Tariffs Impacts on China Dairy Production System and Producer Subsidy Effects: Case of Twin Tariffs

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[Selected Presentation – Lightning Session] 2025 AAEA & WAEA Joint Annual Meeting in Denver, CO; July 27-29, 2025

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Abstract

The trade war was triggered by US concerns about the trade deficit, intellectual property theft, and unfair trade practices. This paper studied the far-reaching impacts of the U.S.-China trade war on agricultural trade dynamics, focusing on the Chinese dairy-livestock belt (primarily in Inner Mongolia) and U.S. agricultural competitiveness. According to time-series data from the China Dairy Association, the paper identified a marked decline in per capita milk production in Inner Mongolia and highlights the economic ripple effects of tariff policies on both nations. The imposition of tariffs on critical commodities, such as alfalfa, oats, and soybeans disrupted supply chains and escalated production costs for Chinese dairy farmers, while simultaneously reducing the global competitiveness of U.S. exports. The paper further analyzes various scenarios regarding tariff impacts and examines how subsidies mitigate the effects of twin tariffs. Results illusion that tariffs on inelastic goods disproportionately affect economic efficiency, leading to cascading supply chain issues.

Keywords: Trade policy, Forage, Dairy production, Economic disruption, Tariffs

JEL CLASSIFICATION: Q17, Q18

Introduction

Trade barriers, such as tariffs, are tools used by nations to address domestic political and economic objectives (V. H. Smith & Glauber, 2020). Since 2018, the U.S.-China trade war has imposed substantial tariffs on dominant products exported to each other in the course of gaming on both sides of the trade policy (P. D. Fajgelbaum & Khandelwal, 2022). Among them, trade in agricultural products is an area of strategic importance. This paper focuses on the repercussions for the Chinese dairy-livestock belt, which is in Inner Mongolia grassland pastoralism at 40°N and an area critical to China's dairy industry. After three rounds of countermeasures, tariffs on more than 90 percent of U.S. agricultural exports to China reaching 25% on U.S. exports like alfalfa, oats and soybeans, which have significantly affected the cost of dairy feed (P. Fajgelbaum et al., 2024).

In the end of 2023, China's State Council Tariff Commission announced an extension of the Section 301 retaliatory tariff exclusions on 12 agricultural products, including alfalfa hay, through July 31, 2024 (China, 2023). As of now, U.S. alfalfa hay exports to China benefit from these tariff exclusions, effectively reducing the additional import duties that were previously imposed. While specific information on current tariff rates for oat hay is limited, China's 2024 tariff adjustment plan, effective January 1, 2024, includes changes to import and export tariffs on various commodities. The plan aims to implement provisional import tariffs lower than the most-favored-nation rates on certain goods. However, the exact impact on oat hay imports from the U.S. remains unclear (China, 2023). Alfalfa and oat hay are significant U.S. exports, particularly to China, which rely on these products to feed its livestock, especially dairy cows. The heightened tariffs led to increased prices for imported feed (alfalfa, oats, and hay), which are vital inputs for dairy farming.

Free trade policies are widely viewed as contributing to improved food security by enabling countries to exploit their comparative advantages, reducing food insecurity by increasing a country's gross domestic product, per capita incomes, and funding for social safety net programs

(V. H. Smith & Glauber, 2020). China does not have a comparative advantage in land-intensive feed grains and proteins such as alfalfa and soybean (Hou et al., 2024). Policymakers must navigate the trade-offs between protecting domestic industries and fostering an open, liberalized trade environment that enhances global food systems (*China-Mexico Economic Relations*, 2024).

Research on trade tariff policy have important contributions for three reasons. Firstly, conceptually, long-run changes to trade barriers likely affect not only farmers and producers in a region but also with consumption and even food security. The empirical studies of Inner Mongolia's dairy industry highlight the importance of government intervention in mitigating the adverse effects of trade disruptions and tariff barriers. This paper relates to studies that evaluate trade war impacts on dairy production and inputs cost, productivity, consumption, and welfare changes.

Literature Review

Trade barriers distort resource allocation, impacting not only producers but also consumers and food security. Richman et al. (2014) generally sees tariffs as a legitimate tool to address chronic trade imbalances, as the Scaled Tariff (ST) brought trade toward balance, tariff revenue would be replaced by increased revenue from higher American incomes. As the Scaled Tariff brought trade toward balance, tariff revenue would be replaced by increased revenue from higher American incomes. U.S. remains a key supplier of alfalfa and oats hay, which is critical component of dairy feeds. The imposition of tariffs disrupted these flows, leading to increased costs for China′s dairy production and reduced competitiveness for U.S. exporters (V. H. Smith & Glauber, 2020).

The theoretical foundation posits tariffs distort market efficiencies and allocation of resources and highlights changes in productivity, input prices, and consumption patterns (V. H. Smith & Glauber, 2020). China's dependence on imported feedstocks, including alfalfa and oats, underscores the vulnerability of its dairy sector to external shocks. Bu & Liao, (2022) noted that China's rural revitalization initiatives aim to reduce reliance on imports by incentivizing domestic forage production. However, structural challenges, such as aging populations and high production costs, continue to hinder progress (Cheng et al., 2022). China and U.S. are likely to subsidize domestic agricultural production and have often done so in ways that expand domestic production and exports while reducing imports, leading to gains in self-sufficiency and productivity (Farrokhi & Pellegrina, 2023).

The role of international trade for such a shift, however, has not yet been explored (Farrokhi & Pellegrina, 2023). In China, on average, two-thirds of every dollar spent on agricultural inputs are paid to foreign suppliers (Farrokhi & Pellegrina, 2023). The escalation of the U.S.-China trade war has intensified the imbalance in agricultural input allocation, with forage and machinery comprising major costs in dairy production, while labor yields minimal returns. Many empirical studies reveal that higher trade costs exacerbate disparities between low- and middle-income countries, widening productivity gaps. The implications for China's dairy industry are profound, as tariffs have increased input costs while limiting access to affordable feed, directly impacting productivity and profitability.

Theoretical Framework

Reductions in trade costs of agricultural production inputs can widen the productivity gap between low-income and middle-income countries while compressing the gap between middle income and high-income countries (Farrokhi & Pellegrina 2023). But higher prices of agricultural productions are likely to improve incomes for farm households but increase average prices for urban populations and, perhaps, food insecurity among the urban poor (V. H. Smith & Glauber, 2020). Tariffs generally insulate producers from competitors, but their costs to domestic consumers can be an incentive for unilateral liberalization and loss of social welfare (Farrokhi & Pellegrina, 2023; Gaigné & Gouel, 2022; Ji et al., 2024). Although tariff revenue from Chinese imports grew following the implementation of higher tariffs, its share of total U.S. tariff revenue declined in recent years as trade shifted to other countries. The average Chinese tariff rate on imports from countries other than the U.S. has fallen from 8.0 percent to 6.5 percent since the trade war in 2018

(Steinberg & Tan, 2024). Consumers and businesses adjusted their purchasing behavior in response to higher tariffs, often substituting taxed goods with alternatives. This behavior reduces the effectiveness of tariffs both as a deterrent to imports and as a significant source of revenue. Tariffs imposed on higher elastic commodity have lower welfare effects on trades (Steinberg & Tan, 2024). Optimal tariffs can be used to reduce trade distortions to trade-off benefits among government, domestic consumers and producers.

