Brazil’s Transportation Infrastructure and Competitiveness in the Soybean Market

Xi He, Guilherme DePaula, Wendong Zhang
xihe@iastate.edu; gdepaula@iastate.edu; wdzhang@iastate.edu

In 2013, Brazil surpassed the United States to become the world’s largest soybean exporter. As figure 1 shows, Brazil’s soybean production and exports have accelerated since its trade liberalization in the mid-1990s, and it has gained extra competitiveness over the United States in the export market during the US-China trade war, when China imposed several waves of retaliatory tariffs on US soybeans. For interested readers, a tool is available on the CARD website that shows historical revealed comparative advantages for six leading export countries at https://www.card.iastate.edu/tools/ag-exports/bubble/. In the 2019/20 marketing year, Brazil’s soybean exports reached 92 million metric tons (MMTs), about twice that of US soybean exports (USDA 2021). While Brazil’s increasing competitiveness in the oilseed market depends critically on its advanced soybean production technology, its adaptation of a double-cropping soy-corn system in the savanna (DePaula and Fortes 2019), extended periods of currency depreciation (Valdes et al. 2020), and declining transportation costs resulting from expanding transportation infrastructure network (He et al. 2021) are key factors as well.

Brazil’s soybean production and road network expansion

Over the past four decades, Brazil’s soybean production expansion came with a drastic shift of major production areas. Figure 2 shows that the major soybean production area shifted from the traditional agricultural region in the south to the agricultural frontier in central-west Brazil, especially in the state of Mato Grosso. Major reasons for this shift include Brazil’s long-term strategy to cultivate the Cerrado savanna, greater investment in the soybean industry by multinational firms since the trade liberalization, and the international price surges in the mid-1990s that stimulated soybean production in South America (Gale et al. 2019).

Over the same period, Brazil’s transportation network has also expanded significantly, facilitating its soybean exports. Figure 3 shows Brazil’s major road network in 2017 and all ports that have ever exported soybeans. Brazil’s transportation network currently provides a major advantage in transporting soybeans to global markets.

1. The central-west area of Brazil produced 60.6% of Brazil’s soybeans in the 2020/21 marketing year.
soybeans. The two major ports for exporting soybeans are the Santarém port in the north and the Santos port in the southeast. Most Brazilian soybeans exported to China were from northern Mato Grosso to Shanghai via the Santos port in the southeast. However, when Brazil finished paving a stretch of BR-163 from North Mato Grosso to Miritituba port in November 2019, the time needed to truck soybeans from Mato Grosso to the northern terminal in Miritituba was cut from 3 days to 1.5 days (USDA 2021), making the northern ports no longer a mere alternative to Brazil’s southern ports but a key to accommodating central Brazil’s ever-expanding grain and oilseed production (CONAB 2020).

To further look at the impacts of the paving of BR-163 on Brazil’s soybean transportation costs and how that adds to Brazil’s cost advantages over the United States, figure 4 presents the decomposition of farm gate price and various transportation costs of transporting Brazilian and US soybeans to Shanghai, China in 2006, 2010, 2015, and 2020. We show the costs of three routes: from the northern Mato Grosso to Shanghai; China via the Santos port in the south and via the Santarém port in the north; and, from Davenport, Iowa, to Shanghai via the US port of New Orleans.

In 2006 and 2010, the farm gate price of Brazilian soybeans was lower than that of US soybeans, but due to its high domestic transportation costs, the landed price of US soybeans in China was lower than that of Brazilian soybeans. However, in 2015 and 2020, which covers the paving of BR-163, the costs of transporting soybeans from northern Mato Grosso to Shanghai, China via the Santarém port decreased significantly, making the landed price of US soybeans in China higher than that of Brazilian soybeans.2

The shift in soybean transport routes is evident in Mato Grosso. In 2012, only 14.5% of Mato Grosso’s grain outflow followed the northern route (North Arch ports). In 2020, for the first time, most of Mato Grosso’s grain outflow, 53.1%, followed the North Arch in Brazil (IMEA 2020). Mato Grosso’s exports have continued to grow as producers in the state move their products north—China’s soybean imports from Mato Grosso totaled 12.74 million tons in

---
2. Brazil’s extended periods of currency depreciation and macroeconomic fluctuations have also contributed to its emergence as a competitor for the United States in global agricultural markets (Valdes et al. 2020).
2019, compared with a total of 16.64 million tons imported from the United States (IMEA 2020). The emergence of Mato Grosso as a competitor in the global soybean export market also signals a shift broader than transportation modes. The Mato Grosso model integrates the technological changes that enabled soybean adaptation to the savanna in a multiple-cropping system in super large farms highly capitalized and integrated into the multinational trading market. Large portions of the new investments in logistics and transportation are private and follow decades of expansion of the Mato Grosso export model. The Brazilian government and many international companies continue to prioritize transportation infrastructure projects that facilitate the export of agricultural

---

**Figure 3. Brazil’s major road network in 2017 and BR-163.**

*Note:* This figure shows Brazil’s major road network in 2017 and the BR-163. Data come from Brazil’s National Department of Transport Infrastructure (DNIT 2020).

**Figure 4. Average production and transportation costs of transporting Brazilian and US soybeans to Shanghai, China, 2006, 2010, 2015, and 2020.**

*Note:* This figure shows the average farm gate price and transportation costs of transporting Brazilian soybeans from northern Mato Grosso to Shanghai, China, via the Santos port in the south and the Santarém port in the north, as well as transporting US soybeans from Davenport, Iowa, via the US Gulf of Mexico. Data come from USDA soybean transportation guide (Salin 2021). Note that the route from northern Mato Grosso to Shanghai, China, via the Santarém port in the north was not commonly used until the recent paving of BR-163. In addition, production costs are also lower in Brazil. See [https://farmdocdaily.illinois.edu/2021/07/international-benchmarks-for-soybean-production-4.html](https://farmdocdaily.illinois.edu/2021/07/international-benchmarks-for-soybean-production-4.html) for details.
What is the Tradeoff between COVID-19 and Economic Recovery?

Peter F. Orazem
pfo@iastate.edu

Since July 2019, Iowa has lost 3.4% of its labor force and 3.3% of its employment. Nationally, employment is 3.7% below the July 2019 level, and so Iowa is doing slightly better on employment loss. However, the national labor force has fallen only 1.4% and in that way Iowa has performed much worse than the nation on labor force participation. That said, there has been a surge in Iowa’s labor force participation from June 2021 to July 2021 as the two-year decrease in labor force participation was -4.7% in June; and thus, there was a substantial improvement in Iowa’s labor force participation over the past month.

