Impacts of Possible Chinese Protection on US Soybeans

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Abstract: China is the world largest soybean importer and imported 93.5 Million Metric Tons (MMT) of soybeans in 2016, about 65% of global soybean imports. China imports soybeans mainly from Brazil, US, and Argentina. The shares of these three countries in China's imports were about 44%, 42%, and 9% in 2016. Canada, Uruguay, and Russia also export soybeans to China. The shares of these countries in total Chinese soybean imports were about 2.1%, 1.9% and 0.5% in 2016, respectively.

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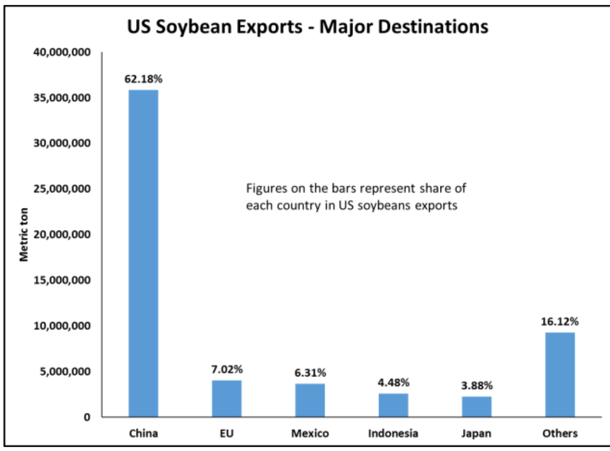
Introduction

China is the world largest soybean importer and imported 93.5 Million Metric Tons (MMT) of soybeans in 2016, about 65% of global soybean imports. China imports soybeans mainly from Brazil, US, and Argentina. The shares of these three countries in China's imports were about 44%, 42%, and 9% in 2016. Canada, Uruguay, and Russia also export soybeans to China. The shares of these countries in total Chinese soybean imports were about 2.1%, 1.9% and 0.5% in 2016, respectively.

Clearly, Brazil and US are the two big suppliers of soybeans to China. Currently, US and Brazil are the two largest soybean producers and exporters. They produced 116.9 MMT and 114.1 MMT of soybeans in 2016, respectively. In 2016, US exported 59.2 MMT of soybeans and Brazil about 63.1 MMT.

It is interesting to examine the major destinations of US exports of soybeans, soybean meal, and soybean oil. These are shown in Figures 1-3. China is by far the largest importer of US soybeans followed by the EU and Mexico. For soybean meal and oil, Mexico is the largest destination. China ranks second as the destination for soybean oil.



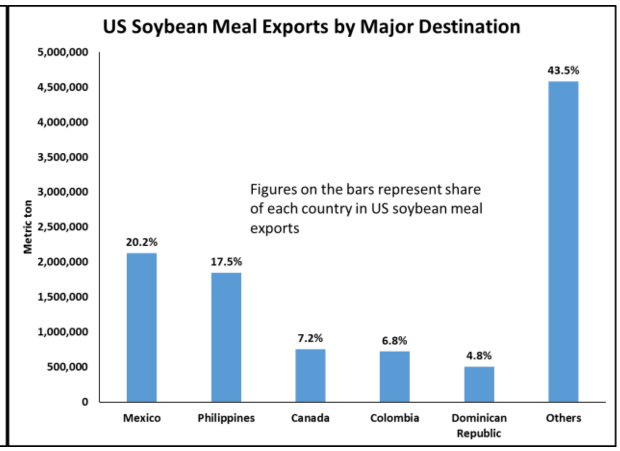
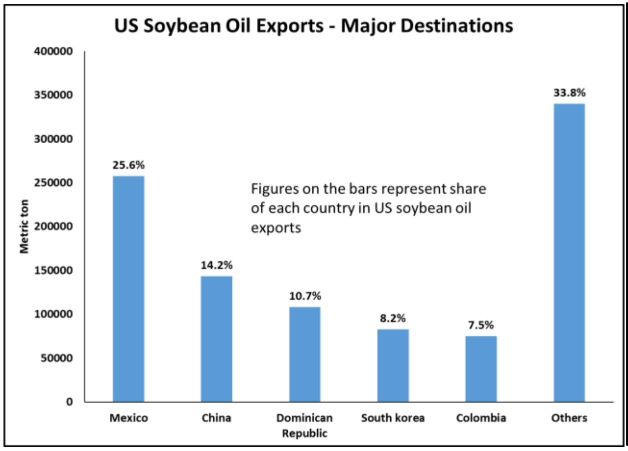


Figure 1. US Soybean exports by major destinations (Source: UN Comtrade database)	Figure 2. US Soybean meal exports by major destinations (Source: National Oilseed Processors Association (NOPA))

Historically, the US was the world's largest soybean producer and exporter until 2012. After that Brazil exported more soybeans than the US. While the US is still the largest soybean producer, Brazil could produce more soybeans than the US in the future. In recent years, production of soybeans has increased rapidly in Brazil, much faster than for the US. Production of soybeans in US and Brazil were about 75.1 MMT and 39.5 MMT in 2000, respectively. In 2000, US production was twice that of Brazil. Between 2000 and 2016 production of soybeans increased by 189% in Brazil, versus 56% for US as shown in Figure 4. In this period, Brazil adopted GMO soybeans and that helped this country to expand its soybean production rapidly.

Brazil competes very closely with the US in the world soybean market. Since China is the largest soybean importer and imports massive amounts of soybeans from US and Brazil, any changes in China's soybean trade policies could have major implications for both US and Brazil. Currently, trade of soybeans is relatively unrestricted by tariffs and other border measures. However, that could change in the future. It is prudent to evaluate what might be the possible consequences on US production and exports if China were to impose trade restrictions on US imports.



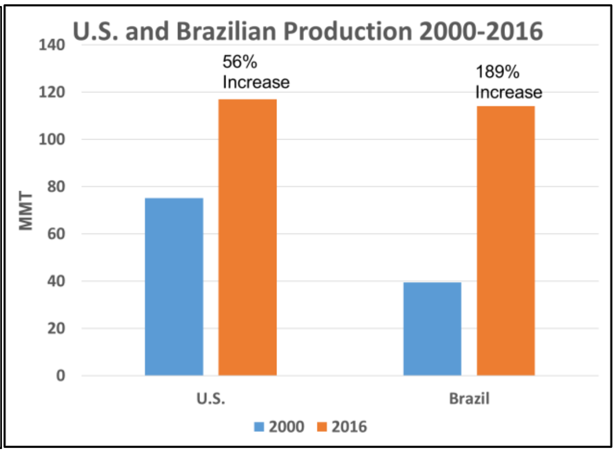


Figure 3. US Soybean oil exports by major destinations (Source: National Oilseed Processors Association (NOPA))	Figure 4. US and Brazilian soybean production growth between 2000 and 2016 (Source: USDA)

In general, imposing a trade barrier (either tariff or other restrictions) on China's soybeans imports from US could generate major adverse consequences for the US soybean producers and US agricultural sector. This research consists of economic analyses to understand these consequences.

To accomplish this task, we use the GTAP model as a vehicle to project impacts of imposing a tariff on China's soybean imports from the US. While China might not use a tariff, but use Sanitary and Phytosanitary (SPS) or other measures instead, we can proxy the impact of any form of trade restriction by evaluating the impacts of various levels of tariffs. GTAP was initially developed to study the economic implications of trade policies and has been used in this area more than any other economic model. We are using an advanced version of this model, named GTAP-BIO. This model has been developed and frequently used to examine the economic and land use impacts of biofuel production and policies. This model can trace production, consumption, and trade of all types of goods and services (including soybeans, soybeans oil, and soybean meals) at the global scale. Taheripour, Cui and Tyner [1] and Taheripour, Zhao, and Tyner [2] described the latest version of this model and its improvements over time. Figure 5 represents the GTAP-BIO main components and structure.