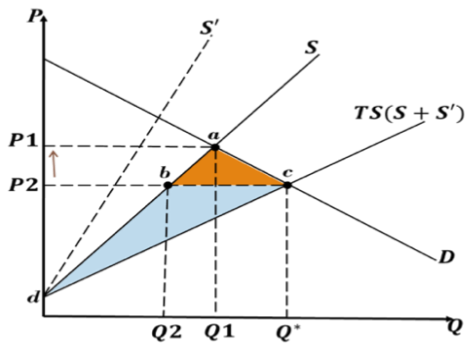

Figure 1: Trade barriers impact on forge supply in China

Chinese tariff on alfalfa, corn and soybeans makes producers worse off, but dairy producer benefits from lower cost in U.S. (Unveren & Luckstead, 2020). Tariffs barriers have led to increased prices for critical dairy production and inputs, thereby affecting productivity in China. In Figure 1, China imposes tariffs on U.S. forage imports, it causes the supply of forage TS move leftward to S, then, the price rises to P1. The decrease in consumer surplus for forage importers (China) is Harberger triangle - abc. The exporter (U.S.) producer surplus loss is dbc, due to export amount reduced Q*- Q1 (Schmitz et al., 2022). Due of the rise in tariffs, the price of forage cost increased, and domestic demand is partially reduced accordingly. Therefore, in short run, the supply of dairy cows' feeds decreased, and the average cost of dairy production raised in China.

Trade War Impacts on Dairy

The trade war disrupted dairy supply chain, increased feed costs in China and reduced the competitiveness of U.S. alfalfa. In retaliation to the U.S. tariffs, China imposed additional tariffs on these types of hay, making price increased from P_2 to P_1 for Chinese buyers (as shown in Figure

1). This had a significant impact on price competitiveness, as Chinese buyers turned to alternative suppliers from other countries and reduced their import volumes altogether because of higher price. The increased tariffs on U.S. imports resulted in higher costs for dairy inputs, which led to increases in domestic dairy prices. From 2018 to 2022, the average prices for alfalfa increased by 15%, per capita milk output in Inner Mongolia declined by 9.2% (Cheng et al., 2022). The 2022 alfalfa hay price represented a 35.6% increase from 2021. Demand for dairy products has been increasing in China over the past few decades, but imports of dairy products have declined significantly since the tariff war in 2018 and continue to show a downward trend (see Appendix Figure 11 - 12). The Figure 2, which shows a decreasing trend in local dairy production per capita. Consumption, on the other hand, is on an upward trend, and at the national level, the domestic dairy market is under pressure of over demand. So, the rise in input costs pushed the Chinese government to adopt a more self-reliant approach, focusing on enhancing domestic production capacity.

Table 1. Regression results of per capita and rural consumption of dairy products in Inner Mongolia

	Coef.	Std. Err.	t	P > |t|	[95% Conf. Interval]	
RPCCop	1.141776	0.1648225	6.93	0.000	0.7689212	1.51463
PCOop	-0.2331796	0.0500897	-4.66	0.001	-0.3464902	-0.1198689
_cons	2020.523	3.897209	518.45	0.000	2011.707	2029.34

Tables 1 show the time-series regressions for the Chinese Dairy Livestock Belt, with a significant downward trend in per capita production over the trade war period (coefficient is 1.14). While local per capita consumption shows a significant upward trend (coefficient is -0.233). Although this paper does not collect data on per capita consumption of dairy products nationwide, the trade tensions coincided with the growing demand for dairy in China, driven by consumer preferences for healthier diets (Sijiu Tong, 2024). As shown in Figure 2, the gap between production and consumption continues to widen, necessitating further policy interventions. There is potential for further expansion of the supply-demand range for dairy products in China, with trade tariff restrictions accelerating this change. In order to reduce the gap in supply and demand for dairy and livestock production in China, South-South trade in agricultural foods has substantially increased (V. H. Smith & Glauber, 2020).

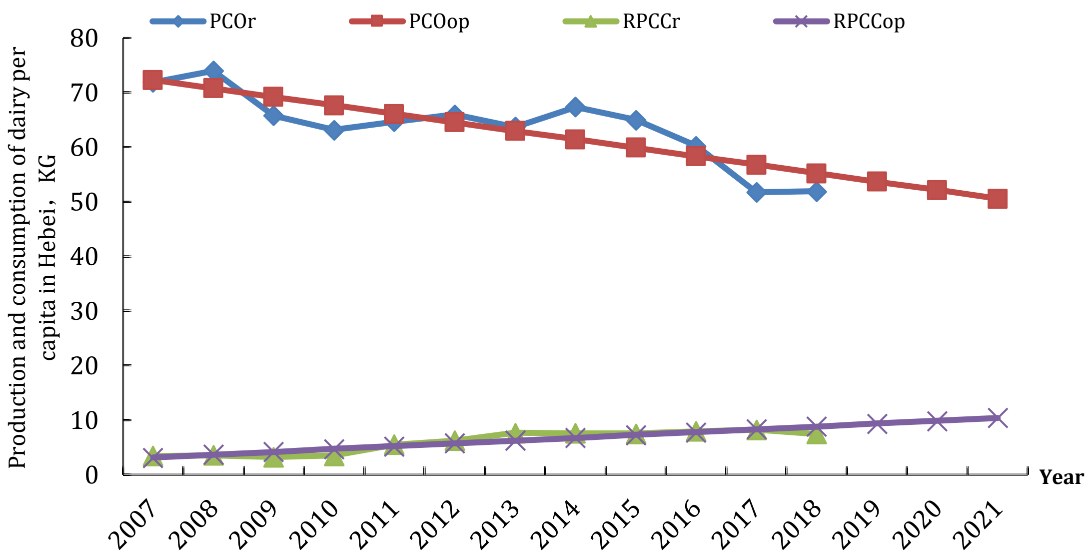

Figure 2. Production and consumption of dairy per capita in Chinese dairy belt 2007-2021

Note: 1. PCOr: the observed value of per capita production of dairy products. 2. PCOop: the regressed per capita dairy products. 3. RPCCr: the observed value of per capita consumption of dairy products. 4. RPCCop: the regressed per capita consumption of dairy products. Source: China Dairy Association

Twin Tariffs on Forge and Dairy

The twin tariffs imposed on forage and dairy increased the dairy inputs cost, and supply prices due to trade war in China. The Figure 3[1] use simple model illustrated that input and output changes with twin tariffs on both of inputs and outputs by China. P_1 is free trade price of alfalfa, Q_d is domestic supply, $(F_s - Q_d)$ is import amount of alfalfa. After tariffs imposed on it, the price of alfalfa increased to P_2 and import amount reduced to $(Q_2 - Q_1)$, supply of alfalfa decreased to Q_2. The dairy import amount decreased from $(F_s - Q_d)$ to $(Q_4 - Q_3)$ due to tariffs and price increased to P_4. The tariffs collected by China government on alfalfa is (abcd) green rectangle and (efgh) blue rectangle on dairy production. Besides, the dairy shift supply curve shift to the left due to supply

