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Crop protection market segmentation: relationship between buyer segments and the use of digital sales channels

RESEARCH ARTICLE

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Abstract

Digital technologies are revolutionizing agricultural trade, enabling farm input suppliers to reach customers through multiple channels. The aim of this study was to segment farmers based on their purchasing behavior for crop protection products and to examine segment-specific characteristics in the digital environment. A cluster analysis of 590 German farm managers was used to identify five distinctive buyer segments based on five characteristics: dealer, brand and service orientation, price affinity and autonomous decision making. The results demonstrate that farmers place high value on personal contacts to stationary suppliers when purchasing crop protection products. Service orientation turned out to be a strong mediator of segment membership, while price and product brand are secondary to farmer segmentation. However, traditional typologies are only suitable for the digitization topic to a limited extent, as digital search and information behavior hardly differs. Even though digital information procurement is becoming increasingly interesting for all segments, an openness to e-commerce applies only to a small group of independent buyers. Concerning e-commerce attitudes, the perception of its advantages and the lack of personal contact differentiates the clusters the most. The results contribute to the scientific understanding of farmers' information and purchasing behavior and provide initial approaches for the development of customer-centric corporate marketing strategies.

Keywords: farm inputs, agri-chemical, cluster analysis, purchasing behavior, omni-channel
JEL code: Q12, Q13

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1. Introduction

Agricultural input markets for products such as animal feed, seeds, crop protection, and fertilizers are essential segments in global agribusiness. They are characterized by ongoing transformation processes, such as lasting agricultural structural change on the customer side and mergers and consolidations on the supplier side (Munz and Doluschitz, 2021). Added to this, the 'megatrend' of digitalization affects all players in agricultural value chains (Gandorfer *et al.*, 2017). Simple and for all market participants transparent and quickly available information on prices and offers for agricultural inputs, induced by digitalization, represent a core challenge for the agricultural input industry. The emergence and increasing spread of online trade (e-commerce), especially by the massive push of digital marketplaces by start-ups, has led to increasing competition (Munz and Doluschitz, 2020). Established companies therefore feel increasing pressure to change or adapt their business models (Deutsch *et al.*, 2020). In Germany, cooperatives and (privately owned) agricultural traders are adapting to market changes by mergers and the implementation of own e-commerce activities. Large cooperatives like Agravis and Baywa or long-standing agricultural retailers like ATR have already expanded their digital sales channels to attract and retain customers (Bickert, 2020).

The transformation processes described can be seen particularly well in the German crop protection sector. In Germany, fertilizers and pesticides are the third-largest cost item for producing agriculture (Pascher *et al.*, 2018). However, the German crop protection market faces a downward trend due to political pressure. Prices for crop protection products have tended to decline or grow only weakly in recent years, and the volume of active ingredients sold and sales in the direct business have declined (Agropages, 2020; Nishimoto, 2019). At the same time, the global crop protection market has developed into an oligopoly market (Bonny, 2017; Nishimoto, 2019). Through mergers and acquisitions, the four leading crop protection manufacturers Bayer CropScience/Monsanto, BASF, Syngenta, and DowDuPont currently hold a market share of more than 70% (Fröndhoff, 2018). In addition, the number of farms in Germany is declining in favor of large farms, with 5% of the largest farms already managing more than 40% of agricultural land (Junge, 2021). The industry is thus confronted with a growing countervailing power of the ever-expanding farms and the changing requirement profiles of trading partners and agricultural customers. To create competitive advantages, agri-chemical companies are increasingly turning to digital business models. Ongoing digital upheaval in agriculture supports this. Digital progress in agriculture creates new possibilities for documentation, precision farming, and procurement of information and resources. Today, farmers are seeking out mobile applications, like pest control apps, and e-commerce options for their farms. 9% of German farmers buy crop protection products online, although the penetration rate for other product groups is higher (Gartzke, 2016). In global comparison, 11% of U.S. farmers and 8% of European farmers buy crop inputs online (Ardrey *et al.*, 2020; Eckelkamp, 2019). The low e-commerce penetration rate for crop protection products suggests that consultation and purchase take place locally, and the local trade relationship is solid, making e-commerce adoption unattractive to farmers to date (Ardrey *et al.*, 2020). Nevertheless, there is an increasing willingness of farmers to conduct e-commerce.

But how does the farmers' reluctance to buy crop protection online, i.e. the preference for more traditional buying, and the push for digital solutions on the supplier side, fit together? Studies indicate the high degree of heterogeneity among farmers in their use of new information media (Fecke *et al.*, 2018b; Kassem *et al.*, 2021) as well as e-commerce (Ackermann *et al.*, 2018; Ardrey *et al.*, 2020; Fecke *et al.*, 2018a; Schulze Schwering and Spiller, 2018).

One opportunity for companies is to target farmers' needs based on their willingness to use digital tools by developing customer typologies that set out the most promising customer group. However, current research has only meagerly addressed this topic. To close this gap, a market segmentation is particularly suitable. Segmentation has been an important marketing tool since the 1970s (Bernecker, 2019). Also in agricultural research, segmentation has become a standard approach to studying agricultural purchasing behavior and has been helping to develop customer-oriented marketing strategies. Seminal studies from the U.S. established a segmentation approach based on factors that are decisive for farmers when selecting a supplier (Alexander

et al., 2005; Gloy and Akridge, 1999). At that time, the focus on building long-term customer relationships among input suppliers increased, which raised the question of which customers should a company attempt to build such relationships with (Gloy *et al.*, 1997). Therefore, studies segmenting commercial farms to identify market segments for agricultural suppliers in order to optimize marketing efforts, have become increasingly common (Gloy and Akridge, 1999; Gloy *et al.*, 2000).

However, these studies date back several years, and only a few studies (at least those that are published) investigated farmers' buying behavior for a specific product category. European agricultural segmentation studies are particularly rare. With agricultural structures and trade undergoing changes, it is therefore interesting for agribusinesses to obtain more recent data. Therefore, the first two research questions aim to clarify whether these long-established segmentation approaches are still valid and whether they are also valid for a specific market like German crop protection. Moreover, the literature lacks consideration of how the identified segments differ in their attitudes toward digital sales channels. For this reason, the third research question addresses the relationship between crop protection market segmentation and the purchase-related usage of digital sales channels. The study provides further insights into the extent to which digital media are already part of the purchasing process and whether these segmentation approaches can be used to identify typologies of digital behaviors in the purchasing process. A comprehensive survey of the purchase of crop protection products among German farmers serves as the data foundation. Principal component and cluster analysis were used to answer the research question.

The following provides an overview of the current state of research on agricultural purchasing behavior. Subsequently, the data collection and evaluation methods used are presented, followed by the presentation of the results. In the discussion part, the results are critically examined and interpreted based on the presented theory, before at the end a conclusion is drawn.

