



Digital Marketing's Impact on Rural Agricultural Products' Market Expansion

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Abstract. At present, the digital economy is booming, and the construction of digital villages is being accelerated, which helps to promote the livability and livability of villages and the affluence of farmers. At the same time, "Internet +" agricultural products out of the village into the city is also driving farmers to increase their income, in 2022 the national agricultural products online retail sales reached 422.1 billion yuan. The purpose of this study is to analyse the influence of digital marketing on the "out-of-circle" of agricultural products in mountainous areas, and use data mining, coding and clustering, and text analysis to conduct the research.

Through crawling consumer comments on online shopping platforms and social media, the LDA topic model was used to model the comment text, mine the topic words and word frequencies, and determine the number of suitable topics. Then, hotspot information of consumer reviews under the produce marketing platform was deeply mined and analysed, and themes such as digital marketing, consumer word-of-mouth, consumer caring awareness, consumer value perception, consumer information perception and purchase intention were summarised. Further farmer and consumer factors such as farmer information perception, farmer responsibility awareness, supporter responsibility awareness and supporter helping methods were summarised through offline interviews. The statistical analysis methods of cluster analysis and LightGBM classification model were used to find out the significant influence of social media and short video platforms, consumer information and consumer love factors on consumers' behaviour and willingness to buy agricultural products through the model parameter adjustment and evaluation results. Finally, the conclusions drawn from the study point to effective channels and important factors for digital marketing of agricultural products and highlight the key role of data analysis in developing marketing strategies and promotion plans to promote the sale and distribution of agricultural products and improve farmers' income and living standards.

Keywords: LDA topic model; Cluster analysis; LightGBM classification model; Digital economy.

1 Introduction

1.1 Background

At a time when the digital economy is booming, the construction of digital villages has been accelerated, promoting the livability of villages and the prosperity of farmers. Broadband has been fully implemented in all existing administrative villages nationwide, and the problem of rural communication difficulties has been solved in a historic way. The digitisation of rural governance has helped to strengthen villages and promote good governance, and the online disclosure rate of party affairs, village affairs and financial affairs has exceeded 70 per cent. The rural information service system has been gradually improved, with a cumulative total of 467,000 agricultural information facilities being built and operated, providing all kinds of services to 980 million people. "Internet +" agricultural products out of the village into the city to drive farmers to increase their income, in 2021 the national agricultural products online retail sales reached 422.1 billion yuan.

As a large agricultural country, rural revitalisation has always been a key focus of the country's major policies.²⁰²² Since then, there have been a number of important documents that have given important instructions on rural revitalisation. The report of the 20th Party Congress proposed to comprehensively promote rural revitalisation. Adhere to the priority development of agriculture and rural areas, adhere to the integrated development of urban and rural areas, and smooth the flow of urban and rural elements. It also promotes the revitalisation of rural industries, talents, culture, ecology and organisations. In January 2022, the Opinions of the Central Committee of the Communist Party of China and the State Council on Doing a Good Job of Promoting Rural Revitalisation in a Comprehensive Manner in 2022 was formally released, and it is the 19th central No.1 document guiding the work of the "Three Rural Areas" since the new century. The document clearly pointed out that we should encourage the expansion of rural e-commerce and other industries, promote e-commerce into the countryside, and promote the standardised and healthy development of agricultural and sideline products live with goods, which is also one of the core initiatives to promote the integration of one, two or three industries in rural areas. ²⁰²² March, rural revitalisation has also been mentioned many times in the government's work report, which states. In March 2022, the government's work report also mentioned the revitalisation of the countryside several times, and "improving agricultural production and promoting the overall revitalisation of the countryside" was one of the main tasks of the government in 2022. Under the urgent demand, top-down strategic guidance + policy support, the media, live broadcasting platforms, e-commerce platforms and other social forces have begun to actively invest in the cause of rural revitalisation.²⁰²³ At the beginning of the year, the "Opinions of the CPC Central Committee and the State Council on Doing a Good Job in Comprehensively Promoting Rural Revitalisation Priorities in 2023" was released, which proposes consolidating and expanding the results of the poverty alleviation campaign, promoting the high-quality development of rural industries, and Broaden the channels for farmers to increase their income and become rich.

