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Introduction

Federally-backed crop and revenue insurance programs help to ease the financial shocks that crop loss can impose on farmers, bankers, and rural communities. In recent years, the government's role in supporting agricultural risk management has been accentuated by a perceived reduction in the Federal agricultural "safety net" via the elimination of deficiency payments and a greater emphasis on letting market forces guide producers' planting and marketing decisions.

While Federally-subsidized crop insurance programs clearly have had a beneficial impact on recipient farms, communities, and regions some question whether crop insurance programs have had other, unintended consequences (Skees). The argument that Federal intervention is crucial to overcoming a failure by the private sector to provide affordable, universally-available multi-peril crop insurance has muted distortion-related concerns in the past. However, growing levels of subsidy outlays combined with certain design aspects of federal crop insurance intervention suggest that there exists the potential for significant unintended market effects.

This study is a preliminary attempt at assessing the extent of market distortion, as measured by acreage and production shifts, directly attributable to Federal crop insurance subsidies. Crop insurance subsidies, converted to commodity-specific price wedges, are incorporated into a national policy simulation model that accounts for intra- and inter-regional acreage shifts and cross-commodity price effects. The results suggest that such subsidies generate small shifts in aggregate plantings. Nationally, wheat and cotton acreage appears to gain the most from Federal crop insurance subsidies. Stronger effects emerge at the regional level as planted acreage shifts away from the Southeast and Far West and towards the Plains States. An additional important result is that price-feedback and cross-price effects tend to dampen the Federal outlays for crop and revenue insurance have grown significantly since the 1994 Federal Crop Insurance Reform Act (figure 1), averaging nearly $1.4 billion annually during the 1995-98 period. Program expenditures are projected to increase to approximately $1.7 billion in 1999. Current legislative proposals (under the rubric of insurance reform and developing a "farm safety net") would continue and in some cases increase own-price effect, suggesting that acreage shifts are substantially smaller than results which ignore feedback and cross-commodity-price effects.

This paper is organized as follows. First, we examine the historical arguments for Federal intervention in crop insurance and its potential for distortion. Second, we discuss the methodology and data used to evaluate potential acreage distortions from Federal subsidies. Third, several limitation to the aggregate modeling approach adopted here are introduced. Finally, we present the preliminary empirical results–national and regional–and briefly discuss their implications from a broader market and trade framework.

Background on Federal Intervention in Crop Insurance Programs

The U.S. government has played a historically active role in targeting producers for protection against yield and revenue risks by developing, promoting, and subsidizing agricultural crop and revenue insurance. Such intervention has been justified on the grounds of a risk market failure due to private sector reluctance to provide universal, multi-peril crop insurance (Goodwin and Smith, 1995; Miranda and Glauber).

USDA's Federal Crop Insurance Commission (FCIC) subsidies are designed to make crop and revenue insurance universally available, and to increase participation in such insurance markets. Premiums are subsidized up to a maximum of 42 percent. With respect to private companies, FCIC subsidies remove the delivery cost and underwriting risk from premiums paid by producers. With respect to producers, FCIC subsidies lower the direct cost of acquiring insurance such that expected benefits are greater than actual premium costs.

the large subsidy transfers. Therefore, it is critical that policymakers fully understand the market effects of such subsidies.

Several aspects of FCIC subsidy design suggest that there exists the potential for significant unintended consequences beyond their original purpose. ***First,*** when viewed as an increase in expected revenue, the premium subsidy provides an incentive to purchase insurance and to marginally expand area under crop production since a producer's expected benefit increases with every insured acre. ***Second,*** by calculating premium subsidies as a percent of total premium they favor production on riskier land where it might not otherwise occur. Since premiums are based on expected payouts, premiums (and therefore the subsidy) are higher on risker land. And to the extent that yield risk varies across both crops and fields, so too does any subsidy-induced distortion suggesting that distortions likely occur across both regions and commodities. ***Third,*** to the extent that federal administrative reimbursement subsidies and sharing of underwriting risk increase the likelihood of insurance delivery, and consequently production, in high risk areas (such as in various locations in the Great Plains), they likely lead to distortions across both regions and commodities.

