IMPLICATIONS OF CLIMATE CHANGE LEGISLATION FOR U.S. COTTON GROWERS

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Abstract

Pending legislation to mitigate climate change would affect cotton producers in multiple ways. First, costs of fertilizers, electricity, and fuel would rise, affecting both production and ginning costs. The potential for growers to sell carbon offsets, however, represents an additional source of income. Offsets from tree planting could significantly reduce cotton acreage in some areas, leading to higher cotton prices. This study evaluates implications of these countervailing effects on producer returns. Negative effects of pending legislation could be reduced or delayed substantially, depending on how programs are implemented. However, large uncertainties about implementation translate into large uncertainties about how cotton producers will be affected.

Introduction

In 2009, the U.S. House of Representatives passed the American Clean Energy and Security Act of 2009 (H.R. 2454, also known as the Waxman-Markey Bill). H.R. 2524 would impose a "cap and trade" system on carbon dioxide (and other greenhouse gas) emissions. In order to emit, industrial manufacturers would need a permit for every unit they emit. The total number of permits is capped, with permitted emissions levels reduced over time. Generators of greenhouse gases then must limit their emissions consistent with the permits they own, or they must purchase additional permits from willing sellers. In this way, industries or firms who can cut emissions at low costs can sell permits to industries with high costs of cutting emissions. Thus, the program creates a private property interest in emission permits and encourages a market for permits that reduces the overall cost of the regulation. Tradable permit systems can substantially reduce costs of cutting emissions compared to command-and-control methods that require industries to adopt specific technologies or that set absolute limits at the industry or plant level (Field and Field, 2005). Tradable permit systems have already been established for other air pollutants such as sulfur dioxide and nitrous oxide.

A critical issue in cap and trade issues is how emission permits are distributed. As the number of permitted emissions falls over time, holding permits becomes increasing valuable. If the government auctions off all permits, the market-clearing price will be equivalent to a carbon tax rate required to cut emissions to the permitted level. Thus, if all permits are auctioned off, a cap and trade system will be relatively close to a carbon tax system. If some permits are given away, this will distribute a valuable asset to emitters receiving them. Emitters can either use all their permits or they can cut their own emissions and sell some of their permits for profit (to higher cost emitters). If emitters are given free permits (emission allowances), this is similar to a tax rebate. They can avoid cost increases associated with the carbon emission cap.

While other climate change legislation has been introduced in the United States, H.R. 2454 is the first to be passed by any house of Congress. Consequently, the potential impact it might have on U.S. agriculture has received significant attention (Golden et al., 2009; USDA, OCE 2009a, 2009b; FAPRI, 2010a). Provisions of H.R. 2454 would have countervailing impacts on cotton grower returns, some negative, but some positive. Agricultural emissions and production practices are not directly regulated. No direct caps are placed on agricultural emissions. However, the cap on emissions from fossil fuels will raise cotton production costs. First, diesel fuel and gasoline costs will increase. Second, electricity costs will increase. Electricity is a greater production expense for cotton producers in Texas and western states, where it is important for groundwater pumping. Third, fertilizer prices will rise. Fertilizer prices are sensitive to increases in the price of natural gas. Increased fertilizer costs are anticipated to be the single largest source of increases in the costs of cotton production. Fourth, increases in electricity and natural gas will increase costs of ginning, where electricity is used to operate machinery and natural gas is used for drying. By raising production costs for cotton and other agricultural commodities, cap and trade would curtail production and increase cotton prices. While cotton price increases mitigate the effect of cost increases, the net effect on cotton grower returns remains negative.

Two provisions of H.R. 2454, however, greatly reduce the cost of carbon regulation. Combined, under certain circumstances, they can actually lead to an increase in cotton grower per acre returns. First, energy-intensive, trade-exposed entities (EITEs) will receive emissions allowances. Thus, these industries will not have to purchase permits for their emissions. According to EPA analysis, sufficient allowances will be distributed to allow EITE industries to counter increased energy costs. Without these allowances, EITE industries would face energy-related costs, while foreign competitors might not. This would put domestic EITE industries at a competitive disadvantage. The EPA lists nitrogenous fertilizer manufacturing as an eligible EITE sector. One may think of the allowances as operating similarly to tax rebates. Thus the EITE allowances let industries, such as fertilizer manufacturers, avoid cost increases from cap and trade, at least in the near-to-medium term. H.R. 2454 specifies that allowances be phased out starting in 2026, with a complete phase-out by 2035 (USDA, 2009a). The termination of allowances is based on the assumption that, by 2035, other countries will have adopted their own climate change mitigation policies, so that U.S. EITE industries will not be at a competitive disadvantage. The bill includes a provision to extend allowances if the President makes a determination that this is not the case. The EITE allowances may or may not apply to natural gas used by ethanol producers. If they do it will provide additional, small, indirect benefits to cotton producers. The main effect of EITE allowances will be to substantially reduce and delay increases in fertilizer costs. It also provides the cotton sector with 10-15 years (or possibly more) to adjust to higher fertilizer costs.

