An Economic Research Service Report

An Economic Assessment of the 1999 Drought

Agricultural Impacts Are Severe Locally, but Limited Nationally

While the 1999 drought has had severe financial impacts on agricultural producers in the drought regions, its impact on U.S. agricultural production has been limited. The drought will reduce commodity receipts relative to 1998 by an estimated $1.29 billion. Estimated farm net income losses, including expected yield losses, increases in expenses, and insurance indemnities, will total $1.35 billion, about 3 percent of expected 1999 U.S. net farm income. Drought impacts in areas of the Northeast designated as extreme and severe drought are expected to reduce farmers' net income by nearly $840 million. The regions affected, the crops grown in those regions, the increased use of irrigation, and crop insurance coverage limited the drought's impacts on agriculture nationally. Drought also affects the rural population by reducing water supplies available for human and livestock consumption.

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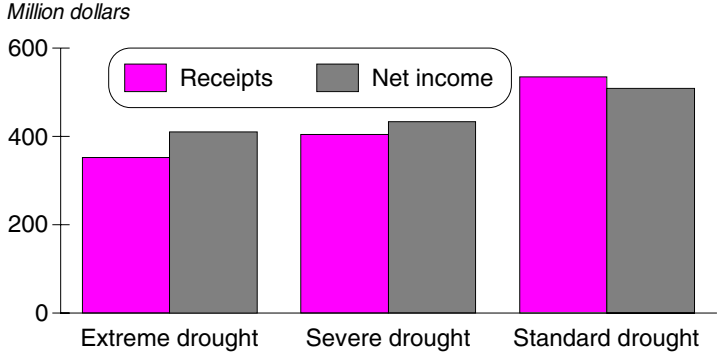
Record Drought Sears the Northeast

The second driest April-July period on record began in 1998 and intensified this year, inflicting the driest growing seasons in 105 years on New Jersey, Delaware, Maryland, and Rhode Island (NOAA News Release, 1999). A total of 1,383 counties, home to 109 million people and an estimated 918,960 farms, suffered some drought in 1999. A quarter of U.S. harvested cropland and 32 percent of pastureland was affected to varying degree. Farms in drought areas accounted for 30 percent of the total value of U.S. agricultural production in 1998, with crops accounting for less than 40 percent of the $59 billion produced in drought areas. Three distinct areas of drought severity (see appendix, "Defining Drought Regions") stretch from the Northeast to Texas and along the eastern Sierras in the West.

Severe and Extreme Drought areas of the Northeast are experiencing crop failure and considerable reductions in yield. Pennsylvania corn was in the most dismal condition of the 17 major corn-producing States, with 65 percent of the crop rated very poor to poor. Many farms that produce corn to feed their own livestock are attempting to chop what corn they can salvage to feed as silage. Soybeans have also suffered from the drought, with 60 percent reported in very poor to poor condi-

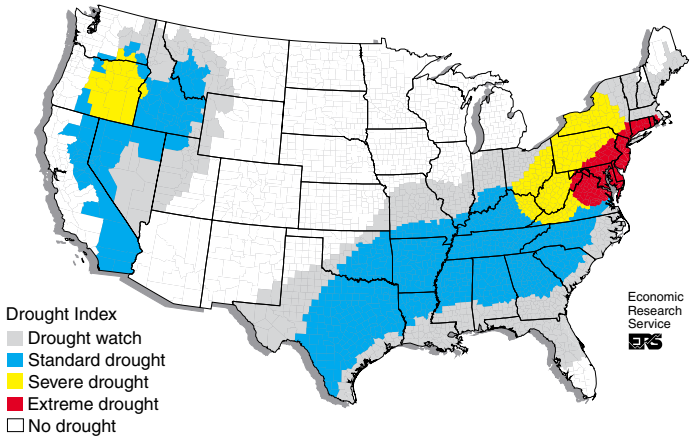
Figure 1
Estimated reductions in commodity receipts and net income relative to 1998 by drought area



tion. In some areas, plants are reported to have pods on them, but no beans in the pods, or the pods are burning up and falling off. According to NASS *Crop Condition* reports, all or nearly all pastures were rated very poor to poor in New Jersey, Connecticut, and Pennsylvania (USDA, 1999a). Hay regrowth is reported to be slow or nonexistent across these areas, implying hay shortages in the face of a greater immediate need for hay as well as for feed over the winter. In the Northwest *severe drought area*, 54 percent of pastures were very poor to poor in Washington and 32 percent very poor to poor in Oregon.

