U.S. Drought Impacts on the U.S. and International Rice Economy

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Abstract

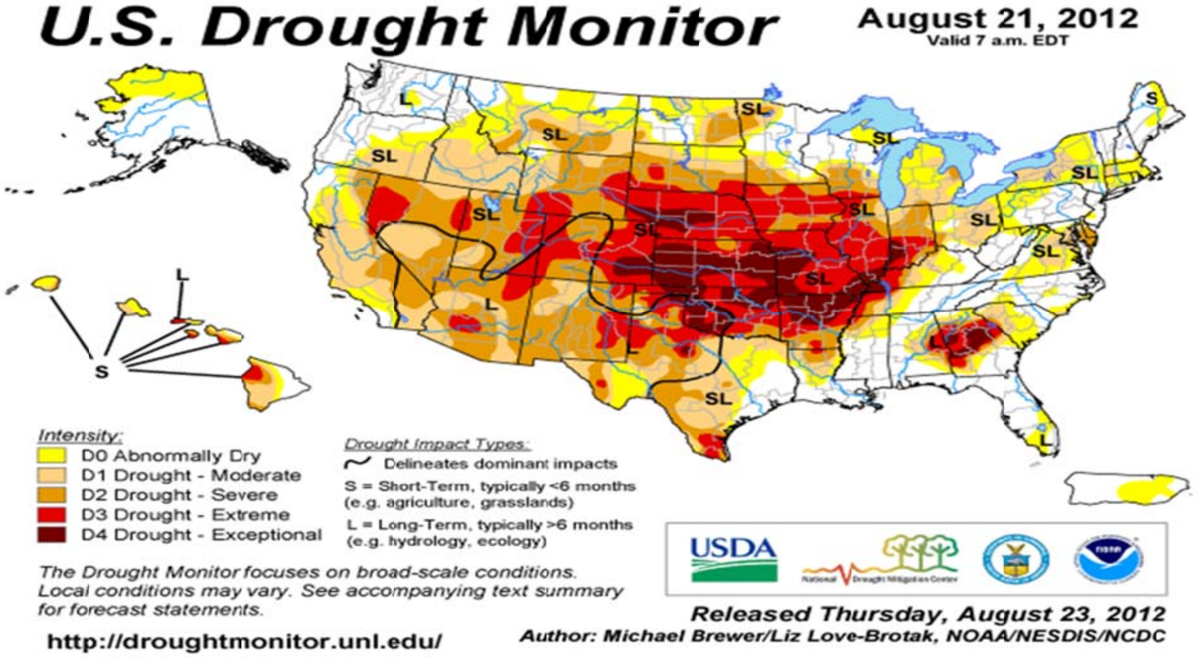
Impact of the U.S. drought on the global rice economy is limited because major exporters hold large stocks, but food deficit nations face food security challenges. Relative prices of corn, soybeans, and wheat to rice, result in rice consumption, trade, and supply responses notably in China, U.S., and Indonesia.