H.R. 2454 also allows agricultural producers to sell carbon offsets to carbon-regulated industries. Regulated industries have the option of purchasing emission permits, curtailing their own emissions, or purchasing emission reductions – offsets – from agriculture. In many cases it might be easier for agricultural producers to reduce carbon dioxide (or other greenhouse gas) emissions than for industrial producers or energy utilities to do it themselves. Thus, a market is anticipated to emerge where agriculture voluntarily "sells" emission reductions to regulated industries. Practices that might earn offsets include production of bio-energy crops (e.g., corn, canola, sunflower, switchgrass, camelina etc.), switching to reduced- or no-till practices (which would sequester soil carbon and reduce carbon emissions from tractor passes over fields), or management of livestock waste (e.g., with methane digesters for livestock operations such as feedlots or dairies). The practice believed to have the greatest potential to generate agricultural offsets, however, is conversion of cropland and pastures to forestland, thereby sequestering carbon. Previous analyses have considered afforestation at a scale to reduce total U.S. cropland by 10-15 million acres by 2030 (USDA, OCE, 2009b; FAPRI, 20010a).

Agricultural offset provisions can benefit cotton producers in two ways. First, some cotton growers may gain income directly by earning offset payments for tree planting or altering tillage practices. Second, taking 10-15 million acres out of production will act as a price-increasing supply control program that will raise the price of cotton and other commodities. Even a cotton grower who does not directly participate in offset markets may benefit indirectly from this increase in cotton prices.

The objective of this study is to (a) quantify the effects of different provisions of cap and trade legislation, (b) to highlight those provisions that are most costly and most beneficial to cotton growers, (c) identify which conditions must hold in order for cotton producers to benefit overall from the legislation, and (d) highlight how sensitive producer returns are to different modeling or policy assumptions.

Materials and Methods

This study follows a partial budgeting approach to assess potential impacts of H.R. 2454 on U.S. cotton growers. Grower cost and returns accounts are measured on a per acre basis. A baseline "budget" of costs and returns to U.S cotton production is first developed that itemizes major production expenses and revenue sources (cotton lint and cottonseed). Next, changes in input and output prices resulting from H.R. 2454 provisions are translated into changes in input expenditures and revenues. New costs and revenues are then compared with the baseline to assess economic impacts on cotton growers. Changes in input expenditures are assumed to be proportional to changes in input prices. For example if the price of fertilizer increases 5%, it is assumed that cotton grower expenditures on fertilizers also increase by 5%. Implicitly, this approach assumes that cotton production uses a fixed-proportion, Leontief technology with no possibility of substitution between inputs. This will likely overstate the costs of input price increases on cotton producers.

H.R. 2454 will also affect the price of cotton. Cotton production will likely fall because of higher production costs, changes in prices of competing agricultural commodities, and land conversion for agricultural carbon offsets. This study relies on price scenarios from analysis by the Food and Agricultural Policy Institute (FAPRI, 2010). Four price scenarios are considered:

1. No change in baseline cotton price.
2. *Cost effect*; changes in production costs and relative prices alters total cotton production and hence its price.
3. *Biofuels effect*; in addition to the cost effect, biofuels producers are allowed to respond to changes in gasoline and diesel prices; ethanol producers receive EITE allowance for their natural gas use
4. *Afforestation effect*; in addition to the cost and biofuels effects, one million acres per year are converted from crop to forestland to earn offset income. Land is retired from crop production for 20 years (2010-2030) until 20 million acres are taken out of crop production.

Each scenario adds to the effects of the previous scenarios, so the forest acreage conversion scenario includes the cumulative effects of all changes. The cotton price increase is more pronounced moving from scenarios 1 to 4.

