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U.S. Export and Domestic Feed Price Trends, 1994-2022

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Abstract

U.S. hay exports have been growing in importance in recent years with alfalfa hay representing most of this increase. Forage export prices have been steadily increasing since the early 2000s, and China has emerged as a major importer of alfalfa in the last decade. In general, real prices for alfalfa, other hay, corn, and soybeans have all trended higher over the 1994-2022 period. However, the spread between export and domestic prices has trended larger for other hay and alfalfa, while the spread for corn and soybeans has been flat. This result is believed to be related to the fact that hay is bulky to move and transport, such that it does not possess the same level of arbitrage between regions that grain transport enjoys. Essentially, all alfalfa and other hay exports originate from the seven most western states of our forty-eight contiguous states as well.

Keywords: Alfalfa, China, Corn, Linear Slope Trend, Other Hay, Soybeans

Introduction

The United States is the largest producer and consumer of alfalfa. This forage can be grown in a mixture with other forage grasses to make "other hay" although it is commonly grown exclusively as alfalfa. The crop's versatility and beneficial traits have pushed it to dominate the global forage market, and the U.S. has emerged as the dominant exporter. Alfalfa is used as livestock feed and is an important protein (Hadidi et al., 2023; Sumner and Rosen-Molina, 2011) and nutrient source, particularly for dairy cattle (Tahir et al., 2022; Tejeda, Kim, and Feuz, 2015). U.S. alfalfa exports are increasing as Asia seeks out U.S. fodder to 0 their growing demand for high quality protein. In addition, alfalfa hay can be used for industrial uses that include biofuels, ethanol, and enzymes (Hojilla-Evangelista et al., 2017; Sumac, Jung, and Lamb, 2006). Alfalfa can also be used as a nutrient dense alternative to wheat flour in the production of bread (Ullah et al., 2016).

Exports help set the market price for hay and compete with domestic end users, who often use hay as a cost-effective feed substitute for corn and soybeans. As shown below, forage export prices have been steadily rising since the early 2000s. Changes in alfalfa demand and prices can greatly affect a state's dairy industry (Hatzenbuehler et al., 2021) and competing dairy feed markets of corn and soybeans (Tejeda et al., 2019). The prices of these three crops have significant implications for consumers as their prices impact the cost of feed for livestock, which, in turn, affects the prices of meat, poultry, and dairy products. Furthermore, the relationships between U.S. export and domestic feed prices are also important for consumers and producers.

To better understand export and domestic prices of hay in relation to other feeds over recent decades, we analyze trends between export and domestic prices and alfalfa export prices compared to other feeds. This paper aims to: (1) quantify trends in U.S. hay export values and identify the top

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importers from 1994 to 2022, (2) analyze trends in monthly export and domestic prices for alfalfa, other hay, corn, and soybeans during the same period, and (3) evaluate the trend between differences in export and domestic prices for alfalfa, other hay, corn, and soybeans.

Hay Export Value Trends and Top Importers

As described in Figure 1, real hay export values have been on a general upward trend from 1994 to 2022. The value of all U.S. hay exports has experienced rapid growth overall, with only a few short periods of decline throughout the past two decades, with certain countries emerging as major importers of U.S. hay. In 1994, hay export values totaled around $370[3] million, but they have steadily increased to reach 1.03 billion in 2009 and $1.7 billion in 2022. However, there were also some years when other hay export values decreased or remained almost flat, from 2002 to 2006 and 2012 to 2018.

Growing populations which demand more milk and meat production appear to have driven the demand for high value animal protein higher, which, in turn, has had a positive impact on the global hay market. This trend largely is driven by livestock markets in East Asia, especially China, and Japan. In these markets, alfalfa is a key ingredient of commercial feeds for dairy cattle and other hay is used for Kobe beef and other livestock nutritional needs (Priolo, Micol, and Agabriel, 2001). The need for hay and forage in these markets is increasing due to their rise in animal production, particularly in countries where land and water resources are at a premium (Putnam et al., 2018).

Japan has traditionally been the leading importer of all hay from the U.S., representing between 50% and 95% of all hay exports in any given year over the 1994-2011 period. However, in 2008, China started to import alfalfa, and they have grown their imports such that in the last couple of years, they have surpassed Japan as the leading importer of all hay. The U.S.' high quality alfalfa is well renowned worldwide, and the Japanese have unique demands for the quality of hay and other feed products (USDA/FAS, 2021). These demands must be met to secure their competitive positions. Other major hay importers are South Korea, Taiwan, United Arab Emirates, and Saudi Arabia. The increasing demand for meat and dairy products, growing consumer income, and growth in animal husbandry are the primary growth drivers for forage (Matthews and Summer, 2019; Putnam et al., 2018). Recent years have seen hay exports reach record levels in both volumes and values. Overall, the growth in hay exports has largely been driven by an increased demand in alfalfa hay from China. A structural change has occurred in China's dairy industry from rather small to large, more modern milking parlor dairies that may prefer alfalfa, mainly imported, as an important feed due to quality, price, and consistency in supply throughout the year (Wang and Yang, 2020; Wang, Hansen, and Xu, 2016).

Alfalfa Hay

In 1994, alfalfa hay exports from the U.S. totaled nearly $95 million in 2022 dollars (Figure 2). Since then, export values have steadily increased 13-fold, reaching $1.2 billion in 2022. During this same period, several countries emerged as key importers of alfalfa hay from the U.S., particularly China and Japan, who together accounted for nearly 68% of total imports from 1994 to 2022 (Figure 2). South Korea, with 15% of total imports during the same period, is the third largest U.S. hay importer.

