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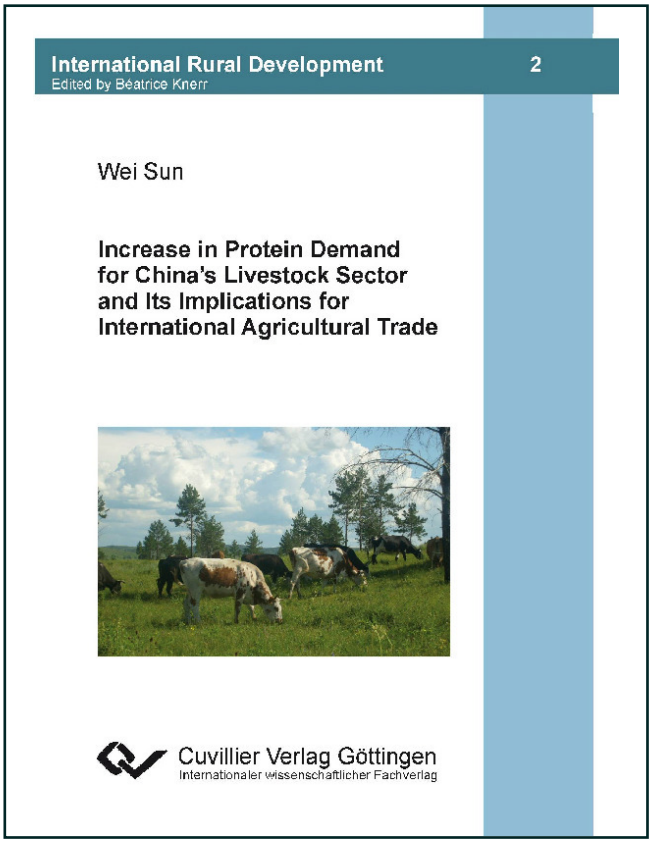
Increase in Protein Demand for China's Livestock Sector and Ist Implications for International Agricultural Trade



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1 Introduction

1.1 Problem statement

Since the early 1980s, China's rapid improvement in living standards accompanying rapid increase in demand for livestock and fish products (animal proteins) has brought about a rising concern over the availability of appropriate, affordable, and high-quality feed ingredients. The question of whether the expansion of China's feed grain output is sufficient to meet increased demand, driven by the country's booming livestock industry, has been studied extensively (Hayes, 1998; Fang and Fuller, 1998; Fuller and Fang, 1999; Huang et al., 1999; Rutherford, 1999; Rae and Hertel, 2000; Ma and Rae, 2004; Nin et al., 2004; Lu and Kersten, 2006). Previous studies yielded contradictory results because the definition of grain differed significantly and different approaches were used. In China, the priority of agricultural policy has been given to food security, which is measured by self-sufficiency in grain production. Under this policy, China has achieved the desired goal of both food grain and feed grain production. However, since the mid-1990s, China's deficit situation in protein ingredients[1] has significantly widened. This trend suggests that the research needs to give its attention to easing the shortages of proteins for the country's feed industry.

As an essential building component of life, protein is a crucial nutrient in the animal diet formulation (Gilbert, 2002). The task of modern feed technology and animal nutrition is to provide protein in animal rations in the most technically efficient way (Miller, 2002). An appropriate energy-protein ratio is required to optimize protein utilization. When insufficient energy is given, protein will be converted into energy rather than body protein. This is the reason an appropriate energy-protein ratio is required.

[1] In this study, protein ingredients refer to high-and-medium protein content meals, which include oilseed meals, fishmeal, and meat and bone meal (MBM).

There may be a broader spectrum of choices regarding the use of feed grain, but proteins for feed, particularly high-quality protein feed, cannot be avoided (Speedy, 2002).

Protein sources for livestock rations vary to a certain extent, providing considerable opportunities for further diversification and substitution (FAO, 2002). Oilseed meals, fishmeal, and meat and bone meal (MBM) are three key protein feeds in commercially produced livestock rations, and they are traded globally (Gilbert, 2002). In China, they provide most of required protein for intensively raised animals (specialized and commercial production) and also a part of the protein for traditionally raised animals.

In addition to rapid rising demand for livestock products, structural changes in China's livestock production toward specialized and commercial operations could accelerate the shortages of proteins. Compared to traditionally raised livestock, intensively raised livestock could utilize more advanced feeding technologies and consume more compound feeds and protein meals. Continued structural changes in China's livestock production have strong implications for international agricultural trade.