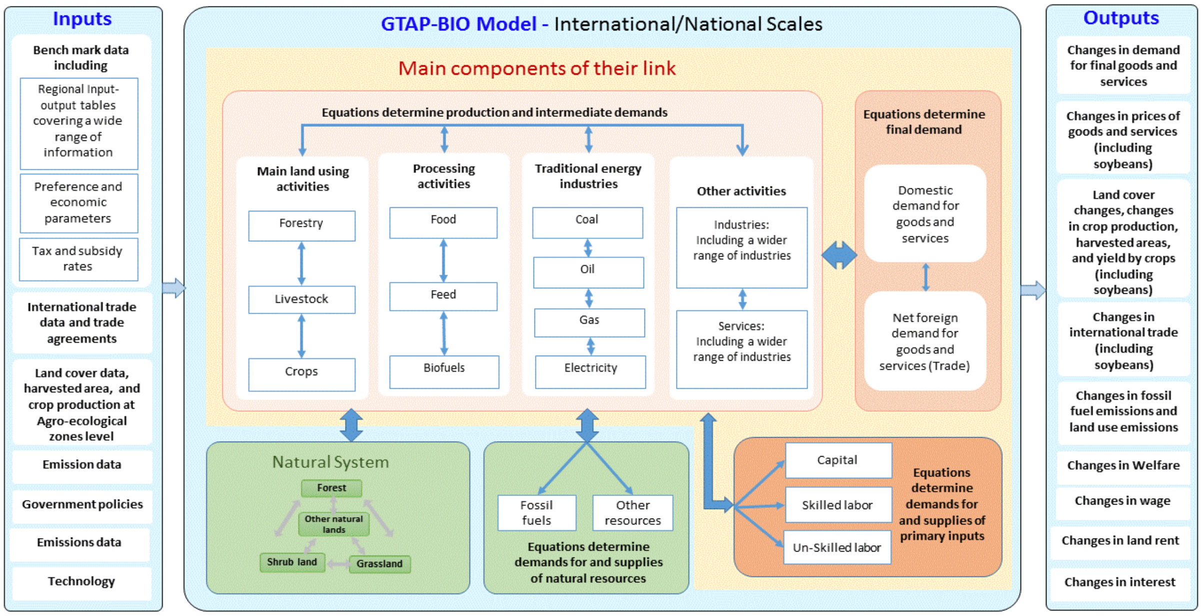


Figure 5: Structure of GTAP-BIO model

The latest version of this model represents the world economy in 2011. Since in recent years the global soybean market (and also markets for other agricultural products) experienced major changes in production and trade, we have updated our data base to represent the world economy in 2016, to provide more up-to-date analyses. The original BTAP-BIO model aggregates the whole world into 19 regions. In this research we aggregated the geographical distribution into 6 main regions including USA, European Union (EU27), Brazil, China and Hong Kong (CHIHKG), South America (S. America), and the rest of the world (Other). This aggregation includes all major players who play an important role in the markets for soybeans, soybean oil and soybean meals.

Update the GTAP-BIO data base

We collected data needed to update our 2011 data base to represent the global economy in 2016. To accomplish this task, we obtained data on macroeconomic variables such as population, GDP, and capital formation by country at the global scale for the time period of 2011-16. These data items are obtained from the World Bank data base. In addition, we collected data on crop production, harvested area, and land cover items by country from the Food and Agricultural Organization (FAO) of the United Nations (UN). We also collected data on biofuels produced across the world from the OECD data bases. With this data, we used the GTAP-Adjust program to update the global economy from 2011 to 2016. In what follows we briefly explain the collected data items

Table 1 represents GDP at constant and current prices for the 6 regions mentioned above. This table indicates that GDP of CHIHKG at constant prices has increased by 41.2% in 2011-2016. The expansion in GDP of CHIHKG at current prices was slightly higher, 47.3%, which represents an increase in the GDP implicit price index. One could expect that the expansion in GDP of CHIHKG plus population growth in this country jointly generated more demand for food, in particular more demand for animal-based food products, leading to higher demand for soybeans, a major food and feed item in CHIHKG.

GDP at constant prices has increased in US (by 11.1%) and EU27 (by 5.4%), but dropped in Brazil (by -2.4%) and South America (by -14.6%) which are the main US competitors in the soybean market. Brazil and South America experienced a recession in recent years. GDP at constant prices has increased by 17% in the rest of the world. Table 1 shows that GTAP at current prices dropped everywhere, except for US and CHIHKG. The updated 2016 data base represents the world economy with these current GDP values.

Table 1. GDP at constant and current prices in 2011 and 2016

Region	GDP at constant prices (billion US$)			GDP at current prices (billion US$)		
	2011	2016	% Change	2011	2016	% Change
USA	15204	16888	11.1	15518	18624	20.0
EU27	17006	17929	5.4	18066	16152	-10.6
Brazil	2297	2248	-2.1	2616	1796	-31.3
CHIHKG	6922	9774	41.2	7821	11520	47.3
S. America	1719	1468	-14.6	1789	1486	-16.9
Others	24900	29221	17.4	27469	26266	-4.4
Total	68048	77527	13.9	73280	75845	3.5

Source: World Bank: World Development Index data base

Table 2 shows gross fixed capital formation at constant prices and population for 2011-2016. As shown in this table, among the six regions, CHIHKG experienced the largest expansion in capital formation (by 73.5%), while its total capital formation in 2016 is less than the corresponding figure for EU27 and US. On the other hand, EU27 has large capital formation, but it only increased by 4.1% in 2011-2016.

Table 2. Gross fixed capital formation and population in 2011 and 2014

Region	Gross fixed capital formation at constant prices (billion US$)			Population (million persons)		
	2011	2016	% Change	2011	2016	% Change
USA	25914	28389	9.6	312	323	3.7
EU27	31010	32296	4.1	495	503	1.5
Brazil	3231	3772	16.8	199	208	4.5
CHIHKG	14247	24725	73.5	1351	1386	2.6
S. America	2181	2733	25.3	201	213	5.9
Others	47732	56086	17.5	4455	4810	8.0
Total	124315	148001	19.1	7013	7442	6.1

Source: World Bank: World Development Index data base

At the global scale population has increased by about 429 million (6.1%) over 2011-2016. Population has increased by 35 million (2.6%) in CHIHKG, by 11 million (3.7%) in US, by 8 million in EU27 (1.5%), 9 million in Brazil (4.5%), 12 million (5.9) in S. America, and 355 million (8%) in other regions. One could expect major expansion in demand for food due to population and income growth all across the world.

To update the GTAP-BIO database to 2016, we also obtained data on changes in crop production, harvested area, and land cover changes by country at the global scale for 2011-16. To accomplish this task, data on production and harvested area were obtained from the FAO data set and aggregated to the crop categories used in GTAP-BIO model and then aggregated to the 6 regions mentioned above.

Table 3 shows global production of crops for 2011 and 2016. In general, this table shows that production of many crops all across the world has increased except for a few items.

