second phase of the establishment of a PMS is the design of a concept-PMS. Also in this phase, several aspects can be classified. First, the PMS model and themes have to be selected. Regarding sustainability there already can be made a distinction between several themes and approaches. For this research, there will be chosen for the common used Triple P-perspective. This approach focus on the

relations between the dimensions people, planet and profit [18]. Although the three dimensions really interact with each other, a conclusion has to be made on what themes the company will focus based on the strategic plan. This process is necessary because a real total comprehensive PMS is an illusion for every company.

After this stage, different performance indicators should be defined to translate the organisation's targets of the strategic plan. With the collected performance indicators, the quality of information and current use of existing indicators should be determined. The different types of performance indicators are defined in section 2.2.2. The organisation should find out which indicators are maintained and monitored, and who the owner(s) and data customer(s) are. Answering the following five question normally should provide sufficient information for this process [12]:

- *What information is being reported?*
- *Who is responsible for collecting and reporting performance information?*
- *When and how often is the performance measure reported?*
- *How is the information reported?*
- *To who is the performance measure reported?*

Several PMSs also use a relationship matrix which presents the relations between the "targets" and "performance indicators". This will make sure the targets are translated into measures. The indicators identified must "cover" all the targets, without neglecting any relevant aspects.

To implement the strategic targets, also the analysis of processes is very important. Each organisation entity consists of several sub-processes, which all differently impact the targets. To implement an effective PMS, an organisation should identify sub-processes, which mostly "influence" targets. All activities can be divided into processes which can be organised into a hierarchy, depending on their impact on the targets. This activity is performed by the use of the so-called "process maps", which contains qualitative and quantitative important information. *Process-maps are graphic representations of activities, the interfaces, the flow of information and the responsibilities connected to the various process actors [12].* The main purpose of process-maps regarding the PMS is to determine process' efficiency and effectiveness, and to define how, where and when performing the quality monitoring. Furthermore, it is necessary to identify the critical aspects of the activities. The methodology of process mapping can be structured by different methods which will be further elaborated in section 2.3.3.

When the design of the concept PMS is finished, the identified indicators should be measured which is part of the third phase. The main purpose of this stage is to collect all the data necessary to monitor the organisation performance on the selected themes. In the fourth phase, this data will be evaluated to check if the indicators are effective and efficient and if the indicators cover the targets. At this stage feedback will be given to the design phase and if the indicators are well functioning, the PMS will get applied.

Besides the aspects mentioned above, several aspects and difficulties can influence the effectiveness and efficiency of a PMS and therefore should be taken in account when developing a PMS.

- Processing too much or too little data
- Focus on the short term
- Lack of human resources
- Collecting inconsistent, conflicting, and unnecessary data
- Measures that are not linked with the organisation's performances
- Measuring progress too often or too less
- Misconception of performance measurement

2.1.3. Existing frameworks

To develop a PMS, many organisations are making use of existing models which they apply on their organisation. There exist several of such models like the performance measurement matrix, results and determinants framework, performance pyramid system, critical few method, integrated performance measurement system, performance prism, performance dashboards etc. which are focussing on business performance on many themes and levels. Nevertheless, not all of these models can be used for sustainability measuring. In this section several of these existing PMS frameworks which are (partly) focussed on, or which can be integrated with, sustainability are described.

- Sustainability Balanced Scorecard (SBSC)

The most popular and common used PMS is the balanced scorecard (BSC) proposed by Kaplan and Norton (1992). The general BS identifies and integrates four different ways of looking at performance (financial, customer, internal business and innovation and learning perspectives). The purpose of a BSC is to formulate hierarchic system of strategic objectives in the four perspectives, derived from the business strategy and aligned towards the financial perspective. This results in several PI in the four perspectives and a strategy map where all the causal links between the indicators are described [19]. The BS is a very open model which can be applied to all kind of companies. Dimensions can be changed or added. To apply the model for sustainable aspects, a Sustainability Balances Scorecard is developed where environmental and social aspects are integrated into the model. There are different approaches to implement these aspects. The environmental and social aspects can be integrated in the four standard perspectives but also a non-market perspective can be added to the perspectives. This last method can be applied when there are environmental aspects which influence the objectives via non-market mechanisms, e.g. child labour [20].

- Performance Pyramid (Lynch and Cross, 1991)

This model is a pyramid which is elaborated on four levels, showing the links between corporate strategy, strategic business units and operations and is focussed on the horizontal flows of materials and information. The strategic objectives (on top level) are translated from the company's vision using a top down process. The strengths of this framework are that it supports both the definition of the relationship between the different indicators and the management process. It also defines the difference between measures concerning external parties-customer satisfaction, quality and delivery, and measures that are primarily of interest within the business like productivity, cycle time and waste [21].

- Environmental Performance Evaluation (EPE; ISO 14031)

The EPE is a result of the ISO 14031 standard which describes the process of measuring environmental performance. It is designed to provide the organisation's management with reliable and verifiable information to assess if the organisation is meeting the criteria set by the management itself. The process which is described in the standard is based on the Plan-Do-Check-Act (PDCA) business process improvement model. In the planning phase, the environmental indicators will be identified which are divided in environmental condition indicators (ECI), management performance indicators (MPI) and operation performance indicators (OPI) [22]. ISO provides a list with already many possible indicators which an organisation can implement in his own organisation. In the second phase, the performance of the organisation will be assessed by collecting the data, converting the data into information, evaluating the information and communicating the results. In the last phase, the system will be reviewed and improved systematically to continuously strive for improving the environmental performance [23].

- Global Reporting Initiative (GRI)

The GRI is a network of several organisations in the world which developed a sustainable reporting framework for organisations. Although the GRI cannot be seen as a total PMS, it is intended to serve as a generally global accepted framework for reporting on an organisation's sustainable performance. The framework contains principles for defining report content and ensuring the quality of reported information and is subjected to testing and continuous improvement. It also provides a broad list with PIs derived from the triple-P approach for all kind of organisations around the world [24].

- European Foundation for Quality Management model (EFQM)

The EFQM model is created by several leading European businesses which were striving for Sustainable Excellence [25]. The model recognises that there are many approaches to achieve sustainable excellence in all aspects of performance [26]. It is based on nine criteria which are classified as "enablers" or as "results". "*The EFQM is based on the premise that excellent results with respect to Performance, Customers, People and Society are achieved through Leadership driving Policy and Strategy, that is delivered through People Partnerships and Resources, and Processes"[26].* For each criteria, which refers to a specific area, PIs can be established and relative weights has to be determined. The model is actually based on Total Quality Management (TQM) but it is possible to integrate the themes of sustainability into the model to assess the sustainability performance of an organisation [26].

2.1.4. PMS elaboration

For the analysis of the PMS in the cases, the performance pyramid will be used in this research because it can provide a clear top down structure of indicators across the whole chain and is also suitable for sustainability aspects. In addition to the performance pyramid, also the EPE will be used for the selection and elaboration of the indicators using the PDCA cycle.

2.1.4.1. Performance pyramid

The performance pyramid of Lynch and Cross (1995) is a model that helps to improve organisational learning [21]. The foundation of the model is based on policy deployment and it is functioning as a relationship matrix (section 2.1.2). This policy deployment concerns the translation of the strategic targets to objectives at all levels in the organisation, and linking these objectives to specific employees in the organisation, either individual or in groups. In this way, the company's objectives are taken over by the employees. At many organisations, the mission, vision and objectives are insufficiently developed and deployed at the process level. The information about the processes is also hardly transferred to the level where the decisions are made. When the policy deployment has been carried out entirely, for all the control levels performance indicators or criteria have been appointed, measures have been performed and objectives have been indicated, in line with the long term strategic targets. The management of the processes concerns the bottom control level in the organisation. This can only be committed properly if a clear relation has been elaborated between the process objectives and the objectives at all other levels in the organisation. For this reason, the set objectives and performance indicators must be set up in consistency.

The performance pyramid distinguishes four levels and ensures an effective link between strategy and operations by translating strategic objectives top down and measures from the bottom up [21]. Besides the four levels, the model also makes a distinction between external "market" effectiveness (left side) and internal "financial" efficiency (right side) (figure 5).

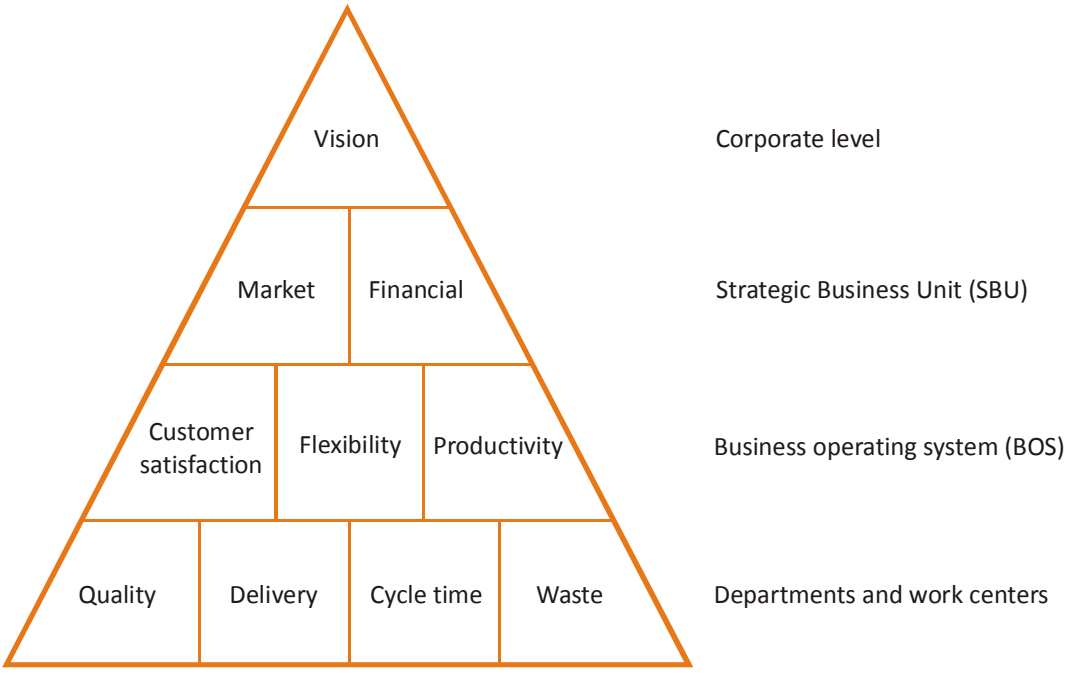

Figure 5: Performance pyramid [21]

At the top level, a vision for the business is stated by the corporate senior management. A company's vision and strategy directly translate into how the company plans to reach its goals and what measures

are truly critical to the plan's success. Examples of the focus of a vision are: price, product innovation, product differentiation, product quality, service etc. [21].

At the second level, objectives for each Strategic Business Unit (SBU) are then defined in market and financial terms. In order to achieve the vision of an organisation, each of the business units and/or divisions must play their part. SBUs make sense when the following criteria are met [21]:

- The unit has distinct business concepts and missions;
- It has its own competitors;
- It competitors are external;
- It is better off managing its strategies in an independent manner.

Most SBUs define success in terms of achieving the long-term goals of growth and market position (market measures), and achieving the short-term goals of specified levels of positive cash flow and profitability (financial measures). At the left side of the pyramid, the market measures can include: absolute market share, relative market share, new product sales and percentage of market, R&D spending etc.. The financial measures at the right side can include: profitability, cash flow and return on investment [21].

At the third level, the model distinguish the Business Operating System (BOS). A BOS can be defined as: "*all the functions and sequences of activities (wherever they may reside in the organisation) required to implement a particular business strategy involving the development, production, and provision of specific products or services to particular markets"* [21]. A BOS includes all internal functions, activities, policies and procedures, and supporting systems. This level is the starting-point for effective measurement and control at the department level and it is the link between each specific department's performance and the overall strategy and performance. It enables departmental measures to focus on the effectiveness of the entire operating system rather than on the efficiency of a single department. In the model the market and financial targets of the SBUs are translated into three different factors/driving forces of a BOS: customer satisfaction, flexibility and productivity. The customer satisfaction signifies how customer expectations are managed. An operating system driven by customer satisfaction places strong emphasis on the market side of the performance pyramid. In a customer-driven operating system, there is also more emphasis on the external measures of quality and delivery from department to department. The driving force "flexibility" is at the heart of the performance pyramid because it addresses the responsiveness of the operating system. Flexibility has both internal and external components. The external components relate to meeting the demands of the customer while the internal components relate to doing that efficiently. The last driving force "productivity" refers to how effectively resources are managed in order to achieve the customer satisfaction and flexibility objectives. It is an internally driven force, with much focus on the financial side of the performance pyramid.
While the top company objectives should be balanced, it is not unusual at the BOS level that one of these driving forces receive more attention that the others [21].

At the final level of the performance pyramid, the departments and work centres are located. At this level, the measures at the operational level are carried out. It forms a link with the objectives and priorities of the BOS. The performance pyramid defines different elements of this linkage which are found

in four principal local operating performance criteria: quality, delivery, cycle time, and waste. The objective of any function or department in the BOS is to increase quality and delivery, and to decrease time and waste. And the performance measures are either external measures that are important to the operation's customer (quality and delivery), or internal measures that are not directly perceived by the customer, but critical to the operation's success (cycle time and waste). The perception of quality in this model is much broader than meeting customer expectations (internal and external) all the time through the delivery of defect-free products or services. On the external side, quality consists of features, performance, durability, reliability, aesthetics, sustainability, perceived quality, etc.. Examples of quality measures are: percentage of good components in final assembly, parts per volume accepted my materials, planning accuracy, percentage of sustainable materials etc. Delivery is defined by the model as: *the quantity of product or service delivered on time to the customer, user, next department, as defined by the customer* [21]. The objective is to align delivery performance with the expectations. Examples of delivery measures are: percentage delivered to schedule and percentage delivered to rush order. On the internal side, the model defines cycle time as: *the sum of process time, move time, inspect time, queue time, and storage time* [21], where only the process time is considered to be "value-added" time. In many companies there is a lot of opportunity for improvements and much can be done by focusing on cycle time reduction. Examples of cycle time measures are time-to-market, development time, manufacturing lead-time, etc. The final element is waste, which is defined as: *the non-value added activities and resources incurred in meeting the requirements of the customer* [21]. Waste includes all the effort and costs associated with failures, appraisals, and surpluses. Examples of waste measures are cost of rejected materials, incoming inspection, warranty costs, etc. [21].

2.1.4.2. Environmental performance evaluation (EPE)

The EPE is an internal management process and tool, designed to provide management with reliable and verifiable information on an ongoing basis. It can be used to determine whether an organisation's environmental performance is meeting the criteria set by the management of the organisation. EPE helps the management of an organisation to assess the status of its environmental performance and to identify areas of improvement [23]. It is an ongoing process of collection and assessment of data and information to provide a current evaluation of performance, as well as performance trends over time by using several indicators and following the "Plan-Do-Check-Act" management model (PDCA) [27].

The PDCA-cycle reflects the principle of ongoing improvement. The speed of the improvement is dependent on the frequency on which the separately defined PDCA loops are carried out [23]. With this principle it is indicated that to reach objectives, an ongoing cycle must be started of planning action, carry out of the planned action, verifying if the results are meeting the targets, and steering or adjusting the implementation of plans as a result of the checkproces. The principle of the PDCA cycle has several applications. At the strategic level, it can be used for the definition of the policy planning cycles including defining, collecting and interpreting information on basis of which policy and strategy are steered. At the operational level the principle is applicable for the management of processes [28].

The EPE standard which use the PDCA cycle and has several objectives which are listed below [23]:

- *Better understanding of an organisation's impacts on the environment;*
- *Providing a basis for benchmarking management, operational and environmental performance;*
- *Identifying opportunities for improving efficiency of energy and resource usage;*
- *Determining whether environmental objectives and targets are being met;*
- *Demonstrating compliance with regulations;*
- *Determining proper allocation of resources;*
- *Increasing the awareness of employees and;*
- *Improving community and customer relations.*

To reach these objectives, the following steps conform the PDCA cycle need to be taken (figure 6):

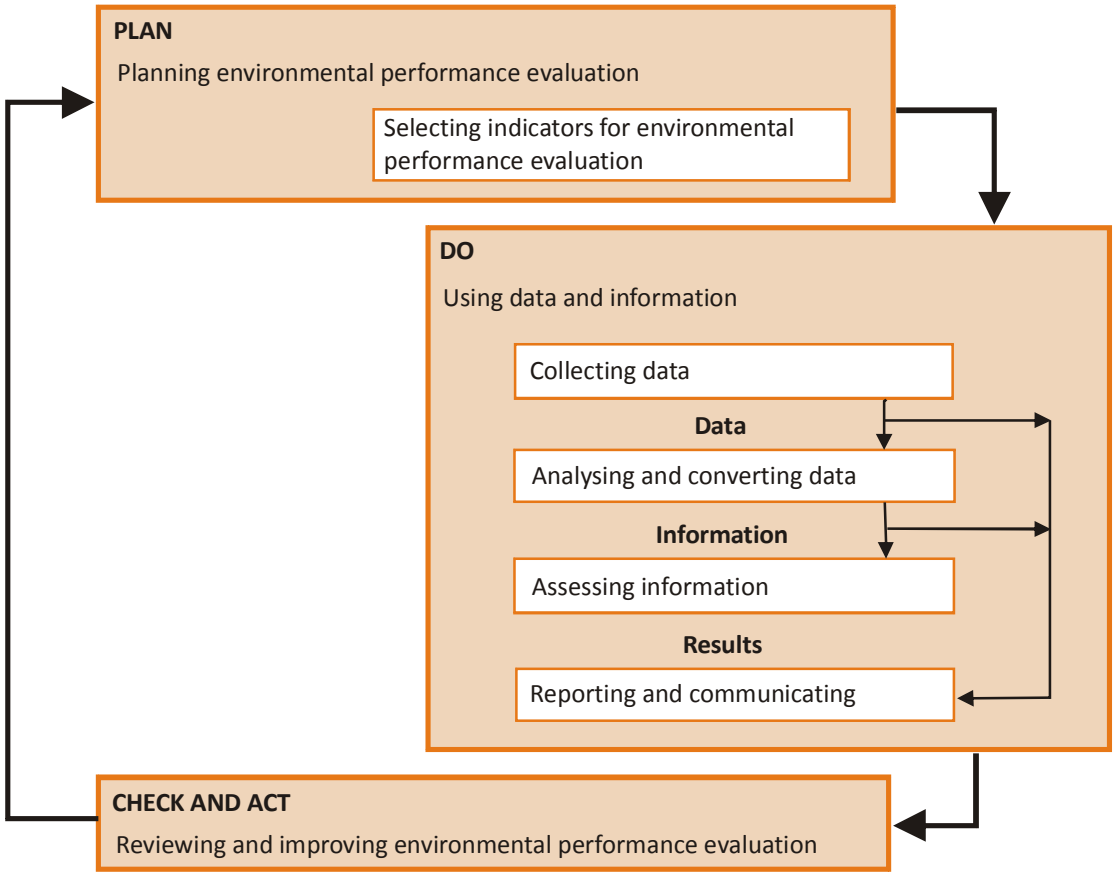

Figure 6: EPE [22].

- Plan

In the planning phase, the main focus is on the selection of indicators. These should be based on: significant environmental aspects; environmental performance criteria (internal and regulatory standards) and the views of interested parties. To make sure the EPE fits into the organisation's vision, the management input is a very important aspect within this phase. If possible, the EPE should also be structured to be consistent with existing environmental management systems and data collection systems [23]

- Do

The second phase involves the collection of data, converting these data into information, evaluating the information and communicating the results. To evaluate the selected performance indicators it is important for an organisation to collect data on a routine basis. Much of this information can be obtained from existing data sources like production data, procedures and records, regulations, storage and spill reports, and reports to government agencies. The quality of the data is very important and all data should be collected and handled in a structured and systematic way. This will ensure that interpretations based on the data will be reliable, verifiable and complete. When converting the data into information first the data should be reviewed and rated based on criteria for: accuracy, bias, age, verifiability, and completeness. Next, the data can be converted to information using data analysis tools like histograms, scatter plots, control charts and process capability analysis. After this stage, the information is compared with the performance criteria and targets established for the organisation. These performance criteria can be derived from specifications found in regulations, operating permits, or benchmarking data. The final step of the "Do" phase is the communication of the results to both internal and external stakeholders. This communication should create awareness, demonstrate commitment and put information in the hands of those who will be responsible for making improvements. Important points that should be addressed in these communication are [23]:

- *A description of the organisation's activities, products and services;*
- *A statement of its significant environmental aspects and related performance indicators;*
- *A comparison of performance indicators to established criteria and targets;*
- *Trends in the organisation's environmental performance;*
- *Legislative and regulatory compliance;*
- *Opportunities or recommendations to improve environmental performance; and*
- *Actions arising from results.*

The results may be communicated as reports or published statements continuously or on a regular base depending on the aim of the communication. In preparation of the reports, the target audience should be considered because different readers will need different types of information [23].

- Check and act

The results of the performance measures should be reviewed periodically to identify opportunities for increasing the environmental performance. The review of the indicators should not only consist the results of the measures, but also:

- *The cost and benefits of the program;*
- *Progress towards meeting environmental performance targets;*
- *How appropriate are the environmental performance criteria;*
- *How appropriate are the selected environmental performance indicators; and*
- *Data quality and data collection methods.*

While reviewing these factors, improvement efforts should focus on improving data quality, enhancing analytical and evaluation capabilities, developing new or more useful performance indicators, changing the scope of the program, and providing additional, or reallocating resources [23].

2.1.5. Analysis

For the elaboration of the PMS in the chain, the performance pyramid and PDCA-cycle of ISO 14031 described in this section will be used. The performance pyramid will be used to translate the corporate vision of the total chain to the individual actors and operational processes in the chain by using performance indicators. This pyramid will be applied on the whole supply chain and limited to three levels (figure 7). On the top level, the chain vision will be described and below this, the vision will be translated to the objectives for different actors in the chain. The final level of the pyramid contains the operational processes and responsibilities throughout the chain. Because the performance pyramid of Lynch and Cross does not provide a clear description for the elaboration of the different levels, the PDCA-cycle of ISO 14031 will be used. For each level, this will results in the following approach:

Plan – What are the targets and which key performance indicators are used?

Do - What data is collected, analysed, reported and communicated?

Check/Act – How are the results reviewed and which actions are taken based on the results?

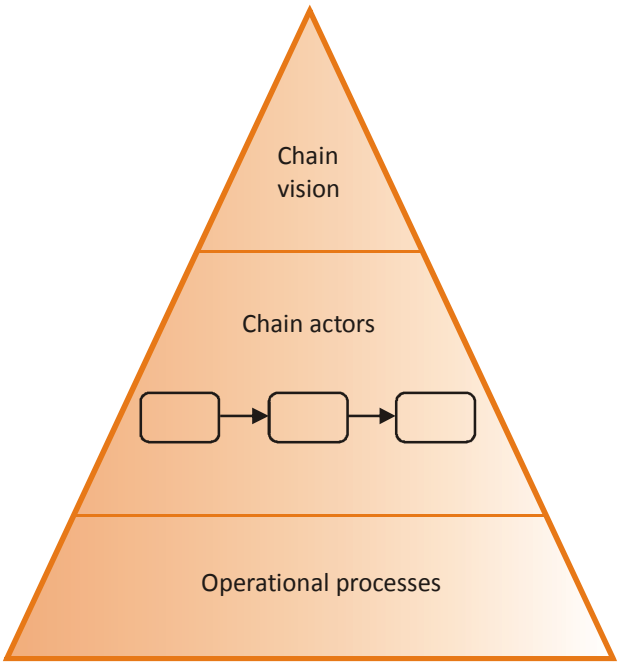

Figure 7: organizational pyramid

2.2. Key Environmental Performance Indicators

In the previous section, several theories are elaborated concerning the PMS and the management of EPIs. To answer the second research question concerning EPIs, in this section a distinction will be made between establishing criteria of KPIs and several classification styles of indicators.

2.2.1. Establishing criteria performance indicators

Although several general lists of existing EPIs exist (e.g. ISO, GRI), not all indicators are adequate and appropriate for every organisation. To create an effective and efficient list of indicators, several criteria can be noticed [29].

The following criteria will be elaborated below:
- Direct relevance to objectives;
- Limitation in number;
- Clarity of design;
- Realistic collection or development costs;
- Clear cause and effect links;
- Reliable and valid;
- Transferable;
- Appropriate spatial and temporal scale;
- Targets and baselines.

- Direct relevance to project objectives [29]

To select appropriate EPIs, it is important to have clear objectives and understand the environmental problems being caused or addressed. The selected indicators should be directly relevant to those objectives. Objectives such as “reducing erosion” or “protecting bio-diversity” are vague or too broad and are not appropriate to select relevant EPIs. Another aspect is that the costs and benefits of the objectives can be simplified when the right EPIs are chosen. If the chosen indicators does not have a connection the identified objective and have no relevance with it, it will be more difficult to evaluate the returns of a specific activity. *For example, in the case of land degradation, what is most important is to measure the degradation’s effect on achievable yield. Indicators that measure various aspects affecting the yield are therefore more useful than indicators of, for example, soil depth [29]*).

- Limitation in number

When selecting EPIs an organisation should not select too many indicators. It causes a dilution of their usefulness. The EPIs would produce too much information which may overwhelm the developers and users and priorities may become confused. It is most effective to be selective, using smaller sets of well-chosen indicators [29]

- Clarity of design

To create a transparent and transferable system it is important that all stakeholders understand the principles of the chosen EPIs. For this reason it is also important to clearly clarify the purpose and definition of the indicator to avoid confusion in the development and in the interpretation[30]. For example, it should be defined how an indicator should be measured and with which scale. There can be a lack of comparability across different sites and staff, even with a seemingly straightforward measure if different measurement scales are used [30].

