

# Present Situation Analysis and High-quality Development Countermeasures of Wadi Sheep Industry in Lubei Region

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**Abstract** This paper systematically analyzed the development status of sheep industry in Lubei region, and comprehensively expounded the scale and distribution of key industries, breed resources and genetic characteristics, feeding management status, disease prevention and control and veterinary services, and sheep product processing and sales. The research shows that the sheep industry in Lubei region has formed a certain scale, but there are some problems such as intensified resource and environmental constraints, unreasonable industrial structure, insufficient scientific and technological innovation capacity and market competitiveness to be improved. In view of these problems, this paper put forward some countermeasures and suggestions to promote the high-quality development of the industry, including establishing forage and feed system, promoting the adjustment and optimization of industrial structure, strengthening scientific and technological innovation and talent cultivation and introduction, and enhancing brand influence and market competitiveness, providing useful reference for the sustainable development of sheep industry in Lubei region.

**Key words** Wadi Sheep; Industrial status quo; High quality; Development countermeasures; Prospect

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As an important agricultural region in Shandong Province, Lubei region has always carried important agricultural production tasks and played an important role in agricultural production for a long time. In the early years, the sheep industry, as an important part of Lubei region, not only occupied an important position in local agricultural economy, but also had an important impact on the development of sheep industry in China. However, with the intensification of market competition and changes in the breeding environment, the sheep industry in Lubei region is facing many challenges and problems<sup>[1-2]</sup>.

The core goal of this study was to deeply analyze the present situation of Wadi sheep industry in Lubei region, explore its problems in production, market and technology, and then put forward effective development countermeasures to promote the sustainable and healthy development of the industry<sup>[3-4]</sup>.

## Research Methods and Data Sources

Qualitative and quantitative research methods were adopted, including literature review, field investigation, questionnaire survey and data analysis. The research results and relevant literature on the Wadi sheep industry at home and abroad were reviewed to

comprehensively grasp the development history, current situation, and future trends of sheep industry in Lubei region. The literature sources include academic journals, government reports and statistics of trade associations. First-hand data on sheep farms, processing enterprises, and sales markets in Lubei region including breeding stock, production output, breeds, feed sources and farmers' breeding techniques and management models were obtained by conducting on-site inspections, interviews and observations. Questionnaires were designed for farmers and processing enterprises, and data were collected in various ways to understand their production scale, market situation, policy support and other information. The collected data were sorted out and analyzed by using the theory of statistics and economics, and the present situation, problems and future trends of industrial development were evaluated. Finally, feasible suggestions were provided for farmers and processing enterprises.

## Analysis on Present Situation of Wadi Sheep Industry in Lubei Region

### Industrial scale and distribution

Wadi sheep is a characteristic local breed in the Yellow River Delta region of Lubei Plain. It is mainly distributed in saline-alkali areas in Binzhou, Dongying, Dezhou and Shanghe County of Jinan. It is an excellent local breed having long-term adaptability to grazing in swampy land, with good meat performance, roughage tolerance and disease resistance. According to historical records, Wadi sheep were first crossbred from Inner Mongolian sheep and Arab sheep over 600 years ago. After hundreds of years of

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artificial breeding, compared with hundreds of sheep breeds at home and abroad, Wadi sheep have the advantages of dual use of meat and skin, delicious meat, early sexual maturity, multiple gestation, four nipples, both grazing and house feeding, good sheepskin, no horns, etc. It is a rare high-quality sheep breed in local area<sup>[5-6]</sup>.

However, in recent ten years, the introduction of exotic breeds and inbreeding have led to a sharp decline in Wadi sheep population. In 1997, the number of ewes of Wadi sheep was about 1.5 million. As the local people often say: "Two sheep per capita lead a well-off life". In 2006, the number of sheep population decreased to 400 000. In 2021, the third national census of livestock and poultry genetic resources showed that there were only about 50 000 sheep left. In recent two years, it has attracted great attention from government departments, increased protection by scientific research institutions and rapid injection of social funds, which has led to the recovery of breeding scale. The protection of original breed and economic benefits have been strengthened and increased year by year. Two original breed farms of Wadi sheep have been gradually established, and a national demonstration garden and 100 standardized farms have been created. Moreover, 210 large-scale breeding households have been cultivated, driving more than 1 800 farmers, and two mutton sheep slaughtering and processing plants have been set up.

