Costs and Benefits of Quality Systems: Case Study

Stephanie Krieger and Gerhard Schiefer

Department of Food and Resource Economics,
Chair of Business Management, Organization and Information Management
University of Bonn, Meckenheimer Allee 174,
53115 Bonn, Germany

st.krieger@uni-bonn.de ; schiefer@uni-bonn.de

Paper prepared for presentation at the 110th EAAE Seminar 'System Dynamics and Innovation in Food Networks' Innsbruck-Igls, Austria
February 18-22, 2008

Costs and Benefits of Quality Systems: Case Study

Stephanie Krieger and Gerhard Schiefer
Department of Food and Resource Economics,
Chair of Business Management, Organization and Information Management
University of Bonn, Meckenheimer Allee 174,
53115 Bonn, Germany
st.krieger@uni-bonn.de ; schiefer@uni-bonn.de

1. Introduction

The variety of quality systems is a very important and an actual theme in the agri-food sector. These quality systems are only partly acknowledged by different quality standard organizations, but customers within the supply chain demand them. Enterprises, which supply different customers and export abroad this, face the problem that they have to deal with several standards and implement them within the enterprise as well as take part in several systems audits and certifications. The economic problem consists of determining the most efficient introduction of a quality system or a combination of quality systems in the enterprise.
The emphasis of the work lies in the development of a framework for the benchmarking of quality systems at all stages of the agri-food production and an allocation and operationalisation of cost and benefit categories. A concept including the database "QualintSys" was developed during a PhD-thesis to estimate the costs and benefits of quality systems.

2. Scenario-dependent results

For the validation of the concept and the linkage of the results of expert interviews with the results from the "QualintSys" database, a selection of scenarios was accomplished, which should bring results as close as possible to reality for the estimation of costs and benefits. Analyse was at the farm, the processing and the retail level. This paper includes the presentation of the farm level.

3. Cost and Benefit on the stage of agriculture

This case study delivers first results about costs and benefits for the implementation of a quality system at the agricultural level.

Scenario
For the validation of the concept for the determination of approximate values for costs and benefits of quality systems at the agricultural level the following scenario was selected. Developments in the quality system industry and on political level suggest that in the future the implementation of a HACCP concept on agricultural level will be obligatory. Moreover a QS certification represents already today a component of the quality management for a high number of pig producers in Germany.
GlobalGAP tries to hold ground on the field of livestock production after successfully introducing its system into the fruit and vegetable growing, so that in the future a GlobalGAP certification at agricultural level for the farmer who produces livestock can become of crucial importance and this not only for the market entrance. Apart from these three quality systems on the international market – predominant in Australia and the USA – an increased demand for the

SQF 1000 is registered (LUNING et al., 2002, p. 259). These four quality systems – beginning with quality control system over quality assurance system up to the quality management system – will be a component of the scenario-related case study.

Benefit-Cost-Analysis

In Germany the number of farms with more than 2 hectares of land lay about 420.000 in the year 2003. This number includes besides livestock production also the plant production. As table 1 shows, nearly 70,000 of these farms are certified after QS (meat).

Table 1. Number of the contracting parties in the QS-system (meat and meat goods) (conditions: March 2007) (QUALITY AND SAFETY, 2007)

Stage	**Quality and Safety participant**	
Single animal feed	919	
Mixture animal feed	613	
Farm	69976	(77 bundle organisations)
Slaughtering	315	
Processing	214	
Meat wholesaler	35	
Food retailer	14995	(98 bundle organisations)
Sum	87067	

This is the reason, why a QS certification (pig) (version 1 of March 2006) on the farm is assumed in the following view and a benefit value cost analysis for an additional implementation of the HACCP concept (HACCP DS 3027), a certification after GlobalGAP (pig) (version 2.0 (March 2005)) or SQF 1000 (4th edition (November 2005)) as well as a combination of these quality systems is analysed.