Table 3. Crop production in 2011 and 216 (million metric tons)

Region	Paddy Rice	Wheat	Sor-ghum	Other coarse grains	Soy-beans	Palm fruit	Rape-seed	Other Oil-seeds	Sugar Crops	Other crops*
2011										
USA	8.4	54.4	5.4	318.6	84.2	0.0	0.7	2.8	52.9	762.4
EU27	3.1	137.9	0.7	149.1	1.1	0.0	19.2	22.1	124.0	886.8
Brazil	13.5	5.7	1.9	56.5	74.8	1.3	0.1	3.5	734.0	96.2
CHIHKG	201.0	117.4	2.1	198.4	14.5	0.6	13.4	20.3	125.2	954.7
S. America	12.8	20.0	5.7	42.2	61.5	6.7	0.2	5.7	112.6	206.5
Others	484.4	363.9	42.6	343.7	26.3	232.3	29.1	117.1	938.0	2263.6
Total	723.2	699.4	58.4	1108.4	262.4	241.0	62.7	171.5	2086.6	5170.0
2016										
USA	10.2	62.9	12.3	392.3	117.1	0.0	1.4	4.2	63.6	753.6
EU27	3.0	141.8	0.7	148.0	2.2	0.0	19.6	19.8	109.5	873.5
Brazil	10.6	6.8	1.2	65.5	96.3	1.6	0.1	3.3	768.7	85.3
CHIHKG	209.4	131.7	2.4	236.7	12.0	0.7	15.3	21.8	130.4	1075.9
S. America	12.9	21.2	4.4	59.4	74.4	9.8	0.4	5.3	114.5	212.5
Others	491.5	386.9	44.9	393.6	34.1	284.1	32.0	128.6	994.9	2508.2
Total	737.6	751.2	65.8	1295.5	336.0	296.2	68.7	183.0	2181.6	5509.0
% Change in 2011-2016										
USA	21.2	15.5	125.5	23.1	39.1	0.0	102.1	49.2	20.2	-1.2
EU27	-2.2	2.8	-5.5	-0.7	99.8	0.0	2.2	-10.3	-11.7	-1.5
Brazil	-21.2	20.1	-40.2	16.0	28.7	26.6	38.5	-3.7	4.7	-11.3
CHIHKG	4.2	12.2	17.0	19.3	-17.4	3.2	13.8	7.2	4.2	12.7
S. America	1.2	5.6	-22.7	40.5	20.9	46.5	78.7	-7.2	1.7	2.9
Others	1.5	6.3	5.4	14.5	30.0	22.3	9.8	9.8	6.1	10.8
Total	2.0	7.4	12.6	16.9	28.1	22.9	9.6	6.7	4.6	6.6

* Feed crops such as silages, forages, fodders, and cultivated grasses are included.

Note: This data and the data in Tables 4 and 5 is from FAO and may differ in some cases from the USDA data presented earlier.

Among all crops, soybeans has increased significantly across the world except in CHIHGK. Total production of soybeans has increased from 262.4 million metric tons in 2011 to 336 million metric tons in 2016, about 28% increase in just 5 years. This is the largest expansion across all crops. Production of soybeans has increased in US, Brazil, and South America by 39.1%, 28.7%, and 20.9%, respectively.

In this time period production of palm fruit also has increased significantly from 241 million metric tons in 2011 to 296.2 million metric tons, about 22.9% increase in 5 years. Most of this increase occurred in Malaysia and Indonesia. Production of coarse grains (identified as Oth-CrGr in Table 3) has also increased from 1108.4 metric tons in 2011 to 1295.5 million metric tons in 2016, about a 16.9% increase in 5 years. Most of this expansion occurred in the US (by 73.7 million metric tons). Unlike soybeans, production of coarse grains has increased in CHIHKG by 383 million metric tons.

Table 4 represents harvested area by crop and region for 2011 and 2016. At the global scale, harvested area of palm fruit represents the largest percentage among all crop categories.

Table 4. Harvested area in 2011 and 2016 (million hectares)

Region	Paddy Rice	Wheat	Sor-ghum	Other coarse grains	Soy-beans	Palm fruit	Rape-seed	Other Oil-seeds	Sugar Crops	Other crops*
2011										
USA	1.1	18.5	1.6	35.6	29.9	0.0	0.4	1.2	0.8	36.8
EU27	0.5	26.1	0.1	29.9	0.4	0.0	6.7	9.6	1.6	37.9
Brazil	2.8	2.1	0.8	13.6	24.0	0.1	0.0	0.7	9.6	14.5
CHIHKG	30.1	24.3	0.5	36.2	7.9	0.0	7.3	6.8	1.9	59.6
S. America	2.4	6.3	1.4	9.1	23.5	0.4	0.1	2.8	1.3	15.6
Others	126.6	143.0	37.9	156.6	18.0	16.0	19.1	68.4	15.2	313.7
Total	163.3	220.3	42.3	281.0	103.6	16.6	33.8	89.4	30.6	478.1
2016										
USA	1.3	17.8	2.5	37.0	33.5	0.0	0.7	1.5	0.8	39.2
EU27	0.4	27.1	0.1	29.5	0.7	0.0	6.5	9.6	1.5	37.9
Brazil	1.9	2.2	0.6	15.5	33.2	0.1	0.0	0.5	10.2	11.9
CHIHKG	30.2	24.3	0.5	41.3	6.6	0.1	7.6	6.5	1.8	61.8
S. America	2.3	6.9	1.1	10.2	25.2	0.6	0.2	2.4	1.4	15.8
Others	124.2	141.6	40.1	160.1	22.1	19.2	18.7	76.4	15.6	334.1
Total	160.4	219.9	44.9	293.6	121.4	20.0	33.7	97.0	31.3	500.8
% Change in 2011-2016										
USA	18.3	-4.0	56.2	4.0	12.1	0.0	64.0	28.7	-2.1	6.4
EU27	-7.7	3.8	-1.9	-1.2	93.1	0.0	-4.2	-0.1	-9.0	0.0
Brazil	-29.4	1.3	-26.3	13.9	38.3	30.4	9.5	-22.9	6.5	-17.7
CHIHKG	0.5	0.3	6.7	14.1	-15.8	5.0	3.6	-3.4	-7.5	3.7
S. America	-1.5	10.1	-22.2	12.2	7.1	33.9	56.1	-13.4	4.3	1.4
Others	-1.9	-1.0	5.8	2.2	23.2	19.8	-2.0	11.7	2.3	6.5
Total	-1.8	-0.2	6.1	4.5	17.2	20.2	-0.2	8.5	2.4	4.7

* Feed crops such as silages, forages, fodders, and cultivated grasses are included.

Harvested area of palm fruit has increased from 16.6 million hectares in 2011 to 20 million hectares in 2016, about 20.2% or 3.4 million hectares expansion. After that harvested area of soybeans represents the second largest percentage among all crop categories. Harvested area of soybeans increased from 103.6 million hectares in 2011 to 121.4 million hectares, about 17.2% (or 17.8 million hectares). In fact among all crop categories soybeans represents the largest increase in harvested area in 2011-2016. Most of this expansion was occurred in Brazil (by 9.2 million hectares), Other region (by 4.2 million hectares), US (by 3.6 million hectares and), and South America (by 1.7 million hectares. Harvested area of soybeans has decreased in CHIHKG by -1.2 million hectares in 2011-2104. One can trace changes in harvested area of all crop categories over 2011-2016 in Table 4.

Table 5 shows land cover items including forest, pasture, and cropland areas for 2011 and 2015. Land cover items for 2016 were not available when we developed this work. As shown in Table 5, global forest and pasture areas declined by -0.3% (or -13.2 million hectares) and -1.3% (-44.3

million hectares). On the other hand, global area of cropland has increased by 2.1% (or 33.1 million hectares). The sum of changes in forest and pasture is larger than the change in cropland. That could represent land converted to other uses. One can trace changes in the geographical distribution of land cover items over 2011-2015 in Table 5. We used these data items to update the GTAP-BIO land cover items for 2015. To accomplish this task, we assigned the annual growth rate between 2011-2105 to 2016.

Table 5. Areas of land cover in 2011 and 2015 (million hectares)

Region	2011			2015			%change		
	Forest	Pasture	Cropland	Forest	Pasture	Cropland	Forest	Pasture	Cropland
USA	309.0	250.4	154.3	310.1	251.0	154.9	0.4	0.2	0.4
EU27	157.0	65.0	118.1	158.5	63.1	117.4	0.9	-3.1	-0.6
Brazil	497.5	196.0	79.4	493.5	196.0	86.6	-0.8	0.0	9.1
CHIHKG	202.2	392.8	122.5	208.3	392.8	135.8	3.1	0.0	10.8
S. America	344.5	265.9	68.1	340.3	267.1	69.6	-1.2	0.4	2.2
Others	2502.2	2149.6	1018.1	2488.4	2105.5	1029.3	-0.6	-2.0	1.1
Total	4012.4	3319.8	1560.4	3999.1	3275.5	1593.5	-0.3	-1.3	2.1

We also collected data on biofuels produced across the world in 2011 and 2016.Data on biofuel production is obtained from the OECD data base. The results are presented in Table 6. As shown in this table, the US is the leading country in ethanol production, mainly from corn. Brazil is the second largest ethanol producer, mainly from sugar cane. EU27 is the leading region in biodiesel production.

