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A Study on Economic Benefits and Transformation Paths of Precision Marketing in Sino-Kazakh Agriculture

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ABSTRACT

Modern agricultural production needs to increase efficiency and sustainability against the background of digitalization and environmental challenges. The purpose of this study is to analyze the impact of precision marketing on the economic performance and sustainable development of agro-industrial enterprises using the example of China, as well as to assess the applicability of the Chinese experience to the agricultural sector in Kazakhstan. The methods used are econometric analysis of panel data and cross-country comparative research. Based on the panel data of ten representative listed agribusinesses in China from 2014 to 2023, the empirical study uses regression analysis and fixed effects model. The results show that the input of selling expenses is significantly positively correlated with the growth of operating revenues, with a marginal benefit as high as 1:17.04, highlighting the central role of precision marketing in resource allocation. At the same time, the strategy significantly impacts the economic efficiency and sustainable development of agribusinesses through reducing resource wastage. The coefficient of determination was R2 = 0.735, which indicates a high explanatory power of the model, and each increase in marketing costs of 100 million yuan was accompanied by an average increase in revenue of 5.165 billion yuan, which indicates a high marginal return (17 times higher than the underlying investment). Special emphasis is placed on the potential of Sino-Kazakh cooperation in the application of precision agriculture technologies such as smart irrigation and drone inspection.

KEYWORDS: Agricultural Market, Marketing, Marketing Strategy, Economy, Economic Efficiency, Digitalization, Sustainable Development, China

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Исследование экономических выгод и путей трансформации прецизионного маркетинга в сельском хозяйстве Китая и Казахстана

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АННОТАЦИЯ

Современное аграрное производство сталкивается с необходимостью повышения эффективности и устойчивости на фоне цифровизации и экологических вызовов. Целью настоящего исследования является анализ влияния прецизионного маркетинга на экономическую результативность и устойчивое развитие агропромышленных предприятий на примере Китая, а также оценка применимости китайского опыта к аграрному сектору Казахстана. В качестве методов применены эконометрический анализ панельных данных и межстрановое сравнительное исследование. На основе панельных данных десяти ведущих публичных агропредприятий Китая за период 2014–2023 гг. проведён эмпирический анализ с использованием регрессионной модели с фиксированными эффектами. Результаты показывают, что инвестиции в сбыт существенно положительно коррелируют с ростом операционной выручки, предельная отдача достигает соотношения 1:17,04, что подчёркивает ключевую роль прецизионного маркетинга в эффективном распределении ресурсов. Кроме того, данная стратегия существенно влияет не только на экономическую эффективность, но и на устойчивое развитие агробизнеса за счёт снижения потерь ресурсов. Коэффициент детерминации составил $R^2 = 0.735$, что указывает на высокую объяснительную силу модели, а каждое увеличение маркетинговых затрат на 100 млн юаней сопровождалось средним ростом выручки на 5,165 млрд юаней, что свидетельствует о высокой маржинальной отдаче (в 17 раз выше базовых инвестиций). Особое внимание уделено перспективам китайско-казахстанского сотрудничества в области применения технологий точного земледелия, таких как интеллектуальное орошение и дрон-мониторинг.

КЛЮЧЕВЫЕ СЛОВА: сельскохозяйственный рынок, маркетинг, маркетинговая стратегия, экономика, экономическая эффективность, цифровизация, устойчивое развитие, Китай

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INTRODUCTION

As a basic industry of the national economy, the modernization and transformation of agriculture is of great significance in guaranteeing food security, promoting rural development and achieving sustainable economic growth. Against the backdrop of accelerating global digitalization and sustainable development agenda, how agricultural enterprises can enhance economic benefits and social value through precision marketing strategies has become the focus of agricultural policymakers and business managers in various countries. China, as a largely agricultural country, has accumulated rich experience in precision marketing through policy guidance, technological innovation and market mechanism innovation in recent years, which provides a model that can be utilized for the efficient operation and sustainable development of agricultural enterprises. Kazakhstan's agricultural sector is crucial to its economic stability and export earnings as a country rich in agricultural resources. However, it is currently facing systemic challenges such as rural labor exodus, insufficient technology application, and inefficient supply chain, which seriously constrain the process of agricultural modernization. Despite Kazakhstan's vast arable land and favorable natural conditions, the market competitiveness of agribusinesses is still limited by the inefficiencies of traditional marketing models. Data shows that the proportion of the rural population in Kazakhstan will decline by 7.3% between 2013 and 2024, and the ageing and skills shortage of the agricultural labor force highlights the problem, which urgently requires innovative models to attract young talents and improve production efficiency. In this context, precision marketing can optimise resource allocation, reduce production waste and enhance market responsiveness through data-driven decision-making, thus injecting new momentum into the sustainable development of Kazakhstan's agriculture.

Using the successful practice of precision marketing in Chinese agribusinesses as a case study, this study explores its dual role in enhancing economic efficiency (e.g., the marginal benefit of sales expenses up to 17.04 times) and promoting the realization of environmental, social, and governance (ESG) objectives. Based on the empirical analysis of 10 listed Chinese agribusinesses from 2014 to 2023, this paper reveals the virtuous cycle of "precision inputs - efficiency improvement - sustainable development" formed by precision marketing through technological empowerment (e.g., big data analytics, blockchain traceability) and policy synergies (e.g., Digital Agricultural Rural Development Plan). Further, taking into account the actual needs of Kazakhstan's agricultural development, the study proposes a localized precision marketing path: in the short term, reduce the threshold of SMEs' transformation through lightweight digital tools (e.g., e-commerce platforms, mobile payments); in the long term, build a synergistic system of education, policy and technology to cultivate new vocational farmers and improve the digital infrastructure. A synergistic "education, policy and technology" system will be built in the long term to nurture new professional farmers and improve digital infrastructure.

The innovation of this paper is that it is the first time to systematically combine China's precision marketing experience with Kazakhstan's agricultural transformation needs, quantitatively analyze the economic benefits of marketing inputs, and propose a phased implementation plan. The study provides an actionable strategic framework for Kazakhstan's agribusiness and a cross-regional reference for countries with similar resource endowments to explore the path of agricultural modernization. In the future, the in-depth collaboration between China and Kazakhstan in technical cooperation, policy dialogue and talent cultivation is expected to become an important engine for sustainable agricultural development in the Eurasian region.

