



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

TESTING A PERFORMANCE MEASUREMENT FRAMEWORK FOR AGRI-FOOD SUPPLY CHAINS

*Lusine Aramyan*¹
*Alfons Oude Lansink*²
*Olaf van Kooten*³

ABSTRACT

Measurement of entire supply chain performance is an important issue, because it allows for 'tracking and tracing' of efficacy and efficiency failures and leads to more informed decision-making with regards to chain organization. The ultimate aim of implementing a performance measurement system is to improve the performance of the organization. If supply chains can get their performance measurement right, the data they generate will tell them where they are, how they are doing, and where they are going.

The choice of appropriate supply chain performance indicators is rather complicated due to presence of multiple inputs and multiple outputs in the system. This issue becomes even more problematic in the field of food and agribusiness due to specific characteristics of agri-food supply chains. These difficulties require a shift in the focus of performance evaluation and benchmarking from characterising performance in terms of single measures to evaluating performance in a multidimensional systems perspective. Efforts as well as progress have been made in this area but supply chain performance measurement received little attention in the field of food and agribusiness. This paper presents a conceptual framework for selection performance measurement indicators for agri-food supply chain. Four main categories of performance measures are identified as necessary components in agri-food supply chain performance measurement system. Each category contains set of performance indicators. Case study research has been designed in Dutch tomato supply chain to test the proposed conceptual framework.

Key words: agri –food chain, indicator, performance, case study

INTRODUCTION

In order to be able to assess the success of supply chains an adequate performance measurement system needs to be developed. The basic purpose of any measurement system is to provide feedback, relative to the set of goals that increases organizations' chances of achieving these goals efficiently and effectively. Recent studies have shown that performance indicators to measure supply chain performance that includes the characteristics of inclusiveness, universality, measurability and consistency are not available (Beamon, 1998). Evaluation of an organisation's performance is complicated in the presence of multiple inputs and multiple outputs in the system. These aspects require a shift in the focus of performance evaluation and benchmarking from characterizing performance in terms of single measures to evaluating performance as a multidimensional systems perspective (Zhu, 2002). Lee and Billington (1992) found that supply chains do not have an adequate performance metrics and firms only aim at achieving their own performance standards. There is less agreement, however, on the matter of what such a system should look like. According to Bunte et al. (1998) performance indicators should relate to both effectiveness and efficiency of the supply chain and its actors. Van der Vorst (2000) makes a distinction for performance indicators on three main levels: supply chain

¹PhD researcher in Business Economics (e-mail: Lusine.Aramyan@wur.nl)

²PhD professor of Business Economics at Wageningen University (e-mail: Alfons.Oudelansink@wur.nl)

³Chair of the Horticultural Production Chains group at Wageningen University (e-mail: olaf.vankooten@wur.nl)



level, organization level and process level. Beamon (1999) suggests a system of three dimensions: resources, output and flexibility.

Measuring the performance of chains and networks received little attention in the field of food and agribusiness. Agri-food supply chains have many specifications, which set them apart from other types of supply chains. Examples are: 1) Shelf life constraints for raw materials and perishability of product, 2) Long production throughput time 3) Seasonality in production 4) Physical product features like sensory properties such as taste, odour, appearance colour, size and image 5) Requires conditioned transportation and storage; 6) Product safety issues and many more.

Recent socio-economic developments have resulted in a change in performance requirements for food supply chains as a whole and for all stages in the supply chain (Van der Vorst, 2000). This change is the result of the variation in buying behaviour of consumers. Besides the consumers' preference variation, environment plays a vital role in agri-food supply chain performance assessment. The environmental variability affects the quantity and the quality of the farm products. The perishability of products put strains on logistics and quality management. Given these facts it is obvious that food quality and environmental issues have a great impact on agri-food supply chain performance. Thus, when developing a performance measurement system for agri-food supply chains, the indicators that reflect the quality aspects of product and processes are important (freshness, food safety, environmental issues, etc.) and together with other indicators, should be included into a performance measurement system.