In their review of crop insurance literature, Knight and Coble (1997) identified the importance from a policy perspective of quantifying how crop insurance programs affect acreage decisions, especially following the 1996 Farm Act policy changes. However, most previous related research has been limited to farm-level or regional partial equilibrium models of behavioral responses with respect to input use or crop insurance participation decisions, and have not looked at the effects of government crop insurance subsidies on aggregate production and prices across a variety of activities and risk environments. Farm- and regional-level partial equilibrium models are unable to capture the feedback effect that acreage response and its resultant production changes engender, while also frequently ignoring cross-commodity price effects. This study attempts to address these research shortcomings.

Methodology Development

This study examines the influence of Federal crop insurance subsidies on planted acreage of eight major field crops–corn, wheat, soybeans, upland cotton, grain sorghum, barley, oats, and rice–for the entire U.S. and in each of seven major production regions. The seven production regions include the Northeast, Southeast, Delta, North Central, Central and Northern Plains, Southern Plains, and Far West (figure 2).
Although multiple-peril crop insurance is available in most major agricultural production regions and for most major agricultural field and specialty crops, the eight crops included in this study account for the majority of crop insurance activity. During the 1995 to 1998 period, these eight crops represented over 90 percent of insured acres and 72 percent of total insured liability, and received 76 percent of government premium subsidies and 74 percent of indemnity payments.

An evaluation of potential subsidy distortions begins by examining the extent of regional and crop-specific subsidy transfers in both absolute and relative terms. The subsidy includes both premium subsidies and estimates of crop and regional shares of the federal administrative/delivery cost reimbursements and net underwriting losses/gains.

County-level summary of business data on premiums, premium subsidies, indemnities, liabilities, and net acres insured are available for each crop, insurance program, and coverage level from USDA's Risk Management Agency (RMA).[1] Information on federal administrative/delivery reimbursements and net underwriting losses are also available from the RMA but only as national aggregates[2]. To make the model operational, each crop's share of aggregate subsidies (within each region) attributable to administrative reimbursement and underwriting risk sharing was estimated under the assumption that crops and regions with historically higher risk received a proportionally greater share of subsidy outlay. Approximations for each crop's share of administrative/delivery reimbursements and net underwriting losses were estimated at the state level by taking the 1994-98 average loss ratio minus one, times the total premium on "buy up" for each crop.[3]

[1]These data may be obtained directly from the RMA web site at www.act.fcic.usda.gov.

[2]An area for extension of this research is to improve the specification of these variables.

[3] The loss ratio is calculated as total premiums divided by total

The total insurance subsidy for a crop within a state is then defined as premium subsidies plus estimated net underwriting losses/gains and administrative/delivery reimbursements. The crop-specific state-level subsidies were then aggregated to the regional level where they were converted to a per-unit basis by dividing by the 1995-98 average production. Table 1 provides a summary of total subsidies, production, and per-unit subsidies for each of the eight crops within each of the seven regions. Clearly, substantial variation exists across crops and regions in terms of per unit subsidies. When national average per unit subsidies are expressed as a percent of projected 1998/99 season average farm prices (SAFP's) the differences become even more extreme (figure 3). The cotton average per unit subsidy of $0.046/pound translates into a 7.5-percent SAFP share compared with about a 1-percent share for rice's $0.051/cwt.

The impact of the crop insurance programs is analyzed through the POLYSYS-ERS simulation model jointly developed by ERS and the Agricultural Policy Analysis Center (APAC), University of Tennessee. POLYSYS is designed to anchor its analysis to a baseline of projections for all model variables and to generate simulation results on commodity supply, demand, ending stocks, prices, net returns and Government payments (Ray, *et al*). The POLYSYS-ERS simulation model replaces the linear programming supply component of POLYSYS with one driven by regional supply elasticities and solves for market clearing prices, which adjust the baseline numbers via a set of price flexibility functions (Lin, *et al*). POLYSYS-ERS simulates market behavior for 8 crops (corn, grain sorghum, barley, oats, wheat, soybeans, rice and cotton). Crop production is modeled in 7 production regions (figure 2). The simulation analysis makes use of the same demand components embedded in POLYSYS.

The impact of the Federal crop insurance program is determined by comparing the base scenario (the February 1999 USDA baseline) with and without the insurance subsidies. Insurance subsidies are introduced into the production decision as commodity- and region-specific price wedges. Farmers respond to lagged farm prices as expected prices plus an insurance price wedge when determining planted acreage. Since the baseline implicitly includes the effects of the insurance programs, the price wedges are subtracted to estimate what production and prices would have been in the absence of the subsidies.

