ECONOMIC ASSESSMENTS OF RED IMPORTED FIRE ANT ON TEXAS' URBAN AND AGRICULTURAL SECTORS

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ABSTRACT

The red imported fire ant (*Solenopsis invicta*) has become a major economic pest to various sectors of the Texas economy. In order to determine the economic costs and benefits of this pest on selected urban areas and on agriculture, two surveys were conducted. Some of the sectors that incurred expenditures due to fire ants included single-family households, golf courses, commercial businesses, schools, and agriculture.

The urban study, conducted in 1998-1999, found that the estimated annual costs of controlling and managing fire ants in the five metroplexes of Austin, Dallas, Fort Worth, San Antonio, and Houston exceeded $580 million. Fire ants had the greatest impact on the household sector in the metroplex areas with an estimated $526 million annual expenditures.

The agriculture study, conducted in 1999-2000, discovered that the estimated fire ant damages and control costs to Texas agriculture exceeded $90 million annually. The greatest expenditure was from production loss to crops and livestock, with damages exceeding $38 million. This study was a cooperative effort that involved Texas Tech University, Texas A&M University, and Texas Agricultural Statistical Service (TASS).

INTRODUCTION

Red Imported Fire Ant [*Solenopsis invicta* Buren (Hymenoptera: Formicidae)] infestations were first documented in Texas in 1953, and today over 56 million Texas acres are infested with fire ants. To control the spread of fire ants, the Texas Department of Agriculture initiated a county quarantine program in 1958 when it quarantined the state's six most eastern counties. However, the fire ant quarantine failed to stop the westward spread and today 160 Texas counties are under quarantine (Texas Imported Fire Ant Research & Management Plan 1996).

In 1997, in order to both control the spread and to document the severity of the fire ant infestation, the Texas legislature funded a 6-year red imported fire ant initiative at an annual rate of $2.5 million. The specific objectives of the legislative initiative were to document the economic and biological severity of the infestations and to discover appropriate and cost-effective management programs that may alleviate continued damage

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from this pest in the future. This on-going program has been a multi-disciplinary effort, involving both the rural and urban sectors of the state. This paper presents results from the economic component of the initiative's first and second two-year phases (Salin, et al. 2000; Willis, et al. 2001).

The specific objectives of the economic component of the Texas Fire Ant Project include:

1. To identify items, which are considered expenditures or costs, and those items, which have value or benefits, associated with the control and management of fire ants.
2. To estimate the cost of various control and management measures used by homeowners, golf courses, schools, cities, and agricultural producers.
3. To discover the various ways and areas where the fire ant affects the urban and agricultural space.
4. To estimate various expenditures associated with fire ant damages.
5. To estimate the overall economic impacts associated with fire ants in metroplexes and agriculture.
6. To serve as a benchmark to evaluate possible control and management programs implemented by the Texas Fire Ant Project.

A literature review revealed that no prior research had used primary survey methods to estimate the economic impact of fire ants on production agriculture or urban areas. However, limited economic impact studies were done by the University of Arkansas and the University of Georgia. Prior fire ant research to estimate agricultural damages has relied on using a combination of secondary data and statistical techniques. In the first two-year cycle of the Texas Fire Ant Project, Polk, Teal, and Segarra (1999) used published secondary data and statistical procedures to construct a statewide crop damage estimate of $45.5 million. In a complementary study, also funded by the Texas Fire Ant Project, Teal et al. (1998) computed a damage estimate for the Texas cattle industry of $255 million annually using limited secondary data sources. Because of a poor statistical fit, their 95% confidence interval estimate was extremely large, having a lower limit of $27.8 million, and an upper limit of $572.9 million. Given the lack of precision and wide variation in existing damage estimates, a decision was made to obtain primary data from the agricultural producer level on the agricultural costs and benefits (if any) associated with fire ant infestations.