2. Market segmentation in agricultural trade

There have been several studies on segmentation in agricultural procurement markets. These studies refer primarily to the U.S. and both to agricultural investment goods (like machines) and expendable goods (such as seed, fertilizer, chemicals). Segmentation was mainly based on the importance of six factors that farmers assess when selecting a supplier: convenience/location, customer service/information (e.g. responsiveness, advice), personal factors (e.g. trust, work relationships), price, product performance (e.g. durability, yield), and support service (e.g. repair, delivery) (Figure 1). On the basis of these factors four main market segments were identified: balance, price, performance, and convenience (Gloy and Akridge, 1999; Borchers *et al.*, 2012; Feeney and Berardi, 2013; Roucan-Kane *et al.*, 2011), where balance buyers weight all factors relatively equally. Few studies have identified a service or relationship-oriented segment (Alexander *et al.*, 2005; Gundersson *et al.*, 2005).

European studies have applied slightly different segmentation variables. According to Dutch results of Kool (1994), the local dealer has a unique position in agricultural procurement. According to the degree of vendor loyalty and commitment, he identified three farmer segments: spurious dealer loyalty, true dealer loyalty, and behavioral dealer loyalty. Zimmermann (2003) investigated German farmers' purchasing behavior for agricultural capital goods (tractors, automatic feeders) and identified market segments built on attitude-based factors: brand loyalty, dealer loyalty, willingness to innovate, pre-sales marketing of the trade, and variety-seeking/prestige consumption and experience. For tractors, dealer- and brand-oriented shoppers as well as smart shoppers and objective loaners were identified. Smart shoppers are innovation-driven and price-conscious, while objective loners are autonomous decision-makers, conservative, and skeptical. For automatic feeders four different clusters evoked: pragmatist, prestige-oriented dealer loyal, knowledge thirsty and price-conscious conservative. While the pragmatists balance all variables fairly equally, the group prestige-oriented dealer loyalty is characterized by dealer and brand loyalty and the influenceability by their social environment (Zimmermann, 2003).

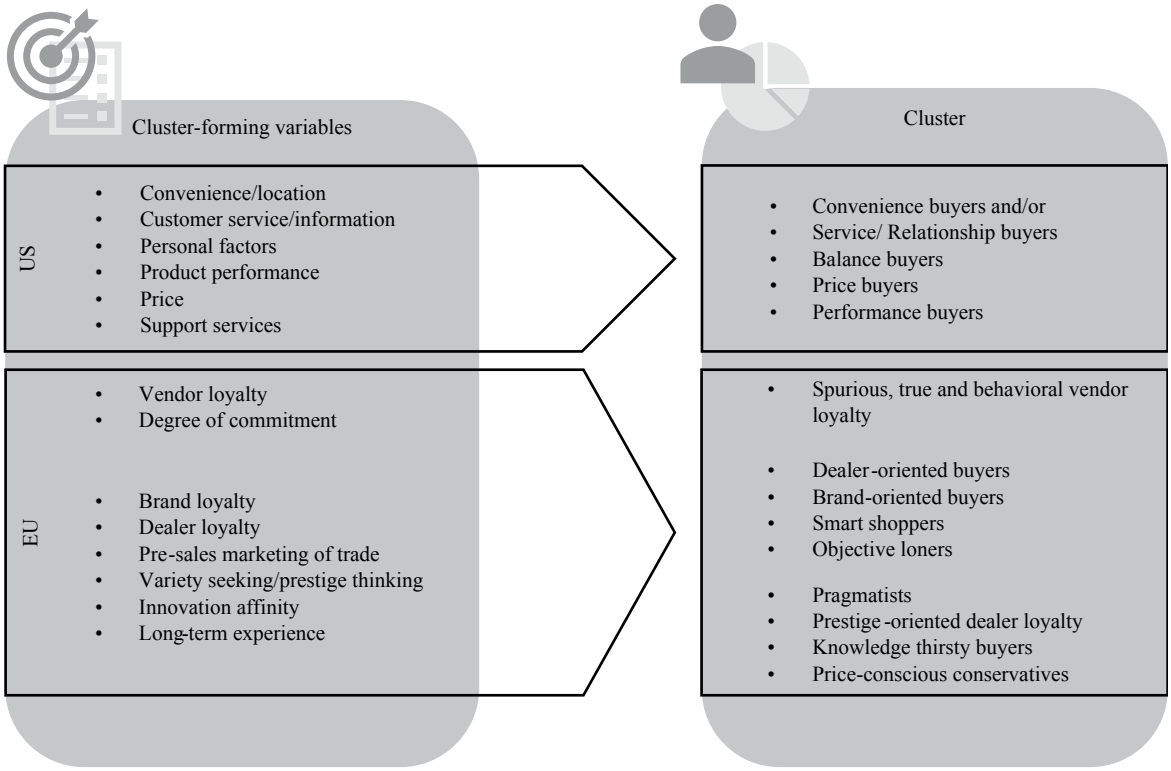

Figure 1. Overview of agricultural market segmentation approaches.

With reference to the subject of this study, the crop protection market: Borchers *et al.* (2012) conducted a separate cluster analysis according to the type of farm input (seeds, crop protection, animal health, and feed) using five factors established by Gloy and Akridge (1999). The data, based on a U.S. survey conducted in 2008 with 980 responding crop producers, identified four segments: balance (57%), price (18%), performance (14.4%), and convenience (10.6%). Views on brands varied significantly, with price buyers being less brand loyal and more favorable towards generic products. Approximately 39% of the balance and convenience segments considered themselves brand loyal. The convenience segment was particularly loyal to its local agricultural trader (71%), whereas the price segment was the least loyal farmer group. Moreover, convenience and price shoppers tended to make their decisions more independently. Due to its size, the balancing segment was desirable to crop protection sellers, and a distinctive feature of these individuals was that they still emphasized support services. Borchers *et al.* (2012) state that the four market segments are relatively consistent across several products, but that purchasing decisions for expendable goods depend on whether they are plant-related (seeds, crop protection) or animal-related (animal health, animal feed).

All in all, the results in the U.S. and the EU are quite similar, for example, there are similarities between: Retailer orientation and the convenience segment, brand orientation and performance buyers or between objective loaners and price buyers. The formation of buyer typologies is still important because the results illustrated the complexity of marketing to commercial agricultural producers and their product category-dependent and heterogeneous buying preferences (Borchers *et al.*, 2012; Gloy and Akridge, 1999). Manufacturers and agricultural retailers must therefore focus on the unique buying preferences of individual segments (Gloy and Akridge, 1999). However, digitalization is changing the markets significantly.

3. Digitization and changing buying behavior in agricultural trade

Even though dealer loyalty is high and personal relationships are critical, agricultural trade pushes for digital solutions and online sales (Bickert, 2020). Agriculture is undergoing a digital transformation. Technology is already part of a farmer's business, and the management of upcoming data is a core resource of future business. Figures show a general increase in penetration of digital technologies and e-commerce on the farm, with about one-third using digital technologies like automatic steering systems or GPS technology (Gabriel *et al.*, 2021). In the next few years, the primary sensors, actuators, and devices in agriculture will be connected via the internet with the fundamental goal of interaction, control, and decision-making (Khanna and Kaur, 2019). Significantly, the latest developments in smartphone technology enable new decision support tools to be integrated into everyday work (Michels *et al.*, 2020). According to Michels *et al.* (2020), 95% of surveyed German farmers use smartphones and 71% use a crop protection smartphone app for gathering information about weather, pest scouting, and infestations forecasts. Those results illustrate that gathering of information on operating resources or production methods is increasingly shifting to the digital format. Looking at the stages of the customer decision journey, most European farmers prefer non-digital options for initiating and completing purchases, while initial product and supplier research is preferred to be conducted online by 87%. Supplier evaluation and use of servicing products are favored online by nearly half of the European farmers (Ardrey *et al.*, 2020).