Recently Aramyan et al. (2005) developed a conceptual framework of performance measurement system for agri-food supply chains, which captures the characteristics of agri-food supply chain as well as other financial and non-financial indicators. The goal of this study is to test the developed conceptual framework for measuring the performance of agri-food supply chains that can be adapted to different decision-makers and decisions to be made.

The paper is organized as follows. In the next section the details of the conceptual framework are briefly discussed followed by the case study description and methods used to carry out the research. Next, the results of the case study are analysed for each member of the supply chain separately. The paper ends with conclusions and discusses areas for future research.

DEVELOPING A CONCEPTUAL FRAMEWORK

This section develops a conceptual framework for measuring performance of agri-food supply chains. Based on the literature review on existing performance indicators a conceptual framework for measuring performance of agri-food supply chains has been developed (Aramyan et al., 2005). The framework takes into consideration specific characteristics of agri-food supply chains. The agri-food supply chain performance indicators are grouped in four main categories: efficiency, flexibility, responsiveness and food quality. These main categories contain more detailed performance indicators (Figure 1). Efficiency aim to maximise value added by the process and minimise the cost absorbed in inventories. It includes several measures, but the most important ones are cost minimisation, profit maximisation and return on investment maximisation. Flexibility indicates the degree to which the supply chain can respond to a changing environment. It may include customer satisfaction, reduction in the number of backorders, lost sales, late order. Responsiveness aims at a high level of customer service and may include fill rate maximisation, product lateness minimisation, customer response time minimization, lead time minimization, error shipping, and customer complaints.

The specific characteristics of agri-food supply chains are captured in the measurement framework in category "food quality". The latter is based on the framework of food quality

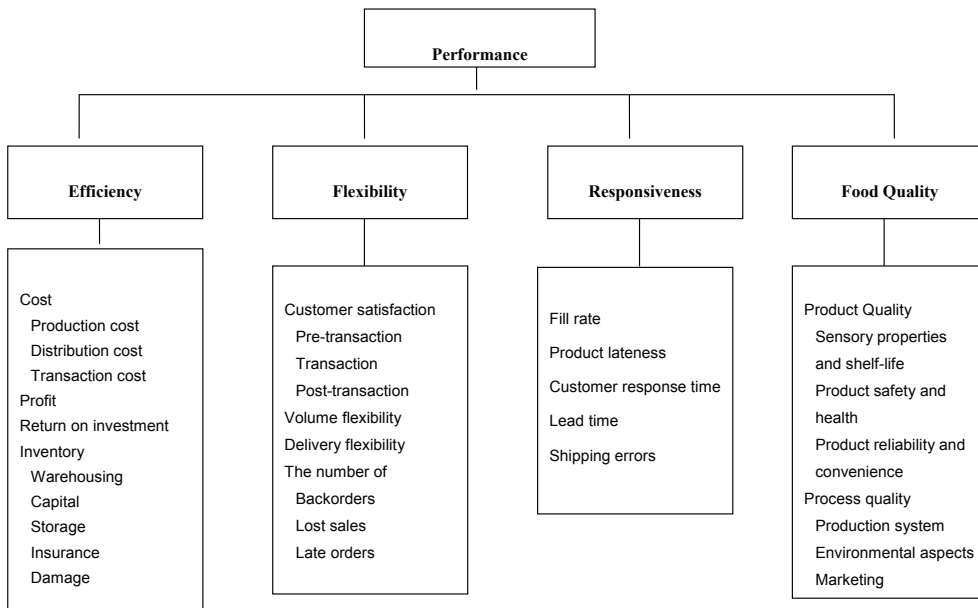


Figure1. Conceptual framework of agri-food supply chain performance indicators

developed by Luning et al (2002). Food quality is divided into product and process quality. Product quality in its turn is divided into 1) Food safety and health, 2) Sensory properties and shelf life 3) Product reliability and convenience refers. Process Quality is divided into production 1) system characteristics, 2) environmental aspects and 3) marketing.

Adding the category “food quality” to the three other categories completes the conceptual framework (Figure 1).

