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Determinants of the Use of Information: An Empirical Study of German Pig Farmers

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Abstract

Due to growing expectations for quality and safety of food products and an increasing demand for more transparent food supply chains, pork production faces new challenges. In the course of this development, chain-wide communication has gained importance in agribusiness. Nonetheless, existing approaches focus primarily on information supply, whereas the use of information for managerial decision-making has only rarely been highlighted. This research gap is addressed in this paper on the basis of a large-scale empirical study of animal health management on German pig farms. By applying factor and multinomial logistic regression analyses, this study identifies determinants of the use of information as well as ways to improve information use on farms. It shows that factors like intrinsic motivation and farmer's competence have a significant influence on information use.

Keywords: Chain-wide communication, information use, animal health management, pork production

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Problem Definition and Goals

Various food crises have laid bare certain deficits in the quality control of food production and have resulted in a considerable loss of trust among consumers. Since the mid-1990s, a political reaction has resulted in the legislation and administration of new food production legislation which encompasses the entire supply chain “from the farm to the fork”, from the pre-production areas of agriculture on through the production, manufacture, and distribution of the products (Fritz and Fischer 2007; Härtel 2007). Industry in turn has responded by implementing various quality control systems, the central element of which similarly aims to oversee all or at least the most important stages in the food production process (Hatanaka, Bain, and Busch 2005; Jahn 2006; Peupert and Theuvsen 2007).

Due to the many efforts of legislators and agribusiness firms to assure the improved quality of food products, the continuous exchange of information among all supply chain partners has become extremely important. Therefore, various efforts have been made to improve communication between supply chain partners. Examples of this development are new legislation concerning the exchange of information on salmonella monitoring in pork production, Regulation (EC) 853/2004 as part of the so-called “hygiene legislation package” regarding food supply chain information, and the requirements established by certification systems to pass on information to supply chain partners (Ziggers and Trienekens 1999; Schulze Althoff, Ellebrecht, and Petersen 2005; Deimel, Plumeyer, and Theuvsen 2008a). So far the exchange of information in agribusiness, particularly in the meat industry, has been hindered by considerable organizational and structural barriers. The transfer of information is difficult due to complex supply chain structures, resulting in numerous organizational interfaces along supply chains, each of which acts as a hurdle the information flow has to overcome (Deimel, Frentrup, and Theuvsen 2008). In the meat supply chain, the interface between agribusiness firms like slaughterhouses and farmers seems to be the most difficult relationship due to structural and organizational disparities (Deimel, Plumeyer, and Theuvsen 2009). Therefore, in recent years great efforts have been made to take advantage of modern information technologies that allow a multitude of information on food quality derived from the findings at slaughterhouses (e.g., results of salmonella testing and other animal health issues) to be systematically gathered and made more available to farmers in order to enable them to improve their animal health (AH) management (Plumeyer, Theuvsen, and Bahlmann 2009).

In order to ensure the effective use of information, it must not only be guaranteed that the information can flow unhindered along food supply chains, it is also important that the recipients use the information provided in their managerial decision-making processes (O'Reilly 1982; Amponsah 1995). The adequate use of information in order to create knowledge can be seen as a “[…] growing individual and collective optimization problem […]” (Stock et al. 1998). Its solution plays an important role in agribusiness firms’ ability to gain and sustain competitiveness (Carneiro 2000). The exchange and use of chain-wide information are of particular importance for hog farmers due to the high prevalence of subclinical infections such as salmonella which result from inadequate hygiene management during piglet and fattening stages, but are in most cases only detected during slaughter (Mack et al. 2005). Blaha (2004) refers to this as the problem of “pre-harvest food safety”, and so far it has received only limited attention.

Considering the need to assure a continuous flow and use of information among the organizational interfaces between farmers and slaughterhouses, it is surprising that so little scientific research has been devoted to this topic. The literature mostly focuses on the use of information systems instead of use of information distributed through such systems (Davis 1989; Morris 1991; Venkatesh et al. 2003; Bahlmann and Spiller 2009). In agribusiness, the literature addresses only the technical design of information delivery systems or the use of information providers (Amponsah 1995). Thus, the absence of research about information use is especially obvious in this field. Therefore, the goal of this paper is to analyze hog farmers' use of information provided by processors and to derive recommendations that contribute to the improvement of communication among all supply chain partners. The contribution this makes to previous studies on the exchange of information lies in the identification of relevant practice-oriented determinants of use of chain-wide information by hog farmers. This allows the development and implementation of more advanced technical approaches which also take into account human information behaviour. The latter is seen as an important influence regarding the use of information systems (Gershon and Slade 1984; Alvarez and Nuthall 2006). In doing so, we first give an overview of the German pig sector. Then we describe the conceptual framework, methodology and sample of our research and present the results of the univariate analyses of our empirical data. Factor and multinomial logistic regression analyses are used to test the theoretical framework underlying the study. The paper closes with a discussion of results, some conclusions and suggestions for further research.

German Pig Sector

Germany is the world's third largest pork producer with an output of 5.4 mio. tons in 2010. In the European Union, Germany is the largest pork producer, followed by Spain, France, Denmark and Poland. After German reunification, German pork production declined due to the privatization process in Eastern Germany and the reduction of production capacities in the new German states. As a result, herd size decreased from 34.2 million pigs in 1990 to 26.5 million pigs in 1996 (Spiller et al. 2005). Since then, production has slowly recovered; in 2010, 32,900 pig farmers kept 26.9 mill. pigs. Due to growing imports of slaughter pigs, pork production reached an all-time high in 2010. In 2006, for the first time in history, Germany was a net exporter of pork (Burchardi et al. 2007).

The major pig producing area is located in North-Western Germany close to the Dutch border where 17,000 farmers keep about 14.7 mill. pigs, or about 55% of the German pig herd. A second important production area is Southern Germany (Bavaria: 3.6 mill. pigs on 7,600 farms; Baden-Wuerttemberg: 2.08 mill. pigs on 3,600 farms). Farm size is much larger in Northern Germany; average herd size is 864.7 pigs in the North-West compared to only 473.7 pigs in Bavaria (Destatis 2010a, 2010b).

The requirements for conventional husbandry apply to over 99% of the hogs in Germany. Less than 1 percent are produced according to the standards for organic farming (Burchardi et al. 2007). Sows were held alone in pens with their piglets and hogs for fattening in heated stables with perforated flooring for the discharge of liquid excrement (98%) according to EU Regulations (2001/88/EG) (Hoy 2002).

In Germany, farmers are confronted with a growing concentration ratio at the processor level, but, with 226 slaughterhouses, there are still enough alternative buyers of slaughter pigs. The leading companies (ISN 2011), Tönnies (24.4% share of total slaughters), Vion (18.4%), and the cooperative Westfleisch (11.3%), follow different sourcing strategies: Tönnies and Vion work with private livestock dealers and pig marketing cooperatives and only rarely with individual farmers. Transportation of slaughter pigs is also provided by these traders. In contrast, Westfleisch introduced marketing contracts with 70% of its farmers in 2001 and owns a logistics centre. However, Westfleisch marketing contracts do not go very far. Farmers are allowed to choose from several breeds, which only have to be evaluated positively in a test program; the same applies to the feed. Thus, the intent of these contracts is only to ensure a certain percentage of the quantities required. Vion, Tönnies and most of the remaining German slaughterhouses do not apply contracts, nor are they vertically integrated—except for some smaller farmer associations that operate their own slaughterhouses (Schulze, Spiller, and Theuvsen 2007).

