China's emerging dairy markets and potential impacts on U.S. alfalfa and dairy product exports

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Abstract

China has rapidly emerged as a large milk producer and dairy product importer and there is a growing need for information on China's dairy market and trade behavior. This study uses the most recently available data to examine the trends of China's dairy production, demand, and imports and to assess the potential impacts on U.S. exports of alfalfa and dairy products. While the empirical results suggest that China is very likely to remain as a large importer of alfalfa, powder milk, whey, cheese, and many other dairy products for meeting its growing domestic demand, China's emerging demand for these imports is expected to bring more opportunities for the U.S. dairy industry. On the other hand, the United States is facing more competitions from other alfalfa and dairy product exporters and more studies are needed for developing effective programs to enhance U.S. competitiveness in the Chinese markets.

Keywords: China's dairy market, U.S. dairy exports, alfalfa, powder milk, whey, projection

1. Introduction:

Although China's economic growth has slowed down since 2010, its imports of many agricultural and food products such as alfalfa, powder milk, and whey have continued to grow at remarkable rates and the United States has been a major supplier of many of these products (State Statistical Bureau of China, 2016). For example, China's alfalfa imports increased steadily from 0.23 mmt in 2010 to 1.21 mmt in 2015 and more than 85% of the imports were from the United States. Similarly, China's powder milk and whey imports increased from 0.417 mmt and 0.264 mmt in 2010 to 0.933 mmt and 0.404 mmt in 2014, respectively (State Statistical Bureau, 2016). The significant increase in China's imports of such products is very important for the U.S. agriculture as many American farmers are struggling to stay in business due to increasing production costs and fluctuating farm gate prices. Increased exports to China have the potential not only to help American farmers, but also to help the United States to reduce its huge trade deficit with China (Gale, Hansen and Jewison, 2015; Wang, Parsons and Zhang, 2010).

While a literature review suggests that many studies have analyzed China's dairy markets and trade, most of them are based on either aggregate data or case studies (Fuller et al., 2006; Wang, Zhang and Parsons, 2010; World Bank, 2014). Also, some recent developments such as the dramatic increase in China's alfalfa imports and the number of large dairy farms have not yet been analyzed quantitatively and there are many unanswered questions. For example, why has China increased its alfalfa imports so much in recent years? Where did the imported alfalfa go in China and who used it? Which nations have been competing with the United States in exporting alfalfa and dairy products to China? What opportunities and challenges exist for the United States in this emerging market? What are the recent trends in China's milk production by farm

size and geographical regions, and how will these affect China's alfalfa and dairy product imports?

The major objectives of this study are to compile the most recently available data from China and other sources and analyze the data to address the above questions. Following this introduction section, the rest of this paper will describe the data and methods, present the analysis and empirical results, and discuss the potential impacts of China's emerging dairy markets on U.S. alfalfa and dairy product exports. While most of the results are presented in graphs, detailed data are available from the authors.

2. Data and research methods:

Through close collaboration with several institutions and researchers in the United States and China, a comprehensive dataset of China's alfalfa and dairy product production, price, and trade from 1980 to 2015 has been compiled. Efforts have also been made to check data quality and consistency across sources such as USDA, FAO, and different Chinese government agents.

In addition to commonly used statistical methods such as regression analysis, this study uses the Country-Commodity Linked System (CCLS) developed at USDA's Economic Research Service to analyze and project China's milk production, consumption, and trade. The system contains 42 country and regional models for the United States, 32 foreign countries and nine regions. The country models account for policies and institutional behavior such as tariffs, subsidies, and trade restrictions. Also, a rest of the world model is used to balance world data. The world prices are solved for by obtaining equilibrium in imports and exports for all country and region models for each specific commodity. The production of crops and livestock, consumption, stocks, imports, and exports all depend on world prices. World prices are transmitted to individual country border prices (import and export prices) and then domestic producer and consumer prices. The price transmission varies among countries based on trade and domestic policies and market access to global markets. The macroeconomic projections are exogenous (determined outside the system by ERS's macroeconomic team) and on domestic and trade policies (determined inside and outside the models). The CCLS is a large system, containing about 18,000 equations per year of projection, and incorporates an extensive amount of USDA country and commodity analysts' expertise.

The system reaches simultaneous equilibrium in prices and quantities for 24 world commodity markets for each of the 10 projected years in the baseline analysis. The 24 commodity markets include coarse grains (corn, sorghum, barley, and other coarse grains), food grains (wheat and rice), soybeans, rapeseed, sunflower seed, cotton seed, palm, coconut, and other oilseeds (and their corresponding meals and oils), other crops (cotton and sugar), and animal products (beef and veal, pork, poultry and eggs).

The primary data sources are USDA's PS&D (USDA FAS, 2015). The U.S. model uses data collected by the National Agricultural Statistical Service (NASS). Additional data for individual country models come from individual country data sources and from the United Nations Food and Agricultural Organization. The USDA's 10 year agricultural projections for

trade were released in February 2016 (USDA, 2016) and production and consumption data is released in March 2016 (USDA, March 2016).

