

Building the First Cattle Market in the Yellow River Basin Utilizing the Bohai Black Cattle Brand: A Case Study of the Beef Cattle Market in Binzhou City

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Abstract Facing the severe decline in beef cattle market prices and leveraging its status as a major cattle-raising city, Binzhou City has actively utilized the superior genetic resources of Bohai Black Cattle. The city has progressively transitioned from small-scale cattle farming to specialized and large-scale breeding communities by collaborating with experts from national and provincial industrial technology systems including the Chinese Academy of Agricultural Sciences, Shandong Academy of Agricultural Sciences, and Shandong Agricultural University. The breeding focus has shifted from Simmental crossbred cattle to purebred Bohai Black Cattle, hybrid cattle, Angus Cattle, and Hereford Cattle, driving the transformation and upgrading of the beef cattle industry. Emphasizing "germplasm source security", Binzhou has capitalized on the unique advantages of Bohai Black Cattle to achieve doubling in quantity, quality, and profitability of high-grade beef cattle breeds. This initiative supports ecological conservation and high-quality development in the Yellow River Basin. A Qilu Model will be established for national modern animal husbandry, further strengthening Shandong's first beef market.

Key words Beef cattle industry; Bohai Black Cattle; Development strategy; Transformation and upgrading; Qilu model

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Due to the rapid decline in the price of milk, the concentrated entry of culled cows into the beef market, and the continuous decline in the price of imported beef, China's live cattle trading prices have dropped significantly since last year, with domestic beef prices falling noticeably, putting considerable pressure on the employees in the beef cattle industry^[1]. Consequently, China's beef cattle industry is transitioning from mass production of standard beef using weight-gaining breeds like Simmental and Limousin to high-grade differentiated beef production through Wagyu, Angus, and high-quality local breeds. This strategic shift focuses on developing differential specific-flavor beef for domestic market, establishing indigenous breed brands, and cultivating new high-end beef cattle strains, charting a distinctive development path combining local independent beef cattle brands serving as the mainstay with cultivation of new high-grade beef cattle strains. The Binzhou Animal Husbandry and Veterinary Management Service Center has proactively implemented management, guidance and service for the the entire life cycle from birth to the end of life and the whole industry chain, encompassing breeding and slaughtering, disease prevention and control and harmless disposal of dead livestock, regulated management of feed and veterinary inputs, and sustainable utilization of livestock waste. Binzhou City has effectively utilized the superior genetic resources of Bohai Black Cattle through active collaboration with national and provincial

beef cattle innovation teams including Chinese Academy of Agricultural Sciences, Shandong Academy of Agricultural Sciences and Shandong Agricultural University to systematically transform local beef production from smallholder farming to specialized farms and large-scale breeding communities while upgrading cattle breeds from Simmental crosses to purebred Bohai Black, hybrid cattle, Angus and Hereford breeds, aiming to achieve doubled growth in quantity, quality and economic returns for both improved breeds of Bohai Black Cattle and high-grade beef cattle and promote ecological conservation and high-quality development in the Yellow River Basin. On this basis, a nationally recognized Qilu Model will be established for modern animal husbandry, further solidifying Binzhou's position as Shandong's first beef market^[2].

Current Development Status of Binzhou's Beef Cattle Industry

In 2023, Binzhou City, Shandong Province maintained a beef cattle stock of 392 400 head, and 681 600 beef cattle were slaughtered. In the same year, its slaughter capacity reached 1.2 million beef cattle, and the number of beef cattle slaughtering enterprises and slaughter volume accounted for 30.51% and 43.76% of the province's total, respectively. With 500 000 t of beef distributed through cold chain logistics, Binzhou serves as a primary beef supplier to the Beijing–Tianjin–Hebei region, Yangtze River Delta, and Pearl River Delta clusters. Yangxin County in Binzhou City invested 720 million yuan to establish the Shandong (Yangxin) Cattle Intelligence Valley Industrial Park, promoting intensive development of the imported beef industry chain. On December 30, 2022, it officially passed the inspection by the General Administration of Customs, becoming a designated supervision site for imported meat with an annual processing and storage capacity of

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360 000 t of imported beef, approximately one sixth of the total annual imported beef in China^[3]. Animal husbandry has emerged as one of Binzhou's five 100-billion-yuan industrial clusters, with annual production of meat, eggs and milk reaching 983 600 t. The output value of the whole animal husbandry industry chain has reached 134.509 billion yuan.