At the same time, the mode formed by the exploration of rural revitalisation in the context of the booming development of the digital economy around the world is also springing up: Jiangyong, Hunan Province, the number of businessmen to promote agriculture based on "expanding domestic demand, promote consumption, stable growth", to the offline experience of the exhibition and sale as a selling point, through the WeChat circle of friends, short video live broadcasts and other ways to attract the eyes of online consumers to create a new consumption scene, not only to explore the potential for the development of the rural economy, but also to promote the development of the countryside, the development of the countryside. Create a new scene of consumption, not only to discover the "taste of the year" "hometown taste", but also to promote and display Jiangyong famous new agricultural products and food culture, empowering the county economy, boosting rural revitalisation; Yangxi, Guangdong's "short video + Netflix live! With goods" adhere to the "online + offline" combination, held a series of promotional activities for agricultural products, guiding the local net red camera to the field, regular short video promotion and live with goods activities, so that the Yangxi agricultural products sell well across the country; Zhejiang Inaccessible market online shopping mall to further deepen the collaboration between East and West Collaboration, play Yuhang digital economy empowerment advantages, efforts to promote the industrial digitalisation process in Tao County, Ganzi Prefecture, Sichuan Province, so that Tao City agricultural products and handicrafts to better go out, sell out, and achieve mutual benefit and win-win situation.

1.2 Literature Review

In recent years, there has been a proliferation of research on digital marketing in various fields, and scholars have shown great enthusiasm for research on digital marketing due to the continuous exploration of the value of digital marketing and the strong support of the state.

Firstly, in terms of digital marketing research, Klingenberg's (2020)^[3] study argues that describing the impact of digitalisation on value creation through the four dimensions of the value chain - activities, flows, participants and governance - leads to the conclusion that value creation is increasingly occurring through platforms operated by large enterprises outside of industry boundaries. Wang, Mingjie (2022)^[4] explored the spatial pattern and evolutionary characteristics of e-commerce specialised villages and found that the overall spatial distribution pattern of Taobao villages is highly consistent with China's basic geographic pattern. Yao Xi and Qin Xuebing (2013)^[9] proposed that with the normalisation of virtual existence, digital marketing will become the most dominant marketing form in the era of virtual existence, and the interaction and integration between digital marketing and traditional marketing methods will exist for a long time. Yao Xi and Han Wenjing (2015)^[10] proposed that interaction is the basis for measuring the communication effect of digital marketing, and the consumers of digital media have a strong sense of participation and active voice, and consumer participation becomes the key to achieve the communication effect of digital marketing under the logic of interaction.

As for the research on agricultural marketing, Guo Jinlong (2007)^[11] proposed that compared to choosing traffickers, agricultural producers with high production concentration, high price fluctuation and high marketing difficulty preferred to choose industrial and commercial enterprises, co-operative organisations or associations and professional wholesale markets. Cha Jinxiang and Lai Dongsheng (2006)^[1] in the study for the current strategic importance of China's agricultural products network marketing and obstacles to the basis of the support system, application system, security system and supporting measures in four aspects of the agricultural products network marketing system framework for the initial proposal. In the study of rural e-commerce, Qin Fang and Wang Jiancheng (2022)^[2] found that the development of rural e-commerce can significantly improve the income of farmers, and in addition, e-commerce development can improve the level of entrepreneurship, increase non-farm employment, and increase the probability of land transfer. Wang Ruifeng (2021)^[5] found that rural e-commerce has nine dynamic characteristics such as model differentiation, social functionality, consumer specificity, unbalanced economic development, competitive weakness, weak foundation, resource integration, government support, and progressive innovation, which can be further categorised and merged into five dimensions, namely, platform, consumer, region, foundation, and innovation. Li Zhiping and Wu Fanfu (2021)^[6] found that rural e-commerce has a significant direct poverty reduction effect; rural e-commerce generates an indirect poverty reduction effect through rural revitalisation; industrial prosperity and rural governance have a positive effect on the indirect poverty reduction effect, but have a non-significant or negative effect on rural civilisation, ecological livability and livelihood prosperity. Chen Weiping and Li Yan (2022)^[7] found that the number of concerned consumers has a significant positive effect on rural e-commerce sales performance.

It can be seen that although there are various studies on the marketing of counting business to promote agriculture, most of the studies on counting business to promote agriculture by our scholars are at the sociological level, through the combination of the relevant theories of advertising and communication for the establishment of the marketing model, and from the statistical point of view, quantitative analysis of counting business to promote agriculture marketing literature is less, this study is precisely to start from this gap, and from the point of view of statistical analysis to analyse more deeply the counting business to promote agricultural marketing Influence factors.