Key Words: Drought, rice, relative prices, substitute crops, AGRM

Introduction

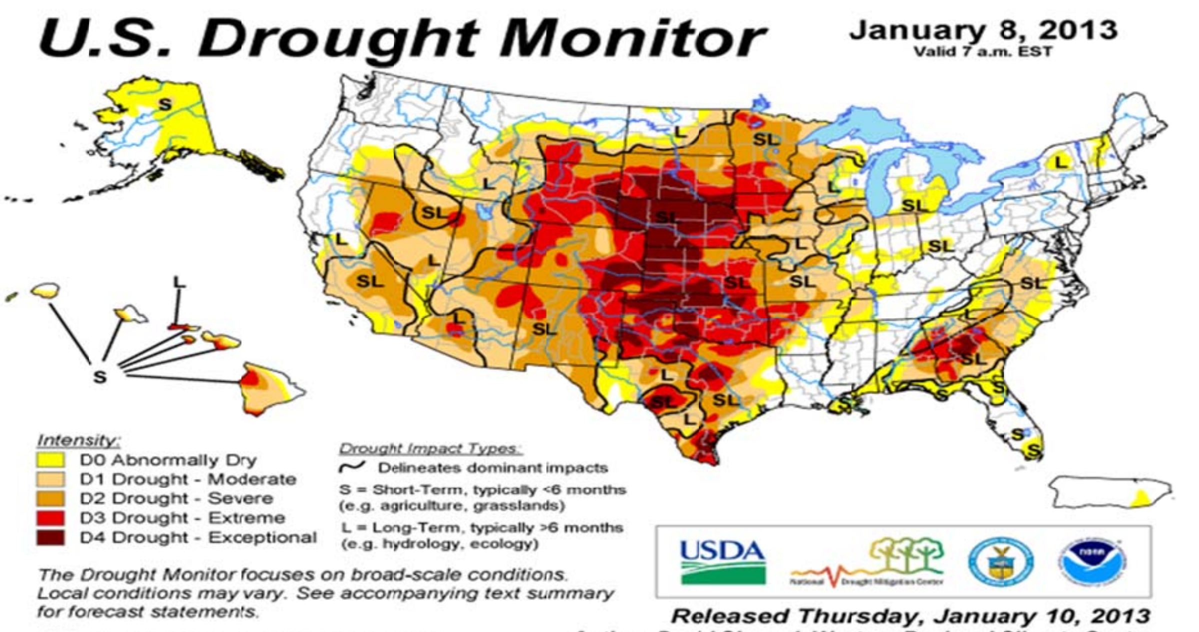
Extreme volatility of food commodity prices has been an overriding issue in various agricultural forums since the occurrence of the food price crisis in 2007/08 season, which triggered riots in a number of countries. The primary driver of concern is food security in developing countries, and price and income effects in general. Food security and food self-sufficiency issues are typically a priority for governments of many countries, especially the food-deficit economies in Asia.

The recent drought in the U.S. and other parts of the world caused spikes in prices of major agricultural commodities such as corn, soybeans, and wheat. Figures 1 and 2 show two maps that give color indication of the progression of the drought in the U.S. from August 21, 2012 to January 8, 2013 (U.S. Drought Monitor, 2013).



The U.S. Drought Monitor is produced in partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration.

Figure 1. Map of the extent of U.S. Drought as of August 21, 2012.



The U.S. Drought Monitor is produced in partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration.

Figure 2. Map of the extent of U.S. Drought as of January 8, 2013.

In December 2012, USDA reported that the most severe and extensive drought in at least 25 years is seriously affecting U.S. agriculture, with impacts on the crop and livestock sectors, with the potential to affect food prices at the retail level. Crop production estimates for several major crops declined throughout the summer as the drought intensified, and by November, production estimates declined for corn by 27.5% and for soybeans by 7 percent, compared to the May estimates—as substantial reductions in both crop yields and share of harvested acres occurred (USDA, 2012).

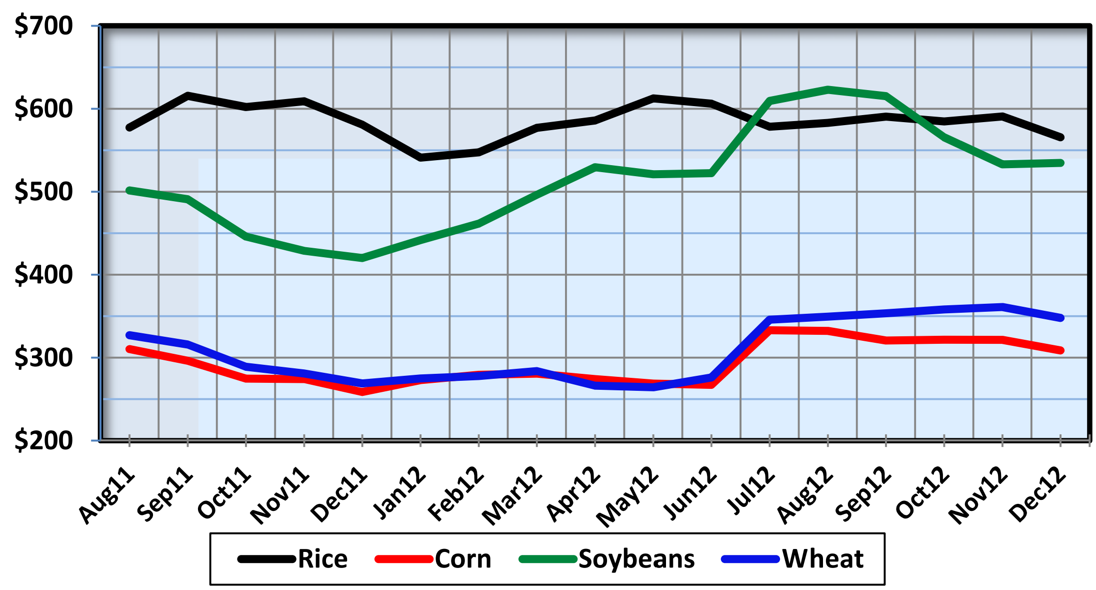
Consequently, global food prices jumped 10% from June to July 2012, driven primarily by the severe Midwest drought (World Bank as cited by Lopez, 2012). Considering that the U.S. is the world's largest exporter of corn and soybeans, the current drought in the U.S. has global impacts. The price of corn and wheat rose by 25%, and that of soybeans rose by 17% during the same period. Surprisingly, rice price was relatively stable during the same period (Figures 3 and 4). The reason is that rice is an irrigated crop and hence relatively unaffected by drought.