This paper combines literature research and quantitative analysis to refine the intrinsic connection between precision marketing and sustainable development by combining the digital practices of typical enterprises. The results show that precision marketing in agribusiness has been upgraded from a mere marketing tool to an essential part of ESG strategy. Precision marketing in agribusiness can enhance corporate income and promote agribusiness transformation.

LITERATURE REVIEW

Precision marketing strategies for Chinese agribusinesses utilize advanced data analytics, digital platforms, and innovative models to expand market reach and consumer engagement. These strategies are critical to adapting to China's fast-growing agricultural market, which is characterized by increasing consumer demand for quality and transparency. Integrating big data, personalized recommendations, and direct marketing models is at the core of these strategies, enabling companies to target and meet consumer needs effectively.

Under the background of the digital economy, traditional marketing theories have realized innovative development in agriculture. 4P marketing theory has formed a precise product development

system based on consumer profiles through digital transformation (Chen & Gong, 2018), significantly reducing the stagnation rate of agricultural product e-commerce (Xiao & Xinfei, 2022). The application of dynamic pricing algorithms (Liu, 2018) and blockchain traceability technology (Zhang et al., 2024) has pushed up the efficiency of agricultural product distribution by 40-60% (Deng, 2024).

Under the background of the digital economy, traditional marketing theories have undergone innovative development in agriculture. The 4P marketing theory has evolved into a precise product development system based on consumer profiling through digital transformation, significantly reducing the stagnation rate of agricultural product e-commerce (Chen & Gong, 2018; Xiao & Xinfei, 2022). Applying dynamic pricing algorithms and blockchain traceability technology has increased the efficiency of agricultural product distribution by 40–60% (Liu, 2018; Zhang et al., 2024; Deng, 2024).

The 4C theory demonstrates renewed value in agricultural practice. Demand analysis based on the Sustainable Development Goals and the construction of digital platforms has significantly enhanced the responsiveness of agricultural supply chains (Guo & Guo, 2024; Zhu, 2021). Studies indicate that digital marketing can increase the conversion rate of small and medium-sized agribusinesses by 35%, though challenges such as the digital divide persist (Qin & Li, 2023).

The ESG framework offers a novel perspective on agricultural marketing. Precision agriculture technologies have led to a 20% reduction in carbon emissions while optimising benefit distribution contributes to improved regional equilibrium (Zhan et al., 2025; Zhu & Zheng, 2024). Furthermore, research confirms that green intellectual capital plays a key mediating role in sustainable development pathways (Zhang et al., 2024). Recent studies suggest a growing trend toward theoretical integration. The integrated "4P × 4C × ESG" model illustrates that digital technologies can enhance productivity by 19%, although 67% of agribusinesses continue to experience data silo issues (Ren & Liu, 2018; Hong, 2024).

Open up online platform sales, the development of live broadcasting and other new modes. Purchasing from the source, reducing intermediaries, supplying consumers with the best quality agricultural products, and cooperating with farmers in direct purchasing also guarantee farmers' income and help them enrich themselves. The "Farmer-Supermarket Direct Purchase" model connects small farmers directly with retailers, ensuring a stable market for agricultural products. This model not only reduces the cost but also ensures quality, avoids a lot of fresh fruits and other fresh products missing the best-selling period because of middlemen changing hands, and improves quality control and food safety standards (Hu & Gale, 2016).

On the other hand, online sales have become very developed and live streaming has become a powerful tool for marketing agricultural products, which allows companies to interact directly with consumers and display products in real-time or through immersive live streaming, which will enable consumers to self-select their products as if they were in the farmland. This approach enhances customer interaction and trust, increasing sales and brand loyalty (Shi et al., 2022). E-commerce platforms use clustering techniques to classify customers and optimize marketing efforts. Enhanced K-means algorithms can improve customer segmentation to capture trends in agricultural production and reduce "low grain prices", leading to more precise targeting and more effective marketing strategies (Shi et al., 2022).

Data-driven marketing with insights into consumer needs. The significance of precision marketing is that it can capture consumer needs while avoiding crop data. Data-driven precision marketing strategies include comprehensive analysis of consumer data to tailor marketing efforts. This includes personalized recommendations and targeted advertisements to improve marketing effectiveness and customer satisfaction significantly (Hong, 2024). Spatio-temporal data clustering and neural networks are used to further refine marketing strategies by predicting consumer behavior and preferences, thereby improving the precision of marketing campaigns (Liu, 2018). China's government-supported digital supply chain program facilitates information sharing between production, supply, and marketing channels (Zhu, 2021). This integration has improved the quality of life by aligning production with market needs and consumer preferences. As people improve their quality and standard of living, agricultural products are no longer as simple as a solution to the problem of food and clothing but also a representation of a healthy and high-quality life (Deng, 2024).

Of course, there are currently some problems with precision marketing, which has significant advantages but also faces challenges, such as data privacy issues and the need for continued technological adaptation. Ensuring data security and compliance with legal standards is critical to the sustainability of precision marketing (Hong, 2024). In addition, technological change is rapid, and agribusinesses must remain flexible and innovative in their market-

ing approaches to remain competitive in the marketplace. Overall, the direction and approach of precision marketing are important for the sustainability of agribusiness.

The sustainable development of agribusiness in China is a multifaceted endeavour that involves improving production efficiency, promoting environmental sustainability and ensuring economic viability. Various factors, including autonomous innovation, government policies and the integration of green technologies, drive this development. The transition to sustainable practices was critical to meeting environmental challenges and ensuring food security in China.