2 Analysis of the Influence Factors of Digital Marketing to Help Mountain Agricultural Products "Out of the Circle"

The analysis of the influence factors of digital marketing to help mountain agricultural products "out of the circle" is mainly achieved through data mining, coding and clustering, and text analysis. LDA (Latent Dirichlet Allocation) topic model is used to mine the topic words and summarise the topics. Firstly, consumer reviews under agricultural marketing are crawled on popular online shopping platforms and social media (Taobao, Shake and Weibo) using python, and the review text is modelled using the LDA^[8] topic model to mine the topic words and word frequencies. Then for the determination of the

number of topics in LDA topic modelling, as the number of topics with lower perplexity and higher consistency is best. And the different number of topics and their perplexity scores and their consistency scores are shown in Fig. 1 & Fig. 2 respectively.

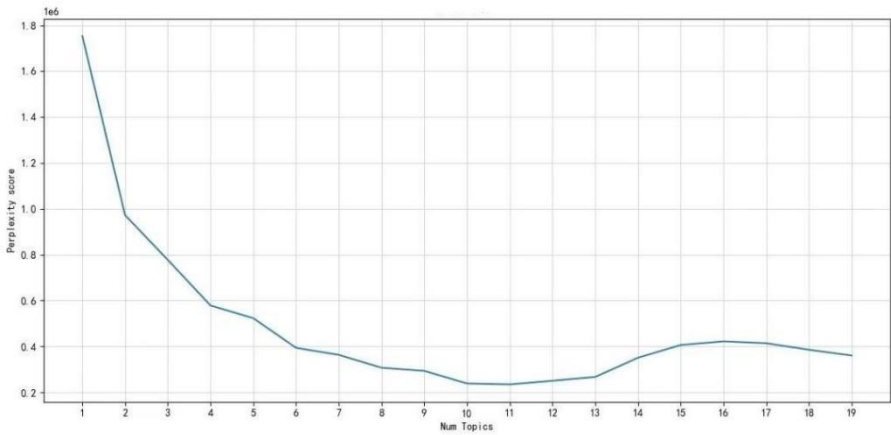


Fig. 1. Number of Topics and Perplexity Scores

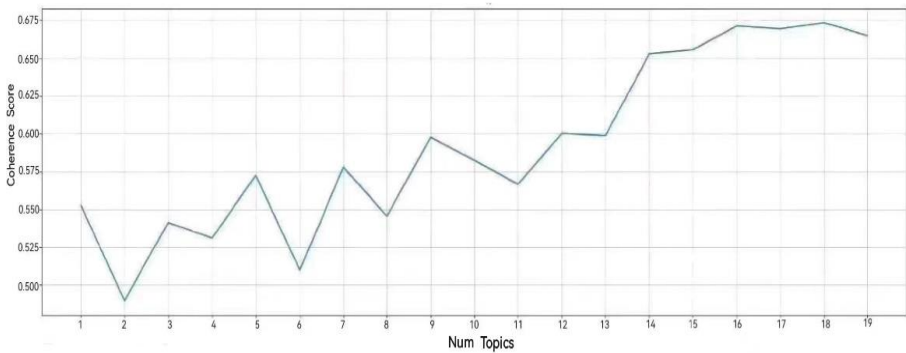


Fig. 2. Number of Topics and Coherence Scores

When the number of topics is 19, it satisfies lower confusion and higher consistency, so the number of topics 19 is chosen to be the number of topics in LDA topic modelling. On this basis, the hotspot information of people's comments under the agricultural products marketing platform was deeply mined and analysed.

The trained LDA topic model is used to extract the topics of people's comments on the agricultural marketing platform, get the "topic-vocabulary" matrix, and calculate the feature words of each topic in the "topic-vocabulary", and the final topic words are shown in Table 1.

Table 1. LDA Modeling Topic Keywords

Topic	Words
Topic 1	Fresh, First time, Life Happiness, Three kilograms, Farmer, County mayor, Appearance, Longing for Gratitude
Topic 2	Boss, Finally, Product, Want, First, Casual, Planting, Link, Double yellow, Out-of-town
Topic 3	Delicious, Potato, Especially, Texture, Fresh, Really, Excellent, Like, Tasty, Qingwang
...	...
Topic 18	Not bad, Fragrance, Place an order, Not good, Grounded, Smell, Ah, family, Don't want, Can only
Topic 19	Kangzi, Recommend, Cheap, Authorized seller, Branded, Delicious food, Success, Not okay, Bad-tasting, In history.