Figure 3 indicates the monthly average prices for rice and the other commodities. The average rice price declined while the rest of the prices spiked and remained elevated at least through October 2012. In fact, rice prices continued to remain stable at the lower prices; and even declined further in December. Another reason for this rice price behavior is that world rice has been a buyers' market due to the abundant supplies in major exporting countries such as India, Vietnam, and Thailand—mainly from surplus stocks. As such, strong price competition for limited import market has emerged among the major players in global rice trade.

Soybean prices stabilized at the high level in August and September; and started to decline thereafter but remained higher than the pre-drought level by December. Wheat prices continue to climb until November albeit slowly before declining slightly in December. Corn prices stabilized at the high level in August and started a slight downward trend since then, although the level is still much higher than the pre-drought level.

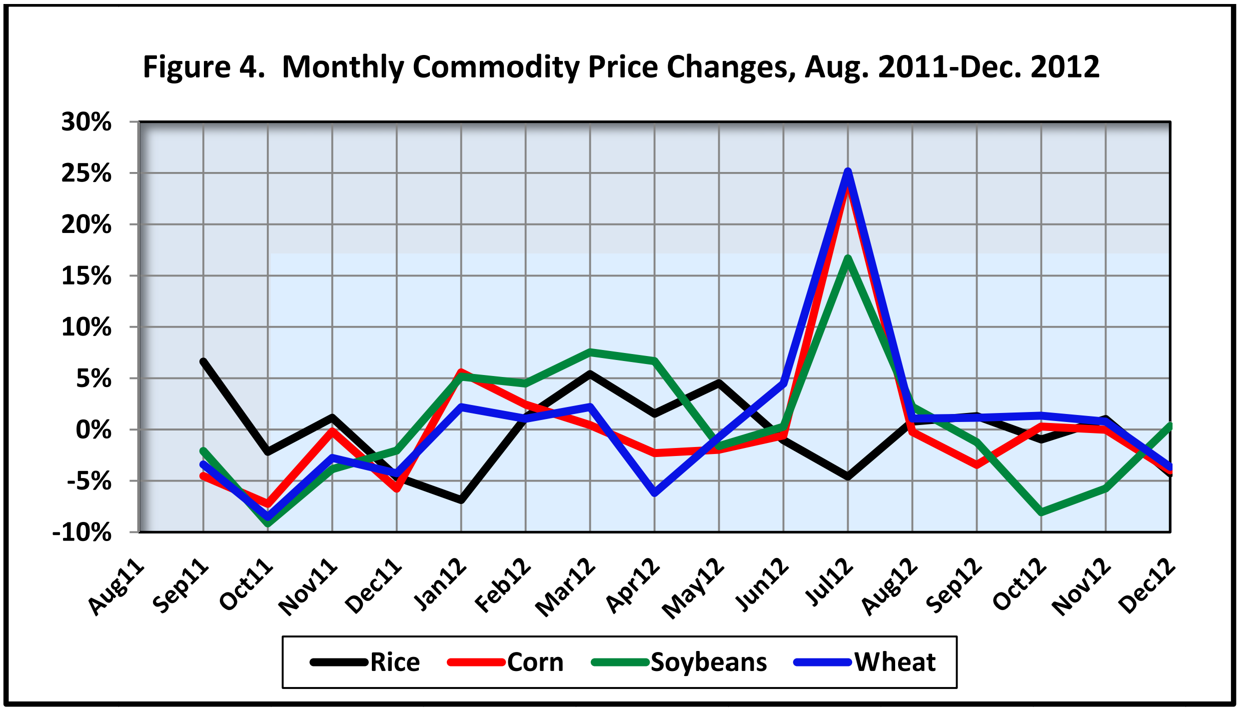
This paper explores the impact of the recent substantial price spikes in corn, soybeans, and wheat on the U.S. and international rice markets, considering that these commodities are substitute crops for rice in the U.S. and other countries. Rice area competes with a number of crops including soybeans, corn, and cotton in rice-producing states of Arkansas, Louisiana, Missouri, Mississippi, Texas, and California.[1]