This research project fills the gap in existing knowledge on fire ant economics. The first phase of the economic analysis targeted the urban sectors. A statewide survey in 1998 provided estimates of expenditures for control and costs of damages and repair in five Texas metroplexes: Dallas, Fort Worth, Austin, Houston, and San Antonio. The estimate of treatment expenses exceeded $300 million. Repair and replacement costs exceeded $80 million and $152 million, respectively. Medical expenses exceeded $47 million. The second phase involved similar data collection for agricultural production. This statewide survey yielded an agricultural damage estimate of $90 million. The data from these five surveys were used to extrapolate expenditures for various other sectors and for all state areas, which are reported elsewhere in The Statewide Economic Impact of Red Imported Fire Ants in Texas (Lard, et al. 2001). The remainder of this paper is organized as follows: (1) description of data collection and analytical methods, (2) summary of survey findings, and (3) conclusions.

DATA COLLECTION METHODS

The data used in the economic analysis were gathered through five different sector surveys. Single-family households, golf courses, schools, and cities sector data were collected during the urban study for 1998. The fifth survey, the agriculture sector, was

conducted in 2000 to obtain fire ant expenses for the calendar year of 1999. Table 1 summarizes the survey design and procedures for the five sectors surveyed.

TABLE 1. Summary of Survey Design and Procedures

	Households	Golf Courses	Schools	Cities	Agriculture
Sample size (n)	272	48	52	5	4,038
Sampling technique	area frame and quota sampling	randomized quota sampling	randomized quota sampling	census	area frame and complete enumeration
Source of expansion factors	Census of Pop. & Ag., Sales Mktg. & Mgmt. Survey	TX Golf Course Directory	TX Education Agency	Does Not Apply	TASS
Survey administration	TASS telephone	TAMU mail/ telephone	TAMU mail/ telephone	TAMU mail/ telephone	TASS personal interview
Date of completion	Jan-Apr 1999	Jan-Apr 1999	Jan-Apr 1999	Jan-Apr 1999	Oct-Nov. 2000

Urban Study. The data collection phase of the urban study was completed in 1998 and 1999 and identified costs and benefits associated with the calendar year 1998. The costs, practices, and benefits were collected for single-family homes, schools (public and private schools, including elementary schools, high schools, and higher education institutions), cities, and golf courses for the five major metroplex areas in Texas: Dallas, Fort Worth, Austin, Houston, and San Antonio.

The primary data were collected from households, schools, cities, and golf courses by using carefully structured questionnaires. Questionnaires were administered by mail to schools, cities, and golf courses, with phone call follow-ups. The household survey responses were obtained by telephone interviews conducted by trained personnel from the Texas Agricultural Statistical Service (TASS). The main goal of the sample design for each sector was to obtain a representative sample of the households, schools, and golf courses. All five metro cities were surveyed to obtain city data. These data were obtained from the city manager's office or the appropriate city department responsible for utilities, parks, and city grounds.

The single-family households (detached homes) were stratified by metroplex using the National Agricultural Statistical Service's area frame sampling scheme. Doyle Fuchs and other personnel at Texas Agricultural Statistical Service (TASS) conducted the sampling and the personal interviews. These area frames were modified with the 1997 Census of Agriculture, which included non-agricultural areas, primarily residences. These adjustments were necessary because the Area Frame Sample for TASS was designed to obtain data about acreage, yields, numbers, etc. of agricultural products and inputs.

Sample size was determined by using the usual scientific statistical procedure as follows:

$$n = \frac{z^2 \sigma^2}{e^2}$$

when n = sample size

z = number of standard deviations from the population mean

σ = the population standard deviation

e = the accepted error or desired level of precision

It was decided that an "e" of plus or minus 10% for the estimated value (sample mean) for fire ant expenditures was acceptable, and thus a sample size sufficient to assume that the estimated sample mean was within 10% of the population mean was specified. The z value was based upon a 10% level of precision as well. An estimate for σ was approximated by use of range tests (Tull and Hawkins 1990). This technique was used to guide the determination of survey size for households, schools, and golf courses.

The types of data collected for each sector included (1) characteristics of each entity, (2) defining the fire ant problem, (3) identifying types of expenditures for control and management, (4) maintenance expenditures and investments, (5) medical expenditures, (6) damages to electrical type equipment, and (7) general information on the sector. The complete text of the questionnaires is available from the authors upon request.