From the experimental results, the topics that consumers are concerned about the agricultural product information released by the agricultural product marketing platform show a wide range and diversity. The content not only covers agricultural product quality evaluation, agricultural product price comparison and other aspects, but also involves agricultural product cultivation climate, farmers' life, consumers' life and other topics. Taking agricultural product quality evaluation as an example, the related comments are mainly related to the price and freshness of agricultural products, so the attribute is described as agricultural product quality evaluation. Based on this approach to group similar topics together, the final topics 1 - 19 are categorised as digital marketing, consumer word of mouth, consumer caring awareness, consumer value perception, consumer information perception and purchase intention.

As for farmers and consumers, offline interviews were used, and the factors found during the interviews were eventually categorised as farmers' information perception, farmers' sense of responsibility and supporters' sense of responsibility, and supporters' methods of helping, respectively, for farmers and consumers.

3 Methods of Statistical Analysis

3.1 Cluster Analysis

The process and steps of cluster analysis are shown in Figure 3

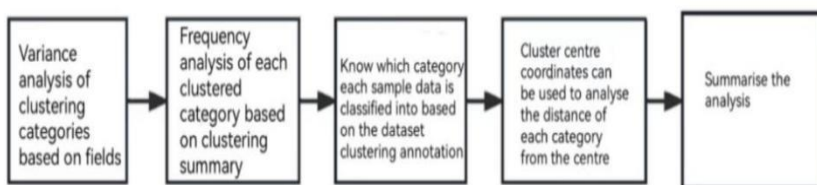


Fig. 3. The process and steps of cluster analysis

(1)Comparison of Number of Clusters

The elbow rule is used to determine the value of K in the K-means algorithm in the comparison of the number of clusters, where the comparison of the number of clusters is shown in Figure 4. The graph is used to select the better number of clusters, the horizontal coordinate is the number of clusters and the vertical coordinate is the K-mean The loss function for clustering is the sum of the squares of the distances of all the samples to the centre of the category, i.e. the sum of the squares of the errors (the smaller the value, the better the clustering). The optimal number of clusters can be found by "flattening the slope". So the optimal number of clusters is 3, i.e. the number of clusters is divided into 3 categories.

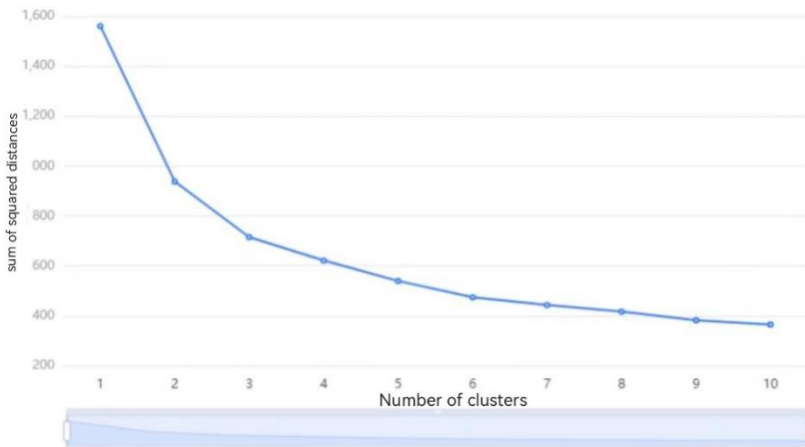


Fig. 4. Comparison of number of clusters

(2)Analysis of Field Differences

Table 2 demonstrates the results of the analysis of variance for the quantitative fields, including the results of the mean ± standard deviation, the results of the F-test^[12], and the p-value for significance. The p-value for each analytical term was analysed for significance (p<0.05). If it is significant, the original hypothesis is rejected, indicating that there is a significant difference between the two sets of data and the difference can be analysed based on the mean ± standard deviation, and vice versa, indicating that the data do not present a difference.