Areas in a broad swath from Texas to North Carolina have had scarce rainfall. As of August 18, 35 percent of cotton was rated very poor to poor in both Georgia and South Carolina and 31 percent very poor to poor in Tennessee. Among the 19 major soybean-producing States, 40-51 percent of the crop was rated in very poor to poor condition in Georgia, South Carolina, Tennessee, and Alabama. Extreme heat contributed to a rapid deterioration in crop and pasture conditions, lower milk production, and higher death rates for poultry and hogs. The heat wave was particularly intense across the South Central U.S., where Dallas-Ft. Worth, Texas, recorded its 19th consecutive day of 100-degree heat on August 18.

Figure 2
Agricultural drought as of August 18, 1999

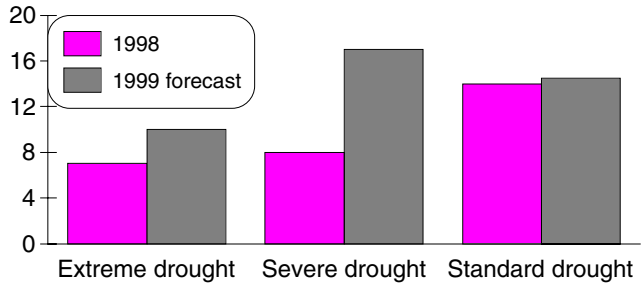


Impacts for U.S. Agriculture Are Small

Commodity receipts, relative to 1998, for the three drought areas will be reduced by nearly $1.29 billion (see table 1). Lower receipts, higher expenses, and adjustments for insurance indemnities will result in reduced net farm income totaling $1.35 billion. While these impacts are significant to the agricultural economies in the *extreme and severe drought areas*, they amount to only 3 percent of expected U.S. net farm income for 1999. More than 40 percent of the total financial impacts relative to 1998 came from the *standard drought* region, with $535.3 million lower receipts and $508.5 million lower net farm income, despite less severe drought effects. Because drought is less severe in this area, some of these impacts may be due to factors not related to drought itself (see appendix, "Modeling Drought Impacts").

Cash-flow problems from unusually low commodity prices are compounded by the drought, and may impede debt repayment. This is a particular concern for commercial farm businesses, which do not have off-farm income sources to remedy cash shortfalls. Debt repayment will be especially reduced in the *severe drought* areas, where the share of farms that do not generate enough income to repay debt is expected to increase from 8 percent in 1998 to 17 percent in 1999. The share of farms in the *standard drought* areas with debt repayment difficulty is

Figure 3
Commercial farms with debt repayment problems
Percent



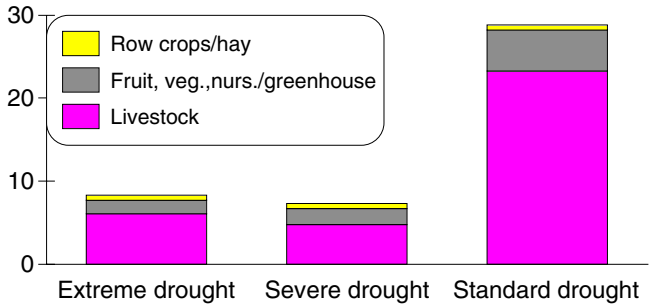
expected to remain similar to 1998 at 14 percent. A relatively low proportion of farms in the *extreme drought* areas had debt repayment problems in 1998, with the drought impacts pushing the share from 7 percent to 10 percent.

Crop Mix and Irrigation Reduced U.S. Impact

The *extreme and severe drought* affected areas with crops that, while crucial to their region's economy, are not critical elements in U.S. agricultural production. Supplemental irrigation blunted impacts in areas affected by less severe drought.