Figure 3. Monthly Commodity Prices, $/MT, Aug. 2011-Dec. 2012



Source: http://www.indexmundi.com/commodities/

[1] The estimated elasticities of the relative net returns from substitute crops vary by rice type (i.e., long grain or medium grain) and by location; and can be found in the AGRM documentation published online at http://ageconsearch.umn.edu/handle/102650.



Source: Computed from Figure 3 data; http://www.indexmundi.com/commodities/

In China, rice competes with corn in the provinces of Guangxi, Heilongjiang, Jilin, and Liaoning; with wheat in the province of Jiangsu; and with both corn and wheat in the provinces of Anhui, Chongqing, Guizhou, Hubei, Ningxia, Sichuan, and Yunnan (Carriquiry, et al., 2012). In India, rice competes with wheat particularly in the northern states.

Methodology

Using the Arkansas Global Rice Model (AGRM)[2], a partial, non-spatial, multi-country statistical simulation and econometric analytical framework, we analyze the short-term and long-term impacts on the U.S. and international rice markets of the recent substantial increases in prices and net returns from crops that compete with rice, namely corn, soybeans and wheat. The AGRM

[2] The structure and other details of AGRM can be found in the online documentation by Wailes and Chavez (2011) published at http://ageconsearch.umn.edu/handle/102650.

interfaces with other commodity models maintained by the Food and Agricultural Policy Research Institute (FAPRI) for the needed data on commodity prices and net returns projections. AGRM covers 43 key rice producing and consuming countries; with all other countries not individually-modeled included in one of the five rest-of-the-region (Africa, the Americas, Asia, Europe, and Oceania) models.

The impact on rice is evaluated by analyzing changes in selected countries by variables, namely area, production, consumption, trade, and prices–by comparing the drought-price shock scenario numbers with the original baseline numbers.

To capture the dynamics of the current price changes, we collaborated with FAPRI-MO and obtained their most recent projections of commodity prices and net returns for the period 2012-2017 for the same set of commodities as of August 2012 (post-drought). The updated FAPRI commodity prices and net returns are transmitted into the different AGRM country models, including the six rice-producing U.S. states (AR, CA, LA, MO, MS, and TX). The percent changes of the prices and net returns from baseline (pre-drought) to post-drought period are presented in Table 1.

The scenario impact on selected variables by country is evaluated by the resulting levels and percent changes from the original pre-drought baseline numbers. While impact simulation results are available for all the 43 countries covered by AGRM, the discussion in this paper focuses on the impact of the drought on major rice-producing and-consuming countries such as the U.S., India, Thailand, Vietnam, China, Bangladesh, Indonesia, and the Philippines—along with discussion on the global effects.

Table 1. Percent Changes in FAPRI Prices and Net Returns by Commodity from March to August Baseline						
% Changes in Prices: August 2012 vs. March 2012						
Commodity	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
corn	68.4%	10.6%	1.3%	-1.9%	-2.3%	-1.0%
wheat	38.1%	24.5%	7.2%	-0.5%	-2.1%	-1.0%
soybeans	43.1%	-0.8%	-2.1%	-0.8%	-0.6%	0.0%
% Changes in Net Returns: August 2012 vs. March 2012						
Commodity	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
corn	53.2%	19.4%	1.2%	-5.4%	-5.6%	-3.1%
wheat	83.7%	54.3%	13.5%	-2.5%	-5.6%	-3.5%
soybeans	29.4%	-0.7%	-3.2%	-1.2%	-0.9%	0.6%
Source: Computed from FAPRI model simulation data.						