- Realistic collection or development costs

When selecting EPIs, the cost of collection and development need to be considered. Some indicators may be extremely simple or inexpensive to collect, but inadequate for various reasons. Other indicators may be more precise but much more difficult or expensive to collect. One way to decide which indicator to collect or develop is therefore to compare the cost of collection/development to the benefits of the increased information which the indicator will contribute [29].

- Clear identification of causal links

In order to design appropriate measures it is important to clearly identify the causal links. *For example, in the forest sector, observing the rate of deforestation alone provides an incomplete picture. If this information is supplemented with an indicator of incentives for forest clearing (for example land ownership policies), one is getting closer to the underlying cause of the problem [29].*

- Reliability and validity

To obtain reliable and high quality information from indicators, the data from which it is derived should also be from high quality and reliable. An indicator is reliable when it gives the same results under the same circumstances at all times [29, 30]. The validity reflects if the EPI is really measuring what it is meant to measure. A distinction can be made between internal and external validity. The internal validity is the degree in which outcomes are disturbed by influences from outside. The external validity reflects to what extent results which the indicator produces can be generalised to reality [30].

- Transferable

It must be possible to reproduce the value of an indicator at a certain time. When indicators are measured more than once, it is also possible to compare the results. This makes it possible to track trends and make a good evaluation. To make transferability possible, the relation between the indicator and the data to be used should be very clear. Also precision at measuring and indicating the data source is very important. If it is not possible to examine how the value of an indicator is created, the indicator is not transferable [30].

- Appropriate spatial and temporal scale

Activities may have an impact far beyond the area in which the activity is measured. There can also be activities which effects are noticed a long time after the activity is measured. For example, changes in the long-term status of bio-diversity often only manifest themselves over long time periods. Therefore, it is desirable that the selected indicators take into account the appropriate spatial and temporal scale.

Besides this, it is also possible that an indicator which is relevant in one year, is not relevant anymore in the next year. Therefore, it needs to be considered every period [30].

- Targets and baselines

To assess performance indicators, the results need to be compared with a certain standard. Several types of standards of the indicators can be distinguished: Baseline value, threshold value, target value and comparison value [29].

- Baseline value

To form a judgement concerning the performance of an organisation, the results of the indicators can be compared with a baseline situation. In this way it can be determined for example if the situation has improved or has deteriorated after a certain period [29].

- Threshold value

For several aspects, the performance is only damaged after a certain point which is called the threshold value. For example, nature is, until the threshold, able to take up certain substances (minerals) without any harmful effects. But if this border is exceeded, harmful effects will arise [29].

- Target value

Targets can also act as standards. For example, when targets have been determined like the RED or NTA8080, it can be assessed how far the current results are still removed from the target [29].

- Comparison value

The last type is the comparison value. A distinction can be made between absolute and relative values. With an absolute value for example, the energy usage of an organisation will be compared to the usage of a year earlier. Relative comparison, looks at how a company performs with respect to other companies [29].

2.2.2. Types and classifications of performance indicators

Besides the criteria for the selection of indicators, also a distinction can be made between different type of indicators concerning sustainability. All these different types (classifications) can be used to translate the organisation vision and objectives. It depends on the aim of the indicators which type is most appropriate.

Below, several types of indicators will be further described:

- Principle's, processes and outcomes

In the model "Corporate Social Performance" [31], a distinction is made between principles, processes and outcomes. Principles concern the motivation that strives an organisation towards sustainable improvements. The processes concern the activities needed for sustainable improvements. Finally, the outcomes contain the real performance measures/indicators. It and can be separated in policy programs

and impacts, where the impacts, are measuring the past and the policy and programs are focussing on the future [1].

- Driving force, State, Response (DSR)

The DSR-classification (OESO, 1999) is mainly used for the measurement of sustainable performance in the agricultural sector. A distinction is made between driving force, state and response indicators. The driving indicators measure the factors that have an impact on the sustainability situation e.g. usage of fertilisers. The state indicators describe the current situation (e.g. water quality) and the response indicators describe the corrective actions which contain the causal link between driving force and state indicators [1].

- Input, Output, Outcome and Impact indicators

Regarding outcome indicators, several subgroups can be distinguished namely; input-, output-, outcome- and impact indicators [32]. Input indicators describe the resources being used. Output indicators describe the outcomes of these input indicators. With successive processes this output can be assessed as input for the next process. The outcome indicators elaborate the short-term effect of the output. Finally, the impact indicators measure the final aimed effect, which describe in how far the objectives are met. The distinction between output and impact is not always very clear. Therefore these categories are combined most of the time [1].

- Individual and integrated indicators

The GRI (2002) makes a distinction between individual and integrated indicators. Integrated indicators differ from simple indicators because they reflect relations and/or proportions. Two types of incorporated indicators can be distinguished: System indicators and ratio indicators. System indicators reflect the relation between the performance of the company and the system in which it functions. For example, a company can express its air pollution as a percentage of maximum air clogging which has been determined for the concerning area. Ratios give the relation between two themes, for example environmental costs [1]. While GRI is striving for the use of incorporated indicators, it can be difficult to implement mainly because the use of these indicators in a PMS is very situation-specific[24].

- Context indicators

Several authors use context indicators [1]. Context indicators do not describe the performance of the actor himself, but describe the surrounding in which the actor operates. This type of indicator is particularly important at assessing environmental performances. For example, a certain score on an indicator for a certain company can be ‘bad’, whereas it is for another company no problem because it is acting in a different context. Examples of different contexts are location, ground type, surrounding nature area etc. The disadvantage of the use of context indicators is that more data need to be collected and performances of different organisations cannot be compared [1, 33].

- Operational-, Management- and Environmental condition indicators

Within the EPE-guidelines [23], a distinction is made between Environmental Performance Indicators (EPI) and Environmental Condition Indicators (ECI). ECIs provide information about the condition of the environment. This information can help an organisation to better understand the actual impact or potential impact of its environmental aspects, and thus assists in the planning and implementation of a PMS. The EPIs can be divided into Management Performance Indicators (MPIs) and Operational Performance Indicators (OPIs). The MPIs provide information about management efforts to influence the environmental performance of the organisation's operations. The OPIs provide management with information on the environmental performance of the organisations operations [23].

2.2.3. Analysis

For the analysis of the cases, the identified indicators of the chain will be analysed regarding the establishing criteria. For each identified criteria also the baseline- and target value will be described if available. For the analysis regarding the appropriate indicator classification for the case analysis, it is important that the classification is simple and clear and the indicators should be comparable to evaluate the different cases. The Corporate Social Performance model is a common used framework to assess the performance of an organisation cq. chain but it also contains the elaboration of an organisation's vision and processes while for this research the performance pyramid is chosen. The driving force, state and response framework it is mainly designed to assess the performance of a whole sector and therefore more appropriate for governmental organisations. In case of the incorporated indicators and context indicators, the classification is strongly situation specific which makes it difficult to compare the indicators of the different cases. Because the context of all the three cases will be different, it will be too difficult to obtain enough information to compare the indicators precisely within this research. To create a clear view of the classifications, the classification of the ISO 14031 with conditional, operational and management indicators will be appropriate and has a good connection with the performance pyramid and therefore these are chosen for this research. The MPIs will provide the management information on the capability and efforts in managing matters like resource allocation and efficient utilisation and corrective actions which have or can have an influence on the chains environmental performance. Besides this, the MPIs will track the accomplishment of the specific chain objectives, effective co-ordination, problem-solving capacity, compliance with legal and regulatory requirements, and conformance with other requirements to which the chain actors subscribes. Secondly, the OPIs will reflect the environmental performance of the chain regarding the environmental targets.

2.3. Supply chain organisation

2.3.1. Introduction

To answer the third research question, concerning the co-operation between chain actors regarding the PMS, it is important to analyse the supply chain on several aspects. There are many aspects which can be taken into account when analysing a supply chain. In the last years, a lot of scientific research is done about supply chain management because of the increasing importance of establishing beneficial

relationships in supply chains. Organisations want to optimise its results by increasing its efficiency and inter-firm synergy. Especially for supply chains dealing with organic products, this optimalisation is very important due to the limited perishableness and high consumer awareness regarding sustainability [34]. The following definition of supply chain management is given by Van der Vorst [35]:

- *SCM is the integrated planning, co-ordination and control of all business processes and activities in the supply chain to deliver superior value at less cost to the supply chain as a whole while satisfying the variable requirements of other stakeholders in the supply chain (e.g. government and NGOs)* [35].

This definition describes that a supply chain is based on a serie of physical and decision making activities which are connected with material and information flows and associated flows of money and property rights that extend the organisational boundaries between related firms [34]. According to Lambert and Cooper [36], the SCM framework consists of the following three interrelated elements:

- The supply chain network structure, describing the member firms and the links between these firms;
- The supply chain business processes, describing the activities producing a specific value to the customer;
- The supply chain components, which describes the managerial variables that integrate and manage the business processes across the supply chain.

2.3.2. Network structure

In many cases, the supply chain does not concern a straight line of consecutive processes but more concerns a complex network of customers and suppliers [34]. In figure 8, a detailed map of a possible supply chain is shown with all the raw material suppliers and customers. Lambert and Cooper [36] have stated that the main aspects of a supply chain structure are the actors of the supply chain, the structural dimension, and the different types of process links. For this research, the network structure of the bio ethanol chains will be elaborated by describing the actors in the chain and the associated links in general without using a focal company.

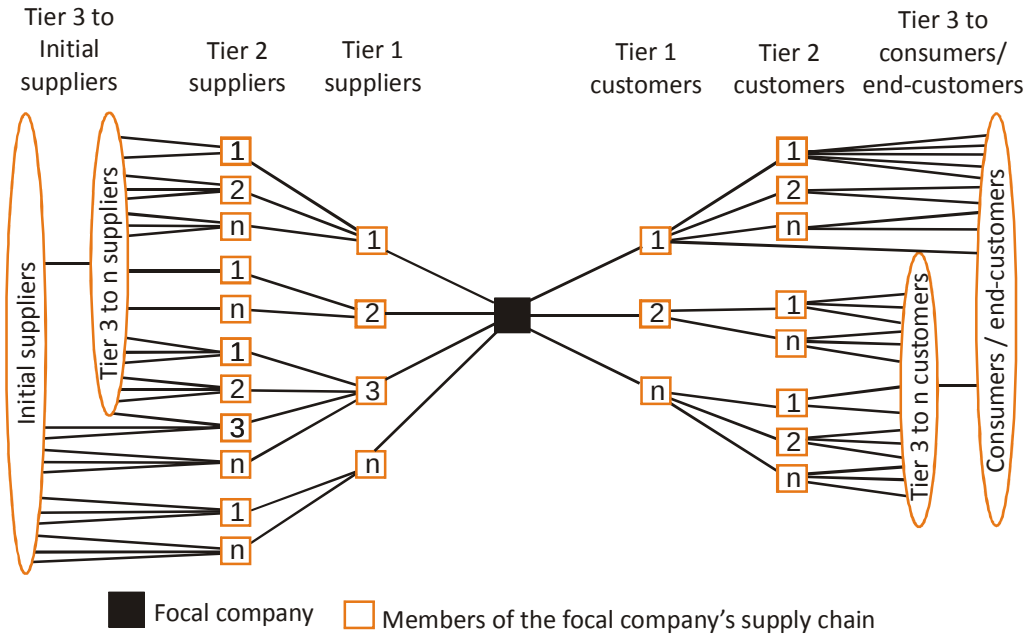

Figure 8: Network structure [36]

2.3.3. Business processes

There are several ways of capturing and visualising the processes in the chain [28]. When making a process diagram, the critical points or risks and the associated controls and guarantee measures have a significant impact. Examples of possible techniques for mapping processes and their critical points or risks are: text, flowcharts, combination techniques, and SqEME Process management. Each technique has its own advantages and disadvantages. When using text, the advantage is that everybody can understand the text and changes to practices can be adopted quickly. The disadvantage of text is that it is difficult to create a clear overview of the processes and the associated steps, responsibilities, resources etc. A flowchart is a visual reproduction of the serial steps that are taken to produce something. By using symbols it is also possible to indicate differences between operations, decisions and document flows in the processes. A disadvantage of flowcharts is that not everybody can read the flowcharts. Also the changing of a flowchart is not always easy when for example procedure modifications or improvements are made. The techniques with texts and flowcharts are also applied in several combinations, for example a flowchart with accompanying text. The advantage of such a combination diagram is that it is compact, and it contains much information. A good overview of the total process can be formed rapidly with a professional layout. With the SqEME technique the processes are considered as individual blocks where the consistency between the blocks is extensively described. The technique does not only contain the description of the processes but it also contains the elaboration of the broader organisational system, like the link with the mission and strategy, information supply and the actors with associated roles, powers and responsibilities. The advantage of the SqEME technique is that it creates a good elaboration of the cohesion between different processes. The disadvantage is that it takes much time to elaborate the whole system and it can be difficult to provide a clear overview of all the aspects [28].

For this research, where the processes have to be visualised and linked with the targets which are identified by the performance pyramid, the combination technique with a flowchart and additional text will be used. The flowchart will visualise the sequential steps and the associated text will show the additional information like the targets/indicators, data collection and reporting based on the PDCA-cycle. In this way the PDCA-cycle will act as a control system which is shown in figure 9. It can also be extended for other purposes like the tracking and tracing of the physical products in the chain.

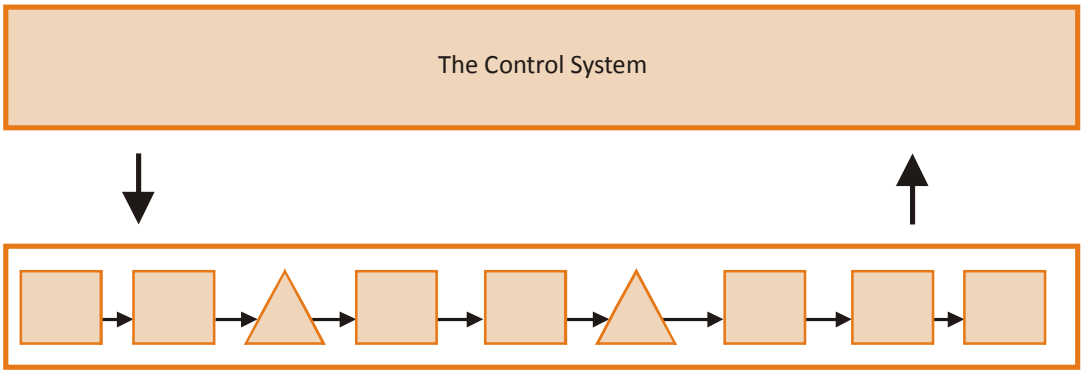

Figure 9: Managing business processes

2.3.4. Components

To obtain good environmental performances in a supply chain it is important that the separate chain actors are well organised. Especially when a PMS is implemented and the whole supply chain is striving for joint targets, a good co-operation with mutual trust and information sharing between the actors in the chain is necessary. The third aspect of the SCM framework which covers these aspects are the SCM components. Lambert and Cooper [36], identified nine management components, which have an effect on the outcome of a supply chain, like the culture and attitude, allocation of risk and rewards and information flow facility structure etc.

For this research, the main interest is to analyse the chain co-operation which is expected to be important to manage the PMS. Because when the level of ambition of the performance management and a PMS increases, this will have an effect on the co-operation in the chain. Within this research, the ambition level of the PMS will be analysed together with the associated co-operation in the chain. Also due to the fact each organisation is dependent on the performance of other chain actors in the highly volatile environment of the bio-ethanol sector, this chain co-operation is important [37]. Within the supply chain literature, there are several articles and models which address the co-operation in a chain. In a model of Hanf and Dautzenberg (figure 10), a distinction is made between the co-operation and co-ordination in the supply chain and therefore this model will be used to elaborate components which are associated with the co-operation and co-ordination. The model makes a distinction between three different levels which are important for the analysis of a chain: the chain level, the dyadic level (which reveals which characteristics and restraints a collaboration between two actors has), and the firm level (Duysters et al., 2004). Therefore it also forms a proper connection with the performance pyramid which makes a distinction between the three different levels. The model of Hanf and Dautzenberg [2] assumes that each collaborating chain has a collective strategy, which results from the chain vision. This can be split up in two domains: partnering strategy (co-operation) and supply chain management strategy (co-ordination).

The co-operation refers to the alignment of individual interests while the co-ordination refers to the alignment of actions. According the model, only when both the individual interests and the actions are aligned, a successful collaboration within the chain is possible. When conflicts arise about the interest of the different actors, problems with the co-operation could be created. The model describes that the degree of co-operation can be expressed on different levels. On the chain level, problems concerning the degree of complexity can arise. This complexity can be analysed based on the transparency, degree of free riding, and possible rivalries and coalitions in the chain. On the dyadic level, problems can arise regarding the opportunism between the chain actors. This opportunism can be analysed based on the specific investments of the chain actors, fit or stretch of core capabilities, and allocation of profits and power. Finally, on the firm level, the co-operation can be dependent on limited resources, co-operation rents and potentials, and external pressure of the environment. Several formal and informal mechanisms can be used to improve or to secure the co-operation on the different levels. Examples are: contracting, common ownership of assets, monitoring and sanctions and the prospect of future interactions [38].

Also the degree of co-ordination can be analysed on different levels. On the chain level, the co-ordination is also based on the complexity in the chain. This can be analysed based on the interdependency and heterogeneity in the chain, the bullwhip effect and is also dependent on the

number of actors, length of the chain, geographical distribution etc.. On the dyadic level, the co-ordination is dependent on the uncertainty about several aspects like information asymmetries, decisions and behaviour between the chain actors. Finally, at the firm level, the co-ordination can be analysed on basis of the managerial skills, capabilities and infrastructure of the chain actors, and the resources of these companies. Within an organisation, the resources can be considered under four key resource areas: people, information, finance and technology. These resources are very important for an organisation but even more important is how these resources are employed and deployed, which describes the competencies of the organisation. *Competencies are the skills and abilities by which resources are deployed effectively through an organisation's activities and processes* [39]. To minimise the co-ordination problems in the supply chain, there are several formal and informal mechanisms like programming (using schedules and standards) and feedback of information and culture aspects influencing interaction and information sharing between supplier and buyer [38].

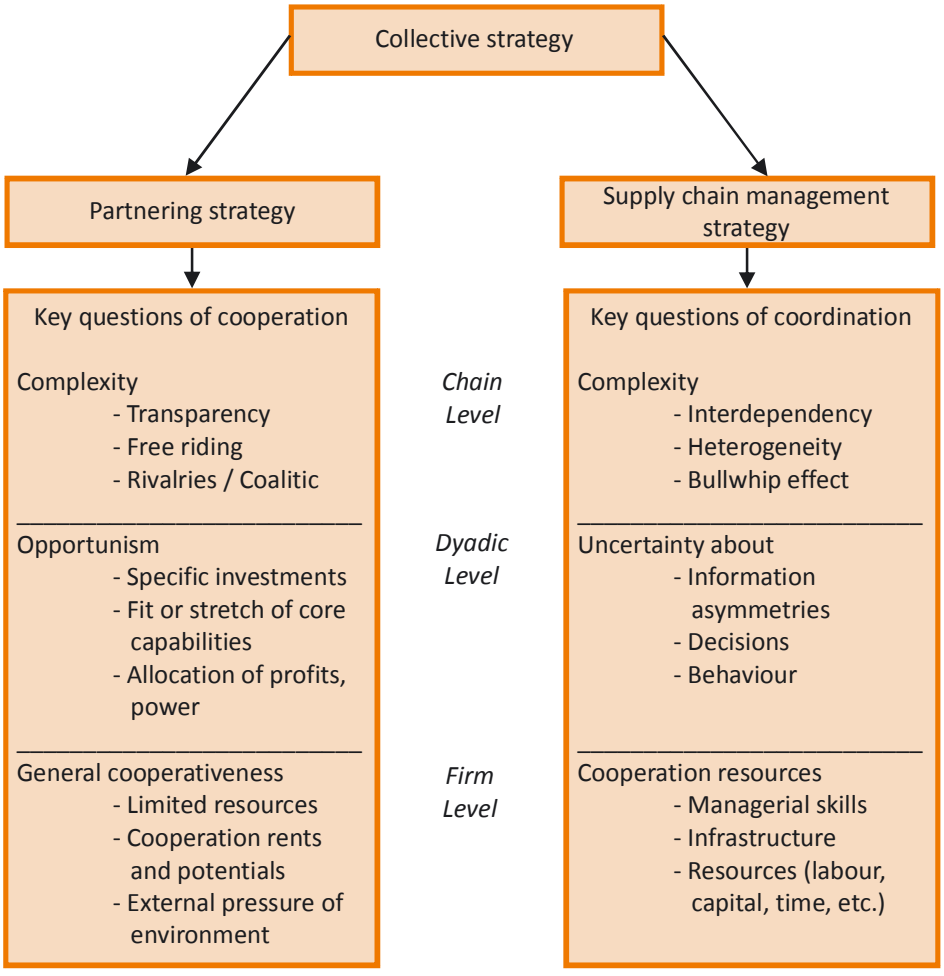

Figure 10: managerial framework for networks [2]

2.3.4. Analysis

For the analysis of the supply chain organisation in the cases, all three elements of this section will be elaborated. The network structure will be described by elaborating all the actors in the chain and the associated links while the business processes will be described together will the elaboration of the PMS. For the analysis of the components in the chain regarding the environmental PMS, the managerial framework for networks of Hanf and Dautzenberg (2006) will be used (figure 10). By applying the model on the cases, it should result in an elaboration of the co-operation and co-ordination in the chains. Each aspect of the model will be elaborated with a focus on the environmental PMS in the chain. It will visualise what the interest is for each actor (reducing risk, economics of scope, inter-firm potentials etc.), how the actors are working together (contracts, information sharing, incentives) what value each actor is adding to realise the supply chain objectives (reporting, liabilities etc.) (figure 11). The exact aspects which are analysed in the cases are shown in the interview protocol (Attachment 1).

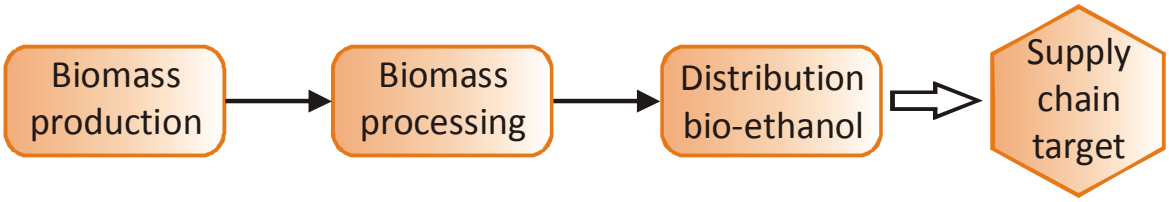

Figure 11: Supply chain

2.4. Conclusion

The theoretical framework wich will be used to carry out the emperical part of the research is based on the three sections of this chapter: PMS, key Environmental Performance Indicators, and the chain organisation. These aspects will be analysed for the cases based on the approach of Lambert and Cooper. First, a small introduction of the chain will be given together with the current chain structure. Next, the current business processes will be described with the elaboration of the performance pyramid. This analysis will be focussed on the environmental aspects of the pyramid. The indicators which are implemented will be analyzed with the Plan-Do-Check-Act cycle and the establishing criteria. With this analysis of the criteria, the ambition level of the PMS will be evaluated. Subsequently, the associated co-operation in the chain to achieve the ambition level will be evaluated with the model of Hanf and Dautzenberg. All the aspects of this model (components) will be examined in the cases to see how all the actors are collaborating to achieve and assure the joint targets for the environmental performances (figure 11). With this analysis, a distinction will be made between the chain, dyadic, and company level. When the first two cases are analysed, the third case will be introduced, and the chain structure will be elaborated. Finally, the recomendations for the PMS and associated co-operation will be given based on the analysis of the first two cases.

3. Research methodology

In the literature study, theories concerning PMSs, EPIs and supply chain management are studied. The theoretical framework described in chapter 2 gives an overview of the factors and variables that will be studied in the case studies. In this chapter it is explained what case studies are used, how the respondents are selected, how the data is collected and how the case studies are analysed.

3.1. Case studies

The objective of the analysis of the Regionol chain (case 1) and Van der Sluijs Groep (Case 2) is to analyze the PMS with key EPIs and the associated co-operation between the chain actors. This analysis should generate inputs for establishing recommendations to Beethanol BV. To use the results of the cases as an input for the Beethanol case, it is necessary to clarify which aspects of both cases will be analysed. For this analysis, the following distinction will be made based on the conclusion of section 2.4.:

1. Analysis of the chain structure and the description of the chain processes and;
2. The elaboration of the environmental PMS including the key EPIs which are implemented in the chain and;
3. The co-operation between the different actors in the chain regarding the assurance of the environmental performances.

If the analysis of the two cases generates insufficient inputs for establishing recommendations, other cases will be added. This could be a similar case or a different case for example from another sector depending on the information which is needed.

The case studies are particularly useful for this explorative and design oriented research, because there is not much known yet about how the different chains are currently dealing with the environmental criteria, which indicators they have identified and how the chain actors are co-operation. This “holistic view” is of interest to this research because it will be researched how the chains are achieving and assuring the environmental criteria, and which targets for the environmental performances they have set. Because not much information is known in advance, the case study leaves the possibility to adjust and switch the focus during the research. A disadvantage of case studies is that the external validity is often under pressure [40]. According to Eisenhardt (1989) less than four cases can lead to problems with generalising the results [41]. Therefore attention has to be given to the validity of the results of the case analysis. In this research, two comparative case studies are performed to give recommendations for the third case. According to Verschuren en Doorewaard [40], two types of comparative case studies can be identified: Hierarchical method and sequential method. In the hierarchical method the case studies are first researched individually and independent of each other. Afterwards, the results are used for a comparative analysis between the different cases. In the sequential method the researcher focuses on one case which is studied in depth. Based on the results of this case study, a second case study is chosen, which is compared with the results of the first case study. In this research a combination of both methods will be used. First the hierarchical method will be used to analyse the two cases individually and independent of each other. Second, the sequential method will be used to compare the Dutch case with the results of the first two cases.