#### **Breed resources and genetic characteristics**

In 1999, Wadi sheep was listed in the *Protection List of Livestock and Poultry Genetic Resources in Shandong Province* and the *National List of Livestock and Poultry Genetic Resources in China (Sheep)*. In 2019, Shandong Binzhou Animal Science & Veterinary Medicine Institute and other units took the lead in formulating the national standard GB/T 37310-2019 *Wadi Sheep*, which provides a standardized basis for breed protection, development and utilization. In recent years, through molecular breeding techniques, a new line of multiparous Wadi sheep has been bred. The lambing rate of primiparous ewes reaches 24.4%, and that of multiparous ewes reaches 300%. Moreover, the average weight of 6-month-old male lambs reaches  $(32.40 \pm 7.20)$  kg, and the dressing percentage is 53%, and the pure meat rate reaches 36.5%. Their economic value is significantly improved. Wadi sheep has become the preferred breed for the development of modern animal husbandry because of its advantages of high reproduction rate, strong resistance and dual use of meat and skin. At present, the breed has been extended to more than ten provinces and regions such as Xinjiang, Qinghai and Gansu, showing good adaptability and economic benefits. Especially in Xinjiang, Wadi sheep have withstood the test of severe cold at  $-40^{\circ}\text{C}$ , with a survival rate of over 93% and a reproductive rate of over 260% for multiparous ewes, becoming an important breed in local Wadi sheep industry.

#### **Current situation of feeding management**

In order to meet the nutritional needs of sheep, the feeding method of Wadi sheep in northern Shandong Province is mainly

grassland grazing, supplemented by supplementary feeding. In recent years, some farms have begun to adopt the method of house feeding, which improves the feeding efficiency by controlling environmental factors. However, due to farmers' uneven technical level, there are many problems in feeding management, such as unreasonable feed ratio and untimely disease prevention, which seriously affect the growth and reproductive efficiency of sheep. Therefore, strengthening farmers' technical training and promotion and improving the level of scientific breeding have become an urgent problem to be solved.

#### **Prevention and control of epidemic diseases and veterinary services**

Disease prevention and control and veterinary services are important guarantees for the healthy development of Wadi sheep industry in Lubei region. At present, prevention and control systems such as vaccination, epidemic monitoring and emergency response have been established in this region, but there are still problems such as nonstandard vaccine use and imperfect monitoring system. In terms of veterinary services, the quality of veterinary teams in some areas is not high, and it is difficult to guarantee the service quality. Therefore, it is suggested to strengthen the training of vaccine management and use, improve the disease monitoring system and enhance the professional level of veterinary team, so as to provide better services for farmers.

#### **Processing and marketing of Wadi sheep products**

The processing and sales of sheep products in Lubei region are diverse, including slaughtering, cutting and curing, but the backward processing techniques and poor equipment in some areas have affected the product quality and market competitiveness. In terms of sales, although the products are sold to local and surrounding markets, the market share is low due to insufficient brand building and limited sales channels. In the future, it is necessary to strengthen the upgrading of processing techniques and brand building, expand new sales channels such as e-commerce platforms, and enhance the added value and market competitiveness of products.

### **Problems and Challenges Faced by High-quality Development**

#### **Intensified resource and environmental constraints**

**Wadi sheep industry in Lubei region is facing increasingly severe resource and environmental constraints** These constraints mainly come from the limitation of natural forage resources and the increase of the cost of special forage, which poses a serious challenge to the sustainable development of Wadi sheep industry. The limited forage resources are a major bottleneck in the development of Wadi sheep industry in Lubei region. The resources of grass industry in this region are relatively scarce, so it is difficult to meet the needs of sustainable development of Wadi sheep industry. With the increase of the number of sheep, the bearing pressure of grass industry is increasing day by day, which leads to

the over-utilization and degradation of grass industry resources and limits the development space of Wadi sheep industry<sup>[7]</sup>.