Table 6. Biofuel production in 2011 and 2016 (million gallons)

Region	Ethanol*			Biodiesel**		
	2011	2016	%Change	2011	2016	%Change
USA	14089	15297	8.6	569	964	69.6
EU27	561	757	35.1	2499	2931	17.3
Brazil	5123	7025	37.1	604	835	38.2
CHIHKG	1597	1725	8.0	0	0	0.0
S. America	255	471	84.5	835	944	13.0
Others	490	614	25.2	100	330	230.0
Total	22115	25889	17.1	4608	6004	30.3

* Includes all types of ethanol produced from grains or sugar crops

** includes all types of biodiesel produced from oilseeds

At the global scale production of ethanol has increased from 22,115 million gallons in 2011 to 25,988 million gallons in 2016. In this period, production of biodiesel has increased from 4,608 million gallons to 6,004 million gallons. One can trace changes in the geographical distribution of biofuels produced during 2011-2016 in Table 6.

Simulation Cases

Using the updated data base, we conducted simulations for different tariff levels and also different degrees of tariff coverage. By different degrees of tariff coverage, we mean the extent of the market to which the protection applies; e.g. US soybeans only; US soybeans, meal, and oil; and all US food and agricultural exports to China.

In addition, simulations were done with two sets of what are called Armington elasticities for soybean trade. Many international trade models, especially computable general equilibrium models like GTAP-BIO, use what is called an Armington structure (named after the economist who developed the concept) [3]. It is based on the notion that substitution among products produced in different countries is not perfectly elastic and that there is some degree of differentiation by country of origin. Thus, an Armington elasticity is a measure of the degree of substitution between home and imported goods and also differentiation by exporting country. The other modeling alternative is termed a homogeneous goods model in which goods produced in different countries are assumed to be perfectly homogeneous, with no country of origin differentiation. One implication of the different structures is that in a model with a homogeneous goods assumption, there tend to be large and rapid responses in trade from very small price changes. However, the Armington structure, in a sense, buffers the responses and is generally believed to result in more realistic trade pattern responses. Previously, we had done a test of sensitivity of Armington elasticities for estimating biofuel land use changes for CRC [4]. Some of this material draws from that report. In that analysis we concluded that with higher Armington elasticities (approaching the homogenous goods model), we got emissions about 30 percent higher than the base cases.

There are two Armington elasticities for each commodity: (1) ESUBD represents the ease of substitution between domestic and imported goods; and (2) ESUBM, represents the degree of substitution among different countries of origin for imports. In GTAP, ESUBM is always set to twice ESUBD. Table 7 contains the two Armington base elasticities of ESUBD and ESUBM for major agricultural and food commodities.

Recent research done at Purdue by Yao et al. [5] suggests that Armington elasticities higher than the default values in GTAP may be appropriate. Earlier work by Hillberry et al. also supports higher Armington elasticities [6].Consequently for the second case, we used Armington elasticities for China soybean imports of ESUBD=10 and ESUBM=20. These high values correspond to the case for which the market for soybean is closer to the homogenous good model with stronger reaction to price changes.

In reporting the simulation results, we will present for each case the impacts on soybean production, trade, prices, and welfare (economic well-being). Simulations examined and reported are presented in Table 8.

Table 7. Original GTAP Armington Elasticities for food industries

Sector	ESUBD	ESUBM	Sector	ESUBD	ESUBM
Paddy Rice	5.05	10.10	Dairy	3.65	7.30

Sector	ESUBD	ESUBM	Sector	ESUBD	ESUBM
Wheat	4.45	8.90	Ruminant	3.33	6.66
Sorghum	1.30	2.60	Non-Ruminant	1.30	2.60
Other coarse grains	1.30	2.60	Proc. Dairy	3.65	7.30
Soybeans	2.45	4.90	Proc. Ruminant	3.85	7.70
Palm fruit	2.45	4.90	Proc. Non-Rum.	4.40	8.80
Rapeseed	2.45	4.90	Bev. & Sug.	1.42	2.84
Other Oilseeds	2.45	4.90	Proc. Rice	2.60	5.20
Sugar crops	2.70	5.40	Proc. Food	2.00	4.00
Other crops	2.46	4.93	Proc. Feed	3.00	6.00
Forestry	2.50	5.00			

Table 8. Cases Simulated

Case	Tariff Level (%)	Tariff Coverage	Armington
1	10	soybeans	Base
2	10	Soybeans, meal, and oil	Base
3	10	All ag and food	Base
4	10	soybeans	elevated
5	10	Soybeans, meal, and oil	elevated
6	10	All ag and food	elevated
7	30	soybeans	base
8	30	Soybeans, meal, and oil	base
9	30	All ag and food	base
10	30	soybeans	elevated
11	30	Soybeans, meal, and oil	elevated
12	30	All ag and food	elevated

Simulation Results

We will be presenting simulation results for changes in soybean trade, production, producer prices, and welfare (economic well-being). Then we will provide a summary of the overall impacts.

Trade impacts

The trade change results for cases 1-6 are presented in tables 9-14. In these tables rows represent exports and columns represent imports. These cases all represent the 10% tariff level. All of the tables represent percentage changes, so it is important to recall that the bases are quite different for each region. A high percentage change on a small base may not be as important as a small percentage change on a large base. The major conclusions from these results are as follows:

1) The first result is that Chinese imports of US soybeans fall under all cases. US exports to other regions increase in all cases, but the degree differs significantly among cases. For the 10% tariff, imports fall 18-45%, and for the 30% tariff, imports fall 46-92%.

2) Second, total US soybean exports globally also fall in all cases. The total export decrease is not as large as the decline in Chinese imports as exports increase to some other regions. In other words there is what is called trade diversion. For example, in Table 9, Chinese imports from the US fall 21%, but US global exports fall 12%. Exports to other countries make up part of the loss in Chinese exports.
3) Global soybean imports decrease by a small percentage as well in all cases.
4) The changes in trade are all much larger for the higher Armington elasticity cases than for the standard cases. In fact, the results are dramatically different. For example US soybean exports to China fall 21% in the base case and 45% in the elevated Armington case for the 10% tariff.
5) Brazilian exports to China increase 10% and 25% in the base and elevated elasticity cases. Global US soybean exports fall 12% in the base case and 20% with elevated Armington elasticities.
6) When the tariff is on all US food and feed, the reduction in Chinese imports of soybeans is a bit smaller, and the increase in US exports to other regions is larger, but total US soybean exports decrease in both standard and elevated Armington trade elasticity cases (10 and 16% respectively).
7) Chinese soybean imports from Brazil and other South America increase in all cases.
8) The differences between the soybeans only and all soybean products tariff cases are very small. This is due mainly to the small level of Chinese imports of meal and oil, compared to imports of soybeans

Table 9. Trade changes for case 1 (soybeans, base elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	11.47	-20.61	7.63	-13.45
BRAZIL	-4.52	10.17	-6.50	8.44
S. America	-2.84	12.20	-4.95	8.84
Global	0.00	-3.16	2.57	-1.81

Table 10. Trade changes for case 2 (all soybean products, base elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	12.33	-20.24	8.49	-12.96
BRAZIL	-4.36	10.10	-6.24	8.41
S. America	-2.74	12.07	-4.75	8.75
Global	0.26	-3.04	3.15	-1.61

Table 11. Trade changes for case 3 (all food and feed products, base elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	14.63	-18.21	10.12	-11.02
BRAZIL	-4.92	10.40	-6.95	8.60