3.2. Selection of the respondents

Because the actors of the specific cases are not all located in the Netherlands, it is difficult to interview all the actors from the chain due to limited time and resources. Therefore, the respondents for the interview are limited to the actors who have a large influence in the chain and who meet the following criteria:

- The respondent can give information about the chain processes;
- The respondent can give information about the chain vision and associated targets;
- The respondent can give information about the identified KPIs across the chain and the associated control/monitoring;
- The respondent can give information about the co-operation between chain actors across the whole chain;
- The respondent is willing to co-operate.

If one or several criteria are not meet after an interview, other respondents in the chain are selected by using the snowball selection method. This entails that, based on the interviews with selected retailers, a second or third respondent is selected for the case study to obtain sufficient information and validate the results.

3.3. Data collection

The interview protocol (attachment 1) which is used for the interview with the respondents is based on the structure provided in section 3.1. First, the chain structure and operational processes are addressed by a few basic questions. Next, the performance pyramid including the key EPIs and the PDCA cycle is addressed based on the environmental criteria stated in chapter 4. Finally, the co-operation between the different actors in the chain is addressed by formulating questions based on each aspect of the model of Hanf and Dautzenberg. The questions formulated in the interview protocol all consist of open-ended questions. In this way, more information can be obtained about the specific situation. In order to better understand the answers of the respondents, explanations and arguments can be asked, to be able to explain existing differences or uncertainties. The interviews are semi-structured, which provides a structure to make sure all the topics that need to be researched are discussed. When conducting the interview, the situation of the chain (chain environment) have to be clear for the researcher. By this way, the scenario of the case can be clearly described and the answers can used for the analysis and comparisation afterwards. This also allows some flexibility to discuss topics in more depth or to discuss topics which are not included in the interview but appear to be important. To increase the internal validity of the research several actions are taken. Information is obtained from different sources and data is obtained from different sources in the field. By using the snowball selection method when necessary, the validity of the results will also be increased. Before conducting the interviews, information about the organisation will be studied in advance (e.g. the website of the organisation). The aim is to conduct face-to-face interviews if possible, which will be performed at the offices of the respondent. Face-to-face

interviews (in comparison to telephone interviews) make it easier to get an impression of the researched companies. Furthermore, it is also more appropriate when asking for explanations and other details concerning the asked questions.

3.4. Analysis of the case studies

After conducting the interviews, the results will get analysed in several steps. First, the two cases are studied individually and independent of each other. When the performance pyramid including the key EPIs and the PDCA cycle is analysed for both cases it will be evaluated if additional inputs for establishing recommendations for Beethanol are needed. Otherwise, other cases or literature will be added. When all the inputs are gathered, it will be evaluated which aspects are relevant and can be implemented for Beethanol based on the specific scenarios of the cases. Due to the fact that each chain is different, it will not be possible to provide the perfect solution. However, it will be possible to analyse the advantages and disadvantages of the different practices which are implemented in the cases. From these results, the conclusions and recommendations concerning the achievement and assurance of the environmental criteria and the associated co-operation between the chain actors will be established.

4. Environmental criteria / objectives

4.1. Introduction

To provide an answer on the fourth research question, first the environmental criteria are elaborated in this chapter. These criteria are forming the basis of the case analysis, where it is analysed how the chains are assuring the environmental criteria. The European RED and the additional Dutch environmental criteria of the NTA-8080 are selected to create this starting point. It will also be controlled if these criteria are considered as a baseline situation or as a target situation. 6 Main environmental principles can be distinguished: CO2 reduction, carbon reservoirs, bio-diversity, soil-, water, and air quality. For each of these principles, the associated criteria and arrangements are shown.

4.2. RED

The Renewable Energy Directive (RED) is published on June 25, 2009 [4]. It states that, before the end of 2010, each EU-member is obliged to implement the directive in their legislation. The RED states that in 2020, 10% of our transport energy should be derived from renewable energy, like bio-fuels, hydrogen, and electricity for the transport sector. In order to prevent negative environmental effects, sustainability criteria have been incorporated. The main sustainability criteria within this directive are:

- The reduction in greenhouse gas emissions must be at least 35%, measured over the entire chain (from production of raw materials through end-use) and compared to fossil fuels. In 2017 the minimum reduction criteria will be increased to at least 50% (and 60% in case of installations operational after 2017);
- Bio-fuels and bio-liquids shall not be made from raw material obtained from land with high bio-diversity value;
- Bio-fuels and bio-liquids shall not be made from raw material obtained from land with high carbon stock (wetlands, continuously forested areas,);
- Bio-fuels and bio-liquids shall not be made from raw material obtained from land that was peatland in January 2008;
- Agricultural raw materials cultivated and used for the production of bio-fuels and bio-liquids taken into account shall be obtained in accordance with the Cross-compliance regulation.

Fuel suppliers will need to show that the bio-fuels they supply meet the above conditions. When different blends are produced with fossil fuel or unsustainable bio-fuels, the Directive pursues the mass balance method. This system:

- *allows consignments of raw material or bio-fuels with differing sustainability characteristics to be mixed;*
- *requires information about the sustainability characteristics and sizes of the consignments to remain assigned to the mixture;*

- *provides for the sum of all consignments withdrawn from the mixture to be described as having the same sustainability characteristics, in the same quantities, as the sum of all consignments added to the mixture.*

Within this Directive, a calculation method for the GHG emissions is provided. This can be applied by using default values, or own values, provided that they are calculated following the methods described in the Directive. A combination of actual values and default values for each process step is also allowed. If a production process also produces co-products, as well as bio-fuels, the GHG emissions of the entire process must be allocated to the various products based on their energy content.

4.3. NTA 8080 Criteria

Based on the Cramer criteria, a NEN project-group has elaborated a norm in which the criteria are translated into sustainable requirements. When a biomass chain wants to label their product according to this standard, they have to show that they can guarantee the environmental criteria mentioned below [7].

1. CO2 reduction

Principle 1: The greenhouse gas balance of the production chain and application of the biomass is positive

Criterion 1.1: In applying biomass there has to be a net emission reduction of greenhouse gases (GHG) over the whole chain. The reduction is calculated with respect to a reference situation with fossil fuels. For bio-fuels this emission should be at least 50%, but for several cases a transition period applies up to 2012 with a minimum emission of 35%.

2. Important carbon reservoirs

Principle 2: Biomass production does not go at the cost of important carbon tanks in vegetation and in the floor.

Criterion 2.1: Conservation of overground (vegetation) carbon reservoirs at construction of biomass entities.
Criterion 2.2: Conservation of underground (floor) carbon reservoirs at construction of biomass entities.

The following areas have been excluded for the construction of new production entities for biomass:
- Areas where the loss of overground carbon reservoirs cannot be recovered in a period of ten years of the aimed biomass production;
- Areas with a large risk of considerable carbon losses from the underground, such as certain grasslands, peat areas, mangroves and wetlands.

Arrangements:

- preceding the construction of a new biomass production entity it has to be determined which carbon stocks in vegetation and in the underground will disappear by the construction of the production entity;
- It has to be determined if these losses can be compensated by means of the cultivation of the aimed at biomass during the next ten years;
- Measures have to be taken to reduce the emission of GHG from the underground during the cultivation;
- The measures have to be monitored, measured and analysed;
- The findings have to be documented.

3. Bio-diversity

Principle 3: The production of biomass does not harm protected or vulnerable bio-diversity and strengthens if possible the bio-diversity.

Criterion 3.1: No violation of national rules and laws which apply to biomass production and the production area.

Arrangements

- When applicable, it have to be proved that the organisation is acquainted with general national laws and legislation and specific legislation concerning land property and land use rights, hunting, protected areas, spatial planning, forest and plantation management, and rules originating of international conventions.
- Measures have to be taken which ensures that the requirements of aforementioned laws and legislation are satisfied;
- Measures need to be taken which ensures that modifications to laws and legislation are satisfied;
- Measures need to be taken which ensures that modifications to laws and legislation and the maintaining of it are properly determined and applied.

Criterion 3.2: With new or recent construction, the bio diversity may not be harmed by biomass production in protected areas.

Arrangements

- Biomass production cannot be exercised in ‘gazetted protected area’ or in an area which is on some point less than 5 km removed of the `gazetted protected area'.

Criterion 3.3: With new or recent construction, the bio diversity in remaining areas with high bio diversity value, vulnerability or high agrarian nature and/or culture values may not be harmed.

Arrangements

- Biomass production may not be exercised in areas which have been designated in dialogue with interested parties as areas with “High conservation value”. Or in an area which is on some point less than 5 km removed of an area with “high conservation value”.

Criterion 3.4: At new or recent construction, the bio-diversity has to be conserved or recovered within biomass production entities.

Arrangements

- At least 10% of the functional ground surface of a production entity has to be maintained with original vegetation, representative for the area, for the conservation of bio diversity;
- It has to be determined in what kind of land the biomass production entity is located;
- It has to be measured if the biomass production contributes to the recovering of degraded areas within the production entity;
- The measures have to be documented in the company plans and these should be monitored, controlled and analysed.
- The findings have to be documented.

Criterion 3.5: With the construction and with management of existing production entities, the bio diversity should be strengthened where possible

Arrangements

- Where possible, the bio diversity within the production entity must be improved and the fragmentation of natural areas by the production entity must be limited;
- Measures have to be made to counteract the disruption of the surroundings by activities on the entity, the use of agro-chemicals, and reducing the sound and invasion of exotics from the production entity.
- The measures have to be documented in the company plans and these should be monitored, controlled and analysed.
- The findings have to be documented.

4. Soil Quality

Principle 4: With the production and processing of biomass the soil and soil quality have to be maintained or improved.

Criteria 4.1: No violation of national rules and laws which apply to soil management.

Arrangements:

- Where applicable, it has to be proved that the organisation is acquainted with general national laws and legislation and specific legislation concerning waste management, the use of agro-chemicals, mineral household, the prevention of soil erosion, environmental impact reports and company audits

in particular.

- It has to be proved that the organisation is acquainted with the provisions of the 'Stockholm convention on persistent organic pollutants' with regard to the application of harmful pesticides.
- Measures have to be taken which ensures that the requirements of aforementioned laws and legislation are satisfied;
- Measures need to be taken which ensures that modifications to laws and legislation and the maintaining of it are properly determined and applied.

Criteria 4.2: With the production and processing of biomass, best practices are applied to maintain or improve the soil quality.

Arrangements

- Annual measures have to be carried out and the outcomes have to be documented with regard to the loss of soil, the organic matter of the soil, the pH in the top layer and the nutrient assessment with regard to Nitrogen (N), Phosphorus (P), and Potassium (K).
- The applied management practices have to be aimed at the prevention and maintenance of the soil erosion, maintenance of the organic matter, and the maintenance of the soil salination.
- The applied management practices have to be focussed on the prevention of risks for the soil as a result of the use of agro-chemicals.
- The applied management practices should be improved continuously
- The measures which are determined have to be documented in the company plans and these should be monitored, controlled and analysed.
- The findings have to be documented.

Criteria 4.3: The use of rest products is not contrary to other local functions for the conservation of the soil.

Arrangements

- The use of agrarian residuals, which are produced at the production and processing of biomass on the production entity, should not compete with other local functions for the maintenance of the soil and soil quality.
- The residuals of the production and processing process of biomass have to be used optimal, to reduce unnecessary losses, and to limit the occurrence of unnecessary burden on the environment.
- The applied management practices should be improved continuously
- The measures which are determined have to be documented in the company plans and these should be monitored, controlled and analysed.
- It has to be documented for which functions the residuals, that are produced at the production and processing of biomass on the production entity, are applied.
- The findings have to be documented.

5. Ground and surface water

Principle 5: With the production and processing of biomass, the ground- and surface water may not be exhausted and the water quality should be maintained or improved.

Criteria 5.1: No violation of national rules and laws which apply to water management.

Arrangements

- Where applicable, it has to be proved that the organisation is acquainted with general national laws and legislation and specific legislation concerning the use of water for irrigation, the use of groundwater, the use of water for agrarian aims in reservoirs, wastewater treatment, environmental impact reports and company audits in particular.
- Measures have to be taken which ensures that the requirements of aforementioned laws and legislation are satisfied;
- Measures need to be taken which ensures that modifications to laws and legislation and the maintaining of it are properly determined and applied.

Criteria 5.2: With the production and processing of biomass, best practices are applied to limit the use of water maintain or improve the ground- and surface water quality.

Arrangements

- Annual measures have to be carried out and the outcomes have to be documented with regard to the use of irrigation water, the origin of the irrigation water and the level of surface water usage on and near the production entity.
- The applied management practices have to be aimed at efficient water usage.
- The applied management practices have to be aimed at the prevention of risk for ground- and surface water as a result of the use of agro-chemicals and other company processes.
- The applied management practices have to be aimed at improving water quality
- The applied management practices should be improved continuously
- The measure have to be documented in the company plans and these should be monitored, controlled and analysed.
- The findings have to be documented.

Criteria 5.3: With the production and processing of biomass, water from not-renewable sources may not be used.

Arrangements

- It should be arranged that no water from not-renewable sources is used.
- The measures which are determined have to be documented in the company plans and these should be monitored, controlled and analysed.
- The findings have to be documented.

6. Air

Principle 6: With the production and processing of biomass, air quality has to be maintained or improved.

Criteria 6.1: No violation of national rules and laws which apply to emissions and air quality.

Arrangements

- Where applicable, it has to be proved that the organisation is acquainted with general national laws and legislation and specific legislation concerning air emissions, waste treatment, environmental impact reports and company audits in particular.
- Measures have to be taken which ensures that the requirements of aforementioned laws and legislation are satisfied;
- Measures need to be taken which ensures that modifications to laws and legislation and the maintaining of it are properly determined and applied.

Criteria 6.2: With the production and processing of biomass, best practices are applied to limit emissions and air pollution.

Arrangements

- Annual measures have to be carried out and the outcomes have to be documented with regard to the emission of substances in the air as a result of the production and processing of biomass on the production entity.
- The applied management practices have to be aimed at the maintenance of waste and to minimise the emission of substances in the air.
- The applied management practices should be improved continuously
- The measures have to be documented in the company plans and these should be monitored, controlled and analysed.
- The findings have to be documented.

Criteria 6.3: With the construction and maintenance of the biomass production entities, no fire may be used.

Arrangements

- It is not allowed to burn the stubbles with the construction or maintenance of the production entities, unless it is shown that this is the most effective and less harmful method to minimise the risk of damage by diseases and pests.
- When burning is permitted as described, it has to be shown that the burning takes place under checked circumstances.
- All events, where burning is used, should be registered and reported at the next audit.

4.3. Analysis

It can be concluded that the most environmental criteria of the RED and the NTA-8080 are focussed on the production of the biomass. The processing of the biomass also contains several criteria but for the distribution of the biomass and bio-ethanol almost no criteria are stated. The most important criteria is the GHG reduction which affects the whole chain and is difficult to achieve for several chains. The other five criteria can be described as prelimiting conditions which has to be dealth with. Within Europe, the RED acts as the statutory basis and the NTA8080 can be seen as an voluntary agreement with additional criteria and is supported by several stakeholders in the Netherlands. The sustainability criteria of the RED clearly does not go as far as the NTA8080 criteria, which cover not just the GHA emissions but also possible competition with food productoin and other local applications, the environment, prosperity and welfare. Currently the projectgroup of the NTA8080 is developing an own certification system which can garuante the compliance to the NTA8080 criteria.

5. Case analysis

5.1. Introduction

In this chapter, the cases will be analysed according the aspects of the theoretical framework. This emperical part of the research will provide an answer on the research questions 4 to 6. In the analysis of Regionol (section 5.2 and Van der Sluijs Groep (section 5.3) research questions 4 and 5 will be answered. These questions concerns the properties of the cases, the environmental targets which are stated, the implemented EPIs and the associated organisation of the actors in the supply chain. The structure of the case analysis is based on section 2.4 of the theoretical framework. First the case will be introduced together with the chain vision and current structure. Second, the business processes will be elaborated with the evaluation of the PMS. Next, the implemented indicators will be analyzed based on the PDCA cycle and the establishing criteria. Finally, the associated co-operation in the chain to achieve and assure the environmental criteria will be elaborated based on the model of Hanf and Dautzenberg [2]. After this stage it will be evaluated if sufficient inputs for Beethanol BV are gathered or that additional cases or literature have to be added. At the end of this chapter, the Beethanol chain will be described and the recommendations deducted from the first cases will be shown in section 5.4. This section wil provide an answer to the research question 6.

5.2. Case 1: Regionol

To analyse the Regionol chain, there have been several contacts with respondents in the chain. A meeting is visited where chain actors were present and an interview is conducted with the manager of Regionol (Mr. Benedikt Sprenker). Besides this interview, also Mr. Karsten Block (Landwirtschaftskammer Nordrheid-Westfalen) Mr. Joachim Schuler (Sasol), Mr. Stefan Majer (German Biomass Research Centre), Mr. Jan M. Henke (Meó Consulting Team) have co-operated to elaborate the case.

5.2.1. Chain introduction

Regionol is a project carried out by an association of nine de-central distilleries. It was started with the idea to produce ethanol for the free market, because of the high uncertainty of the continuation of the state subsidy for distilleries in the coming years by the “Branntwein Monopol”. This Monopol is managed by a federal agency in Germany and the aim is to protect numerous small and medium-size agricultural distilleries and make the economical enterprise of these possible. The Monopol takes over the raw alcohol from the distilleries and converts it to high-quality neutral alcohol and water-free alcohol and sells it to the industries for the production of food, liquor, drugs and cosmetics. In this way, the distilleries are ensured for a fair price for their products by a subsidy of the federal budget. Currently, the EU tries to minimise all the subsidies (direct payments) including the “Branntwein Monopol”. Therefore the distilleries are searching for other opportunities to sell their bio-ethanol [42].

When the first flexi-fuel market was created three years ago, the association started the Regionol project to sell regional produced bio-ethanol. The project is financed by Nordrhein-Westfalen (70%) and by the members (30%). The production started on a very small scale without a big marketing analyses and plan. In the first year, 30.000 litters were produced by one company from which 10.000 litters were sold in the first year and 20.000 in the second year. Currently only one company is producing bio-ethanol for the free

market. All the other companies are still delivering their ethanol to the Branntwein Monopol. The company is just producing the quantity which can be sold. The rest of the biomass is converted by another distillery installation and delivered to the Branttwein Monopol because it is not allowed to deliver ethanol to the Monopol when it is also selling on the free market. From the distillery, the bio-ethanol is transported to Sasol which blends the ethanol with fossil fuel. At this stage, also the quality assurances are made and then the E85 ethanol is transported to several filling stations which sell the fuel to the consumers [42].

5.2.2. Vision

The main vision of Regionol is to produce bio fuel in the region where it is also consumed together with obtaining a very good GHG reduction compared with the fossil fuel situation. Due to the fact that the production is regionally, the chain is also able to realise short transport distances to the filling stations. Besides the main vision, the project also wants to realise a closed mineral circle, which ensures a more environmental friendly product [42].

5.2.3. Chain structure

In this section, the chain structure of Regionol will be elaborated. The chain actors will be described and it is shown which processes they perform. In addition, the transactions between the actors will be noted.

Because the main target of Regionol is to produce regional bio-ethanol with a closed CO_2 and mineral cycle, a model (Figure 12) is developed as a basis for the communication towards the customers and other stakeholders [43].

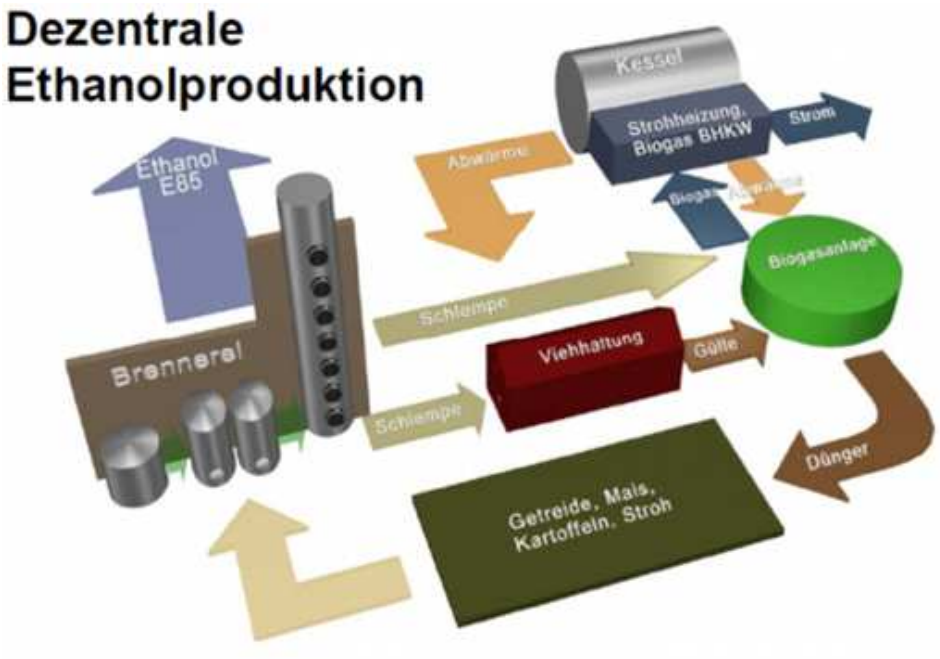

Figure 12: Regionol model [43]

According to the model, weed, triticale, maize and stroh are used as input for the distillery and the outputs of the distillery are ethanol and stillage which are used for the livestock and biogas installation. This Biogas installation is producing biogas for a CHP (Combined Heat and Power) installation which delivers heat and power for other production processes. The other output of the Biogas installation is used as a fertiliser for the biomass production [43]. With this model of regional production a closed cycle is shown and a CO_2 reduction of 76% can be obtained [42]. This simple model is used as a possibility to show which results can be obtained but in real life adjustments can be made to the model [42, 43].

Biomass producers

In the model it is shown that the input of the distillery are different biomass crops like corn and wheat. In the actual situation the inputs of the distillery can differ because it is a multi-feed installation. Currently, sugar residues from the food industry are used as input for the fermentation process because this is the cheapest possibility at the moment [42]. When the biomass crops are used, the consecutive processes are cultivation, harvest, cleaning, milling, hydrolysis, fermentation and distillation [44]. In the model it is also shown that the output of the distillery is E85 ethanol (a blend with 85% bio-ethanol and 15% fossil ethanol). In the actual situation, the distillery can only produce 86% bio-ethanol and then the fuel is transported to the company Sasol where it is de-hydrated to 96% and blended with fossil ethanol. When using the sugar residues, the CO_2-emission results are even better because the residues don't have to be included in the GHG emission calculations according to the RED. For the input of the biogas installation, the residues of the distillery, maize stillage and co-fermenter (residuals from the food production like fatty acids and glycerine) are used. When co-fermenter is used, the distillery does not obtain the NAWARO bonus (a subsidy when only maize and weed from own production are used for biogas installation) but this is compensated by the low cost of the product. In the model, it is also shown that the biogas installation is heated by using a straw burning installation to ensure a close cycle but at the current distillery, this technique is not present. Between the distillery and Sasol, formal contracts and agreements by word are made about the price, quality and transport. In the first year, these were monthly contracts but currently they have half-year contracts. In the contracts it is arranged that Sasol is responsible for the transport of the bio ethanol from the distillery to the factory of Sasol [42].

Sasol

At Sasol, the wet bio-ethanol of the distillery is de-hydrated with an Azeotropic distillation by an entrainer system using cyclohaxane and subsequent it is blended with fossil fuel [45]. At this stage, also the quality assurances are made. According to the model, this process is also carried out by the distillery to show a closed system, but currently the distillery does not obtain the technique to de-hydrate the ethanol until 96%. In this way it will also be easier to arrange the quality assurance and arrange the distribution to the filling station when more distilleries will join. For the distribution of the E85 to the filling stations, Sasol is responsible for the transportation which they arrange with own vehicles [42, 45].

Filling stations

At the filling stations which are in the region of Nordrhein Westfalen, the E85 of Regionol is delivered and stored in specific tanks for E85. Here the E85 gets distributed through a specific E85 fuel pomp.

Between Sasol and the filling stations no contracts are made because the filling stations want to be free and not want to be attached to certain contracts [42].

5.2.4. Performance measurement

In figure 13, the processes of the current situation are visualised for each actor and next, for each process, the characteristics like the in- and outputs, associated environmental criteria, indicator, targets, control and communication are shown in table 1. In this section it will also be concluded that no extensive chain-wide PMS is implemented and it is also not expected that this will occur in the future. Therefore, it will be difficult to recommend certain EPIs from this case analysis to Beethanol BV. However, Regionol expects to satisfy the criteria by obtaining a sustainability certificate in the future. So during the interviews special attention is given towards this development process because this could provide relevant practices to recommend to Beethanol BV. Therefore, before elaborating the current PMS of Regionol , the development process towards certification will be described below.

Development process

While the vision of Regionol is to produce regional bio-ethanol with a very high GHG emission savings and a close mineral cycle, they can currently not make any hard claims towards the other enironmental aspects of the NTA-8080 criteria. At this moment, there is no chain wide quality system available and also no sustainable certification is obtained. Due to the close co-operation and mutual trust between the chain partners, Regionol expects that the minimum environmental requirements of the NTA-8080 and compliance to all relevant legislation are met. However, no information is exchanged about these aspects. The reason why this is not organised yet is because customers are not yet interested in the environmental properties of the ethanol. Also the government is not yet insisting to organise a sustainable production chain. But this is expected to change when the RED get implemented in the German policy (2010). Therefore Regionol is searching to implement a certification system. This system ha to be accepted by the market players and to cover the german sustainability criteria. Other benefits for Regionol to implement a system are: futher improve sustainable production, better transparancy and co-operation in the chain, market expansion, risk reduction, and obtaining higher prices. The ISCC system of Meo Consulting (Attachment 5) is a possible system to obtain a sustainability certificate Regionol also focus to this system. However, this system is not finalized yet and it is currently tested in several pilot projects. It is expected that the system will get accredited begin 2010, and than it is possible to certify each company world wide according the ISCC standard. This system concerns a Meta-Standard which is expected to accept other systems like the BSI, RSB, NTA-8080 but still an additional audit will be needed. On top of the basic ISCC certification, Regionol wants to implement an additional certification to garuantee the special aspects (GHG reduction and close mineral cycle). With these certification, Regionol aims to increase their market share by convincing stakeholders that their ethanol is the best option. But at this moment there are unsufficient financial resources to organise the certification of the whole chain and the associated information exchange. Therefore Regionol is also searching for extra partners to increase the project and make the certification possible. But the uncertaincy of the Monopol and the high dependency on fossil fuel prices increases the risk of the partners creates uncertaincy towards the future.