[1] Twin tariff: tariffs imposed on both inputs (alfalfa) and outputs (dairy), tariffs imposed on alfalfa increased the dairy inputs cost, then the dairy supply curve shift to the left.

of alfalfa decreasing and marginal input cost increased, so the price of dairy increased significant. Higher tariffs on alfalfa and oat hay resulted in a price surge of 20–25% for these inputs (China, 2023; Rose, 2024). As a result, dairy farmers in Inner Mongolia faced increased production costs, leading to a 10% rise in retail milk prices by 2021. But higher price of alfalfa, oats and hay simulates the productivity of Chinese domestic farmer. Before 2022, Chinese importers worried that potential future lockdowns would increase freight prices further and thus decided to expand and replenish their inventories. China imported 999,518 tons of alfalfa hay in 2023, a decrease of about 40% compared to 2022 (see Appendix Figure 8) (Dokken, 2024). According to the statistics of China Customs, alfalfa imports decreased 0.7% in the first quarter of 2024, but import value was US $164 million and declined 35.0%. The average cost, insurance, and freight (CIF) price of alfalfa peaked at $596.1/T, then declined to $383.60/T in 2024, driven by inventories and weakened demand in China, and preliminary data indicate an upward trend in 2025.

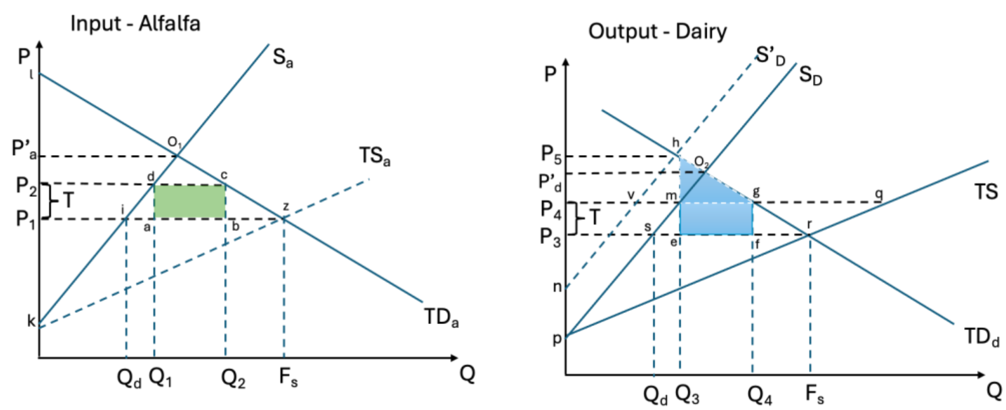

Figure 3. Twin tariffs impact on Chinese dairy industry

The dairy production companies in China which benefit from reduced competition of imports but suffered from higher inputs costs. Household farms emerging increase and get higher price competitiveness. According to the China Food Consumption Report 2022, the number of household farms in China has risen significantly in the post-covid19 era, especially in Inner Mongolia, where local dairy farms become more optimistic. Many residents are shifting their place of dairy consumption to local small farms. So, the true per capita consumption growth is likely to be steeper. China's retaliatory tariffs on alfalfa, oats, corn and soybeans led to an oversupply in the U.S. market leading to a decline in feed costs (Unveren & Luckstead, 2020). Meanwhile, the average price of milk decreased 8.5% from 2022 to 2024 in U.S. city due to export decline (U.S. Bureau of Labor Statistics). The profitability of dairy farming continued to decline, with the price-cost ratio falling from 1.07 in January to 0.98 in December of 2023. According to the National Dairy Cattle Industry Technology System, the average production cost of raw milk on farms was \$0.546/kg. The 2023 Dairy Cattle Industry and Technology Development Report released by China National Dairy System predicts that raw milk production is expected to continue to increase as average cost increasing. Table 2, twin tariff impacts are illustrated as above, if only impose tariff on alfalfa, then tariff revenue will decrease, and dairy producer will loss more, but consumer will loss less. However, if tariffs are imposed solely on dairy products, alfalfa farmers would not incur losses, while dairy producers could experience relative gains. If there are prohibit tariff, there will no trade, but alfalfa producer will gain more but dairy producer loss more compare with twin tariff.

Despite these challenges, policies introduced in 2020 included subsidies for local forage growers and investments leading to an expansion in dairy output by 2023 (Steinberg & Tan, 2024; Sijiu Tong, 2024). While China's dairy farming industry has been expanding, the purchase price of fresh milk decreased from 2022. In 2023, China produced 41.97 million tons of milk, an increase of 6.7 percent compared to 2022, marking the fourth consecutive year of a production increase of over 6% (Dokken, 2024). Additionally, the alfalfa hay import price decreased from \$596/ton to \$400/ton from 2022 to 2023 due to less demand of alfalfa import in China (Appendix Figure 4 - 9).

Table 2: Different scenario of tariff imposed on alfalfa and dairy

Case scenario	Tariff revenue	Production surplus changes		Consumer surplus changes
		Alfalfa	Dairy	
Twin tariff	abcd + efgh	$+P_1P_2di$	$P_5hn - P_3sp$	$-P_5P_3rh$
Tariff on alfalfa	abcd	$+P_1P_2di$	$P_4vn - P_3sp$	$-P_4P_3rg$
Tariff on dairy	efgm	0	$+P_3P_4ms$	$-P_4P_3rg$
Prohibit tariff	No trade	$+P'_aP_1iO_1$	$P_5hn - P_3sp$	$-P_5P_3rh$
Subsidy on alfalfa	efgm	$+k'kcd$	$+P_4P_3sm$	$-P_4P_3rg$

Producer Subsidies Effects

Following the Chinese government's implementation of a subsidy to alfalfa producers as a countermeasure, an alternative scenario emerges, depicted in Figure 4. Under this scenario, the optimal subsidy provided to domestic alfalfa suppliers shifts the alfalfa supply curve from S_a to S'_a, there will be no trade on alfalfa in extreme case period (other configuration would allow for trade alfalfa). Domestic alfalfa producer surplus will increase (k′kcd) and dairy producer surplus will increase (+P_4P_3em) relative to the unsubsidized scenario. Thus, alfalfa farmers are effectively protected without negatively affecting dairy producers, and consumer losses are mitigated compared to the twin-tariff scenario.