Agriculture Study. The agriculture survey reported costs and benefits for the 1999 calendar year. A structured questionnaire was developed in association with trained personnel from the Texas Agricultural Statistical Service (TASS). The primary objective of the sample design was to obtain a representative sample of agricultural producers. To achieve this goal, a sampling scheme based upon the Texas Agricultural Statistical Service's sampling procedure was utilized. The TASS area frame sampling procedure provides accurate regional estimates on acreage, yields, numbers of producers, and input use. TASS administered the required personal interviews as an addendum to their 1999 Fall Area Survey. Over 4,000 surveys were received from TASS.

Secondary data was used to augment the survey data. Secondary data sources used consisted of the 1997 United States Census of Agriculture, and other data annually compiled by the TASS. The TASS also provided the expansion factors (weights) for aggregating the survey damage data into damage estimates for each of the fifteen Texas agricultural statistics districts, in addition to a statewide total.

The types of data collected from each agricultural producer included (1) irrigated and non-irrigated acres of cropland in the operation, (2) crop losses related to fire ants, (3) livestock losses related to fire ants, (4) equipment repair costs due to fire ants, (5) equipment replacement cost due to fire ants, (6) fire ant damages to the farmstead, (7) fire ant related medical expenditures, (8) fire ant related veterinary expenditures, (9) cost of fire ant control materials, (10) special equipment purchased to apply fire ant control materials, and (11) the agricultural benefits of fire ant infestations. The complete text of the questionnaire is available from the authors upon request.

SUMMARY OF SURVEY FINDINGS

Urban Study. The overall cost to metroplexes for fire ant damages and control was over $581 million for 1998. The greatest cost was to the household sector with $526 million in damages and control. The per household average cost due to fire ants was $151. Golf course expenditures were $30 million or $63,495 per golf course. School expenditures were $25 million and city expenditures were $612,453. In each of these sectors, expenditures were assessed for treatment, repair, replacement and medical costs.

Total expenditure by sector and type of expense per metro area are displayed in Tables 2 and 3.

TABLE 2. Total Expenditures for Fire Ants by Urban Sector for 1998.[a]

	Metro Area					
Sector	Austin	Dallas	Ft. Worth	Houston	San Antonio	Total
Households	$45,783.1	$99,346.4	$72,065.3	$111,055.4	$197,632.5	$525,882.7
Golf Courses	$14,185.2	$10,009.8	$1,177.1	$3,537.6	$578.0	$29,487.7
Schools	$1,014.4	$11,933.9	$1,311.7	$7,271.2	$3,910.2	$25,441.5
Cities	$51.6	$194.5	$326.8	$28.9	$10.7	$612.5
Total	$61,034.3	$121,484.6	$74,880.9	$121,893.1	$202,131.6	$581,424.3

[a] Expenditure totals are in thousands.

TABLE 3. Total Expenditures in Urban Areas by Type of Expense for 1998.[a]

Type of Expense	Metro Area					
	Austin	Dallas	Ft. Worth	Houston	San Antonio	Total
Treatment	$22,960.2	$98,240.8	$37,571.8	$73,560.5	$69,218.9	$301,552.0
Repair	$2,828.7	$8,133.4	$34,029.0	$10,087.2	$25,548.2	$80,626.6
Replacement	$32,029.0	$11,177.9	$1,001.0	$1,583.6	$106,288.3	$152,0798
Medical	$3,216.4	$3,932.5	$2,279.2	$36,661.7	$1,076.0	$47,165.9
Total	$61,034.3	$121,484.6	$74,880.9	$121,893.1	$202,131.4	$581,424.3

[a] Expenditure totals are in thousands.