With this high digital level on the farms, the essential prerequisite for e-commerce is given. However, so far, digital procurement options have been adopted only slowly by European farmers. Only 13% have made an online purchase of agricultural inputs, while 33% state that they want to buy agricultural products online (Ardrey *et al.*, 2020). Results from Germany show that agricultural inputs are mainly purchased from stationery retailers. E-commerce is used relatively rarely and only for specific product categories. Agricultural expendable goods, such as seeds, fertilizers, and pesticides, have only seldomly been bought online (Ackermann *et al.*, 2018; Gartzke, 2016; Schulze Schwering and Spiller, 2018). Even with increasing digitization, the main factors that farmers assess when selecting a supplier remain relatively constant. Considering purchasing crop inputs, farmers emphasize price, availability of products and brands, ease of purchasing, and availability of consultants (Eckelkamp, 2019). Fecke *et al.* (2018a) show that farmers demand a significantly higher annual price advantage for switching to an online retailer than switching to another regional retailer. However, short delivery times and initial experience with online shopping may favor the choice of an online store for the purchase of crop protection products (Fecke *et al.*, 2018a). However, it is becoming apparent that the agricultural trade is facing a massive transformation process, which is likely to lead to altered buyer expectations. Therefore, companies have to adapt business models, and farmers must be guided through the complexity and mass of information. As the literature shows, while farmers favor local, personal shopping on the one hand, they are increasingly opening up to digital sales channels such as the internet, mobile apps, or e-commerce on the other hand.

For the players in agribusiness, current research is important, as it is important to know whether there is a relationship between the basic purchasing behavior for crop protection products and the usage behavior of digital sales channels. Since previous segmentation studies have mainly focused on U.S. markets for general inputs and are several years old (Alexander *et al.*, 2005; Gloy and Akridge, 1999), the first step is to examine whether these common segmentation approaches are still valid today and whether they can be transferred to the German crop protection market. Moreover, previous segmentation studies have largely neglected the use of digital media in the purchasing process. Against this background, this study analyzes the segment-specific relevance of digital sales channels. At the same time, this will provide information on the extent to which existing segmentation approaches can be applied to the analysis of digital behavior in the agricultural purchasing process. New research is necessary to understand customers and to derive recommendations for manufacturers as well as for offline and online merchants to remain competitive in this challenging crop protection market. Because German farmers stand out in a European comparison for their openness to digital applications, it is particularly interesting to take a closer look at their purchasing behavior. In addition, studies have highlighted the need for targeted behavioral and digital marketing strategies to increase customer satisfaction (Ardrey *et al.*, 2020; Borchers *et al.*, 2012).

4. Material and methods

4.1 Data collection and questionnaire design

In this study, 590 farmers were interviewed digitally and by telephone by the agricultural market research service provider Kleffmann Group. The study was quoted in terms of region and farm size (Statistisches Bundesamt, 2017). Farms with less than 20 ha of agricultural land were excluded. A quota system was used because an unwanted imbalance could have arisen due to the online recruitment process, making it difficult to transfer the results to the general population of farmers. The survey was only open to farmers involved in the procurement process and who used crop protection in 2017. The questionnaire consisted of four parts: an attitude-based item battery, identification of information sources focusing on digital media, sources of supply, and farm data. The selection of items was based on proven measurement concepts from empirical studies by Kool (1994), Gloy and Akridge (1999), Zimmermann (2003), Alexander *et al.* (2005), Roucan-Kane *et al.* (2011), and Borchers *et al.* (2012). It covered five main areas: convenience, customer service, price, product performance, and support service. Closed questions with a five-level Likert scale from one, 'does not describe me at all', to five, 'describes me very well', were used for the attitude-based items. The question sequence of the individual items of the sections rotated between respondents to avoid order effects.

4.2 Data preparation by multiple imputations with chain equation

For further data analysis, the data set was first subjected to a quality check and adjusted accordingly. Subjects with too fast or stereotypical responses and outliers were eliminated. After data cleaning, a data set with data from 590 farmers remained for further analysis. However, parts of the questionnaire were not answered thoroughly by all respondents. Missing values concerned many observations (18.3%), while only a tiny percentage of the values among the relevant variables was missing (1.2%). Incomplete data may occur since participants were not forced to develop an opinion on all variables. In this case, 108 valid observations showed at least one missing value that otherwise would have been dropped. Missing values are problematic for principal component analyses as they lead to serious distortion and incongruous of obtained results with the relationships inherent in the data (Mackelprang, 1970). Several methods have been developed to overcome the drawbacks produced by missing values (Luengo *et al.*, 2012; Schlomer *et al.*, 2010). Schlomer *et al.* (2010) urge researchers to provide more details on how missing data has been dealt with, even if deletion has been carried out on a case-by-case basis, i.e. incomplete cases disappear. Imputations based on mean values are rejected in the literature as poorly functioning or distorted methods (Schlomer *et al.*, 2010). A state-of-the-art approach is multiple imputations with chained equation (MICE) (Zhang, 2016). If, in detail, no a priori information indicates why responses are lacking, the responses to similar attitudes can be used to predict the response to a missing attitude. Predicting a missing value is characteristic of MICE to improve the prediction of a different missing value for each subject. The optimized prediction is used to improve the previous prediction (Zhang, 2016). Five sets of MICE imputations are performed using ordinal regressions for the prediction functions since the preference variables' ordinal nature is given. The five imputations' median is selected as the imputation value to complete the responses to an attitude. Now, all calculations can use the complete set of 590 observations. The statistical program Stata (StataCorp LLC, College Station, TX, USA) was used for data management and model execution.