Conceptual Framework

Exchange and Use of Information as Success Factors

Research conducted in various industry subsectors and regions has indicated that communication plays a decisive role in firm performance (Narver and Slater 1990; Deshpande, Farley, and Webster 1993; Bigne and Blesa 2003). Fawcett and Magnan (2001) state that "[…] information is the 'life blood' of effective supply chain management". In a survey of firm managers, Baker and Sinkula (1999) were able to show that not only firm performance but also innovativeness correlates significantly with the exchange of information. Moreover, the exchange of information among partners is an essential determinant of the successful strategic positioning of firm networks (Jarillo 1988). Other network theories also consider the continuous exchange of information an essential success factor (Miles and Snow 1984; Granovetter 1985).

Empirical studies have repeatedly confirmed the importance of a continuous exchange of information in food supply chains (Hill and Scudder 2002; Reiner 2005; Schulze, Spiller, and Theuvsen 2006b). Caswell and Mojduszka (1996) and Theuvsen, Plumeyer and Gawron (2007) particularly emphasize the high relevance of information exchange for food quality and safety. Lazzarini, Chaddad and Cook (2001) as well as Windhorst (2004) see the unhindered flow of information between supply chains partners as an essential precondition for the integration of supply chains and networks in the agribusiness sector. Whereas Hollmann-Hespos (2008) analyses determinants of investments in tracking and tracing systems that aim at the improvement of information flows relevant for traceability of food and feed products, Peupert and Theuvsen (2007) discuss how the exchange of quality information in agribusiness can be supported by the use of quality techniques such as quality function deployment.

In addition to the availability and supply of information, its use is also a key success factor (Moorman, Zaltman, and Deshpande 1992). The use of information constitutes a cognitive process that encompasses the acquisition, processing and storage of information, as well as the effect (e.g., the actions of the information user) (O'Reilly 1982). Choo (1996), Weißenberger (1997) and Thong (1999) consider the use of information as the primary goal of the information exchange.

The analysis of information use is difficult since it can neither be observed directly nor described or explained in its entirety. Previous studies, therefore, were confined to an indirect observation of the use of information and could only cover selected aspects. One of the first scientific studies on the use of information was done by Simon et al. (1954) and focused on how information is used in the context of controlling. With regard to agriculture and the food industry, various studies on the acceptance and use of new informational technologies have been published (Davis 1989; Goodhue and Thompson 1995; Venkatesh et al. 2003; Vennemann and Theuvsen 2004). Information use in farmers' decision-making processes was analyzed by Öhlmér et al. (1997), whereas Hannus (2008) took a more technical approach to its analysis in the context of quality assurance processes in the agribusiness sector.

The Exchange and Use of Information in Pork Production

A broad spectrum of information is transferred along pork supply chains, concerning matters as diverse as prices, costs, product quality, expected supply and demand, orders and delivery dates (Deimel, Plumeyer, and Theuvsen 2008a). Drivers of information exchange along pork production chains are legal requirements, certification systems and the need to coordinate business operations between supply chain partners (Plumeyer, Deimel, and Theuvsen 2008). The diverse content of communication, complex business relationships and the danger of information asymmetries pose special challenges for the management of communication relationships in pork production chains (Deimel, Plumeyer, and Theuvsen 2009).

The continuous flow of information along pork production chains with regard to such matters as data gathered at slaughterhouses is hindered by the highly differentiated organizational structure of these supply chains. This is due to an intensive vertical and horizontal division of labour, which results in a complex value-added network in pork production (Bijman et al. 2006; Schulze Althoff 2006). This network is characterized by an extreme inhomogeneity (Horváth 2004; Spiller et al. 2005). A large number of comparatively small farms are confronted with a much smaller number of slaughterhouses operating nationally or even internationally. The complexity of supply chains strongly contributes to the complexity of information flows (Gampl 2006; Theuvsen, Plumeyer, and Gawron 2007).

Despite these problems, the continuous flow of information is considered essential for successful pork production (Den Ouden et al. 1996; Windhorst 2004). Petersen (2003) and Doluschitz (2007) emphasize that the efficiency of businesses processes, animal health and food safety can be improved through more effective communication. Furthermore, the exchange of information between hog farmers and slaughterhouses has been analysed with regard to its effect on the transparency of supply chains (Deimel, Frentrup, and Theuvsen 2008; Deimel, Plumeyer, and Theuvsen 2008a; Frentrup 2008). Other authors have highlighted the relationship between information exchange and the quality of animal health management at the farm level (Schulze Althoff 2006) as well as the influence of alternative forms of vertical coordination of pork production chains on information exchange (Schulze, Spiller, and Theuvsen 2006b).

The use of animal health (AH) information throughout the supply chain is considered essential to the improvement of food quality (Doluschitz 2007; Theuvsen and Plumeyer 2007). Thus, slaughterhouses are continually demanding stricter quality control measures on farms (Petersen et al.

2007) because shortcomings at the farm level (e.g., salmonella infections) often lead to hard-to-tackle problems in downstream industries (Mack 2007). Recent legislation has supported these demands. Hog farmers are now legally required to continuously use available salmonella testing results. However, it is often suspected that hog farmers do not make optimal use of the available information in their animal health management (Morris 1991; Blaha 2007a; Vallan 2007). In fact, empirical studies indicate a very heterogeneous use of the results of salmonella tests (Plumeyer, Deimel, and Theuvsen 2009).

Factors Influencing the Use of Animal Health Information

On the basis of previous studies, this investigation began by outlining the factors influencing the actual use of AH information at all levels of the pork production chain and summarizing them in an exploratory and explanatory model (Figure 1). To this end, a one-step model design was intentionally used in order to obtain basic theoretical understanding of the determinants of use of chain-wide AH information.

The endogenous variable was a direct question concerning the frequency of information use. This question referred to specific information regarding AH management. The exogenous variables were derived from the existing literature in the areas of communications and information research, as well as agribusiness. The model is an ad hoc design developed specifically to address the information needs in the pork production sector.