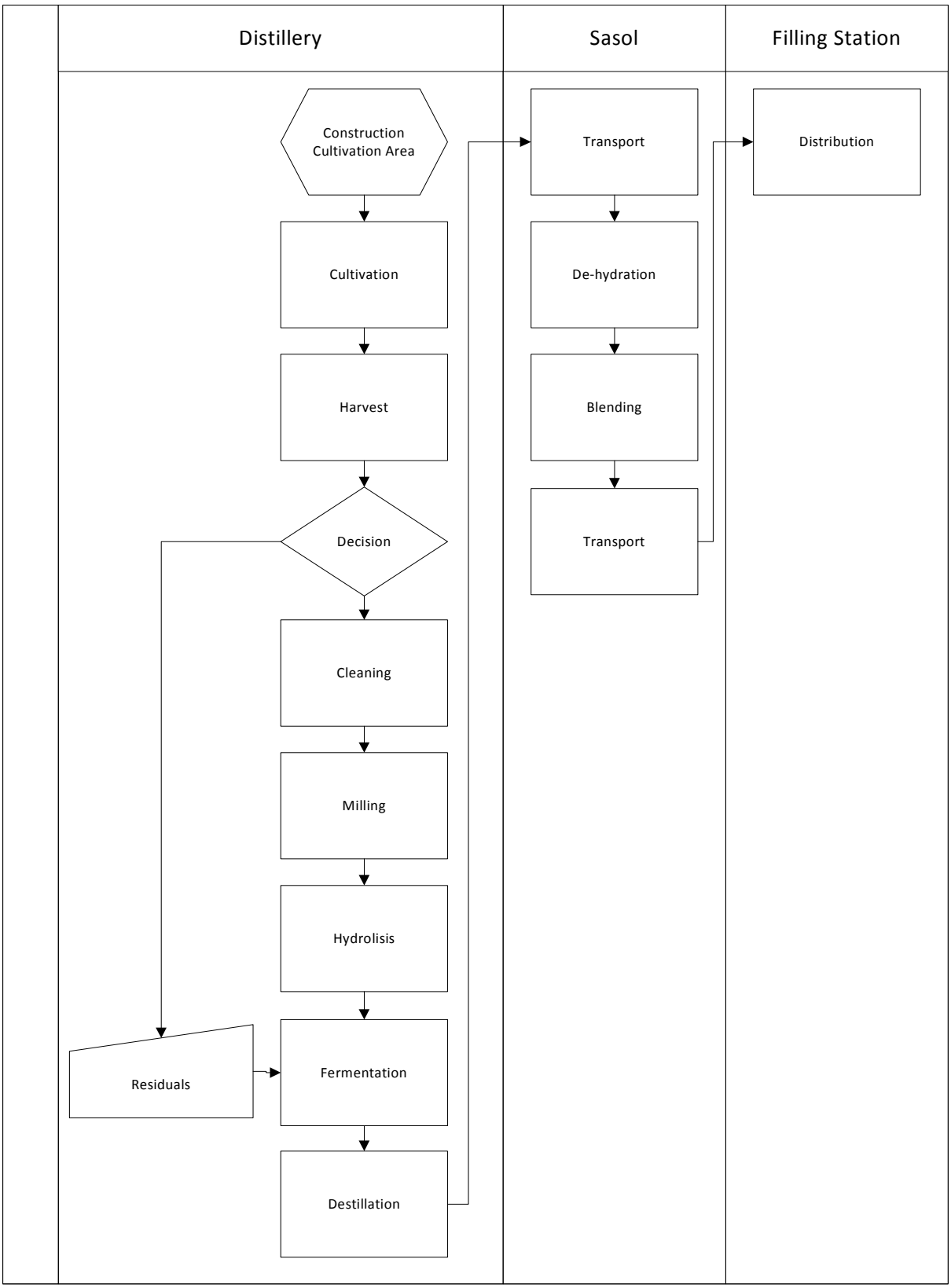

Figure 13: Regionol chain processes [42-44]

Process	Input	Output	Associated NTA-8080 Criteria	Indicator	Target	Control/frequency	Cover criteria	Communication Results
Construction cultivation area	-	-	GHG	GHG model	*	Extern/single	+	General model
			Carbon stocks	-	-	-	-	-
			Bio diversity	Cross compliance	Compliance	Distillery/?	+-	Not communicated
			Air	Cross compliance	Compliance	Distillery/?	+-	Not communicated
Cultivation	Seeds, fertilisers, water, pesticides, energy	Biomass crops, by-products (eg. Straw)	GHG	GHG model	*	Extern/single	+	General model
			Carbon stocks	-	-	-	-	-
			Bio diversity	Cross compliance	Compliance	Distillery/?	+-	Not communicated
			Soil	Cross compliance	Compliance	Distillery/?	+-	Not communicated
			Water	Cross compliance	Compliance	Distillery/?	+-	Not communicated
			Air	Cross compliance	Compliance	Distillery/?	+-	Not communicated
Harvest	Energy	Biomass crops	GHG	GHG model	*	Extern/single	+	General model
			Bio diversity	Cross compliance	Compliance	Distillery/?	+-	Not communicated
			Soil	Cross compliance	Compliance	Distillery/?	+-	Not communicated
			Air	Cross compliance	Compliance	Distillery/?	+-	Not communicated
Cleaning	Biomass crops, water, energy	Clean biomass crops, waste water	GHG	GHG model	*	Extern/single	+	General model
			Soil	-	-	-	-	-
			Water	-	-	-	-	-
			Air	-	-	-	-	-
Milling	Clean biomass crops, energy	Starch material	GHG	GHG model	*	Extern/single	+	General model
			Soil	-	-	-	-	-
			Water	-	-	-	-	-
			Air	-	-	-	-	-
Hydrolysis	Starch material , heat, energy, enzyme	Glucose	GHG	GHG model	*	Extern/single	+	General model
			Soil	-	-	-	-	-
			Water	-	-	-	-	-
			Air	-	-	-	-	-
Fermentation	Glucose (or sugar residuals), yeast	Low % ethanol	GHG	GHG model	*	Extern/single	+	General model
			Soil	-	-	-	-	-
			Water	-	-	-	-	-
			Air	-	-	-	-	-

Distillation	Low % ethanol, heat	86% ethanol, stillage, waste water	GHG Soil Water Air	GHG model - - -	* - - -	Extern/single - - -	+ - - -	General model - - -
Transport	86% ethanol, energy	86% ethanol	GHG	GHG model EMAS	*	Extern/single Extern	+	General model
De-hydration	86% ethanol	EN 15376 ethanol, waste water	GHG Soil Water Air	GHG model EMAS EMAS EMAS	* Compliance Compliance Compliance	Extern/single Extern/annually Extern/annually Extern/annually	+ +- +- +-	General model - - -
Blending	85% EN 15376 ethanol, 15% fossil fuel	E85	-	-	-	-	-	-
Transport	E85, Energy	E85	GHG	GHG model EMAS	* Compliance	Extern/single Extern	+	General model
Distribution	E85, Energy	E85	GHG	GHG model	*	Extern/single	+	General model

Table1: Regionol process characteristics [42, 45]

Performance pyramid

The vision of Regionol is to produce sustainable regional bio-ethanol with a very good GHG emission reduction and therefore it is focussed on the market side of the pyramid. The vision covers both the Quality aspects (GHG emission, closed mineral cycle etc) and the flexibility aspects (quick delivery due to regional location). In the last years the project has invested in these aspects and currently the results of these topics are very good compared to other bio ethanol chains but they do not make profit. Therefore, Regionol currently tries to focus on the financial side of the pyramid by increasing their productivity, market-size and start making profit. Concerning the derivation of the corporate chain vision in indicators over the whole chain, only the GHG emission indicator has an impact on all the chain actors. The other indicators (Cross compliance and EMAS) are not directly derived from the corporate chain vision and are established by the specific actors themselves.

PDCA cycle

Plan

The three implemented indicators which are applied in the chain (table 1) are the GHG emission, Cross compliance and EMAS. Each indicator will get elaborated below:

GHG: In co-operation with the University of Hohenheim (Priv. Doz. Dr. Thomas Senn) a model is created where about 100 different processes within the whole chain are identified and the emission can be calculated for the specific situation (inputs/processes/distances/techniques etc.) with the associated values. Because the GHG reduction is not calculated with the default values of the RED but with own values, precise calculations can be created which assures better results than the default values. In the model it is proven that each possible combination of Regionol achieves a minimum result of 76% GHG reduction. This is a save baseline value of the indicator which does not contain a additional target value because the baseline is already the best practice in the market and there is currently no advantage for Regionol to increase this value. The result of 76% satisfies to the current minimum of the RED (35%) and will also satisfy to the requirement of 50% in 2017 [42].

Cross compliance: This indicator is a regulation from the EU to support the Single Payment Scheme (See attachment 3). It states that farmers who achieve payments have to cope with the national law and states that several other requirements concerning environmental agricultural management[46]. The RED states that when farmers comply with the requirements of the Cross compliance, they automatically comply with all the environmental aspects of the RED[47]. Therefore the distilleries of Regionol have to comply with the Cross compliance regulation. This indicator is a MPI and the target is compliance. When the distilleries do not obtain this target, they also risk missing the subsidy. The indicator is related only on the production, maintenance and harvest of the biomass and not to the other processes which are carried out by the distilleries.

EMAS: This indicator (see attachment 4) is related to all the processes of Sasol and also established by this company. The indicator is a MPI and the target is compliance which means the certification to the requirements of EMAS have to be obtained. With the compliance, Sasol automatically comply to all

relevant environmental laws and legislation and they also have to set own additional targets with associated plans to achieve these targets which stimulates the continuous improvement [48].

Do

For each established indicator, the collection and conversion of the data differs. Concerning the GHG indicator, the indicator is not controlled frequently because it is proven that each possible combination achieves results above the baseline value. The indicator satisfies the RED and NTA-8080 requirements and does not need to be checked periodically. Still when considerable improvements or techniques are implemented the model is adapted also. The results of this model are presented at quarterly meetings to all chain actors and is also reported and communicated to all associated stakeholders. The Cross compliance indicator is controlled externally by a control agency of the government. The disadvantage is that the control of this regulation, only consist of a random control of 1% of the participants per year. This causes that no guarantees towards the chain actors can be given for the results and the indicators. The results of the indicator are also not communicated periodically because it is just expected in the chain that the distilleries comply with the regulation. Also concerning the EMAS indicator, the results are not communicated frequently. But, the result of the indicator is guaranteed by the annual control of an accredited external party which is sufficient to guarantee the results. But this indicator does not cover all the NTA-8080 criteria and therefore it is not sufficient for the sustainability certification but it will have a positive value for this process.

Check and Act

Currently, all the efforts concerning the reviewing and improvements of the indicators are focussed on the certification system. The GHG model is expected to be implemented in this system but it is not known if the Cross-compliance and EMAS will remain when the chain gets certified due to the Meta-Standard. When the certification is arranged, more indicators will get implemented. This does not mean that the information exchange concerning environmental improvement in the chain will increase, because this is not obliged for the certification. At that stage, the actors only will have to prove that they comply with the certification to guarantee the chain actors that all the sustainability criteria are obtained.

Establishing criteria

Because only a few environmental criteria are established in the chain and only one is directly derived from the corporate chain vision it is hard to analyse if these criteria satisfy the establishing criteria mentioned in section 2.2.1. It can be concluded that the EPIs are limited in number but not sufficient to comply with the NTA-8080 criteria. Nevertheless, they are clear of design, contain realistic collection and development cost, are reliable and validated (except Cross compliance), transferable, contain a spatial and temporal scale, and have clear targets and baselines. Only the direct relevance to the project objectives is insufficient with cross compliance and EMAS because they do not cover all aspects and are not integrated in the whole chain. When implementing the certification system this should be an important topic to improve.

5.2.5. Co-operation and co-ordination

To achieve the environmental performances and manage the current indicators and the development process towards the certification, several chain actors are co-operating. By using the model of Hanf and Dautzenberg [2], the co-operation and co-ordination in the chain will be analyzed and the intensity of the corporation will be evaluated. The distinction between chain, dyadic and company level will be made and for each level the different aspects will be described below.

Chain level

Transparency: During the Regionol project the relationship between the distillery and Sasol is getting more transparent. Each member sees each other performances by communicating the results of the model in meetings and visiting the factories where the environmental improvements are shown (distillery and Sasol). The relationship with the filling stations is only a formal relationship, and these actors are not real active yet in the co-operation in the chain regarding the environmental improvements [42].

Free riding: While the distilleries and Sasol are co-operating to obtain good environmental performances, the distributors currently only take the price in account. They want to sell good quality products but don't ask about the environmental performances environmental performances [42].

Rivalries/coalitions: There is no competition in the co-operation between the distillery and Sasol, but the relationship with the filling stations is only based on the price level [42].

Interdependency: The distilleries are currently highly dependent on Sasol because they don't have the right techniques for the de-hydration themselves. In whole Germany, Sasol is also the only company who works with this technique. Besides this, the facility of Sasol is located close to the distilleries (within 80 km) which is important for the co-operation and also for the transport reduction (GHG emission improvements). Unlike the distilleries, Sasol is not very dependent on the distilleries. They have some technical equipment which was not used frequently earlier and with the co-operation they can earn some money with it. Still they have a good relationship based on mutual trust. Concerning the filling stations, the distillery and Sasol are not dependent and vice versa. The filling station only has to make some adjustments to sell bio-ethanol but it can easily get the fuel from Nedalco or Brazil as well. Also the RED does not cover the filling stations except the CO_2-emissions which are almost similar for all the filling stations in the area [42].

Heterogeneity: Within the chain, each actor has different interest. The most important interest of the distilleries is the market entrance. Other interest are risk reduction (less dependent on EU subsidies), higher prices and the generation of new products. For Sasol the main interest is that they can use the technical equipment, which was not used before that much. Another interest is the adaptation of very ecological products to their other products. At last, the co-operation with the distilleries provides an opportunity to work with partners inside the region. The interest of the filling stations mainly consists of the price advantages and delivery assurance (quick delivery/close distance). At last, some filling stations also want to adapt ecological and regional products to their assortment but this is certainly not the most important

aspect. Therefore, it can be concluded that the interests of co-operation between the distillery and Sasol is heterogeneous, but the co-operation with the filling stations contains large differences [42].

Dyadic Level

Specific investments: The distilleries are have their own techniques which are not depending on specific wishes of Sasol. But during the project, the co-ordination between the distilleries and Sasol is increased and when currently a distillery wants to change its processes it will co-ordinate with Sasol if the output is changed also. Also for Sasol and the filling stations, the investments are not specifically co-ordinated because of the chain co-operation. Sasol only had to make small technical adjustments to their equipment but no real investments and the filling stations only had to change their equipment to sell E85 in general [42].

Fit or stretch of core capabilities: Because of the platform formed by Regionol, the knowledge is also applicable outside the chain. But currently there are no financial resources to extend the Regionol project with more chain actors and a broader area. If individual chain actors (distilleries or Sasol) want to quit the co-operation it will be very difficult to apply the knowledge and skills outside the chain because the regional aspect of the co-operation [42].

Allocation of profits and power: The agreements about the distribution between the distillery and Sasol are currently arranged in the contract which delivers no problems. Concerning the distribution of the profits, with the filling stations no real agreements are made because their relationship is based on a free market where price is the most important topic [42].

Information asymmetries: Only at quarterly meetings, results about the environmental performance are exchanged between the distilleries and Sasol. With each load no environmental information is exchanged. Only quality properties are exchanged more frequently, for example when the fuel contains too many acids [42].

Decisions: At this moment, strategic decisions are not made in co-ordination with other chain actors. But in the future Sasol wants to bring more knowledge in the distilleries. Especially when the project is extended with more distilleries, also more strategic decisions will have to be made in co-ordination with each other [42].

Behaviour: Currently each actor is responsible for its own results and there is mutual trust that each actor ensures its own results but there is no co-ordinated control on these aspects [42].

Company level

Limited resources: Because the platform of Regionol, each actor obtains sufficient knowledge about the processes and environmental aspects but currently the whole chain needs more information about the certification and future possibilities like ligno cellulosic. But the main resource which is not present sufficient is the finance to arrange this extra knowledge [42].

External pressure of environment: The distilleries are increasingly insisted by the legislation to increase the sustainability of their products. Currently the customers are not too much aware of the environmental performances and they are only interested in the price. But this is expected to change in the following years. The NGOs are, according to Regionol, focussing on the wrong areas. The NGOs just mention that the bio-fuels are destroying everything but they don't show good alternatives for the chain actors for a fair price. The NGOs only fight for extreme environmental results but in that way is not possible to develop a profitable organisation and with this strategy the market will not be able to develop [42].

Managerial skills: Currently all the targets are being met by the management of the individual actors according Regionol but there is no control system to ensure these results [42].

Infrastructure: Within the chain, each actor has a different infrastructure and systems. The distilleries currently only conform to the cross compliance regulation. The ISCC project of Meo Consulting is currently developing a control system for bio ethanol chains where all the targets can be guaranteed and Regionol expects to implement this system in the future. It will depend on the financial resources how quick the system can be implemented and how fast the EU regulation will be applied [42].

Resources (Labour, capital, time, etc.): More money and more people with the right idealism are needed to increase the environmental performances and to increase the Regionol project [42].

5.3. Case 2: Van der Sluijs Groep

To analyse the Van der Sluijs Groep chain, there have been several contacts with respondents in the chain. An interview is conducted with the bio-fuel manager of Van der Sluijs Groep (Mr. Bart-Willem ten Cate) and with Mr. Sven Sielhorst (Solidaridad) to elaborate the case.

5.3.1. Chain introduction

The Van der Sluijs Groep (VSG) is founded in 1918 as a family company. The first activities consisted of dealing bicycles and selling petroleum. Over the next few decades, storage and shipping activities were introduced. Currently, the VSG combines all the activities involved in selling, storing and transporting (over land and water) mineral oils. It has become the largest independent player in the Netherlands and Belgium offering a range of high-quality logistics services in combination with its own commercial activities [49]. One part of the flow of products within the chain is executed for their own account while the other part is offered as a service to oil companies and traders. Combined, 30% of all the transport fuels is distributed by the network of VSG [50]. The company consists of more than 300 employees and realises an annual turnover of more than 4 billion [49]. It has a well covering network of terminal and storage depots in the Benelux. From the ARA area (Antwerp-Rotterdam-Amsterdam), fuels are transported with own ships to the depots. And from these depots, the fuel is distributed with own trucks to filling stations/wholesalers and retail stations [50].

In 2005, the VSG noticed that the bio-fuels would entry the market. The Dutch government made ethanol-blending mandatory and also VSG has their own obligation for bio components. The fact that VSG is active in the end of the chain, creates an advantage, because bio-fuels are organic material and it is better to blend this with fossil fuels as late as possible. Therefore, they made investments in appropriate blending techniques which they use for themselves and for their customers. The purchased bio diesel is produced from residuals and the bio ethanol is produced from Brazilian sugar cane. Because VSG has no experience with sustainable production they created a co-operation with Solidaridad in the beginning of 2008 to build up a sustainable ethanol chain [50]. Together with Solidaridad they check how the criteria of the RED and RTFO can be treated. At the end they want to certify the chain possibly with a Good Insight label. In this co-operation, Solidaridad will be responsible for the organisation and the guarantee of the environmental aspects while VSG will organise the commercial aspects [50].

<u>Solidaridad</u>

Solidaridad is established in 1976 as a foundation and has its main office in Utrecht. Solidaridad explores new methods to make the global economy healthier and more sustainable. They aim to establish sustainable production chains from producer to consumer in such a way that farmers in several developing countries get a fair price for their products and have access to the global market [51]. The aim of the foundation is:
"Strengthening producer and civil organisations in developing countries that work to make their economy sustainable using the principles of Fair Trade and Corporate Social Responsibility to engage companies, banks and investors in developing trade chains with added value for producers" [51].

The foundation trains farmers in new farming techniques, helps to set up co-operations, and supports production that meets the social and environmental criteria of certification programmes (such as UTZ CERTIFIED, Max Havelaar and SA 8000). By meeting social and environmental criteria, producers qualify for certification and can then sell their products at a higher price. This leads to improved incomes and secure livelihoods. Solidaridad works with producers, companies and civil society organisations to organise the production, export, import, processing and sale of certified sustainable produced products. These products reach the market either as end products (such as Oké bananas) or as ingredients for companies to process into end products (such as coffee, soy, cotton, tea, gold, cocoa and biomass) [51].

Sustainable ethanol chain

Currently, VSG purchases Brazilian ethanol from Rotterdam where minimal sustainability requirements are arranged in the contract like compliance with national laws and legislation which forms a license to operate. While several customers from VSG are requiring more sustainable products and there is a joint storage for all these customers, the highest sustainable requirements have to be obtained [50]. To reach these requirements, the criteria of NTA-8080, RTFO, SEKAB are considered and 350 sugar cane mills in Brazil are ranked on their sustainability performances [52]. Because these requirements and the high European quality specifications for dry ethanol, 50 mills are selected and visited by Solidaridad. Currently there is a list of ten to fifteen potential suppliers which are pioneers in the sector when it comes to the environment, human rights and product quality [50]. At the moment, agreements are being made with these suppliers concerning supply contracts. From the mills, the ethanol will be transported to the large harbours and hereafter shipped toward the ARA area. From here, VSG will ship the product to the inland and organise the blending and distribution. Eventually they want to market a premium product which can be labelled like E85 and E10 and which is differs from the normal fuels that are difficult to label due to the commodity market [50, 52].

Finally, all the experiences which are gained in the chain will be shared with the whole bio-fuels sector. Because of the massive volumes concerned in the sector and because the extra costs cannot be charged to the consumer, the strategy is to involve a big proportion of the sector by making it sustainable. To realise this strategy, Solidaridad is also co-operating with the Better Sugarcane Initiative (BSI) (attachment 6)[52]. This initiative is a co-operation of many companies like Shell, BP, Coca-Cola, NGOs etc. which are establishing sustainable criteria. The aim of the initiative is to establish a worldwide standard for sustainable ethanol [50, 52].

5.3.2. Vision

The vision of VSG is to produce bio ethanol as sustainable as possible with the highest possible GHG emission reduction. With this vision, VSG want to be the first company in the Netherlands that introduces guaranteed sustainable sugar cane ethanol onto the Dutch market. Besides this, it also wants to create a standard for whole the sector [50].

5.3.3. Chain structure

The structure of the current ethanol chain contains many actors. Firstly, there are many sugarcane producers in Brazil and between these producers and the VSG there are a lot of companies involved in the transportation and transhipment of the ethanol.

Biomass producers

The Brazilian biomass producers are mainly located in Sao Paulo State. These producers are mostly active within a co-operation of several other producers. In general, the producers are having a factory (mill) with an area of sugarcane around it. This sugarcane is harvested and hereafter it is processed to bio ethanol and sugar within the mill [50]. The successive processes for the bio ethanol are: cultivation, harvesting, cleaning, milling, evaporation, centrifugation, fermentation, distillation and dehydration [52]. Dependent on the sugar prices on the market, the producers decide if they produce more sugar or more bio ethanol. The final product of the mills is dehydrated ethanol according the EN15376 specification [52].

Transhipments organisations

From the mill, the ethanol is transported to the harbour (mostly organised by the co-operation). This transport mainly takes place by means of small trucks on the road, but the railroad, pipelines and transport over water are also used. At the harbour, the ethanol is stored by several companies (e.g. Vopac, Otfuel etc.). From here, the ethanol is transported by several companies over the sea to the ARA area. This transport concerns a commodity market where arrangements are made according to worldwide freight rates, and long-term co-operations are not common. When the ethanol arrives in the ARA area, it is stored at several depots [50].

VSG

From the depots in the ARA area, VSG buys the ethanol (Free on Board). Hereafter, the ethanol is shipped by VSG to its own distribution depots where the ethanol is mixed with fossil fuel at the last moment in the chain when E85 is ordered. From here, the fuel is distributed by VSG to the consumers [50].

Distributors

The last stage in the chain is the link between the filling stations and the consumers. At these stations, the E85 of VSG is stored and sold to the final consumer [50].

5.3.4. Performance measurement

In figure 14, the processes are visualised for each actor and next, for each process. The characteristics like the in- and outputs, associated environmental criteria, indicators, targets, control and communication are shown in table 2. In this section it will also be concluded that currently also no extensive chain-wide PMS is implemented in this chain. Therefore, it will be difficult to recommend certain EPIs from this case analysis to Beethanol BV. However, in section 5.3.1. it is already stated that VSG is also organising a sustainability certification for the chain. So during the interviews special attention is given towards this

development process because this could provide relevant practices to recommend to Beethanol BV. Therefore, before elaborating the current PMS of VSG, the development process towards certification will be described below.