On the one hand, autonomous innovation plays a key role in the sustainable growth of agribusinesses, showing an "inverted U-shaped" effect on growth. Optimal R&D investment is crucial, with a threshold of 77.85% of operating revenue to maximize growth (Li et al., 2024). Government subsidies and digital transformation are important external and internal factors that can enhance the positive impact of innovation. However, the effect varies depending on the firm's development stage (Li et al., 2024). On the other hand, there are apparent regional differences in sustainable agricultural development, with eastern and central regions generally outperforming western regions. However, the western region shows the highest growth rate (Zhu & Zheng, 2024). Coordination between the agricultural economy and ecology is improving, and regional differences are narrowing. Major obstacles include land efficiency and ecological conservation measures (Zhan et al., 2025).

On the one hand, agribusinesses are actively developing Ecological Low Carbon Agriculture (ELA), critical for reducing carbon emissions and improving sustainability. This involves improving agricultural production systems and promoting carbon sequestration technologies (Guo & Guo, 2024). Green Entrepreneurial Orientation (GEO) and Sustainable Business Model Innovation (SBMI) are essential for improving the sustainable performance of agribusiness, of which Green Intellectual Capital (GIC) is a key agent. On the other hand, agribusiness sustainability is also supported by social support and financial inflows. Agricultural credit significantly contributes to green technological innovation, which increases agricultural green total factor productivity (Zhang et al., 2024). The inflow of industrial and commercial capital promotes sustainable agricultural development by optimising production conditions and improving the rural environment and has positive spillover effects on surrounding areas (Yang & Wang, 2025).

While progress is being made in the sustainable development of agribusiness in China, challenges remain, such as regional imbalances and the need for more effective low-carbon agricultural development pathways. Addressing these issues requires an integrated approach that combines technological innovation, policy support and regional cooperation to ensure the long-term sustainability and resilience of the agricultural sector.

Kazakhstan's agricultural sector is characterised by strengths and challenges, fully reflecting its importance in its economy and food security. The sector benefited from abundant natural resources and favorable climatic conditions, but also faced challenges such as underinvestment, technological backwardness and dependence on certain food imports. The government is actively addressing these issues through various policies and programs to enhance agricultural productivity and sustainable development. The following sections provide an in-depth look at the current status and challenges of agriculture in Kazakhstan. Kazakhstan ranks 32nd in the Global Food Security Index (GFSI), indicating a moderate level of food security with sufficient natural resources to support the agri-food sector (Kazhieva et al., 2020; Malyarenko & Kushebina, 2022; Suieubayeva et al., 2022). Since independence, the country has undergone significant structural changes, transitioning from a state-owned to a private economy and establishing a market economy framework (Pyagay et al., 2022). Livestock farming is an essential part of agriculture, accounting for 47.5% of total agriculture, thanks to abundant pastures and favorable natural conditions (Tekenov et al., 2017).

However, with the development of big data, Kazakhstan's agriculture faces some challenges. Economic accessibility of food products is still low, with more than 50% of consumer spending on food products (Kazhieva et al., 2020). The sector highly depends on imported beef, pork, poultry, and other products, highlighting the need to implement an import substitution policy. Insufficient investment in agricultural technology and climate change poses a significant threat, exacerbating water scarcity and land degradation (Zhanaltay, 2023; Tokbergenova et al., 2018). Inefficient logistics systems and a lack of integration of digital tools hinder productivity (Temirbekova et al., 2021; Bakpayeva et al., 2024). Currently, the government has implemented policies to strengthen agricultural capacity, focusing on enhancing competitiveness and reducing import dependence. The socio-economic risks of rural migration are of great importance (Toguzova et al., 2023). As a result of the increased migration flows of the rural population and the decline in living stan-

dards, the authors attribute the decrease in the level of self-sufficiency of rural households in their own products to the main socio-economic risks of rural migration (Gaysina et al., 2023). Recommendations include strengthening agricultural cooperation, upgrading the technological base, and providing state support through subsidies and financial assistance. Emphasis is placed on digitalization and logistics optimisation to enhance competitiveness and resilience (Bakpayeva et al., 2024). Kazakhstan's agricultural sector faces many development challenges that require comprehensive policy interventions. Digital transformation, investment in technology, and import substitution are key to enhancing the sustainability and competitiveness of the sector. In addition, addressing environmental issues and improving logistics will be crucial for the long-term growth and resilience of the sector.

METHODOLOGY

This paper takes the background of sustainable development of Chinese agricultural enterprises, systematically discusses the importance of China's leading agricultural enterprises under the strategy of precision marketing for the economic development of agricultural enterprises, and how to utilize precision marketing to break the drawbacks of traditional agricultural enterprises such as environmental damage, product waste backlog and other issues. Analyse the current situation of the sustainable development of China's farming enterprises.

The paper begins by analysing the current state of sustainable development in Chinese agriculture. It then evaluates the impact of precision marketing measures on enterprise-level economic performance and their contribution to long-term sustainability. To empirically assess the effectiveness of these strategies, the study employs SPSS statistical analysis tools, specifically conducting regression analysis on firm-level data.

A panel dataset consisting of ten leading Chinese agribusinesses is used, with annual data spanning the period from 2014 to 2023. Such a time frame provides sufficient completeness of observations, allowing us to reflect on the dynamics of internal changes and economic influences. The use of a panel data structure, which includes both temporal and inter-company measurement, is driven by the desire to consider each company's characteristics and ensure control over the influence of factors that change over time.

This provides a cross-sectional (ten firms) and a time-series (ten years) dimension, enabling robust econometric analysis. The data cross-section dimension is a sample of ten firms, and the time dimension is ten years of continuous observation. Dependent variables: operating income (revenue, in billions of USD); net sales margin (sales – expenses, in billions of USD). Control variables: individual firm effects, time-specific effects.

The original regression model used the following formula (1):

$$Revenue_{it} = \beta_0 + \beta_1 Sales\ Expense_{it} + \varepsilon_{it} \quad (1)$$

where:

$Revenue_{it}$ – the operating income of firm i in year t (in billions of dollars);

$Sales\ Expense_{it}$ – the selling expenses of firm i in year t (billions of dollars);

β_0 – the intercept term (base revenue level);

β_1 – the marginal effect of selling expenses (revenue growth per billion dollars invested);

ε_{it} – the random error term.