The Iowa experience is just one of 51 very different labor market outcomes across the 50 states and Washington, DC. Driving the differences in outcomes is the variation in state responses to the pandemic. Some states used strict and comprehensive mandatory shut-downs of their economies to reduce the spread of the disease. Others relied more on voluntary limits on economic activity with more modest and short-lived shutdowns. In this article, I examine the magnitude of the tradeoff between the severity of COVID-19 restrictions and the resulting benefit in reduced spread of the disease against the cost of lost jobs and economic activity.

The overall picture is shown in figure 1, which compares the relative changes in labor supply (those over 15 who are either employed or actively seeking work) and the change in employment. I separate the states into those that suspended supplemental unemployment benefits in June and those suspending them in September. In general, the states in blue have performed better in the sense that they lost less employment and labor force than did the states in red, but it is hard to tie this to the unemployment insurance policy. The reason is that they were also performing better before the suspension of the supplemental unemployment insurance benefit due to less stringent restrictions imposed on their economies in response to the COVID-19 pandemic. I estimate that about 14% of the difference in the labor force participation between the states with and without the $300 additional UI benefit can be tied to dropping the supplemental UI benefit and the rest is due to the differences in other policies that favored employment.

The upper right quadrant of figure 1 includes states that have gained employment and labor force since July 2019. Those states are generally in blue. The lower left quadrant includes states that lost both employment and labor force, and they are disproportionately red. Interestingly, Iowa, a state that had some of the least economic restrictions during the pandemic, has performed atypically poorly compared to the other blue states in both employment loss and lost labor force. So, while Iowa’s labor market appears to have responded to the suspension of the supplemental unemployment insurance benefits, it remains among the poorer performing states overall.

To illustrate the tradeoffs between economic performance and the spread...
of the pandemic, I use the wallethub.com measure of the severity of the restrictions. While there are many measures of the relative degree of COVID-19-related restrictions on mobility, production, sales, and personal hygiene across states, they tend to conform closely with one another. In the wallethub.com measure, the states with the least restrictive policies were Iowa, Florida, Wyoming, South Dakota, and Texas. The most restrictive were Vermont, DC, Delaware, Virginia, and Washington. The least restrictive group averaged a 12.4% COVID-19 incidence rate, a 2.5% loss of employment and a 0.7% increase in their labor force. The most restrictive group averaged a 7.5% COVID-19 incidence rate, a 4% employment loss, and a 2.4% decrease in their labor force.

Figure 2 shows the tradeoffs between the economy and the disease. As the policies went from most restrictive to least restrictive, average disease incidence rose from 8% to 12%, or an increase of 4 percentage points. On the other hand, over the same range, average employment changed from -6% to -1%, an increase of 5 percentage points. From these trend lines, we can capture the indirect effect of employment on the COVID-19 incidence, using the Wald (1940) estimator. The effect of a unit relaxation of economic restrictions on employment is 0.058% more jobs, but with 0.059% more COVID-19 cases.

Therefore, the rate of increase in COVID-19 incidence as jobs increased is 0.059/0.058 = 1.02. A one percentage point increase in jobs results in an increased COVID-19 rate of 1.02 percentage points. Using Iowa numbers as an example, that means that the tradeoff to get 16,000 more jobs (roughly one percent of the workforce) and $959 million in annual compensation, we should expect 32,600 more COVID-19 cases. The cost of lowering COVID-19 cases by one person is $29,390 in lost annual compensation.

Of course, there is a benefit from reducing COVID-19 cases with fewer serious illnesses and deaths. The

Figure 2. How government economic restrictions affected labor supply, employment, and COVID-19 rates.

Source: Author’s analysis of data from the US Bureau of Labor Statistics, the Johns Hopkins University Center for Systems Science and Engineering, and the ranking of states from most to least restrictive COVID-related shutdowns as reported by wallethub.com.

Figure 3. US labor demand and supply from 2019 to 2021.

Wage

Supply in 2019

Demand in 2019

Number of Workers

$W_{2021}$

$W_{2019}$

$N_{2021}$

$N_{2019}$

The Supplemental Nutrition Assistance Program (SNAP), formerly known as the Food Stamp Program (FSP), is the largest food assistance program administered by the US Department of Agriculture (USDA). In 2017, SNAP provided aid to 12.9% of the United States population—the average household received $254 in benefits per month (USDA). The stated objectives of the SNAP program are to reduce hunger, malnutrition, and poverty through the provision of in-kind transfers to households who are eligible for benefits. Nevertheless, in a sample of SNAP households, approximately 61% indicated being food insecure in 2011 and 2012 (Mabli et al. 2013). Although SNAP is a federal program, each state is responsible for distributing benefits to its residents. Distribution dates for each household are determined at the state level and all 50 states currently deliver benefits according to a monthly distribution cycle.

This report utilizes household level supermarket panel data, generated from roughly 850 SNAP households, to evaluate the effect of SNAP issuance on intramonthly grocery spending patterns. In its most granular form, the data set is provided at the universal product code (UPC), date, store, household level and contains purchases made between April 2014 and September 2017. Like many supermarket retailers, the retailer providing the data has developed algorithms that utilize loyalty card numbers and other matchable forms of payment (e.g., credit card numbers) in order to identify all purchases made by a household in the retailer’s stores. Additionally, the retailer sends promotional material to its customer base; and, as a result, the retailer can link the name and address of a specific household to purchases made at the retailer. The data we utilize includes an observation for each purchased item, along with its price and quantity for every household. In addition, we are able to observe the form of payment (e.g., credit card, cash, EBT-SNAP, EBT-WIC etc.), at the transaction level, which can also be linked to the items purchased by the household in that transaction.

SNAP benefits in the state of residence for these households are distributed monthly according to the first letter of the household’s last name. Benefit distribution days in this state begin on the fifth of each month and end on the twenty-third of each month. The exceptional detail of the retail data combined with the state’s benefit disbursement schedule allows us to determine the day and week of the calendar month that each household receives their SNAP benefits. Table 1 illustrates the frequency and percentage of households receiving SNAP benefits on a certain calendar day in the state of residence of the SNAP households.