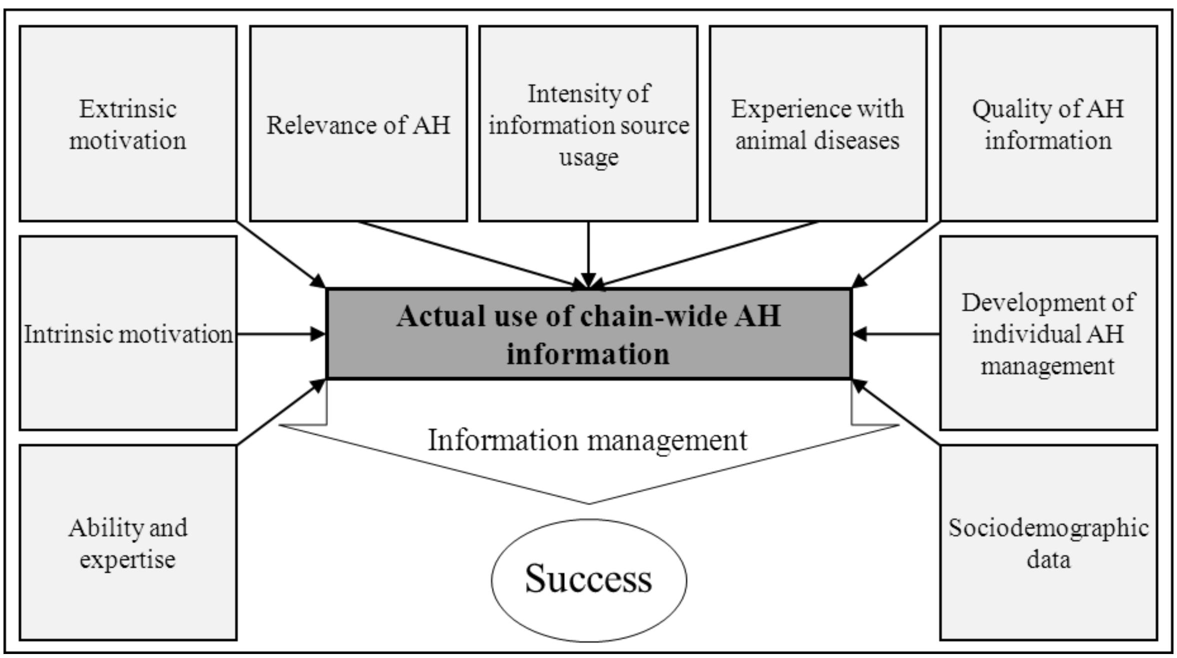

Figure 1. Theoretical Framework

Knierim and Sieber (2005) found that farmers' **ability and expertise** as well as their motivation influence farmers' actions. Fernandez-Cornejo and McBride (2002) also determined a relationship between farm managers' abilities and their decision-making behavior. Regarding the management of salmonella in hog fattening, Blaha (2007a), Bode (2007) and Vallan (2007) assume a diverse use of information due to vast differences in the skills and motivation of farmers. With regard to farmers' motivation, motivation theory suggests distinguishing between **intrinsic and extrinsic motivation** (Frey 1993). The former reflects one's personal goals and the motivation potential of task themselves, such as fattening healthy animals, whereas the latter reflects external pressures, such as the threat of receiving a reduced price from slaughterhouses for infected hogs.

Besides expertise and motivation, Öhlmér, Olson, and Brehmer (1997) identify other factors, for example, the **relevance of a problem** (e.g., health status of hogs) and its operationalization (e.g., with regard to financial outcomes) as determinants of information use. With regard to animal health, both factors are influenced by legal as well as private standards.

An appropriate **intensity of information source usage** is an essential precondition for the use of information (Kuß and Tomczak 2002; Meffert, Burmann, and Kirchgeorg 2008). Mohr and Sohi (1995) also describe the usage of different information sources as an important determinant of chain-wide communication. Current efforts seek to increase the usage of different sources within the pork industry through the implementation of IT-based communication systems (Deimel, Plumeyer, and Theuvsen 2008a).

We also assume that farmers' personal **experience**, for instance, with the outbreak of an animal disease, affects their information use (Öhlmér, Olson, and Brehmer 1997). Jahn, Peupert, and Spiller (2003) were able to identify a change in attitudes towards certification systems among farmers who had experienced quality- and safety-related incidents.

A further determinant is the perceived **quality of AH information**. Zahay and Griffin (2003) hypothesize that the information use depends on the quality of the information provided. The empirical study of McKinnon and Bruns (1992) also indicates that the use of—in this case—controlling information was highly dependent on the quality of information. Similarly, Schulze (2008) and Wocken (2008) found correlations between the perceived quality of information and the intensity of communication in the agribusiness sector.

According to Dippold (2005), the management of information must always be viewed in the context of the problem to be solved. Thus, the **development of a farms' individual AH management** can be identified as another key determinant. Blaha (2007b) states that a certain development level of the AH management as well as a basic understanding of animal health issues are prerequisites for improvement in this area. Finally, **sociodemographic data**, such as farm size and farmers' age, has repeatedly been identified as an influential factor on decision-making processes in agriculture and the food industry (Nayga 1996; Rosskopf and Wagner 2003; Wocken 2008).

Methodology

In order to determine the use of information for animal health management in the pork industry, 3,024 hog farmers from all across Germany were surveyed between April and May 2008. The test persons were approached using a quota from each state. In this manner it was ensured that the regions with a high density of hog fattening were adequately represented. However, despite this measure it is not possible to guarantee the representative status of the study. The response rate was approximately 29% (sample size: N=873). Due to sporadic missing values, sample size varies slightly among the individual analyses. The survey of hog farmers included three thematic blocks. Besides asking questions as to sociodemographic background, data was collected on farmers' use of information and their use of computers and the internet with relation to pork production. The special research question served as a basis for an ad hoc operationalization of the constructs introduced above in statement batteries. Data on information use processes was obtained by asking farmers to agree or disagree with these statements on five-point Likert scales. To this end, the scales traditionally used in social research were applied (Roßteutscher 2004; Spiller and Schulze 2008; Gehring and Weins 2009). The data set was analyzed by univariate as well as multivariate tests, including means comparison, factor analysis and a multinomial logistic regression. The data regarding information use behavior was analyzed using a multinomial logistic regression model. Multinomial logistic regression models enable one to calculate probabilities and identify the influencing factors that determine them (Backhaus et al. 2008) using the maximum likelihood estimation (MLE). With the MLE, the parameters of the logistic regression model can be set so as to maximize the likelihood of preserving the observed data. Since, in order to maximize the occurrence probability for all observable cases at the same time, the probability statement for independent events (information use) should be applied, the likelihood function is maximized through the use of the Newton-Raphson method in an iterative process. Since there is no linear relationship between the independent variables and the occurrence probabilities determined by the logical function, it is difficult to interpret the meaning of the regression coefficient; only the tendency of the influence is recognizable. The odds of obtaining a given event rather than its complement are mirrored in the relationship between the occurrence probability and its complement (Backhaus et al. 2008). Statements concerning the effect of the influence strengths on the occurrence probability can be made by way of so-called effect coefficients (odds ratios), which indicate how the odds change when the value of the independent variable increases by one (Menard 2002; O'Connell 2006). These analyses were completed using SPSS 19 software.

Results

Sample Characteristics

Although respondents from all over Germany participated in the survey, farms from intensive production regions (the Weser-Ems region and North Rhine–Westphalia) are strongly represented in the sample. Respondents are on average 45.4 years old (German average = 44.3 years), and 95% (Germany: Agriculture = 68%) of them were male. The vast majority of respondents (95%) were either owner-managers or successors. The farmers usually worked full-time on the farm (85.8%), and the majority of the farms (69%; Germany = 75%) focused on hog fattening (see Table 1). For the most part (75%), the farms were family farms with an average size of 211 ha. This large average farm size—compared to the overall German average—resulted from the relatively high percentage of large farms from Eastern Germany in the sample. On average, the farms surveyed have room for fattening 1,342 (Germany = 880) hogs; 24% of them plan to extend their capacity by an average by 766 hogs. Table 1 shows technical, economic and structural data regarding the hog production. Taking into account the high standard deviations in the descriptive results, we are facing a partly heterogeneous sample. By looking at the cost of medication and the average loss rate, the high standard deviation clarifies the remarkable differences in success among the farmers surveyed. This could raise the question whether the farmers' information management is related to the success of their farms. This hypothesis, which is also posed in the conceptual framework, is analyzed in Table 4.