Development process

Despite that VSG has the objective to obtain the first certified bio ethanol in the Netherlands they are not sure it they will set up a label for this. The main reason for the sustainability development is that they want to avoid problems by doing proper business and comply to all relevant legislation. The strategy of VSG is to use the BSI as a basis for this development [50]. The main reason to choose BSI is because this standard has large expectations for expansion in the world wide sugar market. It does not only focus on the ethanol market but also on the food sectors which has a larger market share of sugarcane than the ethanol market and in this market no sustainable legislation occurs which offers a good opportunity for sustainable improvements. Moreover, the BSI is set up by several stakeholders such as producers, banks, NGOs and users which results in better reputation and assures that it is broadly accepted. However, the BSI is currently still in development [53]. According to the expectations, the first official certification is possible in 2011 [52]. To show and guarantee that the ethanol of VSG is already obtaining the sustainability standards, VSG is working on several pilot projects. By means of contracts with mills and the organisation of audits, which examine the compliance to the standards and setting up a committee which checks the audit results they already want to guarantee the sustainability [52].

Besides the BSI criteria, VSG and Solidaridad want to extend several social aspects. Solidaridad obtains own support programmes for farmers in Brazil and in co-operation with VSG they want to retrain sugarcane harvesters to assure that these labours do not end up on the streets by the mechanisation of the harvest. It is currently only not sure of VSG want to carry a label for these extra efforts but they surely will communicate these results towards their customers [52].

The steps which VSG currently still must make, are the arrangement of contracts and corporations with the mills and the audits of them, and anticipating on the developments of the BSI standard. The BSI criteria only concerns product requirement for production. They certify the whole chain, a supply chain certification is also necessary to organise the traceability. Therefore, also with transport companies, agreements must be made because they must also make administrative and logistical applications [52].

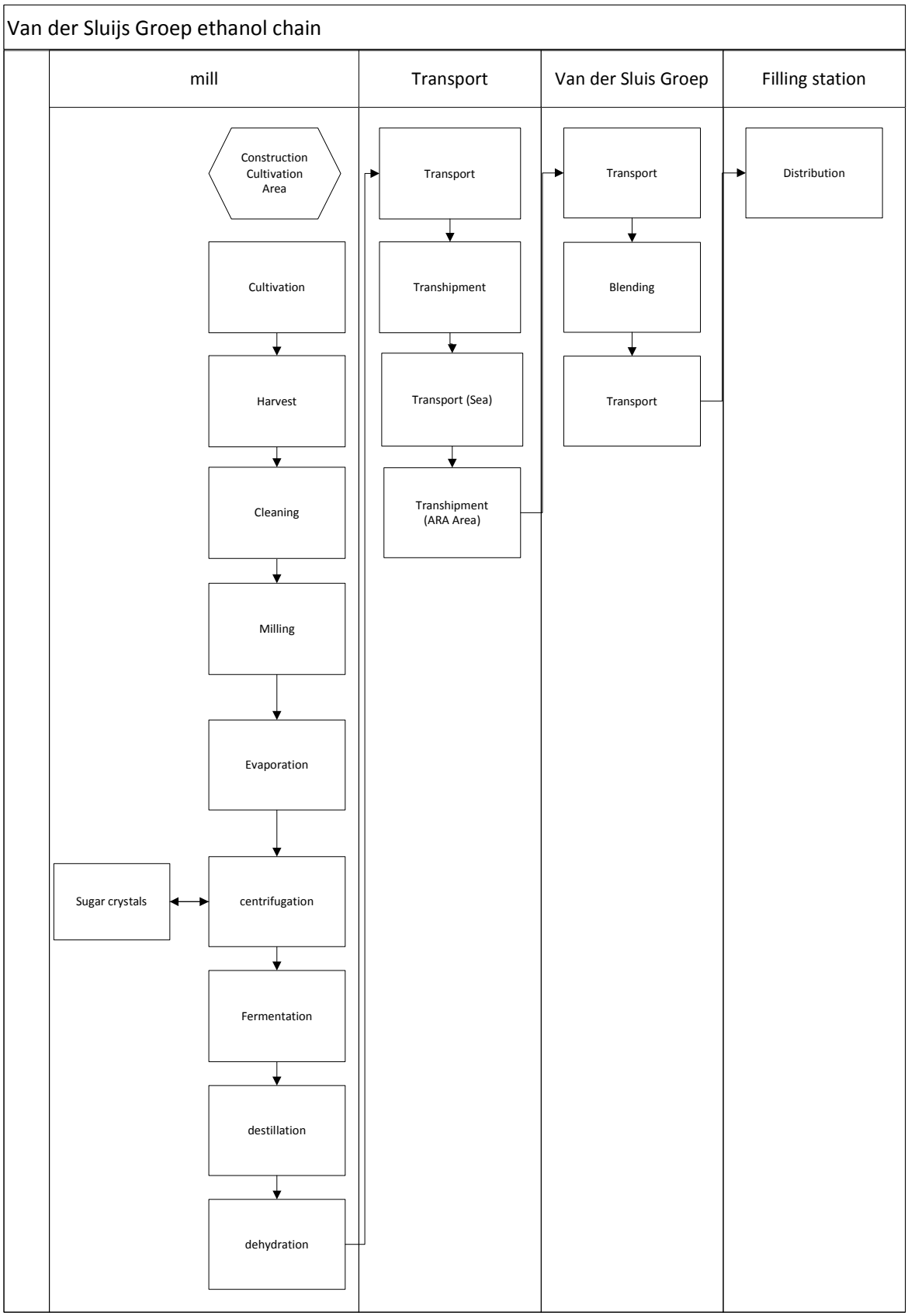

Figure 14: VSG chain processes [50, 52]

Process	Input	Output	Associated NTA-8080 Criteria	Indicator	Target	Control/frequency	Cover criteria	Communication Results
Construction cultivation area	-	-	GHG	-	-	-	-	-
			Carbon stocks	-	-	-	-	-
			Bio diversity	-	-	-	-	-
			Air	-	-	-	-	-
Cultivation	Seeds, fertilisers, water, pesticides, energy	Sugar cane	GHG	-	-	-	-	-
			Carbon stocks	-	-	-	-	-
			Bio diversity	-	-	-	-	-
			Soil	-	-	-	-	-
			Water	-	-	-	-	-
			Air	-	-	-	-	-
Harvest	Energy	Sugar cane	GHG	-	-	-	-	-
			Bio diversity	-	-	-	-	-
			Soil	-	-	-	-	-
			Air	-	-	-	-	-
Cleaning	Sugarcane, water, energy	Sugar cane, waste water	GHG	-	-	-	-	-
			Soil	-	-	-	-	-
			Water	-	-	-	-	-
			Air	-	-	-	-	-
Milling	Sugar cane, energy	Biogases, Cane juice	GHG	-	-	-	-	-
			Soil	-	-	-	-	-
			Water	-	-	-	-	-
			Air	-	-	-	-	-
Filtering	Cane juice, energy	Finesse	GHG	-	-	-	-	-
Evaporation	Finesse, energy	Syrup	GHG	-	-	-	-	-
Centrifugation	Syrup, energy	Sugar crystals, Molasses	GHG	-	-	-	-	-
			Water	-	-	-	-	-
			Air	-	-	-	-	-

Fermentation	Molasses, Yeast	Low % ethanol,	GHG	-	-	-	-	-
			Soil	-	-	-	-	-
			Water	-	-	-	-	-
			Air	-	-	-	-	-
Distillation	Low % ethanol, energy	96% ethanol	GHG	-	-	-	-	-
			Soil	-	-	-	-	-
			Water	-	-	-	-	-
			Air	-	-	-	-	-
De-hydration	Energy	EN-15376 ethanol,	GHG	-	-	-	-	-
			Soil	-	-	-	-	-
			Water	-	-	-	-	-
			Air	-	-	-	-	-
Transport	EN-15376 ethanol, energy	EN-15376 ethanol	GHG	-	-	-	-	-
Transhipment	EN-15376 ethanol	EN-15376 ethanol	-	-	-	-	-	-
Transport	EN-15376 ethanol, energy	EN-15376 ethanol	GHG	-	-	-	-	-
Transhipment	EN-15376 ethanol	EN-15376 ethanol	-	-	-	-	-	-
Transport	EN-15376 ethanol, energy	EN-15376 ethanol	GHG	-	-	-	-	-
Blending	EN-15376 ethanol, fossil fuel	E85	-	-	-	-	-	-
Transport	E85, Energy	E85	GHG	-	-	-	-	-

Table 2: VSG chain processes [50, 52]

Performance pyramid

While the vision of VSG is to purchase the most sustainable bio ethanol, they currently have no environmental indicators in the chain. When analysing the chain according the performance pyramid it can be concluded that currently the only implemented indicator in the chain is that the ethanol is from Brazilian sugarcane. Therefore, no guarantees can be made about environmental results because there is no control. At this moment, VSG is arranging the sustainability certification based on the BSI standard to increase the consumer satisfaction. This certification will imply that several indicators will have to be established on the quality level to guarantee the sustainability. And by being the first mover in the market when obtaining a certificate, a strong position will be created which should result in a better market share and increased profits on the right side of the pyramid. But, these indicators are not implemented yet and because the BSI standard is not finished at this moment, it is not known which indicators will be chosen and implemented.

PDCA

It is hard to analyse the PDCA cycle in the chain with no environmental indicators and the measuring of continuous improvement is hardly possible. Therefore, in this section also the developments of the BSI and the future certification are analysed.

Plan

Besides the CO2 reduction, due to the purchase of sugarcane ethanol, still no environmental claims can be made. Although many mills have an ISO certificate or an own environmental improvement policy, this is not required and controlled at the end of the chain and therefore these are no official indicators. In the future, the indicators provided by the BSI system are expected to be implemented which makes it possible to guarantee environmental claims at the end of the chain.

Do

Because no measures are taken, no results are reported and communicated within the chain. When the BSI is implemented and the chain is transparent by an increased co-operation of chain actors, the communication of the results are expected to increase. In this case it will be communicated that the bio-ethanol satisfies the BSI standard.

Check and Act

When the BSI is implemented, the claims can be made and the satisfaction to BSI can be communicated. Due to the continues improvements aspect of the BSI (see attachment 6) the minimum criteria of the system can be adapted periodically when desired.

Establishing Criteria

Due to the absent indicators in the chain, it is not possible to analyse these indicators with the establishing criteria mentioned in section 2.2.1. Nevertheless, when the BSI label is implemented, all these criteria will be satisfied. Even criteria of the direct relevance to the chain vision will be satisfied because the transparent chain can implement extra indicators and targets besides the BSI standard.

5.3.5. Co-operation and co-ordination

The co-operation and co-ordination in the chain will be elaborated according the model of Hanf and Dautzenberg [2]. The distinction between chain, dyadic and company level will be made and for each level. The different aspects will be described.

Chain level

Transparency: Currently, the only agreement which is made is between VSG and the suppliers in the ARA area is that the ethanol comes from sugarcane from Brazil. It is not known from which mills the ethanol is coming [50]. When the chain is certified the transparency of the chain will be improved [52]. VSG is at the moment visiting mills to achieve contractual supply agreements to guarantee the sustainable requirements (including environmental aspects) and to establish a traceability system to guarantee the product specifications. This is also a requirement of Solidaridad if they attach there name and image to the chain [52].

Free riding: Within the chain, nearly all the environmental aspects concern for the mills in Brazil. Therefore they have to make the biggest efforts for the improvements, but VSG and Solidaridad are willing to facilitate these companies with specific knowledge. The other parties in the chain between the mills and VSG only have administrational criteria when the chain will get certified [52].

Rivalries/coalitions: Inside the chain, the main competition is between the consumers of the sugarcane products since the mills can sell their product on several markets. There is also competition between the transporting companies. This counts for the transport of the mill towards the harbour and the transport over the sea where a lot of companies are active. The involved parties are currently only selected on price basis [50].

Interdependency: The actors in the chain are very dependent on each other. Only the mills from Brazil are less dependent because of the strong Brazilian ethanol market and sugar market. This has a large influence on the sugarcane export for the European market. Moreover it is an organic product which can provide problems with the harvest, for example by storm damage. Furthermore the main harbour in Santos has long waiting times and small storage capacity which also has a negative influence on the export of the ethanol. Due to these facts, a better integrated chain with an improved co-operation between chain actors will deliver VSG several advantages [50, 52].

Heterogeneity: Inside the chain there are several different interests between the actors regarding the co-operation and certification. The mills are having much power but some of them are aiming at the European market because this is a growing market (RED targets). By means of diversification they want to increase their market share and certainty in the future, when the developments of the Brazilian ethanol market and sugar market are not certain. Some mills already made investments in molecular sieves to meet the European dry ethanol specifications (EN15376). The transport companies in the chain are

functioning in a commodity market that is purely based on price competition. It is expected that they will be willing to co-operate for certification because they will not want to miss any large orders. Eventually, certification for them will become a license to operate [50, 52].

Dyadic level

Specific investments: The specific investments concerning the environmental targets and certifications are mainly related to the mills. Because the RED requires that the sugar cane is mechanical harvested and more aspects have to be controlled, several investments have to be made at this stage. VSG and Solidaridad are now working together to check how the harvesters are transformed to prevent that the labours become unemployed. The transporting companies will also have to make investments in collaboration with the other actors for the organisation of the administrational and logistical improvements [50, 52].

Fit or stretch of core capabilities: Since the BSI is a sector related system, the experiences build up in the development process can also be applied outside the chain. VSG also want to become an example for the rest of the sector by means of the certification so that others can learn from the co-operation [50].

Allocation of profits and power: While VSG has only contracts with parties in the ARA area, they are also in conversation with the mills. As mentioned above, several specific investments have to be made, and the final customer is not yet prepared to pay a premium price. Therefore, there are several discussions concerning the distribution of the cost and benefits in the chain. An important obstacle in these conversations is the obscurity about the duration of the co-operation regarding possible uncertainties in the future [50].

Information asymmetries: At this moment, the information exchange inside the chain is very limited. If the certification is arranged, the information exchange concerning the specific environmental aspect is expected not to increase because then the environmental aspects would be covered by obtaining a label [52]. Only between the mills, VSG and Solidaridad, information will be exchanged about the retraining of the harvesters and education of the field officers due to the specific integrated co-operation. The rest of the chain will only exchange information concerning the traceability of the sustainable ethanol when the certification is finished [50, 52].

Decisions: Despite of that, VSG wants to have a better control in the chain. They do not see advantages in a total integrated chain where decisions are made at a corporate level for other actors in the chain. VSG thinks it is important that each company is able to make his own decisions, so each company is also able to focus on their core capabilities. However, VSG wants to have a guarantee that the products they are purchasing are meeting the sustainability requirements by specific agreements mentioned in the contract [50].

Company level

Limited resources: Especially the knowledge at the mills about the environmental requirements is limited. They do not have many experience of the European legislation and criteria but this knowledge will get compensated by Solidaridad and VSG who can provide much experience and contacts to these actors [50].

External pressure of environment: The co-operation in the chain to achieve a more environmental friendly product mainly resulted from own initiative. The consumers do not yet ask for sustainable bio-fuels and also are not prepared to pay a premium price in large numbers. However, the legislation is stimulating the market by establishing sustainability conditions for certification. It is expected that also in the Netherlands, excise duties will decrease for sustainable bio ethanol to increase the consumption of it. Besides this, consumers of VSG are demanding sustainable ethanol because they do not want any problems by non-compliance to the legislation which can hurt their reputation [50]. When the chain is certified, they can be sure that they meet all associated legislation when purchasing ethanol from VSG [50, 52].

Infrastructure: Many actors in the chain including the mills, are already having their own system to improve the quality and environmental results of their company. Several mills for example, are already obtaining an ISO label. Still, these systems are not integrated in the chain and only established from own initiatives. Nevertheless, they will facilitate the implementation of the certification systems and reduce the investments and efforts which have to be made [50].

5.4. Analysis

It can be concluded that the 2 analysed cases are two extremes with regard to their chain structure and organisation. Both cases do not have implemented a chain-wide extensive PMS including EPIs at this moment but they expect to obtain a sustainability certificate in the future. Due to the fact only a few or no indicators are implemented at this moment, it is difficult to establish normative recommendations for the Beethanol chain. Therefore in this section, the main conclusions of both chains will be described and it will be analyzed if sufficient inputs for the analysis of the Beethanol chain are generated.

Conclusion Regionol

Regionol is a small regional chain with a close co-operation between the distillery and Sasol. The co-operation with the filling station is based on short-term contracts and market based transactions. The achievement of environmental performances is not yet required by the consumers. However, the chain obtains very good performances with the GHG reduction that also can be guaranteed by the GHG model. In addition, the distillery satisfies with the Cross-compliance regulation and Sasol comply with EMAS. But these indicators are not sufficient to comply with the NTA-8080 requirements. And because information exchange in the chain not exist, an environmental PMS is missing in the chain. Regarding the sustainability certification, Regionol focus on the ISCC system of Meo Consulting. The problem is that this system is not yet finalised and the financial resources are missing to organise this certification. When the chain achieves a higher market share and/or additional incentives are created by the German Government, this certification could be achieved. Due to the small chain and the close co-operation it is expected that this certification will not create many problems.

Conclusion Van der Sluijs

The chain of VSG is a large international chain with many actors. The chain is currently largely dependent on market based transactions due to the commodity market and the high market power of the sugarcane mills in Brazil because of the national ethanol market and sugar market. Because the limited co-operation in the chain, and missing information exchange about the environmental aspects, an environmental chain-wide PMS is missing. However, several customers of the VSG are requiring sustainable ethanol to reduce their risk of damaging their image due to sustainability problems. To arrange this sustainable ethanol, VSG is currently organising a sustainable chain together with Solidaridad. They focus to implement the BSI system and several additional indicators. However, they are facing several problems with establishing contracts with the selected mills. Especially the distribution of cost and benefits creates several discussions. And the high market power of the mills is not an advantage for VSG. To obtain the certificate, several efforts also have to be taken to satisfy the pre-limiting conditions. The GHG criteria will not create problems because with Brazilian sugarcane ethanol, good results are obtained. Besides, VSG tries to arrange co-operations with transporting and transhipment companies because they also have to be certified regarding their administrational and logistical system to prove the guarantee of origin. Finally, because the BSI is not finished yet, VSG is already trying to establish an own certification body to bridge the time and make a guarantee of sustainability towards the customers already possible. With this strategy, VSG want to create a sustainable standard for whole the market.

It can be concluded that both chains do not have an extensive PMS. The main reason is that the chains are not insisted enough yet by the government and final consumers. However, when the RED will get implemented, the chains will get more insisted to produce sustainable ethanol but the exact strategy of the government is not known at this moment. Also the consumers do not ask for sustainable ethanol and are not prepared to pay a price premium yet. Besides these reasons, VSG has not implemented a PMS yet due to the missing co-operation in the chain but this is currently changing. And for Regionol, an important aspect is the absence of sufficient financial resources. Also in other similar bio-ethanol production chains it is not expected that an extensive chain-wide PMS is implemented. Companies like Shell are also not expected to be useful due to the large differences. Therefore it is expected that it will not be useful to add another case based on another bio-ethanol production chain to generate more inputs regarding relevant EPIs.

Despite the fact that both analyzed chains do not have an extensive chain-wide PMS with key EPIs, the organisation of both chains and the development steps which they have taken are extensively elaborated which provides a lot of information for Beethanol. Nevertheless, the analysed literature does not provide any solutions for the establishment of normative recommendations for the development of a PMS based on the generated inputs. Therefore, scenario based recommendations will be given to the Beethanol chain regarding the assurance the environmental criteria. These recommendations will be focussed towards the development steps, which are needed to be taken to obtain a sustainability certification and the associated co-operation. This certification can be used for assuring the environmental criteria. Therefore, also the institutions which are establishing the certification standards and audit organisations are contacted to gather the required additional information. With this information and the analysis of the two cases already several inputs gathered based on different scenarios, but since both chains are still in development towards the certification, an extra case is needed to obtain more relevant inputs.

For this case, the sustainable wood market is selected and analyzed. This market has faced the same problems in the past as the bio ethanol market and is currently several steps ahead in their progress towards sustainability certification. Therefore it is decided to analyze the market in general instead of one specific production chain. With the analysis of this case, it is aimed to obtain more scenarios which could form input for the recommendations towards the Beethanol chain. The analysis of the case consisted of a desk research and an interview with Ir. G.F. (Fred) van der Burgh from Forest@Design. The elaboration of the sustainable wood market can be found in attachment 2 and the most important conclusions are elaborated below.

5.5. Sustainable wood market

The sustainable wood market shows several similarities and differences with the bio-ethanol market concerning the sustainability criteria and certification. The Dutch government has also described several criteria for the sustainable wood market and they are stimulating companies to comply with these criteria. However, companies are not obliged to achieve compliance to these criteria. Still, the certification of sustainable wood is becoming a standard in the wood market. Within the Netherlands, this is mainly obtained by a promotion campaign of the Forest Stewardship Council (FSC) which increased the awareness of the consumers. This resulted that companies and chains were insisted by their customers to organise the sustainability certification. Concerning the criteria, the sustainability requirements are only focussed to the production of wood and maintenance of the forest. The rest of the chain only face administrational and logistical requirements when they want to obtain a sustainability certification. For these companies, the certification will become easier when an ISO certificate is already in place. When small producing companies are co-operating it is also possible to apply for a group certification which limits the audit and associated costs. The co-operation in the chain to organise the certification differs between the chains. Several chains are based on market based transactions while others have hybrid governance structures (supply contracts, joint ventures) and total vertical integrated chains. This means that it is not obligated to have an intensive co-operation in the chain when the actors are certified for the same system. Eventually it is also expected that the sustainability certification becomes a license to operate for all the actors in the market. Comparing with the bio-ethanol market, it is clearly visible that the wood chains are several steps ahead concerning the certification. There are several systems available, and each system is currently looking to improve their system. Regarding bio ethanol there is still no system available but several organisations are working to establish such a system which is expected to create a similar situation with the sustainable wood market where several systems are competing.

5.6. Case 3: Beethanol chain

In the following section, the supply chain of Beethanol BV will be analyzed. Together with this analysis, the recommendations regarding the achievement and assuring of the environmental criteria will be provided based on the inputs gathered in the analysis of the previous cases. The structure of this case analysis is similar as the previous case analysis. First the chain will be introduced and the vision of the chain will be described. Next, the structure and the development process of the chain will be elaborated. Then, recommendations will be given based on the analysis of the performance pyramid and the PDCA cycle of the first cases. Finally, the recommendations concerning the co-operation and co-ordination will be provided based on the same aspects of the model of Hanf and Dautzenberg.

5.6.1. Chain introduction

After a feasibility study in 2005 and 2006, Agrologistiek BV, Wageningen University and Research AFSG and Actemium have decided to establish a company for the production of small-scale bioethanol factories. These factories will, preferable in property of the farmers, convert grain and beets according to an innovative concept. Beethanol BV, which is managed by Dr. D.F. Broens (project-developer), will facilitate these factories in franchise-format with innovative technology and technical and commercials services with the exploitation [54].

The concept shows several similarities with the Regionol case because it is based on the organisation of local production of bio-fuels near the cultivation fields, in co-operation with bio-ethanol, biogas, horticulture, and possible other functions. The project has shown that it creates advantages on several levels. On the national level it decreases the dependency on fossil fuels, it contributes to the achievement of the Kyoto protocol in 2010, and it also contributes to a more innovative agricultural sector. And on the local and regional level it [54]:

- reduces waste;
- decreases energy losses;
- improves the bio-diversity;
- stimulates rural developments;
- increases the employment in the region and;
- creates proper income for farmers.

Besides these arguments, it achieves more added value and a very high GHG emission reduction compared with fossil fuels. The study concluded that the most sustainable bio-ethanol can be produced due to an optimal heat integration between ethanol, biogas and horticulture and that the associated technique is ready for implementation on several locations [55].

5.6.2. Vision

The vision of the Beethanol project is to establish small factories in co-operation with local partners to produce regional ethanol with a high GHG reduction and a low cost price. This low cost price will be

arranged by using flexible commodities and low transportation costs which will make it possible to compete in the fuel commodity market. There will be focussed on small customers because the regional factories will not be able to supply large volumes [55].

5.6.3. Chain structure

- Factory suppliers
- Distillery
- Dehydration/Blending company
- Transportation companies

5.6.4. Performance measurement

Development process

At this moment, different partners are approached to establish a factory. Possible partners consist of farmers, ethanol producers, engineers, government, local authorities, oil companies, car manufacturers and financial and logistical parties. Also several locations in the Netherlands are considered. When a location is chosen, a factory will be established with a multi-feed installation which means that several inputs can be used. Dependent on the price, sugar beets, weed or residuals from the food industry will be used. To assure the supply, it will also be possible to arrange long term contracts with these suppliers. Especially with the food residuals, large environmental results can be achieved due to the limitation of waste and an increase of the GHG emission reduction because waste material is not counted within the RED calculations.

The objective of Beethanol is to sell the established factory when this is profitable to the associated partners, keeping a specific share in the organisation. The aim is to implement this strategy at several locations in the Netherlands and perhaps also in other EU member states. The reason why at the moment no factories are implemented yet is because the use of bio-fuels does not provide sufficient financial benefits for the final consumers compared with fossil fuels. While in other EU member states, the excise-duty on bio-fuels in decreased, in the Netherlands this is still not arranged. The current development in the Dutch policy is that a reduction of 30% excise is possible when a chain can prove that the bio-fuels are sustainable produced. Therefore in this section, recommendations will be given on how the chain should organise to arrange this sustainability guarantee and which environmental targets and indicators they should implement, based on the analysis of the VSG and Regionol cases [55].

Due to the fact the chain is not established yet and the exact actors and inputs are not known at this stage, the visualisation of the chain processes is not useful. Also because the previous elaborated chains did not implement process specific EPIs it will not be possible to establish process specific recommendations in this research. Still there are several recommendations which can be given concerning the achievement and assuring the environmental criteria based on the analysis of the two ethanol cases and the sustainable wood market.