CASE STUDY DESCRIPTION

The case study is applied to the Dutch tomato supply chain. The choice of this supply chain was conditioned upon the fact that it is one complete chain starting from breeder till the end consumer.

The supply chain in this case is the integral chain management for tomatoes on the vine and consists of one breeder, 12 growers in the Netherlands, one wholesaler in Germany and multiple distribution centres and retailers in Germany. This paper is limited in analysis from breeder till wholesaler due to lack of time. The paper will be extended in the future research till the retail.

Breeder

In this chain there is one breeder, situated in De Lier, the Netherlands. The company is specialised in breeding, production and selling of many different vegetable seeds. The company activities are based on a number of quality control systems such as ISO 9001 norms, NAL system (specific tests for seed characteristics, e.g. germination, purity of seeds). In cooperation with ECAS (European institute for certification for the agricultural sector), the company developed the integral chain management system to guarantee product quality.



GROWERS

In this chain there are 12 tomato growers who grow tomatoes situated in the South of the Netherlands. Together they add up to an area of 24.35 hectares of tomatoes. In total 7 growers agreed to participate in interview. All interviewed growers cultivate 100% tomato except for one grower who cultivate 50% tomato. Quality standards used by the growers are integral chain management, Integrierte Anbau (German control system of integrated cultivation) and Eurep GAP.

WHOLESALER

The wholesaler involved in this supply chain is a vegetable wholesaler in Weeze, Germany. The company is working on certification according to the International Food Standard (IFS). The company delivers half of the production to supermarkets in Germany (3000 supermarkets in total). The share of tomatoes in total sales is 25%.

METHOD

The source of information are interviews with 1) a chain manager in a breeding company 2) owner-growers in seven tomato producing firms, 3) wholesaler in wholesale company. The type of interview is a focused interview (Yin, 1994), in which the interview consists of open-ended questions and a set of questions in the form of questionnaire. The first part of questionnaire includes general open-ended questions to become familiar with the firm. In the second part of the questionnaire respondents are given definitions of possible performance indicators that can be integrated into a performance measurement system. Respondents were given the opportunities to suggest new indicators and/or to reject the proposed ones and to provide suggestions for better (practically possible) ways to measure the suggested indicators. Next, the respondents were asked to rank the listed indicators of performance according to the perceived importance for their firm. The used ranking method is interval ranking (Churchill, 1999). A Likert scale of 1 to 5 was used with 1 being not important at all for measuring performance and 5 being very important. In order to compare the final ranking average and standard deviation of the relative importance weights of indicators were calculated for each respondent. Relative importance weights correct for differences in levels between respondents and for unequal observations per respondent (Calker, 2004). The cause of such differences in levels between respondents is an outcome of different perception of respondents to a Likert scale, e.g. some respondents incline to give only scores 4 or 5 to all indicators, the others 2 or 3. The relative importance weight, W_{ij} for indicator i , respondent j , was calculated as follows:

$$W_{ij} = \frac{(X_{ij})}{(X_j)}$$

Where

(X_{ij}) = the value of indicator i for respondent j

(X_j) = The average ranking of all indicators for respondent j

This procedure has been done only for growers, given that the number of breeder and wholesaler in chain equals to one.

RESULTS OF CASE STUDY

Results of the case study are found in tables 1, 2 and 3. Analyses of results are presented separately for each link of the supply chain.

BREEDER

Category Efficiency

Results shows that four indicators of efficiency out of five are important in measuring the performance of the firm (see table 1). Suggested indicators for efficiency were costs (PRODC, TRANSC) profit (PROFIT), return on investments (ROI) and inventory (INVENT). All suggested indicators are measured in the company. Transaction costs are measured partly, e.g. costs for searching new clients are calculated and included in general costs. Respondent remains indifferent for transaction costs, arguing that these costs do not have much influence on performance. Unlike the growers, breeder emphasized the importance of inventory costs. They have high storage cost, including insurance, because seeds in storage are very expensive.