4.3 Data analysis

After data preparation, a principal component analysis (PCA) with varimax rotation was carried out in order to condense the variables and to operationalize clustering variables following Gloy and Akridge (1999). For this purpose, the initial data were first tested for their suitability for principal component analysis using the Kaiser-Meyer-Olkin criterion (KMO) and the variable-specific measure of sampling adequacy (MSA). The former shows the extent to which the initial variables belong together based on the anti-image correlation matrix and serves as a suitability indicator. According to Kaiser and Rice (1974), the value should be at least 0.5. MSA provides an indication of which individual variables are unsuitable for the principal component

analysis. This value should be greater than 0.6. Thus, three statements had to be excluded. In the second step, a dimension reduction was carried out with an explorative principal component analysis. The information on attitudes and behaviors described as necessary to purchasing was strongly summarized (Backhaus *et al.*, 2016). From 31 applicable statements, all factors with an eigenvalue more significant than one were extracted using the Kaiser criterion (Backhaus *et al.*, 2016). Five factors could be identified. The individual factors were judged as satisfactory based on reliability using Cronbach's alpha (Cα) and validity, the explained total variance. The Cα value should be at least 0.5 (Peterson, 1994) and the total variance at least 50%. In the next step, the extracted standardized factors scores based on PCA were subjected to cluster analysis. Cluster analysis serves to classify the content of groups with homogeneous characteristics that simultaneously exhibit heterogeneity among themselves (Backhaus *et al.*, 2016). The process of cluster analysis is based on the two-stage process following Gloy and Akridge (1999), Alexander *et al.* (2005), Roucan-Kane *et al.* (2011), and Borchers *et al.* (2012). A hierarchical cluster analysis was performed using the Ward method with the squared Euclidean distance to identify the different possibilities of cluster numbers. After a systematic comparison of the cluster possibilities, content considerations, and interpretability, the decision was made in favor of a 5-cluster solution. The solution was then used as the starting value for the iteratively partitioning k-means algorithm, which generated the results. With the help of discriminant analysis, the classification accuracy could be determined. Finally, the clusters were described in more detail, focusing on their sociodemographic and business-related data, digital information, and purchasing behavior. The data was evaluated using IBM SPSS Statistics 25 (IBM Corp., Armonk, NY, USA).

5. Results

First, a sample description is given before the results of the principal component and cluster analysis are presented. This is followed by a description of the segments based on sociodemographic and farm-related data and the attitude towards digital sales channels.

5.1 Sample description

The sample includes 590 interviews generated from 38% online interviews and 62% computer-assisted telephone interviews (CATI). The average age of the respondents is 51.7 years. The farms have an average of 148.3 hectares of agricultural area. On average, professional farms in Germany, i.e. those with 20 hectares and more, cultivate 104 hectares of arable land (Statistisches Bundesamt, 2017). Compared to this average, the represented farm size is relatively large. The gender distribution comprises 97% male and 3% female respondents, thus women are slightly underrepresented. In Germany, less than 10% of farms are run by women (Pascher *et al.*, 2018). 40% of the interviewees manage farms in southern Germany, 26% in northern Germany, 25% in western Germany, and 9% in eastern Germany. The distribution of farms by federal state resembles the agricultural structure in Germany (Hübbers, 2018). The sample consists of 9% livestock farms (swine, poultry), 20% feed-producing farms, 34% cash crop farms (business segments generated 75% of the revenue), and 34% of the farms are mixed farms, i.e. farms with several management branches, whereby no branch accounts for more than 75% of the farm revenue (BMEL, 2019). This breakdown differs from the overall statistics and represents significantly more mixed farms. 77% of respondents have completed a vocational training, 19% hold a university degree, and the remaining 4% do not provide any information. The level of education is approximately in line with the official statistics, with 12% university graduates (Pascher *et al.*, 2018). For 37% of the respondents, cereals are the most important crop on the farm and 28% maize.

5.2 Principal component analysis of clustering variables

According to Kaiser and Rice (1974), the statements with a KMO value of 0.78 could be described as meritorious (Table 1). The limit value of the explained total variance was exceeded. Five factors could be identified from the full statements. The internal consistency of the factors was tested using Cronbach's alpha (Cα), whereby all factors could be accepted based on Cα values above 0.5. The identified factors differ slightly from the five expected categories that formed the questionnaire based on the literature:

convenience, customer service, price, product performance, and support service in accordance with Gloy and Akridge (1999), Alexander *et al.* (2005), Roucan-Kane *et al.* (2011), and Borchers *et al.* (2012). The first factor can be compared most closely with the convenience/location factor in the literature because it refers to the convenience, presence, and location of local suppliers. However, elements of the categories customer service/information and personal factors are included here, which makes the factor more dealer-oriented. According to product performance (product quality and durability) in literature, farmers distinguish between branded products and non-branded products, described by the factor brand affinity. The autonomous decision-making factor contains the attitude towards customer service, and it is based on the factor customer service/information from the literature. The factor service orientation addresses delivery and return services and equals the support service in literature. The price factor consists of only one variable and describes the importance of price.

Table 1. Results of the principal component analysis.[1,2]

Factor and related variables	Factor loadings	Mean	SD
Dealer orientation Cα = 0.82			
I always buy from the same dealer; that's the easiest thing for me.	0.80	3.40	1.39
I prefer a fixed contact person where I buy all crop protection products.	0.75	3.60	1.3
Even if the price is slightly higher, I buy from the retailer I trust.	0.74	3.81	1.15
If the retailer does not have my favorite product, I will buy something similar from him. I will not change the dealer.	0.75	3.43	1.33
I prefer to buy crop protection products locally.	0.66	4.07	1.07
I only buy products where I get good advice.	0.59	3.66	1.31
Brand affinity Cα = 0.78			
I prefer branded products.	0.77	3.08	1.29
For standard products, I prefer branded products.	0.77	3.20	1.31
It is worth spending more money on a product from a well-known company.	0.74	2.68	1.17
Imported products and branded products are of the same quality.	-0.63	2.85	1.20
Generics and branded products are of the same quality.	-0.71	3.26	1.10
Autonomous decision-making Cα = 0.51			
For standard products, I do not need advice.	0.71	3.15	1.22
I decide on the product choice entirely on my own.	0.66	3.13	1.39
I obtain factual information before the purchase and do not need any further advice afterwards.	0.67	3.14	1.17
Service orientation Cα = 0.68			
I always choose the retailer with the best service, such as returns and delivery.	0.84	3.30	1.26
The most important thing when buying crop protection products is the ability to return them.	0.86	2.85	1.35
Price affinity Cα = 1.0			
Costs are the most important factor in product selection.	0.94	2.66	1.12

[1] Explained total variance = 60.013%; Kaiser-Meyer-Olkin criterion (KMO) = 0.786.

[2] Mean value on a scale from 1 (describes me not at all) to 5 (describes me very well); SD = standard deviation; Cα = Cronbach's alpha.

5.3 Cluster analysis and description of clusters

Based on the standardized factor scores obtained from PCA, the hierarchical cluster analysis (Ward method) identified a 5-cluster solution. A cluster center analysis (k-means) led to the final mean values of the cluster-forming variables. The F-values and the significance of the results were used to assess the homogeneity of the identified clusters. Since all variables have high F-values and low significance values, the cluster analysis was assessed as successful (Table 2). Discriminant analysis was used to determine a satisfactory classification accuracy of 94% for the cluster analysis. Table 2 illustrates the cluster-forming variables and the resulting mean values. The clusters are quite homogeneous in size so that neither particularly small nor large clusters are represented. The factor service orientation separates the clusters most strongly (F-value = 153.802 ($P \leq 0.001$)), followed by dealer orientation and the autonomous factor decision-making. In terms of service orientation, all clusters differ significantly from each other. In dealer orientation, clusters I and III and clusters IV and V do not differ significantly from each other. Regarding price affinity, clusters I and IV do not vary. Most clusters have a similar brand affinity, except cluster II, which is only comparable to cluster IV. Cluster I and cluster III differ from all other clusters with respect to autonomous decision-making.