To shed light on the effect of SNAP benefit disbursement on intramonthly expenditure patterns with the retailer, we evaluate changes in daily overall expenditure levels over the course of the benefit cycle. Figure 1 plots the coefficient estimates from a fixed effects regression equation that estimates the effect on household expenditure i days away from benefit receipt, where i ∈ {0,1,…,30}. We use day 28 after disbursement as a reference point for daily spending over the benefit cycle. A unique advantage of our data is that the benefit distribution dates span the four
Futures Market for Ag Carbon Offsets under Mandatory and Voluntary Emission Targets

Oranuch Wongpiyabovorn, Alejandro Plastina, Sergio H. Lence
oranuchw@iastate.edu; plastina@iastate.edu; shlence@iastate.edu

INCREASING CONCERNS about climate change have prompted actions, both by governments and the private sector, aimed at curbing the emissions of greenhouse gases (GHGs). An important number of such initiatives involve the trading of GHG allowances and offsets. An allowance permits its holder to emit a specified amount of GHGs, whereas an offset is a certified reduction in GHG emissions that can be used to compensate for GHG emissions elsewhere. Recently, carbon offsets have attracted the attention of decisionmakers in agriculture for their alleged potential to enhance farmers’ profits, as some agricultural activities can generate offsets by capturing GHGs (e.g., methane capture from manure management, soil carbon sequestration, and fertilizer use reduction). The purpose of this article is to provide some background information on these markets and discuss the potential of the futures market for GHG offsets recently launched by the Chicago Mercantile Exchange (CME) Group to act as a catalyst of the market for agricultural offsets.

Mandatory programs to reduce emissions
According to the World Bank (2020), there are 31 emissions trading systems (ETSs) around the world. In these cap-and-trade systems, governments limit GHG emissions by setting a cap and distributing emission allowances among emitters, who can then choose between reducing emissions themselves or purchasing excess allowances (and sometimes offsets) from others.

The world’s largest carbon market is the European Union (EU) ETS, which is a mandatory cap-and-trade system covering almost 5% of the world’s annual GHG emissions (World Bank 2020), and includes all EU member states.1 The EU ETS currently covers three GHGs, namely carbon dioxide (CO2), nitrous oxide, and perfluorocarbons, from power generation, energy-intensive industry, and commercial aviation sectors. The program is now in phase IV (2021–2030), in which the goal is to reduce emissions by at least 40% compared to the 1990 level, and the cap on emissions decreases annually at a linear reduction factor of 2.2%.

In the United States, there are currently two government-sponsored programs to limit GHG emissions, namely, the Regional Greenhouse Gas Initiative (RGGI), and California’s cap-and-trade program. The RGGI was established in 2005 to regulate emissions from electric power plants in eleven northeastern states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey (withdrew in 2012, rejoined in 2020), New York, Rhode Island, Vermont, and Virginia. The RGGI does not directly regulate agriculture and forestry emissions, but conservation activities to reduce emissions and store carbon from these sectors can generate offsets that can be sold to the capped sectors. In particular, the only agricultural activity permitted as an RGGI offset is methane capture from manure management.

California’s cap-and-trade program, launched in 2013, places a cap on GHG emissions from the state’s power, industrial, and transportation sectors. The program only allows agriculture offsets from capturing of methane from livestock manure and rice (Murray 2015). Offsets for California’s program can be generated outside the state, whereas RGGI only allows offsets within the region.

At the national level, the 2009 American Clean Energy and Security Act proposal intended to establish an emission cap-and-trade program that would cover seven major GHGs from large emitters, petroleum fuels producers and importers, and gas distributors (PEW Center 2009). Using offsets from agriculture and forestry sources would be allowed to meet compliance. However, the bill never materialized partly due to lack of support in the Senate and the recession with prolonged high unemployment rates (Weiss 2010).

Voluntary programs to reduce emissions
In parallel to the programs implemented by governments to reduce GHG emissions, a large number of initiatives have been launched to curb emissions on a voluntary basis. A prominent example of the latter was the Chicago Climate Exchange (CCX), which was established as a voluntary carbon emissions trading program in 2003. The CCX market not only included activities

1. Following Brexit, the UK implemented its own UK ETS as of January 2021. Switzerland, which is not an EU member state, has had its own ETS tied to the EU ETS since January 2020.
THE CHANGING of seasons from summer to autumn usually shifts the focus of agricultural market traders. For crops, the focus shifts from supplies to usage. For livestock, the focus shifts from the current year to the upcoming year. USDA’s monthly projections of the global agricultural supply and demand situation help frame those shifts and outline the anticipated movements within the markets. The September report provided a mix of signals across the crop and livestock markets. In general, the expansion of meat production is slowing down. While meat demand remains strong, animal numbers, especially in beef, have pulled back due to a variety of reasons. Livestock prices are projected to fall in 2022, given the slightly higher production, with the exception of beef (see table 1). Crop production is also projected higher this fall, despite the drought. Crop usage, which was strong throughout most of the 2020 marketing year, fell off during the summer. The crop usage outlook for the 2021 crops was increased slightly, but still is below the previous year’s levels.

For the livestock sector, the 2021 calendar year has been an interesting one. Production across species is at record or near-record levels. The supply chain issues of 2020 have mostly been worked through, but sporadic problems still do occur. Meat demand, both domestic and international, has been robust and pushed prices higher. But livestock producers are also facing higher feed costs, limiting profitability. USDA lowered its annual forecasts for 2021 production in beef, pork, and turkey. The beef reduction is a combination of fewer animals harvested (more cows, but less steers and heifers) and a reduction in carcass weights. The pork industry is also seeing lower-than-expected slaughter numbers in 2021. The drop in production and robust consumption allowed USDA to raise its livestock price projections for 2021 for cattle, hogs, broilers, and turkeys.

However, the outlook for 2022 is a bit more challenging. Compared to 2021,
USDA expects lower beef production and increased pork, broiler, and turkey production. International meat trade is projected to decline in 2022 as well, with beef, pork, and broiler shipments falling, while turkey exports increase slightly. For pork and broilers, the combination of larger production and declining exports pulls expected prices lower for the coming year. For turkey, the increase in exports is not enough to offset the larger supplies, so prices are projected lower as well. For beef, the supply reduction is enough to cover the export decline, and beef prices are projected to continue to rise.