**The climatic factor is also an important factor restricting the development of Wadi sheep industry in Lubei region** The dry climate and little rainfall in this region are not conducive to the growth of grass industry and sheep breeding. Drought and grassland degradation lead to insufficient feed supply for sheep, which makes the production performance of sheep decline.

#### **Unreasonable industrial structure**

##### **Single breed structure and weak resistance to industrial risks**

There is mainly one or several sheep breeds in Lubei region, and such highly concentrated breed structure leads to weak resistance to industrial risk. Once the market demand changes or encounters disasters such as diseases, the whole industry will face great risks. Diversified development of product structure and improvement of the industry's resistance to risks are urgent problems to be solved in the development of Wadi sheep industry in Lubei region.

**Short industrial chain and poor industrial benefit** For the Wadi sheep industry in Lubei region, the breeding links occupy a large proportion, while the deep processing and brand building links are relatively weak. It leads to low added value of products and low industrial benefits. Meanwhile, due to the short industrial chain, farmers are often in a passive position in the face of market fluctuations and cannot effectively resist market risks. Therefore, extending the industrial chain, strengthening deep processing and brand building and improving the added value of products are the keys to improve the industrial benefits of Wadi sheep industry in Lubei region.

**Unbalanced industrial structure and lagging development of related industries** The breeding link in the Wadi sheep industry in Lubei region is not coordinated with the development of related industries such as grass industry and feed industry. The development of related industries lags behind, and farmers can't get market information and technical support in time, which further restricts the development of industries. Optimizing the industrial structure and promoting the coordinated development of related industries is an important direction for the development of Wadi sheep industry in Lubei region.

##### **Insufficient scientific and technological innovation capacity**

In the Wadi sheep industry in Lubei region, the lack of scientific and technological innovation capacity is an important factor restricting its further development. Although this area has a long history and rich experience in sheep breeding, there is still room for further improvement in technological innovation.

(1) Talent cultivation is another bottleneck of technological innovation of Wadi sheep industry in Lubei region. At present, there is a lack of professional Wadi sheep industry leaders in this region, which makes scientific and technological innovation lack strong support. As a result, it is difficult to form scientific and technological achievements and transform them into actual produc-

tive forces.

(2) Insufficient capital investment makes it difficult to effectively support scientific and technological innovation activities, which leads to insufficient research and development motivation of scientific research institutions and enterprises, resulting in difficult formation of a virtuous circle of scientific and technological innovation.

The Wadi sheep industry in Lubei region needs to strengthen scientific and technological innovation, and the level of industrial science and technology should be further improved to promote the sustainable development of Wadi sheep industry.

#### **To-be-improved market competitiveness**

Uneven product quality, lagging brand building and limited market development have weakened the market competitiveness of sheep products in Lubei region.

**Product quality problems** There are great differences in sheep breeding methods and management levels in this region, which directly leads to the quality differences of sheep products.

**Lagging brand building** Although this region is rich in sheep resources and the breeding environment is good, it lacks well-known sheep product brands. Meanwhile, due to the lack of brand support, it is difficult for sheep products in this region to form a brand effect in the market and gain consumers' trust and recognition.

**Limited market development** The region lacks effective means of market development and cannot push sheep products to a broader market. Most sheep products in this region are mainly sold through traditional channels, such as farmers' markets and wholesale markets. The sales scope of these channels is limited and it is difficult to achieve large-scale sales.