The farmer has now the possibility to decide, which of the following alternatives represents the optimum for its enterprise. The following alternatives were analysed in this case study:

1. Implementation of HACCP
2. Implementation of GlobalGAP (pig)
3. Implementation of SQF 1000
4. Implementation of HACCP and GlobalGAP (pig)
5. Implementation of HACCP and SQF 1000
6. Implementation of GlobalGAP (pig) and SQF 1000 and
7. Implementation by HACCP, GlobalGAP (pig) and SQF 1000

For the calculation of the benefit value for the determination of the indirect benefit categories the number of quality system requirements is used as a basis and for the direct benefit values the results of the accomplished SWOT-Analysis.

The number of quality system requirements is determined by ”QualintSys“. Thereby for the HACCP-Analysis, which possibly in the future is legally demanded, the Danish standard DS 3027 is used as a basis. GlobalGAP encloses the modules total module, animal inventory module and pig module with the critical (100%) and non-critical must-have criteria (90%). The SQF-1000-calculation includes the fulfilment of requirements at level 3.

The computation of the additional requirements, which is the first step within the calculation of

the benefits and costs, could be illustrated in the form of figures. Figure 1 shows, as an example, the additional requirements, which are necessary to fulfil, when implementing GlobalGAP (pig) in addition to an already existing QS-(pig)-certification, sorted according to the allocated benefit categories.

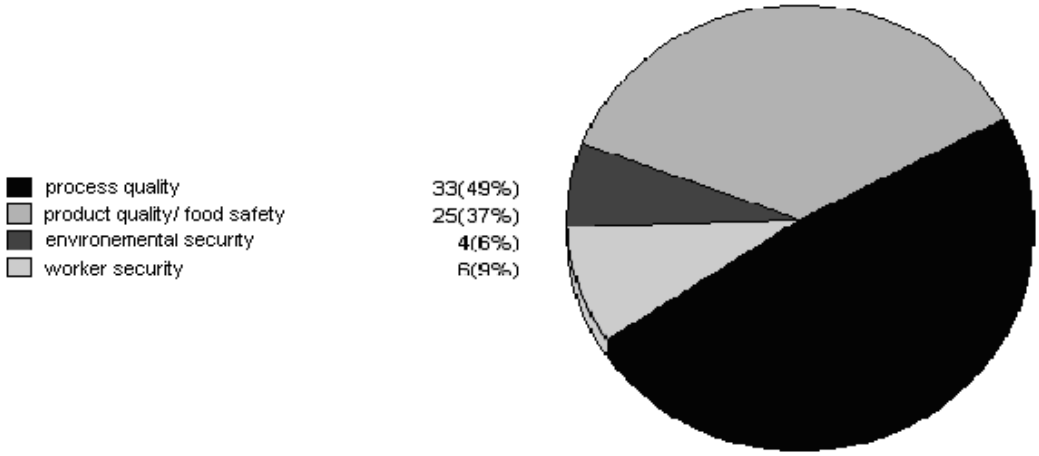

Figure 1. Categorizes additional requirements after use a GlobalGAP (pig) - of an introduction during QS-pig-certification already existing (QUALINTSYS, 2007)

The results show that by the QS certification 27 requirements are already covered by GlobalGAP. The enterprise still has to fulfil 131 new requirements. Within the cost-benefit-analysis the legal requirements were not considered, because it is assumed that they were already fulfilled in the enterprise. The enterprise has to fulfil 68 further requirements for a GlobalGAP-certification.
The additional requirements of the further alternatives were determined in the same form by the database ”QualintSys“ and they are presented in table 2. This table illustrates the number of additional requirements in benefits categories.