Performance pyramid

The vision of Beethanol is to produce sustainable regional bio-ethanol which is focussed on the "market side" of the performance pyramid. They also try to compete in the commodity fuel market to obtain a low cost price which covers the "financial side" of the pyramid. An important aspect of the low cost price will be the reduction of excise duty which requires the guarantee of sustainable production. To achieve this guarantee of sustainability, the chain will not need to implement chain indicators according to the analysis of the VSG and Regionol cases and the sustainable wood market. It can be concluded that only for the guarantee of sustainability an actor should be certified by a certification system which is accepted by the Dutch government. This automatically covers the indicators on the actor level and the process level. The certification system will have specific criteria and indicators which are mainly focussed on the production, maintenance and processing of the biomass criteria (see NTA-8080 criteria). All the other chain actors will only have administrational and logistical indicators to organise the COC system (guarantee of origin). In this case, it will still be possible to make sustainable claims at the end of the chain without each actor is striving for the same corporate vision. Another advantage of the certification is that the associated companies do not have the risk that they will be attacked by certain NGOs because problems like the cutting of rainforest will not be discovered.

Besides the indicator for the compliance to a specific certification system, it is also possible to establish additional indicators like extra CO2 reduction or the reducing of waste streams but it is not known in this research if these extra indicators will provide an added value for the chain actors. As noticed in the analysis of the two cases, the final consumers are not yet interested in sustainable bio ethanol and are not willing to pay a premium price for it. Especially when the product cannot be distinguished like the commodity product E5, it will be very difficult to continue the consumers. Still, it can be possible that consumers will get more interested in sustainable bio-ethanol when they get informed by a large promotion campaign like occurred in the sustainable wood chain.

PDCA

In this part, recommendations will be given on the management of the environmental indicators on the basis of the Plan-Do-Check-Act cycle. This means that it does not include the other aspects like delivery, quality and financial topics.

Plan

As mentioned in the previous part, when a chain like Beethanol wants to guarantee its sustainability accepted by the Dutch government, they can organise a certification according a specific standard. Possible standards are the BSI, ISCC, and currently the NTA-8080 is also developing an own system based on their criteria but they need to be accepted by the Dutch government which is not known at this moment. The chosen system will, in this case, function as a performance indicator for the chain actors. It will also be possible to implement several different indicators because systems like ISCC and NTA-8080 are so called Meta Standards which mean they also accept other systems when they comply with the standards criteria. In this case it could be possible that a biomass producer is BSI certified while the final ethanol is sold with an ISCC label when the ISCC accepts BSI as a system which covers the criteria.

Do

When the implemented environmental indicator is based on certification standards, the data collection, data analysis and converting on chain level can be limited to the achievement of the certification. Also the information exchange and communication of the results can be limited to prove the compliance to the system. To obtain this compliance, the biomass producers and processors will have to comply with several environmental criteria and perhaps makes several improvements. The other actors in the chain will have to obtain a certification based on the administrational and logistical system. This certification is to prove the sustainable origin of the product and to calculate the GHG emission reduction based on the RED default values or own calculated values which is possible with a transparent chain like Beethanol. This administrational system will have to be based on a mass balance- or physical segregation system and will not cost a lot of efforts when an ISO quality system certification is already obtained.

Check and Act

The control if the indicator targets are achieved (=compliance to the standard) will be performed by an external party (auditor). This auditor has to be accepted by the certification body of the system. When implementing a certification indicator, the continuous environmental improvement will not be stimulated in the chain when the indicator target is achieved. Unless the certification oblige the companies to improve themselve like the BSI system, or the systems are adapted with higher criteria.

5.6.5. Co-operation and co-ordination

Chain level

Transparency: In the analysis of the transparency in the chain, there were large differences between Regionol and VSG. With Regionol there was a large transparency between the chain actors due to the regional location, quarterly meetings and information exchange. And in the VSG chain, they are working to increase the transparency but currently the chain is before the purchase of the bio-ethanol in the ARA area not transparent. When it only concerns the certification it is seen that the transparency in the chain can be limited to the supply arrangements where the compliance to the certification can be proven together with the guarantee of origin (COC). But when other indicators will be implemented above the certification like regional production and zero waste an increased integration could be necessary like in the Regionol case. This extra integration could also provide advantages like the logistics and delivery efficiency and increasing supply guarantee, reducing the investment risk by establishing long-term contracts. This is also the main aspect of the discussions between VSG and the mills. Nevertheless, the chain actors do not need to strive for the same corporate vision when it concerns only to the sustainability certification, they only need to comply with the chosen certification standard.

Free riding: In the analysis of both chains it can be concluded that concerning the environmental aspects, the biomass producers and processors need to make the most efforts on the improvements. Also the consumers are seen as free riders because they are not willing to pay a premium price for sustainability while the chains do get insisted by the government to organise a sustainable production. To avoid these discussions like Regionol has with the filling stations, Beethanol should try to create a situation where all the actors will get compensated for the efforts they have made.

Rivalries/coalitions: While the distillery in the chain can select the inputs on price basis and are not obliged to arrange long-term contracts. They can also reduce the risk of rivalries and coalitions in the chain. Still, rivalries and coalitions could be created between the transporting companies which can compete each other, like in the VSG case, provided that they have a certified administrational system.

Interdependence: The distillery is dependent on the suppliers but this dependency is decreased due to the multi-feed installation which accepts several inputs. Still, the suppliers will need to be certified and it can be expected that they want certain guarantees before they make several investments, which also occurs in the VSG chain. Based on the Regionol case, the distillery is also very dependent on the de-hydration company when there is only one located in the area. In the Regionol chain, they try to limit this risk by creating transparency with this company with mutual trust and incentives to establish a strong relation. Because the chain cannot focus their sale to large purchasers due to the low supply amounts, there will be fewer purchasers available which increase the dependency on these companies. To reduce this risk, these companies should be convinced of the added value of the regional bio-ethanol. The cost price will be an important aspect in this case. When the ethanol is more expensive than fossil fuels, then it will be hard to convince these customers. Therefore the whole chain is also dependent on the fluctuating fossil fuel prices.

Heterogeneity: Due to the chain analysis, it is shown that not all actors need to have the same interests concerning the sustainability certification because the certification system will establish the minimum environmental values for the actors. But when extra indicators are implemented like the regional production and zero waste the actors do have to strive for the same interests to achieve these aims.

Dyadic level

Specific investments: Due to the regional production and consumption, and the combination with the several other functions, it is expected that is will be easy to prove the sustainability (=compliance to the system criteria). Nevertheless, several investments will need to be taken regarding the certification system. These investments consist of the achievement of the indicators. A first large audit and smaller periodical audits will have to be done. Especially for the biomass producers and distillery, these investments can be high if no management system is in place yet. All other actors will need to invest in small administrational audits.

Fit or stretch of core capabilities: As shown in the analysis of Regionol and VSG, the experiences which are gained by the establishment of the certification system can also be used outside the chain which is also the case with Regionol and VSG. When a supplier is certified to a certain system they are even able to leave the Beethanol chain and supply to another chain if this has a similar system in place.

Allocation of profits and power: From the analysis of Regionol and VSG it can be concluded that the allocation of the cost and benefits associated to the implementation of the certification systems provides several discussions. The main problem is that the consumers are not (yet) willing to pay a premium price. Still, with the certification, a reduction in excise duty (30%) can be obtained but this reduction will mainly be used to compete with fossil fuels and therefore will not provide significant financial benefits besides an

increasing market share. This means that the biomass producers and distillery has to make extra cost which has to be compensated. In the Regionol case, they still don't know how they will compensate these costs. In the VSG chain, the biomass producers will get compensated by a better price and they can increase their supply guarantee. To arrange a proper financial situation, an equal distribution of cost and benefits could be arranged in the Beethanol chain also, so that not only the biomass producers and distillery has to make the extra costs while the other actors are free riding. Another possible solution which is provided during the research is the establishment of a compensation fund where the excise duty obtained from the fossil fuel market are used for the sustainability certification so that the whole sector contributes to the certification and the achievement of the national EU-targets. In the sustainable wood chain, it is shown that eventually the sustainable certification has become a license to operate for all actors (even the transportation companies) which can become a standard in the bio-ethanol market as well, when the market will increase.

Information asymmetry: As mentioned with the recommendation for the PMS, the information exchange between the actors can be limited to proving compliance to the certification system. Nevertheless, there are other aspects like fuel quality, supply contracts, logistical and financial aspects that will require more information exchange between the actors.

Decisions: Regarding the decisions on the environmental aspects for the certification, the actors will not have a lot of freedom. Only concerning the improvements to obtain the compliance to the certification criteria, chain actors could make decisions together like in the VSG chain where VSG facilitates the biomass producers. Another important aspect is the decisions which certification system will be used. In the VSG chain, VSG has decided together with Solidaridad to focus on the BSI system and they are currently convincing the mills in Brazil to arrange certification according this system. In the Regionol chain, it will be the distilleries in co-operation with Sasol which will make a decision for a certain system. Therefore there are several possibilities for Beethanol on which level they make the decision for a certain system, which is expected to depend on the co-operation between the different actors.

Behaviour: While currently the environmental results of the Regionol and VSG are not known or by mutual trust it is expected that a certain minimum level is obtained, this will not provide any discussion anymore when a system is implemented. In this case, each actor can make his own decisions and strategy concerning the environmental aspects as long as they can prove compliance to the system which is controlled by the external auditor.

<u>Company level</u>

Limited resources: The main limited resources mentioned in the analysis of Regionol and VSG on the company level are the limited knowledge concerning the environmental aspects and the financial resources. VSG is obtaining this knowledge from Solidaridad and the co-operation in the development of the BSI standard. Because beside the certification organisation will arrange the chain audits, they are also able to provide knowledge to the chain actors. Also the co-operation between distilleries and biomass producers by creating a platform like Regionol can create a lot of benefits for the chain actors. Concerning

the financial resources, the discussion is mainly based on the problems mentioned under the allocation of profits and power.

External pressure of environment: As concluded in the analysis of Regionol and VSG, both chains are not yet insisted by the final consumers to provide sustainable ethanol. But the VSG does get pressure from their purchasers because they want to reduce their risks to be attacked by an NGO which could damage their image. As seen in the sustainable wood chain, the awareness of the final customers can increase when a promotion campaign is organised but then the market should increase first. Besides this, certain NGOs could publish dismayed information which also could increase the awareness of the final customers. Next, the chain can get insisted by the government which is also the case with Regionol and VSG. Because each EU member state has their target of 10%, they all have to publish their strategy in 2010 toward this goal. This strategy is expected to obtain pressure towards bio-ethanol chain to certify their chain, possible with subsidies, but the exact strategy of the Dutch government is not yet known.

Managerial skills: To organise the certification, several managerial skills will be required. When these skills would not be available at certain actors, these can be obtained from a third party or by an integrated co-operation with another actor, like the co-operation with VSG and Solidaridad. Therefore, when several actors in the Beethanol chain would face certain problems with the environmental aspects, lobbying or promoting they could consider approaching an NGO or other organisations with specific experience to establish a co-operation.

Infrastructure: Regarding the chain analysis of Regionol and VSG, it is shown that the chain actors in both chains already obtain several systems like ISO, EMAS and other own managing systems. While it will not be obliged to have such systems for the sustainability certification, these systems are creating a lot of benefits for the certification because it will be easier for these actors to comply to the certification system. The ISO quality certification for example, is expected to be almost sufficient to comply with the administrational and logistical requirements. The established system will also provide an added value to the chain organisation concerning aspects like finance, chain image, long term relation's etc.

5.7. Supply chain development stages

As concluded in the previous sections, both chains are clearly still in development to obtain a sustainability certificate. They are both organising their co-operation between the chain actors to arrange this development. When starting this research, it was expected that both chains were already further in progress, by having an integrated co-operation and implemented a extensive chain-wide PMS but this is not the case. In the previous parts, the differences between the chains are extensively elaborated. However, to compare these chains and conduct conclusions concerning the connection between the management of environmental performances, the assurance by obtaining a sustainability certificate and the associated co-operation in the chain, extra literature needs to be added. Therefore, in this section literature about supply chain development stages regarding environmental care strategies is elaborated and added to the research.

Regarding these development stages, there are several models available in the literature. For this research, an article of Hagelaar et al. is used . This article states that the targeted performance and the associated managerial concepts, are linked together by the corporate strategy [56]. Concerning environmental aspects, this strategy can be called and Environmental Care Strategy (ECS). The matching between organisational design (structure for co-operation and the administrative structure) and the targeted environmental performance is linked in the ECS [56]. It is stated that when a supply chain wants to improve their environmental performance continually, they eventually have to change their ECS. From the different combinations of dimensions, three strategies of environmental care (figure 15) can be distinghuised based on the literature which are crisis-oriented strategy, process-oriented strategy ,and chain oriented strategy [56]. Besides these strategies also a zero stage can be distinguished. In this stage there is no environmental awareness and no indicators are implemented. Several companies are located in this stage because they lack resources like personel, knowlegde, and financial inputs. Finaly, it can also occur that a company follow a mixture of the different strategies. *"For instance, a company may have an ambition of eco-efficiency while in fact it not even complies to existing regulation"* [57].

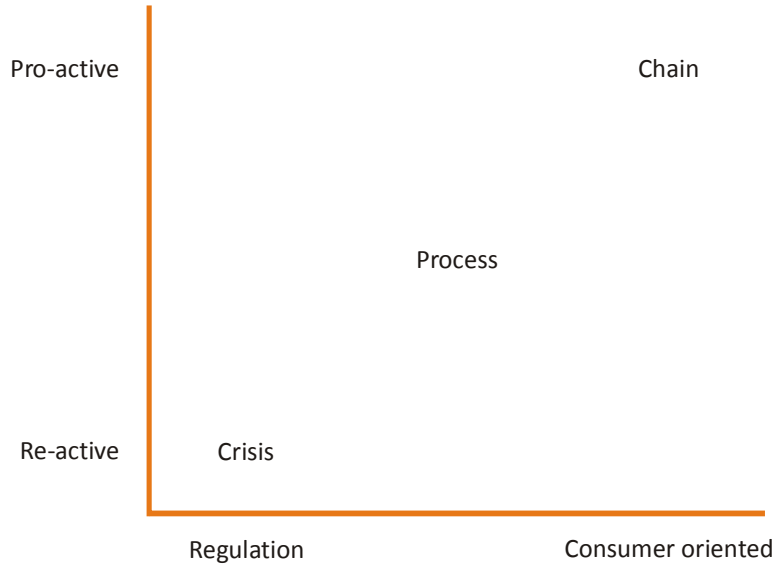

Figure 15: Environmental Care Strategies [57]:

- Crises-oriented strategy: This strategy is directed to the individual actors in the chain and focussed on obtaining minimal compliance with rules and regulations [57]. Every specific actor in the chain has to comply with rules and regulations, which are defining a basic norm which should not be surpassed. The chain can be seen as a fragmented organisation concerning the environmental aspects since each actor should individually comply with the (governmental) demands which are directed. The risks are deducted from those (governmental) demands and rewards are in terms of meeting minimum standards, which eventually should create advantages such as no penalties and the creation of some goodwill with the local or regional authority . The environmental actions can be standardized and centralized in the isolated units throughout the chain where each actor has its own responsibility. The attitude towards the environmental aspects is viewing environmental care as an external issue which has to be dealth with [56].

- Process-oriented strategy: This strategy concerns a more pro-active approach and strives for the control of the environmental burden caused by the production process by means of production integrated measures [57]. The measures achieve both compliance with governmental rules and regulations and a better return. The strategy is deducted from the corporate environmental policy and indirectly also from the market. The risks are limited with this strategy and the rewards are meeting the corporate policy and increasing the marketshare. The location of the environmental actions are more spread over the chain. In some cases, the specific actors receive freedom to reach environmental and financial targets in their own manner. The corporate policy of the chain does not direct procedures to the chain units but targets. Within these units, procedures can be used to manage these targets but the tasks are decentralised and more dynamic. Due to the fact that the units have freedom in choosing methods to reach the targets, employees will be more commited to the environmental performance. The attitude towards the environmental aspects changes to an internal aspect, where economic benefits can be reached by reducing the environmental effect [56].

- Chain-oriented strategy: This strategy contains a pro-active approach which focusses on the environmental demands on the product as a whole by consumers [57]. The strategy aims at the achievement of competitive advantage where the environmental aspects are incorporated into the design process where integration and common goals are the key aspects. The environmental performance is the result of joint effort to design and produce a product, which requires a chain structure where the individual actors work intensively together to open new markets. The strategy is directed at meeting market preferred environmental challenges. Both the risks and rewards are also located in the market. The specific environmental performance is reached by intensive co-operation within the chain by exchanging information, dynamic adaption and building trust. The location of the environmental actions are decentralised and flexible and the attitude towards the environmental aspects is external oriented towards the consumer [56].

It can be concluded that when the environmental care strategy with the associated goals becomes more ambitious, more detailed information need to be gathered. To be able to gather and share this detailed information in a reliable and efficient way, the requirements for the co-operation between the chain actors increases in order to obtain the higher environmental performance objectives. In the article of Hagelaar et al. different types of supply chain co-operation are distinghuished based on the complexity of the supply chain partnership (number of functions included in partnership) and the differentation of the structurel linkage between the chain actors (number of consult structures between partners). In the article it is concluded that when the ECS changes, the complexity and differentation in consulting structures also increases and tighter partnerships are required. To achieve this change, borders of units within a company and between companies have to be crossed which also implies changes in commitment and trust to be able to reach jointly agreed goals. Besides these borders, also the leadership and the administration in the chain will change. The leadership will change from direct, short line control to controlling the execution of procedures (crisis-oriented), to controlling the achievement of targets (process-oriented), to inspiring self-steering teams (market-oriented). And the administration will change from following orders, to following procedures, to taking own responsibility, to target orientation, to flexible adaption towards the market.

- Regionol

The partnership between the distillery and Sasol is based on a supply contract and a good co-operation. The sale and marketing are also together organised. The partnerships with the filling station however, are based on market transactions and shorts term contracts. The ECS of Regionol is a crisis oriented strategy where compliance to the legislation are gained with Cross compliance and EMAS. Next to this strategy, a number of environmental aspects such as the closed mineral cycle and the optimal GHG reduction extend this strategy and are focussed on the specific processes and whole chain (GHG reduction). This requires an more pro-active co-operation because it can be exactly identified what each actors contributes to the final product. With the development and implementation of the certificationsystem, the basis of the crisis-oriented strategy will be raised but the main strategy will not change. Since the GHG results are substantial and creates no sufficient added value at this moment, the extra efforts will be aimed at the compliance with the prelimiting conditions, raising market share and achieving a better evonomic result. Concerning the environmental aspects, the crisis-oriented strategy is sufficient (another strategy provides no added value) and also the co-operation in the chain is sufficient to obtain the aimed results. However, for the other aspects such as the distribution of cost and benefits and supply garuantee an extended form of co-operation perhaps would obtain an added value but that is not incorporated in this research.

- VSG

The ECS of VSG can be typified between a zero stage and crisis-oriented strategy, since there are no environmental indicators and the only requirement is that in contains brazilian sugarcane ethanol. The co-operation is based on market based transactions between the mills, transhipment organisations and VSG. Between the mills however, co-operations and long-term co-operations are present. The mills have much power in the chain due to the internal brazilian market and the high suger prices. Because of this, the supply for VSG can not be garuanteed and it is very difficult to distribute and spread the risks over the chain regarding the extra investments. Due to the co-operation with Solidaridad and development and implementation of the BSI system, currently an crisis-oriented strategy is organised. This strategy must guarantee the compliance to the prelimiting conditions of the sustainability criteria. For the GHG reduction, no extra efforts need to be performed beside the administrative obligations because Brazilian sugarcane ethanol always satisfies to the minimum reduction criteria. To achieve the crisis-oriented strategy, currently several efforts are taken to organise the co-operation between the chain actors. Due to the crisis-oriented strategy these does not neet to contain a high complexity and differentation of structural linkages since the parties can function as loose links to gain compliance for the sustainability criteria. However, the partnerships in the chain will change from market based transactions to supply contracts to arrange the sustainability targets, joint planning and organising trust and commitment. When necessary, VSG will organise certain activities themselves, which will futher increase the integration in the chain. Due to the cooperation with Sollidaridad, the crisis-oriented strategy will get extended on several aspects (labour conditions and sustainability knowlegde) because these are focussed on the specific processes in the chain. This also demands a higher intensity of co-operation which will get realised by setting up contracts and close co-operation with the mills. Both companies (Solidaridad and VSG) will gain benefits by this co-operation. Solidaridad gains results on the labour conditions in Brazil and VSG achieves results by the knowledge contributions of Solidaridad, and the confidence that consumers have in NGOs with the associated promotion possibilities.

6. Conclusion and discussion

This chapter will describe the conclusion and discussion that follow from the research. The objective of the research was:

"To give recommendations for Beethanol BV concerning the assurance of environmental criteria, by analyzing the Performance Measurement System with key EPIs and the associated co-operation between the chain actors in two other different cases".

To accomplish this goal, a theoretical and empirical research was carried out and the main results are included in this chapter. In the three sections of this chapter, first the central research question is addressed in section 8.1. In this part, the findings of the previous chapters will be summarised and the main conclusions will be given. Second, the problems and limitations faced during this research are described in section 8.2. Finally, recommendations for further research on the topic are given in section 8.3.

6.1. Conclusion

The reason to conduct the research was because the European Union is obliging the EU members to obtain a target for 2020 where 10% of the used energy is renewable and produced sustainable. Therefore, in the coming years, the production of sustainable ethanol will be stimulated. The EU is currently working on a certification system, which will be finalised in 2010. But to already obtain the benefits from sustainable ethanol and to prevent sustainability problems and associated harm to the image of companies, several market players are already organising their own sustainable production chain. Also several small regional ethanol producers like the Beethanol project are willing to organise this sustainable production chain. It was expected that the bio ethanol chains had to co-operate intensively and implement a PMS with key EPIs to obtain the sustainable performances and improvements. The problem is however, that the small companies do not know how to co-operate in the chain to achieve and assure the criteria of the RED and NTA-8080. To give recommendations to these companies regarding the environmental aspects, the following main research question is formulated:

"What are the properties of the two cases concerning the environmental PMS including key EPIs and the associated co-operation and which recommendations can be given to Beethanol BV to assure the environmental criteria?"

This main research question is divided in several sub-questions to elaborate the theoretical and the empirical part of the research. Below these questions are divided in the theoretical framework, case analysis and the final recommendations towards Beethanol BV and answered concisely.

For the theoretical framework, 3 sub questions are established concerning the three main aspects. The first research question is about the properties of a PMS and how it can be analysed in a chain. The second research question concerns the key EPIs and how they can be formulated. The third question concerns the

models to analyze the organisation of the chain actors to manage the PMS. Below these questions will be answered concisely.

A PMS is a part of the performance management process which manages performance in line with the corporate and functional strategies and objectives. The objective of a PMS is to provide a control system, which deploys corporate and functional strategies to all business processes, activities, tasks and personell by implementing performance indicators. It provides a structured framework for collecting, analysing and reporting to facilitate the decision and control processes. The development of a PMS can be separated into phases of design, implementation, use and maintenance. Several models can be used to analyze a PMS in a chain. For this research, the performance pyramid is used to translate the corporate vision of the chain to the individual actors and operational processes in the chain by using performance indicators. Because this model does not provide a clear description for the analysis of environmental performances, the PDCA cycle of ISO is added to analyse the implemented EPIs. For this analysis also several establishing criteria are elaborated and and a distinction between different kind of indicator classifications is provided. To analyse the co-operation between the chain actors to manage the PMS, the manegerial framework for networks of Hanf and Dautzenberg is used in this research. This model splits the collective strategy in a co-operating and co-ordination domain and distinghuises three different levels in a chain. After the case analysis, also theory concerning environmental care strategies was described and added to the research to analyse the link between the co-operation in the chains and the environmental intentions. This resulted in the elaboration of three strategies (crisis-, process- and chain-oriented strategy) which are analyzed in the cases.

The theoretical framework is used for the analysis of the cases in the empirical part of the research with the aim to generate inputs for establishing recommendations to Beethanol BV. Two sub-questions are addressed for this analysis. Research question 4 concerns the properties of the cases regarding the implemented PMS including key EPIs and the associated environmental targets based on the environmental criteria. Research question 5 concerns the co-operation between chain actors to achieve the environmental performances. Below these questions are combined and answered for the specific cases.

- Regionol

Regionol is a small regional chain with local actors consisting of a distillery, which also produces the biomass, a processing company (Sasol) and several filling stations. The relation between the distillery and Sasol is based on a supply contract and concerns a transparent relationship due to quarterly meetings and mutual trust. The benefits of the chain co-operation for the distilleries are market entrance in the bio-ethanol market and risk reduction (less dependency on subsidies). The aim is also to obtain higher prices for their products. The main benefits for Sasol are that they can use specific equipment, adopt ecological products and the co-operation with local partners. The relation between Sasol and the filling stations is based on market based transactions due to the fact that the benefits of the filling stations are based on the price advantage. They want to obtain the ethanol for the lowest price and therefore they do not want to be dependent on one supplier. Regionol has a clear vision, which is to produce regional bio-ethanol with a low GHG emission and a closed mineral cycle. However, besides the GHG model, almost no EPIs

have been implemented which are deducted from this vision and can measure and assure the environmental performance. Within the chain, only the compliance to the Cross compliance regulation (distillery) and EMAS (Sasol) are assured. Therefore it is not possible besides the GHG reduction, to observe the incremental environmental improvements, which was expected to be important when beginning this research. The main reason why the PMS is not developed exhaustively is that the chain is not yet insisted by the final consumers and the government to guarantee certain environmental performances. It is expected however, that eventually the sustainability certification becomes obligated when the RED will be implemented by the German government. When this certification becomes obliged, the chain will not have problems with the GHG reduction, since they already have good results (minimum reduction of 86%) which can be guaranteed by the GHG model. Still, for the other pre-limiting conditions additional efforts will have to be performed to guarantee compliance. To achieve this, Regionol is focussed on the ISCC system of Meo Consulting. But this system is currently not finalised yet and the financial resources of Regionol are lacking to achieve this certification at this moment. For Sasol and the filling stations, the certification will only cost little additional efforts because these companies only need to arrange an administrational system to control the guarantee of origin. Due to the ISO quality system, which is already implemented, this should not give any problems.