Results and Discussion

The results of the analysis on selected variables by country are summarized in Table 2 (level changes) and Table 3 (percent changes). As expected, the drought has larger impacts in the initial years as dynamic recovery and stabilization occurs thereafter.

The major rice impacts of the drought in 2012 are on price, consumption and trade; and on area harvested and production in 2013. This makes sense as crop supply response typically has a one-year lag while responses of the other variables are usually current.

Results indicate that the drought-induced corn, soybeans, and wheat price shocks impact global long grain rice prices by +6.2% in marketing year 2012, +3.2% in 2013 and +0.2% in 2014. The magnitude and pattern of changes are larger and different for medium grain rice (at +3.1% in the first year, +9.4% in the second year, and +8.3% in the third year) than for the long grain rice in global markets.

The long grain prices continue to decline after the third year and stabilize by 2020. However, the medium grain prices remain relatively strong over the next seven years. These results indicate that the medium grain rice price is more responsive to the scenario than the long grain rice price, the reason being that international trade in medium grain is much smaller than the long grain and increasingly more important in China's rice consumption.

There is a lagged supply response of one year hence the impact in area harvested starts in 2013. Rice area harvested in the U.S. contracts by -6.1% in 2013, -5.3% in 2014, and -2.8% in 2015, before stabilizing in 2016. U.S. area harvested increases thereafter, as medium grain area responds positively to the relatively strong medium grain prices.

The declines in U.S. rice area harvested in 2013 and 2014 are accounted for largely by the three rice-producing states of California (-48 thousand acres in 2013 and -66 thousand acres in 2014), Louisiana (-44 thousand acres in 2013 and -38 thousand acres in 2014), and Texas (-30 thousand acres in 2013 and -38 thousand acres in 2014). These two-year area declines are equivalent to -14% and -12% for California; -10% and -8% for Louisiana; and -22% and -24% for Texas.

The percent impact on Texas rice area harvested is relatively large because the positive impact of increased returns from rice due to higher rice price is overshadowed by the negative impact of increased returns from the substitute crop (corn) due to much higher corn price. The same story is true for Louisiana (soybean as a substitute crop for rice) and California (corn as a substitute crop for rice), albeit to a lesser degree. The rates of decline in the harvested area of Arkansas, Missouri and Mississippi during the same period are much milder, ranging from 0.5% to 2.1%.

U.S. rice production declines by -6.6% in 2013, -5.8% in 2014, and -3.1% in 2015 and stabilizes in 2016, after which it increases in tandem with area harvested.

China's rice area harvested declines by -4.7% in 2013, -2.6% in 2014, and -1.0% in 2015—with the 2013 impact alone amounting to a decline of 1.4 million hectares which translates to a contraction of 6.7 million mt of production. China's area stabilizes starting 2016.

About 80% of the decline in China's rice area harvested is accounted for by long grain as a result of substitution from both corn and wheat; medium grain rice is substituted by corn.

World rice area harvested declines by 1.3 million hectares (or -0.8%) in 2013 and 564 thousand hectares (or -0.4%) in 2014, before relatively stabilizing thereafter. Global rice production is down by 6.3 million mt (or -1.3%) in 2013 and 2.9 million mt (or -0.6%) before stabilizing.

The downward changes in world rice area and output are accounted for largely by the declines in China and the U.S.—which are only partially offset by minor increases in the rest of the world where there is less substitution between rice and corn, soybeans, and wheat.

The changes in relative international prices also induce an expansion in global rice net trade of 682 thousand mt (or +2.2%) in 2012 and 249 thousand mt (or +0.7%) in 2013. World net trade declines in the following two years; before resuming expansion.

World rice consumption expands by 1.8 million mt (or 0.4%) in 2012, 725 thousand mt (or 0.2%) in 2013, then stabilizes thereafter.

