Development Status, Challenges, and Solutions of China's Beef and Mutton Industry

Ren Jizhou[1] , Li Fadi[1], Cao Jianmin[2], Li Binglong[3], Xu Gang[1], Tang Zeng[1]

1. State Key Laboratory of Grassland Agro-ecosystems, Key Laboratory of Grassland Livestock Industry Innovation of the Ministry of Agriculture and Rural Affairs, College of Pastoral Agriculture Science and Technology, Lanzhou University, Lanzhou 730020, China
2. College of Economics and Management, Jilin Agricultural University, Changchun 130118, China
3. College of Economics and Management, China Agricultural University, Beijing 100083, China

Abstract: The beef and mutton industry plays a strategic role in China in utilizing agricultural resources, improving dietary structures, prospering the rural economy, and maintaining national stability. China's beef and mutton industry has made some achievements and is evolving from subsidiary production to specialized production. However, it still faces multiple challenges, such as the enlarging demand-supply gap, an unreasonable structure of coarse fodder resources, the underdevelopment of cattle and sheep breeds, and increased external competition. This paper proposes several strategic recommendations based on a comparative analysis and trending judgments between China and abroad. This includes integrating the grassland industry and animal husbandry, initiating national key programs that develop key technical links for the beef and mutton industry, improving the reproduction and breeding systems, strengthening the slaughtering and processing industries, and providing support for the beef and mutton industry in Southeast China.

Keywords: beef and mutton industry; grassland farming; meat production; meat consumption

Beef and mutton have high protein content, low fat, and low cholesterol content. They are rich in many essential amino acids, other important minerals, and trace elements, which are easily digested by the human body. Beef and mutton has always played an important role in China's dietary structure. The beef and mutton industry plays an important role in maintaining China's food safety. With China's rapid increase in the consumption proportion of animal products, food security's main pressure comes from feed grain. While the beef and mutton industry utilizes grain-saving animal husbandry, its development is beneficial for alleviating the imbalanced grain supply situation for humans and livestock [1]. Meanwhile, the beef and mutton industry's development can fully utilize various roughage and unconventional agricultural resources in China, which can turn waste into valuables and reduces environmental pollution through its treatment process. Additionally, China's Mongolian, Tibetan, and Islamic minorities regard cattle and sheep as their main meat sources. Grassland animal husbandry, represented by beef and mutton production, is not only the main source of livelihood in minority areas, but an important mode of production. Over thousands of years of animal husbandry production, a variety of unique grassland cultural traditions have formed. These are an important part of Chinese culture.

1 China's current beef and mutton industry's situation

1.1 Beef and mutton production are gradually moving from preliminary production to specialized production

In the 1980s, through a series of system reforms, China abolished planned farming of cattle and sheep, uniform pricing, and circulation restrictions. This formally started the industrialization of the beef and mutton industry. From 1995–2013, China's total beef and mutton production growth rate reached 141%, which was significantly higher than meat's total growth rate. This can be divided into three developing stages. From 1980–1990, farmers initially started transitioning from preliminary to specialized culturing. During this period, the culturing number increased rapidly. From 1991–2006, beef and mutton production developed rapidly, and the growth rate far exceeded the world's average level. From 2007–2020, farmers adjusted and developed the stages of beef and mutton production. The growth rate gradually slowed, as farmers shifted from quantity growth to quality growth. From the production mode perspective, China's beef and mutton industry is still dominated by small-scale farmer's productions. However, new production modes are constantly emerging, as farming is in the stage of transformation and upgrading.

Specialized production has greatly improved China's production levels of beef and button. Over the past 35 years, China's cattle stock has increased by 1.06 times, the number of cattle on the market has increased by 13.20 times, and the output has increased by 25.03 times. Comparatively, sheep stock has increased by 66.03%, the number of sheep on the market has increased by 4.80 times, and the output has increased by 8.93 times. China is already the world's largest country in sheep production and the third largest country in cattle production. The total output value of China's beef and mutton industry is about 571.05 billion yuan, accounting for 19.18% of animal husbandry's total output value. It has become an important source for increasing farmers' income and helping the rural economy prosper.