For corn, the September USDA report provides several adjustments to both supply and demand (see table 2). In the week leading up to the reports, NASS announced it would incorporate information from the FSA acreage data to update their crop acreage figures. Normally, these adjustments are made in October. The national planted area was increased 612,000 acres to a total of 93.3 million. This moved the estimate for national harvested (for grain) area to just over 85 million acres. The September yield estimates are a combination of the data from USDA’s objective yield survey and the simultaneous farmer yield survey. The national average corn-yield estimate rose 1.7 bushels to 176.3 bushels per acre. The pattern of yields across the country remained consistent with earlier estimates, with record yields projected in the eastern Corn Belt and lower yields in the west. The September update reveals slightly better corn crops across most of the nation. Putting together the acreage and yield updates, USDA found evidence to support a record 15 billion bushel corn production projection.

The usage side of the corn ledger was also updated. The main storyline was a slight pullback in old crop usage and a slightly bigger boost to new crop usage. The recent slowdown in ethanol production translated into a 40 million bushel decline in corn grind out of the 2020 crop. Export sales out of the 2020 crop were reduced by 30 million bushels. With the 70 million bushels added back to stocks, the 2020/21 corn ending stocks are projected at 1.187 billion bushels. But the increase in stocks did not impact the 2020/21 season-average price estimate, which increased $0.05 to $4.45 per bushel, revealing that USDA is factoring in more sales from earlier in the marketing year. For the new (2021) crop, both feed/residual usage and exports were increased by 75 million bushels each. However, given the increase in stocks and the higher production projection, 2021/22 ending stocks are now set at 1.408 billion bushels, up 166 million from last month. The 2021/22 season-average price estimate fell $3.00 to $5.45 per bushel.

Nationally, USDA reduced total planted area for soybeans by 320,000 acres, to 87.235 million acres (see table 3). The national average soybean-yield estimate came in at 50.6 bushels per acre, up 0.6 bushels. The general pattern remains—record crops in the east and drought-stressed crops in the west. Overall, national soybean production is projected at 4.374 billion bushels, which would be the third-largest, trailing only the 2017 and 2018 crops. Soybean usage adjustments reduced domestic consumption, but increased international sales. For the 2020 crop, domestic crush was reduced by 15 million bushels, mainly being driven by soybean meal shifts. That change boosted the 2020/21 ending stocks to 175 million bushels. The 2020/21 season-average price estimate held steady at $10.90 per bushel. For the 2021 crop, that reduction in domestic crush is extended, taking away another 25 million bushels as we look forward. However, the positive change in export sales, increased by 35 million bushels, offset that loss. The 2021/22 ending stocks are projected at 185 million bushels, up 30 million from last month, and the 2021/22 season-average price

Table 3. Soybean Supply and Use

<table>
<thead>
<tr>
<th></th>
<th>2020 Estimate</th>
<th>Change from August</th>
<th>2021 Forecast</th>
<th>Change from August</th>
<th>Change from 2020 to 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area Planted</td>
<td>(mil. acres)</td>
<td>83.1</td>
<td>0.0</td>
<td>87.2</td>
<td>-0.3</td>
</tr>
<tr>
<td>Yield</td>
<td>(bu./acre)</td>
<td>50.2</td>
<td>0.0</td>
<td>50.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Production</td>
<td>(mil. bu.)</td>
<td>4,135</td>
<td>0</td>
<td>4,374</td>
<td>35</td>
</tr>
<tr>
<td>Beg. Stocks</td>
<td>(mil. bu.)</td>
<td>525</td>
<td>0</td>
<td>175</td>
<td>15</td>
</tr>
<tr>
<td>Imports</td>
<td>(mil. bu.)</td>
<td>20</td>
<td>0</td>
<td>25</td>
<td>-10</td>
</tr>
<tr>
<td>Total Supply</td>
<td>(mil. bu.)</td>
<td>4,680</td>
<td>0</td>
<td>4,574</td>
<td>40</td>
</tr>
<tr>
<td>Crush</td>
<td>(mil. bu.)</td>
<td>2,140</td>
<td>-15</td>
<td>2,180</td>
<td>-25</td>
</tr>
<tr>
<td>Seed &amp; Residual</td>
<td>(mil. bu.)</td>
<td>105</td>
<td>0</td>
<td>119</td>
<td>0</td>
</tr>
<tr>
<td>Exports</td>
<td>(mil. bu.)</td>
<td>2,260</td>
<td>0</td>
<td>2,090</td>
<td>35</td>
</tr>
<tr>
<td>Total Use</td>
<td>(mil. bu.)</td>
<td>4,565</td>
<td>-15</td>
<td>4,389</td>
<td>10</td>
</tr>
<tr>
<td>Ending Stocks</td>
<td>(mil. bu.)</td>
<td>175</td>
<td>15</td>
<td>185</td>
<td>30</td>
</tr>
<tr>
<td>Season-Average Price</td>
<td>($/bu.)</td>
<td>10.90</td>
<td>0.00</td>
<td>12.90</td>
<td>-0.80</td>
</tr>
</tbody>
</table>

Source: USDA-WAOB

continued on page 19
Predicting China's Corn Acreage and Production in 2021/22 and 2022/23

Xi He, Miguel Carriquiry, Wendong Zhang, Dermot Hayes
xihe@iastate.edu; miguel.carriquiry@gmail.com; wdzhang@iastate.edu; dhayes@iastate.edu

China's corn imports exceeded its corn tariff rate quota (TRQ) of 7.2 million metric tons (MMTs) in 2020 and reached a record of 26 MMTs in the 2020/21 marketing year (USDA 2021a). While China's recent corn import surge was largely due to its feed demand to recover its hog inventory from the African Swine Fever (ASF) outbreak, the prospect for China's corn imports is unclear. Figure 1 shows that China's corn futures price with maturity in November 2021 declined from around $10.80 per bushel in May to $9.70 per bushel in September 2021. The current level is still high relative to the historical norm. Over this period, China’s hog futures price declined from the highest point of around $2 per pound to around $1 per pound. The hog futures price drop suggests that China’s hog inventory recovery is likely making good progress, which will put upward pressure on China’s corn imports in 2021/22 and 2022/23. The net impact will depend on China’s domestic corn production, and to estimate this we need reasonable estimates of Chinese farmers’ acreage and yield price supply elasticities.