S. America	-3.10	12.61	-5.28	9.08
Global	0.39	-1.94	3.86	-0.65

Table 12. Trade changes for case 4 (soybeans, elev. elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	105.43	-45.45	39.41	-23.37
BRAZIL	-36.80	25.45	-52.92	17.41
S. America	-30.44	39.36	-48.80	23.02
Global	-0.21	-3.76	6.58	-1.54

Table 13. Trade changes for case 5 (all soybean products, elev. elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	108.01	-44.91	40.89	-22.59
BRAZIL	-36.84	25.30	-52.94	17.27
S. America	-30.59	38.99	-48.90	22.70
Global	0.20	-3.64	7.40	-1.28

Table 14. Trade changes for case 6 (all food and feed products, elev. elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	116.38	-42.11	43.70	-19.74
BRAZIL	-38.22	25.10	-54.39	16.94
S. America	-31.93	39.10	-50.34	22.51
Global	0.80	-2.46	8.49	-0.18

Tables 15-20 present the changes in trade for cases 7-12, all of which assume a 30% tariff on US soybean exports to China. In these tables rows represent exports and columns represent imports. As would be expected, all the magnitudes are considerably larger with the 30% tariff compared with the 10% results shown above. For example, Chinese soybean imports decrease 50% in the soybeans only case with 30% tariff (case 7) compared with 21% for the 10% tariff (case 1). Other than the differences in magnitudes, all the general conclusions listed above for the 10% case also hold for the 30% case with one minor exception. In case 12, which is the case of a 30% tariff on all food imports and with elevated Armington elasticities, there is actually a small increase in global soybean imports instead of the decrease observed in all the other 11 cases. We do not consider this result to be significant. US exports to the EU increase substantially in the 30% and high Armington cases, as high as 293% in case 12, the most extreme case. We return to this issue in the final section.

Table 15. Trade changes for case 7 (soybeans, base elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	29.66	-50.42	19.08	-32.79
BRAZIL	-12.05	26.01	-16.65	21.58
S. America	-7.49	32.87	-12.59	23.94
Global	-0.08	-6.81	6.38	-3.72

Table 16. Trade changes for case 8 (all soybean products, base elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	31.72	-49.91	21.11	-31.90
BRAZIL	-11.76	25.93	-16.15	21.55
S. America	-7.30	32.63	-12.18	23.78
Global	0.52	-6.66	7.73	-3.33

Table 17. Trade changes for case 9 (all food and feed products, base elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	37.93	-46.37	25.47	-28.14
BRAZIL	-13.31	27.44	-17.91	22.72
S. America	-8.34	35.12	-13.50	25.51
Global	0.87	-4.10	9.70	-1.02

Table 18. Trade changes for case 10 (soybeans, elev. elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	251.78	-92.00	75.09	-47.81
BRAZIL	-71.73	49.57	-83.28	35.74
S. America	-65.57	86.42	-80.25	54.10
Global	5.50	-6.96	17.25	-1.43

Table 19. Trade changes for case 11 (all soybean products, elev. elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	260.57	-91.68	79.06	-46.52
BRAZIL	-72.26	49.60	-83.55	35.74
S. America	-66.25	86.34	-80.60	53.94

Global	6.70	-6.82	19.44	-0.84

Table 20. Trade changes for case 12 (all food and feed products, elev. elas.)

Region	EU27	CHIHKG	OTHER	Global
USA	293.19	-89.49	88.09	-42.28
BRAZIL	-76.45	51.27	-86.21	36.93
S. America	-70.97	91.20	-83.55	57.08
Global	9.61	-4.29	23.62	2.02

The final subject in trade area to consider is the impacts of the Chinese tariffs on trade balances. Table 21 provides the changes in the US trade balances for: soybeans only; all crops; all agriculture, livestock, and forestry (labeled Ag-forestry); and total change in trade balance (labeled All sectors) for the twelve cases. As can be seen from Table 21, all trade balance changes are negative with the largest negative values being for soybeans as would be expected. Also, as would be expected, the smallest impacts on trade balance are for all sectors. The reason is that soybeans constitute a small fraction of total trade. For both the 10% and 30% tariffs, the impacts with the higher Armington elasticities (cases 4-6 for 10% and10-12 for 30%) are almost double those with the standard elasticities. The exception to this result is the overall net trade balance, for which the Armington elasticities yield a smaller net impact. That occurs basically because the higher impacts affect all sectors and tend to wash out. The 30% cases with standard elasticities (cases 7-9) are about double the 10% cases with standard elasticities (cases 1-3).

Table 21. Trade balance changes for the twelve cases and four groupings (mil. $)

Case	Soybeans	Crops	Ag-forestry	All sectors
Case 1	-3,898	-2,563	-2,507	-235
Case 2	-3,783	-2,361	-2,302	-216
Case 3	-3,383	-3,310	-4,045	-288
Case 4	-6,469	-4,316	-4,225	-151
Case 5	-6,271	-4,055	-3,962	-129
Case 6	-5,599	-4,815	-5,521	-206
Case 7	-9,199	-6,019	-5,888	-496
Case 8	-8,985	-5,623	-5,484	-448
Case 9	-8,196	-7,930	-9,627	-632
Case 10	-12,812	-8,561	-8,386	-178
Case 11	-12,490	-8,088	-7,905	-123
Case 12	-11,533	-10,251	-11,908	-318

Production impacts

The detailed impacts on production of all the major crop categories is presented in Appendix A. Table 22 presents a summary of the impacts for all cases on US soybean production. Again, the results are in terms of percentage changes from the base.

The results all follow the patterns that would be expected:

1) Production declines are much higher for all the 30% cases than for the 10% cases.
2) Soybean production declines are smallest for the tariff on all US food imports (cases 3, 6, 9, and12) than for the tariffs imposed on soybeans or soybeans, oil, and meal.
3) The production declines are slightly larger for the tariff on soybeans, oil, and meal than for soybeans alone.
4) Declines are higher with the elevated Armington elasticities than with the base GTAP elasticities.

Table 22. Impacts of Chinese Protection on U.S. Soybean Production

Case	Tariff (%)	Tariff Coverage	Armington	Production Change (%)
1	10	soybeans	base	-5.70
2	10	Soybeans, meal, and oil	base	-6.03
3	10	All ag and food	base	-4.84
4	10	soybeans	elevated	-9.70
5	10	Soybeans, meal, and oil	elevated	-9.92
6	10	All ag and food	elevated	-8.31
7	30	soybeans	base	-13.92
8	30	Soybeans, meal, and oil	base	-14.65
9	30	All ag and food	base	-12.28
10	30	soybeans	elevated	-19.96
11	30	Soybeans, meal, and oil	elevated	-20.58
12	30	All ag and food	elevated	-17.96

Price impacts

As is commonly the case in computable general equilibrium (CGE) models like GTAP, price impacts are smaller in percentage terms that the other changes or than changes one would get with a partial equilibrium (PE) model. This is because there are many more substitution possibilities on both the production and consumption sides in a CGE model than in PE models. For example, US consumption of soybeans and soybean products would increase with the drop in Chinese exports. Also CGE results represent medium to long run price impacts, while PE models concentrate on short run impacts. Table 23 contains the percentage changes in price for each of the 12 cases. The patterns in estimated price changes are as follows:

1) As expected, the price declines are all much larger with 30% tariffs than with 10%.
2) The price changes are larger with elevated Armington elasticities than with base GTAP elasticities, but the differences are not as large as for trade or production. For example, for the 30% tariff price declines are around 4% for the standard elasticities and 6-7% for the

elevated Armington elasticities, Part of the reason the differences are smaller is that the overall percentage price change levels are smaller.

3) There is a difference in the relative ordering of the price changes with tariff coverage. The largest price changes are when the tariff is applied to all food. This is because all commodities are affected, and the commodity prices move together.
4) Another factor to consider is that the restriction on China's import from US drops the price of soybean across the world, except in China. This causes an increase in consumption of soybean across the world, again except for China. For example, for case 12 (all products, 30% tariff, and elevated Armington elasticities for soybeans), consumption of soy increases 7% in the US.