Table 1. Technical and economic performance indicators

Question	Mean	SD
What is your average cost of medication (€) per hog?	4.13	13.31
What is the average weight of your piglets when they begin the fattening process?	28.97	3.93
What is the average number of days that your hogs are fattened?	119.68	14.02
What is the average loss of your pig herd (%)?	2.67	1.13
How many hog fattening pens do you have?	1342.24	2056.46
How many hectares do you farm?	211.12	565.91
I have been active in hog fattening for roughly ____ years.	20.63	10.83
	Modal	**%**
What is your operational emphasis? (Please check only one.)	fattening	50.6
Is your farm your main or an additional source of income?	main income	85.8
In which production system are you fattening your hogs?	solely hog fattening	68.9

Determinants of Information Use

In order to more thoroughly analyze the determinants of farmers' use of animal health information, a group of 28 statements on information use were subjected to factor analysis. The quality of the data for factor analysis was tested with the Kaiser-Meyer-Olkin (KMO) coefficient and the Bartlett-Test for sphericity. The KMO coefficient shows whether sufficient correlations are present to justify a factor analysis. The KMO value of 0.754 can be considered "pretty good" (Backhaus et al. 2008). The Bartlett test checks the null hypothesis that all correlations are equal to zero (sig.= 0.000). The test statistics are Chi-square distributed and account for 3743.827 with 300 degrees of freedom; the correlations, therefore, significantly deviate from zero (sig.= 0.000). The results of both tests show that the variables used in the factor analysis are appropriate. The factor analysis reached acceptable results with 54.89% of the total variance explained. A total of seven factors were extracted (Table 2): extrinsic motivation, relevance of AH, intrinsic motivation, farmer's competence, intensity of information source usage, farm's individual AH management development and quality of AH information. Three factors have only limited reliability since their Cronbach's Alpha values are above 0.614 but below 0.65 (Nunnaly 1978). However, the constructs are not excluded from further analyses since they are consistent both internally and with others' results (Pedhazur and Pedhazur Schmelkin 1991).

A multinomial logistic regression analysis was used to determine which of the identified factors and additional variables determine the actual use of AH information (see conceptual model in Figure 1). In this case, the dependent variable is a single variable indicating the time spent using information about AH management. The variable has three expressions: little time, average amount of time and much time spent in information use.

Table 2. Determinants of information use: Factor analysis

Parameter	Mean	Standard deviation	Factor load
Extrinsic motivation, Cronbach's Alpha = 0.808			
It's a waste of time to go over the salmonella reports.[1]	-1.07	0.832	0.877
I personally can't do anything with the salmonella reports.[1]	-0.87	0.895	0.788
As long as I am not threatened by penalties, I have no interest in/ignore the salmonella reports.[1]	-1.26	0.764	0.785
Relevance of AH, Cronbach's Alpha = 0.614			
I have enormous competitive advantages when my hogs have above-average health.[1]	1.42	0.696	0.840
I can avoid a great reduction in market price when my hogs are in good health.[1]	1.18	0.729	0.735
Intrinsic motivation, Cronbach's Alpha = 0.665			
I feel morally responsible for keeping my hogs in good health.[1]	1.48	0.599	0.718
I take great joy in seeing healthy hogs in the pen.[1]	1.71	0.474	0.640
As a farmer I am responsible for ensuring that the consumers do not get salmonella poisoning.[1]	1.13	0.942	0.617
I'm filled with pride when my farm has a good salmonella status.[1]	1.2	0.785	0.558
When it comes to maintaining the health of my hogs, I go to great trouble.[1]	0.95	0.683	0.555
Farmer's competence, Cronbach's Alpha = 0.657			
When it comes to knowing about diseases affecting hogs, I am an expert.[1]	0.48	0.666	0.707
I always know exactly what to do when my hogs are not healthy.[1]	0.32	0.64	0.729
I receive sufficient information about the health of my hogs.[1]	0.66	0.695	0.698
I pay particular attention to the results of hog health testing.[1]	0.99	0.663	0.503
Intensity of information source usage, Cronbach's Alpha = 0.639			
How often do you use this information in daily operations to improve/optimize hog health?			
Consultant recommendations[3]	0.382	0.931	0.718
Veterinarian recommendations[3]	0.399	0.778	0.711
Salmonella test results[3]	0.846	0.926	0.625
Organ test results[3]	0.818	0.928	0.630
Farm's individual AH management development, Cronbach's Alpha = 0.704			
I frequently check on hog health status because the businesses I sell to require it.[1]	0.38	0.974	0.815
I frequently check on the salmonella status because it is a government requirement.[1]	0.48	0.926	0.811
Quality of AH information, Cronbach's Alpha = 0.628			
How informative do you consider the following resources to be regarding hog health?			
branch-oriented publications[2]	0.73	0.667	0.686
lecture events/informational talks[2]	0.68	0.671	0.643
representatives of the feed or pharmaceutical industry[2]	0.17	0.707	0.622
information on the Internet[2]	0.56	0.758	0.617
other farmers/people in the business[2]	0.356	0.75	0.554

KMO = 0.754; Total variance = 54.89 %; [1] = Scale ranges from 2 = completely agree to -2 = totally disagree; [2] = scale from -2 = completely useless to 2 = very useful; [3] = scale from 2 = very frequently to -2 = never

The information about the model adjustment was acquired through the likelihood ratio test (Backhaus et al. 2008). At 209.158, the chi-square value is highly significant; thus, the model distinguishes reliably between the groups. The quality of the adaptation was evaluated using a classification matrix. The model's hit rate (56.6 %) was not only greater than the proportional probability (29.8 %), but also greater than the maximal coincidence probability (42.1 %); thus, its hit rate can be characterized as good. As a whole, however, the quality of the model is average. This is because the pseudo R-square statistics that quantify the manifested variations of the logistic regression model lie between 0.2 and 0.4 (Backhaus et al. 2008). Both the Cox & Snell R2 (0.264) and the Nagelkerke R2 (0.318) are in that "good" zone; only the conservative McFadden R2 (0.172) lies outside it.

Table 3. Results of the Multinomial Logistic Regression Analysis

	Little time vs. average amount of time[1]	**Much time vs. average amount of time**[1]
	B (Exp (B))	**B (Exp (B))**
Extrinsic motivation	0.174 (1.190)	0.03 (1.003)
Intrinsic motivation	-0.329** (0.720)	0.498*** (1.646)
Quality of AH information	-0.620*** (0.538)	0.387*** (1.473)
Intensity of information source usage	-0.532*** (0.588)	0.489*** (1.631)
Farmer´s competence	-0.715*** (0.489)	0.744*** (2.105)
Farm´s individual AH management development	-0.231 (0.794)	-0.166 (0.847)
Relevance of AH	-0.037 (0.964)	0.078 (1.081)
Hog fattening capacity[2]	0.000 (1.00)	0.000 (1.00)
Experience with gastro-intestinal disease[2]	-0.170 (0.844)	0.184 (1.202)

[1]Reference group; [2]Single variable; B = regression coefficient; Exp(B) = effect coefficient; ***$p \leq 0.001$, **$p \leq 0.01$, *$p \leq 0.05$; likelihood ratio test: chi-square value = 209.158; significance = 0.000; Hit rate of the model = 66.3%; proportional coincidence probability = 47.7%; maximal coincidence probability = 63.4%; Cox & Snell pseudo R^2 = 0.264; McFadden pseudo R^2 = 0.172; Nagelkerke pseudo R^2 = 0.318

As the results shown in Table 3 clearly indicate, the factors identified above influence the use of information. Contrary to the assumption of the conceptual framework, sociodemographic data has little impact on information use; therefore, only the farm's "hog fattening capacity" was taken into account. A second variable represented the farmer´s experience with animal diseases (Did your hogs show evidence of the following diseases over the past two years?; scale from 2 = very frequently to -2 = never). In the social sciences, the rating scale used to measure the variables can be characterized as quasi-metric as long as there are at least five choices (Bagozzi 1981). Based on statistics literature, this justifies its use in this analysis (Jaccard and Wan 1996; Bortz 1999).