We compiled a dataset that includes: (a) province-level planted acreage and yield of corn, soybeans, rice, and wheat; (b) province-level rainfall and temperature over the growing season; (c) national cash price and price volatility of the four major crops; and, (d) national price fertilizer price index from 1990 to 2019. Table 1 presents the province-level average planted acreage and the domestic prices of the four crops in 1990 and 2019. We follow Haile et al. (2016) to estimate China’s national corn and soybeans acreage price elasticities.¹ We then use these elasticities and China’s futures prices for the four crops with maturity in November 2021 and July 2022 to predict China’s acreage and production of the four crops in 2021/22 and 2022/23. Depending on whether we include rainfall and temperature as controls, corn acreage price elasticities range from 0.382 to 0.413, soybean acreage price elasticities range from 0.876 to 0.897, and corn acreage is negatively affected by

---

¹. We estimated the elasticities for the four major crops separately and not in a joint system.
corn volatility. Given that weather data in 2022 are not available, and crop yield will depend on the weather deviation from the normal trend, we use the coefficients without weather variables as controls to predict China's crop acreage in 2021/22 and 2022/23.

Figure 2 presents China's actual acreage of four crops from 1990 to 2020 and predicted acreage in 2021/22 and 2022/23 using the futures prices of the four crops with maturity in November 2021 and July 2022 as of September 10, 2021. We predict that China's corn planted acreage will be 44.33 million hectares in 2021/22 and will decline to 42.5 million hectares in 2022/23. Historically high cash corn prices will drive the increase of corn acreage in 2021/22, and the corn acreage decline in 2022/23 is driven by the lower corn futures prices (as shown in figure 1). The increase of corn acreage in 2021/22 will partially come from land used for soybeans and wheat. Our predicted corn acreage in 2021/22 is slightly higher than the 42 million hectares predicted by the WASDE September report (USDA WASDE 2021).

Figure 3 presents China's actual production of four crops from 1990 to 2020 and predicted production in 2021/22 and 2022/23 without weather variables as controls. We predict that China's corn production will be 280 million tons in 2021/22 and decline to 269 million tons in 2022/23. Our predicted 2021/22 corn production is higher than the 273 million tons predicted by the WASDE September report (USDA WASDE 2021).

We use the predicted corn production and the assumption that China's corn feed consumption to be used in swine feeding will increase by 10% in the next two years to predict China's corn imports. We predict that China's corn imports will be 23.4 MMT in 2021/22 and 34.9 in 2022/23. The large import increase in 2022/23 is partially caused by China's lower predicted production in 2022/23.

Continued on page 18...
MERGING VOLUNTARY carbon markets are attracting lots of attention in US agriculture, to the extent that agriculture carbon credits are usually referred to as the new cash crop. In essence, large companies would purchase carbon credits from multiple sources, including agriculture, to achieve their net zero emission goals. Farmers and ranchers would implement conservation practices that sequester carbon or provide other environmental benefits in exchange for compensation in cash or carbon credits depending on the carbon program. However, not all conservation practices are able to generate carbon credits.

Two major requirements that conservation practices need to fulfill in order to generate credits are additionality and permanence. Additionality requires that practices be additional or different from the baseline, and requires judgement on whether the practice would have been implemented in the absence of the carbon program. Permanence refers to the length of time that a specific practice sequesters carbon from the atmosphere.

A key challenge that annual conservation practices, such as cover cropping and no-till, face is the permanence of the sequestered carbon in the soil. If a farm discontinues the use of cover crops, or vertical tillage is implemented on a farm after several years of no-till (e.g., to manage weed pressure or excess moisture in the soil) then sequestered carbon from previous vintages leaves the soil and returns to the atmosphere. Some carbon programs address the risk of “reversal” through a voluntary carbon reserve, which consists of carbon credits generated by agricultural practices that are kept outside the carbon market untraded for 10 years or more. In those cases, the amount of agricultural carbon credits available for sale is smaller than the total number of carbon credits generated by farmers.

When a practice is temporarily discontinued due to factors external to the farm (mostly due to weather), most carbon programs include penalties associated with skipping payments for the discontinued practices until reinstated and do not count incomplete practices towards carbon credit generation (Plastina and Wongpiyabovorn 2021).

Unfortunately, we are not aware of any farm-level longitudinal study on the drivers and associated probability of temporary or permanent disadoption of conservation practices. However, using county-level data from the 2012 and 2017 US Censuses of Agriculture, Sawadgo and Plastina (forthcoming) evaluate regional patterns of adoption and disadoption of conservation practices in the United States. They estimate that national disadoption rates in cover crops and no-till averaged 15.60% and 39.38%, respectively, between censuses. This article sheds light on the patterns of adoption and disadoption of cover crops and no-till in Illinois, Indiana, and Iowa, which jointly...
accounted for 17% of the value of crop production in the United States from 2016 to 2020 (USDA 2021).

**Cover Crops in the I-States**

In 2017, cover crops were planted in 2,617,335 acres in the I-States, equivalent to 4.12% of their total cropland area, with high variability in the intensity of adoption across counties, ranging from 0.31% in Lake County, Illinois, to 27.05% in Floyd County, Indiana (see figure 1). Iowa planted 973,112 acres, Indiana 936,118 acres, and Illinois 708,105 acres. The region more than doubled its area under cover crops between 2012 and 2017, with most of the increase taking place in Iowa (593,498 acres), followed by Indiana (389,521 acres), and Illinois (343,179 acres).

The rate of adoption of cover crops, calculated as the ratio of cover crop area to total 2017 cropland acres (to eliminate the effect of changes in cropland acres through time from the comparison), increased between 2012 and 2017 from 1.34% to 2.95% in Illinois. Total cropland acres are calculated as the sum of planted (e.g., harvested, pastured, and failed) plus not planted (e.g., summer fallow and idle) acres. The overall low rates of adoption suggest that under the “right” conditions, cover cropping could be substantially scaled up into large additional areas in the I-states to supply agricultural carbon credits into voluntary carbon markets. Among the most relevant incentives to create the “right” conditions are solid price signals from a robust carbon credit demand, transparency in the methodology used to translate practices into credits, and the possibility to stack payments across government-sponsored cost share programs and payments from carbon programs.

An analysis of changes in adoption rates by county indicates that 199 counties out of the 289 counties in the I-states for which there is complete data (69%) increased their rates of adoption, or disadoption (see figure 2). The biggest gain in cover cropped area (20,001 acres) occurred in Keokuk County, Iowa, and the largest drop (-6,374 acres) was observed in Orange County, Indiana.