Table 2. Analysis of field differences

	Clustering categories (mean ± standard deviation)			F	P
	Category2 (n=122)	Category1 (n=68)	Category3 (n=29)		
4.I have used many short video plat-forms	2.508±0.805	2.582±0.88	4.31±0.604	185.994	0.000***

5. I often use short video platforms	2.344±0.758	1.25±0.469	4.207±0.861	185.197	0.000***
6. I think combining it with short videos will be good for helping the sale of agricultural products	2.23±0.665	1.221±0.595	3.138±1.274	74.8049	0.000***
7. I can often brush up on short videos or live streams that help produce	2.574±0.715	1.353±0.617	3.724±0.96	122.611	0.000***
8. Short videos or live streams of produce are more likely to inspire me to buy produce.	2.582±0.88	1.25±0.5	3.621±0.862	111.28	0.000***
9. I am satisfied with the effectiveness of short video platforms to help farmers	2.582±0.822	1.265±0.507	3.552±1.121	103.114	0.000***

Note: ***, **, * represent significance levels of 1%, 5%, and 10%, respectively

The results of the ANOVA showed that: For variable 4 "I have used many short video platforms", the significance p-value is 0.000***, which is significant at the level of rejecting the original hypothesis, indicating that there is a significant difference between the categories divided by the cluster analysis for variable 4; for variable 5 "I often use short video platforms", the significance p-value is 0.000***, which is significant at the level of 0.000***, and the original hypothesis is rejected, indicating that there is a significant difference between the categories divided by cluster analysis for variable 5; for variable 6 "I think that combining with short videos will be conducive to helping the sale of agricultural products", the significance p-value is 0.000***, and the original hypothesis is rejected. The significant p-value is 0.000***, which presents significance at the level, and the original hypothesis is rejected, indicating that there is a significant difference between the categories divided by cluster analysis for variable 6; for variable 7, "I can often swipe short videos or live broadcasts to help agricultural products", the significant p-value is 0.000***, which presents significance at the level, and the original hypothesis is rejected, indicating that there is a significant difference between the categories divided by cluster analysis for variable 7. Significant difference; for variable 8, short videos or live broadcasts to help agricultural products can arouse my desire to buy agricultural products, the significance p-value is 0.000***, the level of significance is presented, the original hypothesis is rejected, which indicates that there is a significant difference between the categories divided by cluster analysis for variable 8; for variable 9, I am satisfied with the effect of short video platforms to help agricultural products, the significance p-value is 0.000***, the level of showing significance and

rejecting the original hypothesis, indicating that there is a significant difference between the categories divided by cluster analysis for variable 9.

(3)Clustering Summary

The clustering summary is shown in Table 3 and Figure 5, where Table 3 shows the results of the model clustering in a visual format, including frequency counts, and percentage share.

Table 3. Clustering summary

Clustering category	frequency	Percentage %
Clustering category_1	68	31.05
Clustering category_2	112	55.708
Clustering category_3	29	13.242
Total	219	100.00

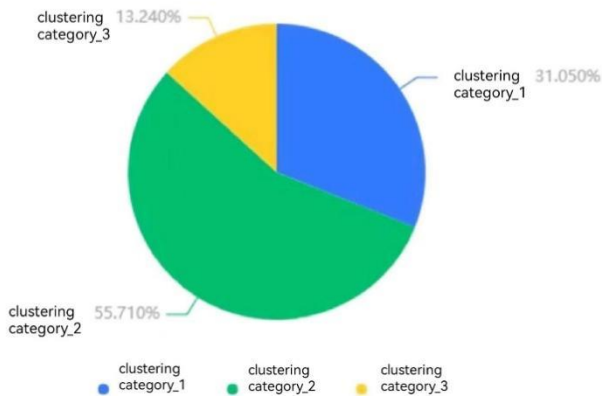


Fig. 5. Clustering summary

(4)Clustered Scatterplot

Figure 6 is a scatterplot based on the data of two variables; if the number of variables is greater than two, the first two principal components after extracting the principal component analysis (PCA) dimensionality reduction are used to draw the scatterplot, and the clustering effect can be viewed to a certain extent, and the plot is not very meaningful if the variance explained by the first two principal components is low. Which clustering scatterplot maximum only show 1000 sample size information, if the sample size is greater than 1000, then in the whole sample for random sampling, select one of the 1000 samples to scatterplot display.