The China model covers 7 livestock sectors and 14 crops. Livestock production is modeled as a function of lagged expected gross returns and feed costs. Consumption includes both rural and urban per capita demand. Imports and exports are modeled as import demand and export supply equations, which are functions of domestic and international prices, and policy instruments for state and non-state trading. Domestic prices solve for equilibrium in the livestock sectors. The crop sectors include area harvested, yield, production, feed and food demand, waste, stocks, imports, and exports. For crop production, the model consists of six different regions for area, which are aggregated by provinces with similar agricultural production. The six regions include northeast, north, northwest, east, central, and south. The China model used in this analysis incorporates behavior of state trading enterprises (STE's) and WTO commitments (such as tariff-rate quotas) into import and export equations for each commodity. World price signals enter the domestic market only to the extent that these STE influenced only the trade equations. China's domestic prices adjust until suppliers make available just as much as users will want to buy for food and feed consumption.

The dairy sector in the China model includes milking herd, yields, milk production, per capita consumption, total consumption, imports and exports of milk. Producer price for milk is solved within the model and for equilibrium. China's imports and exports of milk are quite low as compared to China's milk production. For example, about 1 percent of China's milk supply is imported. The level of milk production is determined by both current, one year and two year lagged producer milk prices, with supply responses at 0.81, 1.04, and 0.62, respectively. Corn price has a negative response of -0.015. The price and income elasticities for per capita milk consumption are -1.25 and 1.1, respectively. The milk import demand equation depends on domestic consumer price and the import price of milk with price elasticities of 1.5 and -1.5, respectively. Milk export is a function of the export price and consumer price, with elasticities of 1 and -1, respectively.

As a limitation of the Chinese model in CCLS, the dairy sector includes only milk and does not include any other dairy products like powder milk, whey or cheese. While the projection of China's milk production, consumption, imports, and exports based on the CCLS will be presented in the next section, this paper will also analyze China's imports of alfalfa, powder milk, whey and cheese without using the CCLS. Such analyses will complement the results from the CCLS and provide useful information for assessing China's imports of such products and the potential impacts on U.S. exports. Using projected milk output and imports from the CCLS model for 2016 to 2025 and estimated imports of powder milk, whey, and cheese in milk-equivalent quantity for 2016 to 2013, the share of imports in China's total supply is estimated for 2016 to 2023.

3. Analysis and empirical findings:

The analysis and empirical results are presented in four sections: (a) China's milk production and dairy product imports, (b) China's alfalfa production and imports, (c) trends of

China dairy market and imports, and (d) opportunities and challenges for the U.S.

3.1. China's milk production and dairy product imports

Data presented in Figure 1 indicate that China's milk output increased steadily from 1995 to 2007, especially during 1998 to 2007, but has fluctuated around 37 mmt since 2008 due to the melamine scandal in 2008. On the other hand, the imports of powder milk, whey and cheese have increased significantly since 2008. Note that powder milk, whey, and cheese imports presented in Figure 1 are in terms of milk-equivalent quantities using the ratio of 1:7.4 for

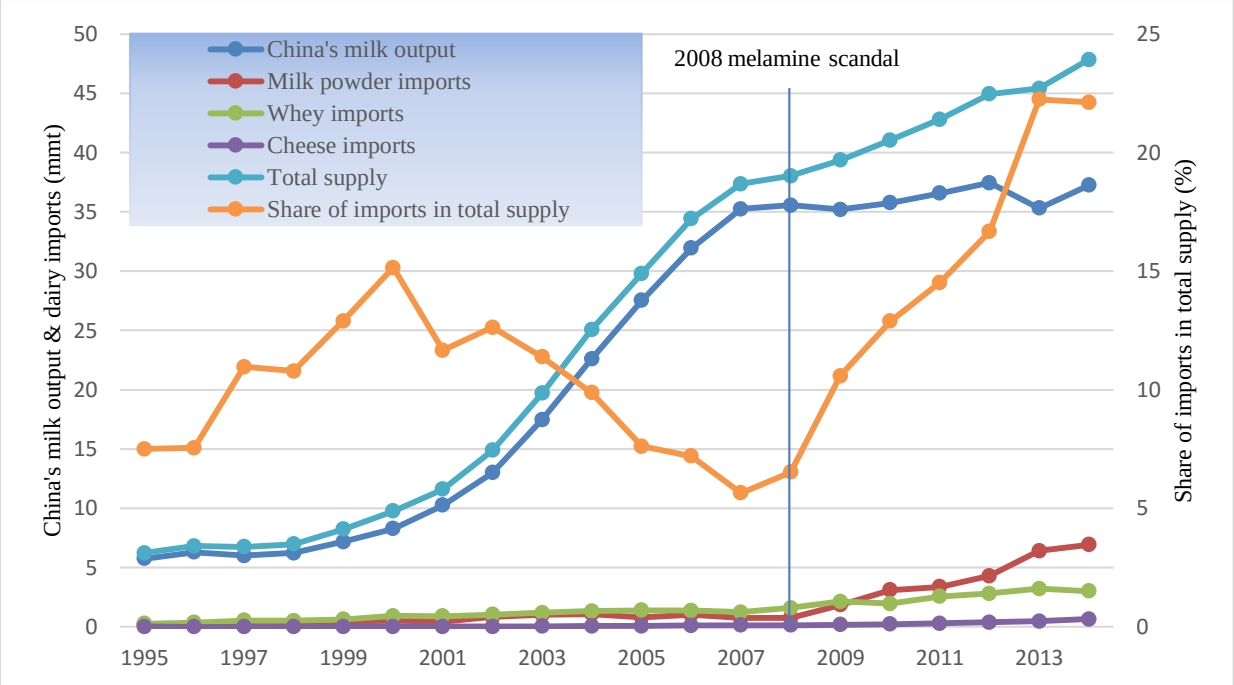

Figure 1. China's milk production and dairy product imports, 1995 – 2014

for powder milk and whey and 1:10 for cheese, respectively. Although whey is a byproduct of cheese production in the United States and other exporting countries, it has been used as a close substitute of powder milk in baby formula and other food production in China.