Research Limitations

The empirical analysis reported in the remainder of this paper should be viewed as indicative of the effects of the current crop insurance program. A number of serious methodological limitations permeate this undertaking and likely cloud the results and their interpretation. The principal shortcomings are briefly described as a context for appreciating the implications of reported results.

First, treating FCIC subsidies as a single price wedge assumes that producers view the full crop insurance subsidy as increased market revenue. To the extent that administrative/delivery reimbursements and net underwriting losses do not accrue directly to farmers and, as a consequence, farmers do not respond to the full subsidies, the analysis may overstate the influence of crop insurance subsidies on supply response. The estimated production and price impacts would be lower if the full dollar value of the subsidy is not reflected in farm-level decision making.

Second, this study assumes that the 1995-98 period represents historic levels of crop and regional benefits associated with subsidized crop insurance. However, a review of the data suggest that the 1995-98 period was associated with relatively few extreme weather events in the major field crop producing regions and may, as a result, understate the true expected subsidy levels for many regions. Future estimates could be improved by adopting a longer historical perspective.

Third, the elasticities used in the POLYSYS-ERS model are estimated as short-run elasticities. Although the simulation experiment is run over time to permit the sector to adjust to an equilibrium with and without the subsidies, some longer run impacts may not be fully accounted for in the analysis.

Fourth, use of a national level model, such as POLYSYS-ERS, can not account for the array of decisions that individual farmers make in response to risk and programs such as crop insurance. Several aggregation issues arise from such a model including the following three.

indemnities. Under actuarially sound rate setting, the loss ratio should be close to one in the long run. The loss ratio minus one represents indemnity payments in excess of premiums, expressed as a share of premiums. "Buy Up" insurance is a catch-all term used to describe the sum of all coverage levels above the minimum catastrophic level of 50/60-percent yield coverage at 55-percent price election. Premiums for catastrophic coverage receive a 100-percent federal premium subsidy and are available for only a small processing fee. Greater risk sharing occurs at higher "buy up" coverage levels.

- The subsidy price wedge is calculated as an average dollar value per unit of output across all production, when in fact not all farmers use crop insurance. This understates the per unit subsidy that individual farmers using crop insurance actually respond to, and since subsidy effects are assumed to occur at the margin where insurance participation tends to be higher, likely understates the effect of subsidized crop insurance on aggregate production.
- By using an average subsidy price wedge for a region, the study ignores subsidy differences based on coverage levels. This may actually produce misleading conclusions about the per unit subsidies for differing regions; however the net impact of this assumption on aggregate production cannot be determined with available information.

- By using an average regional subsidy per unit of production, the study overstates the response of low risk farmers (by suggesting that they face a greater subsidy benefit than is true) and understates the response of high risk farmers (by understating their subsidy). Furthermore, higher risk farms likely have lower yields than low risk farms which means that their true "per unit" subsidy is further understated. Again, the net impact of this assumption is indeterminate.

Impacts of Crop Insurance on the Agricultural Sector

While a regional subsidy by crop is a relatively aggregate measure of the incentives created by insurance programs, this approach, nevertheless, provides important insights into production and price implications associated with crop insurance.

The availability of subsidized crop insurance affects farmers' current crop production decisions by creating a direct incentive to expand production. A typical farmer might base such planting decisions on a comparison of the expected net returns from producing alternative crops, such as corn and soybeans. During the 1995-98 period, crop insurance provided an average subsidy of $0.04 per bushel for corn and $0.09 per bushel for soybeans (table 1). With no land constraint, the farmer would be expected to increase production of both crops in response to the subsidies. With a land constraint, the farmer would likely alter each crop's share of acreage in accordance with the changes in their expected net returns induced by the insurance subsidy.

As individual farmers increase or shift acreage in response to the different subsidy price wedges, production and stocks also increase. Farmers will alter their production decisions in following periods in response to the new price levels. As a result of this feedback price effect, production will shift across commodities and regions. Consumers will also adjust their demand in response to the price changes. Over time, these feedback adjustments tend to moderate the aggregate acreage response to crop insurance.

Since the per unit value of insurance subsidies varies across regions and commodities, the long-run effects of the program on regional production patterns and commodity specific impacts, inclusive of these feedback effects, are evaluated by simulating the impacts of the insurance subsidies over a ten-year horizon. Average results representing years 5 to10 are discussed. In addition, aggregate impacts on net income and trade are discussed.