Category Flexibility

Suggested indicators for category flexibility were Customer satisfaction (CUSSAT), Volume flexibility (VF), Delivery flexibility (DF), the number of backorder (BACK), lost sales (LOSTS) and late orders (LATOR). From table 1 it is obvious that CUSTSAT is the most important indicator of performance. Initially CUSTSAT was divided into 3 phases: pre-transaction, transaction satisfaction and post-transaction satisfaction. Interview reveals that only CUSTSAT in pre-transaction phase is calculated. Company has registered complaints system for customers. By that system the CUSTSAT is measured. In this phase breeder looks at, e.g. willingness to customize service, which is changes in orders due to customer requirements. Occasionally breeder performs a customer research to ask for satisfaction of growers, their opinion about breeder, their image, reliability and so on.

Although DF is important for measuring performance, the company does not measure it. The company has a list of prior customers, which is used in case if rush order takes place. VF is calculated, taking into account a plan of expected sales. At the end of the year actual sales are compared with planning. Breeder is indifferent about reduction in number of backorders. According to respondent lost sales do not happen, because the product is too valuable.

Category Responsiveness

Suggested indicators for the category responsiveness are fill rate (FILRATE), product lateness (PRLATNES), customer response (CRT), lead time (LEADT), customer complaints (CUSCOMP) shipping errors (SHIPER). Table 1 shows that the most important indicator is product lateness, scoring a value 5 and the least important indicator is shipping errors scoring a value 3. From all suggested indicators, three are used in the company: lead time (with the help of planning), customer response time (by sending out questionnaire to customers) and customer complaints (all complaints are registered).

Product Quality

Suggested indicators for food quality were: appearance (APPEAR), colour (COLOR), firmness (FIRMNES), size and form (SIZEFORM), taste (TASTE), shelf life (SHELFL), salubrity (SALUBR), safety (SAFETY), certified product (CERTIFPR), product reliability (PRODREL), convenience in information on packaging (CONVEN). These indicators fall into three subcat-



egories (see section 2). All indicators of food quality are measured in the firm, except for SAFETY, which is the responsibility of the growers. Besides, additional product quality measurements are taking place in the firms of growers and in retail shops. Table 1 indicates that all indicators except for two received value 4 and 5, indicating a high importance of suggested indicators in measuring performance of the firm.

Table 1. Perceived importance scores of indicators for Breeder

Efficiency			Flexibility			Responsiveness			Food quality					
									Product Quality			Process Quality		
Indicators	score	measured	Indicators	score	measured	Indicators	score	measured	Indicators	score	measured	Indicators	score	measured/ checked
PRODC	4	yes	CUSSAT	5	partly	FILRATE	4	no	APPEAR	5	yes	TRACEAB	5	yes
TRANSC	3	partly	DF	4	no	PRLATNES	5	no	COLOUR	4	yes	STORTR	5	yes
PROFIT	4	yes	VF	4	yes	CRT	4	yes	FIRMNES	4	yes	WORK	5	yes
ROI	4	yes	BACK	3	no	LEADT	4	yes	SIZEFORM	4	yes	ENERGY	5	yes
INVENT	4	yes	LOSTS	4	no	CUSCOMP	4	yes	TASTE	5	yes	WATER	4	yes
			LATOR	4	no	SHIPER	3	no	SHELFL	5	yes	PACKAGE	4	yes
									SALUBR	4	yes	REUSE	4	yes
									SAFETY	5	no	PESTUS	4	yes
									CERTIFPR	4	---	EMIS	3	no
									PRODREL	5	yes	PROMOT	5	no
									CONVEN	4	yes	SERVICE	5	no
												DISPLAY	3	no

Process Quality

Suggested indicators for process quality are traceability (TRACEAB), storage and transportation conditions (STORTR), working conditions (WORK), energy use (ENERGY), water use (WATER), the use of packaging materials (PACKAGE), reuse (REUSE), pesticide use (PESTUS), emissions (EMIS), promotions in the supermarkets (PROMOT), client service (SERVICE) and displays in the stores (DISPLAY). These indicators fall into three subcategory (see section 2). The suggested indicators are all measured in the company except for last three indicators of marketing and indicator EMIS. The respondent argued that indicators of marketing are difficult to measure. All indicators of process quality received a high importance scores 4 or 5, except for indicators EMIS and DISPLAY.