Household Expenditures. Fire ant related expenditures for treatment, repair, replacement, and medical costs over the five large metroplexes in Texas were $150.79 per household, leading to total metroplex expenditures of $526 million. Clearly, fire ants have a considerable impact on metroplex households. Treatment costs, including pesticides and other control measures were $280 million for the metroplexes, making up approximately 53% of the total expenditures. Repair costs account for $72.8 million and replacement costs were $126.4 million for the five metroplex household totals. Replacement costs included such items as replacing damaged electrical equipment, such as an electrical panel or a compressor on an air conditioner unit. Total annual metroplex expenditures for medical care costs were $47.1 million. Per household expenditures are displayed in Table 4. While this survey was not primarily a contingent valuation study, questions were posed on (1) the value of specific activities that have been curtailed because of fire ants, and (2) willingness to pay for control. The responses are an interesting and important part of the complete economic impact assessment. Households indicated dollar values for curtailed outdoor activities of $140, almost as high as their actual average expenditures for control and repair ($151).

TABLE 4. Per Household Expenditure for Fire Ants in Urban Areas for 1998.[a]

Type of Cost	Austin	Dallas	Fort Worth	Houston	San Antonio	Weighted Average
Repair	$ 7.90	$ 2.54	$ 57.60	$ 6.44	$ 30.67	$ 19.2
Treatment	$ 68.62	$ 64.44	$ 63.47	$ 45.21	$ 83.64	$ 66.3
Medical	$ 10.05	$ 2.80	$ 3.85	$ 25.46	$ 1.36	$ 9.4
Replacement	$ 58.82	$ 1.16	$ -	$ -	$ 134.58	$ 55.7
Total per Household	$ 145.39	$ 70.94	$ 124.92	$ 77.11	$ 250.25	
					Total per Household	$150.79

[a] Categories with $ -; no damages were reported by respondents.

Golf Course Expenditures. Fire ants have made a large economic impact on the golf courses of the five large metroplexes of Texas. The fire ant expenditures on treatment, repair, replacement, and medical costs was $64,495 per golf course. When looking at each of the four above expenditure categories for the golf courses relating to fire ants, replacement cost was the most significant of the metroplexes total expenditure. Replacement expenditure was $25 million. A considerable proportion was for the replacement of costly irrigation systems due to fire ant habitation in the system. Treatment costs, which included mostly insecticide baits followed by individual mound treatment performed by the golf course management, had an expenditure across the metroplexes of $3 million. Repair costs account for both electrical equipment and physical damage to the different areas of the course, and was $1.15 million. Annual metroplex expenditures for medical care costs were $3,610. Per golf course expenditures are displayed in Table 5.

TABLE 5. Per Golf Course Expenditure for Fire Ants in 1998.[a]

Type of Cost	Austin	Dallas	Fort Worth	Houston	San Antonio	Weighted Average
Repair	$ 2,111	$ 2,330	$ 1,019	$ 2,524	$ 4,391	$ 3,74
Treatment	$ 5,565	$ 5,830	$ 1,800	$ 12,273	$ 3,620	$ 6,53
Replacement	$ 151,499	$ 93,981	$ 11,356	$ 11,997	$ 13	$ 53,20
Medical	$ 10	$ -	$ 19	$ 6	$ 4	$ 8
Per Golf Course	$ 159,185	$ 102,141	$ 14,194	$ 26,800	$ 8,028	$ 63,49

[a] Categories with $ -; no damages were reported by respondents.

School Expenditures. The school sector accounts for more than $25 million in economic impact of fire ants in Texas metroplex areas. Average expenditure per school responding to the survey was $4,954. The leading share of school expenditure (71%) was treatment measures, both by hired professional service companies and by school staff. The Dallas schools responding to the survey reported expenditures that averaged two and even three times larger than schools in the other metro areas. Per school expenditures are displayed in Table 6.

TABLE 6. Per School Expenditure for Fire Ants in 1998.[a]

Type of Cost	Austin	Dallas	Fort Worth	Houston	San Antonio	Total
Treatment	$ 1,980	$ 5,519	$ 985	$ 3,597	$ 3,038	$ 3,532
Repair	$ 350	$ 3,453	$ 1,123	$ 333	$ 418	$ 1,326
Replacement	$ -	$ 264	$ -	$ -	$ 5	$ 75
Medical	$ 126	$ 5	$ 71	$ -	$ -	$ 22
Total per school	$ 2,456	$ 9,240	$ 2,179	$ 3,930	$ 3,461	$ 4,954

[a] Categories with $ -; no damages were reported by respondents.