Table 2. Determined number of quality requirements of the alternatives aggregated in benefit categories (own illustration)

Categories	Alternatives		
	HACCP (DS)	GlobalGAP (P)	SQF 1000
1. Process quality	43	33	44
2. leg.requirements	0	63	12
3. Product liability	SWOT-Analysis	SWOT-Analysis	SWOT-Analysis
4. Product quality	2	25	3
5. Industrial safety	0	6	0
6. Environmental protection	0	4	0
7. Image/Trust	SWOT-Analysis	SWOT-Analysis	SWOT-Analysis
8. Market entry	SWOT-Analysis	SWOT-Analysis	SWOT-Analysis

(Continuation table 2)

Categories	Alternative			
	HACCP+ GlobalGAP (P)	HACCP + SQF 1000	GlobalGAP (P) + SQF 1000	HACCP + GlobalGAP (P) + SQF 1000
1. Process quality	76	77	77	110
2. Legal requirements	107	50	117	137
3. Product liability	SWOT-Analysis	SWOT-Analysis	SWOT-Analysis	SWOT-Analysis
4. Product quality	27	5	28	30
5. Industrial safety	6	0	6	6
6. Environmental protection	4	0	4	4
7. Image/Trust	SWOT-Analysis	SWOT-Analysis	SWOT-Analysis	SWOT-Analysis
8. Market entry	SWOT-Analysis	SWOT-Analysis	SWOT-Analysis	SWOT-Analysis

After the attributes for the respective alternatives were determined, in the next step the weightings for the respective categories from the results of the Expert Choice interviews are consulted and documented (see table 3).

Table 3. Weighting of costs and use (agriculture level) (own illustration)

Categories	Weighting of the categories	Criteria	Weighting of the criteria
Benefit	100	1. Process quality	0,125
		2. Cross Compliance	0,0905
		3. Product liability	0,1395
		4. Product quality	0,209
		5. Worker safety	0,091
		6. Environmental protection	0,0735
		7. Image/Trust	0,104
		8. Market entry	0,1675
Sum	100	Total	1

In the following step the determined scale is consulted and the determined characteristics are assigned to the appropriate scale values (see table as an example 4 + 5).

Table 4. Criterion1: Process quality (own illustration)

Criterion 1	Alternative one	Characteristics	Value
Process quality	HACCP	43	3
	GlobaGAP (P)	33	2
	SQF 1000	44	5
	HACCP + GlobalGAP(P)	120	7
	HACCP + SQF 1000	166	9
	GlobalGAP (P) + SQF 1000	122	7
	HACCP + GlobalGAP (P) + SQF 1000	203	10

Table 5. Criterion 8: Market entry (own illustration)

Criterion 8	Alternatives	Characteristics	Value
Market entry	HACCP	SWOT-Analysis	2
	GlobalGAP (P)	SWOT-Analysis	4
	SQF 1000	SWOT-Analysis	4
	HACCP + GlobalGAP (P)	SWOT-Analysis	7
	HACCP + SQF 1000	SWOT-Analysis	7
	GlobalGAP (P) + SQF 1000	SWOT-Analysis	8
	HACCP + GlobalGAP (P) + SQF 1000	SWOT-Analysis	10

After tabulating the value tables, in the next step the determination of the benefit values for the implementation of the respective alternatives follows. This is accomplished by the multiplication of the respective values of the benefit criteria with the determined hierarchy weightings (result of the accomplished interviews on the agricultural level, see tables 6 - 8).

Table 6. Calculation of the utilizable value of the HACCP introduction (own illustration)

Categories	Criteria	Weighting of the criteria	Value	Weighting * Value
Benefit	1. Process quality	0,125	3	0,375
	2. leg. requirements	0,0905	1	0,0905
	3. Product liability	0,1395	4	0,558
	4. Product quality	0,209	1	0,209
	5. Worker safety	0,091	1	0,091
	6. Environmental protection	0,0735	1	0,0735
	7. Image/Trust	0,104	4	0,416
	8. Market entry	0,1675	2	0,335
sum		1		2,148

Table 7. Calculation of the utilizable value a GlobalGAP (P) of an introduction (own illustration)

Categories	Criteria	Weighting the criteria	Value	Weighting * Value
Benefit	1. Process quality	0,125	2	0,25
	2. leg. requirements	0,0905	5	0,4525
	3. Product liability	0,1395	6	0,837
	4. Product quality	0,209	2	0,418
	5. Worker safety	0,091	1	0,091
	6. Environmental protection	0,0735	1	0,0735
	7. Image/Trust	0,104	5	0,52
	8. Market entry	0,1675	4	0,67
Sum		1		3,312