GROWERS

Efficiency

Results of interview reveal that two indicators (PROD and ROI) are important in measuring performance of the firm and one indicator (PROFIT) received score 5 for being very important with the highest score for relative importance weight 1.24. (see table 2). It is interesting to see that the standard deviation of PROFIT is zero among growers, indicating that profit remains the most important indicator among others. The lowest average score (3.14) is given to INVENT with an average importance weight of 0.77. From 5 suggested indicators of efficiency only 3 are measured by the firms. Transaction costs as well as inventory costs are not measured. In case the firms incur transaction costs, they include them in general costs.

Flexibility

From table 2 it is obvious that CUSTSAT is the most important indicator of performance in category flexibility. Although CUSTSAT received the highest score, it is not measured by any firms. The possible explanation for this fact is that in this particular chain growers are only producers. Every week growers make an overview of expected yield and send it to wholesaler). Based on these overviews, the wholesaler places his order. The product is collected from the firm by wholesaler. Therefore, transaction satisfaction, such as frequency of delivery or on-time

delivery is the responsibility of the wholesaler. In post-transaction satisfaction, if wholesaler is not satisfied with the product, growers receive phone-call.

The second indicator which received a high importance score (4.28) is DF. Although DF is important for measuring performance, firms do not measure it. Growers do consider DF and

Table 2. Mean and standard deviation of perceived importance scores and relative importance weights of indicators for growers

Indicators	Mean scores	SD scores	Measured/ checked	Mean W	IMP. SD IMP.W.
Efficiency					
PRODC	4.85	0.37	yes	1.2	0.11
TRANSC	3.85	0.69	no	0.95	0.17
PROFIT	5	0	yes	1.24	0.04
ROI	4.71	0.48	yes	1.16	0.14
INVENT	3.14	0.69	partly	0.77	0.18
Flexibility					
CUSSAT	4.85	0.37	no	1.2	0.11
DF	4.28	0.48	no	1.05	0.1
VF	3.71	0.48	no	0.91	0.11
BACK	2.42	0.78	no	0.6	0.17
LOSTS	3.14	1.06	no	0.77	0.26
LATOR	3.42	0.97	no	0.84	0.23
Responsiveness					
FILRATE	3.57	1.13	no	0.88	0.28
PRLATNES	3.57	0.97	no	0.88	0.23
CRT	3.85	0.37	no	0.95	0.07
LEADT	4	0.57	yes	0.98	0.12
CUSCOMP	4.42	0.53	yes	1.09	0.14
SHIPER	3.85	0.69	no	0.95	0.16
Product quality					
APPEAR	4.71	0.48	yes	1.16	0.11
COLOUR	4.57	0.53	yes	1.12	0.12
FIRMNES	4.57	0.53	yes	1.13	0.16
SIZEFORM	4	0.57	yes	0.99	0.14
TASTE	4.71	0.48	yes	1.16	0.11
SHELFL	4.71	0.48	yes	1.16	0.11
SALUBR	4	1.15	yes	0.98	0.28
SAFETY	4.42	0.53	yes	1.09	0.12
CERTIFPR	4.42	0.78	-	1.09	0.21
PRODREL	4.71	0.48	yes	1.16	0.14
CONVEN	4.14	0.69	yes	1.02	0.16
Process quality					
TRACEAB	4.57	0.53	yes	1.12	0.12
STORTR	4.28	0.48	no	1.05	0.1
WORK	4.14	0.37	yes	1.02	0.09
ENERGY	4.71	0.48	yes	1.16	0.14
WATER	4	0.81	yes	0.98	0.2
PACKAG	3	0.81	no	0.74	0.2
REUSE	3.57	0.78	yes	0.88	0.19
PESTUS	4.14	1.06	yes	1.01	0.24
EMIS	2.57	0.53	no	0.63	0.12
PROMOT	4	0	no	0.99	0.04
SERVICE	4.14	1.06	no	1.02	0.27
DISPLAY	3.71	0.75	no	0.91	0.18



always put rush orders in the first place. However, there are no records of them. VF is not calculated. The major intention of growers is to produce as much as possible, even if the demand for the product is very low and they make losses. One of the explanations for this is that they are restricted by the size of glasshouse. Yet another explanation is that with agricultural production it is very difficult to predict the volume even having data from previous years, due to e.g. weather uncertainty.