Data presented in Figure 1 suggest two conclusions. First, although China's milk output has fluctuated around 37 mmt since 2008, the total supply has continued to increase at a steady rate due to the remarkable increase in powder milk, cheese and whey imports. In other words, the increase in powder milk, whey, and cheese imports has compensated for the stagnation in China's milk output in meeting its growing domestic demand for dairy products. In addition to powder milk, whey, and cheese, China has imported fluid milk, butter, yogurt, ice cream and other dairy products but they are not included in the figure because their quantities are very small as compared to the three products included in the figure. If the total supply reflects China's total demand for milk and other dairy products, the steady increase in supply suggests that consumer demand for milk and other dairy products in China has been affected by the 2008 melamine scandal and other food safety problems but the overall demand has been increasing at a significant rate due to income growth and other factors (Wang, Parsons and Zhang, 2010).

Second, the share of dairy imports in the form of powder milk, whey, and cheese in China's total milk supply increased from 7.5% in 1995 to 15.0% in 2000, then dropped to about 6% in 2007, and has increased steadily since 2008, reaching about 22% in 2014. The significant increase in recent years suggests that China's dairy market is increasingly linked to the global market. The increasing proportion of imports in China's total supply of dairy products, soybeans, vegetable oil, and several other products have raised concerns and debates in China about the impacts of imports on its food security. As a result, the future of China's food import policies is highly affected by its food security policies.

3.2. China's alfalfa production and imports

As a result of the dramatic increase in large dairy farms and limited growth in domestic production of high quality alfalfa, China's alfalfa imports have increased rapidly since 2008. As shown in Figure 2, China's alfalfa imports increased steadily from 19,601 tons in 2008 to 1.2134 mmt in 2014 or at an average rate of 80.29% per year. Such rapid increases in alfalfa imports might have never been reported from any other country.

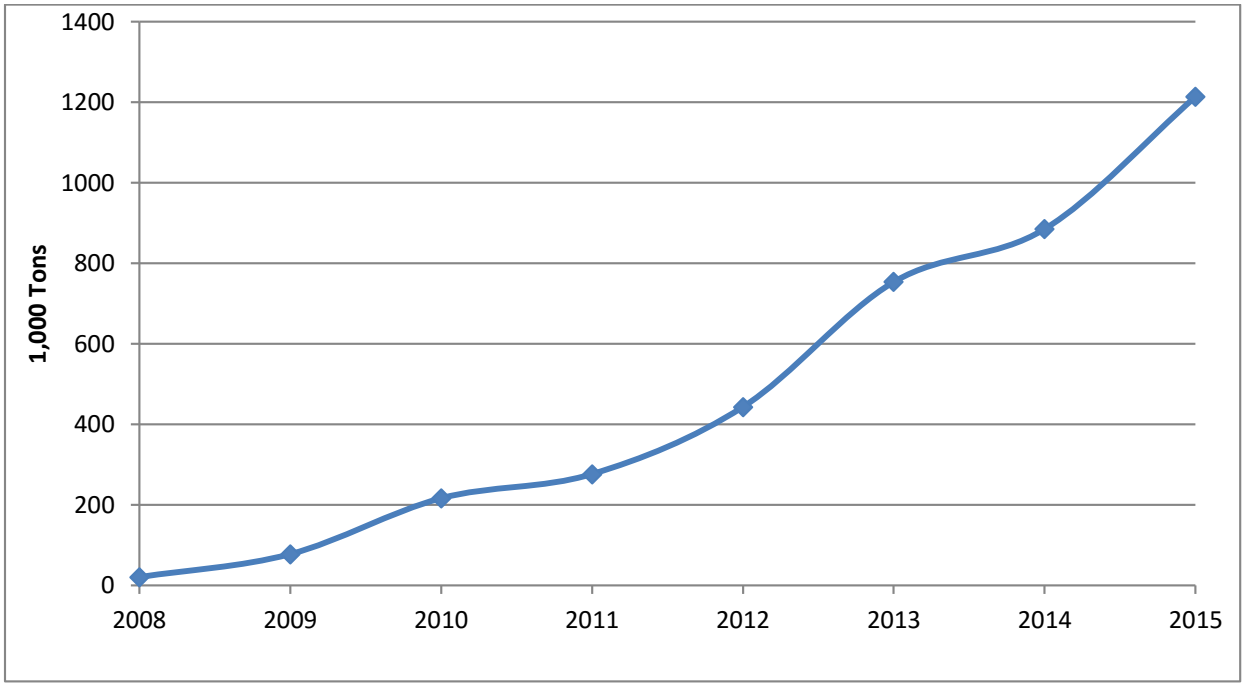

Figure 2. China's alfalfa imports (1,000 tons), 2008 – 2014

Data on China's monthly alfalfa imports (1,000 tons) and the average price in U.S. dollars per tons, presented in Figure 3, suggest that China's alfalfa imports have increased steadily since January 2008 with significant seasonal variations each year. The seasonal variations are likely due to the production seasons in the U.S., storage capacities, international transportation patterns, and other factors. The average price of China's imported alfalfa increased from less than $200 per ton in January 2008 to more than $450 in early 2012 but dropped steadily in 2015, from $403 per ton in January 2015 to $343 per ton in December 2015. More studies are needed to examine how China's increasing alfalfa imports have affected the