[3] All prices and export values are inflation adjusted using the Consumer Price Index for all goods and December 2022 as the base month.

China is currently the leading importer of alfalfa hay, and the rapid growth of its dairy industry (Gooch, Hoskin, and Law, 2017; Fuller et al., 2005) is the main driver for alfalfa demand within the country. China's real alfalfa imports have been steadily increasing, going from around $25 million in 2009 to $709 million in 2022, a 28-fold increase in just 12 years with an annual average increase of nearly $53 million. In contrast, U.S. export values to Japan, the second largest importer, fluctuated between $186 and $257 million during the same period. A growing demand for high quality animal feed appears to be driving growth in the alfalfa hay market, which is mainly driven by greater dairy and meat production. Moreover, a growing awareness about animal nutrition and a rising consumer preference for chemical-free meat and milk products is also contributing to market growth (Bai et al, 2022; Putnam et. al, 2016).

Other Hay

Other hay exports, primarily grass hay exports, also remain an important part of U.S. agriculture exports. In 2022, the five major importers of U.S. other hay are Japan, South Korea, Taiwan, United Arab Emirates, and China, with respectively 61.5%, 21.8%, 6.8%, 2.5%, and 2% of the total value of U.S. other hay exports. Japan has consistently been the largest single purchaser, and the trend in Japan's import values of other hay from the U.S. has grown substantially over the past three decades, reaching its peak in 2012 with a total value of more than $500 million (Figure 3). While the country remains the top importer, its import values have declined since 2012.

South Korea is the second largest importer of other hay from the U.S. In 1994, the country's imports from the U.S. were valued at a little more than $1 million, and in 2022, the imports were valued at almost $107 million, representing a 107-fold increase.

Notably, there have been some changes in the ranking of these countries over the years, with some countries increasing or decreasing their imports from the U.S. For example, the United Arab Emirates ranked third between 2009 and 2012, ahead of Taiwan and China, and remained in the fourth position in terms of value exported in the subsequent years.

Export and Domestic Price Trends

To better understand how relative feed prices of alfalfa, other hay, corn, and soybeans have changed in both domestic and export markets, we plot both export (Figure 4) and domestic (Figure 5) prices for these commodities. Alfalfa exports experienced a price increase from an average price in 1994 of $289/ton to an average price in 2022 of $386/ton (Figure 4), with an overall average of $301.74/ton (Table 1) during the period 1994-2022, while other hay prices rose from an annual average of $281/ton in 1994 to $371/ton in 2022 (Figure 4) with an overall average of $302.09 /ton (Table 1) over the same time period. During the last quarter of 2022, alfalfa export prices have been on an upward trend, starting from $448 in September and reaching $457 in December (Figure 4). This surge has surpassed the previous peak of $402 in April 2015, indicating solid foreign demand for alfalfa. Export prices for soybeans increased dramatically, rising from an average of $447/ton in 1994 to nearly $660/ton at their peak annual average in 2012, with a notable spike to $728.50/ton in October of that year (Figure 4). Subsequently, prices steadily declined until 2020, averaging $396/ton. In 2021, soybean export prices started increasing again and were, on average, for the year at $537/ton, an increase of 36% from the prior year.

A graphical overview of prices and price trends for other hay and alfalfa (Figure 6a) and corn and soybeans (Figure 6b) is provided for 1994 to 2022. These graphs highlight price trends in export

and domestic markets for each feed commodity and reveal how the export and domestic prices for these commodities can move separately at times. For example, from August to September of 2022, alfalfa export prices jumped by over 45% while the domestic U.S. alfalfa price increased by only 0.51%.

From 1994 to 2022, export prices of alfalfa and other hay were, on average, 58% and 109%, respectively, higher than their domestic prices (Figure 6a). Yet export prices for corn and soybeans were, on average, only 25% and 13%, respectively, higher than their respective domestic prices (Figure 6b). We believe the larger spread of hay is mainly due to its form and location. Export prices are for compressed bales, and virtually all exports are from West Coast ports. Other hay prices for the U.S. are substantially less than domestic alfalfa prices, but export prices for other hay have been a bit above alfalfa in recent years. This difference is due to location and quality as most other hay in the U.S. is produced east of the seven most western forty-eight states that provide virtually all the other or grass hay for export through West Coast ports. Since most of the other hay from the seven most western states is grown under irrigation in a semi-arid to arid climate, it is likely of better quality than the other hay produced east of these seven western states in a more humid and wet climate.

Slope Differences

We used linear regressions to evaluate the differences in slope between each commodity's export and domestic price trend and the differences between alfalfa and other feeds' export price trends (Tables 2a and 2b). Each domestic and export commodity price was regressed against a monthly time trend (Table 2a), and we calculated the statistical differences in slopes (Table 2b). The difference in slope between two price series can provide insights into the relative trends of the two crops being compared. We find that the differences in slope between export and domestic prices are significant for other hay and alfalfa but not for corn and soybeans (Table 2b). The slope for the export price of other hay is 0.0156, while the slope for its domestic price is 0.0041 (Table 2a). The difference in slope suggests that the rate of change of the export price is almost four times as high as the rate of change of its domestic price during the period 1994-2022. The rate of change in alfalfa's export price is almost twice as high as what it is for its domestic price.