Extreme drought conditions affected 68,500 farms in 152 counties covering portions of the east coast from Virginia to Massachusetts. Of 10.8 million acres in farms, 59 percent was harvested cropland, mainly supporting livestock. These farms produced nearly $8.9 billion in agricultural commodities in 1998, mainly from livestock production (see table 2). Poultry (58 percent) and dairy (26 percent) accounted for the bulk of livestock production, while nursery and greenhouse (55 percent), vegetables (11 percent), and corn (8 percent) were important crops. Relatively few (3,250) of these farms were large, commercial farms with gross sales of $50,000 or more in 1998.

Figure 4
Value of crop and livestock production, by drought area
Billion dollars

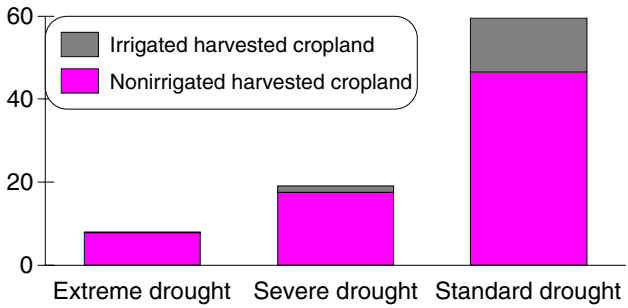


Only about 5 percent of the cropland is irrigated, compared with 15 percent nationally (see table 3). Only vegetable crops had a significant percentage irrigated, almost three-quarters of the harvested acres.

Severe drought affected 263 counties from western New York to Kentucky and in eastern Oregon, with an estimated 182,253 farms operating 43.3 million acres, about half in cropland and half in pasture. A little more than half of the $9.2 billion in total agricultural production came from livestock in 1998. Principal livestock commodities were dairy (67 percent) and cattle (22 percent). Fruit (21 percent), vegetables (14 percent), tobacco (12 percent), hay (12 percent), and nursery or greenhouse (12 percent) were the most important crop commodities. However, almost 13 million acres are irrigated, including orchards (15 percent of harvested acres), vegetables (19 percent), and hay (15 percent).

Less severe *standard drought* affected the largest area, encompassing 968 counties from Virginia to Texas and along the Sierras and containing the most farms (668,247) and the most harvested cropland. The total value of agricultural production in 1998 was almost $41 billion, with $25 billion coming from livestock. Important crop commodities were nursery or greenhouse (13 percent), soybeans (13 percent), cotton (10 percent), and

Figure 5
Total and irrigated harvested cropland, by drought area
Million acres

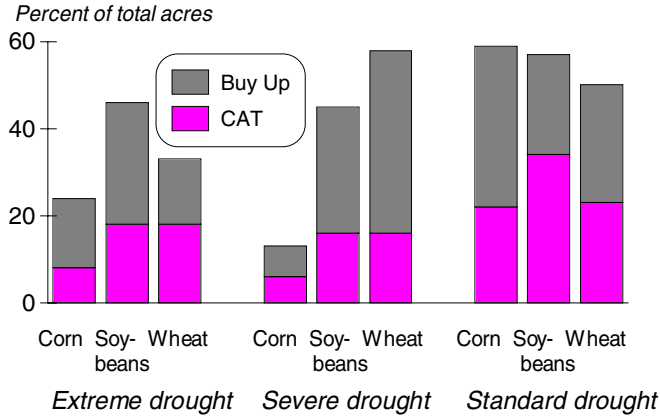


tobacco (10 percent). Poultry (34 percent) and dairy (32 percent) accounted for the largest share of livestock production, followed closely by beef cattle (27 percent). This region contains over 25 percent of the Nation's irrigated land, with a greater share of harvested cropland irrigated than the national average. Irrigation may have significantly mitigated drought impacts in this region, on both crops and livestock.

