Available online at www.HighTechJournal.org

HighTech and Innovation Journal

ISSN: 2723-9535

Vol. 6, No. 4, December, 2025

Correlation Between Agricultural Product Purchases and Live-Streaming Economy in the Digital Economy

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Received 28 April 2025; Revised 14 November 2025; Accepted 19 November 2025; Published 01 December 2025

Abstract

Objectives: This paper aims to explore how agricultural product sales via live streaming affects the purchasing behavior in the context of the digital economy and evaluate the correlation between them. *Methods:* A questionnaire was designed to collect respondent' personal information and information on their purchases of agricultural products. The correlation between agricultural product purchases and the live-streaming economy was measured. *Findings:* Most respondents purchased agricultural products on platforms such as Douyin and Taobao, preferred watching live streaming of internet celebrities and farmers, primarily bought fruits, vegetables, whole grains, and coarse cereals, and expressed high satisfaction with their agricultural product purchases. Correlation analysis indicated that the correlation coefficient between agricultural products and purchases in the live-streaming economy was highest at 0.742. Regression analysis found a significant positive correlation between agricultural products, anchors, live streaming, platforms, and agricultural product purchases. *Novelty:* The research quantifies the relevant information on agricultural product live streaming and purchases through questionnaire analysis. It also reveals the positive influence of the digital economy on agricultural product purchases, providing some references for the further development of agricultural product live streaming.

Keywords: Purchase of Agricultural Products; Live-Streaming Economy; Questionnaire Survey; Digital Economy; Regression Analysis.

1. Introduction

Agriculture is the foundational sector of the national economy, and agricultural products are the basic materials for human survival and development. Agricultural products have high requirements for warehousing, logistics, and sales speed. Unsold inventory will cause huge waste. Therefore, shortening the supply chain, reducing the loss of agricultural products, and increasing farmers' income are important issues that have drawn wide attention in society at present. In the era of the digital economy, enhancing the sales of agricultural products through big data analysis and online marketing has become a mainstream strategy [1]. However, e-commerce platforms for agricultural products often rely solely on basic graphic and video content, which limits their ability to convey product information effectively and comprehensively to consumers. The live-streaming economy is a manifestation of the digital economy [2]. Within this framework, agricultural products can more straightforwardly reflect their quality and characteristics through live-streaming, aided by real-time explanations and demonstrations provided by anchors. This approach not only enhances customer shopping experience but also drives rapid growth in agricultural product transaction within the live-streaming economy, positioning live-streaming as a novel sales method compared to traditional offline and conventional e-commerce platforms. As the live-streaming economy continues to flourish, research in this area has become more

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http://dx.doi.org/10.28991/HIJ-2025-06-04-013

extensive [3]. Chen et al. [4] analyzed farmers' intention to engage in e-commerce via live streaming using the technology acceptance model and identified a positive impact of platform support on perceived ease of use and usefulness. They pointed out that e-commerce platforms should use this technology to provide highly efficient services.

Jing et al. [5] investigated the influence of live-streaming e-commerce on impulse purchases of Chinese tea, finding that the attractiveness and popularity of anchors affect online impulse purchases and responses to promotions. By analyzing live-streaming anchors, Xiao et al. [6] discovered that anchors can commit to a minimum sales volume or pledge to make every effort to engage and attract fans. Through the comparison of decisions and profits, it was found that the commitment to sales volume or effort is mutually beneficial for both sellers and anchors, and the mixed commitment can motivate sellers to reserve more inventory and prompt anchors to make more efforts. Xu et al. [7] analyzed the roles of e-commerce platforms, anchors, and consumers in e-commerce live-streaming, offering certain perspectives on the strategic evolution of the live-streaming e-commerce market. However, despite the growing interest in the live-streaming economy, fewer studies are focusing on the purchase of agricultural products and the live-streaming economy. Liu & Fan [8] comprehensively analyzed data from more than 500 consumers in China through a questionnaire and a structural equation model, analyzed the influencing factors of consumers' repurchase intention in the e-commerce live streaming of agricultural products, and found that both satisfaction and trust had a positive impact on repurchase intention.