The strategy of Regionol concerning the sustainability certification can be typified as a crisis-oriented, where the individual actors show compliance for the certification system. But, besides these environmental aspects, the co-operation between the distillery and Sasol is more integrated than needed to support the strategy. The reason for this is the regional character of the chain, the GHG model, arrangement of supply guarantee and the organisation of a fair distribution of cost and benefits.

- Van der Sluijs Groep

The VSG chain is a large international chain of imported Brazilian ethanol which contains many actors. First there are the mills that produce and process the sugarcane and market their ethanol to transhipment/transport organisations. They can have benefits of the co-operation in the chain by increasing their market share and reducing the dependency on the national market. The interest of the transporting companies to co-operate and invest in the chain is to obtain their orders and increase their market share. From the transhipment organisations, the ethanol is distributed to VSG. VSG is blending the ethanol with fossil fuel and distributes it to large customers. The chain is functions on market based transactions because it concerns a commodity market and the mills have high market power due to a strong national ethanol market and a sugar market. The customers of VSG want to reduce the risk to harm their image created by sustainability problems so they are requiring certified, sustainable ethanol. Together with Solidaridad, VSG is therefore currently organising the chain to arrange the sustainability certification. The associated vision of VSG and Solidaridad is to purchase the most sustainable ethanol as possible and being the first to obtain a sustainability certification in the Netherlands. They also aim to create a standard for the whole ethanol market. However, currently there are no indicators implemented yet and VSG only requires that their ethanol is produced from Brazilian sugarcane. A PMS is not present because there are no indicators, measures and information sharing between chain actors regarding the environmental aspects. To achieve the environmental targets, VSG is aiming to implement the BSI system together with Solidaridad. To arrange this implementation, the transparency in the chain has to increase because at this moment, no mills are certified according the BSI system and they are not insisted to invest

in the organisation of this system. Therefore VSG is selecting sustainable mills and trying to arrange supply contracts with these suppliers but they are facing problems to convince the mills and create mutual advantages of the co-operation. Specifically the distribution of the cost and benefits regarding the certification creates several discussions where the strong market position of the mills is a disadvantage for VSG. To implement the BSI system, it is necessary that the individual companies can prove compliance to the system, which is typical for a crisis-oriented strategy. However, VSG aims to implement additional indicators like extra social criteria and increasing the sustainable knowledge of the mills by the co-operation with Solidaridad. Due to these additional indicators, the intensity of the co-operation becomes more complex which requires a more integrated and transparent co-operation than required for a crisis-oriented strategy. Next, also with the transport and transhipment companies, VSG is organising co-operations to arrange certification for the whole chain. The certification for these companies only contains the administrational and logistical system which will not provide problems when an ISO certification is already obtained. VSG expects that eventually the BSI becomes a standard in the market which means the certification would become a license to operate for all the actors in the market.

Due to the fact that both chains have not implemented an extensive PMS, it is not possible to recommend certain EPIs for the Beethanol chain. However, from the analysis of the cases it can be concluded that implementing a PMS with key EPIs and an integrated co-operation between chain actors is not the only solution for assuring the environmental criteria. Both chains are currently in development to obtain a sustainability certification. Therefore the recommendations to Beethanol BV are mainly focussed towards the development steps Beethanol should take based on the scenario's of both cases. To create an additional scenario, also the situation in the sustainable wood market is analysed because in this market the same problems have been faced. The main conclusions of this analysis is that there are several certification systems available which reduces the costs of implementation, but limits the market possibilities because the same system has to be used in the chain. Supply chains are not obliged to organise an integrated co-operation to obtain a certificate and individual actors only have to prove compliance to the certification system, which can be typified as a crisis-oriented strategy. Due to the fact that sustainable wood is becoming a standard in the market, the certification is already a license to operate for many actors in the market.

After the analysis of the first cases, the Beethanol case is analysed and the recommendations are established which provided an answer to research question 6. This question concerns the recommendations for assuring the environmental criteria and the associated co-operation which is elaborated below.

Beethanol is a project to establish a regional production chain with flexible inputs (residuals, sugar beets and weed). Although the chain is not established yet and the location, is not known the following recommendations can be given based on the scenarios of the analysed chains.
To achieve and assure the criteria of the RED and NTA-8080, an integrated co-operation in the chain is not obliged. Prove the compliance to an accepted system for each individual actor is sufficient. Therefore an extensive chain-wide PMS is not needed. To certify the chain, several systems are available like the BSI, ISCC, RSPO, NTA-8080 etc., but not all these systems are finalised yet. The above mentioned

environmental strategy can be typified as a crisis-oriented strategy. The co-operation needed for this strategy does not have to be complex and high differentiation of structural links and can be based on market based transactions, unless additional indicators are implemented. Moreover, an integrated co-operation could create advantages regarding the guarantee of supply, distribution of cost and benefits and implementation of the certification system. Especially because many biomass producers are not certified yet, a close co-operation creates better opportunities to convince them to obtain a certificate. This is also shown at Regionol where there are fewer discussions between the actors due to the close co-operation. In the research, it is also shown that the regulation about sustainability certification is in development. This development has to be followed properly to obtain benefits in the future. Next year, the RED will be implemented in the Netherlands and it will be clear if and how a reduction in excise duty can be obtained which is necessary for a profitable chain. An opportunity for a quick implementation could also be the establishment of a compensation fund where duties of the fossil fuel sector are used for the sustainability certification. However, to achieve such a solution, a lobby towards the policy makers is necessary. Another recommendation for Beethanol could be the co-operation with an NGO. This co-operation can create benefits by knowledge and promotion opportunities like shown in the co-operation between VSG and Solidaridad. Eventually, it is expected that certification becomes a license to operate for all actors in the bio-ethanol market. In this situation, the discussion between the actors will decrease, and competition between the certification systems could increase that also occurred in the sustainable wood market.

6.2. Discussion

This section discusses the limitations and constraints regarding the findings of this research. This is important while interpreting the conclusions and recommendations. Below, the main aspects for discussion are elaborated.

The main limitation of the research considers the absence of an extensive chain-wide PMS including EPIs in the cases. Before starting the research, it was expected that both cases had implemented such a PMS. Therefore the theoretical framework was established with the aim to analyze the cases to create recommendations for implementing a PMS with key EPIs for Beethanol BV. However, this PMS was not implemented and therefore it was not possible to recommend certain EPIs to Beethanol BV. This also resulted that several aspects of the theoretical framework like the theory about the EPIs (section 2.2) was less useful in the case analysis. This problem could have been avoided, when the cases would have been analyzed shortly, before establishing the theoretical framework. Than it would have been noticed that no EPIs were implemented yet and the focus of the research and theoretical framework could have been adapted before conducting the main case analysis. The second limitation considers the amount of the cases. Within this research only two bio-ethanol chains and the sustainable wood market are analysed which limits the validation. However, the respondents of the cases were well known with the topic and willing to co-operate. Due to the fact both the production chains are trying to obtain a sustainability certificate, several recommendations could be established. These are mainly based on the sustainability certification and associated co-operation in the chain. Therefore, also the development models were added to make the analysis between the three cases possible. However, the cases are very different and contain many differences with the Beethanol chain. This made it difficult to create normative conclusions

and recommendations. When interpreting these conclusions, the scenarios of the cases should therefore be taken into account. Next, the research was focussed on the environmental aspects and the associated co-operation in the chain. To obtain a sustainable product, also financial and social aspects should be taken into account. While the management of the certification for these topics will not differ with the environmental aspects, it could have differences for the optimal co-operation in the chain. Besides, the establishment of the certification systems is still in development at this moment. Therefore it can be possible that the situation changes in the future when large adaptations are made. The developments in the policy should also be considered. Next year, the RED will be implemented in the Dutch policy. At this moment, not much is known about the exact strategy of the government, which creates uncertainty for the future situation. Therefore this could have an effect on the validity of the recommendations.

6.2. Recommendations on further research

In this section recommendations will be given on further research based on the conclusion and discussion.

First, the research was focussed on the environmental performances in the bio-ethanol chain. While the research also analysed the organisation of a sustainability certification in general, additional research concerning social and financial aspects could be recommended. This could create extra insights in the establishment of the chain organisation. Also the chain governance from in the chain could have additional research. Within this research, the environmental strategies and the associated co-operation types are analysed. But for the supply guarantee and optimal distribution of cost and benefits, other governance types could be more beneficial for Beethanol. Next, the development of the certification systems and government policy should continuously be researched. This could prevent large problems in the future, when large adaptations in the systems of policy would be implemented. This additional research should also contain recommendations about lobby strategies towards the policy. For example concerning the establishment of the compensation fund, which could speed up the sustainability certification in the bio-ethanol sector.

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Appendices

Appendix I. Interview protocol

Name:

Company:

Function:

General

1. How many actors are functioning in the chain?
   - Biomass producers
   - Processing companies
   - Distribution companies
2. What are the operational processes being carried out in these companies?
   - Input
   - Processing
   - Output
3. How are the transactions arranged between the different actors?

Performance Measurement System

4. What is the general chain strategy regarding environmental improvements?
5. What are the targets according this strategy on the following aspects?

5.1: Net emission reduction GHG across the whole chain?

- How are the targets distributed over the biomass production, processing and distribution companies?
- What are the targets for the specific primary processes?
- Which indicators are used to evaluate these targets? And why these?
- With which frequency are these indicators measured? And is this sufficient to guarantee the results?
- Who is responsible for these measures? Which results are reported and for who are these results intended?
- Which actions are taken based on the results?

5.2: Protection Carbon storage in vegetation and in the soil?

- Which indicators are used to evaluate these targets? And why these?
- With which frequency are these indicators measured? And is this sufficient to guarantee the results?
- Who is responsible for these measures? Which results are reported and for who are these results intended?
- Which actions are taken based on the results?

5.3: Protection of biodiversity?

- Which indicators are used to evaluate these targets? And why these?
- With which frequency are these indicators measured? And is this sufficient to guarantee the results?
- Who is responsible for these measures?
- Which results are reported and for who are these results intended?
- Which actions are taken based on the results?

5.4: Protection of soil quality?

- How are the targets distributed over the biomass production and processing companies?
- What are the targets for the primary processes?
- Which indicators are used to evaluate these targets? And why these?
- With which frequency are these indicators measured? And is this sufficient to guarantee the results?
- Who is responsible for these measures?
- Which results are reported and for who are these results intended?
- Which actions are taken based on the results?

5.5: Protection of ground- and surface water?

- How are the targets distributed over the biomass production and processing companies?
- What are the targets for the primary processes?
- Which indicators are used to evaluate these targets? And why these?
- With which frequency are these indicators measured? And is this sufficient to guarantee the results?
- Who is responsible for these measures? Which results are reported and for who are these results intended?
- Which actions are taken based on the results?

5.6: Protection of air quality?

- How are the targets distributed over the biomass production and processing companies?
- What are the targets for the primary processes?
- Which indicators are used to evaluate these targets? And why these?
- With which frequency are these indicators measured? And is this sufficient to guarantee the results?
- Who is responsible for these measures?
- Which results are reported and for who are these results intended?
- Which actions are taken based on the results?

Chain organisation

Chain level

6. Is it clear what each actor is providing to the environmental prestations?

- if Yes; - Does everybody know the prestations of each other?

7. Are there any actors in the chain which obtain profit of the environmental performances of the chain without considerable efforts?
8. Is there any competition between actors within the chain? If yes, between which parties and what is the cause of this competition?
9. To what extent are the actors dependent on each others environmental performances? Which actors are more dependent than others?
10. To what extent have the actors different interests in the cooperation within the chain? Why do the following parties want to join the cooperation?
    - Biomass producers:
    - Processing:
    - Distribution:

Dyadic level

11. Are actors coordinating their investments in their own company on the specific wishes of the partner in the chain regarding the environmental performances? If yes, to what extent:
    - Biomass producers:
    - Processing:
    - Distribution:
12. To what extent is the knowledge and the skills of actors concerning the environmental performances also feasible outside the chain? Do actors need unique knowledge and skills?
    - Biomass producers:
    - Processing:
    - Distribution:
13. How are the agreements made concerning the distribution of profits in the chain? Are there also discussions about this topic?
14. Is all the information on the environmental performances and financial aspects shared with each other? And how are these information flows organised between the parties?
15. Are strategic and operational decisions concerning the environmental targets always made with each other? Does it occur that decisions are taken without discussing with the actors for which these decisions apply?
16. Is it clear that every actor sticks to the agreements concerning the environmental targets? And how can you be sure about this aspect?

Company level

17. To what extent each individual actor has the resources (money, knowledge, technique etc.) to achieve the requested targets of the chain?
18. Why do the separate actors have advantage of the cooperation in the chain?
    - Biomass producers:
    - Processing:
    - Distribution:
19. On which manner are the separate actors externally insisted to cooperate in the chain? (Legislation/customers/NGOs etc.)

- Biomass producers:
- Processing:
- Distribution:

20. Are the separate actors organised sufficiently to achieve the requested targets?
21. Do the separate actors have systems like ISO, GMP etc. to achieve the environmental targets?

Bottlenecks and improvements

22. Do you see any bottlenecks within the cooperation in the chain concerning the achievement of the environmental targets?
23. Where do you see the largest possibilities within the chain to improve the environmental performances?

Appendix II. Sustainable wood market

In this attachment, the properties of the sustainable wood market are elaborated and which has been used to compared with the bio-ethanol sector.

Legislation

The international legislation about sustainable wood only states that it has to be proved that the purchased wood is legal (but it does not have to be sustainable). Also the Dutch legislation does not oblige companies to use sustainable wood, but for their own orders (government agencies) they do oblige suppliers to prove that it is sustainable wood. To distinguish sustainable wood, the Dutch government has formulated several criteria (Timber Procurement Assessment System (TPAS)) which they use to assess the different certification systems to control if the systems comply to their criteria. Actually each country already has sufficient laws to obtain sustainable wood but the control in many countries is insufficient and therefore not reliable and also the systems are used to organise the traceability of sustainable wood[58, 59].

Motives

The main motives in the Netherlands to certificate sustainable wood have derived from the governmental policy and because of a large promotion campaign from Forest Stewardship Counsil (FSC) Netherlands, which is created by several environmental organisations. This campaign has resulted in awareness of the final consumers which started to ask for certified wood. This has ensured that several chains started to certify their wood[58].

Sustainable criteria

The main criteria of sustainable wood is that the maintenance of the forest is everlasting. This contains the replanting of trees, maintenance of the ecosystem, biodiversity and environment etc. The sustainable criteria and KPIs for sustainable wood used in the available certification systems only refer to the maintenance of the forest at the beginning of the chain. All the other actors in the chain only have administration requirements because the origin must be proved. Therefore it is still possible to buy impregnated sustainable wood which damages the environment. One of the main international certification system is the FSC which has elaborated 10 main principles for sustainable wood[60]:

1. Compliance with all applicable laws and international treaties
2. Demonstrated and uncontested, clearly defined, long–term land tenure and use rights
3. Recognition and respect of indigenous peoples' rights
4. Maintenance or enhancement of long-term social and economic well-being of forest workers and local communities and respect of worker’s rights in compliance with International Labour Organisation (ILO) conventions
5. Equitable use and sharing of benefits derived from the forest
6. Reduction of environmental impact of logging activities and maintenance of the ecological functions and integrity of the forest
7. Appropriate and continuously updated management plan

8. Appropriate monitoring and assessment activities to assess the condition of the forest, management activities and their social and environmental impacts
9. Maintenance of High Conservation Value Forests (HCVFs) defined as environmental and social values that are considered to be of outstanding significance or critical importance
10. In addition to compliance with all of the above, plantations must contribute to reduce the pressures on and promote the restoration and conservation of natural forests.

For each country, the FSC has developed specific standards for each principle so the criteria are adjusted to the country specific situation.

Certification systems

While the FSC is created by several external environmental organisations, several other organisations inside the market also created own internal certification systems which resulted in several certification systems for sustainable wood. The most known systems are[58]:

- Forest Stewardship Council (FSC)
- Programme for Endorsement of Forest Certification (PEFC)
- Canadian Standards Association (CSA)
- Sustainable Forestry Initiative (SFI)
- Malaysian Timber Certification Council (MTCC)

These systems have created confusion towards the customers. Especially between FSC and PEFC, because the systems ar the two common used systems in the Netherlands, and in general almost similar. This does not create an ideal situation. Due to the confusion, the consumer might loose trust in the systems. Currently the consumers just require ''sustainable wood'' without making a distinction between the different labels because they do not know the differences between them. As a consequence sustainable wood chains mainly base their decision for their certification system on the cost of the certification. The advantage of more systems is that due to the competition the price of the certification is limited. Still, the optimal situation would be that there would be one internationally accepted system which is trusted by the consumers [58, 59].

Sustainable chain

The chain of sustainable wood consists of several actors. The most important actor are the forest owners which manage the production of sustainable wood. After the forest owners, the wood is processed by cutters, sawmills, processors, traders, (engineering companies), consumers and the associated transport activities. For each chain, the integration of the actors differs. Several chains are totally integrated from the forest ownership until the trading and the whole chain is controlled by one organisation. Other chains all have different actors and are coordinated by formal agreements where the actors ask FSC compliance documentation to their suppliers. In both cases, all the actors should be certified to prove sustainability [58].

Chain of Custody

Two COC systems are used within the sustainable wood market: Physical segregation and Mass Balance. Especially the integrated chains have organised a physical segregation because they only use sustainable certified wood. Also the mass balance is used where for example 70% of the processed wood is certified and 30% not. This 30% may be created due to specific suppliers which can not be certified due to their size or other specific requirements. This system also limits the administrational and logistical burden because they do not have to separate all the wood which is processed [58].

Development process

When the customers started to require sustainable wood, the systems mentioned earlier were developed because companies wanted to meet the needs of the customer and some companies wanted to produce/process sustainable wood from their own conviction. Therefore, the requirements for sustainability certification mainly started with the consumers at the end of the chain and from here, it is required to the suppliers in the chain. Still, there are also several consumers which do not prefer certified wood because they do not want to pay the premium price. But it in the future it is expected that all chains will be certified and no unsustainable wood will exist anymore. In each country different systems are developed, but the implementation of the FSC label in the Netherlands was very succesfull because of the involvement of several market companies at the development phase and a proper promotional campaign. This has ensured that the systems are applied widely by many companies. For example, the FSC in Finland has only one employee which resulted that companies do not take the system seriously and therefore it is not successful. When the chain actors want a sustainable certificate, firstly the forest owner has to meet the sustainable requirements. Second, each actor must manage a administrational system which controls the (sustainable) origin of the wood. All certified actors will be audited annually to guarantee the results. The sustainable wood systems do not make use of a “Meta Standard” but when companies already obtain a ISO label, the implementation of the system and audits are much easier because for the most actors only the administration has to be arranged correctly. It is also possible to arrange a group certification when several partners are too small to arrange a certification. In this case, one person is responsible for the implementation of the system at all the companies, which also results in less audits and cost. Currently, several systems watching to each other and they all are trying to increase their market size. The systems are also searching for possibilities to certify residuals and other materials then wood to increase the capabilities and the reputation of the label [58, 59].

Analysis

The sustainable wood market shows several similarities and differences with the bioethanol market concerning the sustainability critiria and certification. The Dutch government has also described several criteria for the sustainable wood markt and they are stimulating companies to comply with these criteria. However, companies are not obliged to achieve compliance to these criteria. Still, the certification of sustainable wood is becoming a standrd in the wood market. Within the Netherlands, this is mainly obtained by a promotion campaign of the Forest Stewardship Counsil (FSC) which increased the wareness of the consumers. This resulted that companies and chains were insisted by their customers to organise the sustainability certification. Concerning the critiria, the sustainability requirements are only focussed to the production of wood and maintenance of the forest. The rest of the chain only face administrational

and logistical requirements when they want to obtain a sustainability certification. For these companies, the certification will become easier when a ISO certificate is already in place. When small producing companies ar co-operating it is also possible to apply for a group certification which limits the audit and associated costs. The co-operation in the chain to organise the certification differs between the chains. Several chains are based on market based transactions while others have hybrid governance structures (supply contracts, joint ventures) and total vertical integrated chains. This means that it is not obligated to have an intensive co-operation in the chain when the actors are certified for the same system. Eventually is is also expected that the sustainability certification becomes a license to operate for all the actors in the market.

Comparing with the bio-ethanol market, it is clearly visible that the wood chains are several steps ahead concerning the certification. There are several systems available, and each systems is currently looking to improve their system. Regarding bio ethanol there is still no system available but several organisations are working to establish such a system which is expected to create a similar situation with the sustainable wood market where several systems are competing.

Appendix III. Cross compliance

In 2003, the EU's Common Agricultural Policy made cross compliance mandatory for all Member States (Council Regulation 1782/2003). Due to the cross compliance regulation, direct aids to farmers are made mainly via one 'Single Payment Scheme' (SPS) payment per year. 'Cross-compliance' links the direct payments to farmers to their respect of environmental and other requirements set at EU and national levels. All farmers who receive direct payments must comply with all legislation affecting their businesses. Beyond the compliance with the legislation, the cross compliance regulation is extended by including requirements regarding public, animal and plant health, animal welfare, and the maintenance of all agricultural land in good agricultural and environmental condition. It should not be confused with the higher standards ('good agricultural practices') involved in voluntary agri-environment schemes, where farmers may receive a payment for providing environmental services which go beyond basic mandatory legal standards. Failure by farmers to respect the cross-compliance conditions can result in deductions from, or complete cancellation of, direct payments[46].
The cross-compliance regulation can be separated in two parts:

- **Good agricultural and environmental condition (GAEC)[46]**

"*All farmers claiming direct payments, whether or not they actually produce from their* land, must abide by standards to be established by the Member States*. This new requirement is a consequence of the introduction of the SPS and is intended to avoid the abandonment of agricultural land (and its environmental consequences)*."

This requirement concerns
- Soil erosion: minimum coverage, minimum land management reflecting site specific conditions, retain terraces
- Maintenance of organic matter and soil structure: standards for crop rotations where applicable
- Minimum maintenance of set-aside lands: maintenance of set-aside land/protection of permanent pasture, retention -of landscape features, avoiding the encroachment of unwanted vegetation on agricultural land.

- **Statutory Management Requirements (SMRs)[46]**

*"Farmers must respect other cross compliance standards called statutory management requirements set-up in accordance with **19** EU Directives and Regulations relating to the protection of environment; public, animal and plant health; animal welfare."*

The following directives and regulations are related to the production of biomass:
- Birds and Habitat Directive;
- Groundwater Directive;
- Sewage sludge Directive;
- Nitrate Directive;
- Restrictions on the use of plant protection products.

The main administrators of the CAP Member States play the leading role in applying cross-compliance. Their responsibilities include establishing the definition of good agricultural and environmental condition for their agricultural circumstances (at national or regional level), taking into account the specific characteristics of the areas concerned, including soil and climatic condition, existing farming systems, land use, crop rotation, farming practices, and farm structures[46].

The control of cross-compliance requirements will be carried out on the basis of the already existing Integrated Administration and Control System (IACS) for direct payments. A minimum of 1 % of farms should be spot-checked each year for each standard.

Conclusions

Strengthened cross-compliance is a strong move in favour of environmentally-sustainable agriculture, and a response to other societal demands (e.g. relating to animal welfare, food safety etc. The good agricultural and environmental condition requirement should ensure good land management across the EU.

Appendix IV. Eco-Management and Audit Scheme (EMAS)

The EU Eco-Management and Audit Scheme is a voluntary management tool for companies to "*evaluate, report and improve environmental performance. The tool is available since 1995 and was originally restricted to companies in industrial sectors. Since 2001, EMAS is available to all economic sectors including agriculture. In addition, the ISO 14001 was integrated as the environmental management system required by EMAS"[61]*.

To receive EMAS registration farmers have to implement the following steps:

- Conducting an environmental review which considers the environmental impacts of all farm activities and identifies those that most urgently require action. The environmental assessment also includes compiling all relevant legislative standards and verifying whether they are complied with.
- Setting goals for improving environmental performance and determine by what means these goals will be achieved (environmental management system)
- Carrying out an internal audit which assess the management system in place and how it conforms with the goals and programme as well as compliance with relevant environmental regulatory requirements.
- Providing a statement of the farm's environmental performance which lays down the results achieved against environmental objectives and the future steps to be undertaken in order to continuously improve environmental performance[61].

EMAS has no predefined list of standards that have to be complied with in order to be awarded the certificate. Farmers have to set their own goals depending on specific conditions, preferences and circumstances. However, compliance with legal requirements is an integrative element of the scheme. Therefore, all the environmental cross compliance standards should be covered by EMAS. When farmers want to obtain a EMAS label, a checklist of potential environmental impacts that should be assessed is available, suggesting for instance to address storage of substances hazardous to water, impacts on conservation areas, storage of manure and slurry, protection of groundwater etc., but also measures that exceed cross compliance standards, such as minimising resource use and optimising energy efficiency [62]. The environmental review, the environmental management system, the internal audit procedure and the environmental statement must be approved by an accredited EMAS verifier. When the company is certified, the farmer can use the EMAS logo. This logo signals ensures that the farmer comply with all relevant environmental law provisions, that he makes efforts to improve the environmental performance of his company beyond the legislative minimum standards, and that the measures he takes are regularly audited and published [61].