Table 2. Level Impacts of U.S. Drought on Selected Countries and Variables by Year, 2012-21

Variable	Unit / Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
World Area Harvested	(1000 ha)	6.0	-1332.3	-564.1	-63.4	240.4	311.2	219.8	51.0	14.9	43.4
World Production	(1000 mt)	118.4	-6317.4	-2864.3	-589.3	801.8	1163.3	743.0	280.8	222.9	383.4
World Consumption	(1000 mt)	1809.5	725.5	81.1	-176.9	31.1	680.4	639.1	177.5	-73.6	-53.1
World Net Trade	(1000 mt)	682.2	248.7	-48.4	-130.7	92.9	409.3	463.4	339.3	103.2	-8.0
Long Grain International Reference P	US$/mt	28.8	14.4	1.0	-3.1	-7.1	-8.6	-6.4	-3.5	0.1	1.0
U.S. No.2 Medium Grain Price fob C/	US$/mt	28.4	91.8	81.1	42.6	43.0	-1.6	5.2	43.6	41.2	43.9
U.S. Season Ave. Farm Price	(US$/cwt)	0.1	0.0	0.9	1.1	1.5	0.3	0.6	-0.2	0.6	0.2
U.S. Total Harvested Area	(1000 ac)	0.0	-169.3	-154.7	-83.5	-8.8	61.6	50.8	62.0	25.0	39.6
AR Harvested Area	(1000 ac)	0.0	-12.4	-6.3	1.9	9.5	16.4	9.3	10.3	1.3	4.7
LA Harvested Area	(1000 ac)	0.0	-43.8	-37.5	-21.2	2.8	30.4	26.0	35.8	18.1	25.5
TX Harvested Area	(1000 ac)	0.0	-30.3	-38.1	-32.5	-18.8	-4.3	-2.0	2.8	-2.5	0.9
MO Harvested Area	(1000 ac)	0.0	-2.7	-3.2	-3.2	-2.5	-1.3	-1.8	-1.4	-2.7	-2.5
MS Harvested Area	(1000 ac)	0.0	-3.1	-3.4	-2.2	-0.1	1.8	1.4	1.8	0.3	0.8
CA Harvested Area	(1000 ac)	0.0	-77.1	-66.2	-26.2	0.3	18.6	17.8	12.8	10.5	10.1
U.S. Production	(1000 mt)	0.0	-415.5	-383.0	-211.6	-35.8	129.2	106.1	130.8	45.6	79.6
U.S. Consumption	(1000 mt)	-37.1	-27.3	-21.3	-7.5	-5.3	29.5	71.6	106.6	154.9	259.3
Bangladesh Area Harvested	(1000 ha)	0.0	45.5	36.4	14.5	0.4	-14.6	-26.5	-29.8	-27.8	-22.4
Bangladesh Production	(1000 mt)	0.0	180.5	146.0	64.0	10.9	-46.6	-91.2	-105.3	-100.4	-81.9
Bangladesh Consumption	(1000 mt)	-2.2	-1.2	-0.1	0.3	0.6	0.8	0.6	0.3	0.0	-0.1
China Area Harvested	(1000 ha)	0.0	-1402.5	-749.8	-286.9	-20.0	68.3	22.3	-12.1	8.8	25.4
China Production	(1000 mt)	0.0	-6669.6	-3554.1	-1321.2	-28.6	403.3	154.7	-17.5	103.6	193.5
China Consumption	(1000 mt)	1426.9	368.8	-116.6	-220.7	-180.5	112.7	96.1	-116.0	-155.0	-171.2
India Area Harvested	(1000 ha)	0.0	-91.5	-0.1	119.2	208.4	242.8	255.9	117.5	54.2	25.3
India Production	(1000 mt)	0.0	-192.8	36.7	327.5	541.1	624.1	656.7	311.2	153.3	81.9
India Consumption	(1000 mt)	203.3	139.7	45.0	-3.3	-14.1	-6.5	0.0	0.0	0.0	0.0
Indonesia Area Harvested	(1000 ha)	0.0	33.5	21.9	4.8	-2.4	-8.1	-11.1	-9.0	-5.2	-0.4
Indonesia Production	(1000 mt)	0.0	134.6	100.9	40.2	13.1	-11.5	-27.2	-22.7	-10.7	7.4
Indonesia Consumption	(1000 mt)	1492.0	1060.4	370.0	1.0	-49.9	32.0	65.6	35.6	-0.7	-10.1
Philippines Area Harvested	(1000 ha)	0.0	11.0	16.0	15.2	12.8	8.8	4.3	1.1	-0.5	-0.3
Philippines Production	(1000 mt)	0.0	47.2	61.3	56.2	48.3	34.6	19.0	8.8	4.2	5.9
Philippines Consumption	(1000 mt)	-221.9	-118.0	-8.7	25.6	62.6	83.0	64.0	33.5	-0.7	-11.0
Thailand Area Harvested	(1000 ha)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thailand Production	(1000 mt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thailand Consumption	(1000 mt)	-16.7	-8.6	-0.6	1.9	4.4	5.5	4.2	2.2	0.0	-0.6
Vietnam Area Harvested	(1000 ha)	0.0	3.0	2.6	1.0	0.1	-0.6	-1.0	-0.9	-0.6	-0.2
Vietnam Production	(1000 mt)	0.0	73.3	63.8	40.5	29.4	16.9	7.9	7.0	9.5	15.4
Vietnam Consumption	(1000 mt)	-299.5	-158.1	-11.5	33.7	82.5	108.9	83.6	44.5	-0.3	-4.5