The estimated slope differences between exports of the four commodity crops are statistically significant except for the differences between alfalfa and soybeans and other hay and soybeans (Figure 2b). The estimated slope magnitudes in export price for other hay (0.0156) is higher than for alfalfa export (0.0108) (Table 2a), suggesting that the rate of change of the export prices for other hay is 44% higher than the rate of change for the alfalfa hay price. However, export price trends indicate that drivers on export prices do not necessarily correspond with overall rising U.S. prices when comparing the slopes (Table 2b). Other hay and alfalfa, in particular, show that their export prices (i.e., West Coast prices) have been rising more rapidly than their overall U.S. domestic prices.

Price Difference Values

The price trend for differences between export and domestic prices is rather interesting because this shows how markets may have gradually shifted over time for essentially the same product. For example, changes in international demand for alfalfa, corn, and soybeans could cause fluctuations in export prices that do not necessarily reflect their domestic counterparts. Additionally, certain government policies can also influence the comparative values between export and domestic prices.

Export and domestic price differences from 1994 to 2022 reveal some interesting trends. As one would expect, all four commodities had consistently higher export prices than their domestic counterparts (Figure 7). What is particularly noteworthy regarding the trend in differences between export and domestic prices is that the spread between these markets has steadily grown for other hay and alfalfa while the spread has been essentially flat for soybeans and corn. During the 1994-2022 period, the average difference between export and domestic prices of other hay, alfalfa, soybeans, and corn were, respectively, $185/ton, $110/ton, $52/ton, and $44/ton (Figure 7). The larger spread between export and domestic prices for U.S. alfalfa hay and other hay can be attributed to a complex mix of supply and demand factors, as well as transportation costs and market conditions.

Summary and Conclusion

This paper provides an overview of changes in U.S. alfalfa, other hay, corn, and soybean prices from 1994 to 2022 for export and domestic markets. Real prices for all commodities have generally trended higher over the period. Also, the export market has grown greatly for U.S. forage over this period, particularly for alfalfa hay. Indicators suggest that the increase in alfalfa exports has been driven by an increase in demand for dairy forage and scarcity of water and productive agricultural land in the Middle East and East Asia. The spread between real export and domestic prices has trended larger for other hay and alfalfa over this period, while the spread has been constant for corn and soybeans. This result is believed to be related to the fact that hay is still a relatively bulky commodity to transport between regions compared to grain, and virtually all hay exports are from the West Coast, the location with generally very favorable shipping rates to East Asia with many empty return containers and an ever-growing market for livestock forage.

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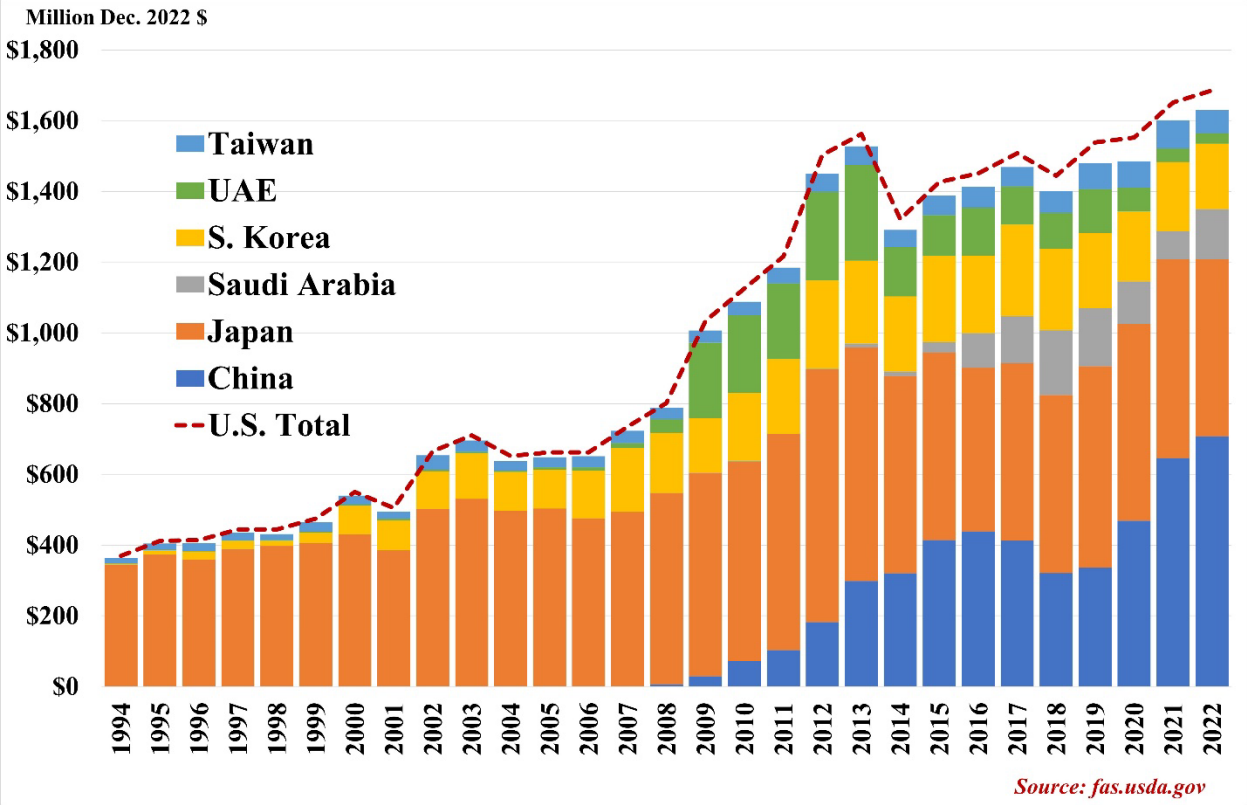