In Indiana, twenty counties experienced a total decline in cover crop area of 40,616 acres, equivalent to 22.7% of their 2012 cover cropped area. In Illinois, seven counties reduced their cover cropped area by 5,603 acres, equivalent to 28.0% of their 2012 levels. In Iowa, four counties experienced a total decline of 8,572 acres, equivalent to 42.5% of their 2012 levels.

**No-Till in the I-States**

In 2017, no-till systems were implemented on 19,571,098 acres in the I-States, equivalent to 30.84% of their total cropland area, with high variability in the intensity of adoption across counties, ranging from 2.97% in Winnebago County, Iowa, to 77.04% in Shelby County, Iowa (see figure 3). Iowa used no-till on 8,196,199 acres, Illinois on 6,471,985 acres, and Indiana on 4,902,914 acres. The region increased its no-till area by 9.0% between 2012 and 2017, with most of the increase taking place in Iowa (1,245,363 acres), followed by Illinois (424,156 acres), which compensate a net disadoption of no-till on 49,217 acres in Indiana.

The rate of adoption of no-till, calculated with respect to total 2017 cropland acres, increased between 2012 and 2017 from 26.47% to 30.88% in Iowa, from 25.46% to 26.96% in Illinois, and declined from 39.33% to 37.98% in Indiana. The overall high rates of adoption suggest that no-till could be more difficult to scale up into additional areas in the I-states than cover crops. Particularly concerning for this practice is the potential for carbon reversals occurring when long-term no-...
Carbon Offset Futures

continued from page 7

in the United States, but also many corporations and institutions in eight Canadian provinces and sixteen other countries. CCX members were legally bound to meet GHG emissions reduction requirements. Participants below their emissions thresholds could sell the surplus allowances and participants above their thresholds could purchase them. In addition, agricultural offset projects, from methane collection and soil carbon sequestration, were eligible to offset excess emissions. However, the minimum scale to trade carbon offsets in the CCX market was 10,000 metric tons of CO2-equivalent GHGs (CO2e), which translated roughly into 25,000 acres in conservation practices (Ribera and McCarl 2009). Therefore, aggregators that charged 8%–10% of carbon credits at market price on a yearly basis managed most agricultural projects (Ribera et al. 2009). The scale required to supply carbon credits to the CCX severely limited the interest from the agricultural sector.

Although the price of carbon offsets traded in the CCX peaked at $7.40 per CO2 metric ton in May 2008, the price plummeted to $1.0 per metric ton in August 2010 (Griesinger 2010). The problem of the CCX was that the verified emission reductions achieved exceeded the compliance requirement, so the carbon offsets were oversupplied (ICE 2011), which prompted the collapse in their price and the eventual closing of the trading platform at the end of 2010.

Futures markets based on mandatory ETSs

Trading carbon credits in a spot market can involve large price risks, as demonstrated by the CCX experience described in the preceding section. Hence, it should not be surprising that several futures markets have emerged for allowances and offsets. By far, the most successful of such markets has been the one at the Intercontinental Exchange (ICE) for futures contracts on EU Allowances (EUA). EUA is the official name for the emission allowance of the EU. The holder of one EUA is allowed to emit one metric ton of CO2e. EUA futures have been trading at ICE for more than a decade, and are a well-established market, with daily volume averaging 32 million EUAs in 2020, and open interest of 1 billion EUAs (i.e., 1 gigaton of CO2e) as of the end of September 2020 (ICIS 2020).

By comparison, the EUA cap was 1.816 gigatons of CO2e in 2020, and the EU’s overall 2018 GHG emissions were estimated at 3.9 gigatons of CO2e (ICAP 2021).

Futures market based on voluntary programs to reduce emissions have encountered very limited interest.

In contrast to the success of the EUA futures market at ICE, futures markets for allowances and offsets based on voluntary programs to reduce emissions have encountered very limited interest.

Is there a future for futures based on voluntary programs?

Given the success of ICE’s futures market for EUAs, an interesting question for the US agricultural sector is whether one can expect a similar success for the recently created CME N-GEO futures market. The answer would be particularly relevant for the agricultural sector because such futures could help catalyze the overall market for agricultural offsets.

To respond to the question just posed, it is critical to understand the drivers of the success of the EUA futures market at ICE. First, the definition of an EUA implies that it is perfectly standardized and homogeneous, thus representing an almost ideal “commodity” for futures trading purposes. Second, the EU ETS scheme, which has been made operational by the creation of the EUAs, is the world’s largest ETS program, covering

As of August 20, 2021, the average prices of GEO and N-GEO futures are $5.11 and $7 per one metric ton of CO2e, respectively. Trading volumes in August 2021 averaged 198 and 503 contracts per day (equivalent to 0.2 and 0.5 million metric tons of CO2e) for GEO and N-GEO futures, respectively, with open interest of 835 and 6,092 contracts at the end of the month.

In contrast to the success of the EUA futures market at ICE, futures markets for allowances and offsets based on voluntary programs have encountered very limited interest.

Futures market based on voluntary programs

In contrast to the success of the EUA futures market at ICE, futures markets for allowances and offsets based on voluntary programs to reduce emissions have encountered very limited interest. In March 2020, the CME Group began trading CBL Global Emission Offset (GEO) futures contracts. The aim of this futures contract is to help manage risk

in carbon prices and establish a global pricing benchmark for the voluntary emissions offset market (CME Group 2021a). In August 2021, the CME Group also started trading futures contracts for offsets generated from agriculture, forestry, and other land use, called Nature-Based GEO (N-GEO). To ensure the transparency of N-GEO futures, only the offsets from Verra’s Verified Carbon Standard for Agriculture, Forestry, and Other Land Use projects and/or the Climate, Community, and Biodiversity Standards are accepted for trading (CME Group 2021b).