Aggregate Impacts for the 8 Major Crops

For commodities where net acreage increases, stocks build modestly over time dampening prices and moderating the longer-term impact on acreage. Lower market prices also lead to changes in product use. In addition, production adjusts in response to cross-price effects in related markets (recall that all 8 crops receive some level of crop insurance subsidy).

As a result, the estimated net impact on aggregate crop production and prices is relatively small once feedback effects are allowed to stabilize. An average annual FCIC subsidy of $1.4 billion devoted to production of the 8 field crops translates into a net aggregate acreage increase of approximately 600,000 acres (a 0.2 percent increase), while reducing prices for most commodities by less than 1 percent. The initial impacts (in the first year) of introducing subsidized insurance are somewhat larger with acreage expanding by about 1.0 million acres in the first year. But importantly, the modest 0.2 percent increase in long-run planted acreage masks somewhat larger commodity and regional impacts.

Commodity Impacts for the 8 Major Crops

The insurance subsidies induce increased production for six of the eight major crops (figure 4). The subsidy impacts differ in response to direct and cross-price effects. The largest initial impact occurs for wheat with area increasing by 870,000 acres in the first year, a 1.6-percent increase. In subsequent years, wheat area

responds to lower wheat prices combined with cross price impacts from competing crops to reduce wheat acreage as the sector approaches equilibrium. After several years the increase in wheat area averages only about 330,000 acres over baseline levels and wheat prices stabilize at about 1 percent lower. Wheat acreage impacts vary across regions–production increases in the Plains and North Central regions are partially offset by small declines in the Southeast and Far West regions.

The largest long-run impact in relative terms, however, occurs for cotton with annual acreage planted expanding by 1.2 percent (160,000 acres). As a percentage of price, the per unit value of the insurance subsidies is also largest for cotton. Cotton insurance subsidies averaged $0.043 per pound, or almost 9 percent of the season average farm price received, during the 1995 - 1998 time period.

At 72,000 additional acres planted, long-run annual average corn production expands more than any crop except for wheat and cotton. However, this increased area represents a relatively small portion of total corn area (0.1 percent).

Rice and soybean long-run acreage appears to decline modestly in response to the crop insurance program. Historically, the crop insurance programs for these two commodities have been more actuarially sound than most other crops, although this has varied by region. A relatively higher per unit subsidy value for soybean production in the Delta states leads to a modest increase in production which is offset by an equivalent decline in the Southeastern states. The increased relative profitability of soybean production in the Delta states draws about 10,000 acres out of rice production. The decreased rice production in the Delta is partially offset with increased production in the Southern Plains and Far Western states. Nevertheless, the net impact is a small reduction in rice production accompanied with a 0.1 percent increase in prices.

For grain sorghum, insurance subsidies draw production out of the Central and Northern Plains region into the Southern Plains region. The average grain sorghum subsidy is $0.25 per bushel in the Southern Plains region compared to less than $0.05 in other regions.

Regional Production Patterns

The impact of FCIC subsidies becomes more evident when regional production patterns are examined (figure 5). Regional acreage adjustments reflect differences in commodity insurance subsidies across regions and differences in commodity response in POLYSYS-ERS. Over 70 percent of the national increase in planted area attributable to crop insurance subsidies occurs in the Southern Plains region, even though it contains only 10 percent of the nation's cropland. Production also increases in the Central and Northern Plains and the North Central regions, while acreage declines in the Southeast and Far West regions.

The average per unit value of insurance subsidies is considerably higher in the Southern Plains, reflecting the higher risk in this region compared to other regions of the country. Per unit subsidies for wheat, upland cotton, corn, grain sorghum, and soybeans are highest in the Southern Plains region. The higher per unit value of subsidies induces a 1.6 percent increase in planted area in the Southern Plains in response to the insurance programs. Wheat and cotton account for most of the increase. About two-thirds of the national increase in wheat and cotton acreage is in the region.
The second largest acreage adjustment occurs in the Central and Northern Plains region where FCIC subsidies draw about 165,000 acres into production. Most of the increase is wheat; however, feed grain production also increases marginally, with the exception of grain sorghum. As mentioned previously, federal insurance subsidies encourage a shift in grain sorghum production from the Central and Northern Plains region to the Southern Plains. In the North Central region, wheat and corn production increase while soybean production declines in response to the program.