City Expenditures. On average, cities manage approximately 225 individual sites per city including parks, buildings, airports, cemeteries, etc. Costs for repairing areas damaged by fire ants averaged $901 per city and totaled $11,370 for the entire metroplex areas. These repairs were made by city maintenance staff, parks departments, aviation employees, and private contractors. Outdoor lighting fixtures and city parks were by far the most often repaired areas; however, lawn areas and airport areas were the most expensive areas to repair ($5,267 and $2,579, respectively).

There were various types of fire ant treatments made by respondents, including the use of insecticide mound treatments, insecticide baits, biological controls, mechanical disturbance, and other specialized remedies. The areas receiving the greatest number of treatments were lawns/landscapes, parks, athletic fields, and cemeteries, with a total of 1,020 hours being expended on fire ant treatment activities during the course of an "average" year. The total costs of performing these treatment activities averaged $19,889 per city, totaling to $226,740 for the entire metroplex areas. Per city expenditures are displayed in Table 7.

TABLE 7. Per City Expenditure for Fire Ants in 1998.[a]

Type of cost	Austin	Dallas	Fort Worth	Houston	San Antonio	Weighted Average
Repair Damage	$ 1,400	$ -	$ 1,700	$ 1,000	$ -	$ 901
Treatment	$ 9,625	$ 500	$ 59,886	$ 25	$ 6,000	$ 19,889
Control	$ 11,312	$ 54,825	$ 4,488	$ 11,050	$ 1,600	$ 18,643
Medical	$ 15	$ -	$ 5,000	$ -	$ -	$ 1,463
Replacement	$ 2,100	$ 4,250	$ 17,550	$ -	$ -	$ 6,493
Electrical Repair	$ 3,450	$ 10,650	$ 9,500	$ 1,800	$ -	$ 6,239
Total per City	$ 27,903	$ 70,225	$ 98,124	$ 13,875	$ 7,600	
				Total per City		$ 53,628

[a] Categories with $ -; no damages were reported by respondents.

The control cost was a weighted average per city of $18,643 or a total cost for the metroplex areas of $212,527. The average expenditure for fire ant control and management per city was $53,628 or $612,453 for all five metroplex areas for all types of costs.

Electrical Expenditures. A corollary study conducted by Texas Tech University (Teal et al. 1999) examined costs associated with fire ant damages to electrical and communications equipment. This report found that annual fire ant related damages sustained within the metroplex regions to electrical and communications equipment totaled $111 million. This number raises the total economic impact of fire ants to metroplexes to over $691 million.

Agricultural Study. Fire ant damages exceeded $90 million for Texas agricultural producers in 1999. Fire ant damages are reported for nine damage categories in Table 8. Collective crop yield losses due to fire ant activity are the largest damage category at $33.4 million and comprise 36.9% of all reported damages. Equipment repair cost is the second largest damage category at nearly $17 million. This is closely followed by control material expenditures at $16 million. Thus crop yield losses, equipment repairs, and control material expenditures account for 73.3% of all fire ant damages. Farmstead damages and equipment replacement cost account for $9.1 million and $7.4 million of fire ant damages, respectively. Livestock losses are a relatively small fraction of annual damages at $4.6 million. The medical ($0.56 million) and veterinary ($0.86 million) costs associated with fire ants each comprise less than 1% of total agricultural damages.

TABLE 8. Texas Fire Ant Damages for 1999 by Loss and Expenditure Category. [a]

Damage Category	Damage	Percentage of Total Damage	Number of Farms Reporting Damage [b]	Percent Farms Reporting Damage [b]
Crop Yield Loss	$33,441,777	36.92%	259	7.17%
Livestock Loss	$4,627,030	5.11%	211	5.84%
Repair Cost	$16,956,961	18.72%	375	10.38%
Replacement Cost	$7,390,836	8.16%	135	3.74%
Farmstead Cost	$9,056,496	10.00%	240	6.64%
Medical Cost	$561,356	0.62%	87	2.41%
Veterinary Cost	$860,856	0.95%	40	1.11%
Control Cost	$16,019,737	17.69%	1,181	32.70%
Equipment Cost	$1,656,983	1.83%	113	3.13%
State Total	$90,572,032	100.00%	1,358	37.60%

[a] The farm survey consisted of 3,612 completed questionnaires.