Crop Insurance Mitigates Financial Losses due to Crop Failure

For those producers who obtained insurance coverage, indemnities are paid based on the difference between the insurance guarantee and the actual output. Crop insurance coverage is based on expected yields or revenue and falls into two categories: Catastrophic Risk Protection (CAT) and Buy Up. Producers pay a flat fee instead of a premium for CAT coverage, which covers 50 percent of expected yield at 55 percent of expected price. For example, if a producer with CAT coverage had a total loss, the insurance indemnity, net of premium, would be about 28 percent of expected revenue (100% of revenue

Figure 6
Federal crop insurance coverage, by drought area



minus 50% of revenue as a premium, times 55% of expected yield times price). Buy Up policies allow the producer to "buy up" coverage above the 55 percent CAT level, up to a maximum of 75 percent (or 85 percent in a few areas) of expected yield, indemnified at levels up to 100 percent of expected price. Producers pay a portion of the actuarially fair insurance premium for Buy Up coverage. The most popular Buy Up level has been 65 percent of yield at 100 percent of price. For example, a producer at this level with a total crop loss would receive an indemnity of 65 percent of expected revenue (100% of revenue times 65% of expected yield times price), less the cost of the premium.

Producers in each of the drought areas, and for different crops, chose to insure at varying levels, thus protecting their financial situation against the impact of the drought (see table 4).

In the *extreme drought* area, about 1.7 million crop acres (30 percent) were insured in 1999. About 80 percent of the insured acreage in this area was corn and soybeans. About 25 percent of corn acreage usually harvested for grain was insured, while about 45 percent of the soybean acreage usually harvested was insured. Farmers chose the CAT level (50 percent of expected yield, indemnified at 55 percent of expected price) on 40 percent of the insured corn and soybeans. The balance was insured at Buy Up levels greater than CAT (up to 75 percent of expected yield, indemnified at up to 100 percent of expected price).

In the *severe drought* area, farmers insured 20 percent of the cropland usually harvested (about 2.9 million acres of crops) in 1999. About half of the insured acreage was corn and soybeans, and 45 percent was covered at the CAT level.

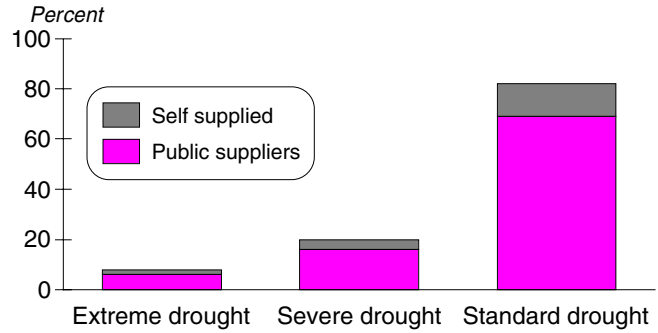
Producers generally insure their crops to a greater degree in the *standard drought* area than in the *extreme and severe drought* areas. About 40 percent of the cropland in the standard drought area was insured in 1999, with slightly more than half of the acreage insured at the CAT level.

Rural Populations Suffer Drought Impacts on Water Supply

Beyond the financial impacts of drought on farmers, drought reduces stream flow, water tables, and reservoir levels, reducing supplies of water for human consumption. Reduced stream, lake, and reservoir levels also impact wildlife and fish that depend on these waters, especially if they are drawn down for human use. Fortunately, smaller numbers of people are affected in the more severe drought areas, but the proportion of self-supplied water users in these regions is greater than in areas that experienced milder drought.

In the *extreme drought* area, almost 6 million people depend on water delivered through public supply systems which generally supply urban areas (see table 5). In the Northeast, public supply systems are large, professionally staffed, and often have reserve supplies for use in drought emergencies. Individual wells supply almost all of the domestic water for about 2 million people in rural areas of this region. Individual wells tend to be shallow and many will be affected by a drought of this historical magnitude. State and local governments across the *extreme drought* region encouraged voluntary water conservation, and mandatory restrictions were imposed on domestic water use in Maryland,

Figure 7
Population using water supplies, by drought area



Delaware, and New Jersey. Releases from upstream reservoirs on the Potomac River were made to augment reduced flows for fish and wildlife. While no estimate is available, the cost of providing alternative water supplies or deepening rural domestic wells for household and livestock use will be significant.

In the *severe drought* area, almost 16 million people depend on water delivered through public supply systems. Individual wells supply domestic water for about 4 million people in this region. Shallow groundwater wells may be affected by a drought of this severity. In the *standard drought* area, 69 million people are served by public systems, and 13 million are self-supplied, entirely from individual wells.