The likelihood ratio test, which represents a quality judgment on the variable level and indicates the explanatory power of independent variables (Backhaus et al. 2008), identifies the factors, or variables, 'intrinsic motivation', 'quality of AH information', intensity of information source usage' and 'farmers competence' as significant influencing factors in distinguishing between the groups. It is not surprising that a high 'quality of AH information' increases the likelihood that a farmer will devote more time to information use. The same is true for the increased use of information sources; this also has a positive effect on the extent of information use. Furthermore, both greater farming competence and stronger intrinsic motivation raise the probability that more information will be used.

Information Management and Success in Animal Health Management

In order to integrate the success of animal health management into the analysis, the farmers surveyed were grouped into three groups with regard to their perceived success in animal health management: less successful farms (N=30), those with average success (N=500), and more successful farms (N=229). A comparison of the mean values reveals that the prerequisites for the use of AH information, as well as the varying degree of information management, significantly varies among the three groups (Table 4). In addition to the great significance determined, which may have been due to the influence of the larger sample size, the results reveal the tendency that more successful farms have a better information management. The comparison thus provided interesting clues to the positive influence information management exerts on the success of hog farming.

Table 4. Information management among hog farmers: comparison of mean values

Please compare your success with hog health with that of other farms.	Less successful farms	Farms with average success	More successful farms
[a]I learned in my training about the importance of hog health. ***	0.8 (σ=0.96)	0.91 (σ=0.69)	1.11 (σ=0.72)
[a]I receive adequate information about the health of my hogs. ***	0.35 (σ=0.77)	0.58 (σ=0.68)	0.82 (σ=0.66)
[a]I carefully evaluate the data regarding the health of my hogs. ***	0.47 (σ=0.73)	0.09 (σ=0.65)	1.19 (σ=0.61)
[b]How much time do you spend learning about ways to improve the health of hogs? ***	2.93 (σ=0.78)	3.02 (σ=0.64)	3.35 (σ=0.69)

[a]Scale: 2=totally agree to -2=totally disagree; [b]Scale: 5=a lot of time to 1=very little time;
**** = p < 0.001, ** = p < 0.01; * = p <0.05;* σ *= standard deviation*

According to the empirical results, the farmers who experience average success and those with above-average success learned more about the importance of animal health during their training, feel that they receive more information on animal health, more carefully analyze animal health information and spend more time on acquiring information about animal health.

Discussion and Conclusions

Various researchers have advocated intensifying information exchange in order to promote continuous improvement of quality management in the pork industry (Doluschitz 2007; Petersen et al. 2007; Deimel, Plumeyer, and Theuvsen 2008a). Thus, in addition to a request for adequate availability of information, there should be a stronger focus on its use. Initial efforts in this direction can be seen in both public and private regulations concerning salmonella in pork; these regulations have established mandatory information exchange between farmers, veterinarians and consultants for farms in the worst salmonella category.

Four factors extracted in the factor analysis show a significant influence on the time spent in information usage. It is interesting to note that the use of information does not depend on sociodemographic factors. Instead, it is influenced by manifest factors such as “Intensity of information source usage” as well as latent parameters such as intrinsic motivation. The negligible influence of sociodemographic factors has already been shown in other studies, for instance on the willingness of dairy farmers to change their dairy company (Wocken and Spiller 2009). Main influences of the information use are the quality of AH information, intrinsic motivation, intensity of information source usage and farmers competence. Knierim and Siebert (2005) have already emphasized the great significance the expertise of the farmers has when it comes to the effectiveness of handling their affairs. Greater expertise has a positive effect on the use of information (Fernandez-Cornejo and McBride 2002). The present study confirms this finding in the case of animal health management.

It is not surprising that the intrinsic motivation of farmers exerts a positive influence on the use of information. Extrinsic motivation stemming from external forces such as sanctions has no significant influence. This indicates that external pressure alone is not sufficient to bring about improvement. Rather, additional efforts to improve farmers’ intrinsic motivation are important. Measures that could be taken along this line within the meat industry might include a reliance on role models (for instance, successful, widely known farmers) as well as educational activities (Theuvsen 2003).

A high-functioning exchange of information has repeatedly been identified as a success factor (Narver and Slater 1990; Deshpande, Farley, and Webster 1993; Bigne and Blesa 2003). The means comparison in this study also revealed significant differences between more successful and less successful farms with regard to animal health management. This indicates a positive correlation between information management and successful animal health management. The fact that successful farmers had learned more about the importance of animal health management in their training presents a starting point for influencing the attitude of farmers towards animal health management. In addition, the correlation between the use of animal health information and business success is significant. The valence theory shows that positively valued outcomes—in this case, greater business success—motivate individuals to improve animal health management on their farms in order to attainment these goals (Vroom 1964).

The implementation of IT-based communication systems is currently a widespread trend in the meat sector (Bahlmann, Spiller, and Plumeyer 2009). According to the results of our study, the success of such systems is not solely dependent on their technical capabilities; it also depends on the behaviour of the farmers using those systems and the information provided by these systems (Theuvsen and Plumeyer 2007) as well as farmers’ attitudes towards animal health management. Therefore, although IT-based systems are an important component of communication along food chains, their implementation has to be supplemented by additional measures that address the determinants of information use.

Further research might provide a more in-depth analysis of the determinants of the use of animal health information in order to develop longer-term strategies for the successful implementation of IT-based information systems. According to the insights gained by the foregoing explorative models, a multi-layer conceptual model should be developed (for instance, Structural Equation

Model). This would enable determination of interdependencies between the constructions. Possible cause-and-effect relationships could be analysed via a causal analysis. It is conceivable that moderating variables such as technical or economic performance indicators and various methods of production could highlight differences between various groups. In terms of different hog production structures in Germany, a multiple-group comparison should be implemented for the north-western, southern and eastern German region.

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References

Alvarez, J., and P. Nuthall. 2006. Adoption of computer based information systems: The case of dairy farmers in Canterbury, NZ, and Florida, Uruguay. *Computers and Electronics in Agriculture* 50 (1):48-60.

Amponsah, W. 1995. Computer adoption and use of information services by North Carolina commercial farmers. *Journal of Agricultural and Applied Economics* 27:565–576.

Backhaus, K., B. Erichson, W. Plinke, and R. Weiber. 2008. *Multivariate Analysemethoden: Eine anwendungsorientierte Einführung*. 12 ed. Berlin [u.a.]: Springer.

Bagozzi, R.P. 1981. Evaluating Structural Equation Models with Unobservable Variables and Measurement Error: A Comment. *Journal of Marketing Research* 18 (3):375-381.

Bahlmann, J., and A. Spiller. 2009. Inter-organizational information systems in meat chains: The linkage between supply chain organization and system requirements. *Journal on Chain and Network Science* 9 (1):59-69.

Bahlmann, J., A. Spiller, and C.-H. Plumeyer. 2009. Akzeptanz Internet-basierter Informationssysteme in der Fleischwirtschaft. In *Anforderungen an die Agrarinformatik durch Globalisierung und Klimaveränderung*, edited by R. Bill, P. Korduan, L. Theuvsen and M. Morgenstern. Bonn: Köllen, 15-20.

Baker, W.E., and J.M. Sinkula. 1999. Learning Orientation, Market Orientation and Innovation: Integrating and Extending Models of Organizational Performance. *Journal of Market Focused Management* 4 (4):295-308.

Bigne, E., and A. Blesa. 2003. Market Orientation, Trust and Satisfaction in Dyadic Relationships: A Manufacturer-Retailer Analysis. *International Journal of Retail and Distribution Management* 31 (11):574-590.