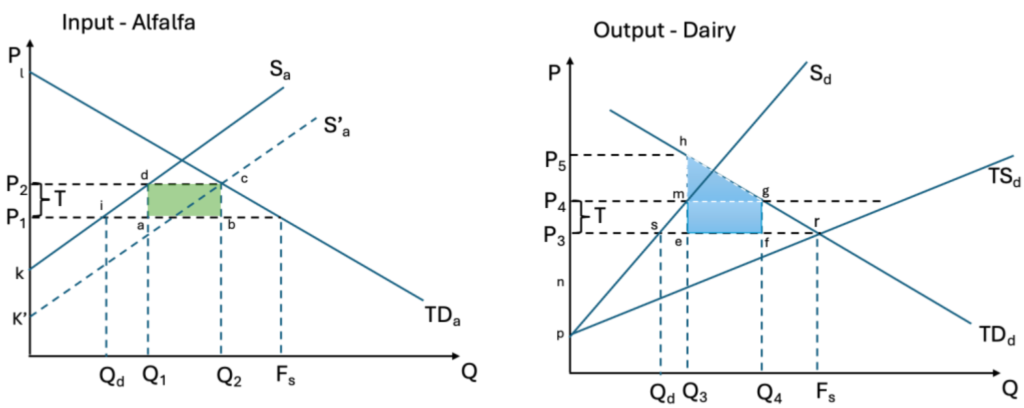

Figure 4: Implemented subsidies on alfalfa after tariff imposed

Besides, in response to the trade-war, Chian made efforts in trade diversification away from the U.S. PIIE research shows that China has sought out alternative markets for its agriculture imports, even while the U.S. remains reliant on Chinese import demand (Rose, 2024). China has also ratified its participation in the Regional Comprehensive Economic Partnership (RCEP), the world's largest free trade area by market size, and applied to join the Comprehensive and Progressive Trans-Pacific Partnership (CPTPP), neither of which includes the U.S. as a member (Rose, 2024; China, 2023). China's diversification into alternative markets push future U.S. tariffs impacts to be smaller bite and weaker leverage. China's imports of alfalfa meal/pellets totaled 15.12 million kg in 2023, primarily sourced from Italy and Spain, with only 24,745 kg imported from the

U.S., representing a decline of about 90% compared to 2022 (World Integrated Trade Solution). However, the U.S. remained China's principal supplier of imported alfalfa hay, providing 898,186 tons, accounting for 89.9% of the market (see Appendix Figure 1-4, 7-10).

The optimal welfare tariff is welfare-improving for the importing country, but these tariffs create a net loss when all countries are considered. Importing businesses pay tariffs and decide whether to pass any portion of the cost on to consumers through higher prices in China (Schmitz et al., 2022). The tariffs that China imposed on U.S. exports were calculated to broadly match the value of U.S. tariffs, avoiding a spiral of escalation, but they were economically costly for the U.S. agricultural exports to China suffered, compelling U.S. to channel tens of millions of dollars' worth of subsidies to farmers (Steinberg & Tan, 2024). The revenue generated by tariffs for China during the trade-war would have been a temporary boost, but it came at the cost of higher prices for Chinese consumers. By late 2019, the U.S. had imposed tariffs on roughly $350 billions of Chinese imports, and China had retaliated on $100 billion U.S. exports but with expense welfare loss of about 0.3% of GDP (P. D. Fajgelbaum & Khandelwal, 2022). Trump's tariff policy failed to account for the differing terms-of-trade effects that tariffs have on large versus small countries. Small countries are price taker, but large country can influence the world prices through trade policy. For example, China impose tariffs on dairy can lower the world price from P_f to P_a due to reduced demand and increased domestic supply (see Appendix Figure 12-13). To generate the same level of tariff revenue (cdef) in a large country as that produced by the initial tariff T_0 in a small country, the tariff should be higher (see Appendix Figure 13). If China imposes an optimal import tariff (P_B' –P_A') on alfalfa, it acts as a monopsonist on the buying of imports from U.S.

Export subsidies have long been viewed as particularly trade distorting because of their targeted use for specific commodities in specific markets. But this benefits countries with relatively low national incomes and inadequate food supplies, especially those that depend on imported food. Richer countries' domestic agricultural subsidy and export restraints programs may have long-term adverse real income and food security impacts in lower income countries (V. H. Smith & Glauber, 2020). In the context of agricultural commodities, the U.S. have used some subsidy on agriculture and export restraints and with the primary objective of lower prices within the country but to reduce the commodity's availability on world markets and raise its price on the international market, and removing government surpluses (Gaigné & Gouel, 2022).

Empirical Results

The U.S. is the world's largest alfalfa exporting country, comprising 15.46 million acres on average. Alfalfa exports totaled 2.8 million tons in 2022 and decreased to 0.89 million tons in 2023 due tariff barriers (*China*, 2023; USDA, n.d.). Retaliatory tariffs make U.S. corn, oats and alfalfa export to be three-year low, although exports to Canada and Mexico are increasing because these two countries markets cannot compensate the China market loss (Adjemian et al., 2019). The Trump administration provided $28 billion aid to farmers who suffered from the trade war, which implies the actual loss is close this level (Morgan, 2022).

Table 3. Estimated Losses by Commodity

Commodity	Est. annualized losses in $MIl
Dairy	$367
Soybean	$10664
Wheat	$344
Corn	$216
Coarsegr	$904

Sources: (Grant et al., 2021; USDA ERS - Agricultural Trade, n.d.)

China is the largest importer of alfalfa, soybean, and corn (land intensive non-food crops) from U.S (*USDA*, 2023). Chinese per capita farmland scarcity diet structure changes determines its imports demand of dairy products and forge (China, 2021). China's demand for U.S. alfalfa remains strong, but ongoing tariffs, non-tariff barriers, and currency fluctuations continue to create headwinds for U.S. exporters. Table 3 shows estimated export value losses by commodity of U.S. in 2020 (Miller, 2023; *USDA ERS - Countries & Regions*, n.d.). The new tariffs are measured affects more than $18 billion in trade coverage, as compared with total U.S. merchandise imports of $3.826 trillion in 2023 (Steinberg & Tan, 2024; Wolff, 2024). U.S. export to China is forecaster to be down by over 1 billion dollars from 2023 (Kenner, 2024; Hanrahan, 2024; *USDA ERS*, n.d.).

Dairy producers and forage exporters should stay informed about policy changes that could affect market access because the agricultural sector remains sensitive to policy shifts. As of 2024, the trade situation between the U.S. and China, particularly concerning agricultural products like alfalfa and oat hay, remains affected by lingering tariffs from the trade war that began in 2018. These tariffs range between 10% and 25%, which has impacted U.S. hay exporters by making their products more expensive for Chinese buyers (*China, 2024*, 2023, 2021). The Figure 5 demonstrated the short-run dynamic impacts of the tariff war on the dairy supply chains in both countries. Dairy production declined from 2018 to 2020 due to increased input costs and tariffs restrictions in China. Following China's imposition of tariffs on primary feed ingredients and dairy products, the price of whole milk in the U.S. decreased, leading to varying degrees of economic losses across states because of retaliatory tariffs.