Demographic and general farm characteristic data such as age, education, farm size, and location are used to describe the individual clusters (Table 3). Single factor variance analysis (ANOVA) was used to show mean differences and significance for age and farm size. The significance and percentage distribution of other characteristics was derived from the x^2 statistic of the cross-tabulation. The results show relatively high significant differences between the clusters. The investigation of the sources of supply shows that the local dealer or cooperative serves as the main source of supply. Farmer purchasing groups, field sales representatives, and contractors are partly used. E-commerce plays a subordinate role in purchasing crop

Table 2. Mean values of the cluster-forming variables.[1]

		Cluster I Relationship	**Cluster II Independent**	**Cluster III Balance**	**Cluster IV Persistent**	**Cluster V Service comfortable**	
Sample size (#)		118	99	126	111	136	
		20%	17%	21%	19%	23%	
Factor mean values (FMV) and mean values (MV) of the cluster-forming variables							**F-value**
Dealer orientation	FMV	0.127^{III}	-1.477	0.026^{I}	0.534^{V}	0.506^{IV}	136.66***
	SD	0.77	0.67	0.83	0.74	0.59	
	MV[b]	3.93	2.28	3.69	3.94	4.18	
Brand affinity	FMV	0.033^{III-V}	-0.384^{IV}	$0.170^{I,IV,V}$	-0.020^{I-V}	$0.110^{I,III,IV}$	5.15***
	SD	1.03	1.10	0.95	0.94	0.93	
	MV[b]	2.96	2.55	3.10	2.98	3.16	
Autonomous decision-making	FMV	-1.059	$0.337^{IV,V}$	-0.478	$0.632^{II,V}$	$0.600^{II,IV}$	120.09***
	SD	0.68	0.73	0.77	0.81	0.72	
	MV[b]	2.20	3.59	2.77	3.57	3.62	
Service orientation	FMV	0.410	0.051	-0.593	-0.995	0.969	153.80***
	SD	0.76	0.83	0.67	0.73	0.52	
	MV[b]	3.56	2.81	2.43	2.07	4.27	
Price affinity	FMV	0.654^{IV}	0.208	-0.972	0.547^{I}	-0.265	85.08***
	SD	0.84	1.00	0.59	0.80	0.76	
	MV[b]	3.38	3.01	1.70	3.14	2.31	

[1] FMV = factor mean value, where positive (negative) values indicate that the variable is overrepresented (underrepresented) in the cluster compared to the survey population (Backhaus *et al.*, 2016). SD = standard deviation; F-values on ANOVA significance level: ***$P \leq 0.001$; b = mean values on a scale from 1 (does not describe me at all) to 5 (describes me very well) I-V: according to the post hoc test, the clusters did not differ significantly ($P<0.05$) from marked clusters.

Table 3. Demographic and farm characteristics.[1]

	Cluster I Relationship	Cluster II Independent	Cluster III Balance	Cluster IV Persistent	Cluster V Service comfortable
ø-age (years)[2*]	50.7	50.1	50.6	51.2	54.8
ø-farm size (hectares)[2***]	142	302	90	87	145
Education (%)[3]					
University degree	11.0	35.3	16.7	18.9	15.4
Region (%)[3]					
North	29	28	30	23	21
East	9	19	2	5	10
South	35	32	41	52	40
West	27	20	26	21	29
Number of requested quotes[2***]	1.6	2.6	1.7	1.4	1.5
Source of supply locally (%)[3]					
100%	51	24	48	66	57
≥50% <100%	4	12	8	10	4
<50%	5	5	4	3	2

[1] ø = average; ***$P \leq 0.001$, *$P \leq 0.05$.

[2] Differences between clusters were highly significant according to ANOVA.

[3] Differences between clusters were significant according to χ^2-test ($P \leq 0.05$).

protection products in this sample. Before buying crop protection products, the clusters request significantly different numbers of quotations (Table 3).

Relationship. Cluster I comprise 20% of participants and is dealer- and service-oriented. About 51% buy 100% at local dealers or cooperatives. The cluster comparisons show that buyers in the relationship segment want to be actively advised and accompanied in their decision-making and purchasing process. They tend to focus more on the additional services and support provided by the supplier. They are less sensitive to brands but value product prices. Even when prices are closely scrutinized, ties to local dealers would weigh more heavily. Buyers in the relationship segment cultivate an average of 142 hectares, which is in the middle range in a cluster comparison. A characteristic feature of this segment is the comparatively lower level of education, with 11% having a university degree.

Independent. Cluster II is the smallest cluster, with 17% of the participants. Farmers in this segment are very autonomous decision-makers and buyers. They are identified as free spirits, neither dealer- nor brand-oriented. Regarding the source of supply, only 24% of this segment purchase 100% of their crop protection products at local trade or cooperatives. They ask for the most quotes before buying, which indicates that they do not feel tied to a particular supplier. Service and prices are not of great importance to them, either. Information is obtained and weighed up independently, thus a consultation is mostly unnecessary for them. Services such as return options and delivery are only partly crucial to them. Independent buyers farm significantly more agricultural land and tend to be younger farmers with significant high education levels. The second cluster has the largest share of farms in eastern Germany.

Balance. Cluster III represents the second-largest segment with 126 members (21%). Compared to the other clusters, a low cost-orientation is the feature of this cluster that stand out, indicating that prices are not the most crucial buying criterion. Balance buyers weight other factors relatively equally, without further serious expressions. Their dealer orientation is the weakest after independent buyers but is still strong and weighted higher than product prices. The balance segment farms an average of 90 hectares and consists mainly of farmers from southern and northern Germany. In a cluster comparison, the balancing segment is in the middle range regarding age, education, and supply source.

Persistent. With 19%, the segment of persistent buyers forms the second-smallest cluster. It is characterized by its dealer orientation, which is just as high as that of the relationship buyers. However, this cluster does not attach particular importance to consultations and prefers to make decisions autonomously. Service is not given huge importance, either. This is even the lowest service orientation in comparison. Products brand and price play only a moderate role in the purchasing process. Their behavior seems to be guided by known situational circumstances by relying on tried-and-true, well-functioning purchases at local dealers or cooperatives. 66% buy 100% of their inputs at local dealers or cooperatives, and farmers request the least number of quotes. More than half of the fourth cluster is from southern Germany, and they cultivate the smallest area in comparison. However, with 19% holding a university degree, the fourth cluster has the second-highest educational level.

Service comfortable. Cluster V is the largest cluster with 23% (n=136). This cluster stands out by the highest dealer and service orientation, coupled with a strong need for autonomous decision-making. Local dealers or cooperatives are the only sources of crop protection supply for 57% of service comfortable farmers. It attaches only moderate importance to branded products. In a cluster comparison, respondents belonging to this cluster reject second-most that price is important buying criterion. Return options and delivery conditions are decisive purchasing criteria. Local dealers are preferred over price and product benefits and are evaluated based on their service offerings. The segment is largely made up of farmers from western and southern Germany. With an average age of 55 years, it represents the oldest cluster and runs the second-largest farms (145 ha).