Han et al. [9] analyzed the influence of emotional factors on consumers' purchase intention in agricultural product live streaming. Based on 365 valid samples, a quantitative study was conducted, and it was found that interactivity and presence had a positive influence on consumers' intention to make purchases. Chou et al. [10] analyzed the role of online media in agricultural product live streaming using the stimulus-organism-response model and demonstrate the positive influence of perceived professionalism and perceived interactivity on consumers. Zhang & Zhang [11] developed the formation mechanism of consumers' purchase intention towards geographical indication agricultural products in the context of live sales. They found that the type of geographical indication agricultural products and the live appeal strategy interacted with each other, and consumers' purchase intention was generated through the mediation of consumers' value perception. Zeng et al. [12] investigated the influence of short-video live streaming on agricultural product purchases. They found a significant influence; it can reduce agricultural product waste and increase the economic income of relevant practitioners.

Li [13] analyzed the growth of live-treaming commerce for agricultural products under the background of COVID-19, summarized prevalent challenges, including insufficient professional expertise among live streamers and elevated logistics costs, and explored the future development prospects of live streaming to assist agriculture. Gu et al. [14] studied how to design an agricultural product sales live streaming system based on user perception and preferences and identified four positive factors: natural quality, support for domestic agriculture, transportation services, and information attractiveness. Zhou et al. [15] found that consumers' viewing experiences during agricultural product live streaming influence their purchasing behaviors. Therefore, the marketing model can be broadened by improving basic network facilities. Besides its economic value, the development of agricultural product live streaming also holds more profound significance. Firstly, in terms of rural development, this new mode provides a low-threshold sales channel for farmers in remote areas and small and medium-sized agricultural operators, which is conducive to promoting rural revitalization and further narrowing the urban-rural income gap. From an environmental perspective, efficient production-to-sales docking can reduce the unsalable situation and losses of agricultural products caused by overly long circulation chains, thereby reducing the waste of agricultural products. Therefore, the research on agricultural product live streaming has far-reaching practical value.

Therefore, this paper analyzed the correlation between agricultural product purchases and the live-streaming economy by taking the consumers of agricultural product live streaming as research subjects under the background of the digital economy. A multi-dimensional research model containing anchors and platforms was established, and core factors that drive live-streaming purchases of agricultural products were identified, offering theoretical support for the sustainable development of live streaming of farm products and providing bases for further research in the live-streaming economy. This paper presents the research subjects and methods, the designed questionnaire, and questionnaire validity and reliability tests in Chapter 2, presents the analysis of the questionnaire results and the correlation between agricultural product purchase and live-streaming economy in Chapter 3, and presents a summary of research content and findings in Chapter 4.

2. Research Subjects and Methods

2.1. Concept Definition

(1) Digital economy

It refers to an emerging economic form centered on digital technology, which achieves the digitization and intelligent transformation of economic activities through technical methods like big data and cloud computing [16]. It covers sectors such as e-commerce and digital finance, and aims to drive business mode innovation and facilitate the transformation and upgrading of traditional industries through digital means [17].

(2) Agricultural products

These refer to products such as food, vegetables, and fruits that are obtained through agricultural production activities. As direct outputs of farming, they constitute a fundamental component of daily human consumption.

(3) Live-streaming economy

This term denotes an emerging economic mode in which commodities are presented and sold through live-streaming platforms. It represents both an extension of e-commerce and a vital component of the digital economy [18].

2.2. Questionnaire Design

This paper used a questionnaire to collect relevant data, aiming to explore the correlation between the purchase of agricultural products and the live-streaming economy. The workflow is shown in Figure 1.