The regression model built as part of the study considers the individual characteristics of each company and the time effects, which minimizes the bias associated with missing variables. The analysis is carried out in the SPSS environment, which provides a comprehensive check of the significance of the model, the reliability of the coefficients, the degree of autocorrelation of the residuals and multicollinearity. The mathematical expression of the model assumes the presence of a free term reflecting the basic income level in the absence of marketing costs, as well as a coefficient interpreted as a marginal effect from the growth of investments in sales activity.

This methodology is chosen due to its ability to quantify the impact of marketing strategies on financial results in the agricultural sector, which is especially important in the context of the growing dependence of agriculture on digital tools and demand management mechanisms. In addition, this approach allows us to identify statistically significant dependencies and conclude the potential effectiveness of using similar strategies in other countries, particularly Kazakhstan, which is considered a key beneficiary of experience transfer.

RESULTS AND DISCUSSION

To assess the impact of marketing expenses on the economic performance of agricultural enterprises, a linear regression model was built, implemented in the SPSS environment based on the collected panel data. The purpose of the analysis is to identify the degree of dependence of operating revenue on

the volume of sales and promotion costs. The results of the evaluation of the model parameters are presented below, reflected in the summary table, which includes the coefficients of determination, the standard error of the model and the autocorrelation index of the residuals. These values allow us to judge the reliability of the model and its explanatory power.

The results of the linear regression analysis using SPSS are presented in Table 1.

Table 1. Model summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin Watson
1	0.857[a]	0.735	0.732	149.624963	0.420
a. predictors:(Constant), Sales-Expense&#10 b. Dependent variable: Revenue&#10					

Note: compiled by authors

The regression model reveals a strong linear association between selling expenses and operating income. There is a high positive correlation between the two variables, with selling expenses accounting for approximately 73.5% of the variation in operating income. The model maintains strong explanatory power even after adjusting for the number of predictors. However, the Durbin-Watson statistic is notably low, suggesting the presence of positive autocorrelation in the residuals.

The results of the ANOVA test indicate that the regression model is statistically significant overall (see Table 2).

Table 2. ANOVA summary[a]

Model	Type	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6089244.516	1	6089244.516	271.991	<0.001[b]
	Residual	2193987.705	98	22387.630	-	-
	Total	8283232.221	99	-	-	-
a. Dependent variable: Revenue&#10 b. Predictors: (Constant), Sales-Expense&#10						

Note: compiled by authors

The F-statistic = 271.991 and the p-value < 0.001, meaning that the model significantly predicts the dependent variable (operating income) and that selling expenses have a statistically significant impact. This analysis allows us to determine how statistically significant the regression equation is and whether it explains the variations of the dependent variable better than the model without predictors. The value of the F-criterion and the corresponding significance level (p-value) indicates that the impact of marketing expenses on operating revenue is not random, and the model as a whole has a high predictive value.

Further, for a more detailed understanding of the impact of marketing expenses on the operating revenue of agricultural enterprises, estimates of regression coefficients are presented in Table 3.

Table 3. Regression coefficient[a]

Model	Unstandardized B	Coffi-cients Std.	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Lower Bound	Interval for B Upper Bound	Collinearity Tolerance	VIF
1 (constant)	-65.149	18.856	-	-3.455	<0.001	-102.567	-27.731		
Sales-Expense&#10.	51.651	3.132	0.857	16.492	<0.001	45.436	57.866	1.000	1.000
a. Dependent variable: Revenue&#10									

Note: compiled by authors

The table contains weighted (non-standardized) coefficients that reflect the absolute change in the dependent variable when the predictor changes and standardised coefficients (Beta) that compare the contribution of various factors. The constant term of the model is -65.149 with a significance level of $p < 0.001$, which indicates that with zero marketing expenses, operating revenue has a negative value on average. This indicates the presence of significant fixed costs and the structural dependence of the agricultural business on external sales channels. The coefficient for the variable "marketing expenses" is 51.651, which means that with an increase in sales costs of 1 billion yuan, operating revenue increases by an average of 51.651 billion yuan. There is also a high level of statistical significance of this indicator ($p < 0.001$), and the confidence interval ranges from 45.436 to 57.866, which confirms the stability of the estimate. The indicators of tolerance (1.000) and VIF (1.000) indicate the absence of multicollinearity in the model.

Residual analysis was performed to verify the correctness of the model specification and compliance with the prerequisites of linear regression, the results of which are presented in Table 4.

Table 4. Residuals statistics

Indicator	Minimum	Maximum	Mean	Std.Deviation	N
Predicted	-64.5295944	871.544189	124.083583	248.007097	100
Residual	-403.131134	591.943176	0.00000000	148.867364	100
Std. Predicted Value	-0.761	3.014	0.000	1.000	100
Std. Residual	-2.694	3.956	0.000	0.995	100

Note: compiled by authors

The standard deviation of the residuals is 148.87, which indicates a moderate variation in the actual values around the regression line. The minimum value of the remainder was -403.13, and the maximum was 591.94, which indicates the presence of observations with deviations in both directions. However, none of the values of the standardised residues exceeds the permissible limit of ± 4 (the highest value is ±3.96). This confirms the absence of outliers and anomalies that can distort the regression analysis. The standardised predicted values range from -0.761 to 3.014, which also fits within acceptable limits. Together, these indicators confirm the reliability of the model and its compliance with basic statistical requirements.

Overall, compared with the standard 3-5 times the return rate of the manufacturing industry, agribusiness 17 times the marginal benefit is exceptionally prominent, combined with the characteristics of the industry, such as policy subsidies and rigid demand, can be explained as the country's fundamental Overall, compared with the standard 3-5 times the return rate of the manufacturing industry, agribusiness 17 times the marginal benefit is exceptional, combined with the characteristics of the industry, such as policy subsidies, rigid demand, we can explain, as the country's fundamental agriculture, the rigid demand for agricultural products by the government to protect the policy subsidies and other assistance to help the sale of agricultural products. Hence, the enterprise precision marketing is as good as "a tiger with wings" to break traditional agriculture in the pursuit of high quality of life in society, in the pursuit of "the best of all possible worlds" of high quality of life in society, agricultural products have great potential for development.