Table 8. Calculation of the utilizable value of the SQF 1000 introduction (own illustration)

Categories	Criteria	Weighting the criteria	Value	Weighting * Value
Benefit	1. Process quality	0,125	5	0,625
	2. leg. requirements	0,0905	1	0,0905
	3. Product liability	0,1395	6	0,837
	4. Product quality	0,209	1	0,209
	5. Worker safety	0,091	1	0,091
	6. Environmental protection	0,0735	1	0,0735
	7. Image/Trust	0,104	4	0,416
	8. Market entry	0,1675	4	0,67
Sum		1		3,012

For the combined quality system implementations the same calculation is taken as a basis. The results of these calculations show the noted results for the alternatives 4-7:

4. Benefit value **4,683** for the implementation of HACCP and GlobalGAP (pig)
5. Benefit value **5,1765** for the implementation of HACCP and SQF 1000
6. Benefit value **4,2575** for the implementation of GlobalGAP (pig) and SQF 1000
7. Benefit value **6,6945** for the implementation of HACCP, GlobalGAP (pig) and SQF 1000

After the benefit values were computed, in the following step the costs of the implementation of the respective alternative are determined. The cost analysis is accomplished separately to the benefit value analysis, because an evaluation problem divides itself in principle into the evaluation of the benefit on the one and the costs on the other side.

Cost calculation

The cost calculation is based on (with for agriculture specific weighting criteria) the following equation. The weighting criteria are the results of the accomplished expert interviews. The arrangement takes place according to the 1st hierarchic level of the cost categories; the computation takes place according to the 2nd hierarchic level.

R_p, R_{pr}, R_v, R_i, C_d

$$\sum R_{transport} * 0{,}025776 + \sum R_{envir} * 0{,}012672 + \sum R_{ani.welfare} * 0{,}069984 + \sum R_{w\text{-}security} * 0{,}00481 + \sum R_{haccp} * 0{,}01656 + \sum R_{storage} * 0{,}022752 + \sum R_{trace} * 0{,}010944 + \sum R_{veteri} * 0{,}029088 + \sum R_{farming} * 0{,}08424 + \sum R_{hyg.measures} * 0{,}1551 + \sum R_{labor} * 0{,}0329 + \sum R_{reclama} * 0{,}00304 + \sum R_{training} * 0{,}01952 + \sum R_{manage} * 0{,}02516 + \sum R_{doku} * 0{,}0209 + \sum R_{self\text{-}control} * 0{,}01541 + \sum R_{kennz} * 0{,}01397 + \sum R_{con.mea} * 0{,}07671 + \sum R_{techn.equi} * 0{,}34829 + \text{certification costs} + \text{licence costs} + \text{registration costs}$$

For the computation of the costs of the respective alternatives first the expenditure value is computed and afterwards it is converted into the according monetary value. The monetary costs of certification, license and registration are summed within the cost analysis.

Cost computation

The cost computation is based first on the number of different quality system requirements, whereby the number of the requirements is sorted according to the specific cost categories and the appropriate alternatives (see figure 2-5).

Figure 2 illustrates that most of the requirements within the process category, which would occur during the respective alternative implementation, result for the alternatives 7, 4 and 6.