## **Research on High-quality Development Countermeasures**

### **Establishing a forage system and reducing the impact of resource and environmental constraints**

It is necessary to expand the production scale of high-quality forage, further promote the implementation of the national project of changing grain to forage and the demonstration construction project of high-yield and high-quality alfalfa, and accelerate the adjustment of planting structure and the development of modern forage industry. The measures such as expanding the planting area of high-quality forage materials including corn and rice for both grain and feed, popularizing silage techniques including cellar storage, bag storage and wrapping and business models including formula fertilization and water and fertilizer integration techniques and improving the socialized service system of "planting, managing, harvesting, storing and transporting" forage can be taken. Socialized service organizations of forage grass should be strengthened to guide the establishment of a number of socialized service organizations that "collect, process, store, transport and sell" forage grass on a large scale, so as to promote the effective docking of

production and marketing. The planting area of high-quality forage grass such as silage corn should be expanded. The processing techniques of green (yellow) straw silage and microbial ensilage should be popularized to improve the use efficiency of straw such as peanut, corn and wheat straw<sup>[8-9]</sup>.

### **Promoting the adjustment, optimization and upgrading of industrial structure and improving the mutton sheep slaughtering and processing system of Wadi sheep**

**Extending industrial chain** At present, the Wadi sheep industry in Lubei region mainly focuses on the production and sales of primary products such as wool and mutton, with short industrial chain and low added value. Enterprises should be encouraged to increase investment in science and technology, develop deep processing industries, such as wool textile, wool products and mutton processing, and increase the added value of products. The industrial chain should be extended to feed planting, culture waste treatment and other fields to form a complete closed-loop industrial chain and improve resource utilization.

**Optimizing industrial structure** The Wadi sheep industry in Lubei region should be gradually transformed to high-end and intelligent direction. While reducing the production proportion of traditional products with low added value, we will increase the production proportion of products with high added value such as high-quality breeding sheep and high-end mutton. We can improve production efficiency and product quality and enhance market competitiveness by introducing advanced techniques and management experience. Characteristic industries such as wool artworks and special mutton catering can also be developed to broaden the road of industrial development.

**Strengthening industrial integration** The integrated development of Wadi sheep industry and related industries in Lubei region is an important way to realize industrial upgrading. We can promote the diversified development of Wadi sheep industry through deep integration with tourism, culture, science and technology and other industries. For example, rural tourism can be developed to let tourists experience agricultural activities such as raising sheep and shearing wool. Sheep-themed tourist souvenirs can be developed to increase the added value of products. We should ponder over the words "local specialty", seek benefits from the integration of the first, second and third industries, and drive local leading dairy enterprises to develop internationally. It is necessary to promote Binzhou Zhongyu Food Industry Co., Ltd. and Shandong Binzhou Animal Science & Veterinary Medicine Institute to jointly build Binzhou Dairy Laboratory, and promote scientific and technological cooperation between the laboratory and Shandong Jiuniu Agriculture and Animal Husbandry Technology Co., Ltd. to develop new products and supply them to the local market and even all parts of the country.

**Perfecting the mutton sheep slaughtering and processing system of Wadi sheep** It is necessary to improve the equipment level of central kitchen infrastructure and processing facilities, and

further enhance the mutton sheep processing capacity of Wadi sheep. Standardized slaughtering and segmentation of mutton sheep should be promoted. The production processes such as slaughtering, cutting, acid removal and cold preservation should be improved, and the facilities and equipment such as mutton cutting and processing, refrigeration and cold chain distribution facilities should be completed. We should also improve the technical conditions of mutton quality inspection, harmless treatment and laboratory testing facilities, develop special mutton products, and extend the industrial chain, so as to continuously improve the output, quality and efficiency of mutton products. Existing designated slaughterhouses should be standardized and integrated, and standardized, mechanized and automated slaughterhouses should be established to accelerate the transformation and upgrading of slaughter processing industry. We should vigorously develop the deep processing of mutton. New techniques, new processes and new equipment can be adopted to upgrade existing meat processing production lines and build central kitchens. The focus will be put on developing prefabricated mutton dishes such as mutton soup, mutton shashlik and roasted whole sheep to enrich and innovate the varieties of prefabricated dishes. Deep processing bases should be built for high-quality mutton. It is necessary to promote intensive production of mutton sheep processing and improve the level of industrialization and standardization, so as to reduce costs and increase efficiency, and the value chain can be upgraded with the model of "semi-finished products in central kitchen + omni-channel sales to end users". We should promote the comprehensive utilization of by-products. It is necessary to make full use of sheep bones, blood, casings and internal organs and realize the integration and interest linkage of by-product resources. The focus will be put on developing catgut, high-end skincare products (such as sheep placenta extract and collagen), bone soup powder, hydrolyzed compound protein seasoning, bone oil, bone powder, serum, casings, sheep placentae and sheepskin to improve the comprehensive utilization level of meat processing by-products.