Figure 1: Real Value of All Hay Exports from the U.S. by Country, 1994-2022

Data source: (USDA/FAS, 2022)

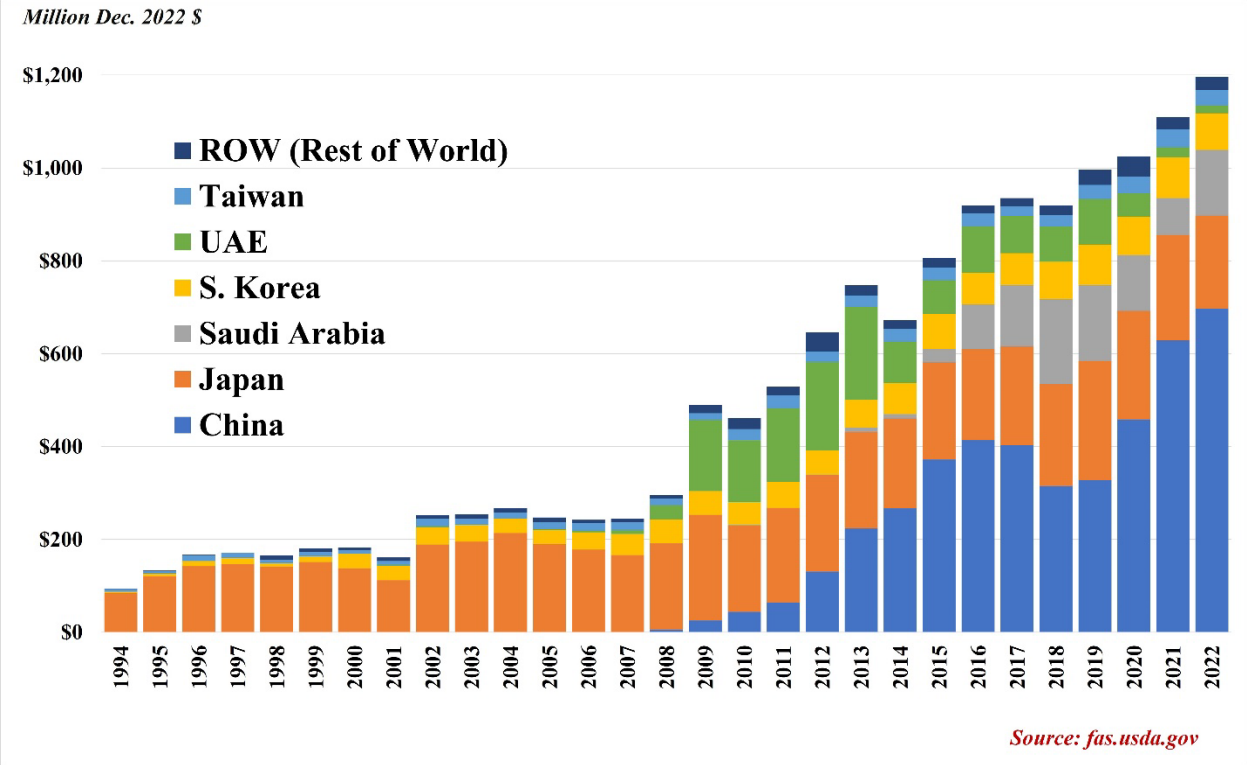

Figure 2: Real Value (December 2022 $) of Alfalfa Exports from the U.S. by Country, 1994-2022

Data source: (USDA/FAS, 2022)