Reduction in BACK, LOSTS and LATOR are not calculated. These indicators also received the lowest scores of importance ranging between 2.42 and 3.42. These answers are explained by the fact that the wholesaler takes care of products collection and transportation. Therefore, these indicators are more important for wholesalers, than for growers.

CATEGORY RESPONSIVENESS

From table 2 we can see that the most important indicators are CUSCOMP (4.42) and LEADT (4). From all suggested indicators, only two are used in the firms: lead time and customer complaints. In general growers think that this part is more applicable to wholesaler, because wholesaler collects products; thus growers are not responsible for logistic.

Product Quality

All sensory properties mentioned are measured by breeder four times per year at growers' firms and at supermarkets. Twice per year KCB (Dutch Quality Control Bureau) also provides quality checks of products. From Table 2 we can see that all product quality indicators received high perceived importance (ranging from 4.00 till 4.71) scores and high average relative importance weight scores (ranging from 0.98 till 1.16). In order to increase the product quality respondents indicated the importance of feedback from wholesaler about the customer complaints.

Process Quality

From table 2 we can see that 8 indicators obtained a high importance score, 3 indicators (PACKAG, REUSE and DISPLAY) received indifferent importance score and one indicator (EMIS) is perceived to be unimportant. Energy use (ENERGY) is perceived to be the most important indicator in this category due to high share of energy costs in total costs. At the current moment growers do not have restrictions on energy use (or CO₂ emissions) from government, but it is expected on 2010. The glasshouse sector signed an agreement with the government aiming at reducing the use of energy. However it is not on firm level, but it is in sector level, which makes grower not very much concerned.

WHOLESALE

Efficiency

All suggested indicators are calculated in the company. However, not all indicators appeared to be important (see table 3). The wholesaler is indifferent about the inventory costs and transaction costs, arguing that these indicators do not affect the performance of the firm.

Flexibility

Customer satisfaction is very important for the company. The indicator is measured by the company. For instance, in pre-transition satisfaction phase the ease of placing orders is considered. The company has fixed contracts with customers concerning the orders, which makes order placing easy. In case if problem emerge, they are addressed immediately. In transition

satisfaction phase the frequency of delivery is measured. In post-transaction satisfaction phase, wholesaler takes a responsibility of damage adjustment.

The attitude to the DF and VF is the same as in two previous links. They are not calculated, although they score a high value of importance. Rush orders are done in the first place. Reduction in number of backorders, lost sales and late orders are registered for short-term. The respondent is in different about backorders and lost sales, because it rarely happens.

Responsiveness

From all suggested indicators of responsiveness, only CUSCOMP received a low score (in-different). Surprisingly, the company does not pay much attention on customer complaints. Fill rate is calculated and it is very important. PRLATENES is not calculated, though it is considered very important. The respondent explained the contradiction by the argument that product has to be in time, no mistakes are allowed and usually do not happen. The remaining indicators in category responsiveness are calculated by the firm and received high score of importance (see table 3).

Product Quality

From table 3 we can see that all indicators of product quality received very high scores of importance, indicating that the company takes product quality very serious. All indicators are measured except (for SALUB) in the company by quality inspectors of the company. The indicators PRODREL and CONVEN are checked by KCB. SHEFL is measured, with growers group every month. SAFETY is registered according to rules in quality checks by Food Compass.