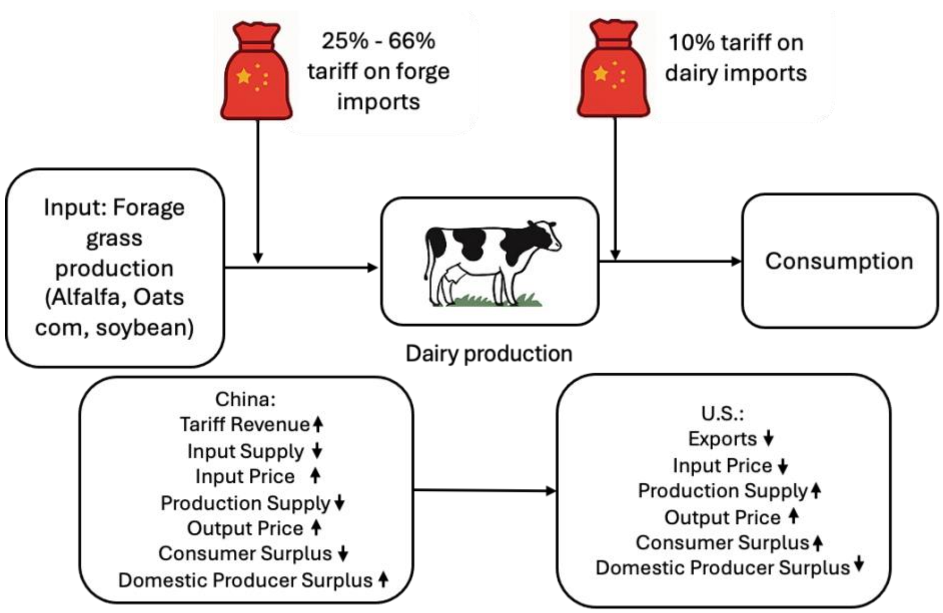

Figure 5. Tariffs impacts on dairy supply chain

The findings of this study illuminate the multifaceted impacts of the U.S.-China trade war on China's dairy sector. Increased tariffs on alfalfa and oat hay disrupted the input supply chain for dairy farmers. These challenges initially weakened China's dairy production capacity. Subsidies for local forage and investment support for regional dairy bases in Inner Mongolia have collectively improved the sector's resilience. Besides, increased tariffs and rising import costs also led China to ramp up policies supporting local production. These policies provide financial incentives for dairy production, forage production, and improving breeding practices to boost output and quality standards. Additionally, the Chinese dairy sector's reliance on imported feed revealed vulnerabilities that were exacerbated by tariffs. Policy responses should consider following points: 1. Expanding trade partnerships can reduce dependence on single suppliers. 2. Mechanization and precision agriculture can improve efficiency. 3. Aligning trade policies with domestic agricultural strategies is critical for sustainable growth.

Conclusion

The U.S.-China trade-war imposed tariffs on agricultural imports increased production costs and disrupted supply chains, and spurred policy innovations aimed at enhancing self-sufficiency. This paper provides the study of the impacts of trade-war on animal feeds and dairy industries. The imposition of tariffs led to increased input costs, which initially threatened the stability of dairy and livestock production. These findings align with Unveren & Luckstead, (2020) and Farrokhi & Pellegrina, (2023), who demonstrated that tariffs on agricultural inputs lead to reduced productivity, particularly in sectors reliant on imported resources.

From 2020 to 2022, there is a sharp increase in U.S. forage exports, and Chinese dairy consumption demand increased a lot (see Appendix Figure 1-4, 11). U.S. dairy price represented a significant decrease after 2022, due to alfalfa export reduced and inputs cost decreased (see Appendix Figure 5-6). Hou et al., (2024) highlights the U.S. immense potential advantage in alfalfa trade with China. Changes in China's dietary structure, especially the growing demand for dairy products, may turn alfalfa trade into a new highlight. But from 2024, agricultural trade between China and the U.S. fell by 32.8% to $11.02 billion. China is also a significant importer of oat grass from Australia due to Australia's proximity, sufficient production, and a zero tariff on exports to China. However, in 2021, political tensions between Australia and China resulted in trade disruptions, during which most export permits for Australian oat grass facilities expired and were not renewed. In 2023, China imported only 72,029 tons of oat grass from Australia, a decrease of 52.72 percent (Dokken, 2024). So, the cost of dairy production in China may get a significant increase in the future.

Chinese government implemented a series of measures aimed at bolstering domestic production and reducing reliance on imports. These measures included subsidies for forage supply farmers, investments in agricultural infrastructure and farming technologies, and the establishment of model dairy farms, all of which contributed to mitigate some of these adverse impacts and improve resilience of the dairy industry (Smith & Glauber, 2020). Besides, as China continues to diversify its trade partnerships and invest in domestic agriculture, the dairy and livestock sector demonstrates resilience in the face of international trade disruptions (V. H. Smith & Glauber, 2020). The Inner Mongolia dairy industry provides a valuable case study for other regions navigating similar trade challenges. Even the production of dairy was expended in last 3 years, the production cost is still high due to poor performance of dairy farming industry and tariff uncertainty in China. Moving forward, optimal tariff policies and international collaboration will be pivotal in ensuring the comparative competitiveness of agriculture (Van Kooten et al., 2022).

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Appendix:

Table 1. Significance test of the regression for per capita dairy production and consumption

Source	SS	DF	MS	
				Number of obs = 12
Model	136.189277	2	68.0946137	F(2,9) = 89.98
Residual	6.8107725	9	0.756752506	Prob > F = 0.000
Total	143	11	13	R-squared)= 0.9524
				Adj R-squared = 0.9418
				Root MSE = 0.86992

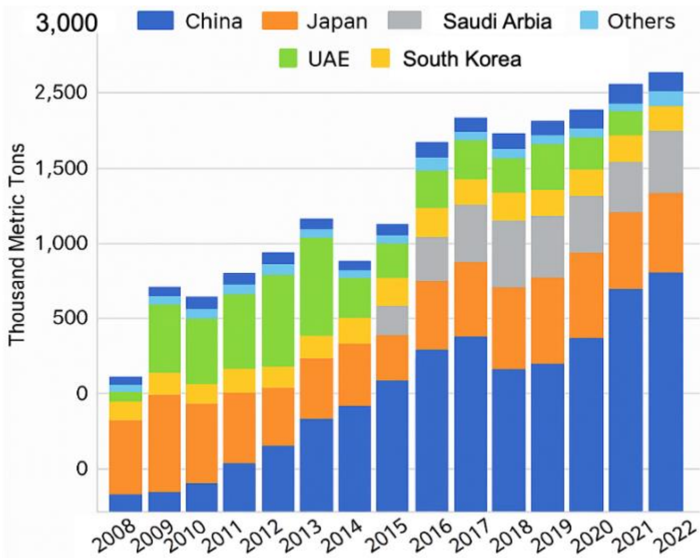

Figure 1: U.S. alfalfa hay export quantities by top destinations (Thousand tons)
Source: USDA-FAS; Hay & Forge Grower (2024)

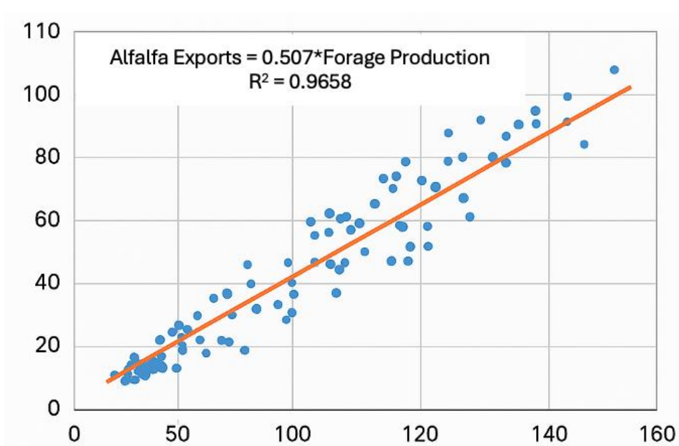

Figure 2: Relationship of U.S. alfalfa exports to all states to forage production exports (Million US$)
Source: Sall et al., (2023)