Additionally, an inter-company analysis was conducted to identify differences in marketing strategies. A comparative analysis of ten listed Chinese agricultural enterprises over 2014-2023 highlights a substantial disparity in marketing investment. The maximum difference reaches 1.812 billion yuan, with Xiwang Foods recording an annual average of 689 million yuan, compared to only 0.05 billion yuan by Wanfang Development. Except for 2020, when the COVID-19 pandemic likely disrupted normal operations, most enterprises show a consistent upward trend in marketing investment across the ten years.

An analysis of the sales expense ratio of each firm over time, as illustrated in Figure 2, reveals that seven out of the ten companies exhibit a synchronous upward trend in both sales expenses and operating income.

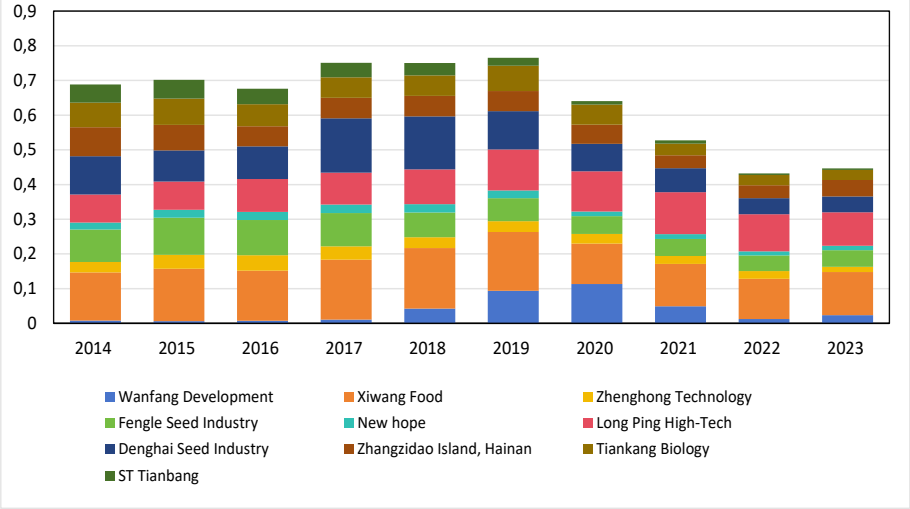

Figure 2. Trend of sales expense ratio of Top 10 agribusinesses for 2014-2023

Combined with the results of the regression model, we can show that the fixed-effects model introducing the time dimension raises the coefficient of selling expenses to 20.175, indicating that the base model underestimates the true effect of selling expenses by failing to control for firms' differences and that this dynamic perspective reveals two key points: firstly, the firms' inherent idiosyncrasies (e.g., channel layouts or patented technologies) may implicitly amplify the effect of sales inputs, and secondly, the government's subsidies to leading firms may further strengthen the Matthew effect.

From a practical point of view, the model's conclusions need to be applied differently - headline companies (e.g., New Hope) can expand their marketing budgets based on the high marginal effect of 20.175. Still, they need to guard against the tipping point of diminishing returns. At the same time, SMEs (e.g., Denghai Seeds) should prioritize efficiency improvement through channel optimization, such as e-commerce transformation, if the actual return is lower than the predicted value rather than blindly increasing investment.

The Chinese experience demonstrates a high marginal return on investments in marketing, especially when considering the specifics of individual enterprises. However, for the practical application of these strategies, it is vital to assess their relevance in other countries with an agrarian bias. Next, the identified patterns' applicability to Kazakhstan's agro-industrial complex is analyzed.

Kazakhstan's per capita production value of agricultural products, expressed as a proportion of the country's GDP per capita, has remained relatively stable over the past 15 years, as shown in Figure 3.

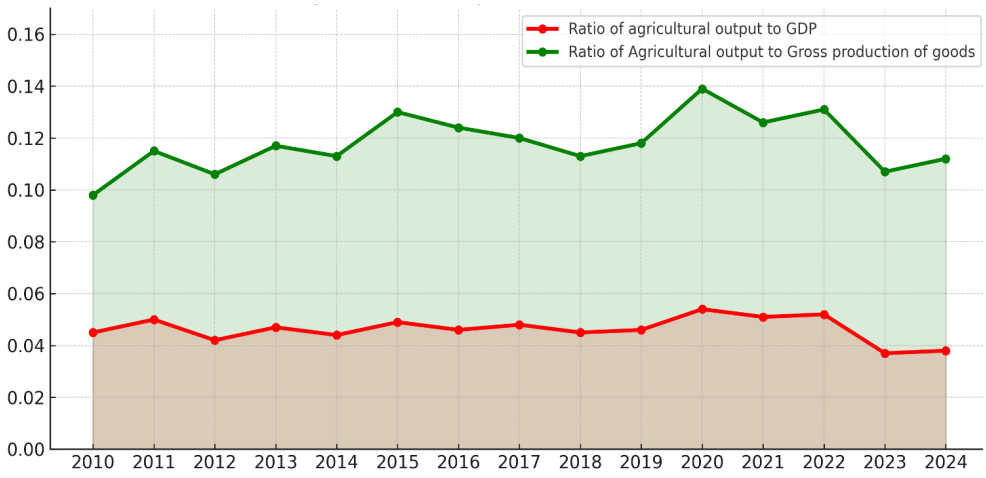

Figure 3. Trends in the ratio of agricultural output to GDP in Kazakhstan for 2010-2024

This shows that in the past 15 years, Kazakhstan's agricultural production value has not reached the expected development, accompanied by the gradual transformation of agricultural science and technology in developed countries. Kazakhstan's agricultural production value is low, the development and upgrading of agricultural products are slow, and the modernization of agricultural transformation is imminent.

Consumption of agricultural products in Kazakhstan as a percentage of total national consumption. As shown in Figure 4 below, the consumption of agricultural products has a better momentum than the previous figure, with a clear upward trend.