To respond to the question just posed, it is critical to understand the drivers of the success of the EUA futures market at ICE. First, the definition of an EUA implies that it is perfectly standardized and homogeneous, thus representing an almost ideal “commodity” for futures trading purposes. Second, the EU ETS scheme, which has been made operational by the creation of the EUAs, is the world’s largest ETS program, covering
almost 5% of the world’s annual GHG emissions (World Bank 2020). Hence, the potential size of the market for EUAs is quite large. Finally, and perhaps most importantly, the EU has demonstrated a commitment to make the cap on emissions binding. For example, in response to the substantial drop in GHG emissions caused by the 2008–2009 financial crisis—which resulted in an oversupply of allowances—the EU implemented reforms to the ETS program to avoid the collapse of the EUA price (ICIS 2020). More recently, the annual shrinking of EUA allowances has substantially driven up the EUA price, from below $10/EUA in 2018 to around $60/EUA in September 2021. The cap established by the EU is meant to be binding, which not only supports the price of the EUAs, but also makes it volatile. Price volatility is essential to attract speculators, which are critical to improve the liquidity of the futures market.

In contrast to the mandatory EU program underlying the ICE EUA futures contracts, participants in voluntary programs have incentives to strategically set emission reduction targets that can be achieved at relatively low cost, and avoid imposing stringent caps upon themselves. Thus, voluntary programs lack “hard” caps by design. This feature implies that it is very difficult for prices in a voluntary N-GEO market to rise much or be highly volatile, thus reducing their attractiveness for speculators. In addition, the amount of offsets involved in the voluntary N-GEO program is quite small compared to the number of allowances established by the EU ETS. As a result, one should not expect the market for N-GEO offsets to be as deep as the one for EUAs. Most importantly, however, during times of reduced economic activity (e.g., as in the great recession), emission caps are likely to become non-binding, which would drive their price to zero and make their market collapse. Further, volunteer firms’ lower incentives (and ability) to participate at precisely such times, because of the financial distress probably faced by many of them, would compound this negative effect. These differences between the ICE EUA futures and the CME N-GEO futures suggest that it is reasonable to be skeptical about the latter’s ability to become a highly liquid market that could serve as a pricing benchmark for voluntary agricultural offsets.

References


tilled fields are tilled to manage weeds, reduce compaction, or other reasons, releasing the carbon sequestered in the soil back to the atmosphere. While voluntary carbon programs will likely penalize a temporary disadoption of cover crops by temporarily discontinuing the accumulation of partial carbon credits, a carbon reversal from a temporary disadoption of no-till could have much harsher consequences, ranging from losing accumulated credits to monetary sanctions.

An analysis of changes in adoption rates by county indicates that 175 counties out of the 291 counties in the I-states for which there is complete data (61%) increased their rates of adoption by at least 1 percentage point between 2012 and 2017, while 20 counties (7%) kept it relatively stable (change between 0 and 1 percentage points), and 96 counties (33%) experienced disadoption (see figure 4). The biggest gain in no-till area (62,616 acres) occurred in Plymouth County, Iowa, and the largest drop (-35,435 acres) was observed in Jasper County, Indiana.

In Indiana, forty-six counties experienced a total decline in no-till area of 369,247 acres, equivalent to 14.6% of their 2012 cover cropped area. In Illinois, thirty-nine counties reduced their no-till area by 292,086 acres, equivalent to 12.1% of their 2012 levels. In Iowa, eleven counties experienced a total decline of 95,457 acres, equivalent to 11.1% of their 2012 levels.

Concluding Remarks
This article highlights the non-permanence of two annual conservation practices between 2012 and 2017 in the I-States: 11% and 33% of the counties in the region disadopted cover crops and no-till, respectively, reducing their areas in those conservation practices by 25% and 13% with respect to 2012 levels. If these percentages are indicative of the probability that farmers participating in voluntary carbon programs could temporarily discontinue contracted practices and trigger penalties from carbon programs, our findings suggest that farmers planting cover crops and using no-till would face non-trivial probabilities of being penalized over the life of a multi-year carbon contract.
calendar weeks of the month, which alleviates concerns that the day of SNAP distribution might be correlated with other monthly income shocks (e.g., cash welfare payments, paycheck receipt, rent payments, utility bills etc.) that occur on the first of the month.

Visual inspection of figure 1 indicates that the effect of SNAP disbursement on intramonthly spending patterns has a statistically significant and positive impact for 10 to 12 days after benefit receipt. Notably, on the day that SNAP benefits are disbursed, spending is $13 higher relative to 28 days after benefit receipt. The effect of disbursement on spending is roughly $2 to $4 one to three days after benefit receipt and $1 to $2 four to twelve days after benefit receipt.

The extreme peak in expenditures around the day of SNAP disbursement has motivated researchers to identify whether the SNAP disbursement cycle has other effects on participants. Research finds that a correlation between expenditure and consumption cycles exist for SNAP households (Kuhn 2018), which explains the reduced caloric intake of SNAP recipients at the end of the benefit month compared to the beginning (i.e., calorie crunch) (Shapiro 2005; Todd 2015). Other research shows that criminal activity increases over the benefit month (Foley 2011); and, Carr and Packham (2019) show that the expenditure cycle is directly connected to grocery store theft rates. Further findings suggest that children bear a smaller burden than adults of the calorie crunch (Kuhn 2018). Cotti et al. (2018) and Bond et al. (2021) find that standardized test scores are lower for children of SNAP households at the end of the benefit month.

Policymakers should consider the influence of the SNAP disbursement cycle on the health and economic outcomes of SNAP households. Our findings highlight how monthly welfare payments influence spending patterns of recipients. Having multiple, smaller, disbursement days within a single month may help recipients smooth their consumption over the course of the benefit cycle.

Table 1. Calendar Disbursement Days of SNAP Benefits

<table>
<thead>
<tr>
<th>Disbursement Day of Calendar Month</th>
<th>Number of Households Assigned</th>
<th>Percentage of Total Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>105</td>
<td>12.40</td>
</tr>
<tr>
<td>7</td>
<td>109</td>
<td>12.87</td>
</tr>
<tr>
<td>9</td>
<td>95</td>
<td>11.22</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>8.38</td>
</tr>
<tr>
<td>13</td>
<td>76</td>
<td>8.97</td>
</tr>
<tr>
<td>15</td>
<td>90</td>
<td>10.63</td>
</tr>
<tr>
<td>17</td>
<td>100</td>
<td>11.81</td>
</tr>
<tr>
<td>19</td>
<td>93</td>
<td>10.98</td>
</tr>
<tr>
<td>21</td>
<td>38</td>
<td>4.49</td>
</tr>
<tr>
<td>23</td>
<td>70</td>
<td>8.26</td>
</tr>
<tr>
<td>Total</td>
<td>847</td>
<td></td>
</tr>
</tbody>
</table>

References


Suggested citation

China’s Corn Acreage
continued from page 11

experienced heavy rain in its major corn-producing region in the north (Reuters 2021). Using the estimated corn harvested area and yield elasticity, with respect to rain and temperature, and the rainfall and temperature data as of September 2021, we predict that China’s 2021/22 corn production will decrease by 0.141%, which translates into 395,017 metric tons—around half of the 850,000 metric ton reduction predicted by China’s Ministry of Agriculture and Rural Affairs. The weather-induced corn production reduction would likely increase China’s corn imports in 2021/22.