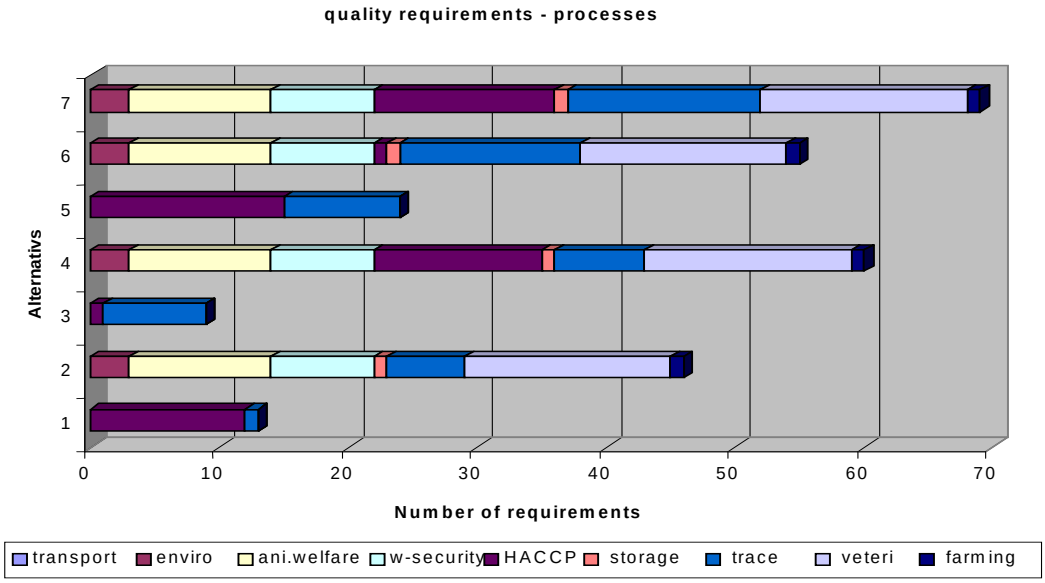

Figure 2. Determined number of quality requirements of the process cost category of the alternatives 1-7 of the case study on the stage „agriculture "(QUALINTSYS, 2007)

Figure 3 shows a very similar picture about the allocation of the additional requirements during the implementations of the respective alternatives. The alternatives 7, 6 and 4 would also within the field of the product requirements cause the largest number of new requirements, which should be fulfilled. Altogether the number of requirements, which should be fulfilled, is smaller in this cost category than in the field of the cost category "process".

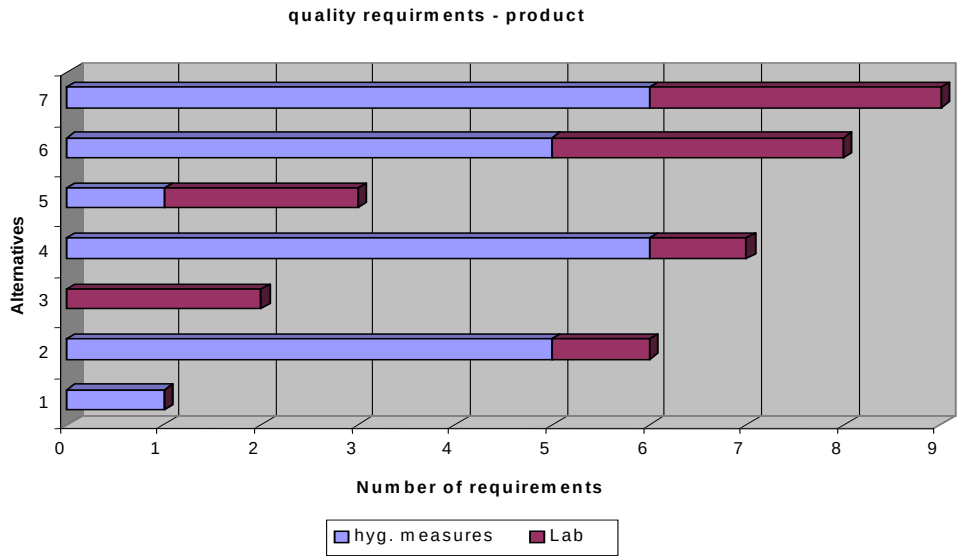

Figure 3. Determined number of quality requirements of the product cost category of the alternatives 1-7 of the case study on the stage „agriculture "(QUALINTSYS, 2007)

Another picture results within the field of the category "Administrative" (see figure 4). Also this category includes the most additional requirements for the alternatives 7 and 6. However, with the choice of the alternative 5 this would represent the following category.