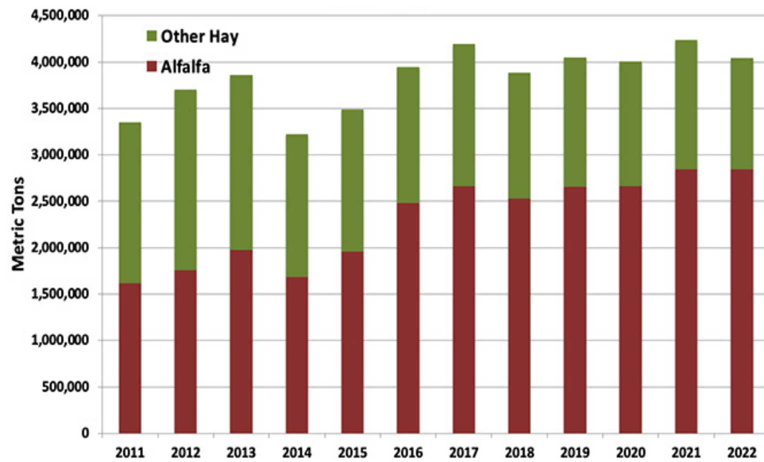

Figure 3: U.S. hay exports from 2011 to 2022
Source: Hay & Forge Grower, 2024; USDA-FAS

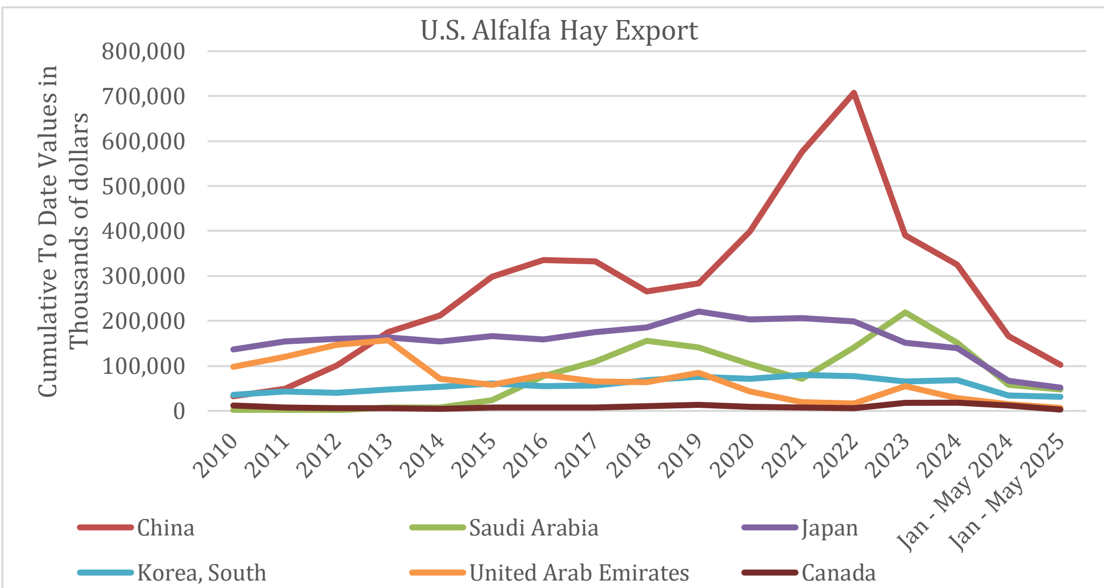

Figure 4. U.S. alfalfa export value from 2010 to 2025
Source: U.S. Census Bureau Trade Data

Figure 5: Average price of milk, fresh, whole, fortified in U.S. city (US$/gallon)
Source: U.S. Bureau of Labor Statistics via FRED

Figure 6: Distribution of estimated annualized losses due to retaliatory tariffs
U.S. dollars (Million)
Source: Morgan, S. (2022)

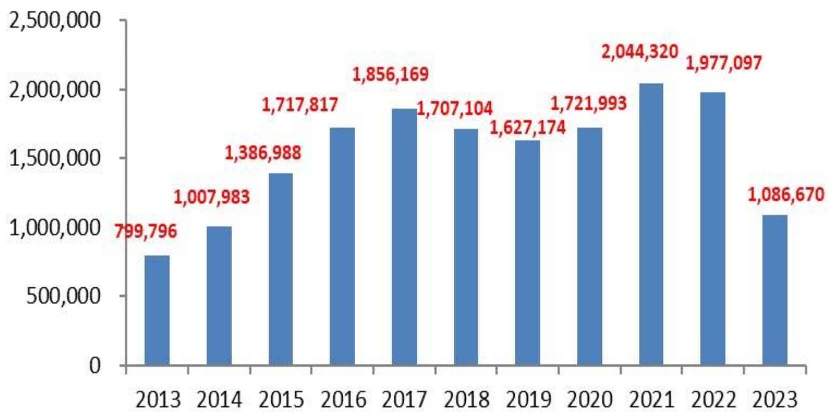

Figure 7: China's import of forages (tons)
Source: GACC Statistics; USDA-FAS, (2024)

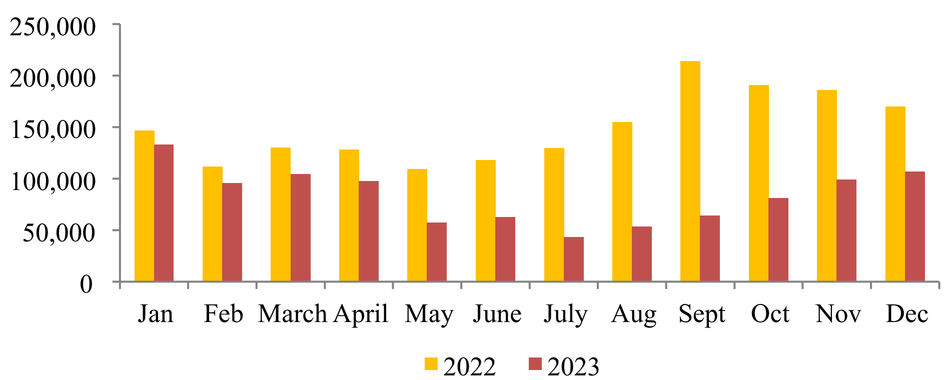

Figure 8. China's imports of alfalfa 2022 vs 2023 (tons)
Source: GACC Statistics; USDA-FAS, (2024)