References


Suggested citation

COVID-19 Economic Recovery
continued from page 5

Department of Transportation values one life at $11.6 million (USDOT 2021). Taking that estimate at face value, we can generate the corresponding value from a single incident of the disease. With death rates from COVID-19 infection at 0.2% in the United States (Johns Hopkins), it takes 515 COVID-19 cases to get one death on average. Hence, we need to reduce 515 cases to save one life. The value of reducing COVID-19 cases by one is $11.6 million/515=$22,524, a value just a few thousand dollars below the cost of lost jobs from reducing that COVID-19 case. The states at the left side of figure 2 have decided to lower the risk of disease spread at the cost of lost jobs, while those at the right side have decided to take on more risk in order to generate more economic activity.

Interestingly, there is almost no relationship between COVID-19 incidence and labor force participation. As we go from most to least restrictive economic policies in figure 2, average labor force participation does not change, and we cannot reject the hypothesis that there is no relationship.

One final point. There is considerable debate as to whether the slow recovery of employment is due to weak labor demand or weak labor supply. It seems clear cut that the weakness is labor supply, and it is holding the economy back. The Bureau of Labor Statistics reported over 10 million new job openings in June 2021, just under 3 million more openings than in June 2019. There were only 8.7 million unemployed workers, so there were more vacancies than unemployed workers. Because of the small number of individuals wanting work, over 3.3 million of those openings were not filled.

We can offer a geekier economics proof that it is weak labor supply holding back the labor market recovery in figure 3. Note that since 2019, real wages have risen, even as employment has fallen. With unemployment at 3.5% in 2019, we can claim that the labor market was at full employment. Since then, wages have risen from \( W_{2019} \) to \( W_{2021} \), and employment has fallen from \( N_{2019} \) to \( N_{2021} \). Perhaps there has been a decrease in labor demand from 2019 to 2021, but the only way to get falling employment with rising wages is if that decrease in labor demand is accompanied by a much larger decrease in labor supply. Increased stimulus payments are unlikely to resolve a weakness in labor supply.

References


Suggested citation
Brazil Soybean Market

continued from page 3

products. Several important railroad projects under consideration include the north-south (EF-151) road, the West-East Integration Railroad (EF-334), and the Ferrogrão Railroad (EF-170), which will be adjacent to BR-163 and is expected to alleviate traffic conditions on BR-163 by serving as an alternative route for soybean and corn exports. These projects are likely to further reduce Brazil’s domestic transportation costs, which will likely put further pressure on US soybean competitiveness.

References


Crop Projections

continued from page 9

estimate fell $0.80 to $12.90 per bushel.

These projections show the markets will have plenty of product to work with as the calendar flips to 2022, no matter whether you are looking at the crop or livestock part of agriculture. Record to near-record supplies usually indicate lower prices ahead, which is projected to be the case for pork, broilers, and turkey. Beef, corn, and soy are relying on enough usage to buck that trend. The export markets will likely drive the pricing picture moving forward—several products set export quantity records within the past year, including beef, corn, and soy. The USDA projections show a drop in those export quantities; however, they maintain sizable enough international shipments to keep the outlook for annual average prices higher.

Suggested citation

Cover Crops

continued from page 16

References


Recent CARD News

CARD Researchers Receive New Funding Awards

CARD researchers Amani Elobeid, Dermot Hayes, GianCarlo Moschini, Hongli Feng, J. Arbuckle, John Crespi, Phil Gassman, Wendong Zhang, and Yongjie Ji, and are all involved in various projects that have qualified for funding from USDA, the Iowa Nutrient Research Center, and the Iowa Water Center.

J. Arbuckle and Phil Gassman are team members on the project “#DiverseCornBelt: Resilient Intensification through Diversity in Midwestern Agriculture,” which received a $10 million grant from USDA’s National Institute of Food and Agriculture. The Purdue University-led project seeks to make Midwestern agriculture more resilient by moving away from the dominant corn-soybean rotation.

Amani Elobeid will serve as an investigator on the project “Regenerating America’s Working Landscapes to Enhance Natural Resources and Public Goods through Perennial Groundcover.” The project received $9.99 million in funding from USDA’s National Institute of Food and Agriculture to develop and de-risk a transformative method for increasing groundcover on working landscapes.

John Crespi received a $97,000 USDA Economic Research Service grant for the project “Swine Production and Carbon Markets.” This project seeks to investigate ways in which swine producers can be incentivized to join carbon markets to lower their overall carbon footprint. The project will also include Dermot Hayes and CARD Faculty Collaborator Jerome Dumortier from Indiana University-Purdue University Indianapolis.

Hongli Feng will serve as principal investigator on the project “The Effectiveness of Carbon Credit Programs at reducing Nutrient Losses: An Assessment of Public and Private Conservation Programs and Their Interactions.” The project will receive a total of $148,484 from the Iowa Nutrient Research Center to investigate the effectiveness of carbon credit programs at reducing nutrient losses. Wendong Zhang will serve as a co-PI on the project.

GianCarlo Moschini received two grants from USDA’s Economic Research Service. The project “Industrial Organization of Meat Processing: Market Power, Efficiency, and Resiliency” received $299,483 in funding to examine long-standing and recent concerns at the structure of the industry and its operating practices. The project “R&D and Agricultural Productivity Growth in the United States: Patent Data and Knowledge Stocks” also received $31,500 in funding.

Wendong Zhang and Yongjie Ji will serve as principal investigators on the project “Environmental Justice for All: Nutrient Impacts on Lake-Based Recreation and Tourism by Rural and Socially Disadvantaged Iowans.” The project received $40,749 in joint funding from the Iowa Water Center and the Iowa Nutrient Research Center through a special grant program designed to encourage research on the social dimensions of Iowa water quality.