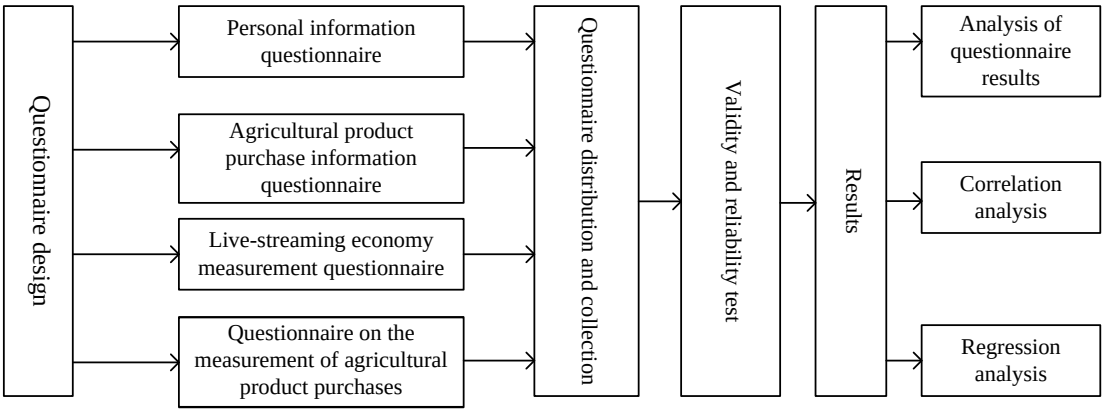

Figure 1. The workflow diagram

The first question in the questionnaire asks respondents whether they have previously purchased agricultural products within the live-streaming economy. If respondents choose "no," they will be asked to stop answering the following questions. If they select "yes," they proceed to answer additional questions. The reason for setting this question is to screen and obtain qualified samples relevant to the research purpose, thereby ensuring the reliability of the questionnaire data. The questionnaire gathered personal information from the respondents initially. The design of the questionnaire is shown in Table 1.

Table 1. Personal information questionnaire

Question	Option
Your gender?	1. Male 2. Female
Your age?	1. 18~25 years 2. 26 to 40 years 3. 41-50 years 4. Over 50 years
Your education background?	1. High school or below 2. Junior college/undergraduate 3. Postgraduate or above
Your occupation?	1. Student at school 2. Enterprise employee 3. Public institutions/civil servants 4. Freelancers 5. Others
Your monthly income?	1. 3,000 yuan or less 2. 3,001-5,000 yuan 3. 5,001-8,000 yuan 4. 8,001 or more
Where do you live?	1. Cities and towns 2. Countryside
Your marital status?	1. Married 2. Unmarried

The respondents were subsequently surveyed for information on their agricultural product purchases in the live-streaming economy, and the questionnaire was designed as Table 2.

Table 2.1 Agricultural product purchase information questionnaire

Question	Option
Which live-streaming platform do you primarily purchase produce from? (Multiple choice)	1. Taobao 2. Jingdong 3. Pinduoduo 4. Douyin 5. Other
What is the main type of anchor you watch? (Multiple choice)	1. Internet celebrity 2. Star 3. Local official 4. Peasant household
What type of produce do you regularly purchase? (Multiple choice)	1. Whole grains and coarse 2. Fruit and vegetables 3. Meat, egg, and milk 4. Aquatic products and seafood 5. Flowers and plants 6. Others
Why do you buy produce in the live stream? (Multiple choice)	1. Cheap and fine 2. Help farmers 3. Support the anchor 4. Attractive display of products
What is the price range of produce you regularly purchase?	5. Less than 50 yuan 6. 50-100 yuan 7. 100-200 yuan 8. More than 200 yuan
How many times per month do you buy produce in the live stream?	1. Less than 5 2. 6-10 3. More than 10
What do you think of the produce purchased in the live stream?	1. Very satisfied 2. Satisfied 3. Neutral 4. Dissatisfied 5. Very dissatisfied

The second part of the questionnaire investigated information about the live-streaming economy. Based on relevant literature and the current scenario, the questionnaire was designed as shown in Table 3.