The Bohai Black Cattle is China's only entirely black-coated yellow cattle breed and one of the four major black-coated cattle breeds in the world, with a breeding history spanning nearly 2 000 years. Known as the "Black Diamond" for its uniformly black hair, hooves, horns, and tongue along with superior meat quality, this breed was documented in the *Cattle Breeds in China* during the 1980s and included in *National Conservation List of Livestock and Poultry Genetic Resources* in 2000. Experts recognize it as an exceptionally valuable germplasm material^[4]. The beef of Bohai Black Cattle is tender and has a unique flavor characteristic of local cattle breeds. After fattening, it exhibits pronounced marbling, and the total amount of amino acids in its protein reaches 95.11%, of which essential amino acids (excluding tryptophan) account for 40.85%. The contents of essential amino acids (such as arginine) and polyunsaturated fatty acids (such as Ω -3) are higher than those of imported marbled beef, while the levels of trans-linoleic acid and α -linolenic acid are significantly lower than those of A3-grade imported marbled beef. It plays an important role in preventing cardiovascular diseases, promoting brain cell growth and development in infants, increasing muscle mass and strength, and improving exercise endurance^[5]. As a high-quality specialty livestock product, Bohai Black Cattle beef was designated as the exclusive beef for the 11th Asian Games in 1990. Wudi Huaxing Bohai Black Cattle Original Breed Farm (a national-level core breeding farm) in Shandong Province currently maintains a herd of 780 Bohai Black Cattle, including 350 basic cows, 16 breeding bulls, and 20 reserve bulls, with an annual production of over 20 000 frozen semen straws. In May 2014, it officially became the beef supply base for elite athletes at the Shandong Provincial Sports Training Center, currently supplying 30 t of Bohai Black Cattle beef annually at a price of 120 yuan/kg. In December 2020, at the first National China Cattle · High-quality Beef Tasting Conference, Bohai Black Cattle won the "Best Flavor Award" and the "Recommended Breed Award" for high-quality beef production.

Challenges and Issues in the Beef Cattle Industry

Price inversion in the beef market poses the greatest challenge to industry development

Since 2023, China's beef cattle and beef market prices have declined significantly, primarily due to weakening external demand, insufficient domestic demand, and coexistence of cyclical and structural issues. While domestic beef production capacity continues to grow steadily, the price of imported beef has remained low, leading to a further increase in annual import

volumes. Even during peak consumption seasons, market prices struggle to rise, resulting in a notable drop in domestic live cattle trading prices. Industry experts predict that the current market conditions in China's beef cattle industry will persist as a phased norm^[6].

Slow early growth of Bohai Black Cattle

The birth weight of Bohai Black Cattle calves ranges from 28–30 kg, and their weight at 12 months of age generally falls between 213 and 302 kg. Compared with imported beef cattle breeds such as Angus and Simmental, Bohai Black Cattle exhibit relatively lower birth weights and slower daily weight gain. However, the growth rate difference becomes less pronounced after 12 months of age. Therefore, it provides the main direction for the breeding and hybridization of Bohai Black Cattle in the future.

Low population quality of Bohai Black Cattle and small commercial hybrid population

Wudi Huaxing Bohai Black Cattle Original Breed Farm in Shandong Province is China's only breeding farm for Bohai Black Cattle, currently maintaining a herd of 780 purebred cattle. There are a total of 2 231 Bohai Black Cattle in the entire city. The beef is tender and has a unique local flavor. It shows superior marbling, and higher levels of amino acids, essential amino acids and polyunsaturated fatty acids compared with imported marbled beef. It also plays an important role in preventing cardiovascular diseases, promoting brain cell growth and development in infants and young children, growing muscles and enhancing muscle strength, and improving exercise endurance. However, due to the small commercial hybrid population and limited meat production after slaughter, its market share in the beef market is low, making it difficult to form a well-known brand.