The baseline scenario was developed using USDA cost and return estimates derived from its Agricultural Resource Management survey (ARMS). Operating costs and allocated overhead costs for hired labor and machinery and equipment replacement were summed to derived total production costs. Data from 2008 were used because cost shares for energy and energy related inputs were relatively high in this year. This means that subsequent scenarios that increase these input prices will have a larger effect on costs. Total baseline production costs were assumed to be $605.20 / acre (Table 1). This is reasonably close to the $550 / acre variable production costs assumed in USDA's Baseline Projections for 2019/20, the $569.98 / acre variable cost projections assumed in the FAPRI 2010 U.S. and World Agricultural Outlook, and the $596.02 / acre costs assumed in the FAPRI (2010b) analysis of H.R. 2454.

Table 1. Baseline cost, return, yield, and price assumptions for U.S. cotton production, 2020 and 2030

	$ / acre
Gross value of production:	
Cotton	$606.60
Cottonseed	$125.01
Total revenue	$731.61
Operating costs:	
Seed	$64.78
Fertilizer	$90.95
Chemicals	$62.76
Custom operations	$20.79
Fuel, lube, and electricity	$61.10
Repairs	$33.22
Ginning	$137.05
Total operating costs	$470.65
Allocated overhead costs:	
Hired labor	$14.21
Capital recovery (machinery, equipment)	$120.33
Total, allocated overhead	$134.55
Total costs (operating + allocated)	$605.20
Net returns (total revenues - total costs)	$126.41
Cotton lint yield (lbs. / acre)	900
Cottonseed yield (lbs. / acre)	1488.2
Cotton price ($ / lb.)	0.674
Cottonseed price ($ / lb.)	0.084

Baseline yield was assumed to be 900 pounds of cotton lint per harvested acre (Table 1). Again, this is close to the value 898 pounds / acre assumed in the FAPRI Outlook (FAPRI 2010b) and the 910 pounds / acre assumed in the

USDA Baseline Projections, both for 2019/20. The baseline output lint price was assumed to be 67.4 cents / pound for cotton lint in 2020, exactly matching the assumptions of FAPRI (2010a). Cottonseed revenues were based on 2008 revenues per acre derived from 2008 USDA ARMS data. It was assumed that cottonseed yields increased in proportion to cotton lint yields from 2008 to 2020. FAPRI (2010b) does not project significant changes in cottonseed prices by 2020.

H.R. 2454 scenarios are considered at two points in time, 2020 and 2030. The year 2020 represents the end point in USDA and FAPRI projections for cotton markets. The EITE allowances are scheduled to phase out some time between 2020 and 2030. Thus, analysis in 2020 allows examination of the impacts of the EITE allowances, while 2030 analysis allows examination of the effects of their withdrawal. The two years are also considered in several other studies of H.R. 2454 impacts, so assumptions from other studies can be used in this analysis, while our results can be compared with those of other studies. Yield, costs, and output prices are maintained at 2020 levels in the 2030 baseline. Implicitly this assumes no yield growth and changes in real (inflation adjusted) costs and revenues over the decade.

Input price shocks are based on two EIA scenarios, the Basic and the High Cost scenarios (EIA, 2009). The Basic Case assumes low carbon emission technologies such as renewables, nuclear, and carbon capture and storage (CCS) for fossil fuels are adopted widely. It also assumes there are no major obstacles to developing domestic and international carbon offset markets and that credit for offsets and allowances can be "banked" to apply to future emission limits. The High Cost Case assumes that costs of nuclear energy, CCS, and biomass energy are 50% higher than assumed in the Base Case.

The FAPRI (2010a) analysis used energy cost increases from these two cases to generate per-acre input cost increases. We assume the same energy price increases as that study (Table 2). These energy price increases are then used to develop input cost estimates for U.S. cotton production.

Table 2. Estimates of percentage changes in energy costs and cotton production costs from cap and trade

Scenario year	2020	2020	2030	2030
EIA cost assumptions	EIA Basic	EIA High Cost	EIA Basic	EIA High Cost
Nominal energy cost impacts[a]				
Diesel fuel	8.3%	9.0%	15.0%	17.5%
Electricity	3.8%	5.4%	22.3%	32.7%
Industrial natural gas	14.4%	20.2%	25.9%	39.9%
Modeled cotton cost impacts[b]				
Fertilizer (with EITE rebate)	1.7%	1.7%	NA	NA
Fertilizer (without EITE rebate)	11.5%	16.2%	20.7%	31.9%
Chemicals	0.1%	0.1%	0.1%	0.1%
Fuel, lube, and electricity	8.3%	9.0%	15.0%	17.5%
Ginning	0.6%	0.8%	1.8%	2.7%
Operating Costs (with EITE rebate)	1.6%	1.7%	NA	NA
Operating Costs (without EITE rebate)	3.5%	4.5%	6.5%	9.3%
Total Costs (with EITE rebate)	1.2%	1.4%	NA	NA
Total Costs (without EITE rebate)	2.7%	3.5%	5.1%	7.2%

a. Source: FAPRI (2010). b. Developed by author.