### **Strengthening scientific and technological innovation and talent cultivation and introduction and promoting the development of new quality productivity of Wadi sheep industry**

Under the background of increasingly fierce global scientific and technological competition, scientific and technological innovation has become a key force to promote the development of Wadi sheep industry in Lubei region. In order to achieve this goal, we must strengthen scientific and technological innovation and talent cultivation and introduction, and provide strong scientific and technological support and talent guarantee for the Wadi sheep industry in Lubei region. In order to cultivate high-quality talents that meet the needs of the development of Wadi sheep industry in Lubei region, we should strengthen the cultivation and introduction of talents. We should actively introduce outstanding external talents, and attract more high-level talents to join the Wadi sheep industry in Lubei region through talent introduction, cooperation

and exchange.

(1) Through the "Double Hundred Foreign Expert Project" of Shandong Province, professors from Kazakh National Agrarian University and Kazakhstan Institute of Animal Husbandry and Forage Production, as well as researcher Andrew, winner of Qilu Friendship Award in 2022 and academician of Canadian Academy of Health Sciences, were introduced to develop series of products such as cheese, yogurt, pure milk and school milk with reference to foreign experience.

(2) Relying on Binzhou Key Laboratory of Zoonosis, Shandong Provincial Sheep Research System Disease Prevention Post Expert, Binzhou Sheep Industry Service Group of Shandong Provincial Science and Technology Commissioner Innovation and Entrepreneurship Community and other platforms, we will establish comprehensive disease prevention and control techniques guided by differential detection techniques, with disinfection and deworming, combined vaccination and "Chinese veterinary drugs + functional feed additives" as the core, and guide sheep farms to carry out application demonstrations of important infectious disease prevention and control technique products. It will provide technical support and material guarantee for promoting the green, low-carbon and sustainable development of Wadi sheep industry.

(3) The development of new quality productivity in Wadi sheep industry should be further enhanced by introducing and cultivating talents. A three-level breeding system of core original population, improved breed breeding group and production group of multiparous polytocous Wadi mutton sheep, so as to increase selection strength and fix excellent traits. Identification standards and grading indexes should be established from appearance characteristics, genetic stability, growth traits, dressing percentage, carcass weight, meat quality, lambing rate and adaptability. Prolificacy gene *FecB* can be utilized to improve prolificacy genes in multiparous polytocous Wadi sheep, and sheep with high prolificacy gened can thus be bred<sup>[10-11]</sup>. furthermore, external blood can be introduced to improve meat production performance. Excellent mutton sheep breed Dorper can be introduced and cross with Wadi sheep to improve meat yield, and standardized fattening can be carried out using the Duwa F<sub>1</sub> generation. Research and integrated demonstration can be conducted on key commercialization technologies. Artificial insemination techniques, frozen semen conditions and sperm transportation conditions can be further optimized to promote the utilization of excellent germplasm resources and better preserve excellent genes<sup>[12-14]</sup>. It is of great significance to explore a set of fattening mode suitable for the Duwa F<sub>1</sub> generation for commercial production of this breed.