Technical Paths and Measures for Beef Cattle Industry Development

Technical paths

Given the current population status of Bohai Black Cattle at Wudi Huaxing Bohai Black Cattle Original Breed Farm in Shandong Province, multi-omics technologies will be employed to eliminate existing exogenous gene contamination in the resource population. A purebred Bohai Black Cattle reference population will be established, followed by screening for specific genes associated with economically important traits such as growth rate, fat deposition, and meat quality (including flavor). A dedicated gene database for Bohai Black Cattle will be constructed. Phenotypic data from the purebred Bohai Black Cattle population will be systematically measured and collected to establish a comprehensive phenotypic database. The integration of genomic and phenomic datasets will facilitate correlation analyses aimed at identifying novel germplasm resources with distinctive Bohai Black Cattle characteristics. Subsequent fattening trials conducted on newly identified germplasm populations will enable the selection of superior individuals with accelerated growth rates and enhanced meat quality, thereby validating the production performance of new Bohai Black

Cattle germplasm populations.

An integrated technological system incorporating synchronized estrus, superovulation, embryo transfer and *in-vitro* embryo production techniques will be established. High-quality purebred Bohai Black Cattle populations along with Simmental, Hereford and Angus cattle herds within Binzhou City will be systematically selected for embryo transfer programs to rapidly expand the Bohai Black Cattle resource population and optimize its breeding system. Concurrently, The hybridization and improvement of Bohai Black Cattle will be carried out to enhance their production performance, achieve efficient breeding, and lay a foundation for the promotion and application of characteristic new germplasms.

Population doubling paths

Leveraging the technical expertise of the provincial industrial technology system's cattle innovation team and building upon the core population of Bohai Black Cattle at Wudi Huaxing Bohai Black Cattle Original Breed Farm in Shandong Province, 5 – 10 breeding cow farms across the city can be selected to implement purebred embryo transfer and crossbreeding programs for Bohai Black Cattle. The expansion and breeding process of Bohai Black Cattle will be accelerated by employing advanced biotechnologies such as genetic testing, leading to a doubling improvement in both the quantity and quality of the core population, as well as the production-scale hybrid Bohai Black Cattle herds for functional beef.

The national subsidy policy for beef cattle basic cow herd expansion and quality improvement will be fully leveraged through a seven-in-one integrated model involving "leading enterprises (conservation enterprises) + breeding cooperatives + farmers + banks + agricultural guarantee + insurance + digital technology". This comprehensive approach will facilitate the widespread adoption of the "breeding cows and raising calves" model among farming households, effectively addressing multiple challenges including financing difficulties, high capital costs, lack of sales channels and technologies, and significant risks in cattle farming. Meanwhile, this initiative will pioneer a new path for industrial transformation and upgrading towards high-quality marbled beef production, which will achieve the goals of creating sustainable mechanisms for increasing farmers' income, promoting rural revitalization, and achieving common prosperity.

Production and extension models

Quality improvement and population expansion of Bohai Black Cattle In collaboration with the Shandong Academy of Agricultural Sciences, experts from the provincial industrial technology system's cattle innovation team will be stationed at the Wudi Huaxing Bohai Black Cattle Original Breed Farm. Multi-omics technologies will be employed to conduct biological assessments of the population to eliminate individuals exhibiting exogenous gene contamination from the Bohai Black Cattle resource population, so as to establish a purebred reference population. Synchronized estrus, superovulation, embryo transfer and *in-vitro* embryo production technologies will be implemented concurrently to select high-quality breeding cow populations of Bohai Black Cattle, Luxi