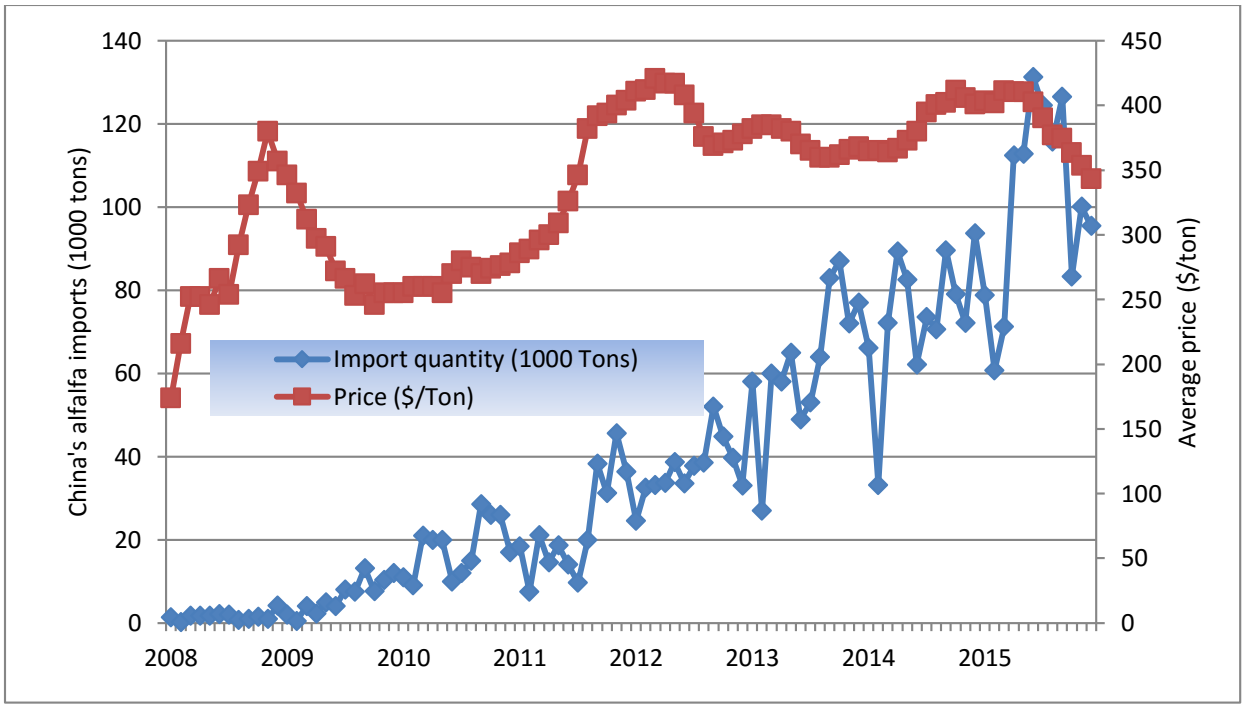

Figure 3. China's monthly alfalfa imports and average price, 2008 – 2015

international market price and how the changes in international market price have affected China's imports.

The dramatic increase in China's alfalfa imports in recent years is largely due to two factors: the rapid increase in the number of large dairy farms and the limited growth in domestic production of high quality alfalfa. The composition of dairy farms in China has been in transition from a vast number of small "backyard farms" with less than 10 cows, to an increasing number of medium-sized farms with 10 to 500 cows and large farms with over 500 cows. For example, the number of small farms with less than 10 cows dropped from 2.37 million in 2008 to about 1.5 million in 2014. As shown in Figure 4, the number of large dairy farms with 500 or more cows increased steadily from 374 in 2002 to 3,585 in 2012. Those large dairy farms are generally commercial farm and implement more scientific feed and nutrition management as compared to smaller farms. The increase in such large farms has increased the demand for alfalfa, especially high quality alfalfa.

Available data and our field studies in China suggest that, although great efforts have been made by both the government and private sectors to expand alfalfa production and improve its quality, the progress has been very slow due to China's limited natural resources for alfalfa production. As shown in Figure 5, China's alfalfa production is concentrated in northern China, from Xinjiang in Northwest China to Neilongjiang in Northeast China. The average annual planted area over the period from 2001 to 2012 was less than 3 million hectares except in 2004, 2011, and 2014. While data on China's alfalfa yield and distribution are very limited, our field research in China suggests that most production regions have low yield and low quality due to climate and other natural factors. Many large dairy farmers may prefer imported alfalfa due to the higher, stable quality, consistent supply over seasons, and competitive price. Given the