Table 23. Estimated soybean price changes due to Chinese protection

Case	Tariff (%)	Tariff Coverage	Armington	Price Change (%)
1	10	Soybeans	base	-1.95
2	10	Soybeans, meal, and oil	base	-2.06
3	10	All ag and food	base	-2.51
4	10	Soybeans	elevated	-3.21
5	10	Soybeans, meal, and oil	elevated	-3.27
6	10	All ag and food	elevated	-3.58
7	30	Soybeans	base	-4.35
8	30	Soybeans, meal, and oil	base	-4.55
9	30	All ag and food	base	-5.42
10	30	Soybeans	elevated	-5.95
11	30	Soybeans, meal, and oil	elevated	-6.09
12	30	All ag and food	elevated	-6.84

Economic welfare

The changes in economic welfare (economic well-being) are provided in Tables 24 and 25, with Table 24 containing the results for the 10% tariff, and Table 25 results for the 30% tariff. The economic welfare results are expressed as increases or decreases in million $. The following general conclusions can be drawn from the welfare analysis:

1) US economic welfare falls in all cases. The range of the drop for the 10% tariff is $1.3 to $4.1 billion. For the 30% tariff, the range of drop is $2.7 to $8.0 billion.
2) Welfare also falls for China for all cases. The drop for the 10% tariff is $0.3 to $1.5 billion. The drop for the 30% tariff case is $2.6 to $8.4 billion. Interestingly, the Chinese drop in economic welfare for the 30% case is about the same or even greater than the US drop.
3) Global economic welfare also falls in all cases. For the 10% tariff cases, the range is $0.3 to $1.7 billion. For the 30% case, the fall in global economic welfare is $1.7 to $6.1 billion.
4) The winners are Brazil and rest of South America, the major competing soybean exporters. For the 10% tariff, the combined economic welfare increase ranges from $1.1 to $2.5 billion. For the 30% tariff, the combined gain ranges from $3.2 to $6.9 billion. The combined gain for Brazil and rest of South America is somewhat smaller than the US loss.

5) The EU experiences a welfare gain in some cases and a welfare loss in others. When the tariff is on soybeans only or on soybeans plus oil and meal, the EU experiences a modest loss in economic welfare. When the tariff is on all food imported from the US, the EU experiences a modest gain in economic welfare. Essentially, EU food exports would displace US exports to a limited extent. In general, the economic welfare changes are smaller for the EU than for other regions.
6) The rest of world region has a welfare gain in all cases, because some of these countries also export soybeans.
7) The welfare gains or losses are higher with the elevated Armington elasticities than with the base case GTAP values.

Table 24. Economic welfare Changes for the 10% Tariff Cases (million $)

Region	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
USA	-1282.2	-1393.2	-3307.7	-2171.2	-2253.6	-4081.9
EU27	-58.7	-53.3	209.2	-180.2	-172.6	100.8
BRAZIL	754.4	771.4	885.8	1621.4	1627.9	1690.4
China	-311.6	-359.9	-824.0	-1027.5	-1077.1	-1532.9
S. America	321.1	337.9	412.8	755.5	765.1	821.9
Rest of World	321.7	384.3	1362.6	298.1	357.4	1325.3
Total	-255.3	-312.8	-1261.3	-703.9	-753.0	-1676.3

Table 25. Economic welfare Changes for the 30% Tariff Cases (million $)

Region	Case 7	Case 8	Case 9	Case 10	Case 11	Case 12
USA	-2745.4	-2948.6	-6949.0	-3869.7	-4038.3	-7981.4
EU27	-250.9	-245.1	305.9	-514.1	-506.0	53.1
BRAZIL	2189.7	2237.3	2628.6	3999.7	4054.2	4499.1
China	-2561.6	-2772.9	-5485.0	-5088.3	-5353.8	-8369.7
S. America	964.3	1008.5	1269.1	2022.0	2066.0	2394.3
Rest of World	715.0	852.6	3048.4	858.2	1005.1	3294.9
Total	-1689.0	-1868.3	-5182.0	-2592.2	-2772.7	-6109.6

Summary of Results

Generally, the results of this analysis conform to prior expectations. One of the big uncertainties is the magnitude of the Armington elasticity. The results are much more severe in the Armington cases than for the base values. For example, with a 10% tariff, global US soybean exports fall about 13% with the base values and about 23% with the elevated elasticities. The corresponding result for the 30% case are about 33% and 48%. Recent evidence supports a larger Armington elasticity for soybean market. Also, in general higher Armington elasticities may be appropriate for commodities that are sourced from multiple countries. Prior literature suggests the Armington structure is more appropriate than the homogeneous goods approach in general. Given the uncertainty in appropriate magnitude of the Armington elasticities, in Table 26, we report the average of the results from the standard GTAP Armington elasticities and the higher values for soybeans.

Table 26. Summary Impacts of a Chinese tariff on US Imports

Variable	10% Tariff	30% Tariff
Chinese soybean imports from US (% change)	-33.0	-71.2
Total US soybean exports (% change)	-18.4	-40.3
US production (% change)	-7.7	-16.9
US Producer soybean price (% change)	-2.6	-5.2
US economic welfare change ($ bil.)	-1.7	-3.3

To provide a simplification of the results, we use just the tariff on soybeans because it has essentially the same results as the tariff on soybeans, oil, and meal. Also, the tariff on all food is less likely. Table 26 provides the changes in soybean exports to China and globally, changes in US soybean production, US producer prices, and reduction in US economic well-being. With these results, either tariff level causes a significant drop in Chinese imports from the US, with US total exports dropping a bit more than half the Chinese import changes. US soybean production drops from 8 to 17% depending on the tariff level. US soybean producer prices drop from 2.6% to 5.2% for the two tariff levels. Finally, US economic well-being drops from $1.7 billion to $3.3 billion depending on the tariff level.

There are important caveats to consider in interpreting these results. First, the numerical results all depend on the multitude of assumptions, data sets, and parameters that are included in the model. Also, CGE models, which usually evaluate medium to long run market responses to the changes in economic variables often implicitly assume a good deal of flexibility in substitution among goods and services, in production, consumption and trade. In the short rum markets may react sharply to the changes in economic conditions. CGE models may not capture these sharp short run tolerances.

In this analysis, for example, when the Chinese tariff is applied on US soybeans, the model expands US soybean exports to the EU, particularly for the high Armington cases. Table 27 provides results for the original case 12 (see Table 20) but with a restriction that EU soy imports not grow more than 150%. The comparison is interesting. The EU import restriction causes almost no changes in the global import column. EU imports from the US go from an increase of 293% to the imposed level of 150%. There is also almost no change in the global export row. Also, there are almost no changes in the China and Other import columns. All the changes are in the EU import column, and they amount to a redistribution of trade among the different sources. EU imports from Brazil go up from -76% to -64%, and EU imports from other South America go up from -71% to -56%. In other words, the increase in EU imports from the US that is not allowed to occur because of the assumed restriction mainly gets shifted to other exporters. The global balances are largely unchanged. As indicated previously, all the impacts for all cases should be considered medium term. In the short run, some of the estimated changes would not have time to adjust, and the adverse impacts on the US would be more severe.