Bijman, J., S.W.F. Omta, J.H. Trienekens, J.H.M. Wijnands, and E.F.M. Wubben. 2006. Management and Organization in International Agri-food Chains and Networks. In *International Agri-food Chains and Networks - Management and Organisation*, edited by J. Bijman, S.W.F. Omta, J.H. Trienekens, J.H.M. Wijnands and E.F.M. Wubben. Wageningen: Wageningen Academic Publishers, 15-28.

Blaha, T. 2004. Tiergesundheitsprogramme in Schweinebeständen als Grundlage für Qualitätsmanagement und Lebensmittelsicherheitssysteme. In *Gesunderhaltung der Nutztierbestände und vorbeugender gesundheitlicher Verbraucherschutz*, edited by S.L.f. Landwirtschaft. Dresden, 58-66.

Blaha, T. 2007a. Frühzeitige Reaktionsmöglichkeiten der Betriebe als erstes Glied der Lebensmittelkette. Vortrag im Rahmen des QS- / ZDS- Experten-Workshop: Salmonellen-Überwachung / -Bekämpfung. Kassel, 18.10.2007.

Blaha, T. 2007b. Salmonellenbekämpfung im Schweinebestand - Chance und Herausforderung für den praktizierenden Tierarzt durch das im Rahmen des QS-Systems durchgeführte Salmonellenmonitoring in Schweinebeständen. www.tiho-hannover.de/einricht/bakum/forschung/salmbe.pdf, 10.11.2007.

Bode, K. 2007. *Serologische und epidemiologische Untersuchungen zur Salmonellendynamik in Schweinebeständen für die Optimierung des Salmonellenmonitorings beim Schwein*. Hannover: Tierärztl. Hochschule.

Bortz, J. 1999. *Statistik für Sozialwissenschaftler*. 5., vollst. berarb. und aktualisierte Aufl. ed, *Springer-Lehrbuch*. Berlin [u.a.]: Springer.

Burchardi, H., A. Hansen, T. Herzfeld, S. Thiele, and H.D. Thiele. 2007. Die Märkte für Fleisch und Fleischprodukte. *Agrarwirtschaft* 56:48–70.

Carneiro, A. 2000. How does knowledge management influence innovation and competitiveness? *Journal of knowledge management* 4 (2):87.

Caswell, J.A., and E.M. Mojduszka. 1996. Using Informational Labeling to Influence the Market for Quality in Food Products. *American Journal of Agricultural Economics* 78 (5):1248-1253.

Choo, C.W. 1996. The Knowing Organization: How Organizations Use Information to Construct Meaning, Create Knowledge and Make Decisions. *International Journal of Information Management* 16 (5):329-340.

Davis, F.D. 1989. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*:319-339.

Deimel, M., M. Frentrup, and L. Theuvsen. 2008. Transparency in Food Supply Chains: Empirical Results from German Pig and Dairy Production. *Journal on Chain and Network Science* 8 (1):21-32.

Deimel, M., C.-H. Plumeyer, and L. Theuvsen. 2008a. Qualitätssicherung und Transparenz durch Kommunikation: Das Beispiel Fleischwirtschaft. In *Innovationsqualität: Qualitätsmanagement für Innovationen*, edited by G. Goch. Bremen: Shaker, 235-256.

Deimel, M., C.-H. Plumeyer, and L. Theuvsen. 2008b. Zertifizierungssysteme und stufenübergreifender Informationsaustausch in der Fleischwirtschaft: Einsatzmöglichkeiten für IT als Führungsinstrument. In *Referate der 28. GIL-Jahrestagung*, edited by R.A.E. Müller, H.-H. Sundermeier, L. Theuvsen, S. Schütze and M. Morgenstern. Kiel: Ges. für Informatik.

Deimel, M., C.-H. Plumeyer, and L. Theuvsen. 2009. Stufenübergreifender Informationsaustausch in der Fleischwirtschaft: Recht und Zertifizierung als Einflussgrößen. *Berichte über Landwirtschaft* 87 (1):118-152.

Den Ouden, M., A.A. Dijkhuizen, R.B.M. Huirne, and P.J.P. Zuurbier. 1996. Vertical Cooperation in Agricultural Production-marketing Chains, with Special Reference to Product Differentiation in Pork. *Agribusiness* 12:277-290.

Deshpande, R., J.U. Farley, and J.F.E. Webster. 1993. Corporate Culture, Customer Orientation, and Innovativeness in Japanese Firms: A Quadrad Analysis. *Journal of Marketing* 57 (1):23-37.

Destatis. 2010a. *Land- und Forstwirtschaft, Fischerei: Schlachtungen und Fleischerzeugung*. Vol. Reihe 4.2.1., *Fachserie 3*. Wiesbaden.

Destatis. 2010b. *Land- und Forstwirtschaft, Fischerei: Viehhaltung der Betriebe – Agrarstrukturerhebung*. Vol. Reihe 2.1.3., *Fachserie 3*. Wiesbaden.

Dippold, R. 2005. *Unternehmensweites Datenmanagement: von der Datenbankadministration bis zum Informationsmanagement*. 4 ed. Braunschweig [u.a.]: Vieweg.

Doluschitz, R. 2007. Barrieren und Strukturbrüche überwinden. *Fleischwirtschaft* 87 (5):12-21.

Fawcett, S.E., and G.M. Magnan. 2001. *Achieving World-Class Supply Chain Alignment: Benefits, Barriers, and Bridges*. Phoenix, AZ: National Association of Purchasing Management.

Fernandez-Cornejo, J., and W.D. McBride. 2002. Adoption of Bioengineered Crops. In *Agricultural Economic Report 810*, edited by E.R.S. United States Department of Agriculture. Washington D.C.

Frentrup, M. 2008. *Transparenz in Wertschöpfungsketten des Agribusiness: Entwicklung eines Messkonzepts und Evaluierung des Status quo am Beispiel der deutschen Milch- und Fleischwirtschaft*. Lohmar and Cologne: Josef Eul.

Frey, B.S. 1993. Motivation as a Limit to Pricing. *Journal of Economic Psychology* 14 (4):635-664.

Fritz, M., and C. Fischer. 2007. The Role of Trust in European Food Chains: Theory and Empirical Findings. *International Food and Agribusiness Management Review* 10 (2):141-164.

Gampl, B. 2006. *Rückverfolgbarkeit von Lebensmitteln: Eine empirische Analyse kettenübergreifender Informationssysteme*. Göttingen: Cuvillier.

Gehring, U.W., and C. Weins. 2009. *Grundkurs Statistik für Politologen und Soziologen*. 5th ed. Wiesbaden: VS, Verlag für Sozialwissenschaften.

Gershon, F., and R. Slade. 1984. The Acquisition of Information and the Adoption of New Technology. *American Journal of Agricultural Economics* 66 (3):312-320.

Goodhue, D.L., and R.L. Thompson. 1995. Task-Technology Fit and Individual Performance. *MIS Quarterly* 19 (2):213-236.

Granovetter, M.S. 1985. Economic Action and Social Structure: The Problem of Embeddedness. *American Journal of Sociology* 94:481-510.

Hannus, T. 2008. Informationsmanagement im betrieblichen Qualitätswesen. Ph.D. Thesis, University of Bonn.

Härtel, I. 2007. Das Agrarrecht im Paradigmenwechsel: Grüne Gentechnik, Lebensmittelsicherheit und Umweltschutz. In *Neue Haftungsrisiken in der Landwirtschaft: Gentechnik, Lebensmittel- und Futtermittelrecht, Umweltschadensrecht*, edited by C. Callies, I. Härtel and B. Veit. Baden-Baden: Nomos, 28-60.