Yellow Cattle, Simmental, Hereford and Angus Cattle in Wudi County and Binzhou City for embryo transfer programs, which will accelerate the expansion of the Bohai Black Cattle resource population while optimizing the breeding system of Bohai Black Cattle. Concurrently, crossbreeding improvement will be implemented to enhance the production performance of Bohai Black Cattle and achieve efficient population expansion of Bohai Black Cattle. Selected individuals with unstable genetic traits from the Bohai Black Cattle population and crossbred cattle will undergo a continuous fattening process aimed at producing specialty functional beef. The Bohai Black Cattle population doubling plan will be implemented to expand market share and further enhance the brand value of Bohai Black Cattle.

Development and expansion of the new Lumeng Black Cattle strain

Yangxin Yiliyuan Halal Meat Co., Ltd. has established China's first 5G-enabled smart ranch for high-quality beef cattle equipped with comprehensive facilities including a central kitchen, 5G base stations, intelligent ranch management systems, video surveillance, environmental control equipment, cattle brushes, livestock fans, and warm water troughs. The ranch currently maintains approximately 5 000 head of high-end beef cattle, within a 12 000 m² organic fertilizer workshop capable of producing 10 000 t annually. Through integration with world-class digital processing plants and cold chain logistics systems, a comprehensive digitalized ecosystem covering from breeding to consumption has been established. Yangxin Yiliyuan Company has been officially designated by the Ministry of Agriculture and Rural Affairs as Shandong Province's sole national standardized demonstration base for modern agricultural whole-industrial-chain development.

Leveraging the remote industrial cooperation opportunity of the poverty alleviation program "Niu Wenzhang" in Inner Mongolia's Horqin Right Wing Middle Banner supported by the Publicity Department of the Communist Party of China, and fully utilizing national support policies including "Beef Cattle Basic Cow Herd Expansion and Quality Improvement", "Grain-to-Feed Conversion", "Pastoral Area Livestock Breeding Subsidy", "Grassland Ecological Protection Reward", and "Pastoral Animal Husbandry Transformation and Upgrading", the company established Inner Mongolia Lumeng Black Cattle Technology Development Co., Ltd. Through the seven-in-one "Breeding Cows and Raising Calves, Northern Breeding – Southern Rearing" model, the company integrated the dominant genes of Bohai Black Cattle, Angus Cattle, and Australian Wagyu, and developed China's new high-end beef cattle strain, Lumeng Black Cattle, by organically combining conventional breeding with modern molecular breeding techniques. Further, high-end organic beef with independent intellectual property rights was produced, achieving a new breakthrough in high-end beef cattle germplasm resources. Within 2 – 3 years, Binzhou's Yangxin County and Inner Mongolia's Horqin Right Wing Middle Banner successfully established a 10 000-head Lumeng Black Cattle breeding base. This initiative doubled the quality and economic returns of beef cattle in both regions, effectively

increasing incomes for local farmers and herders. It also stimulated development in related industries including transportation, forage cultivation, and beef processing across surrounding areas, contributing to rural revitalization and advancing common prosperity.

Breeding and crossbreeding of Hereford and Angus Cattle Shandong (Boxing) Modern Animal Husbandry Technology Co., Ltd. has imported 2 100 purebred Hereford breeding cows and 500 Angus breeding cows from overseas for purebred breeding of Hereford and Angus Cattle, as well as crossbreeding of Hereford with Fleckvieh Cattle for fattening purposes. The company has successfully established a technical service cooperation agreement with the Institute of Animal Science and Veterinary Medicine of Shandong Academy of Agricultural Sciences. Through on-site guidance from provincial agricultural experts and the deployment of university interns, the company has implemented body condition scoring for its Hereford herd. Following rational grouping based on age and physiological stages, first, the company has prioritized research on efficient beef cattle reproduction technologies. The company will implement synchronized estrus, artificial insemination, and embryo transfer technologies while introducing frozen semen from superior breeding bulls. High-quality individuals will be selected to establish core breeding herds, and standardized reproductive management protocols for breeding cows will be developed. Archive management will be improved, and comprehensive calf care technical specifications will be formulated to enhance calf survival rates. Second, precision feeding technologies will be implemented. Customized feed formulations will be developed according to the physiological stages of grouped breeding cows. Stage-specific precision feeding techniques will be investigated based on the growth characteristics and nutritional requirements of fattening cattle at different development stages. Thirdly, comprehensive disease prevention and control technologies for beef cattle will be studied. Routine disinfection protocols for cattle farms will be established, along with annual vaccination plans targeting major infectious diseases such as foot-and-mouth disease and bovine ephemeral fever. The quarantine inspection and isolated observation system for cattle import and export will be improved, forming an integrated bovine disease prevention and control technical framework. Fourthly, targeted commercial and industrial development will be conducted for Hereford and Angus Cattle to produce high-quality differentiated and flavor-enhanced beef products. This initiative will accelerate brand development for high-end Hereford and Angus beef.