Table2 3. Measurement of live-streaming economy

Variable	Question	Content
Agricultural product	A1	The agricultural product is of good quality.
	A2	The agricultural product has a lower price.
	A3	The agricultural product has brand advantages.
	A4	The agricultural product receives overwhelming praise.
Anchor	B1	The anchor is well-known and has many followers.
	B2	The anchor has a better understanding of produce.
	B3	The anchor is warm and humorous, and the atmosphere of the live stream is perfect.
	B4	The anchor can provide a real taste test and trial demonstration.
	B5	The anchor explains produce in a lively and interesting way.
Live streaming	C1	The anchor is always available to answer questions during live stream.
	C2	There are occasional lucky draws during the live stream, which bring surprises to people.
	C3	The anchor's description during the live stream is objective and truthful, without falsification.
	C4	It is easy to place an order with one click in the live room.
	C5	You can interact well with other viewers in the live stream.
Platform	D1	The shopping process on the live platform is secure and does not result in privacy breaches.
	D2	The logistics service is excellent, and the produce was received undamaged.
	D3	Returns and exchanges are easy, and the after-sales service is excellent.
	D4	The information provided by the platform related to agricultural products is genuine.

The third part of the questionnaire surveyed information on the purchase of agricultural products. Based on relevant literature and the current scenario, the questionnaire was designed as shown in Table 4.

Table3 4. Measurement of agricultural product purchases

Variable	Question	Content
Purchase of agricultural products	E1	Willing to buy produce in live stream
	E2	Willing to buy produce through live streaming again
	E3	Willing to recommend others to buy produce via live streaming

Both measurement questionnaires were scored using a five-point Likert scale [19], corresponding to:

1 - Strongly disagree,

2 - Disagree,

3 - Unsure,

4 - Agree,

5 - Strongly agree.

2.3. Questionnaire Reliability and Validity Testing

An anonymous questionnaire was distributed based on the website www.wjx.cn and through multiple channels such as social media groups, Sina Weibo, and forums to cover respondents from as many different sources as possible. Totally 721 questionnaires were distributed, and 689 valid questionnaires were successfully retrieved. Each piece of data was manually verified to ensure its validity and authenticity. The reliability of the questionnaire was evaluated using Cronbach's α [20] (Table 5).

Table 5. Reliability tests

Variable	Number of questions	Cronbach's α
Agricultural food	4	0.87
Anchor	5	0.86
Live-streaming	5	0.88
Platform	4	0.91
Purchase of agricultural products	3	0.93

A Cronbach's α value exceeding 0.7 [21] indicates that the questionnaire is acceptable. From Table 5, it is evident that the Cronbach's α values for each section of the questionnaire exceeded 0.8, demonstrating good reliability. The validity of the questionnaire was assessed using Kaiser-Meyer-Olkin (KMO) values and Bartlett's test of sphericity [22] (Table 6).

Table 6. Validity tests

Variable	KMO value	Bartlett's test of sphericity		
		Approximate chi-square	Degree of freedom	Significance
Agricultural products	0.92	1,421.25	4	0.000
Anchor	0.84	1,258.33	6	0.000
Live stream	0.77	1,125.95	1	0.000
Platform	0.83	865.85	7	0.000
Purchase of agricultural products	0.91	874.69	2	0.000

A KMO value exceeding 0.6 and a significance level below 0.05 [23] indicates that the questionnaire is acceptable. From Table 6, it is evident that the KMO value for each section of the questionnaire exceeded 0.6, and the significance level = 0.000, demonstrating good validity.

3. Results and Analysis

The personal information of the respondents was analyzed (Table 7).