Hatanaka, M., C. Bain, and L. Busch. 2005. Third-party Certification in the Global Agrifood System. *Food Policy* 30 (3):354-369.

Hill, C.A., and G.D. Scudder. 2002. The Use of Electronic Data Interchange for Supply Chain Coordination in the Food Industry. *Journal of Operations Management* 20 (4):375-387.

Hollmann-Hespos, T. 2008. *Rückverfolgbarkeitssysteme in der Ernährungswirtschaft : eine empirische Untersuchung des Investitionsverhaltens deutscher Unternehmen*. Hamburg: Kovač.

Horváth, L. 2004. Supply Chain Management in der Fleischerzeugung: Konzeption, Implementierung und Perspektive. Ph.D. Thesis, TU München.

Hoy, S. 2002. Schweinehaltung in Deutschland. *Fleisch aus Deutschland*, http://www.zds-bonn.de/schweinehaltung_in_deutschland.html, 21.04.2011.

ISN. 2011. ISN-Schlachthofranking: TOP 4 schlachten bereits mehr als 60 Prozent aller deutschen Schweine. www.schweinenet.de, Press release March 17, 2011.

Jaccard, J., and C.K. Wan. 1996. *LISREL approaches to interaction effects in multiple regression, Sage university papers, Quantitative applications in the social sciences*. Thousand Oaks, Calif. [u.a.]: Sage.

Jahn, G. 2006. Qualitätssicherungssysteme in der Ernährungsindustrie. Ph.D. Thesis, Georg-August University of Göttingen.

Jahn, G., M. Peupert, and A. Spiller. 2003. *Einstellungen deutscher Landwirte zum QS-System: Ergebnisse einer ersten Sondierungsstudie*. Georg-August-University of Göttingen: Institut für Agrarökonomie.

Jarillo, J.C. 1988. *Strategic Networks: Creating the Borderless Organization*. Vol. 2. Oxford: Butterworth-Heinemann.

Knierim, A., and R. Siebert. 2005. Förderung des Biodiversitätsschutzes durch Landwirte: Eine Analyse des aktuellen Wissensstands. In *Schriften der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues e.V.*, edited by K. Hagedorn, U.J. Nagel and M. Odening. Münster-Hiltrup: Landwirtschaftsverlag, 489-500.

Kuß, A., and T. Tomczak. 2002. *Marketingplanung: Einführung in die marktorientierte Unternehmens- und Geschäftsfeldplanung*. 3rd ed. Wiesbaden: Gabler.

Lazzarini, S.G., F.R. Chaddad, and M.L. Cook. 2001. Integrating Supply Chains and Network Analyses: The Study of Netchains. *Journal on Chain and Network Science* 1 (1):7-22.

Mack, A. 2007. Nutzungskonzept für ein integriertes Audit- und Dokumentenmanagementsystem im überbetrieblichen Gesundheitsmanagement Schweine haltender Betriebe. Ph.D. Thesis, University of Bonn.

Mack, A., T. Schmitz, S. Gymnich, and B. Petersen. 2005. Modell eines integrierten Audit- & Dokumentenmanagement-Systems im Rahmen der Qualitätssicherung in QS-Bündlerorganisationen. In *Proceedings of 7. Internationale Tagung Bau, Technik und Umwelt in der landwirtschaftlichen Nutztierhaltung*. Braunschweig.

McKinnon, S.M., and W.J. Bruns. 1992. *The Information Mosaic*. Boston, MA: Harvard Business School Press.

Meffert, H., C. Burmann, and M. Kirchgeorg. 2008. *Marketing: Grundlagen marktorientierter Unternehmensführung ; Konzepte - Instrumente - Praxisbeispiele*. 10., vollst. überarb. und erw. Aufl. ed. Wiesbaden: Gabler.

Menard, S.W. 2002. *Applied logistic regression analysis*. 2nd ed, *Sage university papers Quantitative applications in the social sciences*. Thousand Oaks, Calif.: Sage Publications.

Miles, R.E., and C.C. Snow. 1984. Fit, Failure, and the Hall of Fame. *California Management Review* 26 (3):10-28.

Mohr, J., and R.S. Sohi. 1995. Communication Flows in Distribution Channels: Impact on Assessments of Communication Quality and Satisfaction. *Journal of Retailing* 71(4):393-416.

Moorman, C., G. Zaltman, and R. Deshpande. 1992. Relationship between Providers and Users of Market Research: The Dynamics of Trust Within and between Organizations. *Journal of Marketing Research* 29 (3):314-328.

Morris, R. 1991. Information Systems for Animal Health: Objectives and Components. *Revue Scientifique et Technique* 10 (1):13-23.

Narver, J.C., and S.F. Slater. 1990. The Effect of a Market Orientation on Business Profitability. *Journal of Marketing* 54 (4):20-35.

Nayga, R.M.J. 1996. Determinants of Consumers' Use of Nutritional Information on Food Packages. *Journal of Agricultural and Applied Economics* 28 (2):303-312.

Nunnaly, J. 1978. *Psychometric Theory*. Vol. 2. New York: McGraw Hill.

O'Connell, A.A. 2006. *Logistic regression models for ordinal response variables*, *Sage University papers series Quantitative applications in the social sciences*. Thousand Oaks, Calif. [u.a.]: Sage Publ.

O'Reilly, C.A. 1982. Variations in Decision Makers Use of Information Sources: The Impact of Quality and Accessibility of Information. *The Academy of Management Journal* 25:756-771.

Öhlmér, B., K. Olson, and B. Brehmer. 1997. Understanding Farmers' Decision Making Processes and Improving Managerial Assistance. *Agricultural Economics* 18 (3):273-290.

Pedhazur, E.J., and L. Pedhazur Schmelkin. 1991. *Measurement, Design, and Analysis: An Integrated Approach*. Hillsdale, NJ [u.a.]: Erlbaum.

Petersen, B. 2003. Überbetriebliches Qualitätsmanagement in Wertschöpfungsketten der Agrar- und Ernährungswirtschaft. In *Prozessorientiertes Qualitätsmanagement - Gestalten, Umsetzen, Bewerten*, edited by T. Pfeifer. Aachen: Shaker, 63-77.

Petersen, B., A. Mack, V. Schütz, and G. Schulze Althoff. 2007. Nahtstelle als neuralgischer Punkt - 3-Ebenen-Modell zur Weiterentwicklung überbetrieblicher Qualitätsmanagementsysteme. *Fleischwirtschaft* 87 (4):89-94.

Peupert, M., and L. Theuvsen. 2007. Improving Quality-related Communication in Food Chains with Quality Function Deployment: The Dairy Industry. In *Quality Management in Food Chains*, edited by L. Theuvsen, A. Spiller, M. Peupert and G. Jahn. Wageningen: Wageningen Academic Publishers.

Plumeyer, C.-H., M. Deimel, and L. Theuvsen. 2008. Qualitätskommunikation und Prozessoptimierung in der Fleischwirtschaft: Recht, Zertifizierungssysteme und Informationssysteme als Einflussgrößen. *Elektronische Zeitschrift für Agrarinformatik* 3:1-23.

Plumeyer, C.-H., M. Deimel, and L. Theuvsen. 2009. Netzwerkbeziehungen und betriebliches Qualitätsmanagement: Ergebnisse einer empirischen Untersuchung. In *Qualitätsmanagement in Wertschöpfungsnetzwerken*, edited by L. Theuvsen and M. Deimel. Aachen: Shaker, 167-184.