Aggregate production in the Southeast is lower than it otherwise would be as a result of the insurance program. Wheat area declines by 1.3 percent. This decline can be attributed to the relatively lower per unit value of insurance subsidies in the region combined with a response to the lower national-level wheat prices. Soybean production declines primarily in response to the relatively lower regional subsidy. Cotton acreage increases. While the cotton crop insurance subsidy is lower in the Southeast ($0.031/pound) than in the Southern Plains ($0.111/pound), the subsidy is sufficiently high to encourage a 1.0 percent increase in cotton area.

Net Returns

Subsidized crop insurance enhances net returns to farmers by lowering the costs of participating in the insurance program. However, all of the subsidy does not accrue to producers since the insurance program induces increased crop production and thus lower prices. In spite of

increased crop production, cash receipts for crop production decline by $210 million in response to the lower prices. Additionally, variable costs of production increase by about $85 million due to the increased planted area. The net effect of combined higher costs and lower cash receipts is that a $1.4 billion payout in annual crop insurance subsidies increases net farm income from crop production by less than $1.2 billion annually.

Lower crop prices also induce a spillover effect in the livestock market. Livestock production increases in response to the lower feed costs. Increased livestock supplies depress market prices somewhat. Livestock cash receipts drop by approximately $23 million.

Trade

Crop insurance subsidies appear to have a small impact on trade, as measured by U.S. exports (figure 6). The largest relative distortions occur for cotton where exports are projected to increase by 2.0 percent in response to the subsidies. Wheat, corn and barley exports increase moderately, while rice exports decline. With the exception of cotton exports, the current crop insurance program does not appear to significantly distort trade.

Government Costs

Government subsidies for insurance translate directly into program costs. Although not explored in this analysis, FCIC subsidies could have a secondary impact on government costs. This analysis indicates that insurance programs lead to reductions in prices and cash receipts. In years such as 1998 and 1999, when commodity markets are weak, an additional reduction in commodity prices increases budgetary exposure from marketing loans and loan deficiency payments, particularly for cotton and wheat. In addition, the increased cotton production, and subsequent exports, attributable to the program can lead to higher costs for the cotton step 2 payment program.

Concluding Remarks

The results reported here should be viewed as indicative of the impacts of FCIC crop insurance subsidies on commodity production and prices. This analysis treats federal insurance subsidies as explicit price gains available to all producers. Obviously, not all farmers respond to such a price incentive in the same manner. Participation in crop and revenue insurance represented about 61 percent of eligible acres in 1998 indicating that a large share of producers chose to ignore the subsidy incentive. And while the subsidy creates an income transfer, not all farmers seek to maximize such subsidy transfers. Instead many producers base their insurance and production decisions on a combination of risk management and farm returns objectives.

Many of the subtleties of insurance and insurance products are not captured in our aggregate subsidy wedge. Use of an aggregate subsidy masks individual decision making and glosses over the differences in risk aversion known to exist at the farm level. In addition, use of an average price wedge likely understates the true subsidy incentive faced by those farmers with riskier land that tend to participate in the program. These influences indicate a potential for the POLYSIS-ERS approach to underestimate the impacts of insurance on production and prices.

Nevertheless, in spite of these and other shortcomings, this preliminary look at the potential for commodity market distortions via an aggregate model, when viewed in combination with micro level analyses, enriches our understanding of how insurance subsidies may affect production decisions.

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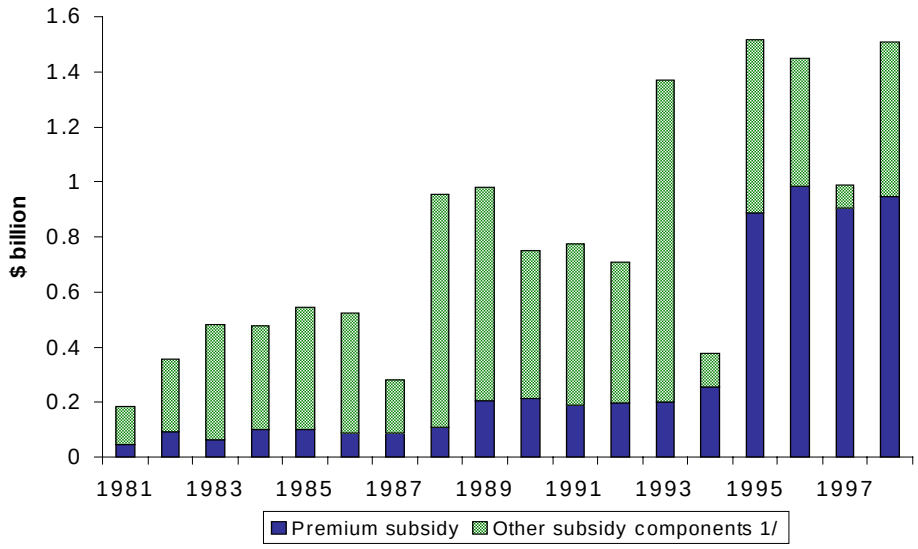
Figure 1. Federal Crop Insurance Subsidies, 1981-98