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Appendix 1
Defining Drought Regions

Regions experiencing agricultural drought of varying severity were identified using the National Drought Mitigation Center's drought monitor for the week ending August 18, 1999 (see map on p. 3). There are several different ways of defining drought (National Drought Mitigation Center, 1999). The classification of drought severity ranged from *extreme drought* in the Northeast, having major crop and pasture damage and widespread water shortages, to *standard drought* in the mid-South with some damage to crops and pastures (see table, next page). In many of the affected areas drought has been building for nearly a year, with a dry spring and hot summer following below-normal winter precipitation. Critical stages of crop development generally occur in mid- to late July. Despite any subsequent rainfall, most of the agricultural damage is irreversible.

A number of indices are used to characterize the seriousness of drought. Among others, these include.

• The Palmer Drought Severity Index (PDSI)—Developed by Palmer in 1965 to "measure the departure of the moisture supply" (Palmer, 1965). The PDSI is a "meteorological" drought index and responds to weather conditions that have been abnormally dry or abnormally wet. The PDSI uses precipitation and temperature data, as well as the local "available water content" of the soil to calculate all the basic terms of the water balance equation, including evapotranspiration, soil recharge, runoff, and moisture loss from the surface layer. Human impacts on the water balance, such as irrigation, are not considered.

• USDA/NASS Topsoil Moisture—Soil moisture supplied in the top 6 inches of the soil, relative to what is required for normal crop development.

• Satellite Vegetation Health Index—A numerical index of veg-

etation condition that changes from 0 (extremely poor) to 100 (excellent) based on a combination of chlorophyll and moisture content monitored by plant color and temperature.

Using these multiple indices allows for a more comprehensive assessment of the complex interplay between weather, soil, and vegetation when identifying agricultural drought. For example, the extreme drought areas are characterized by a PDSI of -4.0 or less (which translates to 30 percent or less of normal precipitation over a period of 2-3 months), 80 percent or more of topsoil moisture considered short, and a satellite vegetation health index below 15. Normal ranges for these measures would be a PDSI above 0 (60 percent or more of normal precipitation over 2-3 months), 20 percent or less of topsoil moisture considered short, and a satellite vegetation health index above 50.

Drought severity classification

Drought watch	Standard drought	Severe drought	Extreme drought
Palmer Drought Severity Index			
-0.6 to -2.0	-2.0 to -3.0	-3.0 to -4.0	-4.0 to -5.0
USDA/NASS Topsoil Moisture (percent short and very short)			
20-50%	50-65%	65-80%	80-90%
Satellite Vegetation Health Index			
35-45	25-35	15-25	5-15
Impact			
Minor, but cause for concern	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low; some water shortages developing or imminent	Moderate crop or pasture losses likely; fire risk very high; water shortages common	Major crop/pasture losses; severe fire danger; widespread water shortages

Source: Modified from National Drought Mitigation Center (1999).

Appendix 2
Modeling Drought Impacts

Estimates of 1999 production and crop receipts based on NASS State *Crop Progress* reports and yield expectations as of August 18, 1999, were used to create parameters for each of the three drought-affected areas (USDA/NASS, 1999b). The relationship between drought conditions and expected production and receipts is more discernible in the *extreme* and *severe drought* areas. Expectations for commodity receipts in the *standard drought* area are more likely to reflect a combination of many factors rather than drought alone. Adjustments were made to individual commodity receipts and expenses. Allowance was also made for Federal Crop Insurance indemnity payments. The farm business financial partial budgeting model was used to forecast 1999 financial conditions for each of these regions relative to 1998. The farm business financial partial budgeting model is a static short-term forecasting program (Morehart, 1999). The model reflects historical production patterns and farm structural characteristics so that any dynamic response on the part of farms is not treated. The model incorporates elements of income and expenses to project cash-flow, assets, and debt. The model operates on individual farm data from USDA's Agricultural Resource Management Study (1998). Model results can be summarized across various groupings of farms, such as region, commodity specialization, or size categories.

The drought impacts applied varied by intensity of drought conditions. For example, the reduction in corn receipts ranged from 40 percent in the *severe drought* areas to 10 percent in the *standard drought* region. Expenses incurred as a result of additional irrigation, tight feed supplies, and other costs incurred to compensate for drought resulted in an average increase in cash expenses of 5 percent in the *extreme* and *severe drought* areas and 2 percent in the *standard drought* region.