1.2 Beef and mutton have become an important part of Chinese residents' dietary consumptions

China is changing from single pork consumption to a balanced consumption of various meats. Beef and mutton play an important role in enriching the national meat consumption structure. The development of China's beef and mutton consumption is mainly experienced in four different stages. In the early days, since the founding of the People's Republic of China to the eve of reform and opening-up, the consumption of beef and mutton was in a downturn. From 1978–1985, Chinese residents started consuming beef and mutton. From 1986–2005, beef and mutton production in all meat consumption products began increasing. Since 2006, consumption growth slowed, differential consumption gradually appeared, and consumption demand for high-end beef and mutton has increased. Presently, China's beef and mutton also show characteristics of large outdoor consumption proportions, large differences between urban and rural areas, and a transformation to national consumption [2,3]. With the promotion of economic development, urbanization processes, and changes in consumption concepts, it is predicted that there will be more opportunity for beef and mutton consumption level growth in the future.

Currently, China's annual per capita consumption of beef and mutton is increasing at the same rate as other meat products. The proportion is maintained around 9%, but only accounts for 30.69% of the world average, with a gap of at least 8 kg between the world's per capita annual consumption of beef and mutton. In beef and mutton consumption, the main difference is beef consumption, as the proportion of mutton in China's meat consumption is similar to the world's meat consumption structure. Therefore, the growth space is smaller than beef.

1.3 Steady improvement in industrial science and technology levels

After the transformation of the production system, science and technology have gradually became the core power by promoting development in the beef and mutton industry. In the past 35 years, a number of important scientific research achievements, in the beef and mutton industry, have been obtained, spread, and applied. In 2017, China's average meat production level for each beef cattle was 47.86% higher than it was in the early 1980s. In 2017, China's average meat production level for each mutton sheep was 44.34% higher than it was in the early 1980s. Beef cattle and mutton sheep's marketing rates concurrently increased about 10 times and 3 times respectively. The average technical efficiency in the beef cattle's culture industry was 0.813 from 1999–2014, and the average technical efficiency of mutton sheep culture industry was 0.83 in 2012. Thus, the combined share of scientific and technological progress reached 45.9% [4].

1.4 Preliminarily formed advantage production areas

China's beef and mutton industry layout has basically matured, forming four advantage areas in the Central Plains, Northeast, Northwest, and Southwest. From 1995–2015, the country's proportion of cattle production increased from 80.26% to 86.78%, and sheep production increased from 76.49% to 88.09%. Additionally, scale breeding gradually appeared. From 2003–2014, the number of cattle farms (households) increased in other scales, expect for the number of cattle farms (households) with 1–9 heads of cattle annually, where market decreased year-over-year. Mainly due to annual scatter feeding, sheep farms on the market below 29 heads of sheep annually quit. Thus, the number of sheep farms in 2014 decreased by 11.33 million compared to 2003.