China's widening deficit in protein sources reflects as the massive imports of protein meals. Due to expanded oilseed processing and extraction capacities and rising demand for vegetable oils for human consumption, China's imports of proteins are mainly in the form of oilseeds, especially soybeans (Tuan et al., 2004). The major change in the global oilseed sector is that China, once a net soybean exporter, has turned into a leading importer. China's imports grew from almost zero in the 1980s to more than 50 million metric tons in 2010, accounting for more than 40% of the world's soybean trade (USDA PS&D database, various years). Table 1.1 presents the quantities of China's soybean production, total domestic consumption and imports. It indicates that the gap between total domestic consumption and its production have enlarged significantly since the mid-1990s.

Table 1.1: China's production, total domestic consumption and imports of soybeans from 1978 to 2010 (Thousand Metric Tons)

Year	Production	Imports	Total Dom. Cons.
1978/1979	7,565	261	7,552
1979/1980	7,460	810	8,063
1980/1981	7,940	540	8,337
1981/1982	9,325	530	9,745
1982/1983	9,030	30	8,740
1983/1984	9,760	0	8,960
1984/1985	9,695	0	8,615
1985/1986	10,509	280	9,529
1986/1987	11,614	190	10,054
1987/1988	12,184	208	10,910
1988/1989	11,645	33	10,469
1989/1990	10,227	1	9,121
1990/1991	11,000	1	9,713
1991/1992	9,710	136	8,756
1992/1993	10,300	150	10,150
1993/1994	15,310	125	14,335
1994/1995	16,000	155	15,761
1995/1996	13,500	795	14,073
1996/1997	13,220	2,274	14,309
1997/1998	14,728	2,940	15,472
1998/1999	15,152	3,850	19,929
1999/2000	14,290	10,100	22,894
2000/2001	15,400	13,245	26,697
2001/2002	15,410	10,385	28,310
2002/2003	16,510	21,417	35,290
2003/2004	15,394	16,933	34,375
2004/2005	17,400	25,802	40,212
2005/2006	16,350	28,317	44,440
2006/2007	15,967	28,726	46,120
2007/2008	14,000	37,816	49,818
2008/2009	15,540	41,098	51,435
2009/2010	14,700	50,338	59,430

Source: USDA PS&D database, various years

1.2 Research objectives

Based on above mentioned background, the objectives of this study are designed to investigate supply, demand and trade of protein ingredients (oilseed meals, fishmeal, MBM) in China; the influence of internal and external determinants and changes in the macro-economic policies on these markets.

The principal objectives are summarized as:

1. What is the supply, demand, trade situation and policy environment for protein ingredients and their associated grain and livestock products in China?
2. What are the impacts of China's increase in livestock production and trade liberalization on demand for protein ingredients?
3. What is the effect of technical change on production of main protein ingredient (soybean meal)?
4. What is the effect of the alternative protein ingredient (rapeseed meal) on the demand for the main protein ingredient (soybean meal)?
5. What are China's future supply, demand, and trade situations for protein ingredients?

From this, the following specific research objectives are derived:

a) To investigate the economic structure (supply, demand, and trade) and macroeconomic policy environment for China's livestock products, feed grain and protein ingredients;

b) To analyze the development of protein ingredient market after the Bovine spongiform encephalopathy (BSE) crisis and determine its effect on the use of processed animal proteins (MBM, blood meal, poultry meal, and feather meal) as protein sources in China;

c) To develop a structural econometric model that can provide a quantitative assessment of the impact of China's increasing livestock production on demand for protein ingredients and their joint oilseeds;

d) To estimate the effect of technical changes on China's soybean production;

e) To identify the substitution relationship between rapeseed and soybeans, driven by livestock production;

f) To determine the impact of China's World Trade Organization (WTO) accession on imports of soybeans;

g) To project China's future demand, supply and deficit positions in protein ingredients;

h) To draw general conclusions from the estimated elasticities and projected results and formulate appropriate policy recommendations for marketing agents and policy makers.

1.3 Research hypotheses

The hypotheses for this research are as follows:

1. Soybean meal provides the main protein source for feeding China's farm animals. According to FAOSTAT database (2010), China's soybean yield per hectare is about 35% lower than its competitors (U.S., Argentina, and Brazil). An increase in soybean yield can significantly ease the shortages of proteins. It is hypothesized that the technical change by improvement in agricultural infrastructure and rising investment in agricultural research has a positive effect on the soybean production in China.
2. China is the world's largest producer of rapeseed (FAOSTAT database, 2010). In China, rapeseed meal ranks as the second largest protein source after soybean meal. It is an alternative protein source that can replace soybean meal in animal rations. Identification of the substitution relationship between soybeans and rapeseed will help China's government formulate appropriate agricultural policy. It is hypothesized that there is a substitution relationship between soybeans and rapeseed in China.
3. China's WTO accession was a landmark event in its economic development and reform history.It has fundamental influence on international agricultural trade between China and the ROW. It is hypothesized that China's WTO accession has a positive impact on imports of soybeans.