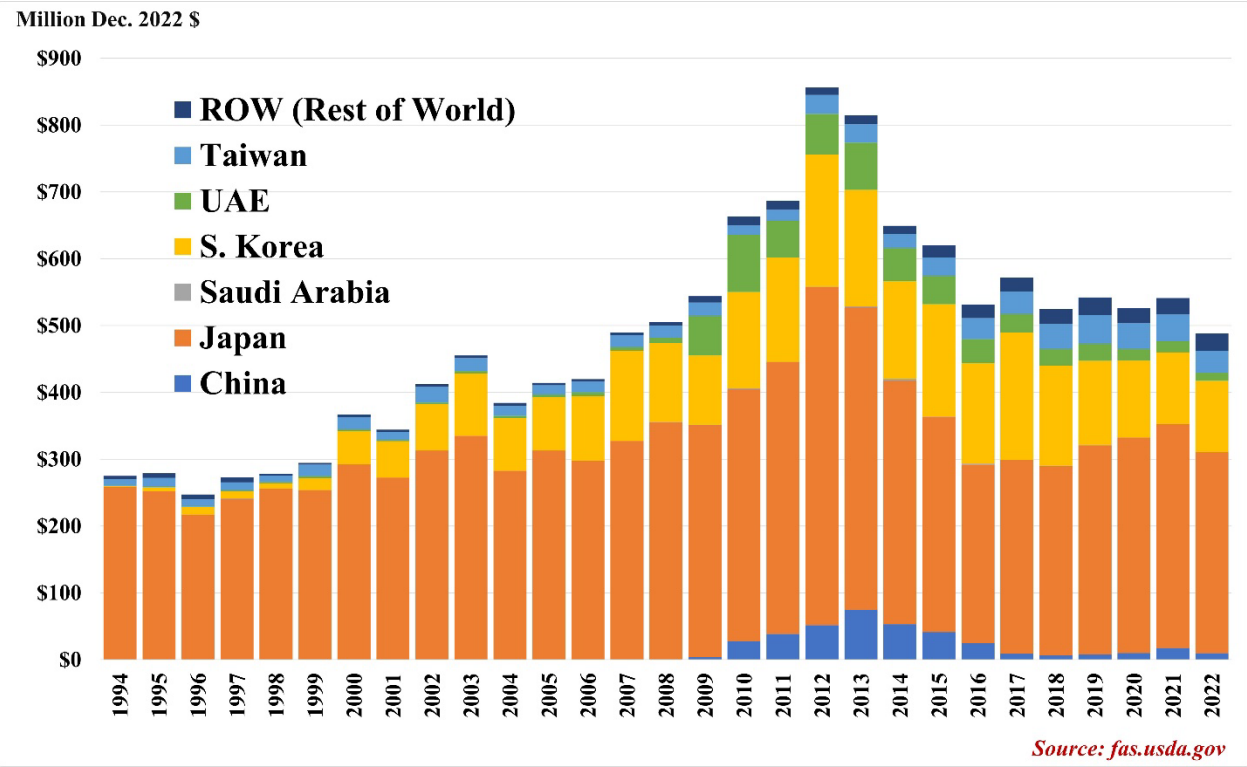

Figure 3: Real Value (Dec. 2022 $) of Other Hay Exports from the U.S. by Country, 1994-2022

Data source: (USDA/FAS, 2022)

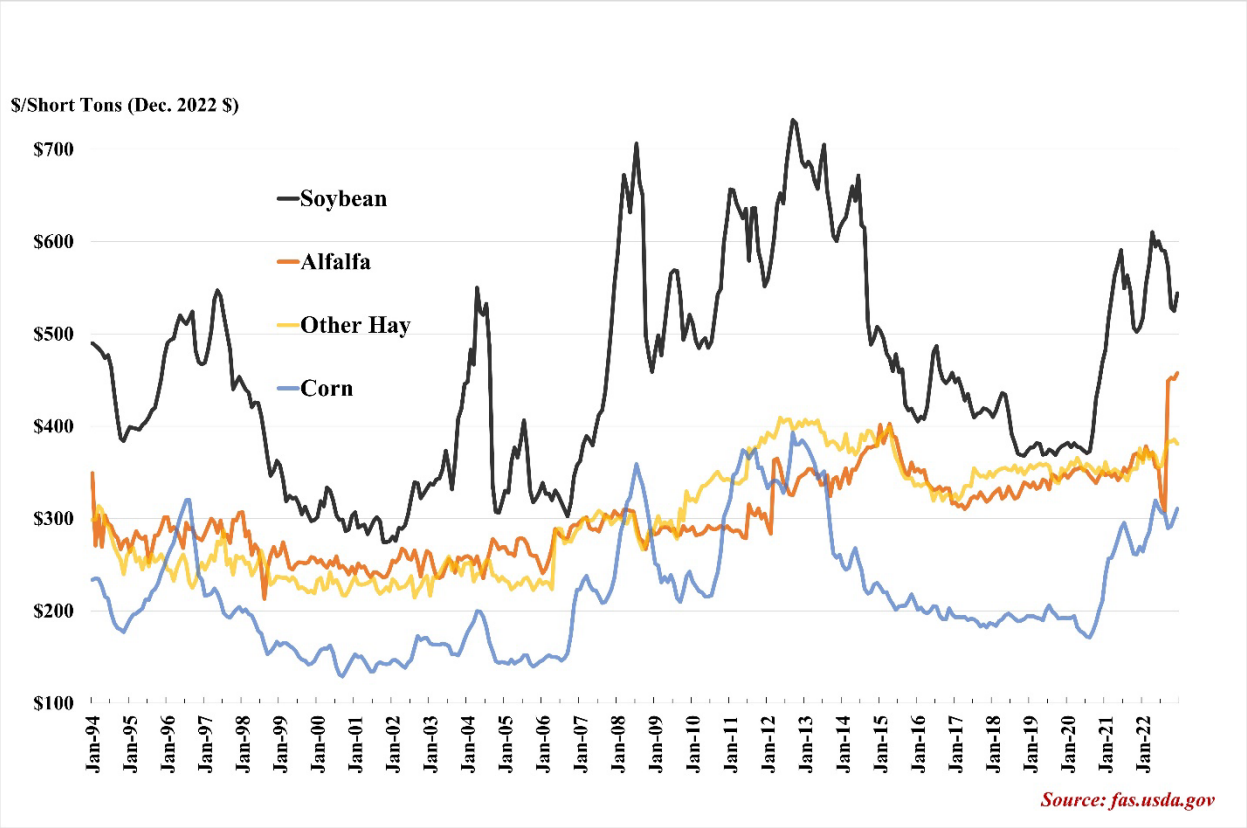

Figure 4: Real Monthly U.S.'s Feed Export Unit Prices (December 2022 $), 1994-2022

Data source: (USDA/FAS, 2022)