Specialized fattening of Angus and Simmental Cattle Support will be provided to Binzhou Mingsheng Animal Husbandry Co., Ltd., Huimin Yulong Animal Husbandry Company, and Yangxin Huayang Group Shangdian Livestock Breeding Co., Ltd. for developing specialized Angus and Black Cattle fattening operations. These enterprises will focus on producing high-grade marbled beef products to supply high-end beef markets in China's first-tier cities including Beijing, Shanghai, Guangzhou, and

Shenzhen.

Shandong (Zouping) Herun Animal Husbandry Development Co., Ltd. and Shandong (Zouping) Junhui Agriculture and Animal Husbandry Development Co., Ltd. will be encouraged to utilize corn oil residue powder from Xiwang Group as feed material for fattening beef cattle, adopting a cost-saving contract farming model for Simmental Cattle. Enterprises including Yangxin Huasheng Group, Yangxin Huayang Halal Meat Co., Ltd., Yangxin Xinyuan Halal Meat Co., Ltd., Yangxin Fuan Halal Meat Co., Ltd., Shandong (Yangxin) Jiejian Cattle Industry Development Co., Ltd. and Yangxin Wanbang Halal Meat Co., Ltd. will develop integrated industrial chains focusing on Simmental Cattle fattening, slaughtering, processing and chilled meat distribution. The standardized breeding communities in Liupowu Town and Wendian Town of Yangxin County, as well as the Wuying breeding community in Wudi County, are gradually shifting from the primarily fattening model of weight-gaining Simmental cattle breeds to the breeding development mode of characteristic meat-type cattle such as hybrid Bohai Black Cattle, hybrid Hereford Cattle, and contract farming Lumeng Black Cattle. This adjustment aims to effectively mitigate the market risks caused by price inversion in the beef cattle industry and ensure stable income for breeders.

Establishing an imported beef processing and distributing center Yangxin County in Binzhou City has developed the Shandong (Yangxin) Beef Intelligence Valley Industrial Park, which has been approved by the General Administration of Customs and officially became the designated supervision site for imported meat on December 30, 2022. Pursuing an integrated development model combining breeding, farming and processing with convergence across primary, secondary and tertiary industries, Yangxin County has nurtured 39 national and provincial-level agricultural industrialization leaders and 437 SC-certified beef processing enterprises. The county has an annual slaughter capacity of 1.2 million cattle, and a storage capacity of 360 000 t of processed imported beef, accounting for about 1/6 of the total annual imported beef in the country. The "slaughter scale of beef cattle", "quantity of imported beef" and "number of processing enterprises" rank first at the county level in China. Yangxin County has cultivated one China famous brand, one well-known Chinese trademark, one China time-honored brand enterprise, and six organic product certifications, and two vice-chairman units of the Cattle Branch of China Animal Agriculture Association. In 2019, "Yangxin Beef" won geographical indication certification and received the "China Brand Agriculture Shennong Award". According to evaluations released by the National Agricultural Market Research Center, the regional public brand value of "Yangxin Beef" has reached 21.026 billion yuan.