1/ Other subsidy includes reimbursement for administrative and delivery costs, as well as government share of net underwriting losses and excess loss payments.
Source: Risk Management Agency, USDA

Figure 2. US Crop Production Regions

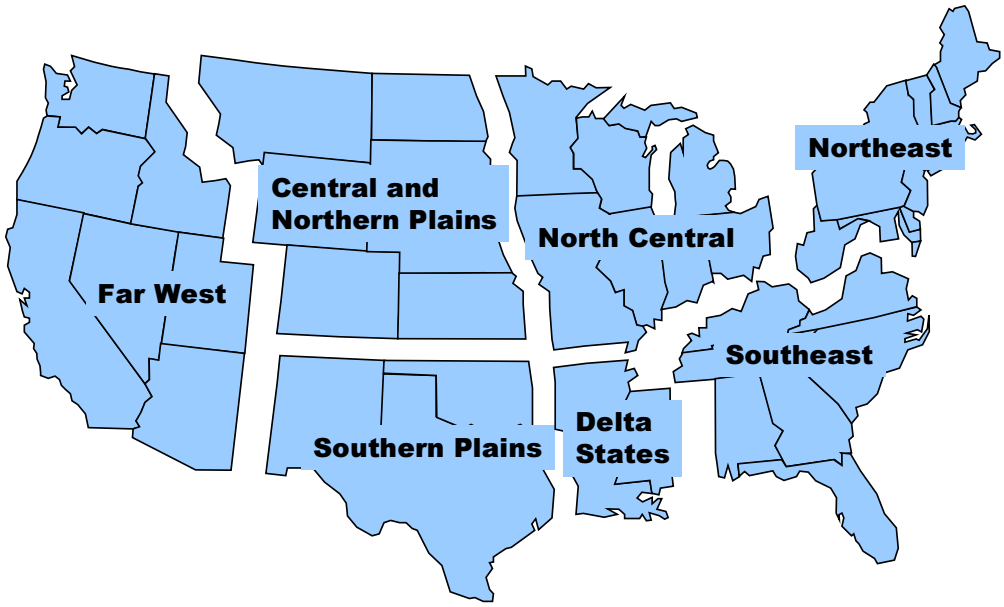


Figure 3. Commodity level subsidies

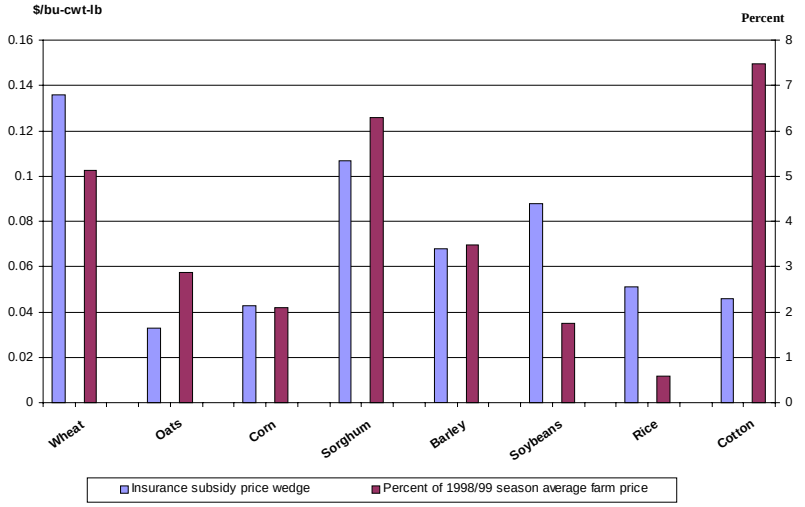


Figure 4. Percent change in acreage impacts by commodity

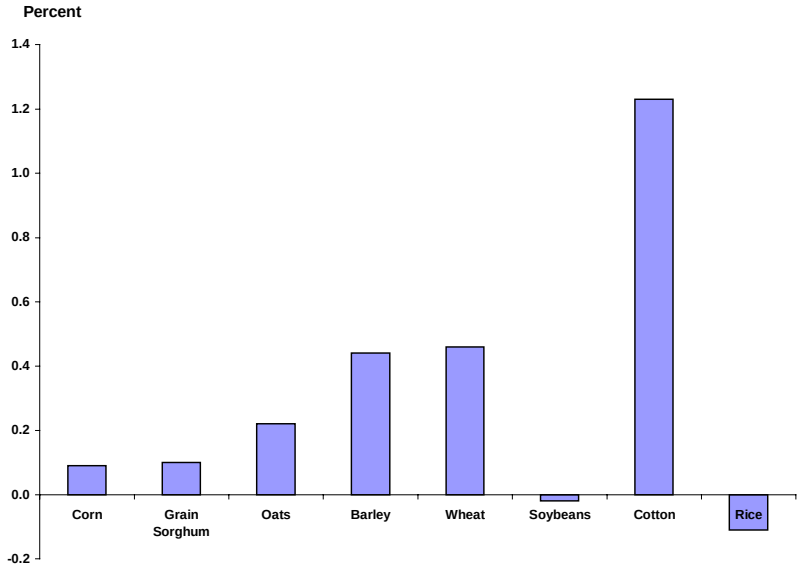


Figure 5. Estimated regional acreage impacts

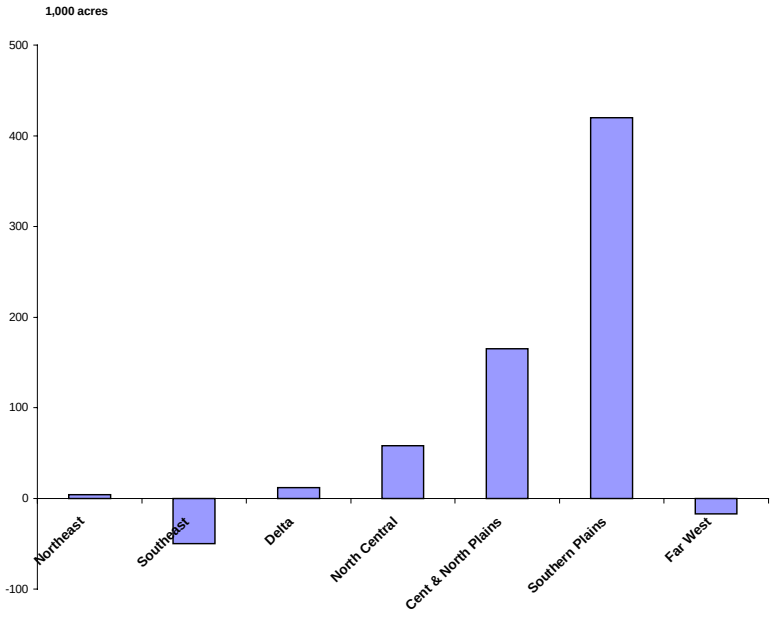


Figure 6. Percent change in trade by commodity

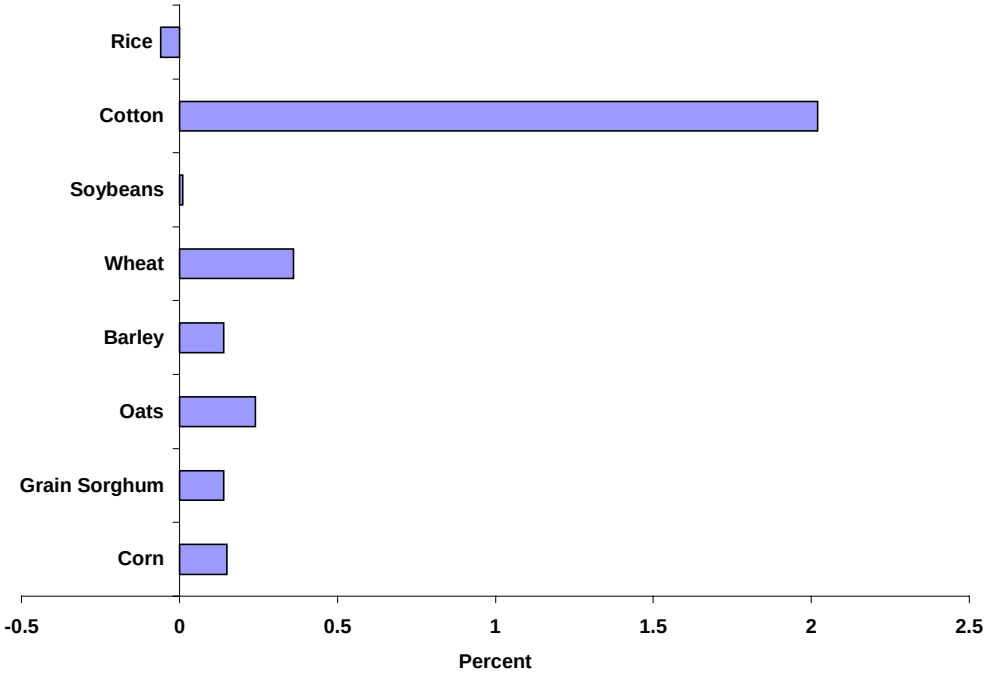


Table 1– Government crop insurance subsidies by production region for major field crops, annual average during 1995-98.

Region	Wheat	Oats	Rice	Upland Cotton	Corn	Grain Sorghum	Soybeans	Barley	Total 4/
Federal Subsidy	---------- $ Million ----------								
Northeast	0.3	0.0	—	—	8.0	0.0	2.4	0.0	10.8
Southeast	4.2	0.0	7.6	69.0	19.8	0.1	15.9	0.1	109.2