Table 7. Analysis of respondents' personal information

		Frequency	Percentage
Gender	Male	305	44.27%
	Female	384	55.73%
Age	18-25 years	211	30.62%
	26-40 years	287	41.65%
	41-50 years	126	18.29%
	Over 50 years	65	9.43%
Education background	High school or below	164	23.80%
	Junior college/undergraduate	359	52.10%
	Postgraduate or above	166	24.09%
Occupation	Student at school	184	26.71%
	Enterprise employee	167	24.24%
	Public institutions/civil servants	115	16.69%
	Freelancers	166	24.09%
	Others	57	8.27%
Monthly income	Less than 3,000	12	1.74%
	3,001-5,000 yuan	58	8.42%
	5,001-8,000 yuan	386	56.02%
	More than 8,001	233	33.82%
Place of residence	Cities and towns	284	41.22%
	Countryside	405	58.78%
Marital status	Married	311	45.14%
	Unmarried	378	54.86%

According to Table 7, there were slightly more female respondents than male respondents, suggesting that females may have a higher interest in live purchasing of agricultural products. This may be somewhat related to traditional family roles. In many families, women are still the main purchasers of household items. As agricultural products are at the core of daily consumption, their purchase also attracts the attention of women. In terms of age distribution, the majority of respondents was between 18 and 40, comprising over 70% of the total. In contrast, the number of respondents over 40 was small, indicating that younger individuals are more interested in live purchasing of agricultural products. The 18-40 age group has grown up with the Internet. They have a higher acceptance of the emerging live-streaming business format and are more proficient in operating it. However, consumers over 40 years old may be less involved due to reasons such as a greater reliance on offline shopping and unfamiliarity with live-streaming and payment methods. Regarding education background, the most significant proportion of respondents had junior college/undergraduate degrees, accounting for 52.10%.

This may be because the higher the level of education, the greater the concern for food safety and healthy eating. The selling points of agricultural product live streaming, such as "fresh and direct delivery" and "green and organic", hit the demands of consumers. In terms of occupation, school students, enterprise employees, and freelancers each accounted for around 20% of the respondents, suggesting that individuals in these occupations are more inclined to purchase agricultural products via live streaming channels. Students and freelancers enjoy relatively flexible schedules and exhibit higher engagement with the internet, demonstrating greater propensity to adopt emerging consumption patterns. For employees, live-stream shopping is an efficient means to accomplish purchasing tasks. In terms of monthly income, over 90% of respondents had a monthly income exceeding 5,000 yuan, indicating that consumers with higher income levels tended to be more inclined to make purchases through live streaming. High-income groups have a stronger ability to withstand the possible risks of emerging consumption patterns, and their trial-and-error costs are relatively low. Therefore, they can make decisions more decisively. The urban-rural difference was not significant, suggesting that rural residents are increasingly exposed to live streaming of agricultural products due to improved internet access and rising consumption levels. The difference between married people and unmarried people was also small.

The agricultural product purchase information of the respondents was analyzed, and the results are presented in Table 8 and Figures 2 to 4.

Table4 8. Analysis of agricultural product purchase information (multiple-choice section)

		Frequency	Percentage
Which live-streaming platform do you primarily purchase produce from? (Multiple choice)	Taobao	321	46.59%
	Jingdong	105	15.24%
	Pingduoduo	169	24.53%
	Douyin	486	70.54%
	Others	55	7.98%
What is the main type of anchor you watch? (Multiple choice)	Internet celebrity	354	51.38%
	Star	231	33.53%
	Local official	123	17.85%
	Peasant household	281	40.78%
What type of produce do you regularly purchase? (Multiple choice)	Whole grains and coarse cereals	302	43.83%
	Fruit and vegetables	542	78.66%
	Meat, egg, and milk	141	20.46%
	Flowers and plants	125	18.14%
	Others	43	6.24%
Why do you buy produce in the live stream? (Multiple choice)	Cheap and fine	538	78.08%
	Help farmers	254	36.87%
	Support the anchor	109	15.82%
	Attractive display of products	394	57.18%
What is the price range of produce you regularly purchase?	Less than 50	284	41.22%
	50-100 yuan	276	40.06%
	100-200 yuan	87	12.63%
	More than 200	42	6.10%
How many times per month do you buy produce in the live stream?	Less than 5	507	73.58%
	6-10	101	14.66%
	More than 10	81	11.76%
What do you think of the produce purchased in the live stream?	Very satisfied	268	38.90%
	Satisfied	277	40.20%
	Neutral	89	12.92%
	Dissatisfied	41	5.95%
	Very dissatisfied	14	2.03%