Source: Computed and summarized from AGRM model simulation results.

Table 3. Percent Impacts of U.S. Drought on Selected Countries and Variables by Year, 2012-21											
Variable	**Unit / Year**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
		Percent Impact									
World Area Harvested	(1000 ha)	0.0	-0.8	-0.4	0.0	0.2	0.2	0.1	0.0	0.0	0.0
World Production	(1000 mt)	0.0	-1.3	-0.6	-0.1	0.2	0.2	0.2	0.1	0.0	0.1
World Consumption	(1000 mt)	0.4	0.2	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
World Net Trade	(1000 mt)	2.2	0.7	-0.1	-0.4	0.3	1.1	1.3	0.9	0.3	0.0
Long Grain International Reference P	US$/mt	6.2	3.2	0.2	-0.7	-1.6	-2.0	-1.5	-0.8	0.0	0.2
U.S. No.2 Medium Grain Price fob C/	US$/mt	3.1	9.4	8.3	4.2	4.1	-0.1	0.5	4.1	4.0	4.3
U.S. Season Ave. Farm Price	(US$/cwt)	1.0	0.2	6.1	8.1	11.6	1.9	4.6	-1.3	4.4	1.8
U.S. Total Harvested Area	(1000 ac)	0.0	-6.1	-5.3	-2.8	-0.3	2.1	1.7	2.1	0.9	1.3
AR Harvested Area	(1000 ac)	0.0	-1.0	-0.5	0.1	0.7	1.2	0.7	0.8	0.1	0.4
LA Harvested Area	(1000 ac)	0.0	-10.1	-7.9	-4.3	0.6	6.5	5.6	7.9	3.9	5.6
TX Harvested Area	(1000 ac)	0.0	-22.1	-23.6	-19.1	-11.6	-2.8	-1.2	1.8	-1.6	0.6
MO Harvested Area	(1000 ac)	0.0	-1.3	-1.5	-1.5	-1.2	-0.6	-0.9	-0.7	-1.3	-1.2
MS Harvested Area	(1000 ac)	0.0	-2.0	-2.1	-1.3	-0.1	1.0	0.8	1.0	0.2	0.5
CA Harvested Area	(1000 ac)	0.0	-13.9	-11.7	-4.6	0.0	3.3	3.1	2.2	1.8	1.7
U.S. Production	(1000 mt)	0.0	-6.6	-5.8	-3.1	-0.5	1.9	1.5	1.9	0.6	1.1
U.S. Consumption	(1000 mt)	-0.9	-0.6	-0.5	-0.2	-0.1	0.6	1.5	2.2	3.2	5.3
Bangladesh Area Harvested	(1000 ha)	0.0	0.4	0.3	0.1	0.0	-0.1	-0.2	-0.3	-0.2	-0.2
Bangladesh Production	(1000 mt)	0.0	0.5	0.4	0.2	0.0	-0.1	-0.3	-0.3	-0.3	-0.2
Bangladesh Consumption	(1000 mt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
China Area Harvested	(1000 ha)	0.0	-4.7	-2.6	-1.0	-0.1	0.2	0.1	0.0	0.0	0.1
China Production	(1000 mt)	0.0	-4.7	-2.5	-0.9	0.0	0.3	0.1	0.0	0.1	0.1
China Consumption	(1000 mt)	1.0	0.3	-0.1	-0.2	-0.1	0.1	0.1	-0.1	-0.1	-0.1
India Area Harvested	(1000 ha)	0.0	-0.2	0.0	0.3	0.5	0.5	0.6	0.3	0.1	0.1
India Production	(1000 mt)	0.0	-0.2	0.0	0.3	0.5	0.6	0.6	0.3	0.1	0.1
India Consumption	(1000 mt)	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indonesia Area Harvested	(1000 ha)	0.0	0.3	0.2	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0
Indonesia Production	(1000 mt)	0.0	0.4	0.3	0.1	0.0	0.0	-0.1	-0.1	0.0	0.0
Indonesia Consumption	(1000 mt)	3.7	2.6	0.9	0.0	-0.1	0.1	0.2	0.1	0.0	0.0
Philippines Area Harvested	(1000 ha)	0.0	0.2	0.3	0.3	0.3	0.2	0.1	0.0	0.0	0.0
Philippines Production	(1000 mt)	0.0	0.4	0.5	0.5	0.4	0.3	0.2	0.1	0.0	0.0
Philippines Consumption	(1000 mt)	-1.7	-0.9	-0.1	0.2	0.5	0.6	0.4	0.2	0.0	-0.1
Thailand Area Harvested	(1000 ha)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thailand Production	(1000 mt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thailand Consumption	(1000 mt)	-0.2	-0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Vietnam Area Harvested	(1000 ha)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vietnam Production	(1000 mt)	0.0	0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.1
Vietnam Consumption	(1000 mt)	-1.5	-0.8	-0.1	0.2	0.4	0.5	0.4	0.2	0.0	0.0