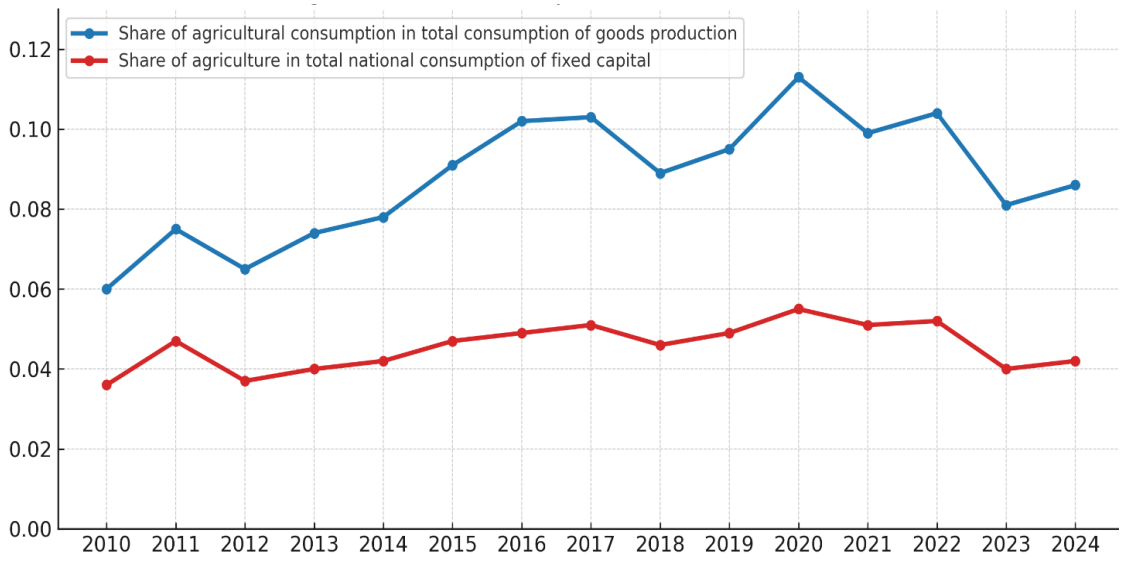

Figure 4. Trends in the ratio of consumption of agricultural products to total domestic consumption of fixed capital in Kazakhstan for 2010-2024

It shows that Kazakhstan's national consumption of agricultural products is still improving, but the country's agricultural production value is low, resulting in high demand and low supply; the national fine agricultural products processing can only rely on imports. Figure 5 illustrates the distribution of small and medium-sized enterprises (SMEs) in Kazakhstan as of 2024, categorised by legal form and sectoral contribution.

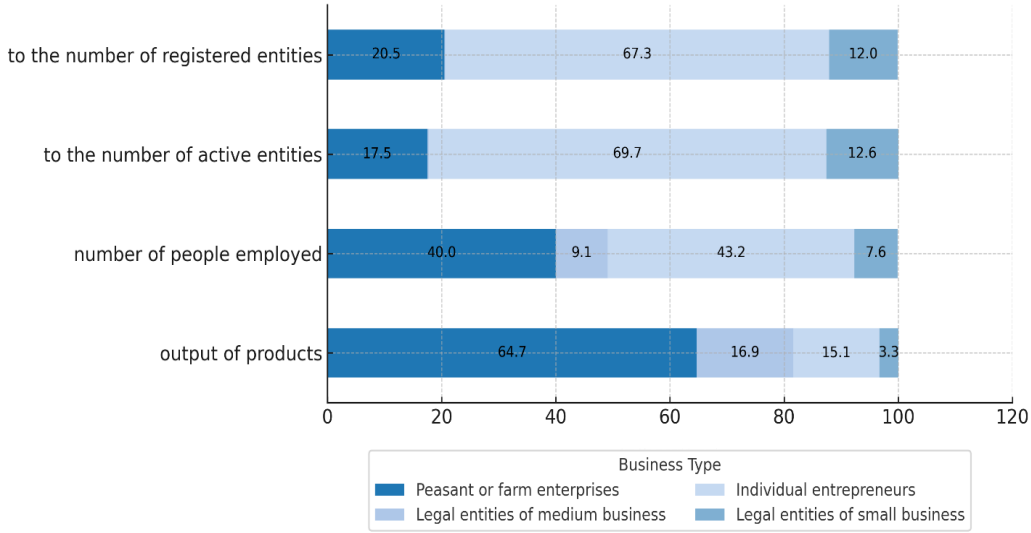

Figure 5. The structure of the leading performance indicators of SME entities for January - September 2024

According to the data, individual entrepreneurs account for 69.7% of all operating SMEs, followed by legal entities of small businesses (17.5%), peasant or farm enterprises (12.6%), and legal entities of medium-sized businesses (0.2%). Among all operating small and medium-sized enterprises (SMEs), the largest product output is farmers' enterprises, accounting for 64.7%, which shows that although agricultural enterprises are not the first choice for registered SMEs and the number of agricultural enterprises is smaller than other industries. However, agriculture is still used as a pillar industry in Kazakhstan, with the largest product output, combining with the results of the previous charts, we can conclude that the development of agriculture in Kazakhstan is facing a Bottleneck in the development of agriculture in Kazakhstan, but it is still the mainstay of the national economy, but the existence of agricultural production efficiency is underground, agricultural products can not meet the needs of the national high quality of life, agricultural enterprises are also facing the same dilemma.

Results of regression analysis and data analysis of Chinese agribusinesses

Through theoretical analysis and empirical testing, this study systematically explores the impact of precision marketing on the economic management efficiency and sustainable development of Chinese agribusinesses in the context of today's big data utilization. Based on the panel data of 10 listed agribusinesses from 2014-2023, the regression analysis study found that:

(1) The high-return nature of precision marketing in agriculture. It highlights the core role of a data-driven marketing strategy for the optimal allocation of resources. On the one hand, precision marketing improves the accuracy of farmers' trends in the production of crops, and enterprises directly dock with farmers to reduce transit costs; on the other hand, precision marketing utilizes big data, analyzes consumer preferences, and clarifies the direction of agribusinesses' iterative upgrading of products, boosting domestic demand.