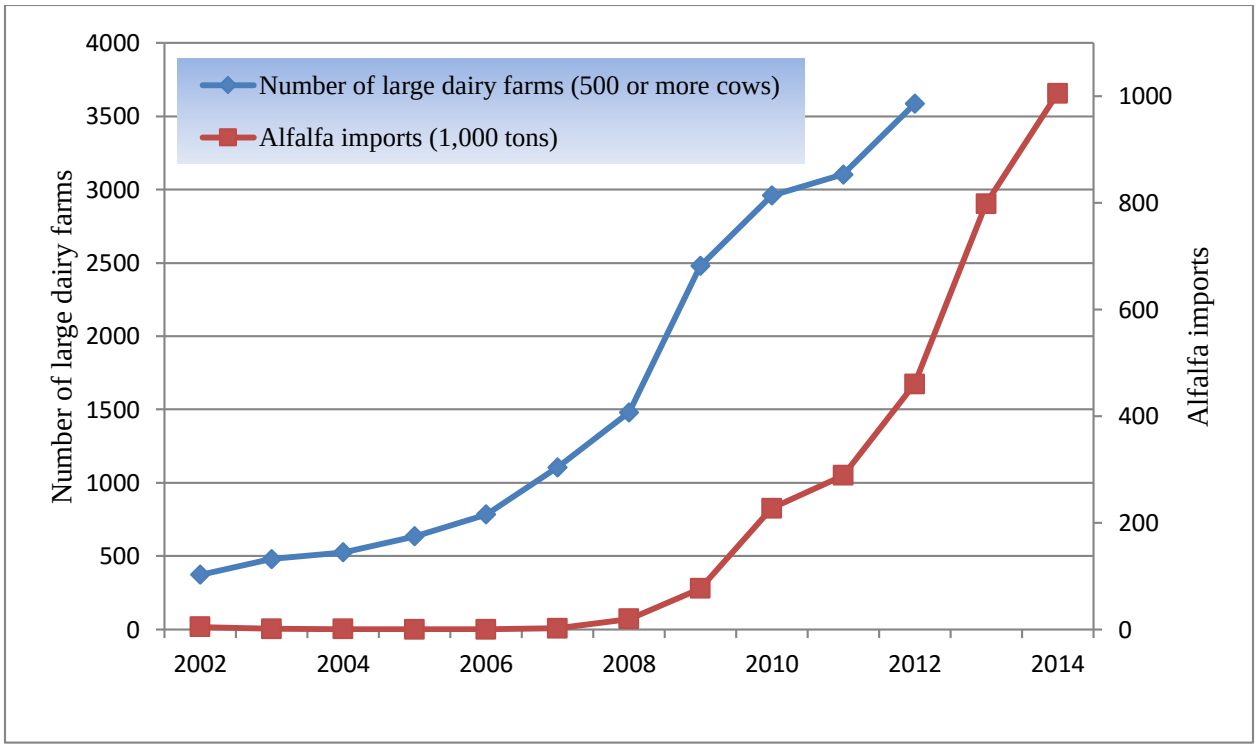

Figure 4. China's number of large dairy farms and alfalfa imports, 2002-2014

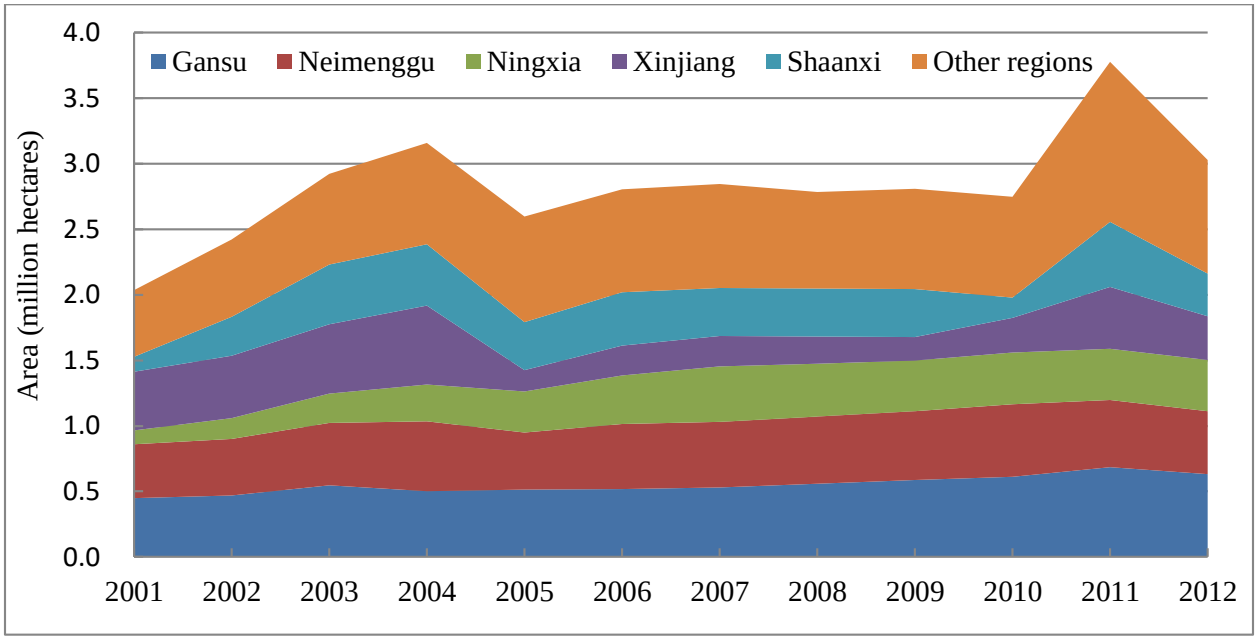

Figure 5. China's planting area of alfalfa, 2001 – 2012

prediction that small dairy farms will continue to be merged into large farms at a significant rate and limited growth in high-quality alfalfa production in China, its alfalfa imports will likely continue to increase at a significant rate.