Appendix V. The ISCC project

Currently, consumers do not have the opportunity to choose between sustainable and non-sustainable products. It is only the price and not the quality of a product that determine its success. Therefore, markets do not provide any incentives for sustainable operating farmers and bio-energy producers. This failure of the markets can be corrected by the certification of sustainable biomass and bio-energy. The different initiatives which are developing certification systems for biomass but they are all facing difficulties to guarantee sustainability and GHG savings. The International Sustainability and Carbon Certification Project (ISCC), conducted by consulting company Meo Corporate Development GmbH, provides a solution for this problem. Meo is developing a certification system for biomass and bio-energy that is implementable in practice. ISCC is an internationally oriented, pragmatic certification system, which keeps administration requirements as low as possible, reduces the risk of non-sustainable production and can be used as verification for greenhouse gas emissions from biomass and bio-energy during their life cycle. With this project, ISCC puts the requirements of the Renewable Energies Directive and Biomass Sustainability Regulation (Germany) into practice. Furthermore, initiatives of other countries with sustainability requirements like the NTA8080 are being integrated. The goal of Meo consulting is to create a certification system jointly with partners in Europe, Brazil, Argentina, Malaysia and Indonesia, which enables the verification of sustainability and the reduction in greenhouse gases for the most important resources and bio energies throughout their entire life cycle. While the system is still in development, it documents the bio energy's path all the way back to the field or plantation using a mass balance approach. In this way sustainable biomass can be mixed with biomass of unverified origin along the supply chain. The respective percentages will be recorded along the chain and verified by an independent third party. The ISCC will provide the necessary systems for a mass balance. However, other approaches to traceability may also be integrated. Independent certifiers will use an ISCC checklist for the auditing. The certification itself can be organised cost efficiently due to the acceptance of already existing systems, if they comply with the requirements and certification regulations which avoids multiple certifications. Only a meta-system, such as this, promises a quick implementation at a low cost and with a high acceptance [63].

The ISCC project is not only focussing on bio energy because large quantities of biomass is also used for food and chemical-technical applications, and if these remain unconsidered, no real improvements can be achieved. Therefore the conventional markets are included also and in this way, bio-energy will act as an accespoint for the global introduction of sustainability standards[63].

In principle, the ISCC sets out unambiguous, measurable and verifiable criteria. This is the only way that the conformity of the ISCC Standard can be assessed. Jointly with NGOs and other stakeholders they are developing standards and certification regulations for the entire supply chain. Further criteria for a sustainable agriculture are derived from the good practices and Cross Compliance Regulations from the EU[63].

While the ISCC System is still in development it has already been tried in a test phase. It showed that the programme is suitable for practice and that the results are reproducible and reliable. Sustainability and greenhouse gas audits with different resources and bio-fuels were carried out in the EU as well as in Latin America and Southeast Asia. The Standard clearly describes how results are to be interpreted and which conclusions are to be drawn from specific results[64].

At the end, the aim is to develop a universally applicable system for the entire range of products and to establish verifiable criteria for the most important supply chains. There will always be consumers which are not interested in certified products, and governments that will have no interest in climate protection or the protection of species diversity, but the ISCC wants to make a start to increase the market of certified products[63].

Environmental ISCC criteria [65]

1. Land use

1.1 Biomass is not made from raw material obtained from land with high bio-diversity value - MAJORMUST
This means land that had one of the following statuses in or after January 2008, whether or not the land still has this status:

(a) primary forest and other wooded land, that is to say forest and other wooded land of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed;
(b) (i) areas designated by law or by the relevant competent authority for nature protection purposes; or (ii) areas for the protection of rare, threatened or endangered ecosystems or species recognised by international agreements or included in lists drawn up by intergovernmental organisations or the International Union for the Conservation of Nature.

1.2. Biomass is not made from raw material obtained from highly biodiverse grassland - MAJORMUST
This covers:
(i) highly biodiverse natural grassland, that is to say grassland that would remain grassland in the absence of human intervention and which maintains the natural species composition and ecological characteristics and processes; or
(ii) highly biodiverse non natural grassland, that is to say grassland that would cease to be grassland in the absence of human intervention and which is species rich and not degraded, unless evidence is provided that the harvesting of the raw material is necessary to preserve its grassland status.

1.3 Biomass is not made from raw material obtained from land with high carbon stock
This means land that had one of the following statuses in January 2008 and no longer has this status:
(a) wetlands, that is to say land that is covered with or saturated by water permanently or for a significant part of the year;
(b) continuously forested areas, that is to say land spanning more than 1 hectare with trees higher than 5 metres and a canopy cover of more than 30%, or trees able to reach these thresholds in situ;
(ba) Land spanning more than 1 hectare with trees higher than 5 metres and a canopy cover of between 10% and 30%, or trees able to reach these thresholds in situ, unless reliable evidence is provided that the carbon stock of the area before and after conversion is such that, when the methodology laid down in Annex VII.C is applied, the conditions laid down in 15(2) would be fulfilled. The provisions in this control point shall not apply if at the time the raw material was obtained, the land had
the same status as it had in January 2008.

1.4. Biomass is not made from raw material obtained from land that was peatland in January 2008 - MAJORMUST
Possible only if it is proven that the cultivation and harvesting of this raw material does not involve drainage of previously undrained soil.

1.5. The biomass production does not impair food security - MAJORMUST
The biomass production shall not replace stable crops and does not impair the local food security.

1.6. The producer can proof that the land is used legitimately - MAJORMUST
Documents show legal ownership or lease, history of land tenure and the actual legal use of the land. The producer can must identify existing land rights and does respect them.

1.7. Natural vegetation areas around springs and natural watercourses are maintained or re-established - MAJORMUST
The status of riparian vegetation is known by the producer. Where natural vegetation in riparian areas has been removed there is a plan with a timetable for restoration. Awareness of producer at interview. Timetable and implementation available, where applicable.

1.8. ALL production areas, farms etc. comply the requirements of this standard - MAJORMUST
The registered producer does not have other production areas, farms, companies etc. where for example land use change is undertaken in a way which is not allowed under this standard.

1.9. Environmental aspects are considered if planning buildings, drainage etc. MAJORMUST
Environmental impact of new buildings, drainage systems etc. is assessed and kept as little as possible. If any of these activities are done at the farm documents must be available to show that environmental aspects have been considered.

1.10. Hunting done according to local legislation Local legislation must be complied to. MAJORMUST
Controlling any illegal or inappropriate hunting, fishing or collecting activities; and developing responsible measures to resolve human-wildlife conflicts

2. Soil Erosion

2.1. Field cultivation techniques used to reduce the possibility of soil erosion - MINOR MUST

Evidence of measures of reduce soil erosion available. Maps of fragile soils must be available. A management strategy should exist for plantings on slopes above a certain limit (needs to be soil and climate specific). A management strategy should be in place for other fragile and problem soils (e.g. sandy, low organic matter soils)

3. Soil organic matter

3.1. Soil organic matter is maintained/preserved - MINOR MUST
Soil organic balance (can be generic) or every 6 years a soil organic matter analysis. Results are kept for 7 years.

3.2. There is a restriction on burning as part of the cultivation process - MAJOR MUST
The burning of stubble/other by-products is not allowed. Only with permission of competent authority.

4. Soil structure

4.1. Techniques have been used that improve or maintain soil structure, and to avoid soil compaction - MINOR MUST
Techniques applied are suitable for use on the land.

5. Ground water

5.1. Chemicals are stored in an appropriate manner, which reduces the risk of contamination the environment - MAJOR MUST
Visual assessment of leak tightness of storage facilities for chemicals, this includes mineral oils (fuel).

6. Seed/Rootstock quality and Orign

6.1. Purchased seeds are accompanied by records of variety name, batch number, supplier, seed certification details and are seed treatment records retained - MINOR MUST
Producer must provide records of variety name, batch number, supplier, seed certification details and seed treatments applied.

6.2. Home-saved seed have available records of the identity, source, treatments applied (e.g. cleaning and seed treatments) - MINOR MUST
Producer must keep records and have them available on the farm.

7. Irrigation

7.1. The producer can justify the irrigation in light of accessibility of water for human consumption - MAJOR MUST
Beside the use of water for irrigation/fertigation, water is available for human consumption. Visual assessment, documentation.

7.2. The producer respects existing water rights, both formal and customary - MAJOR MUST
The producer can identify existing water rights and does respect them.

7.3. The producer can justify the method of irrigation used in light of water conservation - MINOR MUST
The idea is to avoid wasting water. The irrigation system used is the most efficient available for the crop and accepted as such within good agricultural practice.

7.4. To protect the environment, water is abstracted from a sustainable source - MAJOR MUST
Sustainable sources are sources that supply enough water under normal (average) conditions

7.5. If ground water is used for irrigation, the level of the groundwater table is monitored - MAJOR MUST
The level of the ground water table is measured at least annually. Comparison with former values. Action if necessary.

7.6. Advice on abstraction has been sought from water authorities, where required by law - MAJOR MUST
Where required by law, there must be written communication from the local water authority on this subject (letter, license, etc.).

8. Advice on quantity and type of fertiliser

8.1. Recommendations for application of fertilisers (organic or inorganic) are given by competent, qualified advisers holding a recognised national certificate or similar? Do producers who use outside professional help (advisers and consultants) regarding the use of fertilisers satisfy themselves that the people on whom they rely are competent to provide that advice - MINOR MUST
Where the fertiliser records show that the technically responsible person making the choice of the fertiliser (organic or inorganic) is an external adviser, training and technical competence must be demonstrated via official qualifications, specific training courses, etc., unless employed for that purpose by a competent organisation (i.e. fertiliser company).

8.2. Where such advisers are not used, producers are able to demonstrate their competence and knowledge - MINOR MUST
Where the fertiliser records show that the technically responsible person determining quantity and type of fertiliser (organic or inorganic) is the producer, experience must be complemented by technical knowledge (e.g. product technical literature, specific training course attendance, etc.) or the use of tools (software, on farm detection methods, etc.).

8.3. During the application of fertilisers with a considerable nitrogen content care is taken not to contaminate the surface and ground water - MAJOR MUST
The producer must demonstrate that he observes at least a distance of 3 m to river banks etc. He takes care that there is no run-off of applied fertiliser into surface water bodies and the ground water.

8.4. Fertilisers with a considerable nitrogen contends are only applied onto absorptive soils - MAJOR MUST
Fertiliser with a content of more than 1.5% of nitrogen in the dry matter are not applied onto flooded, water logged or frozen soils.

9. Records of application

9.1. Complete records of all fertiliser applications are available - MINOR MUST

Records are kept of all fertiliser applications including: The name or reference of the field, exact dates (day/month/year) of the application, the trade name, type of fertiliser (e.g. N, P, K), amount of product which was applied in weight or volume, application machinery type used and the method, name of the operator. Document check at inspection.

10 **Application Machinery**

10.1. Is fertiliser application machinery kept in good condition and verified annually to ensure accurate fertiliser application? - MINOR MUST

There are maintenance records (date and type of maintenance and calibration) or invoices of spare parts of both the organic and inorganic fertiliser application machinery available on request. There must, as a minimum, be documented records stating that the verification of calibration has been carried out by a specialised company, supplier of fertilisation equipment or by the technically responsible person of the farm within the last 12 months.

11 **Fertiliser Storage**

11.1. Are inorganic fertilisers stored in a covered area? - MINOR MUST

The covered area is suitable to protect all inorganic fertilisers, i.e.powders, granules or liquids, from atmospheric influences like sunlight, frost and rain. Based on risk assessment (fertiliser type, weather conditions, temporary
storage), plastic coverage could be acceptable. Storage cannot be directly on the soil. It is allowed to store lime and gypsum in the field for a day or two before spreading.

11.2. Are inorganic fertilisers stored in a clean area? - MINOR MUST

Inorganic fertilisers, i.e. powders, granules or liquids, are stored in an area that is free from waste, does not constitute a breeding place for rodents, and where spillage and leakage is cleared away.

11.3. Are inorganic fertilisers stored in a dry area? - MINOR MUST

The storage area for all inorganic fertilisers, i.e. powders, granules or liquids, is well ventilated and free from rainwater or heavy condensation. No storage directly on the soil.

11.4. Are inorganic fertilisers stored in an appropriate manner, which reduces the risk of contamination of water courses? - MINOR MUST

All inorganic fertilisers, i.e. powders, granules or liquids are stored in a manner which poses minimum risk of contamination to water sources, i.e. liquid fertiliser stores must be BMrrounded by an impermeable barrier (according to national and local legislation, or to contain a capacity to 110% of the volume of the largest container if there is no applicable legislation), and consideration has been given to the proximity to water courses and flood risks.

12 Integrated Pest Management

12.1. Assistance with implementation of IPM systems has been obtained through training or advice - MINOR MUST

The technically responsible person on the farm has received formal documented training and / or the external technical IPM consultant can demonstrate their technical qualifications.

12.2. The producer can show evidence of implementation of at least one activity that falls in the category of "Prevention" - MINOR MUST

The producer can show evidence of implementing at least one activity that includes the adoption of cultivation methods that could reduce the incidence and intensity of pest attacks, thereby reducing the need for intervention.

12.3. The producer can show evidence of implementation of at least one activity that falls in the category of "Observation and Monitoring" - MINOR MUST

The producer can show evidence of implementing at least one activity that will determine when, and to what extent, pests and their natural enemies are present, and using this information to plan what pest management techniques are required.

12.4. The producer can show evidence of implementation of at least one activity that falls in the category of "Intervention" - MINOR MUST

The producer show evidence that in situations where pest attack adversely affects the economic value of a crop, intervention with specific pest control methods will take place. Where possible, non-chemical approaches must be considered.

13 Use of plant protection products (PPP)

13.1. If the choice of plant protection products is made by advisers, they can demonstrate competence - MAJOR MUST

Where the plant protection product records show that the technically responsible person making the choice of the plant protection products is a qualified adviser, technical competence can be demonstrated via official qualifications or specific training course attendance certificates. Fax and emails from advisors, governments, etc. are allowable.

13.2. If the choice of plant protection products is made by the producer, competence and knowledge can be demonstrated - MAJOR MUST

Where the plant protection product records show that the technically responsible person making the choice
of plant protection products is the producer, experience must be complemented by technical knowledge that can be demonstrated via technical documentation, i.e. product technical literature, specific training course attendance, etc..

13.3. All workers handling and/or administering plant protection products have certificates of competence, and/or details of other such qualifications - MAJOR MUST

Records must identify workers who carry out such tasks, and show certificates of training or proof of competence. No N/A

13.4. Producers only use plant protection products that are registered in the country of use for the target crop where such official registration scheme exists - MAJOR MUST

All the plant protection products applied are officially registered or permitted by the appropriate governmental organisation in the country of application. Where no official registration scheme exists, refer to the FAO International Code of Conduct on the Distribution and Use of Pesticides. No N/A.

13.5. There is a process that prevents chemicals that are banned in the European Union from being used on crops for biomass - MAJOR MUST
The documented plant protection product application records confirm that no plant protection product that have been used within the last 12 months on the crops grown under ISCC are prohibited by the E.U. (under EC Prohibition Directive List - 79/117/EC.)

13.6. The producer follows the label instructions - MAJOR MUST
Records and visual assessment. All requirements (protective clothing, storage, handling etc.) have to be followed for the products used.

13.7. All application equipment is calibrated - MAJOR MUST
Documented evidence of up to date maintenance sheets for all repairs, oil changes, etc. undertaken. Application machinery (automatic and non-automatic) has been verified for correct operation within the last 12 months and this is certified or documented either by participation in an official scheme (where it exists) or by having been carried out by a person who can demonstrate their competence. No N/A.

13.8. Invoices of registered plant protection products kept - MINOR MUST
Invoices of the registered plant protection products used, must be kept for record keeping and available at the time of the external inspection. No N/A.

13.9. If there are local restrictions on the use of plant protection products they are observed - MAJOR MUST
Visual assessment, documented evidence available. Producer is aware of restrictions.

13.10. All the plant protection product applications have been recorded including the crop name and/or variety, date, location and trade name of product - MAJOR MUST
Records are available and complete.

13.11. All the plant protection product applications have been recorded including justification for application, product quantity applied, application machinery used, operator - MINOR MUST
The common name of the pest(s), disease(s) or weed(s) treated is documented in all plant protection product application records. No N/A.

14. Disposal of surplus application mix
14.1. Surplus application mix or tank washings is disposed of according to national or local law - MINOR MUST
National or local legislation is observed. Records, awareness during interview.

14.2. Surplus application mixes or tank washings are applied onto designated fallow land, where legally allowed, and records kept - RECOM.
When surplus application mix or tank washings are applied onto designated fallow land, it can be demonstrated that this is legal practice and all the treatments have been recorded in the same manner and detail as a normal plant protection product application, and avoiding risk o surface water contamination.

15 . Plant protection product storage
15.1. Plant protection products are stored in accordance with local regulations - MAJOR MUST
The plant protection product storage facilities comply with all the appropriate current national, regional and local legislation and regulations.

15.2. Plant protection products are stored in a location that is secure - MAJOR MUST
The plant protection product storage facilities are kept secure under lock and key. No N/A

15.3. Plant protection products are stored in a appropriate location - MINOR MUST
The plant protection product storage facilities are: structurally sound and robust, have a sealed floor, built of materials or located so as to protect against temperature extremes, built of materials that are fire resistant (Minimum requirement RF 30, i.e. 30 minutes resistance to fire), have sufficient and constant ventilation of fresh air to avoid a build up of harmful vapours, are located in areas with sufficient illumination both by
natural and by artificial lighting, to ensure that all product labels can be read easily on the shelves, located in a separate air space independent from any other materials.

15.4. The plant protection product store is able to retain spillage - MINOR MUST
The plant protection product storage facilities have retaining tanks or are bunded according to 110% of the volume of the largest container of stored liquid, to ensure that there cannot be any leakage, seepage or contamination to the exterior of the store. No N/A.

15.5. All plant protection product storage shelving is made of non-absorbent material - RECOM.
The plant protection product storage facilities are equipped with shelving which is not absorbent in case of spillage, e.g. metal, rigid plastic.

15.6. There are facilities for measuring and mixing plant protection products - MINOR MUST
The plant protection product storage facilities or the plant protection product filling/mixing area if this is different, have measuring equipment whose graduation for containers and calibration verification for scales has been verified annually by the producer to assure accuracy of mixtures and are equipped with utensils, e.g. buckets, water supply point etc. for the safe and efficient handling of all plant protection products which can be applied. No N/A.

15.7. There are facilities to deal with spillage - MINOR MUST
The plant protection product storage facilities and all designated fixed filling/mixing areas are equipped with a container of absorbent inert material such as sand, floor brush and dustpan and plastic bags, that must be signposted and in a fixed location, to be used in case of spillage of plant protection product. No N/A.

15.8. The product inventory is documented and readily available - MINOR MUST
A stock inventory which indicates the contents (type and quantity) of the store is available and it is updated at least every 3 months. Quantity refers to how many bags, bottles, etc., not on milligram or centilitre basis.

15.9. All plant protection products are stored in their original package - MAJOR MUST
All the plant protection products that are currently in the store are kept in the original containers and packs, in the case of breakage only, the new package must contain all the information of the original label. No N/A.

15.10. Liquids are not stored on shelves above powders - MINOR MUST
All the plant protection products that are liquid formulations are stored on shelving which is never above those products that are powder or granular formulations. No N/A.

16. Obsolete plant protection products
16.1. Obsolete plant protection products are securely maintained and identified and disposed of by authorised or approved channels - MINOR MUST
There are documented records that indicate that obsolete plant protection products have been disposed of by officially authorised channels. When
this is not possible, obsolete plant protection products are securely maintained and identifiable.

17. Empty plant production products containers
17.1. The re-use of empty plant protection product containers for purposes other than containing and transporting of the identical product is avoided - MINOR MUST

There is evidence that empty plant protection product containers have not been or currently are not being reused for anything other than containing and transporting of the identical product as stated on the original label. No N/A.

17.2. The disposal of empty plant protection product containers does occur in a manner that avoids exposure to humans and the environment - MINOR MUST
The system used to dispose of empty plant protection product containers ensures that persons cannot come into physical contact with the empty containers. The risk of contamination of the environment, watercourses and flora and fauna is minimised. No N/A.

17.3. Official collection and disposal systems are used when available - MINOR MUST
Where official collection and disposal systems exist, there are documented records of participation by the producer.

17.4. Empty containers are rinsed either via the use of an integrated pressure rinsing device on the application equipment, or at least three times with water - MAJOR MUST

Installed on the plant protection product application machinery there is pressure-rinsing equipment for plant protection product containers or there are clear written instructions to rinse each container 3 times prior to its disposal. No N/A.

17.5. The rinsate from empty containers is returned to the application equipment tank - MINOR MUST
Either via the use of a container-handling device or via written procedure for the application equipment operators, the rinsate from the empty plant protection product containers is always put back into the application equipment tank when mixing.

17.6. All local regulations regarding disposal or destruction of containers are observed - MAJOR MUST
All the relevant national, regional and local regulations and legislation if it exists, has been complied with regarding the disposal of empty plant protection product containers.

18. Subcontractors
18.1. When the producer makes use of subcontractors, all the relevant information is available on farm - MINOR MUST
Subcontractors must carry out an assessment (or the producer must do it on behalf of the subcontractor) of compliance against the ISCC control points relevant to the services provided on farm. This assessment must be available on farm during the external inspection and the subcontractor must accept that ISCC approved certifiers are allowed to verify the assessments through a physical inspection where there is doubt. The producer is responsible for observance of the control points applicable to the tasks performed by the subcontractor by checking and signing the assessment of the subcontractor for each task and season contracted. Review of documents. N/A if no subcontractors used.

19. Waste disposal
19.1. The premises have adequate provisions for waste disposal - MINOR MUST
The farm has designated areas to store litter and waste. Different types of waste are identified and stored separately. Visual assessment for example for oil/lubricants, tyres and batteries.

19.2. There a documented farm waste management plan to avoid or reduce wastage and pollution and avoid the use of landfill or burning, by waste recycling - *MINOR MUST*

A comprehensive, current, documented plan that covers wastage reduction, pollution and waste recycling is available. Air, soil, water, noise and light contamination must be considered.

20. Energy efficiency
20 .1. The producer can show monitoring of energy use on the farm - MINOR MUST
Energy use records exist. For example, farming equipment shall be selected and maintained for optimum consumption of energy. The use of non-renewable energy sources should be kept to a minimum.

Appendix VI. The better sugar cane initiative

The Better Sugarcane Initiative (BSI) is a collaboration of sugar retailers, investors, traders, producers and NGOs who are committed to sustainable sugar production by establishing principles and criteria that are applied in the sugarcane growing regions of the world. The BSI is funded by members, among who are consumer companies (e.g. Tate & Lyle, Coca Cola, Cadbury Schweppes), commodity traders (e.g. ED & F Man, Cargill), NGOs (e.g. WWF, Solidaridad/Fairtrade), national and local producers (e.g. UNICA, EID Parry) and oil companies (e.g. Shell, BP). The BSI is focussed on the Sugarcane production which produces 1.35 million barrels bio-ethanol per day from approximately 18 million hectares farmed with sugarcane[53].

There is a growing demand for agricultural and industrial enterprises of the fact they need to operate in a sustainable manner. The energy use, production efficiency, elimination of wastage and the effect on global climate change all need to be considered. The sugar industry has much to gain in being involved, because the natural advantage will surely position the industry more favourable as an agro-industrial industry contributing positively to the well being of all. Currently there is also a pressure from the market place for a system to certify that sustainable practices are being adhered. However it is not only the consumers that are the driver for measuring sustainability. Society at large realises the responsibility it has to the greater welfare of the planet[53].

The main aim of the BSI Standard is to develop and promote measurable standards in key environmental and social impacts of sugarcane production and primary processing while recognising the need for economic viability[53].

For the framework, five different headline principles are classified:

- Obay the law;
- Respect human rights and labour standards;
- Manage input, production and processing efficiencies to enhance sustainability;
- Actively manage bio-diversity and ecosystem services;
- Commit to continuous improvement in key areas of the business.

For each of these principles, different indicators and criteria are proposed because the BSI framework is currently still in development. In the long run it is expected that practices conforming the BSI standards will save money, as inputs such as energy and raw material are used more efficiently, losses and wastage are minimised and manpower is used more productively[53].

In table 3 the environmental criteria and indicators of the draft version of the BSI framework are presented[53].

Criteria	Agr.	Proc.	Verifier	Standard*
To comply with relevant applicable laws				
- Relevant national laws and international conventions complied with	x	x	Yes/No	Yes
To monitor production and process efficiency; to measure the impact of production and processing so that improvements are made over time				
- Total raw materials used per kg product		x	kg/kg	<11
- Sugarcane yield	x		tc/ha harvested/y	
- Biomass yield	x		tc/ha harvested/y	
- Mill overall time efficiency		x	%	80
- Factory Performance Index		x	%	90
- Industrial Efficiency		x	%	90
To monitor climate change impacts				
- global warming burden per unit mass product	x	x	t CO2/t sugar	Total <0.4
To assess direct and indirect impacts of sugarcane enterprises on bio-diversity and ecosystems services				
- aquatic oxygen demand per unit mass product	x	x	t/t	
- High Conservation Value areas at risk	x		Yes/No	No
- Soil nutrient status	x		%	80
- Eutrophication per unit mass product	x		tt/cane	
- Ecotoxity to aquatic life per unit mass product	x		tt/cane	
To consult relevant stakeholders and implement appropriate mitigation where adverse impacts are identified				
- documented consultation plan	x	x	Yes/No	Yes
To continuously improve the status of soil and water resources				
- Net water consumed per unit mass of product	x	x	kg/kg	
- soil organic carbon	x		%C	
- soil acidification	x		pH	>4.4, <8.0
To continuously improve the quality of sugarcane and products from the sugar mill				
- Theoretical recoverable sugar in cane	x	x	%	10
To promote energy efficiency				
- Total Net Primary Energy Usage per kg product	x	x	kJ/kg	Total <0
- Energy used in cane transport per tonne cane transported		x	MJ/t cane	<50
- Net primary energy use per tonne of sugarcane	x		MJ/t	<200
To reduce emissions and effluents. To promote recycling of waste streams where practical				
- Atmospheric acidification burden per unit mass product	x	x	t/t	<0.005
- Non-hazardous solid residues per tonne cane	x	x	t/t cane	
For expansion or new sugarcane projects to ensure transparant, consultative and participatory processes that addresses cumulative and induced effects via an environmental and social impact assessment				
- Recognized ESIA	x	x	Yes/No	Yes
- High Conservation Value areas interpreted nationally used as a % of total land affected by a new project or expansion	x	x	%	0

Tabel: 3: Environmental criteria BSI.