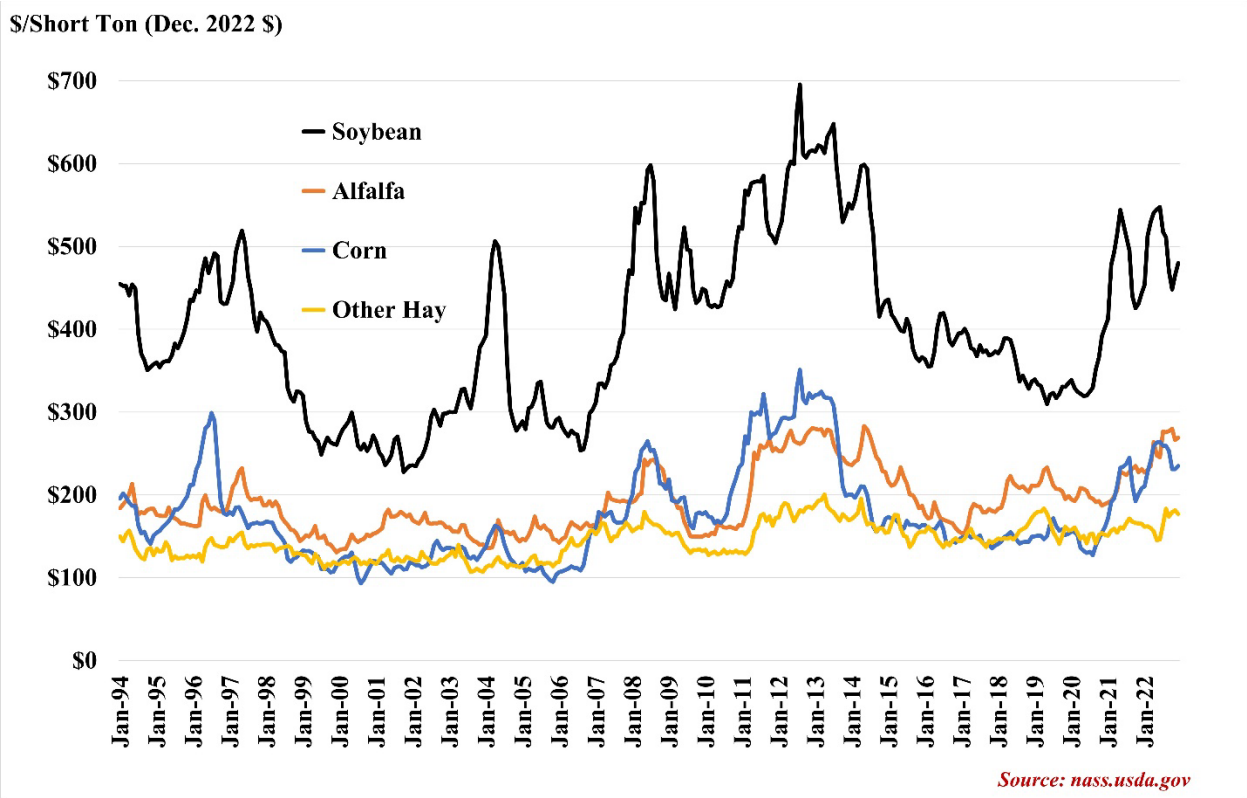

Figure 5: Real Monthly U.S.'s Feed Domestic Prices (December 2022 $), 1994-2022
Data source: (USDA/NASS, 2022)