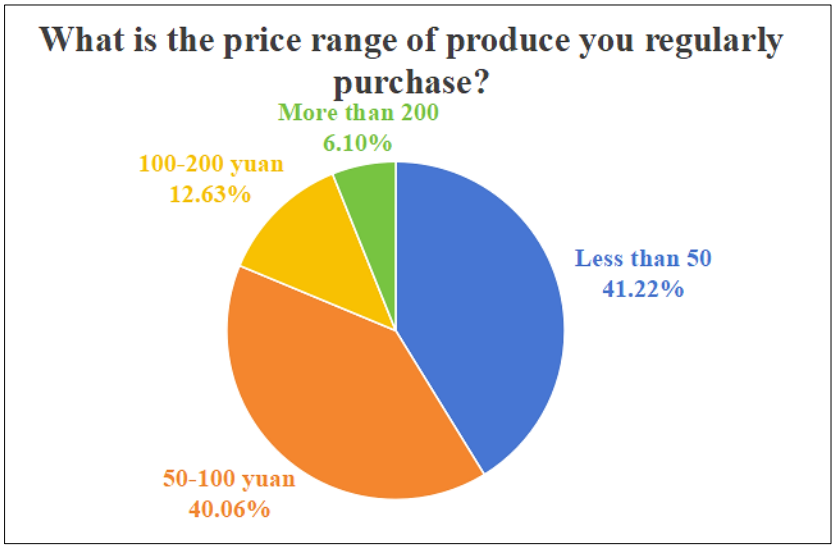

Figure 2. Analysis of information on purchasing agricultural products (single-choice question 1)

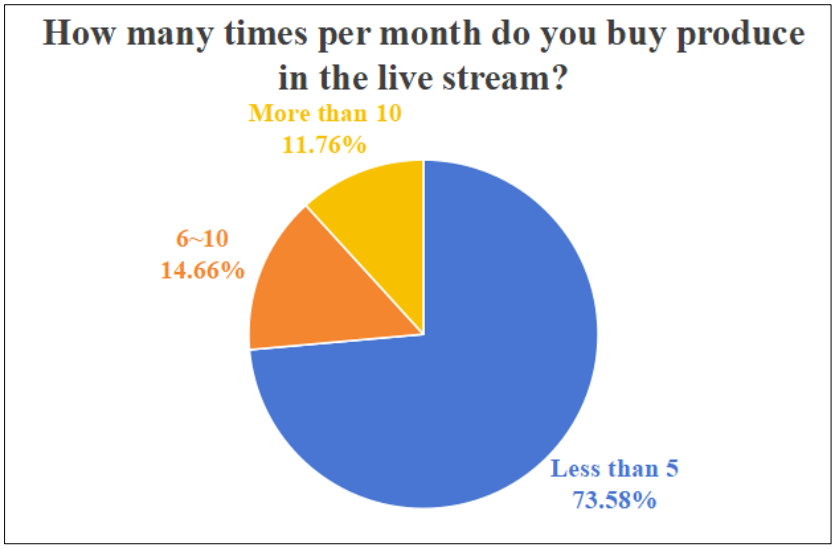

Figure 3. Analysis of information on purchasing agricultural products (single-choice question 2)