3.3. Trends of China's alfalfa and dairy product imports

While the limited data on China's alfalfa production and demand do not permit any quantitative projection of China's alfalfa imports, it seems very reasonable to predict that China's alfalfa imports will continue to grow at a significant rate due to the ongoing transition from small dairy farms to large, commercial dairy operations that require alfalfa as an important feed. Also, the increasing labor costs and rising quality and safety standards that are relatively difficult for small farms to meet will likely speed up the transition to large dairy operations. The projection from the CCLS indicates that China's milk production will likely increase from 39.8 mmt in 2015 to 45.0 mmt in 2020 and reach 49.2 mmt in 2023, a 2.2% per year increase. The imports of fluid milk are projected to increase about 4.8% per year over the same period, from 0.44 mmt to 0.56 mmt, to meet the projected increase in domestic demand for fluid milk. The most recent CCLS projection is available for 10 years, from 2016 to 2025, but Table 1 includes the numbers for only the first eight years.

Table 1. Projections of China's dairy market, 2016 – 2023

	2016	2017	2018	2019	2020	2021	2022	2023
Milk output	39.78	40.75	42.11	43.58	45.00	46.39	47.76	49.23
Milk imports	0.440	0.43	0.46	0.48	0.505	0.52	0.54	0.56
Milk exports	0.028	0.030	0.030	0.031	0.032	0.032	0.033	0.033
Milk consumption	40.15	41.15	42.54	44.02	45.46	46.87	48.27	49.76
Imports of powder milk, whey, and cheese	11.64	12.25	12.84	13.48	14.15	14.86	15.60	16.38
Share of imports in total supply (%)	23.29	23.37	24.00	24.26	24.57	24.90	25.26	25.60

As discussed in the previous section, the Chinese model in the CCLS system includes only fluid milk and does not include any processed dairy products like powder milk or cheese. While China's dairy imports have been dominated by powder milk, whey, and cheese, their annual imports in terms of milk-equivalent quantity are presented in Figure 6.

As a very simplified analysis and prediction, the growth rate of 5% in total import of powder milk, whey and cheese (in milk-equivalent quantity) from 2013 to 2014 is used to predict China's imports of these three products for 2015 to 2023 and predicted values are reported in Table 1. Note the growth rate of 5% per year is likely a low and conservative estimate if the growth rates in previous years are considered. As shown in Table 1, at a growth rate of 5% per year, China's imports of those three dairy products (in milk-equivalent quantity) are estimated to reach 11.64 mmt in 2016 and 16.38 mmt in 2023. With such estimates, the share of dairy imports (milk, powder milk, whey and cheese) in China's total supply in terms of milk will increase from 23.29% in 2016 to 25.60% in 2023. If a growth rate of 10% per year is applied, China's estimated total imports of powder milk, whey and cheese in fluid milk equivalent quantity will reach 23.76 mmt in 2023 and the share of total dairy imports in its total supply will reach 33.32%.