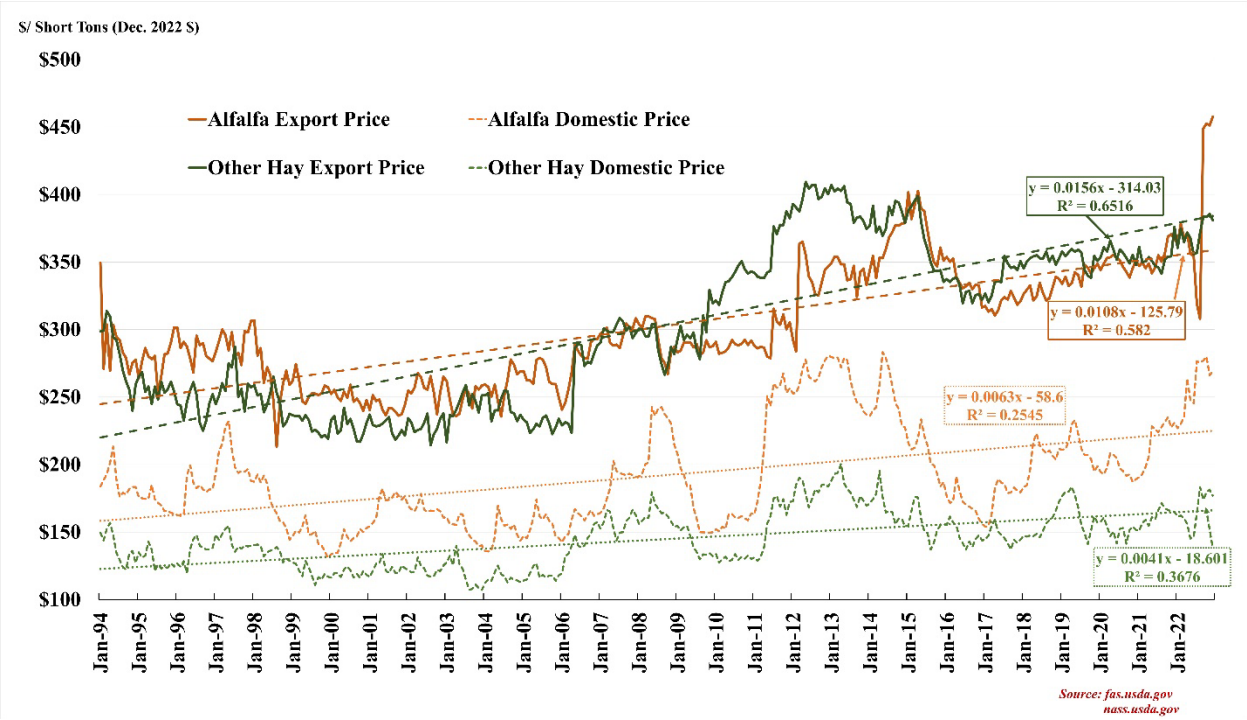

Figure 6a: Real Monthly Alfalfa and Other Hay Prices for U.S.'s Export and Domestic Markets, 1994-2022 *Data source: (USDA/FAS, 2022; USDA/NASS, 2022)*

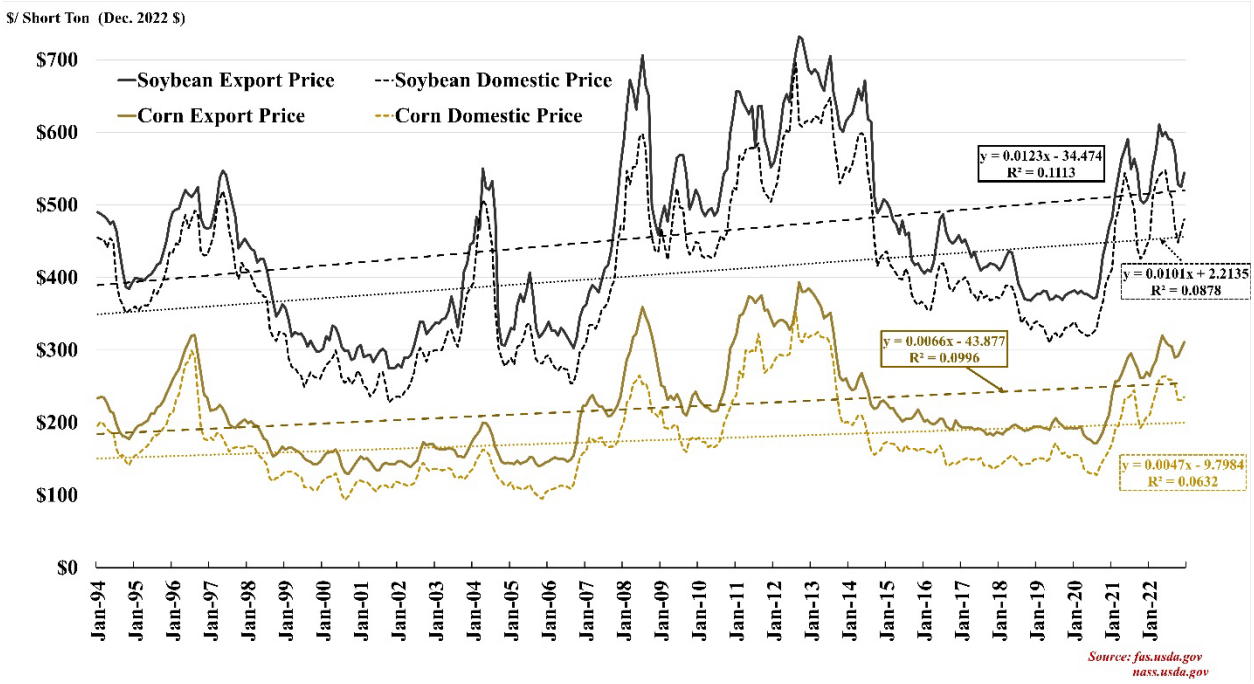

Figure 6b: Real Monthly Corn and Soybean Prices for U.S.'s Export and Domestic Markets, 1994-2022 ***Data source: (USDA/FAS, 2022; USDA/NASS, 2022)***