[b] The value for the total number of farms reporting damages is not equal to the sum of the number of observations in each damage category. The state total value is the number of surveyed farms reporting at least one type of damage, but many farms reported more than one type of damage.

Despite the annual statewide fire ant damage estimate of $90 million, only 37.6% of the 3,612 surveyed farms reported at least one fire ant related damage, with the most common cost being expenditures for control materials (32.7%). Moreover, only 7.2% of the surveyed farms reported crop losses due to fire ants, even though yield losses account for nearly 37% of all damages. These results illustrate the spotty nature and distribution of the occasionally severe impact from red imported fire ants.

In addition to damages not being uniformly distributed over the damage categories, damages are not uniformly distributed over the state (Table 9). Fire ant damages for the

two Northeastern Texas Agricultural Statistical Districts (Districts 4 and 5-N) comprise more than 53% of all reported damages. The high reported damages for these two regions might be explained by Adams et al. (1983) and Semevki et al. (1996), which report that corn and soybean yields are sensitive to fire ant density levels. These two districts have a relatively high level of soybean and corn production and the fire ant density levels in these districts are the highest in the state (Quarles 2000). Figure 1 identifies each of the 15 Texas Agricultural Statistical Districts on a map of Texas. The unidentified district below District 5-N in Figure 1 is District 5-S. Generally, the eastern districts have the greatest percentage of farms reporting fire ant damages. Nearly 73% of the farms in district 8-S report damages. A combination of warm temperature and high soil moisture create favorable fire ant habitats. In the hot, relatively dry Texas High Plains districts (1-N, 1-S, and 2-N) and the arid district 6 of West Texas, fewer than 1% (7 farms) of the 738 farms in these four districts report damages. This finding is consistent with the fact that none of the 68 counties comprising these four districts is currently under a fire ant quarantine.

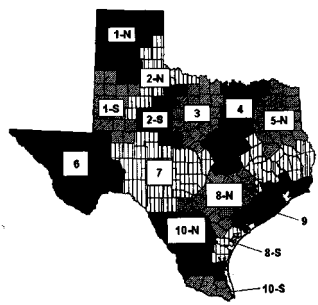

FIG.1. Texas Agricultural Districts

District per Farm and per Acre Total Damages. Table 10 presents a statewide district level comparison for the percentage of surveyed farms reporting at least one category of fire ant damage, and two alternative average per farm total damage measures. The first measure is average total farm damage by district for farms reporting damages, and the second measure is average total farm damage by district for all surveyed farms. District 10-S in South Texas has the highest average total damage for farms reporting damages at $9,438, which is 10 times larger than the statewide average of $941. District 10-S is the only area in Texas where high valued oranges and grapefruit are commercially grown. Prior research by Banks et al. (1991) has shown that citrus seedlings are especially sensitive to fire ant activity. Thus, in an effort to protect their valuable orchards, many citrus growers in this region invest heavily in chemical control methods and specialized application equipment. Nearly 90% of the $9,438 per farm damage in this district was contained in these two damage categories. It should be noted that only 5.5% of the farms in this district reported damages. Other possible explanations for the damages in District 10-S: citrus producers could be reporting damages from other ant species, such as *Atta texana*, the Texas leaf cutting ant, or this was a statistical survey and this result could be outside

the 10% confidence interval. The great majority of farms in this district are not citrus orchards and do not invest heavily in specialized chemicals and application equipment. This is borne out by the fact that the average per farm total damage measure for all farms surveyed in district 10-S is $515, only 45% higher than the corresponding statewide average per farm damage of $354. By both per farm damage measures, damages tend to be above the statewide average in the eastern districts and well below the statewide average in the western districts.

TABLE 9. Summary Data on Number Farms Surveyed, Number Farms Reporting Damages, and Total Reported Damages by District for 1999 Texas Fire Ant Damages.