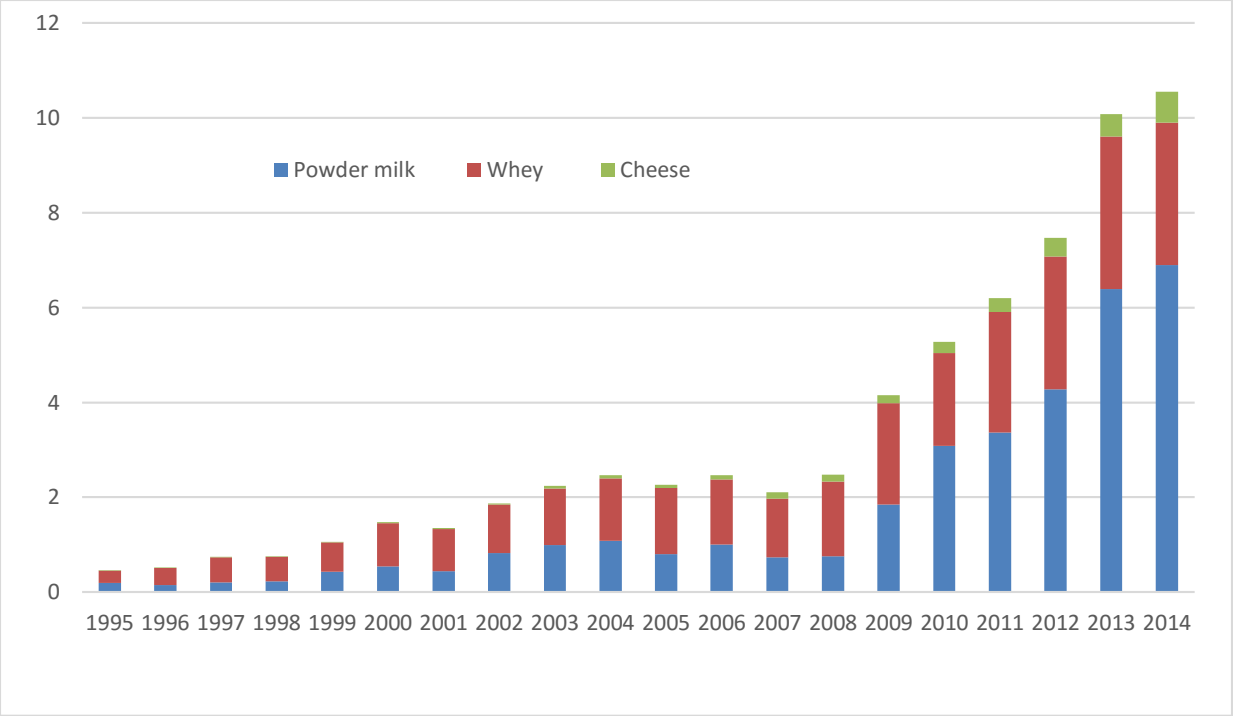

Figure 6. China's powder milk, whey, and cheese imports in milk-equivalent quantity (mmt)

3.4. Opportunities and challenges for the United States

As shown in Figure 7, the United States has dominated China's alfalfa imports for many years but has faced more competition from Australia, Spain and Canada in recent years. The United States will likely continue to dominate China's alfalfa imports due to its well established reputation and customer base and preferences in China. On the other hand, China's increasing alfalfa imports have attracted other major alfalfa exporters such as Australia, Spain, Canada, and Kyrgyzstan and created competition for U.S. alfalfa producers and exporters. In 2015, Chinese alfalfa imports from the United States were 1.04 mmt while the imports from all other nations totaled 0.17 mmt.

As shown in Figure 8, the total market share of U.S. powder milk, whey, and cheese in China's imports dropped from 37% in 1995 to 18% in 2000, then increased to 33% in 2008, and has decreased to 19% in 2014. While U.S. market share in China's powder milk imports has fluctuated significantly, the share in China's cheese imports has increased steadily in recent years. The United States has dominated China's whey imports but the market share has declined in recent years due to increased competition from other exporters.

4. Concluding remarks

This study has analyzed China's alfalfa and dairy market and trade using the most recently available data and the CCLS framework developed at ERS/USDA. Empirical analyses and results presented in this paper suggest four major conclusions: First, China's dairy sector