The Shandong (Yangxin) Beef Intelligence Valley Industrial Park serves as the pioneering and leading zone for Binzhou's beef cattle industry development. Its designated customs supervision site for imported meat has implemented a streamlined clearance system featuring "single declaration, single inspection, and single

release", reducing clearance time to 7 d (a 67% improvement) and generating annual cost savings of 36 million yuan. According to incomplete statistics, Yangxin County processed 360 000 t of imported beef valued at 18 billion yuan in 2022. With all customs clearance procedures and payments conducted through Yangxin Port, all the foreign trade quota of 18 billion yuan will be left within Yangxin, making substantial contributions to Binzhou's economy.

Promoting the "Bincai Fencheng" regional public brand for beef prepared foods Key support will be provided to strengthen the beef prepared food industry through enterprises including Yangxin Yiliyuan Halal Food Co., Ltd., Shandong Yangxin Guangfu Livestock Products Co., Ltd., Yangxin Huayang Group Co., Ltd., Shandong Fuan Halal Food Group Co., Ltd., and Wudi Huaxing Bohai Black Cattle Breed Industry Co., Ltd. The "Home-style Steak" of Yiliyuan received China's Beef Product Innovation Award, while its "Braised Beef" was honored among Shandong's first batch of "Qilu Famous Dishes". The "Dongpo Beef Steak" of Yiliyuan served as the fifth course in the state banquet of G20 Summit in Hangzhou City. Hong'an "Beef Ribs" became the designated supplier for the SCO Summit in Qingdao. Huayang "Beef Dumplings" were selected for the Most Popular New Product Award at China International Food and Drink Exhibition. Fuan Company has comprehensively developed two major beef prepared food brands, "Niuxianniu" and "Zhaofu", launched over 80 products in five categories: chilled marinated meats, bone-broth stews, ready-to-eat low-fat options, ready-to-eat rice mixes, and yak meat products. Adopting a combined offline and online sales model, the company successfully transitioned from B2B to B2C mode, achieving high-quality development in county-level prepared food industry and contributing to building the "Capital of Chinese Beef Prepared Foods". Binzhou City has successively issued *Opinions on Accelerating High-Quality Development of the Prepared Food Industry*, dedicating efforts to establish the "Bincai Fencheng" regional public brand for prepared foods. There are currently 490 enterprises engaged in deep processing of meat products and prepared food production in the city, with an annual output reaching 1.25 million t and production value amounting to 15.2 billion yuan.

Industrial Development Goals

Binzhou City will undergo 3–5 years of continuous structural

adjustment in its beef cattle industry, persistently following the specialized, refined and distinctive industrial development path. By 2030, the city will achieve 2 000 purebred Bohai Black Cattle, 5 000 crossbred cattle in inventory, and 2 000 crossbred Bohai Black Cattle for slaughter, with an annual production of 1 300 t of beef with special functions, which will be mainly used as protein-rich food primarily for athletes supplying to national and provincial sports centers. The development plan aims to achieve annual breeding of 10 000 Lumeng Black Cattle with 15 000 commercial-generation Lumeng Black Cattle ready for slaughter, producing 6 500 t of high-grade marbled beef annually, while establishing a core Lumeng Black Cattle population of 2 000 head. It also targets an annual production of 3 200 t of quality-differentiated and flavor-enhanced beef from meat-type breeds including Angus and Hereford Cattle. The city will develop contract farming and integrated industrial chain enterprise operations for growth-type Simmental cattle breeds to produce 130 000 t of conventional beef annually, while achieving 360 000 t of imported beef processing capacity through Yangxin's designated customs supervision site for imported meat. The city will establish a national-level pioneer zone for the Yellow River beef cattle industry belt, create a national distribution hub for high-grade marbled beef and quality-differentiated flavor beef, and achieve dual domestic-international circulation. A Qilu Model for modern animal husbandry nationwide will be built, further solidifying the first beef cattle market in the Yellow River basin^[2].

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