Delta	4.9	0.0	7.6	36.7	6.4	1.1	32.2	—	89.0
N Central	33.3	1.1	0.3	2.3	212.5	1.6	111.1	3.3	365.6
C & N Plains	213.3	3.8	—	0.1	104.4	17.2	55.0	19.9	413.8
S Plains	56.5	0.2	—	253.6	27.4	44.3	4.3	0.0	386.4
Far West	11.2	0.1	1.2	9.4	0.9	0.0	—	1.6	24.4
Total 1/	323.8	5.3	9.1	371.2	379.5	64.5	220.9	25.0	1,399.2
Production	----- Mln bu. -----		Mln cwt	Mln lbs	---------- Mln bu. ----------				
Northeast	36.2	16.3	—	—	252.1	—	38.6	11.4	—
Southeast	113.3	5.3	—	2,258.3	387.4	5.1	153.6	7.7	—
Delta 6	1.9	0.8	119.3	2,074.3	110.1	22.9	180.7	—	—
N Central	337.2	68.7	6.2	242.3	5,850.2	47.8	1,769.7	32.0	—
C & N Plains	1,174.6	55.0	—	3.3	1,977.0	349.3	342.7	195.0	—
S Plains	250.6	6.6	16.6	2,202.7	247.4	176.7	14.8	0.5	—
Far West	399.2	9.4	37.0	1,325.1	76.0	—	—	119.5	—
Total 2/	2,373.0	162.2	179.1	8,106.0	8,900.1	601.9	2,500.0	366.0	—
Per Unit Subsidy	----- $/bu. -----		$/cwt	$/lbs	---------- $/bu. ----------				
Northeast	0.008	0.002	—	—	0.032	—	0.062	0.004	—
Southeast	0.037	0.008	—	0.031	0.051	0.024	0.103	0.012	—
Delta 0.079	0.025	0.064	0.018	0.058	0.050	0.178	—	—	
N Central	0.099	0.016	0.052	0.010	0.036	0.034	0.063	0.103	—
C & N Plains	0.182	0.070	—	0.030	0.053	0.049	0.160	0.102	—
S Plains	0.226	0.034	—	0.115	0.111	0.251	0.290	0.079	—
Far West	0.028	0.006	0.031	0.007	0.012	—	—	0.014	—
Average 3/	0.136	0.033	0.051	0.046	0.043	0.107	0.088	0.068	—

"—" implies no appreciable values. 1/ Total Subsidy= premium subsidy plus share of subsidized administrative and delviery costs and net underwriting losses. The latter are calculated as the loss ratio minus one times the premium subsidy on buy-up coverage. Calculated from RMA/USDA data. 2/ Calculated from NASS/USDA data. 3/ Dollars per bushel for wheat, oats, corn, sorghum, soybeans, and barley; dollars per pound for cotton; and dollars per cwt for rice. 4/ Sum across the eight field crops listed. Totals are only relevant for subsidy values since production units vary.
Source: Economic Research Service, USDA.