Plumeyer, C.-H., L. Theuvsen, and J. Bahlmann. 2009. Einfluss der Kommunikationsmedien auf den stufenübergreifenden Informationsaustausch in der Schweinefleischwirtschaft. In *Anforderungen an die Agrarinformatik durch Globalisierung und Klimaveränderung*, edited by R. Bill, P. Korduan, L. Theuvsen and M. Morgenstern. Bonn: Köllen, 133-136.

Reiner, G. 2005. Supply Chain Management Research Methodology Using Quantitative Models Based on Empirical Data. In *Research Methodologies in Supply Chain Management*, edited by H. Kotzab, S. Seuring, M. Müller and G. Reiner. Heidelberg: Physica-Verlag, 431-444.

Rosskopf, K., and P. Wagner. 2003. Requirements for Agricultural Software and Reasons for Adoption Constraints. In *Information Technology for a Better Agri-food Sector, Environment and Rural Living*, edited by Z. Harnos, M. Herdon and T. Wiwczaroski. Debrecen, 651-658.

Roßteutscher, S. 2004. Von Realisten und Konformisten — Wider die Theorie der Wertsynthese. *Kölner Zeitschrift für Soziologie und Sozialpsychologie* 56 (3):407-431.

Schulze Althoff, G. 2006. *Stufenkonzept zum Aufbau überbetrieblicher Informationssysteme für das Qualitäts- und Gesundheitsmanagement in Wertschöpfungsketten der Fleischwirtschaft*. Göttingen: Cuvillier.

Schulze Althoff, G., A. Ellebrecht, and B. Petersen. 2005. Chain Quality Information Management: Development of a Reference Model for Quality Information Requirements in Pork Chains. *Journal on Chain and Network Science* 5 (1):27-38.

Schulze, B. 2008. Verbraucherverhalten und Supply Chain Management: Herausforderungen für Unternehmen des Agribusiness. Ph.D. Thesis, Georg-August-University of Göttingen.

Schulze, B., A. Spiller, and L. Theuvsen. 2006a. Determinants of Trust between Buyers and Suppliers in Agribusiness: Empirical Evidence from German Pork Sector. In *Trust and Risk in Business Networks, Proceedings of 99th European Seminar of the European Association of Agricultural Economists*, edited by M. Fritz, U. Rickert and G. Schiefer. Bonn, 117-125.

Schulze, B., A. Spiller, and L. Theuvsen. 2006b. Is more Vertical Integration the Future of Food Supply Chains? Empirical Evidence and Theoretical Considerations from German Pork Production. In *International Agri-food Chains and Networks: Management and Organization*, edited by W.J.J. Bijman, S.W.F. Omta, J.H. Trienekens, J.H.M. Wijnands and E.F.M. Wubben. Wageningen: Wageningen Academic Publishers, 49-64.

Schulze, B., A. Spiller, and L. Theuvsen. 2007. A Broader View on Vertical Coordination: Lessons from German Pork Production. *Journal on Chain and Network Science* 7 (1):35-53.

Simon, H.A., H. Guetzkow, G. Kozmetsky, and G. Tyndall. 1954. *Centralization vs. Decentralization in Organizing the Controller's Department: A Research Study and Report*. New York: Controllership Foundation.

Spiller, A., and B. Schulze. 2008. *Zukunftsperspektiven der Fleischwirtschaft: Verbraucher, Märkte, Geschäftsbeziehungen*. Edited by A. Spiller and B. Schulze. Göttingen: Univ.-Verl. Göttingen.

Spiller, A., L. Theuvsen, G. Recke, and B. Schulze. 2005. *Sicherstellung der Wertschöpfung in der Schweineerzeugung: Perspektiven des Nordwestdeutschen Modells. Gutachten im Auftrag der Stiftung Westfälische Landschaft*. Münster.

Stock, J., H. Wolff, H. Mohr, and J. Thietke. 1998. Delphi-Befragung 1996/1998 "Potentiale und Dimensionen der Wissensgesellschaft - Auswirkungen auf Bildungsprozesse und Bildungsstrukturen". In *Endbericht im Auftrag des Bundesministeriums für Bildung, Wissenschaft, Forschung und Technologie*. München und Basel: Prognos. http://edok01.tib.uni-hannover.de/edoks/e01fbdig09/598731482.pdf.

Theuvsen, L. 2003. Motivational Limits to Tracking and Tracing: Principal-Agent Problems in Meat Production and Processing. In *Quality Assurance, Risk Management and Environmental Control in Agriculture and Supply Networks*, edited by G. Schiefer and U. Rickert. Bonn: ILB-Press, 223-230.

Theuvsen, L., and C.-H. Plumeyer. 2007. Certification Schemes, Quality-Related Communication in Food Supply Chains and Consequences for IT-Infrastructures. In *Environmental and Rural Sustainability through ICT*, edited by C.G. Parker, S. Skerratt, C. Park and J. Shields. Glasgow: Proceedings of EFITA/WCCA Conference.

Theuvsen, L., C.-H. Plumeyer, and J.-C. Gawron. 2007. Certification Systems in the Meat Industry: Overview and Consequences for Chain-wide Communication. *Polish Journal of Food and Nutrition Sciences* 57:563-569.

Thong, J.Y.L. 1999. An Integrated Model of Information Systems Adoption in Small Businesses. *Journal of Management Information Systems* 15 (4):187-214.

Vallan, H. 2007. Innovative Lieferantenbewertungssysteme und Salmonellenmonitoring in der Schweinehaltung. Presentation on the Workshop "Qualitätsmanagement: Innovative Lieferantenbewertungssysteme und Salmonellenmonitoring in der Schweinefleischproduktion". Göttingen, 12.03.2007.

Venkatesh, V., M. Morris, G. Davis, and F. Davis. 2003. User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly* 27 (3):425-478.

Vennemann, H., and L. Theuvsen. 2004. Landwirte im Internet: Erwartungen und Nutzungsverhalten. In *Integration und Datensicherheit - Anforderungen, Konflikte und Perspektiven*, edited by G. Schiefer, P. Wagner, M. Morgenstern and U. Rickert. Bonn: GI-Edition, 214-244.

Vroom, V.H. 1964. *Work and Motivation*. New York [u.a.]: Wiley.

Weißenberger, B. 1997. *Die Informationsbeziehung zwischen Management und Rechnungswesen: Analyse institutionaler Koordination*. Wiesbaden: Deutscher Universitäts-Verlag.

Windhorst, H.-W. 2004. Qualitätssicherung in der Lebensmittelkette: Wo liegen die Herausforderungen? . In *Lebensmittelqualität und Qualitätssicherungssysteme*, edited by Dachverband Agrarforschung. Frankfurt am Main, 21-33.

Wocken, C. 2008. Supplier Relationship Management im Agribusiness. Ph.D. Thesis, University of Göttingen.

Wocken, C., and A. Spiller. 2009. Sind hohe Milchauszahlungspreise wirklich alles? - Ergebnisse einer Studie zum Geschäftsbeziehungsmanagement. In *Milchwirtschaft ohne Quote*, edited by L. Theuvsen and C. Schaper. Lohmar and Cologne, 145-177.

Zahay, D.L., and A. Griffin. 2003. Antecedents and Consequences of Personalization and Customization. *Journal of Database Marketing* 10 (3):255-326.

Ziggers, G.W., and J. Trienekens. 1999. Quality Assurance in Food and Agribusiness Supply Chains: Developing Successful Partnerships. *International Journal of Production Economics* 60-61:271-279.