District	Total Damage	District Percentage of State Damages	District Farms Surveyed	Surveyed District Farms with Damage	Percentage of Farms Reporting Damages [a]
1-N	$6,256	0.01%	257	1	0.39%
1-S	$66,640	0.07%	262	3	1.15%
2-N	$2,808	0.00%	186	3	1.61%
2-S	$70,556	0.08%	243	6	2.47%
3	$6,998,447	7.73%	350	215	61.43%
4	$25,826,786	28.52%	506	252	49.80%
5-N	$22,194,130	24.50%	346	189	54.62%
5-S	$7,002,361	7.73%	285	126	44.21%
6	$0	0.00%	33	0	0.00%
7	$4,590,655	5.07%	325	185	56.92%
8-N	$8,529,670	9.42%	347	185	53.31%
8-S	$6,847,868	7.56%	33	24	72.73%
9	$4,508,108	4.98%	247	129	52.23%
10-N	$2,568,191	2.84%	137	37	27.01%
10-S	$1,359,557	1.50%	55	3	5.45%
State Total	$90,572,032	100.00%	3612	1358	37.60%

[a] State total for percentage of farms reporting damages is a weighted statewide average value.

Table 11 complements Table 10 and presents the per acre total damage comparisons by district. As expected, average per acre damage for farms reporting damages is greatest in South Texas district 10-S. However, close inspection of Table 11 reveals that only 0.03% of the surveyed acres in this district are associated with farms reporting damages, and average per acre damage for all surveyed acreage in this district is below the state average ($0.45 versus $0.62). Per acre damages for farms reporting damages are highest in district 5-N (northeastern Texas) with a per acre value of $13.25. The lowest per acre damages are in district 1-N (Texas panhandle) with a per acre value of $0.11. Over 75% of the acreage in district 5-N is associated with farms reporting fire ant damages, whereas only 0.3% of the crop acreage in district 1-N is associated with farms reporting fire ant damages. Farms reporting damages in districts 2-S, 4, 5-N, and 8 are

larger in terms of cropland acreage than farms not reporting damages. The opposite is true in all other districts.

TABLE 10. Summary Data on Number Farms Surveyed, Percentage Farms Reporting Damages, Per Farm Damage for Farms Reporting Damages, and Per Farm Damage for all Surveyed Farms Damages by District for 1999 Texas Fire Ant Damages.

District	Surveyed Farms	Percentage of Surveyed Farms with Damage	Average Farm Damage for Farms Reporting Damage [a]	Average Farm Damage for All Surveyed Farms [a]
1-N	257	0.39%	$150.00	$0.58
1-S	262	1.15%	$46.67	$0.53
2-N	186	1.61%	$26.33	$0.42
2-S	243	2.47%	$311.83	$7.70
3	350	61.43%	$655.29	$402.53
4	506	49.80%	$1,385.17	$689.85
5-N	346	54.62%	$1,611.94	$880.51
5-S	285	44.21%	$570.25	$252.11
6	33	0.00%	$0.00	$0.00
7	325	56.92%	$716.77	$408.01
8-N	347	53.31%	$669.38	$356.88
8-S	33	72.73%	$1,159.71	$843.42
9	247	52.23%	$552.74	$288.68
10-N	137	27.01%	$697.11	$188.27
10-S	55	5.45%	$9,438.33	$514.82
State	3,612	37.60%	$941.37	$353.93

[a] State averages are weighted averages.

Fire Ant Benefits to Texas Agriculture. There is an ongoing debate concerning the existence of potential agricultural benefits to fire ant infestations. Some researchers hypothesize that fire ant infestations prey on agricultural pests such as boll weevils and corn earworms. If this benefit can be documented, it could offset some of the damages associated with fire ants in some areas of the state. Probably the most interesting finding is that 3.74% (135 out of 3,612) of the surveyed farms reported benefits, but only 10 respondents could provide a dollar measure of the benefit value. As many as 10% of the farms in the heavy corn producing districts 4, 5-N, 8-N, 8-S, and 9 reported benefits (usually numerically unquantifiable). Despite the fact that most farmers in these four districts were unable to quantify the benefit value received from fire ant infestations, they tended to agree that the primary benefit is attributable to a reduction in the corn earworm population. Other benefits mentioned less frequently were the control of tick and boll weevil populations. The $1.54 million statewide benefit estimate provided in Table 12 is derived only from those respondents able to quantify the benefit value (which is less than 10% of the respondents stating there was a benefit value). Thus, the survey results presented in this study probably significantly understate the statewide benefit from fire ants.