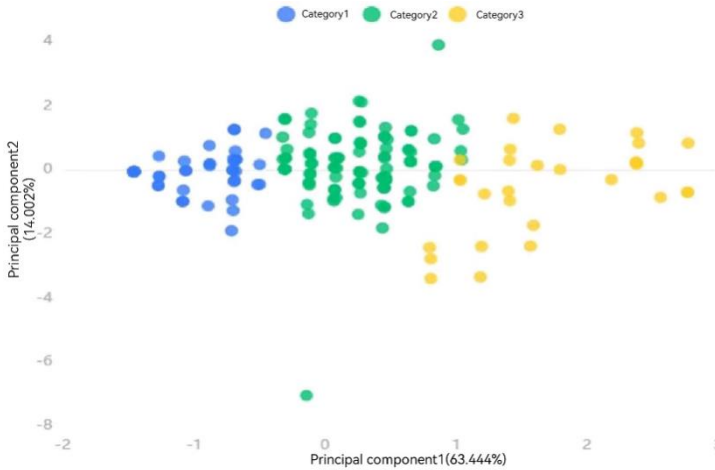


Fig. 6. Clustered scatterplot

(5)Cluster Evaluation

The clustering evaluation metrics are shown in Table 4. Where the contour coefficient for a collection of samples, its contour coefficient is the average of the contour coefficient of all samples. The range of values of the contour coefficient is [-1,1], the closer the samples of the same category are to each other the further the samples of different categories are from each other, the higher the score, the better the clustering effect is. The DBI (Davies-bouldin) indicator is used to measure the ratio of the intra-cluster distance followed by the inter-cluster distance for any two clusters to the inter-cluster distance. The smaller the indicator, the better the clustering effect. CH (Calinski-Harbasz Score) is used to measure the closeness of the class by calculating the sum of the squares of the distances of the points within the class from the centre of the class (denominator), and the separateness of the data set by calculating the sum of the squares of the distances of the centroids of the class from the centroids of the data set (numerator), and the CH indicator is obtained by the ratio of the separateness and the closeness, and the larger the CH indicator, the better the clustering effect. The larger indicates the better clustering effect. So through the clustering evaluation index in Table 3 can be concluded while in our clustering effect is better.

Table 4. Clustering evaluation indicators

Contour Coefficient	DBI	CH
0.341	1.121	127.543

3.2 LightGBM Classification

LightGBM classification process is shown in Figure 7. Where due to the randomness of LightGBM, the results of each operation are not the same, if the current training

model is saved, the subsequent data can be directly uploaded to be substituted into the current training model to calculate the classification. Because LightGBM cannot get a definite equation like traditional models, the model is usually evaluated by testing the classification effect of the data.

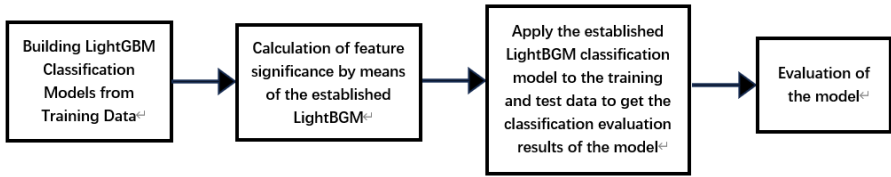


Fig. 7. LightGBM Classification Process

(1)LightGBM Classification Results

Figure 8 shows the proportion of importance of each characteristic (independent variable).

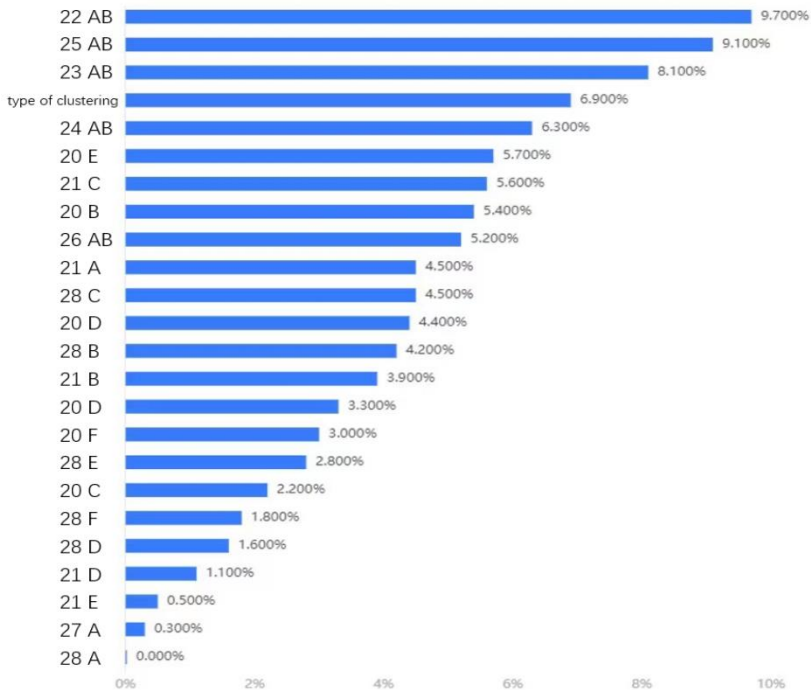


Fig. 8. Characteristic importance

Part of the questionnaire is presented in Figure 9.