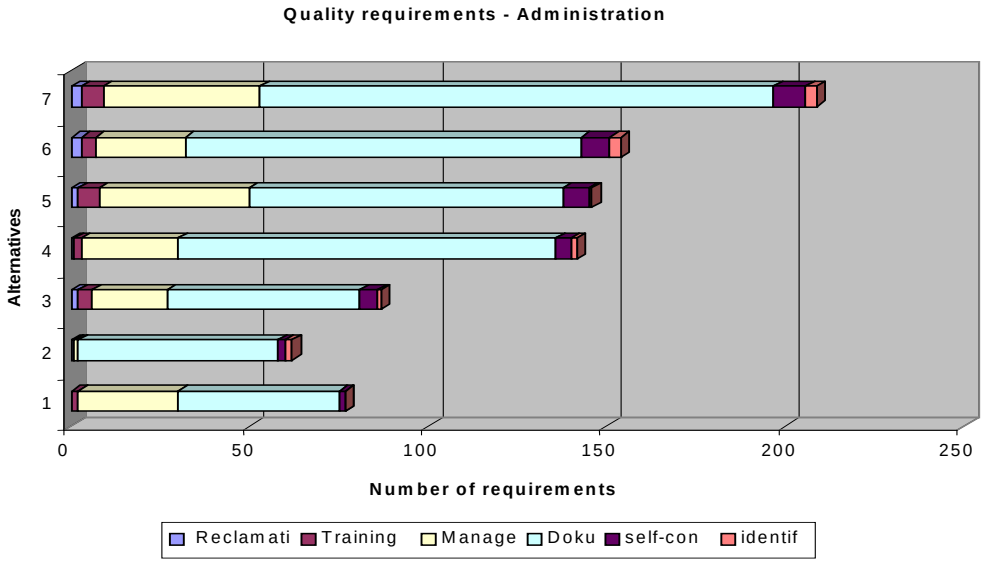

Figure 4. Determined number of quality requirements of the administrative category of the alternatives 1-7 of the case study on the stage „agriculture "(QUALINTSYS, 2007)

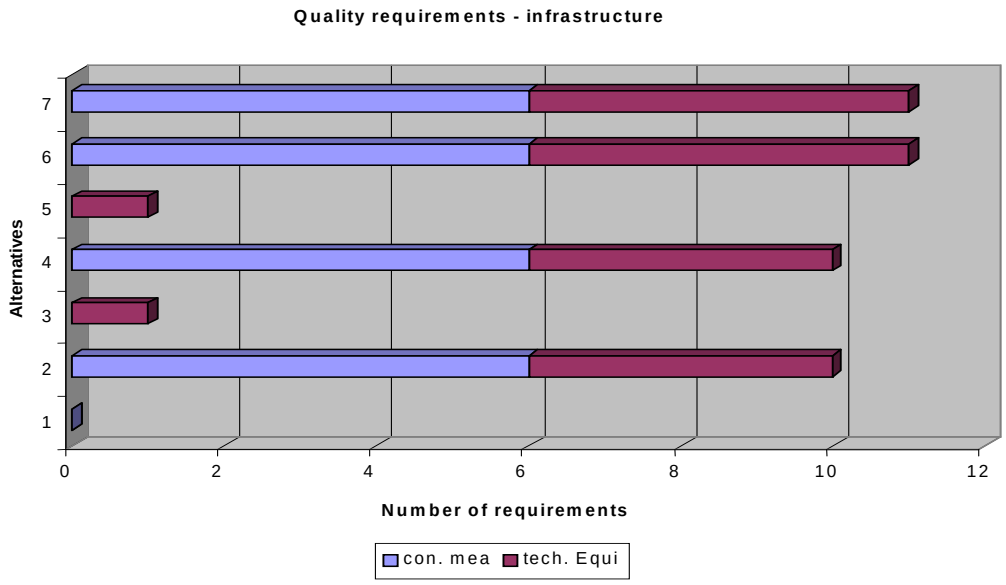

Figure 5. Determined number of quality requirements of the infrastructure category of the alternatives 1-7 of the case study on the stage „agriculture "(QUALINTSYS, 2007)