1.5 Increasing foreign trade deficits

In 2020, China's beef and mutton trade is developing from general balances in importing and exporting, where there is an increasing net importing trend. Before 2008, China's importing and exporting of beef and mutton were generally balanced. After 2008, imports rapidly grew and exports reduced. Cattle and sheep imports increased from USD 0.553 billion in 1996 to USD 3.498 billion in 2015. Specifically in 2013, imports were USD 1.548 billion higher than the prior year (Fig. 1). Beef imports were mainly from Australia, Uruguay, New Zealand, Argentina, and Canada. Mutton imports were from New Zealand, Australia, and Uruguay. It is estimated that the average number of beef smuggled into China reached 1 million tonnes per year from 2013–2015 [5]. From the domestic consumption drive and the comparative advantages of foreign products, China's import volume of beef and mutton will continue to grow in the future.
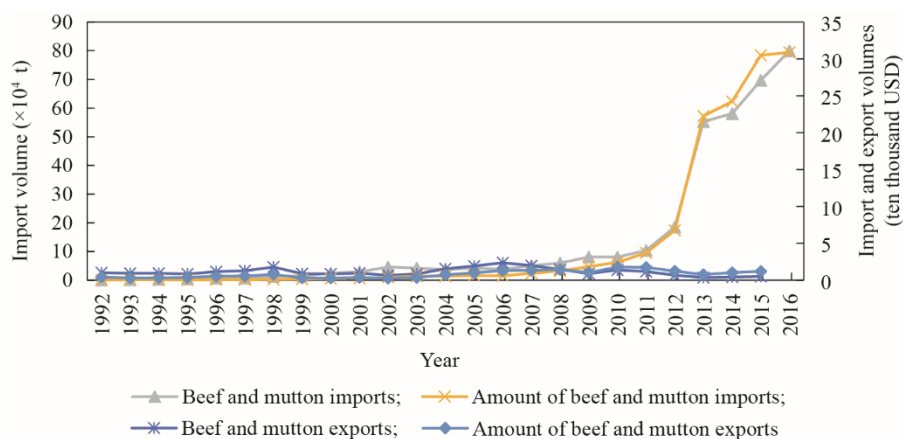

Fig. 1. China's international trade situation of beef and mutton since 1992.

Source: United Nations Food and Agricultural Organization's Public Database

2 China's future development trends and challenges in the beef and mutton industry

2.1 Demand-supply gap will continue to grow

With global economic growth and demand-drivers, the absolute value of global beef and mutton production continued to increase after World War II. However, the relative proportion of global beef and mutton production relative to all meat was declining (Fig. 2). Since China's consumption habits are similar to Asian countries, China's future consumption of beef and mutton can be predicted by referring to several typical Asian developed countries (regions). Calculate the per capita GDP of China in 2020, 2025, and 2030 relative to the average annual growth rate of 7%. Compared with Japan, South Korea, Singapore, Taiwan (China), and Hong Kong (China), which are more developed in Asia, take the consumption and growth rates of beef and mutton per capita, at this level of GDP per capita, as a reference. Considering the smuggled cattle and sheep, it is estimated that by 2020, 2025, and 2030, China's total annual consumption of beef and mutton will reach 15.33 million tonnes, 18.38 million tonnes, and 19.87 million tonnes, respectively.

Explore China's supply possibilities through the current trade pattern of beef and mutton in the world (Figs. 3 and 4). The United States, India, Australia, Brazil, Canada, New Zealand, Uruguay, and Argentina are the world's leading exporters of beef and mutton. It is estimated in 2020 and 2030 that the export volume of beef and mutton in

these eight countries will increase to 7.8 million tonnes and 9.9 million tonnes, respectively. However, considering the competitive factors on the import side, the world's supply of beef and mutton to China is difficult to exceed 20% of domestic demand. In the mid–long term, China will face a demand-supply gap of cattle and sheep which cannot be satisfied by the international market.
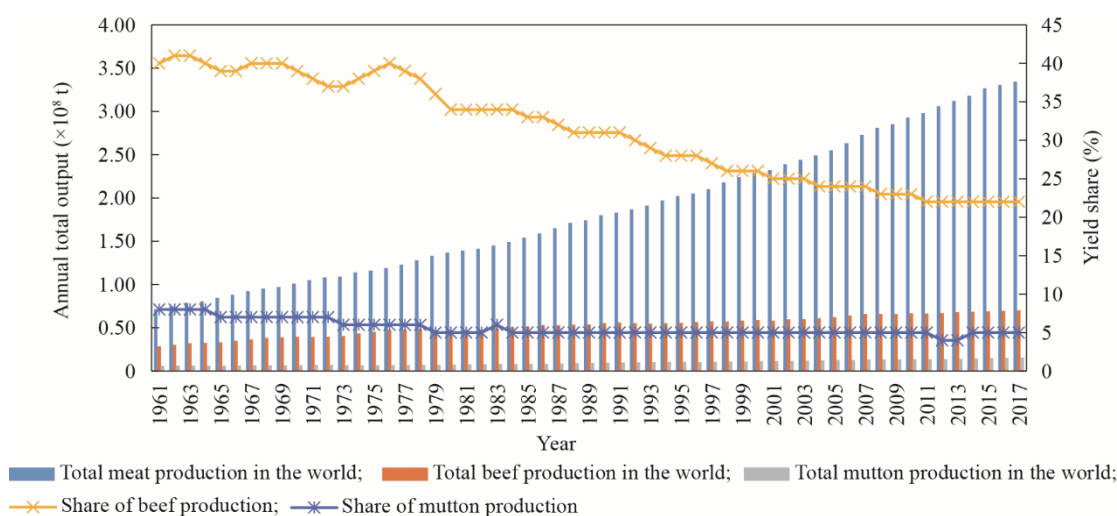