(2) Sustainable development of synergistic effects and forming a virtuous cycle. First of all, precision marketing through big data technology, accurate matching of consumer demand, predicting planting trends, guiding planting plans, reducing waste of resources to enhance farmers' enthusiasm for production; secondly, to enhance the transparency of the supply chain, such as blockchain traceability to ensure food safety, the development of organic agriculture and the promotion of branding strategy, in line with the needs of modern young people for high-quality, high-quality life, tapping the potential of agricultural products, and to enhance the benefits. Third, big data technology supports feedback on the user experience of agricultural products, from agricultural products to solve the problem of food and clothing to agricultural products to enhance the sense of well-being and gradually transform traditional agriculture. Forming a virtuous cycle of "precise input - benefit enhancement - sustainable development".

(3) Precision marketing strategy needs to be adapted to the heterogeneous characteristics of enterprises: the strategy of precision marketing should be adapted according to the different scales, market shares, market positioning, and characteristics of agricultural products of agribusinesses, e.g., the marketing efficiency of the head enterprises (e.g., COFCO, Makuhari) is significantly higher than that of small and medium-sized enterprises (SMEs), and the government subsidies and technological accumulations have further strengthened the Matthew effect. Small and medium-sized agricultural enterprises need to break through the resource constraints through lightweight digital tools such as e-commerce live broadcasting and channel innovations such as agricultural super docking.

(4) Policy and technology-driven: China's "Digital Agriculture and Rural Development Plan" and other policies for precision marketing to provide institutional safeguards, while the popularity of 5G, AI and other technologies will promote the digitalization of the whole industry chain synergies such as drones precision spraying of pesticides; big data technology to analyze consumer preferences; a new marketing strategy to help the sale of agricultural products, etc., high and new technology to help farmers to improve production and broaden sales channels.

Results of big data analysis in Kazakhstan's agriculture

(1) Correlation of agricultural output with GDP. Figure 3 illustrates the trend of agricultural output as a percentage of national GDP in Kazakhstan from 2010 to 2024. The data show that agricultural output has been flat for the last 15 years, with only a small increase in 2020, followed by a return to the doldrums. This trend indicates that Kazakhstan's agriculture has failed to achieve the expected rapid development, especially in the context of the rapid global transformation of agricultural science and technology, its agricultural production efficiency is slow to improve, and modernization and transformation is imminent. The inefficiency of agriculture, as an important component of the national economy,

has a direct impact on the country's economic potential and food security.

(2) Imbalance between consumption and supply of agricultural products. Figure 4 reflects the share of consumption of agricultural products in the total national consumption of Kazakhstan. As can be seen from the figure, the consumption of agricultural products shows a clear upward trend, indicating that the national demand for agricultural products continues to grow. However, combined with the agricultural output data in Figure 3, it can be found that the domestic supply capacity of agricultural products is insufficient, leading to the contradiction between high demand and low supply. This imbalance further exacerbates the dependence on imported processed agricultural products, especially in fine processing and high-value-added products. This dependence increases economic costs and limits the scope for upgrading local agriculture.

(3) Status of import and export of processed agricultural products. Figure 5 shows the import and export of processed agricultural products in Kazakhstan in 2010-2024. Although exports pick up after 2022, imports are always high and remain stable even during the epidemic. This shows that Kazakhstan heavily depends on the international market for processed agricultural products and has insufficient local processing capacity. Raw materials dominate exports, while high-value-added products dominate imports, and this trade structure limits agriculture's economic efficiency and industrial upgrading potential.

(4) Structure of SMEs and agricultural output. Figure 5 illustrates the sectoral distribution of SMEs and their output in Kazakhstan in 2024. The data show that while agricultural enterprises (e.g., farmers' enterprises) account for a small share of registered SMEs (12.6%), their product output accounts for 64.7%. This paradoxical phenomenon indicates that agriculture is still the mainstay of Kazakhstan, but enterprises are generally small, inefficiently productive, and technologically and managerially backwards. Difficulties agribusinesses face include resource fragmentation, weak market competitiveness and lack of modern marketing tools.

DISCUSSION

The current state of Kazakhstan's agriculture highlighted the contradiction between resource abundance and system inefficiency. Through digital reform, technical cooperation and policy synergy, the country is expected to break through the development bottleneck and realize the transition from traditional to high-value-added agriculture. China's experience in precision marketing provides an important reference for it, but it needs to be adapted to local realities. If the reform is successful, Kazakhstan may become an essential model for sustainable agricultural development in Eurasia.

Analysis of the feasibility of Kazakhstan drawing on the Chinese experience:

(1) Replicability of policy guidance and top-level design. China has systematically promoted the digital transformation of agriculture through policies such as the Digital Agriculture and Rural Development Plan, which provides institutional safeguards for precision marketing. Kazakhstan can learn from this model and formulate a national-level agricultural digitalization strategy with clear short- and long-term goals, such as establishing an agricultural big data platform and promoting e-commerce policies to help farmers. China's experience shows that government-led top-level design can effectively integrate resources and reduce the risk of business transformation.

(2) Rapid landing of lightweight digital tools. The success of precision marketing for agriculture in China is partly due to low-cost, easy-to-promote digital tools such as live e-commerce, mobile payments and social marketing. Kazakhstan could prioritize promoting similar technologies, especially for small and medium-sized farmers and agricultural cooperatives, to lower the barriers to digitization. For example, the "agricultural super-docking" model in China could be used to reduce intermediate links and increase farmers' profitability.

(3) Technical cooperation and industrial synergy. China has developed mature applications in agricultural technology, such as drones, AI prediction and blockchain traceability. Kazakhstan can rely on China-Kazakhstan technological cooperation to introduce customized solutions, such as smart irrigation and precise fertilization, to improve production efficiency. In addition, the experience of Chinese companies in cross-border e-commerce (e.g. Alibaba, Pinduoduo) can also help Kazakhstan's agricultural products explore the international market.

(4) Similarities between market demand and consumption upgrading. Like China, Kazakhstan's consumer demand for high-quality, traceable agricultural products is growing. Precision marketing can help local companies tap into domestic demand through branding strategies (e.g., "Kazakh organic beef") to increase price premiums and reduce dependence on imported processed foods.