Most additional infrastructure requirements would again result within the implementation of the alternatives 7, 6 and 4 and moreover with the implementation of the alternative 2 (see figure 5). With these results the determination of the cost values follows. The number of quality system requirements of the appropriate cost categories is computed with the determined weights from the interviews on the agricultural level (see table A1).
After regarding the cost value, the direct costs, which result from an implementation of a quality system, are also included into cost considerations. They are calculated and converted into according point values (table 9) (DNV, 2007; FOODPLUS, 2007; SAFE QUALITY FOOD, 2007). A study was the basis for the calculation of the point value. Monetary costs were results of this study concerning the implementation of SQF 2000 (NICHOLLS & VENOUTOSOS, 2001). These costs were connected with the results of a SQF 2000 implementation, which were identified with QualintSys. Accordingly the point value is 1.835€.

Table 9. Certification costs of HACCP, GlobalGAP and SQF 1000 (own illustration)

Systems Costs	HACCP	GlobalGAP	SQF 1000
Hours for auditing * Money per hour	5 * 500 € = 2500 €	3 * 500 € = 1500 €	10 * 500 € 5000 €
Registration costs	-	120 €	-
Certification costs	40 €	150 €	40 €
Sum	2540 €	1770 €	5040 €
Value	**1,38**	**0,96**	**2,74**

The final results of the cost calculation are to be inferred from table 10 for the respective alternatives.

Table 10. Monetary costs of an introduction on agricultural level of the appropriate alternatives (own illustration)

Alternative	**Calculation**	**Point**	**Monetary value**
1. HACCP	1,885 + 1,38	3,265	5.991,27 €
2. GlobalGAP (Pig)	5,404 + 0,96	6,364	11.677,94 €
3. SQF 1000	2,35 + 2,74	5,09	9.340,15 €
4. HACCP + GlobalGAP (Pig)	7,238 + 1,38 + 0,96	9,578	17.575,63 €
5. HACCP + SQF 1000	4,052 + 1,38 + 2,74	8,172	14.995,62 €
6. GlobalGAP (Pig) + SQF 1000	7,866 + 0,96 + 2,74	11,566	21.223,61 €
7. HACCP + GlobalGAP (Pig) + SQF 1000	9,47 + 1,38 + 0,96 + 2,74	14,55	26.699,25 €

Benefit-cost quotient

The results of the benefit and cost analysis are summarized in the following step and multiplied according to the determined results from the expert interviews on agricultural level. The decision table 11 shows the result of this benefit -cost analysis. The alternative with the highest benefit-cost quotient represents the best alternative for the decider. In order to attain a better comparability of the benefit values with the costs, a multiplication of the benefit value with 1000 follows.

Table 11. Decision table for the introduction of quality systems on agriculture level (own presentation)

Value Quality system	Benefit value* Weighting	Costs* Weighting	Benefit value *1000/costs
HACCP	2,148* 0,5	5.991,27 € * 0,5	**3,59**
GlobalGAP (Pig)	3,312 * 0,5	11.677,94 € * 0,5	2,84
SQF 1000	3,012 * 0,5	9.340,15 € * 0,5	3,22
HACCP + GlobalGAP (Pig)	4,683 * 0,5	17.575,63 € * 0,5	2,66
HACCP + SQF 1000	5,1765 * 0,5	14.995,62 € * 0,5	**3,54**
GlobalGAP (Pig)+ SQF 1000	4,2575 * 0,5	21.223,61 € * 0,5	2
HACCP + GlobalGAP (Pig) + SQF 1000	6,6945 * 0,5	26.699,25 € * 0,5	2,5

4. Discussion of the results

This case study shows as a result that for the farmer the implementation of the HACCP concept represents the best alternative, whereby an integrated introduction of HACCP and SQF 1000 is the second-best alternative.

Moreover the analysis of the results shows that the certification costs for a single certification represent a smaller share of the costs than the indirect costs. For multiple certifications the relationship between the direct and indirect costs changes, since in relation the indirect costs sink tendentious by an integrated execution, but the direct costs are summed (KRIEGER, 2008).