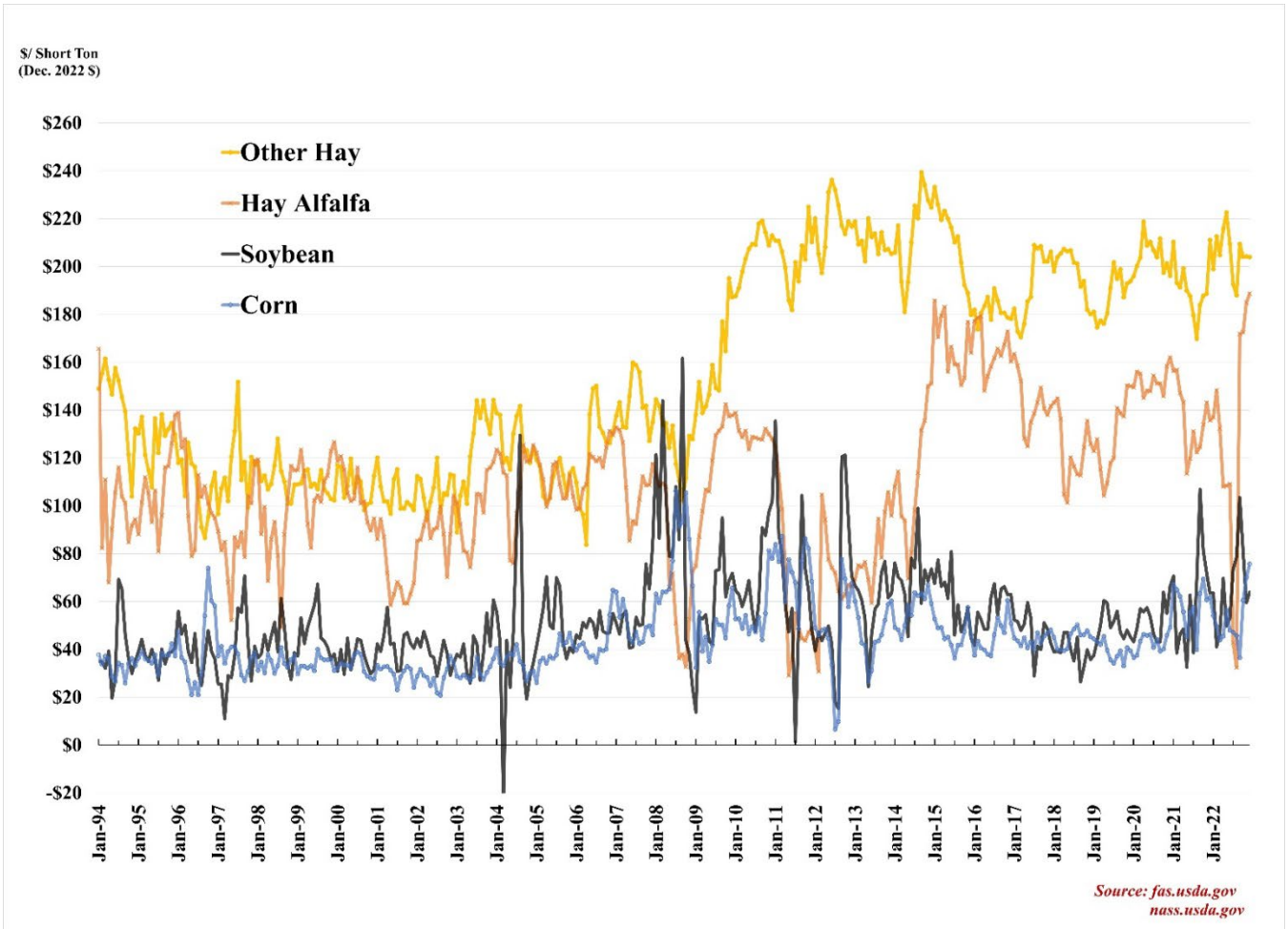

Figure 7: Monthly Difference Between U.S. Export and Domestic Real Unit Prices of Alfalfa, Other Hay, Corn, and Soybeans from 1994 to 2022

Data source: (USDA/FAS, 2022; USDA/NASS, 2022)

Table 1: Descriptive Statistics of Monthly U.S. Export and Domestic Prices, 1994-2022

Monthly U.S. Export Prices* (in Dec. 2022 $/ton)				
Commodity	Alfalfa Export	Other Hay	Corn	Soybeans
Min	213.22	214.42	128.97	274.56
Max	457.68	409.24	393.27	731.86
Average	301.74	302.09	219.23	454.50
Median	291.20	298.80	201.34	440.64
Monthly U.S. Domestic Prices (in Dec. 2022 $/ton)**				
Commodity	Alfalfa	Other Hay	Corn	Soybeans
Min	130.68	107.09	93.24	227.71
Max	283.20	200.39	351.06	695.68
Average	191.58	144.43	175.02	402.48
Median	183.56	143.39	161.68	388.92

**Source: USDA/ FAS*

*** Source : USDA/ NASS*

Table 2a: Estimated Linear Trends of Export and Domestic Real Prices for Alfalfa, Other Hay, Corn, and Soybean

Variable Name	Linear Slope Trend	Standard Error
Export Prices		
Alfalfa Export (AEx)	0.0108	0.0005
Other Hay Export (OHEx)	0.0156	0.0006
Corn Export (CEx)	0.0066	0.0011
Soybeans Export (SEx)	0.0123	0.0019
Domestic Prices		
Alfalfa Domestic (ADo)	0.0063	0.0006
Other Hay Domestic (OHDo)	0.0041	0.0003
Corn Domestic (CDo)	0.0101	0.0018
Soybeans Domestic (SDo)	0.0047	0.0010

The number of observations, N=348.

Table 2b: Estimated Linear Trends of Differences Between Export and Domestic Prices for Alfalfa, Other Hay, Corn, and Soybeans

Variable Difference	Linear Slope Trend of Differences	Standard Error	p-value
Export vs Domestic			
AEx-ADo	0.0045	0.0008	0.0000
OHEx - OHDo	0.0114	0.0007	0.0000
CEx - CDo	0.0020	0.0014	0.1716
SEx - SDo	0.0022	0.0026	0.3830
Export Differences			
AEx - CEx	0.0042	0.0012	0.0005
AEx - SEx	-0.0016	0.0019	0.4238
AEx - OHEx	-0.0048	0.0008	0.0000
OHEx - SEx	0.0032	0.0020	0.1040
OHEx - CEx	0.0089	0.0012	0.0000
SEx - CEx	0.0057	0.0022	0.0085
Domestic Differences			
ADo - CDo	0.0016	0.0011	0.1436
ADo - SDo	-0.0038	0.0018	0.0404
ADo - OHDo	0.0022	0.0022	0.0007
OHDo - SDo	-0.0060	0.0018	0.0008
OHDo - CDo	-0.0005	0.0010	0.5858
SDo - CDo	0.0054	0.0020	0.0067

The degree of freedom of all the regressions is 692.