Fig. 2. World beef and mutton production, and the share of total meat production from 1961–2017.

Source: United Nations Food and Agriculture Organization Public Database.
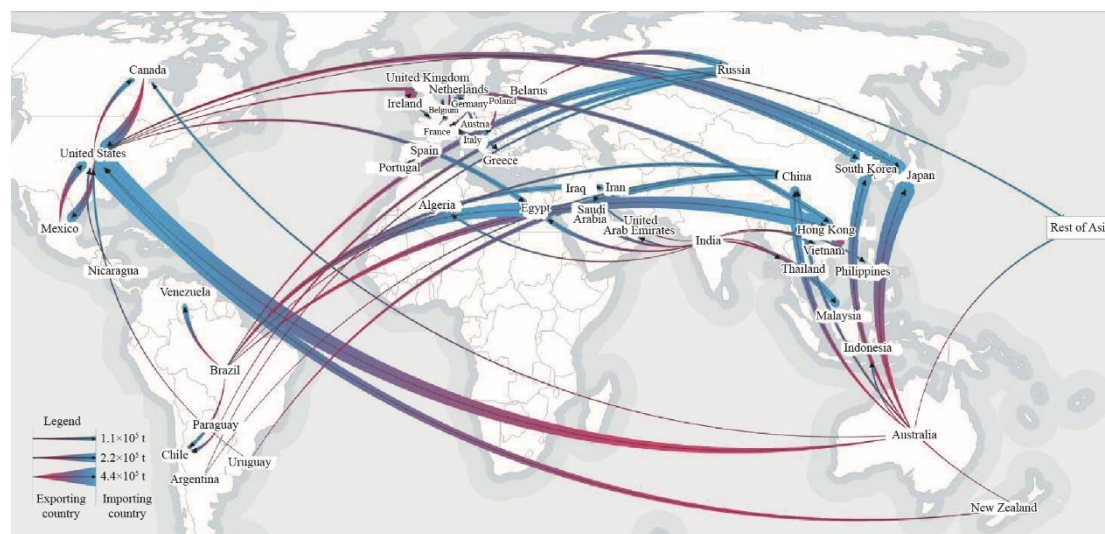

Fig. 3. Current status of global beef trade.

Source: United Nations Commodity Trade Statistics' Database.