5.4 Differences in the use of digital media as a source of information

Respondents were asked which sources of information they use and how important these are to them when purchasing crop inputs. Twenty sources of information were given, and multiple answers were possible. For further analysis, each source is assigned to a media category: personal, print, digital. Personal media includes colleagues, private/public consultants, working groups, sales representatives, and events. Print media covers regional and national agricultural journals, books, experimental results of traders or the chambers of agriculture, and company brochures. Digital sources include newsletters or websites of newspapers/journals, a newsletter of the industry, social networks, social media, and the internet. Results show that 52% use newsletters, social media, or the internet in general, and 25% of respondents use new digital media (apps, WhatsApp groups, forums) as a source of information or advice. In general, 36% of all respondents reject an app for crop protection advice, and 36% express their interest. The importance of those media categories is illustrated in Figure 2 by taking the mean values per category on a scale of 1 (unimportant) to 5 (very important). Personal information sources are more important than print media and are ranked nearly one scale dimension higher than digital sources.

In the following, the clusters will be analyzed with respect to their current and future use of digital media. The data in Table 4 and Table 5 were generated using a cross table and were tested for significance (x^2). Even if only small significances were found, the information can provide an idea of cluster trends.

Information sources such as newsletters, social networks/media, or the internet are in most cases of moderate importance but are used by at least half of the respondents. 57% of the service comfortable segment and 55% of the persistent segment use at least one of these digital information sources when purchasing crop protection products. A differentiated analysis shows that the persistent cluster and the service comfortable cluster rate the internet to be more critical, but even at a low rate (Table 4). Only comparatively few of the service- and consulting-averse persistent buyers want to use an app for consulting purposes (27%), while their general use of digital media like apps, forums is comparatively higher.

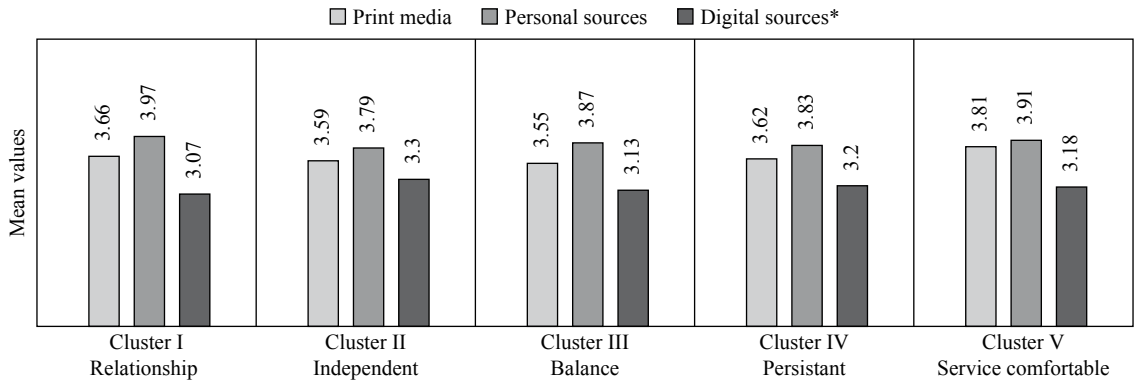

Figure 2. Importance of information sources. Mean values according to print media = magazines, technical books, brochures, test results (n=539), personal sources = colleagues, private/public consultants, events (n=576), digital sources = newsletter, social media, internet (n=302); 1 (unimportant) – 5 (very important); *significance level $P \leq 0.10$ by ANOVA.

Table 4. Cluster characterization concerning information process.

Description criteria (%)	Cluster I Relationship	Cluster II Independent	Cluster III Balance	Cluster IV Persistent	Cluster V Service comfortable
Do you use newsletter/websites of magazines, industry newsletters, social networks/media, internet?					
yes	47.5	44	53	55	57
n.a.	52.5	56	47	45	43
How important is the internet to you when deciding to buy crop protection products? (n=248)[1]					
important	16	16	16	26	20
Do you use digital media (apps, WhatsApp groups, forums) to look for information or advice when choosing plant protection products?					
yes	25	31	22	27	22
no	75	68	77	72	77
The industry is currently increasingly developing apps for crop protection advice. Can you imagine using them?					
yes	40	35	41	27	41
partly	29	17	19	25	15
no	30	37	30	44	35
How should the information or advice of the apps look like for you to use it?					
independent	13	23	13	19	13
fast/up to date	20	24	14	20	18
easy to use	15	20	14	18	16
not annoying	13	16	10	16	11

[1] Differences between clusters were significant according to χ^2-test ($P \leq 0.05$).

This is exactly the opposite for the relationship and balance buyers. Although some of them are using digital information channels, they attach little importance to the internet and general apps, messenger groups or forums, while two-fifths would use a specific crop protection app presumably because of their demand for advice. This would also explain why 56% of the service comfortable segment are willing to use or at least interested in crop protection apps. The independent segment is open to digital media. Individuals in this segment seem to favor mobile information sources like WhatsApp groups or general apps. Specific apps for crop protection advice are viewed more cautiously. More than one-fifth of the independent segment want apps to be more independent, easy to use and fast, and up to date. Finally, digital information channels are partly used and seem to raise at importance, especially apps with specific content seem promising. In summary, however, the results are not significant regarding cluster specific digital information behavior and are therefore only indicative.

5.5 Attitude towards e-commerce for crop protection purchase

E-commerce plays a minor role in the procurement of crop protection products by farmers, which is true for all clusters. In addition, the proportion of farmers who are aware of advantages of e-commerce is rather small. However, regarding the potential future use of e-commerce, the clusters differ significantly (Table 5).

E-commerce seems most likely to be an option for the independent segment. 29% would like to purchase plant protection products online, while more than 80% of farmers belonging to other segments refuse to buy pesticides on the internet. Advantages of e-commerce, such as saving time and costs and convenience, are seen more strongly by this segment. In contrast, one of the main disadvantages of agricultural e-commerce, the lack of personal contact with dealers/consultants, is perceived by only about 30% of the independent buyers. Other perceived disadvantages are the lack of negotiation options (22%) or safety regulations (15%). More than one-fourth of the independent segment would buy online if prices were lower online (27%). Service comfortables, the largest cluster, show the least online buying interest at only about 7%. In a cluster comparison, they are least likely to expect online purchasing to be convenient or to provide price or time advantages. Compared to the relationship buyers, they rate special or security regulations slightly more disadvantageous, but might possibly be persuaded to buy online by better prices, convenience, and product availability. However, missing personal advice is the main reason for e-commerce rejection among all clusters but especially for the relationship segment, with 61% refusing to buy online for this reason. A lack of negotiating opportunities (18%) is also a barrier, while price and time advantages make e-commerce more attractive to them. The higher price sensitivity might be one reason why the e-commerce intention of relationship buyers is twice as high as that of service comfortable buyers, which rate convenience higher but cannot observe it online. The balance buyers also show a low intention to use e-commerce (13%) which can be attributed to a lack of personal contacts, benefits, or product suitability. The second highest intention to use e-commerce is shown by persistent buyers (17%). In comparison, they perceive advantages of e-commerce

Table 5. E-commerce attitude per cluster.