Using EIA Basic Case price projections, USDA (2009b) estimated that fertilizer prices would increase by only 1.7% in the near term (2012-18). Fertilizer price increases are modest because fertilizer manufacturing is assumed to be an EITE industry. As such, it would receive emission allowances that will allow the industry to avoid most of the effects of rising natural gas prices on fertilizer production costs. This 1.7% increase is assumed for fertilizer costs for 2020 if EITE allowances are given to the fertilizer industry (Table 2). Huang (2007) estimated a long-run ammonia price elasticity with respect to natural gas price of 0.8. This suggests that a 10% increase in natural gas would lead to an 8% increase in ammonia prices. Ammonia is the fundamental ingredient in nitrogen fertilizers.

Accordingly, if no EITE allowances were in place, fertilizer costs are assumed to increase by 0.8 times the percentage increase in natural gas prices (Table 2).

Cotton fuel, lube, and electricity prices are assumed to increase by the same percentage as diesel fuel prices. While this cost category includes both fuel and electricity, fuel costs make up the bulk of these costs in Delta and Southeastern states (see USDA (2009) Appendix Table 5). In Texas and the Southwest, however, electricity costs (for groundwater pumping are more significant). Diesel fuel prices increase more than electricity prices in 2020, but by less in 2030. Using diesel fuel price increases may overstate fuel, lube and electricity cost increases in 2020, but understate increases in 2030. Following FAPRI (2009) agricultural chemical costs are assumed to increase by 0.1%. Cotton ginning requires electricity for machinery and fuel for drying. The increases in electricity and natural gas are prorated based on ginning cost shares using data from Valco (2009) to estimate increased ginning costs.

The baseline cotton lint price and price shocks are derived from FAPRI (2010a). For 2020, price increases in cents per pound are used. For 2030, percentage price increases are used instead. The FAPRI (2010a) analysis increases absolute price and cost levels between 2020 and 2030, while this study does not. Using absolute price changes for 2030, then would imply much larger percentage price increase and possibly overstate per acre revenue gains from H.R. 2454. No price changes are assumed for cottonseed.

Table 3. Effects of cap and trade on cotton producer costs and returns, 2020 by EIA scenario (Basic vs. High Cost) and assumptions about EITE allowances for fertilizer manufacturing

	Baseline	High Cost No EITE allowance	Basic No EITE allowance	High Cost EITE allowance	Basic EITE allowance
Gross value of production:					
Cotton	$606.60	$606.60	$606.60	$606.60	$606.60
Cottonseed	$125.01	$125.01	$125.01	$125.01	$125.01
Total revenues	$731.61	$731.61	$731.61	$731.61	$731.61
Operating costs:					
Seed	$64.78	$64.78	$64.78	$64.78	$64.78
Fertilizer	$90.95	$105.65	$101.43	$92.50	$92.50
Chemicals	$62.76	$62.82	$62.82	$62.82	$62.82
Custom operations	$20.79	$20.79	$20.79	$20.79	$20.79
Fuel, lube, and electricity	$61.10	$66.60	$66.17	$66.60	$66.17
Repairs	$33.22	$33.22	$33.22	$33.22	$33.22
Ginning	$137.05	$138.15	$137.82	$138.15	$137.82
Total operating costs	$470.65	$492.01	$487.04	$478.86	$478.10
Percent change in operating costs		4.5%	3.5%	1.7%	1.6%
Allocated overhead costs:					
Hired labor	$14.21	$14.21	$14.21	$14.21	$14.21
Capital recovery (machinery, equipment)	$120.33	$120.33	$120.33	$120.33	$120.33
Total, allocated overhead	$134.55	$134.55	$134.55	$134.55	$134.55
Total costs (operating + allocated)	$605.20	$626.56	$621.58	$613.41	$612.65
Percent change in total costs		3.5%	2.7%	1.4%	1.2%
Net returns	$126.41	$105.05	$110.03	$118.20	$118.96
Percent change in total costs		-16.9%	-13.0%	-6.5%	-5.9%