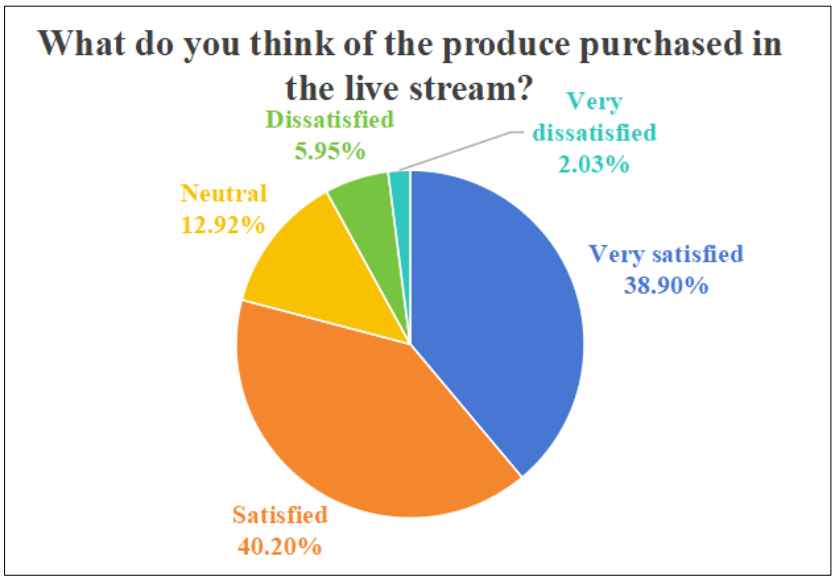

Figure 4. Analysis of information on purchasing agricultural products (single-choice question 3)

According to Table 8, Douyin and Taobao were the most commonly used platforms, with market shares of 70.54% and 46.59%, respectively, followed by Pinduoduo and Jingdong at 24.53% and 15.24%. In terms of the type of anchors that the respondents prefer to, half chose internet celebrities, followed by peasant households at 40.78%, indicating a clear preference for live streams hosted by these two groups. In terms of frequently purchased agricultural products, fruits and vegetables were the most popular, accounting for 78.66%, followed by whole grains and coarse cereals at 43.83%. In terms of purchasing preferences, 78.08% of respondents prioritized "affordable and high-quality" products, followed by 57.18% who valued the attractive presentation. Regarding the price range of frequently purchased agricultural products (Figure 2), the majority of respondents preferred lower-priced items, and 80% selected products priced below 50 yuan or between 50 and 100 yuan. The frequency of product purchases (Figure 3) showed that the largest proportion of respondents purchased products fewer than five times per month, accounting for 73.58%. As shown in Figure 4, most respondents expressed satisfaction with their purchases. In summary, the findings indicate that respondents predominantly purchase agricultural products through Douyin and Taobao, prefer watching the live streams hosted by internet celebrities and peasant households, frequently purchase fruits, vegetables, whole grains, and coarse cereals, prioritize product quality and affordability, and generally report high levels of satisfaction with their purchases.

The correlation between purchase of agricultural products and live-streaming economy was analyzed (Table 9).

Table5 9. Analysis of correlation between purchase of agricultural products and live-streaming economy (: p < 0.01)**

	Agricultural products	Anchor	Live streaming	Platform	Purchase of agricultural products
Agricultural products	1				
Anchor	0.784**	1			
Live streaming	0.811**	0.776**	1		
Platform	0.769**	0.812**	0.823**	1	
Purchase of agricultural products	0.742**	0.684**	0.665**	0.681**	1

In Table 9, a strong correlation was observed. Specifically, the correlation coefficient between farm products and the purchase of farm products was the highest (0.742), suggesting that the characteristics of agricultural products play a significant role in influencing their purchase. Additionally, the correlation coefficients between anchors, platforms, live streaming, and purchases of agricultural products were 0.684, 0.681, and 0.665, respectively. These values indicate that all factors within the live-streaming economy have a notable influence on the purchase of agricultural products.

Regression analysis was employed to further investigate the relationship between the purchase of agricultural products and the live-streaming economy (Table 10).