2.2 The structure of feed resources is unreasonable

Presently, structural problems in the feed resources for China's beef and mutton industry are mainly manifested from the oversupply of straw and an inadequate supply of high-quality forage and other resources. By analyzing the correlation between natural grassland pasture production capacity and beef and mutton production capacities in countries (regions) around the world, the results show that the world's natural grass production capacity has a significant linear positive correlation with the beef production capacity. However, according to the per capita natural grass production capacity of the top 20 countries in global beef and mutton production, China is only 10.16% of (the average of) the top 20 countries, and it is only 27.12% of (the average of the) world (Table 1). Thus, it has to develop an equipped high quality artificial grassland. The mismatch between the supply capacity of natural grass and the

production capacity of beef and mutton requires a large number of cattle and sheep to rely on concentrated feed during the breeding process, which is a common phenomenon in China [6].
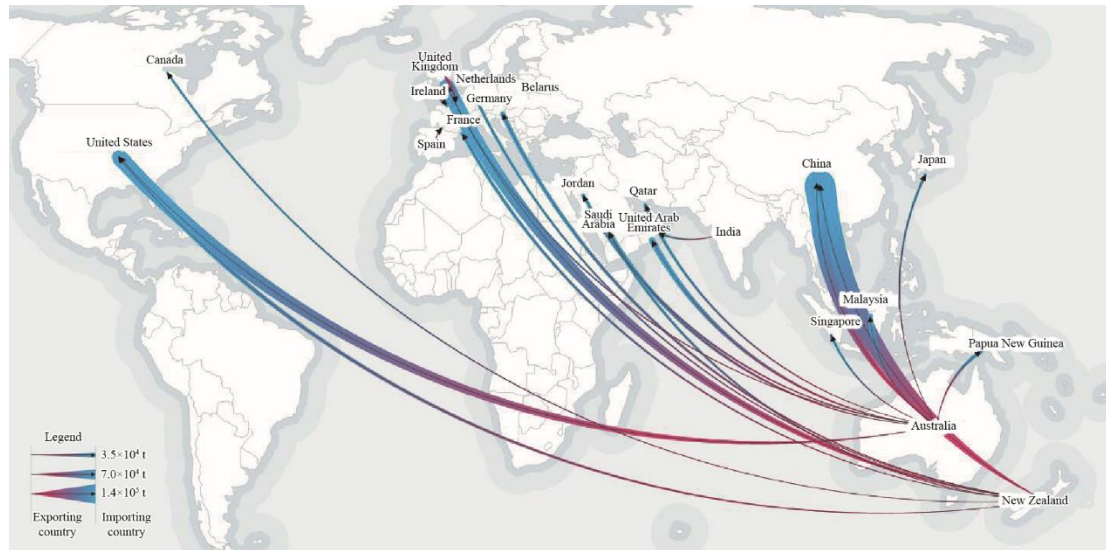

Fig. 4. Current status of the global mutton trade.

Source: United Nations Food and Agricultural Organization's Public Database.

Table1. Per capita natural grassland production capacity of the top 20 countries in global beef and mutton production (unit: t).

Order	Country	Per capita dry matter of grass	Order	Country	Per capita dry matter of grass
1	The United States	7.48	11	South Africa	11.73
2	China	1.31	12	Germany	0.11
3	Brazil	18.12	13	England	1.97
4	India	0.39	14	New Zealand	10.40
5	Australia	96.90	15	Canada	39.07
6	Argentina	22.42	16	Egypt	0.12
7	Mexico	9.60	17	Uzbekistan	1.05
8	Russia	21.46	18	Italy	1.44
9	France	1.09	19	Columbia	7.39
10	Turkey	4.42	20	Nigeria	1.29

Note: Grass area data from 2013 MODIS, includes five types: canopy, open shrub, Savannah, Mubensawa, and non-woody grassland. The productivity data is from 2013, simulated by the BIOME-BGC model. Artificial grass pasture is not included in the table.

2.3 The development of cattle and sheep breeds is still facing severe challenges

Breed is the main technical bottleneck in the current beef and mutton industry. The experience summary shows that the relative contribution rate, of the breed to the whole industry, accounts for about 40%, which has become the main exerting point of improving technology in the beef and mutton industry. There are 195 cattle and sheep breeds in China, but there is a lack of national top-level strategic design in reproduction and breeding aspects. The two viewpoints of breed conservation and improvement have not obtained consistency, and paid more attention to introductions instead of reproduction and breeding. Meanwhile, no cooperative working mechanism was formed. Reproduction, breeding, and propagation are fighting for each other, but have not formed an oriented cultivation concept, which inevitably leads to duplication of work and a waste of resources.