Description criteria (%)	Cluster I Relationship	Cluster II Independent	Cluster III Balance	Cluster IV Persistent	Cluster V Service comfortable
Would you like to purchase plant protection products on the internet?[1]					
yes	14	29	13	17	7
no	81	56	83	81	88
What are the advantages of online purchasing over traditional purchasing for you?					
low price[1]	10	20	11	11	4
better availability	5	6	5	5	3
convenience[1]	9	24	7	13	3
time savings[1]	9	21	7	11	6
Why can't you imagine buying crop protection products online?					
no personal advice[1]	61	30	56	51	57
special regulations	6	11	10	16	10
safety regulations	11	15	14	19	15
lack of negotiation	18	22	12	17	16
product not suited for online purchase	12	12	17	19	14
What might drive you to shop online?					
low price	25	27	24	21	28
better availability	8	11	14	16	13
convenience	8	5	13	7	10
time savings	11	11	17	14	11

[1] Differences between clusters were highly significant according to χ^2-test ($P \leq 0.001$).

less than independent buyers but even stronger than the remaining clusters. In addition to the lack of personal contact, security regulations or product suitability also have a negative effect, while low prices and product availability are the strongest e-commerce drivers for this segment.

In summary, Table 5 indicates that apart from the independent buyers, the listed advantages are perceived by just 3-13% of the farmers of the remaining segments. The main drivers of e-commerce for crop protection products are lower prices (21-28%), time savings (11-17%) and better availability (8-16%). Finally, the results show that the independent cluster stands out from the other clusters in terms of e-commerce perception. Even if the remaining four clusters share several common and reserved characteristics, different tendencies in their e-commerce attitudes can be deduced. In relation to Table 3 it gets obvious that age, education and farm size do not show a linear correlation with the interest of the individual segments' in e-commerce.

6. Discussion

The present study conducted a segmentation of German farms regarding the purchase of crop protection products and identified five different market segments. In the following, selected core results are first discussed and managerial implications derived, before finally the segmentation approach is discussed and research recommendations are developed.

An overarching review of the results highlights the declining role of the long-term dominant price-performance concept in favor of a more service-oriented concept. The cluster analysis reveals that service orientation is particularly well-suited for segmenting farmers, while brand affinity is hardly suitable for segmentation in the crop protection market, because brands play a relevant but limited role in all segments. Accordingly, the present study identified a price-averse segment rather than a price or performance segment as known from other studies (Alexander *et al.*, 2005; Borchers *et al.*, 2012). The increasing service orientation can be attributed to saturated markets, more interchangeable products and services, constantly rising customer demands or increased market transparency due to the internet. Therefore companies are increasingly forced to develop service concepts to satisfy customers and successfully differentiate themselves from competitors (Kittinger, 2010). A shift of agribusiness companies from selling products to offering more services (Vidickiene and Gedminaite-Raudone, 2018) is already observable, with service that is typically based on face-to-face interactions and serves as a differentiator in service offerings (Kindström, 2010). Especially due to the increasing resistance to pesticides, the use of increasingly specific agents becomes more consultation and service intensive. A remarkable aspect in this context is the strong dealer orientation of four out of five clusters. German farmers still attach great importance to local, personal points of contact and close business relationships. Expanding the service area will contribute to long-term customer loyalty, as crop management requires a bundle of decisions that force face-to-face interactions, which cannot easily be met entirely by digital sales channels. This can be a competitive advantage for stationary dealers, as they have personal touchpoints, many years of customer knowledge, and often also enjoy an advantage of trust. Especially this is needed when it comes to the currently widespread shift from a product-centric approach to a customer-centric approach (Gupta and Ramachandran, 2021; Habel *et al.*, 2020). The results suggest such a shift and require retailers to expand their analytical capabilities to create unified, holistic customer profiles to meet their personalization needs (Gupta and Ramachandran, 2021). According to Habel *et al.* (2020) it is important for suppliers to act in a customer-oriented manner both at the level of the entire company and at the level of the salesperson. Furthermore, the perceived customer orientation is closely related to the loyalty intentions of customers, which gives stationary retailers a competitive advantage that should be exploited.

Alongside customer centricity and service orientation, digitization is arguably the enduring sales and marketing strategy of all industries. The aim of the study was therefore to examine the segment-specific relevance of digital sales channels. In terms of the digital information/search behavior of farmers, the clusters differ only slightly. The results on e-commerce attitude show significant differences and confirm that the majority of German farmers cannot imagine purchasing crop protection products online. In the customer decision journey presented in this study, it has become evident that, besides personal and print media, farmers are increasingly

interested in digital information channels such as newsletters, company websites, social networks or apps, while purchases are preferably made in analog form (Ardrey *et al.*, 2020). Since the digital information sources are currently only of moderate importance but will be encountered more frequently in private and professional contexts, it is particularly important to deliver the right, valuable and segment-specific content (Wang *et al.*, 2019).

It is also interesting to note that the segment of service comfortables is quite open to digital media as an information source, contrary to what can be assumed from literature (Alexander *et al.*, 2005; Feeney and Berardi, 2013). However, this segment illustrates that internet usage alone is not a guarantee for a potential e-commerce usage. On the contrary, the results prove that e-commerce offerings have so far been poorly tailored to customer needs. Farmers are not aware of the advantages or the added value that can be generated by online purchasing, and the lack of personal contact in particular is criticized. This goes in line with what is known from literature (Gartzke, 2016; Schulze Schwering and Spiller, 2018). Manufacturers and retailers have to optimize their e-commerce offerings, credibly communicate the added value and, above all, must not neglect their physical presence. Approaches for improvement include price advantages, better availability and time savings combined with convincing services. To serve farmers in a more customer-centric way, companies are increasingly required to engage their customers across multiple channels, ideally with the channels tightly interconnected in real time and thus providing the customer with a seamless shopping experience (omnichannel) (Ishfaq *et al.*, 2022). At the same time, a servitization approach could be implemented as a convergence between new digital services and existing products (Jang *et al.*, 2021). However, when delivering multi-channel and omni-channel strategies, conscientious customer analytics (Gupta and Ramachandran, 2021) and cross-channel content marketing (Wang *et al.*, 2019) are crucial, for which the present study provides initial analysis approaches.

The results allow to derive strategies for several clusters that show similarities in the use of digital sales channels. In the cluster-specific analysis of the information media, it is noticeable that the service-oriented clusters show a correspondingly high willingness to use crop protection apps. The sales potential of apps for crop protection is high among these segments and gives the industry reason to expand and further develop mobile apps. Coupled with the high level of smartphone equipment (Michels *et al.*, 2020) and the location-independent workload on farms, a mobile-first approach is recommended for companies here (Mullins, 2015). This would also incorporate the approach of customer retention through additional (digital) services, which can be observed in many cases today (Jang *et al.*, 2021; Kittinger, 2010). Cluster-specific intended use should be considered. For the service comfortable cluster an app could support the well-informed autonomous decision-making process, while for the advice-loving relationship buyers, it could be an add-on service to local face-to-face consultation. The latter could also hold for balance buyers. For these three clusters in particular, a hybrid interaction model, with dedicated crop protection apps being implemented as the next digitization step, could be promising. App developers and marketers should pay attention to be independent, fast and up-to-date. To increase customer satisfaction and loyalty, suppliers can further expand personal contact points in the form of e.g. event and recommendation marketing like local sales days, or the implementation of the lead user approach. They should also provide digital information and advice via newsletters, social media and crop protection apps.