Results and Discussion

The first scenario considers impacts of H.R. 2454 in 2020, ignoring any cotton price increases. It highlights the importance of EITE allowances and energy cost assumption in determining impacts on cotton growers. EITE allowances greatly reduce costs of regulation to cotton growers. Total costs rise 1.2%-1.4% (depending on energy price increases) compared to 2.7%-3.5% without allowances (Table 3). Note also that the presence or absence of allowances has more influence on producer costs and returns than the energy cost scenario (Basic vs. High Cost). Without EITE allowances, net returns fall 13-16.9%. EITE allowances cut those losses roughly in half.

Table 4 illustrates the importance of output price effects in 2020 scenarios. Changes in net returns range from a loss of –5.9% to a gain of 5.5%, depending on the size of cotton price effect (Table 4). Net returns per acre increase only when there is large-scale afforestation.

Table 4. Effect of cap and trade on 2020 cotton costs and returns with cotton price effects included (EIA Basic Case energy price shocks)

	Baseline	No price increase	Cost effect	Biofuels effect	Afforestation effect
			($/ acre)		
Cotton revenues	$606.60		$610.38	$611.91	$621.00
Cottonseed revenues	$125.01	$125.01	$125.01	$125.01	$125.01
Total revenues	$731.61	$731.61	$735.39	$736.92	$746.01
		0.0%	0.5%	0.7%	2.0%
Total costs (operating + allocated)	$605.20	$612.65	$612.65	$612.65	$612.65
Percent change in total costs		1.2%	1.2%	1.2%	1.2%
Net returns	$126.41	$118.96	$122.74	$124.27	$133.36
Percent change in net returns		-5.9%	-2.9%	-1.7%	5.5%

Table 5. Effect of cap and trade on 2030 cotton costs and returns with alternative cotton price effects (EIA Basic Case and High Cost energy price shocks)

	Total revenue change		Total cost change		Net returns change	
	$ / acre	%	$ / acre	%	$ / acre	%
Basic						
Cotton price change assumption						
None	$0.00	0.0%	$30.59	5.1%	-$30.59	-24.2%
Cost effect	$12.13	1.7%	$30.59	5.1%	-$18.46	-14.6%
Biofuels effect	$18.20	2.5%	$30.59	5.1%	-$12.39	-9.8%
Afforestation	$36.40	5.0%	$30.59	5.1%	$5.80	4.6%
High Cost						
Cotton price change assumption						
None	$0.0	0.0%	$43.55	7.2%	-$43.55	-34.4%
Cost effect	$12.1	1.7%	$43.55	7.2%	-$31.41	-24.9%
Biofuels effect	$18.2	2.5%	$43.55	7.2%	-$25.35	-20.1%
Afforestation	$36.4	5.0%	$43.55	7.2%	-$7.15	-5.7%

By 2030, cost increases are greater because energy price shocks are higher in later years and because of the phase-out of EITE allowances. Costs rise 5.1% under EIA Basic price shocks and 7.2% under High Cost price shocks

(Table 5). The effect of carbon offsets for afforestation is larger as the full 20 million acres of land is converted to forestland. With afforestation, total revenues rise 5%. Cotton price increases substantially reduce producer losses. With no price increase, producer returns fall 24.4%-34.4% depending on cost scenario (Table 5). With offsets and afforestation, producer returns decline 5.7% in the High Cost Case. Producer returns actually increase 4.6% with afforestation in the Basic Case. This occurs because the increase in revenue outweighs the increase in costs.

Table 6 highlights how different assumptions about energy price shocks, EITE allowances, and cotton price increases affect cotton grower returns per acre. In 2020, there is relatively little difference in returns between the EIA Basic and High Cost energy price scenarios. In 2020, producer returns are lower under the High Cost energy price shocks, but the difference is less than $1 / acre. By 2030, however, returns under the High Cost scenario are nearly $13 / acre lower than under the Basic scenario. In 2020, providing EITE allowances reduces the costs of cap and trade by more than $8 / acre and increases net returns accordingly. Price increases under afforestation have the largest positive effect on producer returns. In 2020, cap and trade increases per acre returns if EITE allowances are in place and if large-scale afforestation is implemented. In 2030, with EITE allowances phased out, cap and trade increases per acre scenarios with large-scale afforestation and under the Basic Case energy price shocks.