Core problems and deep-rooted challenges to agricultural development in Kazakhstan:

(1) Imbalance in industrial structure and locking in the low end of the value chain. Kazakhstan's agriculture is caught in the typical "resource curse" predicament, its agricultural output only accounted

for 4-6% of GDP, and the rich agricultural resource endowment is seriously mismatched. Data show that 80% of agricultural exports are primary raw materials. In comparison, the dependence on imports of high-value-added processed food is as high as 65%, forming a deformed pattern of "exporting wheat and importing bread".

(2) Inadequate digital infrastructure. The lack of network coverage and digitization in rural areas of Kazakhstan may hinder the popularization of precision marketing technology. China has invested far more than Kazakhstan in infrastructure such as 5G and IoT, so the latter needs to prioritize improving its rural network and logistics system. Otherwise, it will be difficult for big data analytics and e-commerce marketing to get off the ground.

(3) Sustainability of policy implementation and long-term investment. China's agricultural policy has continuity and strong implementation, while Kazakhstan may face policy fluctuations or weak local implementation. If there is a lack of long-term capital investment and talent training, precision marketing may be reduced to a short-term program, making it difficult to form a long-term mechanism.

Systemic solutions for precision marketing-driven agricultural transformation in Kazakhstan:

(1) Building digital agricultural infrastructure. Implement the "digital literacy" project and develop lightweight applications that fit the characteristics of pastoral areas, such as the cell phone information system based on the USSD protocol, which can cover 90% of farm households without relying on smartphones. Drawing on China's experience, we will improve the coverage rate of rural networks, laying the foundation for blockchain traceability. Build a cross-border agricultural big data platform between China and Kazakhstan, integrating 12 types of core data, such as climate, soil, market, etc., to improve the accuracy of planting decisions.

(2) Innovate production and management organization. Promote the "virtual agricultural cooperatives" model and integrate decentralized farmers through digital platforms. Establish a "digital credit" system, transforming IOT equipment usage data into a basis for credit ratings to solve financing problems. Developing "order agriculture + digital contract", utilizing smart contract technology to realize accurate docking between production and marketing and reducing the risk of default.

(3) Reshape the policy and market system. Establish a special fund for digital transformation and popularize smart agriculture technology. Create a "double-cycle" branding system: establish a regional public brand of "Green Grassland" internally and expand cross-border e-commerce by relying on the "Digital Silk Road" externally. Increase the proportion of processed agricultural products exported from Kazakhstan. Construction of Sino-Kazakh "digital twin" demonstration farms to reduce the cost of agricultural products through satellite remote sensing + drone inspection and other high-tech.

CONCLUSIONS

The core contradiction in Kazakhstan's agriculture is "abundant resources but inefficient system". Through digital reform, supply chain transparency and policy synergy, it is expected to break through the monopoly of middlemen and enhance competitiveness. China's experience in precision marketing and e-commerce to help farmers can provide an important reference, but it needs to be combined with localized adjustments (e.g., herders' cooperative model). If the reform is successful, Kazakhstan may become an essential supplier of high-value-added agricultural products in Eurasia. Taking the successful practice of precision marketing by Chinese agribusinesses as a reference, this paper systematically explores the feasible paths and challenges of Kazakhstan's agricultural modernization transformation. The study shows that precision marketing can not only significantly improve the economic efficiency of agribusiness but also promote the realization of sustainable development goals through data-driven resource allocation. China's experience shows that every 100 million yuan increase in selling expenses can lead to a 1.704 billion yuan increase in operating income, a high return feature highlighting the unique value of precision marketing in the agricultural sector. At the same time, precision marketing effectively promotes the synergistic development of environmental, social and governance (ESG) objectives by reducing resource wastage, optimizing supply chains and improving governance.

Despite its rich natural resources, Kazakhstan's agriculture has long faced systemic challenges such as structural imbalances, production inefficiencies and lack of digitization. Specifically, the share of agricultural output in GDP remains low, and primary agricultural products dominate exports, while high-value-added processed products depend on imports; the coverage of rural digital infrastructure is less than 30 per cent, and the small-farmer model of the economy restricts technological innovation; and the inefficiency in the implementation of policies and the imperfection of the market system has led to a high rate of distribution wastage. These structural contradictions have seriously hampered the process of agricultural modernization, and there is an urgent

need to achieve a breakthrough through innovative models.

Based on China's practice, this paper proposes a three-phase solution for the transformation of Kazakhstan's agriculture: focusing on the promotion of lightweight digital tools (e.g., mobile payment and e-commerce platforms) in the short term, the construction of an agricultural big data platform and blockchain traceability system in the medium term, and the improvement of the digital agricultural ecosystem in the long term. Key measures include reforming the subsidy mechanism and establishing special funds for digitalization, developing "virtual agricultural cooperatives" to enhance the organization of small farmers, building regional public brands, and expanding cross-border e-commerce channels. Of particular interest is the technological cooperation between China and Kazakhstan under the framework of the Digital Silk Road, such as the introduction of smart irrigation, drone inspection and other precision agricultural technologies to improve agricultural production efficiency.

The main contribution of this study is the first systematic construction of a theoretical framework of "precision marketing-digital transformation-sustainable development" applicable to Kazakhstan and the proposal of differentiated implementation paths. Future research could quantify the cost-benefit ratios of transformation for agribusinesses of different sizes, as well as the effectiveness of policy combinations. Overall, if Kazakhstan can effectively overcome the digital divide and improve the institutional environment, it has the potential to transform its resource advantages into industrial competitiveness and become an important supplier of high-value-added agricultural products in the Eurasian region. This transformation concerns Kazakhstan's agricultural development and provides an important reference for the modernization process of countries with similar resource endowments.

AUTHOR CONTRIBUTIONS

Conceptualization and theory: LY; research design: LY and WW; data collection: LY and WW; analysis and interpretation: LY; writing draft preparation: LY; supervision: LY and WW; correction of article: LY and WW; proofread and final approval of article: LY and WW. All authors have read and agreed to the published version of the manuscript.

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