20. Where did you find out about Farming for Agriculture [Multiple Choice] **[↵]
- A. Short video platform marketing[↵]
 - B. Recommended by friends[↵]
 - C. Unit announcement[↵]
 - D. TV program[↵]
 - E. News information[↵]
 - F. Other[↵]
21. Where do you see the most marketing of agricultural products on short video platforms [Multiple Choice] *[↵]
- A. Platform adverts[↵]
 - B. Short video introduction[↵]
 - C. Live streaming sales[↵]
 - D. Retweet sweepstakes[↵]
 - E. Other[↵]
22. You usually search for the goods you want to buy on short video platforms [Single Choice][↵]
- A. Strongly agree B. Agree C. Neutral D. Disagree E. Strongly disagree[↵]
23. You trust big brand accounts or official government accounts more [Multiple choice question][↵]
- A. Strongly agree B. Agree C. Neutral D. Disagree E. Strongly disagree[↵]
24. farmers' short videos have made you more aware of agricultural products [Single Choice][↵]
- A. Strongly agree B. Agree C. Neutral D. Disagree E. Strongly disagree[↵]
25. you would consciously buy some of the agricultural products that help farmers [Multiple choice question][↵]
- A. Strongly agree B. Agree C. Neutral D. Disagree E. Strongly disagree[↵]
26. You will be impressed by the contents of short videos and buy agricultural products [Multiple choice questions][↵]
- A. Strongly agree B. Agree C. Neutral D. Disagree E. Strongly disagree[↵]
27. Do you think that purchasing agricultural products is a way of contributing to the countryside [Multiple choice] [↵]
- A. Yes[↵]
- B. No[↵]
28. What kind of marketing is more likely to make consumers buy agricultural products [Multiple Choice] * Reassuring good quality[↵]
- A. Reassuringly good quality[↵]
 - B. The favourable price of the live broadcast[↵]
 - C. The authority of a government or brand account[↵]
 - D. Introduction of short videos from farmers' personal accounts[↵]
 - E. Hot topics driving the demand for purchase[↵]
 - F. Moving stories in the video[↵]

Fig. 9. Questionnaire

(2)LightGBM Classification Model Evaluation Results

The LightGBM classification model evaluation results are shown in Table 5. The table demonstrates the prediction evaluation metrics of the cross-validation set, the training set and the test set, which measure the prediction effect of LightGBM through quantitative metrics. Among them, the evaluation metrics of the cross-validation set can continuously adjust the hyperparameters to obtain a reliable and stable model. Among them, the accuracy rate is the proportion of correctly predicted samples to the total samples, the larger the accuracy rate, the better; the recall rate is the proportion of predicted positive samples in the results of actual positive samples, the larger the recall

rate, the better; the precision rate is the proportion of actual positive samples in the results of predicted positive samples, the larger the precision rate, the better; F1 is the reconciled average of the precision rate and the recall rate, and the precision rate and the recall rate affect each other, although the two Both high is a desired ideal situation, however, in practice, it is often a high precision rate, recall is low, or recall is low, but the precision rate is high. If there is a need to balance both, then the F1 metric can be used.

Table 5. LightGBM classification model evaluation

Data set	Accuracy	Recall	Precision	F1
Training set	1	1	1	1
Testing set	0.80	0.80	0.79	0.80

4 Conclusion

Using LDA thematic modelling, we identified 19 different themes covering various aspects of consumer engagement, including product quality evaluation, price comparison, growing climate, and socio-economic factors affecting farmers and consumers.

Our statistical analysis used cluster analysis and LightGBM classification for segmentation of consumer groups and prediction of behavioural patterns. Cluster analysis revealed three distinct consumer categories, each exhibiting unique characteristics and preferences related to the consumption of agricultural products. The LightGBM classification model demonstrated high accuracy in predicting consumer behaviour. The results of the analysis suggest that short video platforms, consumer information and consumer liking factors influence consumer behaviour and willingness to buy agricultural products to a greater extent.

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