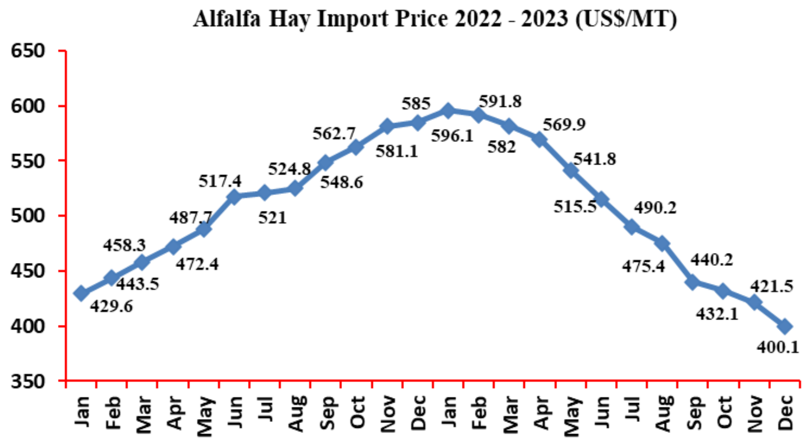

Figure 9: China's alfalfa hay imports price from 2022 to 2023 monthly (US$/ton)
Source: Holstein Farmer (China); USDA-FAS, (2024)

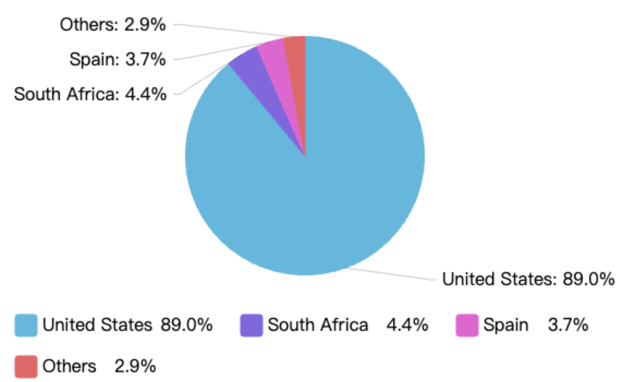

Figure 10: Chinese alfalfa hay imports in 2023 (Tons)
Source: 2024 Market Overview - Alfalfa Hay and Other Forages in People's Republic of China

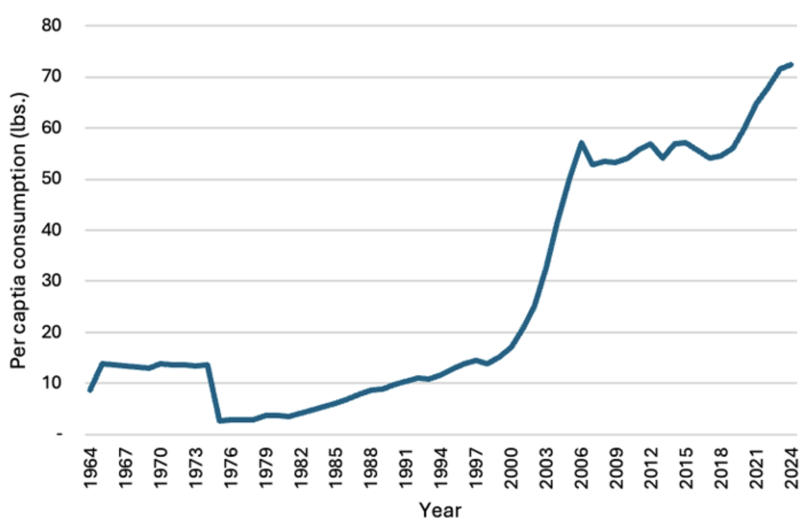

Figure 11: China's per capital dairy consumption from 1964 to 2024
Source: Hoard's Dairyman Intel

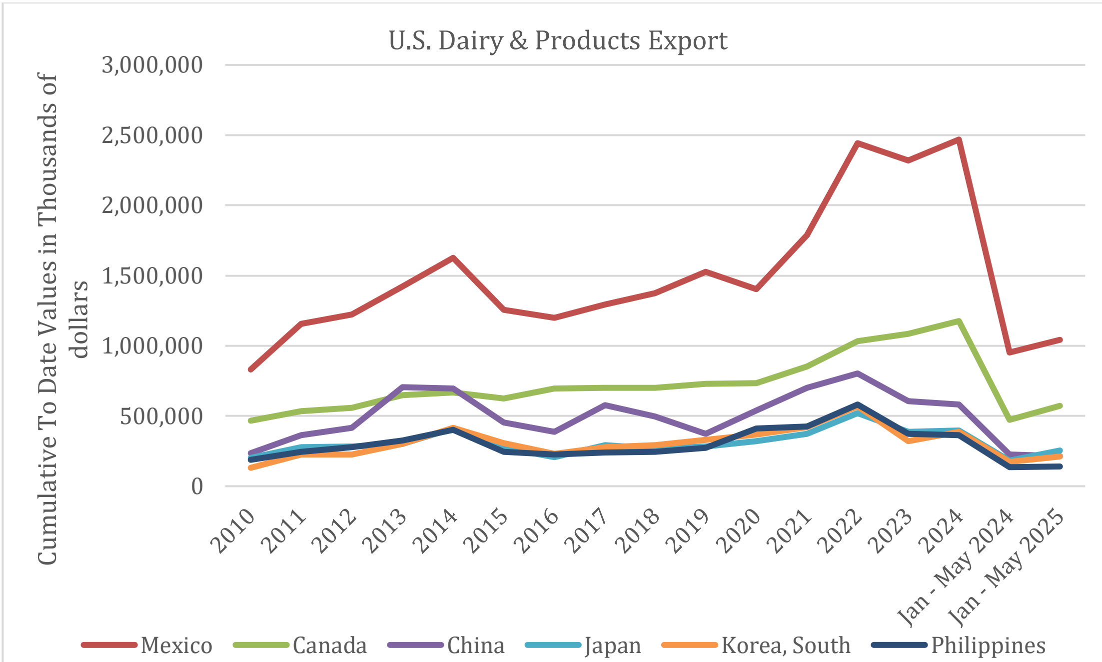

Figure 12: U.S. dairy & products export value from 2010 to 2025
Source: U.S. Census Bureau Trade Data

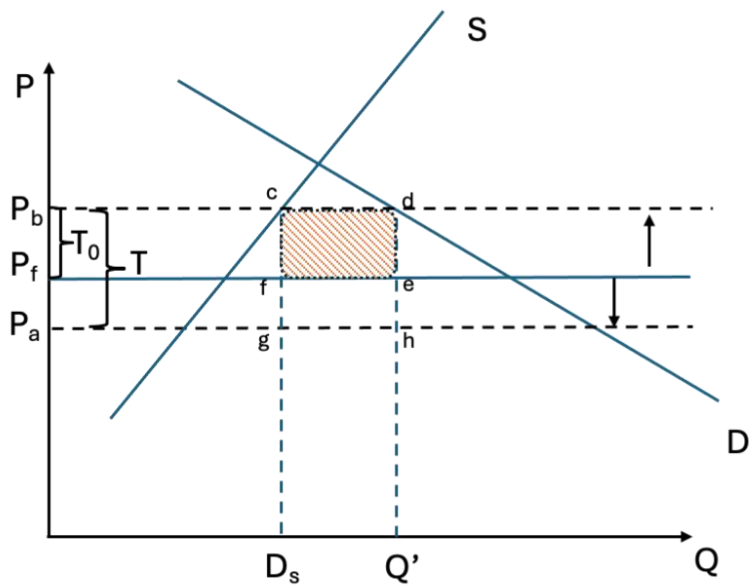

Figure 13. Effects of tariffs on terms of trade effects in large county and small country

Notes: Given the supply S_d and demand TD, the free trade price is P_f, for the tariff T_0 in the small country assumption, trade restricted import is Q' – Ds. For the large country case, this is no longer true, consider the effect of tariff T result in the change of the trade. The result changes the size of tariff revenue is (cdef) in small country, however the lager country is (ehgf).