Source: Computed and summarized from AGRM model simulation results.

These results highlight the impact of possible area substitution from rice to corn, soybean, and wheat--as the relative returns from growing rice become unfavorable.

For China, India, and Indonesia, wheat is a substitute staple food crop for rice. The impact of drought in these countries is positive for rice consumption, as the higher prices of wheat encourages shifting to rice. The increases in wheat prices in these countries dominate the increases in rice prices.

In the Philippines and Vietnam, the impact of the drought on rice consumption is negative as neither of the other crops is a substitute for rice. As expected, the higher rice prices dampen rice consumption. The negative impacts of the drought in rice consumption in Bangladesh, Thailand and the U.S. are relatively small.

As expected, the average impact of the drought is muted beyond the third year, as dynamic adjustments occur in the rice market. There is a mild recovery in world rice area harvested, production, and consumption during the same period.

As in any typical market shock, eventually the normal forces of supply and demand in the market set in. This is evident in the much lower level of impact in most of the countries for the period beyond the third year, with the exception of India. India’s area harvested comes back strongly starting in 2015 driven by expansion in rice exports, as declining long grain prices makes the country more competitive in the global rice market. This situation comes in tandem with resumption of release of its larger-than-normal national rice stockpile.

In general, the deterministic impact of the recent U.S. drought appears to be relatively muted for the global rice economy due to large stocks in China, India, and Thailand. Nevertheless, the food-deficit economies including Bangladesh, Indonesia and Philippines remain faced with food security challenges brought about by risks and uncertainties related to weather, government policies, and politics, among other factors.

Conclusions

As expected, the impact of the U.S. drought is concentrated during the first few years after the event. It takes about three years before the drought-induced impact on the rice sector stabilizes. While the impact of the U.S. drought is relatively muted for the global rice economy due to large stocks in China, India, and Thailand, there are nevertheless, challenges faced by key food deficit nations regarding food security as rice prices increase.

The current price surges in corn, soybeans, and wheat as a result of the recent drought in the U.S., and the relative stability in rice price during the same period have consequent changes in relative net returns and competitiveness of the crops---with potential substantial rice supply responses in the U.S. and China. Important demand responses also occur in the Philippines and Vietnam—where rice consumption declines as rice price increases; and in Indonesia where shifting to rice consumption occurs due to higher wheat prices.

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