2.4 Domestic production costs continue to rise and external competitive pressure increases

Due to the sharp increase in production costs, such as labor, young animal fees, and feed, the total cost of beef cattle feeding, in China's main productive area, reached an average annual growth rate of 15.2% from 2008–2012,

which more than doubled. The single feeding cost of scatter feeding mutton sheep has increased from 243.5 yuan in 2004 to 1084.81 yuan in 2014, which increased 3.5 folds in 10 years [7]. Currently, the four indicators of the international competitiveness index include China's beef and mutton producer price index, international market share, revealed comparative advantage index, and trade competition index. These are at a disadvantage compared to the world's main production countries, which has seriously lowered domestic industry competitiveness [8].

3 Main recommendations to promote the development of China's beef and mutton industry

3.1 Optimizing the supply structure of feed resources and promoting the integrated construction of grass and livestock

It is proposed to further promote the integrated development strategy of grass and livestock by adjusting the planting structure. Organically combining the cropping structure adjustment, such as grain changing into feedstuff within the beef and mutton industry's development programming, and turning production structures of "grain + straw + cattle and sheep" into the structure of "forage + cattle and sheep," which reverses the current structural misalignment in the beef and mutton industry, where there is an oversupply of straw in feed resources and lack of quality protein feed. In the short term, regard grains changing into feedstuff in the sickle Bay Area, as the focus. In the mid–long term, the main production areas of beef and mutton will be the core. Regard the county as a unit to deliver the planting and breeding balance design. Refer to livestock demand to determine what to plant. According to the resource carrying capacity and the radius of consumption for planting and breeding industry waste, determine the planting scale and breeding scale, rationally arrange the farm, and support construction of forage bases and dung treatment facilities. The subsidy and support policies for grass and livestock were released. The production organizational modes combining planting and breeding are supported, such as farm's circulation, cultivating their own land, and ordered production, and conditional areas are encouraged to build high quality grassland to graze cattle and sheep.

3.2 Strengthening key R&D and transformation of core technologies in the beef and mutton industry

Based on current key technology requirements in China's beef and mutton industry development, it is recommended to increase the support of two research directions. These include cattle and sheep's reproduction and breeding, and the efficient utilization of feed resources.

A national key R&D plan for cattle and sheep breeding includes Simmental cattle, Angus cattle, Qinchuan cattle, and Yanbian cattle as the main species of beef cattle. The plan focuses on cultivating an excellent variety of bulls. Regarding the discovery and utilization of native beef cattle's genetic resources, China should implement crossbreeding and cattle improvement to improve the meat production performance and select the group with a better foundation of variety breeding to cultivate new varieties. Concerning strengthening the foundation of buffalo variety breeding, a river-type buffalo can be designedly introduced for crossbreeding, which improves dairy performance. Yak's variety breeding can be strengthened through crossbreeding, thus to improve production performance. Mutton sheep breeding should focus on the small-tailed Han sheep, Hu sheep, Dubo sheep, and Suffolk sheep, and variety breeding should be continuously conducted. The discovery and utilization of the genetic resources of native mutton sheep mainly protects reproductive performance, meat quality, stress resistance, and other germplasm characteristics. These processes actively implement variety breeding, crossbreeding and improvement, and accelerate the cultivation of new varieties that meet market demand.

The national key R&D plan for feed resources efficient utilization. In terms of forage, efforts should be focused on solving problems including technology integration of natural grassland rational utilization and moderate improvement, the main paradigm of grassland–livestock combination in different ecological regions, and the utilization and management of grassland resources in the south. As for straws, the key technical problems need solving include key technologies in processing, silage, transportation, and other aspects of feed utilization, as well as special new equipment development, supporting facilities construction, and policy subsidy input mechanisms. As for other processing by-products, China should solve problems concerning nutrient value improvement technology, specialized utilization demonstrations, and waste innocuous treatments for cattle and sheep feeding and utilization.