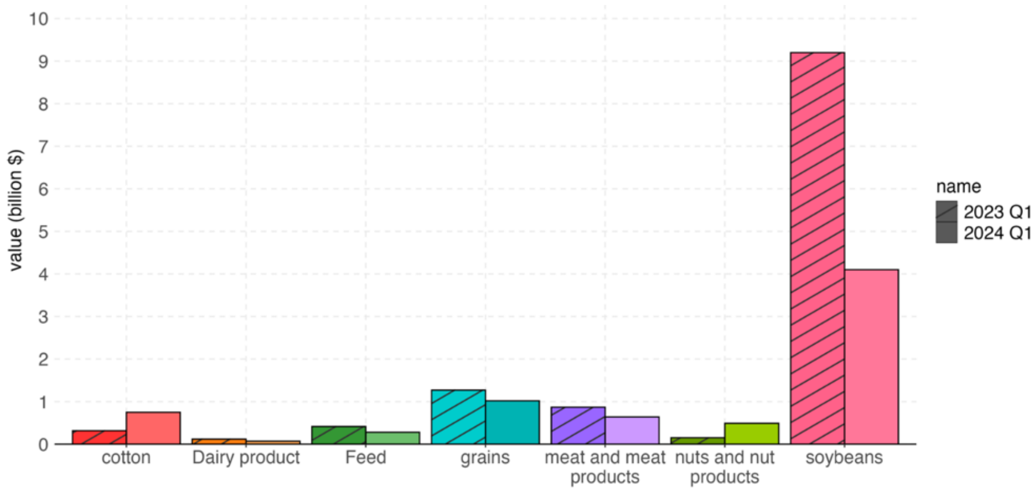

Figure 14: U.S. Main export product to China comparison between 2023 Q1 and 2024 Q1
Source: Hou et al., (2024). General Administration of Customs, China

Figure 15: Oats Prices - 45 Year Historical Chart
Source: Macrotrends (https.www.macrotrends.net2536oats-prices-historical-chart-data)

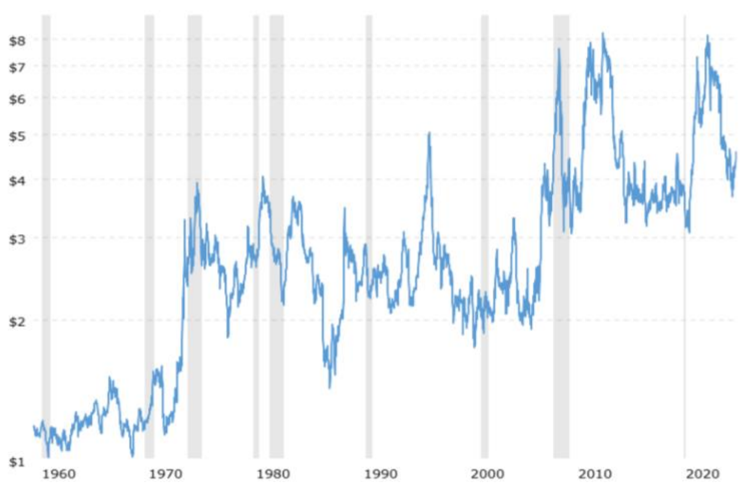

Figure 16: Corn Prices - 55 Year Historical Chart
Source: Macrotrends (https.www.macrotrends.net2536oats-prices-historical-chart-data)

Figure 17: Soybean Prices - 45 Year Historical Chart
Source: Macrotrends (https.www.macrotrends.net2536oats-prices-historical-chart-data)

Table 2: Estimated Trade Losses from Retaliatory Actions

Retaliatory Partner	Est. annualized losses in $MIl
China	$14079
Canada	$1658
Mexico	$342
EU	$329

Sources: (Carter & Steinbach, n.d.; Grant et al., 2021)

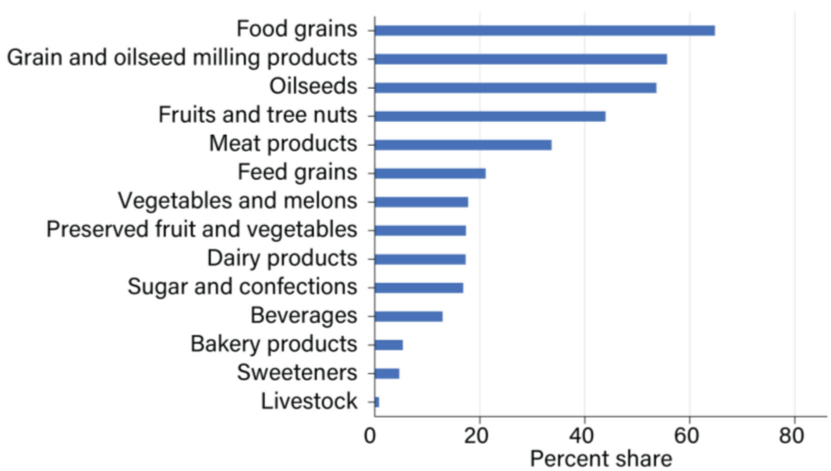

Figure 18: U.S. export value share of production from 2013 to 2022
Source: USDA, Economic Research Service using data from U.S. Department of Commerce, Bureau of the Census.

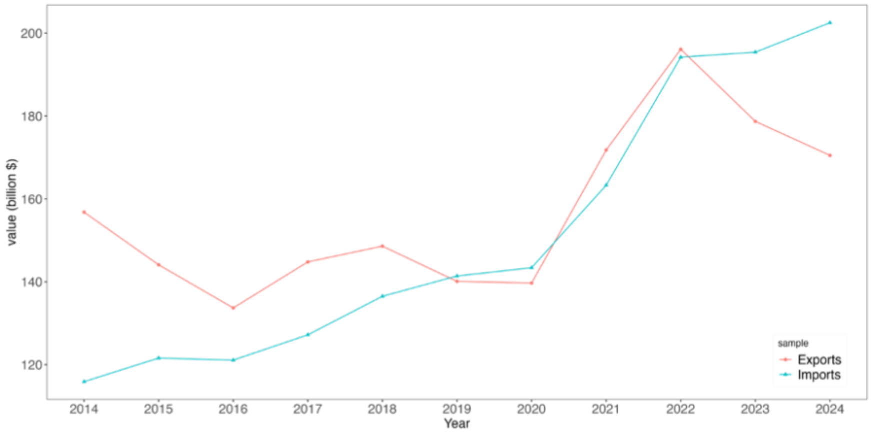

Figure 19: Yealy trend of the U.S. agricultural exports and imports from 2014-2024
Source: Hou et al., 2024. USDA, Economic Research Service, Foreign Agricultural Service analysis and forecasts using data from U.S. Department of Commerce, Bureau of the Census.

For Further Information on U.S. Agricultural Exports from USDA