Table 27. Case 12 (high Armington and 30% tariff) with EU Import restriction

Region	EU27	CHIHKG	OTHER	Global
USA	150.00	-89.33	88.85	-42.94
BRAZIL	-64.01	51.17	-86.36	36.97
S. America	-55.70	90.80	-83.77	57.25
Global	-39.87	52.50	76.69	1.91

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Appendix – Detailed Production Changes for the 12 Cases

Case 1: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total

Paddy_Rice	1.26	0.04	-0.42	-0.02	-0.16	-0.01	0.00
Wheat	1.33	-0.16	-2.35	0.05	-0.64	-0.09	0.02
Sorghum	0.33	0.01	-0.52	-0.24	-0.36	-0.05	0.01
Oth_CrGr	0.58	-0.04	-0.67	-0.26	-0.41	-0.10	0.01
Soybeans	-5.70	0.60	4.84	1.63	1.59	0.09	-0.41
palmf	0.27	1.06	1.01	1.22	0.89	0.02	0.04
Rapeseed	3.29	0.24	-1.06	1.01	0.32	0.38	0.65
Oth_Oilseeds	3.20	0.58	-0.05	1.29	1.17	0.19	0.54
Sugar_Crop	0.05	0.00	-0.36	-0.02	-0.03	0.01	-0.09
OthAgri	0.96	0.02	-1.18	-0.04	-0.27	-0.01	0.00
Forestry	0.05	0.00	-0.10	-0.01	-0.04	0.00	0.00
Dairy_Farms	0.06	0.00	-0.06	-0.05	-0.05	0.00	0.00
Ruminant	0.15	0.00	-0.23	0.00	-0.04	0.00	0.00
NonRuminant	0.19	0.00	-0.36	-0.05	-0.06	0.00	-0.02

Case 2: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total
Paddy_Rice	1.34	0.04	-0.43	-0.02	-0.16	-0.01	0.00
Wheat	1.40	-0.17	-2.38	0.05	-0.67	-0.10	0.02
Sorghum	0.35	0.01	-0.53	-0.24	-0.37	-0.06	0.01
Oth_CrGr	0.62	-0.05	-0.68	-0.27	-0.42	-0.11	0.02
Soybeans	-6.03	0.82	4.90	1.63	1.64	0.22	-0.48
palmf	0.39	1.08	1.16	1.43	0.95	0.04	0.07
Rapeseed	3.47	0.26	-1.03	1.13	0.35	0.41	0.71
Oth_Oilseeds	3.39	0.62	0.04	1.46	1.25	0.20	0.59
Sugar_Crop	0.05	0.00	-0.37	-0.02	-0.03	0.01	-0.09
OthAgri	1.01	0.02	-1.20	-0.04	-0.29	-0.01	0.00
Forestry	0.05	0.00	-0.10	-0.01	-0.04	0.00	0.00
Dairy_Farms	0.07	0.00	-0.06	-0.06	-0.05	0.00	0.00
Ruminant	0.16	0.00	-0.24	0.00	-0.04	0.00	0.01
NonRuminant	0.20	0.00	-0.37	-0.05	-0.06	0.00	-0.02

Case 3: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total
Paddy_Rice	2.63	0.09	-0.47	-0.01	-0.18	-0.02	0.00
Wheat	2.62	-0.35	-2.85	0.26	-0.88	-0.29	0.04
Sorghum	0.10	0.11	-0.57	0.56	-0.45	-0.12	-0.07

Oth_CrGr	0.29	0.00	-0.72	0.73	-0.50	-0.23	0.08
Soybeans	-4.84	0.81	4.99	1.47	1.68	0.18	-0.05
palmf	-0.56	1.08	1.93	2.07	1.31	0.16	0.19
Rapeseed	-5.83	0.00	-0.42	0.74	1.39	0.65	0.10
Oth_Oilseeds	-3.86	0.34	0.94	1.05	2.58	0.20	0.22
Sugar_Crop	-0.05	0.01	-0.38	-0.02	-0.02	0.02	-0.09
OthAgri	0.32	0.05	-1.20	0.12	-0.36	0.03	0.02
Forestry	-0.59	0.01	-0.11	0.10	-0.02	0.14	0.03
Dairy_Farms	-0.10	0.02	-0.06	-0.08	-0.05	0.02	-0.01
Ruminant	-0.22	0.13	-0.18	0.03	0.00	0.04	-0.01
NonRuminant	-0.86	0.18	-0.10	0.05	0.05	0.08	0.00

Case 4: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total
Paddy_Rice	2.09	0.09	-0.88	-0.04	-0.38	0.00	-0.01
Wheat	2.24	-0.29	-4.76	0.03	-1.48	-0.12	0.02
Sorghum	0.60	0.03	-1.09	-0.32	-0.79	-0.07	0.03
Oth_CrGr	0.99	-0.06	-1.39	-0.35	-0.90	-0.14	0.03
Soybeans	-9.70	1.93	9.88	3.29	3.98	-1.00	-0.21
palmf	0.51	2.32	-0.01	1.71	1.27	0.07	0.09
Rapeseed	4.34	0.30	-3.39	1.18	-0.57	0.30	0.71
Oth_Oilseeds	4.22	0.79	-1.99	1.50	0.63	0.13	0.51
Sugar_Crop	0.08	0.00	-0.74	-0.02	-0.07	0.03	-0.18
OthAgri	1.62	0.05	-2.46	-0.07	-0.62	0.01	0.00
Forestry	0.07	-0.01	-0.21	-0.01	-0.10	0.00	0.00
Dairy_Farms	0.11	-0.01	-0.12	-0.06	-0.13	0.00	0.00
Ruminant	0.26	0.00	-0.49	-0.01	-0.12	0.00	0.00
NonRuminant	0.32	0.00	-0.74	-0.06	-0.16	0.01	-0.02

Case 5: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total
Paddy_Rice	2.14	0.10	-0.88	-0.04	-0.38	0.00	-0.01
Wheat	2.29	-0.30	-4.76	0.03	-1.49	-0.13	0.02
Sorghum	0.61	0.03	-1.09	-0.32	-0.79	-0.07	0.04

Oth_CrGr	1.01	-0.06	-1.39	-0.35	-0.90	-0.14	0.04
Soybeans	-9.92	2.01	9.87	3.27	3.98	-0.97	-0.29
palmf	0.60	2.32	0.14	1.92	1.33	0.09	0.12
Rapeseed	4.50	0.32	-3.32	1.30	-0.52	0.33	0.77
Oth_Oilseeds	4.38	0.83	-1.89	1.66	0.72	0.15	0.56
Sugar_Crop	0.08	0.00	-0.75	-0.02	-0.07	0.03	-0.18
OthAgri	1.66	0.05	-2.46	-0.07	-0.63	0.01	0.00
Forestry	0.08	-0.01	-0.21	-0.01	-0.10	0.00	0.00
Dairy_Farms	0.11	-0.01	-0.12	-0.07	-0.13	0.00	0.00
Ruminant	0.27	0.00	-0.49	-0.01	-0.12	0.00	0.00
NonRuminant	0.32	0.00	-0.74	-0.06	-0.16	0.01	-0.02

Case 6: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total
Paddy_Rice	3.39	0.14	-0.89	-0.03	-0.39	-0.02	0.00
Wheat	3.46	-0.47	-5.07	0.25	-1.67	-0.31	0.04
Sorghum	0.34	0.13	-1.09	0.51	-0.85	-0.13	-0.05
Oth_CrGr	0.64	-0.01	-1.38	0.67	-0.96	-0.26	0.09
Soybeans	-8.31	1.53	9.67	2.78	3.93	-1.19	0.15
palmf	-0.43	2.25	0.95	2.52	1.65	0.19	0.23
Rapeseed	-5.02	0.05	-2.63	0.88	0.52	0.57	0.13
Oth_Oilseeds	-3.08	0.52	-0.91	1.22	2.05	0.13	0.17
Sugar_Crop	-0.02	0.02	-0.74	-0.03	-0.06	0.03	-0.18
OthAgri	0.90	0.08	-2.39	0.10	-0.69	0.05	0.01
Forestry	-0.57	0.01	-0.21	0.10	-0.07	0.14	0.03
Dairy_Farms	-0.05	0.01	-0.12	-0.08	-0.12	0.02	-0.01
Ruminant	-0.12	0.13	-0.42	0.03	-0.07	0.04	-0.01
NonRuminant	-0.75	0.18	-0.45	0.05	-0.04	0.09	-0.01

Case 7: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total
Paddy_Rice	2.92	0.18	-1.13	-0.07	-0.42	-0.02	-0.02
Wheat	3.03	-0.37	-6.05	0.12	-1.75	-0.18	0.05
Sorghum	0.76	0.02	-1.43	-0.58	-0.96	-0.11	0.02