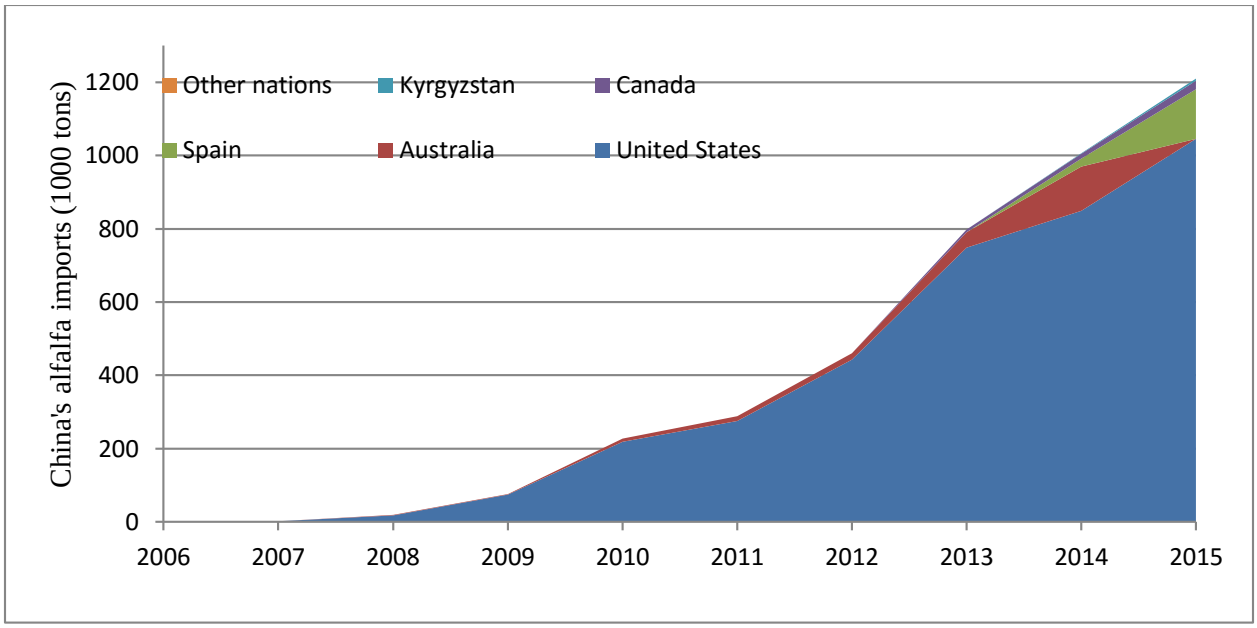

Figure 7. China's alfalfa imports, 2006 – 2015

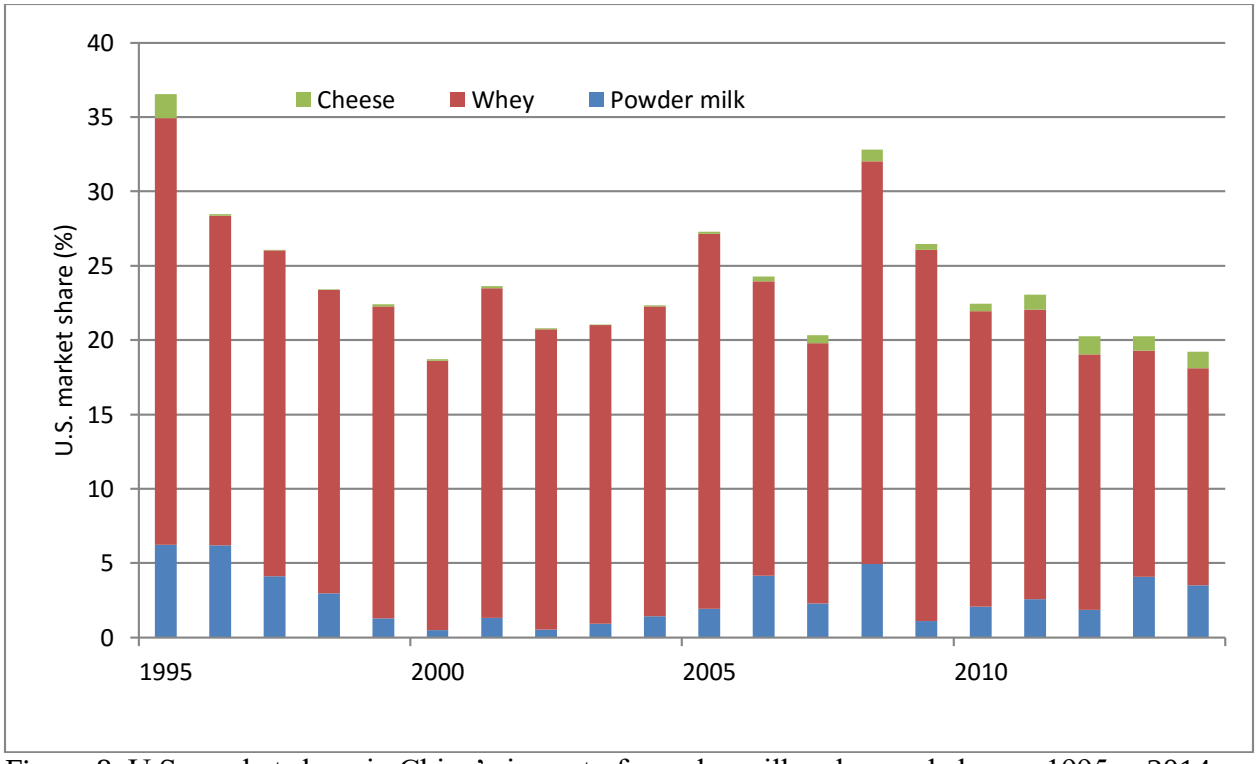

Figure 8. U.S. market share in China's import of powder milk, whey and cheese, 1995 -- 2014

has been under gradual transition from a huge number of small-scale backyard operations to increasing numbers of medium and large scale dairy farms and this transition is likely to continue due to the economy of scale, increasing production costs, and increased milk quality and safety standards that are more difficult for small farms to meet. Also, the significantly

higher labor costs for farming, and more work opportunities for rural laborers in urban areas have encouraged more small dairy farmers to give up their dairy operations and obtain employment in urban areas.

Second, China will very likely to remain as a large alfalfa importer due to alfalfa's role as a primary input in large dairy operations and the ongoing transition from small to medium and large dairy operations. As the population of China demands larger amounts of dairy in their diet, the Chinese economy will likely respond in two ways: increase its direct imports of dairy products such as whey, powder milk and cheese, and increase its imports of dairy industry inputs like alfalfa. As discussed earlier in this paper, the growth in China's alfalfa production has been very limited and China seems to have a lack of comparative advantage in alfalfa production. As China's trade behavior is increasingly determined by economic factors, China's alfalfa imports are very likely continue to increase.

Third, China has emerged as a larger importer of powder milk, whey, cheese and other dairy products in recent years. The increasing income, concerns about safety of domestic dairy products, especially for urban consumers with higher income, and other factors that have contributed to the increase in China's dairy product imports in recent years will likely continue to enhance China's dairy imports. The relaxation of the one-child policy announced in 2015 is expected to increase the birth rate and infant population and therefore increase the demand for baby formula. The quality and price advantages of imported powder milk and whey have created strong preference for imported powder milk and whey among baby formula producers in China.

Fourth, China's emerging dairy market and increasing imports have provided opportunities for American alfalfa growers and dairy product producers. While the United States has dominated China's alfalfa and whey imports, other export nations such as Canada, New Zealand, Spain, Australia, and Kyrgyzstan are making great efforts to increase their exports to China and some of them have started to gain market share. This is likely to increase price competition and drive down the price for alfalfa, whey and powder milk. This is a potential challenge for U.S. alfalfa producers, particularly those in the western United States that face serious water shortages. The water shortage will likely increase the production costs due to the need to drill deep wells into aquifers for irrigation water.

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