**Enhancing the brand influence of Wadi sheep and improving the market competitiveness of mutton products**

**Paying attention to brand building and the promotion of market competitiveness** Brand building is the foundation of industrial development, and the promotion of market competitiveness is the key to industrial development. First, we should cultivate the

industrial brand of Wadi mutton sheep and the famous brand of mutton, and build the technical support for high-quality development of key brands. It is necessary to expand the brand effect to all aspects of the whole industrial chain covering breeding, slaughtering, deep processing and sales, and fully tap product value and enhance the premium capacity. Enterprises and farmers should be guided to share and create characteristic brands of agricultural products, well cultivate pure natural, pollution-free green organic brands, and build brand gene culture. When promoting brand building and dissemination, the focus should be put on such five elements as origin, quality, scale, market and brand, and the capacity of continuous batch supply should be continuously improved<sup>[15]</sup>. Second, the dairy brand strategy should be implemented to regain the registered trademark rights of the 40-year-old brands of "Binlian" and "Aonate" and give the products strong vitality. We will gradually promote the entry of local dairy industry brands into campuses by selecting a group of kindergartens, primary schools and middle schools or actively entering some vocational colleges and universities through the Municipal Education Bureau.

**Vigorously expanding market share** Market share is an important index to measure industrial competitiveness. The Wadi sheep industry in Lubei region can expand its market share in many ways. In particular, it is necessary to strengthen the construction of marketing channels and expand the sales channels and coverage of products by combining online and offline methods. Meanwhile, cooperation with large buyers and processing enterprises should be strengthened to establish a stable supply chain and sales network. The visibility and exposure of products can also be improved by participating in exhibitions, promotion conferences and other activities, so as to attract more potential customers and partners. It is necessary to improve the brand marketing system of mutton sheep. Led by the local government, leading enterprises, farmers' cooperatives, family farms, village collective cooperative economic organizations and other new business entities can carry out the construction of public brands of Wadi sheep meat and increase the publicity of mutton sheep brands through "Qilu Agricultural Supermarket", fairs, trade fairs and other platforms, as well as live-streaming e-commerce and other forms.

## Research Prospect

For the future development of Wadi sheep industry in Lubei region, attention should be paid to the improvement of breeding standardization, breed improvement and propagation, upstream and downstream integration of industrial chain and policy support and supervision.

**Strengthening the construction of breeding standardization**

On existing basis, advanced breeding techniques and management experience should be further popularized, and more detailed breeding standards should be formulated, including breeding environment, feed ratio, and disease prevention and control.

Through standardized breeding, the survival rate and production efficiency of sheep in Lubei region can be effectively improved, and the breeding cost can be reduced, thus improving breeding efficiency.

Enhancing breed improvement and breeding

Combined with market demand and resource advantages, we should strengthen the breeding and popularization of excellent breeds to improve the growth performance and meat quality of sheep in Lubei region. Meanwhile, we should also pay attention to the introduction and cultivation of breeding sheep. New breeds that meet the market demand can be bred by introducing excellent breeding sheep at home and abroad and crossbreeding and improving them, providing strong support for industrial development.

Deepening the integration of upstream and downstream enterprises in the industrial chain

The cooperation and integration between the upstream and downstream enterprises in the industrial chain should be strengthened to form a close industrial chain. The upstream enterprises should provide high-quality breeding sheep and feed, and the mid-stream enterprises should strengthen breeding management and technical services, and the downstream enterprises should expand sales channels and increase the added value of products. Through the integration of the industrial chain, a virtuous circle of resource sharing and complementary advantages can be formed, and the Wadi sheep industry in Lubei region can be promoted to a higher level.

Strengthening policy support and supervision

The government should continue to increase its support for the industry by providing financial, technical and market support. Meanwhile, we should strengthen supervision, establish a sound supervision system, and strengthen supervision over breeding, processing and sales to ensure the quality and safety of products. Through the joint efforts of policy support and supervision, the healthy, stable and high-quality development of Wadi sheep industry in Lubei region can be promoted and ensured.

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