It is interesting to note that despite their comparatively high retailer orientation, the persistent buyers show the second strongest e-commerce acceptance. This could be attributed to their low demand for service and advice coupled with their stronger price sensitivity and affinity for digital information channels. Accordingly, this cluster represents a potential future e-commerce segment. Especially for e-commerce systems of stationary retailers this can result in a competitive advantage. If they conduct successful content marketing, e-commerce could offer additional value to this buyer segment without losing the direct customer contact.

Independent buyers also show a high affinity for digital sales channels and form a small and exceptional buyer group. Their higher e-commerce acceptance can be explained by their low dealer orientation and loyalty as well as their high educational level (Ackermann *et al.*, 2018). In combination this serves as a good

prerequisite for direct online sales by agrochemical companies. Online platforms offer large companies a quick way of comparing prices and the pesticide industry an uncomplicated way of doing business. Overall, digital media and e-commerce offer exciting opportunities for this segment. To reach this segment, suppliers should not only optimize factors such as automated pricing, fast product availability and time savings of e-commerce they also need to communicate them in a correspondingly credible manner. Their content marketing should also not neglect barriers like safety regulations, personal touch points and negotiation opportunities. Especially, for these two more digitally affine clusters, suppliers should focus even more on digital visibility and good interaction marketing as part of their digitization strategy, e.g. e-commerce strategy. The results prove a digital information search and that there are five buyer segments with different demands. By means of search engine optimization (SEO) potential customers, such as independent buyers, can be reached more effectively. Tools like chatbots or voice and video assistants are also efficient tools to enable personal interaction and to increase both trust in e-commerce and customer experience. Digital tools and the information collected, can support the introduction of a customer relationship management system that serves as a company-internal basis for individual, customer-specific addressing, and segmentation.

The farmer typology turned out to be an only limited predictor of farmers' digital behavior in input purchasing. Therefore, further analysis is needed to gain more cluster-specific answers. Accordingly, specific typologies based on attitudes toward the online business would probably be more useful here. Studies on e-commerce or digital media segmentation are already available and segmented based on use behavior, attitude, or psychographic characteristics (Mathew, 2016; Nakano and Kondo, 2018). For the agricultural sector, e-commerce studies may face the problem of low agricultural e-commerce penetration (Ackermann *et al.*, 2018; Ardrey *et al.*, 2020), which might result in low sample sizes or e-commerce user shares and less meaningful results. Therefore, such segmentation studies should be primarily built on attitude-based rather than usage-based factors. They should also include aspects of channel switching propensity, as shown by Fecke *et al.* (2018a), to identify promising agricultural user groups of digital sales channels. Presented customer profiles must be analyzed more extensively and compared with existing customer data. Exciting results are promised by analyzing information behavior, digital usage, course of purchasing behavior, and company-specific ties to develop detailed marketing strategies. Other studies show that belonging to a market segment is relatively consistent across all consumables, suggesting that manufacturers and retailers should develop customer or purchase-based marketing strategies rather than product-specific marketing strategies (Borchers *et al.*, 2012). Whether this also applies to the usage of digital sales channels should be examined in follow-up studies, as some studies have already pointed to the product-group-specific use of e-commerce (Ackermann *et al.*, 2018; Gartzke, 2016; Schulze Schwering and Spiller, 2018). However, Borchers *et al.* (2012) found a strong correlation between cluster memberships for crop protection products and seeds. It can be assumed that digital media use in the purchasing process of crop protection products can be transferred to the purchase of seeds.

Compared to the presented literature, the identified segments show similarities to the four segments described in previous studies. According to this, the first cluster can mainly be compared with the relationship segment of Gundersson *et al.* (2005), the balance segment shows particularly similarities to the balance cluster of Feeney and Berardi (2013) while the fourth cluster matches especially to Zimmermann's (2003) group of pragmatists. The service comfortable cluster corresponds mostly to the convenience segment of Borchers *et al.* (2012) and combines attributes of the service and convenience clusters of Gloy and Akridge (1999). Accordingly, it can be assumed that the presented segmentation approaches can still be replicated today, including the German crop protection market. However, a major finding of this study is that in addition to the four clusters comparable to the literature, the second cluster of independent buyers is a new cluster that did not exist in former studies. There are only two similarities with the price segments of previous studies, as it is well educated and does not value convenience and location (Alexander *et al.*, 2005; Borchers *et al.*, 2012). As a result, independent buyers are a newly identified group that requires detailed analysis. Three main aspects can explain these naturally existing deviations from previous studies: (a) the condensation of the from literature derived statements into different factors (PCA); (b) former segmentation studies are based on the American region, where different agricultural structures prevail compared to Europe, e.g.

Germany; (c) brand affinity (performance) turned out to be hardly suitable for German crop protection market segmentation. Future studies should therefore critically consider whether to include this factor in segmentation, since today the business focus is turning to service orientation (Jang *et al.*, 2021; Kittinger, 2010). Given the proven farmer-dealer relationships, newer segmentation approaches could integrate the relationship, loyalty and service level even more; in accordance to Kool (1994).

7. Conclusions

Finally, this work provides some important contributions: First, while it proves that the segmentation approach is in general still applicable today by identifying five buyer segments, it also shows that farmers' buying behavior is increasingly moving away from a price-performance approach. Service orientation emerges as a particularly relevant segmentation variable, highlighting the importance of supplier's service concepts to satisfy farmer demands and to differentiate themselves from competitors. Even if the explanatory power of this segmentation approach to explain the digital behavior of farmers within the purchasing process of agricultural inputs is limited, the results provide initial indications of their attitudes toward digital sales channels. While digital search behavior differs only slightly between the clusters, the small, novel cluster of independent buyers stands out with its openness to e-commerce. The attitudes toward purchasing crop protection products vary, indicating segment-specific intentions to use digital sales channels. It is therefore advisable for suppliers to pay attention to segment-specific content when designing digital channels and at the same time to work on the visibility and measurability of the e-commerce benefits. The results provide first initial approaches that can help to better understand customer needs and wishes to create personalized customer profiles.

The age of the database (2017) may limit the interpretation of the results, as digital sales channels have evolved significantly since 2017, especially in e-commerce. Nevertheless, the present study can be interpreted as a meaningful exploratory study because the trends and influencing factors identified here can be interpreted over the long term, as it is scientifically supported that attitudes remain largely stable over time; although they may reach a different level (Olson and Zanna, 1993). From the present study, crop protection manufacturers and retailers can derive initial correlations between the internationally most common form of customer segmentation and farmers' online behavior. However, digital information and buying behavior of farmers should be surveyed more specifically in further studies. This would help researches to identify causal factors of farmers input purchasing and support managers to implement more customer-centric sales and marketing strategies.

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