Table3. Perceived importance scores of indicators for Wholesaler

Efficiency			Flexibility			Responsiveness			Food quality					
									Product Quality			Process Quality		
Indicators	score	measured	Indicators	score	measured	Indicators	score	measured	Indicators	score	Measured/ checked	Indicators	score	Measured/ checked
DISTR	4	yes	CUSSAT	5	yes	FILRATE	5	yes	APPEAR	5	yes	TRACEAB	5	yes
TRANSC	3	yes	DF	5	no	PRLATNES	5	no	COLOUR	5	yes	STORTR	5	yes
PROFIT	5	yes	VF	4	no	CRT	4	no	FIRMNES	5	yes	WORK	4	yes
ROI	4	yes	BACK	3	registered	LEADT	4	yes	SIZEFORM	5	yes	ENERGY	4	yes
INVENT	3	yes	LOSTS	3	registered	CUSCOMP	3	yes	TASTE	5	yes	WATER	2	yes
			LATOR	4	registered	SHIPER	4	yes	SHEFL	5	yes	PACKAG	4	yes
									SALUBR	5	no	REUSE	3	yes
									SAFETY	4	yes	EMIS	3	no
									CERTIFPR	5	-	PROMOT	5	no
									PRODREL	5	yes	SERVICE	3	no
									CONVEN	4	yes	DISPLAY	5	no

Process Quality

Compared to the previous category the scores of the different indicators in this category are more varied (see table 3). From 10 suggested indicators, 5 received high importance scores and 3 indicators (REUSE, SERVICE and DISPLAY) received indifferent importance scores and one indicator (WATER) is perceived to be unimportant. The perceived unimportance is explained by the fact water is hardly used in the company.

Although plastic boxes are reused and carton boxes are recycled, the company does not measure these indicators. The respondent explained that the value of reuse/recycle is very small and do not affect the total production. The company has no constraints from government concerning emissions which explains why the respondent is indifferent about this indicator. Indica-



tors for marketing (PROMOT, SERVICE and DISPLAY) are not measured by the company, because it is too difficult to measure, which is in line with the answer of the breeder.

SUMMARY OF RESULTS

The table 4 presents indicators that received low scores of importance (3.85 and lower) in at least one of the links of the supply chain. Chain members jointly appear to be indifferent about several indicators (or found not important) such as transaction costs, backorders, emissions arguing that these indicators have no impact on performance measurement (see table 4).

This particular chain is very tight. Growers are not allowed to sell their products to wholesalers that are not a part of the chain. Growers do not seek other marketing channels such as e.g. marketing via auction or direct marketing. The explanation of this occurrence is that growers benefit from the wholesaler having no transportation costs and saving time for marketing their products. On the other hand wholesaler trusts the growers and is assured of a constant supply of products. Therefore, we can conclude that there is a high level of trust between chain members. This fact is reflected in mutual agreement upon e.g. delivery of products, customer response time or delivery flexibility, where many transactions are based purely on telephone calls. The fact that transaction costs appeared to be not interesting indicator for all chain members once again shows that there is a high level of trust between chain members.

Results show that there is a joint agreement between supply chain members on category product quality, where all indicators received high score of importance in all links of the supply chain. This implies that product quality is one of the major determinants of the chain per-

Table 4. Comparison of low score-received-indicators between members of the chain

Indicator	Breeder score	Grower score	Wholesaler score
Efficiency			
TRANSC	3	3.85	3
INVENT	4	3.14	3
Flexibility			
VF	4	3.71	4
BACK	3	2.42	3
LOSTS	4	3.14	3
LATOR	4	3.42	4
Responsiveness			
FILRATE	4	3.57	5
PRLATNES	5	3.57	5
CRT	4	3.85	4
CUSCOMP	4	4.42	3
SHIPER	3	3.85	4
Process Quality			
WATER	4	4	2
PACKAG	4	3	4
REUSE	4	3.57	3
EMIS	3	2.57	3
SERVICE	4	3.57	3
DISPLAY	3	3.71	5

formance. There is a high level of agreement between chain members on category efficiency. The disagreement is reflected on only one indicator, which is inventory. Inventory costs are important for breeder given a large amount of expensive seeds kept in the storage for long time-period, which increases the costs of warehousing. A wholesaler sells its whole stock within one day. Agreement among chain members in category efficiency one more times shows that the costs remain one of the major concerns for measuring supply chain performance.