Table 10. Regression analysis results

	Unstandardized coefficient		Standardized coefficient Beta	t	Sig	VIF	R^2	Adjusted R^2	F
	B	Standard error							
(Constant)	0.812	0.207	-	3.874	0.000	-			
Agricultural products	0.215	0.056	0.212	4.268	0.000	1.325			
Anchor	0.133	0.048	0.127	3.625	0.000	1.283	0.251	0.234	35.254
Live streaming	0.186	0.051	0.185	2.215	0.000	1.276			
Platform	0.167	0.047	0.177	2.014	0.000	1.272			
Dependent variable: purchase of agricultural products									

According to Table 10, R^2=0.251 and adjusted R^2=0.234, indicating a good fit. The significance of each variable was less than 0.5, suggesting a significant positive correlation between agricultural products, anchors, live streaming, platforms, and the purchase of farm products. In comparison, agricultural products exerted the greatest influence on consumer purchasing decisions, followed by live streaming, and anchors played a minor role. This result has some similarities with the research of Wang et al. [24]. The research of Wang et al. [24] found that in the live streaming of agricultural products, the indirect and overall impact of commodities on customer satisfaction is the strongest. From the perspective of the technology acceptance model, consumers' intention to buy agricultural products is significantly influenced by perceived usefulness and perceived ease of use. Among them, perceived usefulness is reflected in the fact that the live streaming mode provides consumers with far more product information and value perception than text and pictures. The quality of agricultural products is the strongest factor driving perceived usefulness, while perceived ease of use benefits from consumers' familiarity with the operation of the live streaming platform. These results indicate that in the live streaming of agricultural products, technology is more of an empowerment tool, and the final result still highly depends on the physical attributes of products. Based on these findings, to enhance the benefits of agricultural products in the live-streaming economy, the following strategies should be implemented.

- Platforms should guarantee the freshness and maintain the quality standards of agricultural products by optimizing supply chain management to reduce losses during logistics, ensuring timely delivery of high-quality products to buyers. Additionally, cultivating distinctive brands should be focused on to enhance product attractiveness and competitiveness.
- Platforms should conduct extensive research on the live-streaming economy, strongly support live streaming to assist farmers, and explore ways to optimize the content and format of agricultural product live-streaming. Moreover, they can promote the diversity and freshness of live streaming, increase entertainment and interactivity, and meet consumers' purchasing needs from various angles to enhance satisfaction.
- Platforms should enhance the training of agricultural product live-streaming anchors to build professional and trustworthy images.

4. Conclusion

This paper mainly analyzed the correlation between agricultural product purchases and the live-streaming economy in the digital context. A questionnaire survey and regression analysis discovered that the leading platforms for purchasing agricultural products were Douyin and Taobao, the predominant types of anchors are internet celebrities and peasant households, and the most commonly purchased items were fruits, vegetables, whole grains, and coarse cereals. The primary motivations for purchase included product quality and affordability, and overall satisfaction with the purchased items was high. Agricultural product purchases showed a significant correlation with all aspects of the live-streaming economy. Regression analysis further revealed that agricultural products had the largest influence on purchases, followed by anchors. Therefore, in the live-streaming economy, farmers should place greater emphasis on enhancing the quality of agricultural products. They should actively show the planting environment and the picking and sorting processes of agricultural products through live streaming to make the quality visible. Platforms should strengthen the cultivation of live-stream anchors and train high-quality anchors who understand both the Internet and agriculture. At the same time, they should establish a mechanism to preferentially recommend agricultural product live-stream rooms with high repurchase rates and few complaints to ensure the healthy development of this industry. Relevant government departments should regard agricultural product live streaming as an essential part of digital rural construction, further improve the construction of rural networks, logistics, and other hardware facilities, and severely crack down on behaviors such as passing off inferior products as good ones and false propaganda so as to better stimulate the purchase of agricultural products and promote the further growth and advancement of live streaming for agricultural products.

5. Declarations

5.1. Author Contributions

Conceptualization, Z.W., H.Z., and X.W.; methodology, Z.W. and H.Z.; validation, Z.W.; formal analysis, Z.W.; investigation, H.Z. and X.W.; data curation, Z.W.; writing—original draft preparation, Z.W., H.Z., and X.W.; writing—review and editing, Z.W., H.Z., and X.W.; visualization, Z.W. All authors have read and agreed to the published version of the manuscript.

5.2. Data Availability Statement

The data presented in this study are available in the article.

5.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

5.4. Institutional Review Board Statement

Not applicable.

5.5. Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

5.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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