3.3 Improving reproduction and breeding systems and strengthening the union of reproduction and breeding

It is recommended to establish the national cattle and sheep genetic assessment center to improve the accuracy and timeliness of genetic evaluations in cattle and sheep, which guides reproduction and breeding enterprises to rationally implement selection and assortative mating. The National Committee of Livestock and Poultry Genetic Resources improves new varieties and examines the approval systems of supporting departments. Additionally, they explore, develop examinations, and approve new lines. Reproduction and breeding work mechanisms include exploring the establishment of breed alliance and implementing union reproductions and breeding. Make full use of multi-channel funding from central and local governments as well as enterprises. They corporate and share results to form a seed industry development mechanism where reproduction and breeding enterprises server as the main body; productions, education, and research are combined; and cultivation, reproduction, and extension are integrated. Focus on localized breeding selections of the main introduced varieties and the effective protection and utilization of local livestock and poultry genetic resources. Establish an assessment system for cattle and sheep reproduction and breeding, and build a number of large cattle and sheep breed enterprises and national brands.

3.4 Improving regulations and standards, promoting the development of cattle and sheep slaughtering in the processing industry

It is recommended that the laws and standards for slaughtering and processing beef cattle and mutton sheep in China should be revised and improved as soon as possible. The laws and regulations, issued by national and local governments, for the centralized slaughter of beef cattle and mutton sheep should resolutely restraint slaughter without authorization, except for self-consumed farming herdsman, by realizing appointed-abattoir slaughtering. Formulating and revising the slaughtering and processing standards for beef cattle and mutton sheep, such as the classification standards for live cattle and sheep, grading standards for cattle and sheep, and quality standards and hygienic standards, is crucial. Establish quality and safety control systems and traceability systems for the whole course, from aquaculture, transportation, slaughtering, segmentation, and processing to sales, strengthening veterinary epidemic prevention and product quarantines, testing, inspection and grading, and encouraging high quality and outstanding prices. Simultaneously, it is recommended to actively guide the cluster development of cattle and mutton slaughtering and processing enterprises. Enhancing the strength of slaughtering and processing enterprises is one of the keys to the industrialization of beef and mutton. This should identify macro-controls for the quantity, layout, and slaughtering processing capacity of beef cattle and mutton sheep slaughtering and processing enterprises. Realizing the area matching of production and slaughtering helps nearby slaughterhouses and strictly controls the livestock flow across regions, which reduces the risk of epidemic prevention. Explore the support policies for cattle and sheep development, such as the integration of quality seed subsidies with leading enterprises as the undertaking point and enrich the source of cattle and sheep for slaughter.

3.5 Strengthening the cultivation of the beef and mutton industry in Southwest China

It is recommended to strengthen the cultivation of the beef and mutton industry in Southwest China and to identify it as one of the key industries for poverty alleviation and development. The southwestern part of China has many natural conditions, such as many mountains, few sunny days, abundant rainfall, moderate temperatures, social characteristics of high proportion for a poor population, and centralized distribution. It has excellent basic conditions for the development of artificial grassland + beef and mutton industry model. It has great production potential, and it has high product quality. It is necessary to promote the construction of experimental demonstration zones in the grassland ecological beef and mutton industry, or create special projects for poverty alleviation in the grassland ecological beef and mutton industry in combination with poverty alleviation funds. Regarding the development of grassland ecological animal husbandry in the Southwest karst area, summarize the existing successful models' management experience and technical achievements, strengthen the organizational leadership and extended applications, and further support finance and banking, infrastructure, technology support, processing, marketing, and other aspects. Form a stable and orderly development mechanism for the grassland ecological cattle and mutton industry in Southwest China.

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