Table 1—Estimated reductions in 1999 commodity receipts and net income relative to 1998

	Standard drought	Severe drought	Extreme drought	All regions
		1,000 dollars		
Receipts	535,266	403,873	352,110	1,292,249
Net income	508,536	433,398	409,689	1,351,623

Source: ERS analysis of USDA ARMS data.

Table 2—Farms and value of production by drought area, 1998

	No drought	Drought watch	Standard drought	Severe drought	Extreme drought	All regions
Number of farms	720,662	415,083	668,247	182,253	68,464	2,054,709
Percent of farms	35	20	33	9	3	100
			Million dollars			
Total value of production	94,994	33,366	40,992	9,163	8,865	187,380
Crop	55,609	21,251	15,972	4,307	2,280	99,419
			Percent of crop			
Corn	23	18	8	10	8	18
Wheat	7	6	6	4	3	7
Soybean	18	21	13	8	7	17
Cotton	1	8	10	0	0	4
Rice	0	3	7	0	0	2
Tobacco	0	5	10	12	1	3
Hay	5	4	7	12	7	6
Fruit	12	5	9	21	6	10
Vegetables	12	5	9	14	11	10
Nursery/ greenhouse	14	15	13	12	55	15
			Million dollars			
Livestock	39,385	12,115	25,020	4,857	6,584	87,961
			Percent of livestock			
Cattle	48	25	27	23	8	34
Hogs	15	23	3	2	3	11
Dairy	31	27	32	67	26	32
Poultry	4	24	34	7	58	19

Source: ERS analysis of USDA ARMS data.

Table 3—Land use and irrigation, by drought area, 1997

	No drought	Drought watch	Standard drought	Severe drought	Extreme drought	All regions
			1,000 acres			
Total acres in farms	492,271	165,864	220,239	43,286	10,816	932,475
			Percent			
Harvested cropland	37	39	26	31	59	35
Pasture	50	46	58	46	20	50
Cropland idled	4	4	2	3	2	3
Other land use	10	11	14	20	20	12
			1,000 acres			
Harvested cropland	175,917	63,452	59,492	19,117	7,988	325,968
			Percent of harvested cropland			
Corn, grain	26	20	9	39	37	23
Wheat, all	24	17	15	9	8	20
Soybeans	19	26	20	6	18	20
Hay, all	16	14	38	29	23	20
Cotton	1	10	8	0	0	4
Vegetables	1	1	1	2	2	1
Fruit	2	1	2	1	1	2
Subtotal	89	88	93	86	89	89
			1,000 acres			
Irrigated harvested cropland	27,166	7,935	12,968	1,493	293	49,855
			Percent of harvested crop acres			
Corn, grain	18	3	14	0	2	13
Wheat, all	5	4	12	8	0	6
Soybeans	5	1	20	0	3	6
Hay, all	15	17	12	15	0	14
Cotton	87	27	28	0	0	36
Vegetables	80	71	69	19	74	72
Fruit	92	72	42	25	16	78

Source: ERS analysis of USDA ARMS data.

Table 4—Federal Crop Insurance coverage, by drought area, 1999

	Standard drought		Severe drought		Extreme drought	
	CAT	Buy Up	CAT	Buy Up	CAT	Buy Up
			Percent of crop			
Corn	22	37	6	7	8	16
Soybeans	34	23	16	29	18	28
Wheat	23	27	16	42	18	15

Source: ERS analysis of Risk Management Agency data.

Table 5—Population and water source, by water supplier and drought area, 1995

	No drought	Drought watch	Standard drought	Severe drought	Extreme drought	All regions
Population			*Million people*			
Public suppliers	64	70	69	16	6	225
Self-supplied	14	10	13	4	2	42
Water source			*Percent of withdrawals*			
Public suppliers:						
Ground water	32	43	41	24	39	37
Surface water	68	57	59	76	61	63
Self-supplied:						
Ground water	98	98	100	99	99	99
Surface water	2	2	0	1	1	1

Source: USGS, *Estimated Water Use in the U.S.*, 1995.

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