1.4 Organization of the thesis

The organization of this dissertation is as follows. Chapter 1 states research problem, the objectives of this study, and research hypotheses. Chapter 2 provides background information related to this study. It includes an analysis of production, consumption,

and trade of livestock products in China; nutrition characteristics of various protein ingredients; development of feed ingredient market and use of processed animal proteins after the BSE crisis; structural changes in China's livestock production; development of China's livestock industry, biotechnology and agricultural trade policies; the effects of country's food security policies on its livestock, feed grain, and oilseed markets.

Chapter 3 reviews existing research on the market of protein ingredients and their joint oilseeds for both China and the ROW. A complete understanding of previous studies on protein ingredients for China's livestock industry is essential for this study. Although only a few directly related studies are available, a number of related studies provide general information regarding nutrition characteristics of various protein ingredients, supply of and demand for protein ingredients in the ROW, and the appropriate approaches for analyzing oilseeds and their products (oils and meals). Relevant literatures can be divided into four sub-categories: (1) China's availability and deficit position of protein ingredients; (2) China's demand and trade of soybeans; (3) protein sources for feed industry in the ROW; (4) supply, demand, and trade of oilseeds and their products in the ROW.

Chapter 4 first outlines the commodities included in the model. Then it presents the conceptual framework of this study. The development of the conceptual framework follows the structural model. The theory of joint products is introduced to explain supply and demand dynamics between soybeans and their products. Because of the trade of different types of commodities between China and the ROW, the basic structural model is extended to a two-country partial equilibrium trade model. The system equations of the extended structural model are constructed to connect the household demand for livestock products with derived demand for protein ingredients, via various livestock inventories.

Chapter 5 presents the estimated results of the system equations for China and the ROW, based on the conceptual model constructed in Chapter 4. First it displays methodology and data sources, second it shows the estimated results of the system

equations and finally, it provides a comprehensive discussion of the estimated parameters and elasticities.

Chapter 6 presents China's deficit position of protein ingredients based on the simulation results and its implication for global shortages of protein sources. "Demand approach" is employed to project the country's demand for livestock products and protein requirements for feeding its farm animals. Per capita household demand for livestock products is projected through incorporating of average per capita household consumption of livestock products in the base year, real household income growth rates, and income elasticities of the demand for livestock products. The consumption of livestock products at the national level is calculated by multiplying estimated average household consumption of livestock products by the number of population. Projected national consumption of livestock products, multiplied by the feed-meat conversion ratio, gives the country's total requirement for feed. Projected country's total feed requirement and the average use of protein meals in different raised animal rations (traditional and specialized) are incorporated to obtain the national demand for protein meals. Three alternative scenarios are developed that provide the baseline, high-bound, and low-bound projections for the demand, supply, and trade of protein meals.

Chapter 7 is dedicated to a summary of the study, the test results for the hypotheses, conclusions from the estimated results, and policy recommendations.

2 China's Livestock Sector, Protein Sources for Feeding Farm Animals and Policy Environment

2.1 China's production, consumption and trade of livestock products

2.1.1 Production of livestock products

Since the 1980s, China's fast population growth, massive rural-to-urban migration, an increase in living standards, and a shift in diet consumption patterns from traditional food staples such as cereals (wheat, maize, and rice) toward more livestock and fish products have resulted in a significant increase in demand for animal protein in China (Fischer et al., 2007). Therefore China's livestock sector has been growing faster than any other agricultural sub-sector. A group of researchers from the International Food Policy Research Institute (IFPRI), the Food and Agricultural Organization (FAO), and the International Livestock Research Institute (ILRI) have projected that future increases in global animal protein consumption would mainly come from low-and-middle income countries (Delgado et al., 1999). The term "Livestock Revolution" was used to describe the rapid expansion of livestock production in low-and-middle income countries and structural change in the global agriculture. Emerging economies (countries with constant economic growth), particularly by Brazil, China, and India, lead the "Livestock Revolution", which reflects the demand-driven characteristics.

The livestock sector in China not only provides ample dietary protein for human consumption but also has other important uses, including providing draught power, transportation, a source of fertilizer, as well as animal by-products. It is the core component of China's agricultural sector and has achieved a remarkable progress since the rural reforms[2] began in the late 1970s. The livestock sector's contribution to China's agricultural economy has grown continuously from 18% in 1980 to 22%

[2] China has started its rural reform at the end of the 1970s by abolishing the people's commune system and introducing the household responsibility system (HRS). Means of production, including was redistributed to individual households, based on household size. The right of decision making for livestock production was given to individual household.