Table 6. Effects of cap and trade on producer net returns per acre differing by energy cost scenarios, provision of EITE allowances, cotton price effects

	2020 EITE Basic	2020 EITE High Cost	2020 No EITE Basic	2020 No EITE High Cost	2030 No EITE Basic	2030 No EITE High Cost
No price effect	-$7.45	-$8.21	-$16.39	-$21.36	-$30.59	-$43.55
Cost effect	-$3.67	-$4.43	-$12.61	-$17.58	-$18.46	-$31.41
Biofuels effect	-$2.14	-$2.90	-$11.08	-$16.05	-$12.39	-$25.35
Afforestation effect	$6.95	$6.19	-$1.99	-$6.96	$5.80	-$7.15

Table 6, then, outlines conditions where it is possible for cap and trade to actually increase per acre returns to cotton production. For net returns to improve in both 2020 and 2030: (a) energy prices increase along the lines of the EIA Basic Case, EITE allowances are provided to the fertilizer industry, and (c) land conversion from agricultural offsets generates significant increases in the price of cotton. Recall that avoiding energy price increases as under the High Cost scenario requires that there are no impediments to rapid adoption of low-carbon energy technologies or development of domestic and international carbon offset markets. Table 6 also shows that small changes in assumptions produce relatively large changes in net returns. For example, net returns swing from losses of more than $30 / acre (with High Cost energy price shocks and only cost effects on cotton price) to a more than $5 / acre gain (Basic energy price shocks and afforestation effects).

Summary

Results of this analysis suggest that effects of cap and trade legislation such as H.R. 2454 on cotton grower returns can vary widely, from $30 / acre or more losses to nearly $6 / acre gains. Agricultural emissions or production practices are not directly limited by this legislation. However, limits on carbon emissions will increase costs of energy and energy intensive inputs, particularly fertilizer. These cost increases are only partially mitigated by rising cotton prices (from lower cotton production).

Two provisions in H.R. 2454 substantially reduce the negative impacts of climate change legislation on cotton growers. The first is allocation of carbon allowances to fertilizer producers as energy-intensive trade-exposed entities. This EITE provision could substantially reduce fertilizer cost increases and delay them for 10-15 years, or more. Distribution of EITE allowances to ethanol producers also provides some indirect benefits to cotton producers, but these are relatively minor. The second provision is the sale by agriculture of carbon offsets to carbon-regulated industries. Cotton growers can benefit in two ways from carbon offsets. First, they could gain directly, earning income by planting trees or adopting carbon sequestering production practices. Second, they can gain indirectly from supply control effects of afforestation. Studies of agricultural offset potential indicate that converting crop and pastureland to forestland is the most likely economical option with millions of acres converted. Our analysis considered a case with 20 million acres converted by 2030. Such large-scale cropland retirement has a similar supply control effect as the Conservation Reserve Program. This supply control raises cotton prices and can increase cotton revenues more than other provisions of legislation raise costs. Thus, under certain scenarios, H.R. 2454 can actually increase per acre producer income.

Whether climate change legislation has positive income effects also depends crucially on rapid deployment of low-carbon energy technologies (e.g. nuclear, solar, biomass, carbon capture and storage) and development of domestic and international carbon offset markets. Our analysis shows that net income effects are highly sensitive to small changes in scenario assumptions. There is a high degree of uncertainty about just what climate change legislation would do to cotton grower income.

To conclude, there are two important areas for future research. First, this study has not estimated the potential income cotton growers could obtain from selling carbon-offset credits, particularly from tree planting. However, previous studies suggest that the Delta, Eastern Texas, and the Southeastern United States could account for a significant share of afforestation acres (FAPRI, 2010; Murray et al., 2005). This suggests that a significant number of cotton growers might be able to benefit from selling carbon offsets. A useful area for research would be to more formally assess the income potential from selling offset credits. Large-scale land retirement may affect the economic viability and location of cotton gins. Second, while the EITE allowances would delay increases in fertilizer prices, their eventual phase out suggest that cotton growers will eventually face much higher fertilizer costs. The EITE allowances, however, would give cotton producers and the cotton research system a decade or more to adjust to the coming cost increase. Thus, an important area of future research would be to consider scope for energy- and fertilizer-saving technical change in cotton production. Research areas would include (a) identification of input-saving management practices, (b) evaluation of returns to these practices under higher energy and fertilizer prices, and (c) estimate how much input-saving technical change could reduce the costs of carbon emission regulations.

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