There is less agreement between chain members on importance of categories flexibility, responsiveness and process quality. Indicators in these categories such as e.g. fill rate, product lateness, customer complaints, water use, packaging, display in the stores, etc. (see table 4) received different importance perception in different links of the chain. Fill rate is not very interesting ifor growers, because wholesaler is responsible for transportation. The same goes for product lateness. Surprisingly customer complaints received low score at wholesaler, while breeder and growers find this indicator more important. During the interview growers explained that they would appreciate to have feedback information about customer complaints. Obviously growers lack information from the end of the chain. Water use and packaging received different scores in different links, because of differences in use of these indicators in different links.

CONCLUSIONS AND DISCUSSIONS

This paper tests a conceptual framework for selection performance measurement indicators for agri-food supply chain. Summarizing all results it became obvious that four main categories of performance measures suggested in the conceptual framework are confirmed as the necessary components in agri-food supply chain performance measurement system. Some of the suggested indicators within these categories such as e.g. transaction costs, backorders or emissions are proved to be not important for measuring the performance of the chain. Some of the suggested indicators e.g. production costs, profit, customer satisfaction and product quality indicators are very important for all members of supply chain. Chain members disagree about the importance of several indicators, e.g. fill rate, water use. Therefore, the framework can be adjusted to each member of the chain, based on the importance of the given indicators for each chain member. Namely, by using four main categories (efficiency, flexibility, responsiveness and food quality) integrated into one measurement system, chain members have the choice to include/exclude suggested indicators in the system based on their own perceptions about the importance of these indicators.

In order to have a complete view of how should measurement system look like for entire supply chain, for the future research the case study needs to be extended till the retail. Furthermore, in order to test the applicability of this framework to real world an empirical research needs to be carried out. One of the suitable methods of analysis could be Multi Criteria Decision Making approach.

REFERENCES

Aramyan, L., Ondersteijn, Ch., Van Kooten O., Oude Lansink, A.(2005).Performance Indicators in agri-food production chains. In Press. In C. Ondersteijn et al (Ed.), "Quantifying Supply Chains", Kluwer Academic Publisher, Dordrecht, The Netherlands.

Beamon, B. M., 1998. Supply chain design and analysis: Models and methods. *International Journal of Production Economics* 55, 281-294.

Beamon, B. M, 1999. Measuring supply chain performance. *International Journal of Operations and Production Management* 19(3), 275-292.



Bunte, F., Mulder, M., Van Tongeren, F., and De Vlieger, K. (1998). Meting van de 'performance' van agrarische productiekolommen. LEI-onderzoeksverslag 163, Den Haag.

Churchill, G.A.(1999). Marketing research: Methodological foundations. Orlando: The Dryden Press, 1017pp.

Disco, A.(2004). Scoren op kwaliteit eist doorzettingsvermogen. Groeten & Fruit, week 48, pp18-19.

Luning, P.A., Marcelis, W.J., Jongen, W.M.F., 2002. Food Quality Management: a techno managerial approach Wageningen Academic Publishers, The Netherlands.

ECAS, 2003. Certificatieschema 'IKZ®'. Integrale ketenzorg, versie 2, 23p.

Van Calker, K.J., Berensten, P.B., Giesen, G.W., and Huirne, R.B.(2005). Identifying and ranking attributes that determine sustainability in Dutch dairy farming. Agriculture and Human Values 22, 53-63.

Van der Vorst, J.G.A.J., 2000. Effective Food Supply Chains. Generating, modelling and evaluation supply chain scenarios. PhD thesis Wageningen University, The Netherlands.

Yin, R.K. (1994). Case study research. Design and methods. Applied Social Research Methods Series, volume 5, second edition. Thousands Oaks, London.

Zhu, J., (2003). Quantitative models for performance evaluation and benchmarking. Kluwer Academic Publishers, Dordrecht.