Oth_CrGr	1.30	-0.11	-1.81	-0.63	-1.09	-0.22	0.00
Soybeans	-13.92	1.83	12.29	4.00	4.26	0.30	-0.81
palmf	1.78	3.17	2.80	3.24	2.57	0.16	0.22
Rapeseed	8.86	0.70	-2.68	2.63	0.94	1.16	1.80
Oth_Oilseeds	8.60	1.72	0.01	3.38	3.23	0.59	1.52
Sugar_Crop	0.11	0.00	-0.99	-0.06	-0.09	0.03	-0.24
OthAgri	2.19	0.05	-3.16	-0.10	-0.74	0.00	-0.01
Forestry	0.10	-0.01	-0.27	-0.01	-0.12	-0.01	-0.01
Dairy_Farms	0.14	-0.01	-0.16	-0.14	-0.16	0.00	-0.01
Ruminant	0.35	0.00	-0.64	-0.01	-0.14	0.01	0.01
NonRuminant	0.43	0.01	-0.93	-0.13	-0.19	0.01	-0.05

Case 8: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total
Paddy_Rice	3.07	0.20	-1.14	-0.06	-0.44	-0.02	-0.02
Wheat	3.17	-0.39	-6.13	0.13	-1.81	-0.19	0.05
Sorghum	0.80	0.02	-1.45	-0.59	-0.99	-0.12	0.02
Oth_CrGr	1.36	-0.12	-1.84	-0.65	-1.12	-0.23	0.01
Soybeans	-14.65	2.33	12.43	4.04	4.37	0.59	-0.96
palmf	2.07	3.24	3.15	3.64	2.72	0.21	0.28
Rapeseed	9.34	0.75	-2.57	2.89	1.04	1.24	1.94
Oth_Oilseeds	9.09	1.83	0.25	3.72	3.45	0.64	1.64
Sugar_Crop	0.12	0.00	-1.01	-0.07	-0.10	0.03	-0.25
OthAgri	2.30	0.05	-3.20	-0.10	-0.77	-0.01	-0.01
Forestry	0.11	-0.01	-0.28	-0.01	-0.13	-0.01	-0.01
Dairy_Farms	0.15	-0.01	-0.16	-0.16	-0.17	0.00	-0.01
Ruminant	0.37	0.00	-0.65	-0.01	-0.14	0.01	0.01
NonRuminant	0.46	0.01	-0.95	-0.14	-0.20	0.01	-0.06

Case 9: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total
Paddy_Rice	6.17	0.35	-1.28	-0.05	-0.51	-0.06	-0.01
Wheat	6.26	-0.78	-7.30	0.55	-2.39	-0.62	0.12
Sorghum	0.40	0.27	-1.59	0.96	-1.20	-0.25	-0.13

Oth_CrGr	0.84	0.02	-2.00	1.27	-1.32	-0.47	0.14
Soybeans	-12.28	2.53	13.07	4.02	4.63	0.59	0.08
palmf	0.31	3.53	5.77	5.03	3.89	0.45	0.54
Rapeseed	-14.98	0.13	-1.04	2.07	3.66	2.01	0.46
Oth_Oilseeds	-9.34	1.24	2.45	2.93	6.66	0.69	0.78
Sugar_Crop	-0.11	0.03	-1.09	-0.07	-0.09	0.03	-0.27
OthAgri	0.86	0.16	-3.31	0.29	-0.96	0.09	0.04
Forestry	-1.35	0.03	-0.31	0.26	-0.08	0.33	0.09
Dairy_Farms	-0.12	0.03	-0.18	-0.26	-0.17	0.03	-0.03
Ruminant	-0.28	0.27	-0.58	0.06	-0.07	0.09	0.00
NonRuminant	-1.82	0.45	-0.48	0.07	0.02	0.20	-0.03

Case 10: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total
Paddy_Rice	4.05	0.34	-1.93	-0.11	-0.90	-0.01	-0.04
Wheat	4.29	-0.55	-9.96	0.05	-3.53	-0.17	0.04
Sorghum	1.18	0.07	-2.47	-0.66	-1.86	-0.11	0.06
Oth_CrGr	1.85	-0.11	-3.11	-0.73	-2.10	-0.23	0.01
Soybeans	-19.96	1.39	20.03	7.18	9.05	-2.04	-0.36
palmf	2.30	5.72	0.12	3.87	3.22	0.22	0.28
Rapeseed	9.65	0.73	-7.20	2.64	-1.38	0.81	1.66
Oth_Oilseeds	9.31	1.97	-4.20	3.37	1.36	0.36	1.21
Sugar_Crop	0.16	0.00	-1.70	-0.06	-0.18	0.05	-0.41
OthAgri	3.11	0.13	-5.40	-0.14	-1.48	0.05	-0.02
Forestry	0.14	-0.01	-0.47	-0.01	-0.25	0.00	-0.01
Dairy_Farms	0.20	-0.02	-0.27	-0.16	-0.34	0.00	-0.01
Ruminant	0.50	0.01	-1.09	-0.01	-0.31	0.02	0.00
NonRuminant	0.60	0.01	-1.57	-0.14	-0.42	0.03	-0.06

Case 11: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total
Paddy_Rice	4.16	0.35	-1.95	-0.10	-0.91	-0.01	-0.03
Wheat	4.39	-0.56	-10.04	0.06	-3.58	-0.17	0.04
Sorghum	1.21	0.07	-2.50	-0.67	-1.88	-0.11	0.07

Oth_CrGr	1.89	-0.12	-3.14	-0.74	-2.12	-0.24	0.01
Soybeans	-20.58	1.46	20.16	7.21	9.13	-1.98	-0.52
palmf	2.55	5.79	0.47	4.31	3.36	0.26	0.33
Rapeseed	10.12	0.78	-7.10	2.91	-1.26	0.88	1.79
Oth_Oilseeds	9.77	2.07	-3.98	3.72	1.59	0.39	1.32
Sugar_Crop	0.16	0.00	-1.73	-0.07	-0.18	0.05	-0.42
OthAgri	3.18	0.13	-5.44	-0.14	-1.50	0.05	-0.02
Forestry	0.15	-0.01	-0.47	-0.02	-0.26	0.00	-0.01
Dairy_Farms	0.21	-0.02	-0.27	-0.17	-0.34	0.00	-0.01
Ruminant	0.51	0.01	-1.10	-0.01	-0.32	0.02	0.00
NonRuminant	0.62	0.01	-1.59	-0.15	-0.42	0.03	-0.06

Case 12: Agricultural Production Changes (%)

Commodity	USA	EU27	BRAZIL	CHINA	S. America	OTHER	Total
Paddy_Rice	7.33	0.50	-2.08	-0.09	-1.01	-0.05	-0.02
Wheat	7.55	-0.96	-11.15	0.50	-4.22	-0.61	0.11
Sorghum	0.80	0.32	-2.65	0.91	-2.15	-0.24	-0.09
Oth_CrGr	1.34	0.02	-3.31	1.23	-2.40	-0.48	0.14
Soybeans	-17.96	-0.01	20.78	6.63	9.55	-2.49	0.51
palmf	0.73	6.11	2.86	5.74	4.50	0.50	0.59
Rapeseed	-14.25	0.16	-5.70	2.13	1.21	1.66	0.31
Oth_Oilseeds	-8.76	1.47	-1.79	2.98	4.83	0.43	0.45
Sugar_Crop	-0.06	0.03	-1.82	-0.07	-0.18	0.07	-0.44
OthAgri	1.71	0.23	-5.59	0.25	-1.73	0.15	0.03
Forestry	-1.32	0.02	-0.50	0.25	-0.21	0.34	0.08
Dairy_Farms	-0.06	0.02	-0.29	-0.28	-0.35	0.04	-0.03
Ruminant	-0.14	0.28	-1.05	0.06	-0.26	0.10	-0.01
NonRuminant	-1.67	0.46	-1.14	0.06	-0.22	0.23	-0.04