References

DNV (2007). Persönliche Mitteilung von Frau Frede im Mai 2007
FOOD PLUS (2007)
www.eurep.org DNV (2007). Persönliche Mitteilung von Frau Frede im Mai 2007
KRIEGER, St. (2008). Qualitätssysteme der Agrar- und Ernährungswirtschaft –Entwicklung eines Beratungssystems zur Kosten- und Nutzenschätzung. Dr. Kovac Verlag, Hamburg (in print)
LUNING P.A., MARCELIS, W.J. & JONGEN, W.M.F. (2002). Food quality management – a techno-managerial approach. Wageningen Pers
NICHOLLS, D. & VENOUTOSO, D. (2001). Seafood industry case studies on implementation of the SQF 2000 quality system. WA seafood quality management initiative, Department of fisheries, WA and New West Foods (WA) Pty Ltd
QUALINTSYS (2007)
www.qualint.de/project/eval
QUALITY & SAFETY (2007)
www.q-s.info
SAFE QUALITY FOOD (2007)
www.sqfi.com

Annex

Table A1. Cost calculation for quality systems on farm level (own illustration)

Alternatives	Calculation	Cost value
HACCP	12 * 0,01656 + 1 * 0,010944 + 28 * 0,02516 + 45 * 0,0209 + 2 * 0,01541 =	1,885
GlobalGAP (P)	3 * 0,012672 + 11 * 0,069984 + 8 * 0,00481 + 1 * 0,022752 + 6 * 0,010944 + 16 * 0,029088 + 1 * 0,08424 + 5 * 0,1551 + 1 * 0,0329 + 1 * 0,00304 + 1 * 0,02516 + 56 * 0,0209 + 2 * 0,01541 + 2 * 0,01397 + 6 * 0,07671 + 4 * 0,34829 =	5,404
SQF 1000	1 * 0,01656 + 8 * 0,010944 + 2 * 0,0329 + 2 * 0,00304 + 4 * 0,01952 + 21 * 0,02516 + 54 * 0,0209 + 5 * 0,01541 + 1 * 0,01397 + 1 * 0,34829 =	2,35
HACCP and GlobalGAP (P)	3 * 0,012672 + 11 * 0,069984 + 8 * 0,00481 + 12 * 0,01656 + 1 * 0,022752 + 7 * 0,010944 + 16 * 0,029088 + 1 * 0,08424 + 5 * 0,1551 + 1 * 0,0329 + 1 * 0,00304 + 27 * 0,02516 + 101 * 0,0209 + 4 * 0,01541 + 2 * 0,01397 + 6 * 0,07671 + 4 * 0,34829 =	7,2338
HACCP and SQF 1000	15 * 0,01656 + 9 * 0,010944 + 1 * 0,1551 + 2 * 0,0329 + 2 * 0,00304 + 6 * 0,01952+ 42 * 0,02516 + 88 * 0,0209 + 7 * 0,01541 + 1 * 0,01397 + 1 * 0,34829 =	4,052
GlobalGAP (P) and SQF 1000	3 * 0,012672 + 11 * 0,069984 + 8 * 0,00481 + 1 * 0,01656 + 1 * 0,022752 + 14 * 0,010944 + 16 * 0,029088 + 1 * 0,08424 + 5 * 0,1551 + 3 * 0,0329 + 3 * 0,00304 + 4 * 0,01952 + 25 * 0,02516 + 111 * 0,0209 + 8 * 0,01541 + 3 * 0,01397 + 6 * 0,07671 + 5 * 0,34829 =	7,866
HACCP, GlobalGAP (P) and SQF 1000	3 * 0,012672 + 11 * 0,069984 + 8 * 0,00481 + 14 * 0,01656 + 1 * 0,022752 + 15 * 0,010944 + 16 * 0,029088 + 1 * 0,08424 + 6 * 0,1551 + 3 * 0,0329 + 3 * 0,00304 + 6 * 0,01952 + 44 * 0,02516 + 144 * 0,0209 + 9 * 0,01541 + 3 * 0,01397 + 6 * 0,07671 + 5 * 0,34829 =	9,47