TABLE 11. Summary Data on Cropland Acres for Farms Surveyed, Percentage of Cropland Acres with Damages, Total Per Acre Damage for Cropland Acres Associated with Farms Reporting Damages, and Total Per Acre Damage for all Surveyed Acreage by District for 1999 Texas Fire Ant Damages.

District	Cropland Acreage for all Survey Farms	Percentage Surveyed Acreage Associated with Farms reporting at Least One Damage Category	Per Acre Average Damage for Farms Reporting Damage [a]	Per Acre Average Damage for All Surveyed Farms [b]
1-N	451,528	0.29%	$0.11	$0.00
1-S	271,114	0.80%	$30.73	$0.00
2-N	176,646	0.65%	$0.07	$0.00
2-S	300,971	2.62%	$0.24	$0.01
3	63,954	40.07%	$5.50	$2.20
4	164,337	56.75%	$3.74	$2.12
5-N	30,508	75.39%	$13.25	$9.99
5-S	22,209	77.25%	$4.19	$3.24
6	5,876	0.00%	$0.00	$0.00
7	58,020	40.42%	$5.65	$2.29
8-N	55,611	33.13%	$6.72	$2.23
8-S	131,443	29.19%	$0.73	$0.21
9	35,026	52.91%	$3.85	$2.04
10-N	242,182	4.08%	$2.61	$0.11
10-S	63,585	0.03%	$1,584.79	$0.45
State	2,073,010	13.41%	$4.60	$0.62

[a] Per acre average damage for farms reporting damage is calculated as total district damage divided by the sum of all cropland acres within a district associated with farms reporting at least one type of damage.

[b] Per acre average damage for all surveyed farms is calculated as total district damage divided by the sum of all cropland acres for all surveyed district farms.

CONCLUSIONS

The survey findings reported in this paper indicate the perceived economic significance of the red imported fire ant as a pest in Texas metropolitan and agricultural areas by survey respondents. Furthermore, as the fire ant continues to move farther north and west, these damages can be expected to increase if there is no coordinated action to control them. Annual expenditures in metroplexes for control of fire ants, and for repair or replacement of damaged items, exceeded $581 million in 1998, based on studies of metropolitan households, golf courses, schools, and cities. Fire ant damages cost Texas agricultural producers $90 million in 1999. The initial assessment of economic impact serves as a baseline for evaluation of the benefits of new control and management programs, such as the community-based effort underway as part of the Texas Imported Fire Ant Research and Management Plan. The work demonstrates the importance of sound economic input into inter-disciplinary research and extension programs.

TABLE 12. Summary Data on Number Farms Surveyed, Percentage of Surveyed Farms Reporting Benefits, Number Farms Reporting Benefits, and Total Benefits by District for 1999 Texas Fire Ant Benefits.

		Farms Reporting Benefits but Unable to Quantify Benefit Value		Farms Reporting Benefits and Able to Quantify Benefit Value		
District	Surveyed Farms	Percent	Number	Percent	Number	Estimated Benefit [a]
1-N	257	0.00%	0	0.00%	0	$0
1-S	262	0.38%	1	0.00%	0	$0
2-N	186	0.00%	0	0.00%	0	$0
2-S	243	0.00%	0	0.00%	0	$0
3	350	1.43%	5	0.57%	2	$6,558
4	506	4.94%	25	0.99%	5	$1,500,204
5-N	346	6.65%	23	0.87%	3	$31,503
5-S	285	2.81%	8	0.00%	0	$0
6	33	0.00%	0	0.00%	0	$0
7	325	3.38%	11	0.00%	0	$0
8-N	347	10.37%	36	0.00%	0	$0
8-S	33	9.09%	3	0.00%	0	$0
9	247	8.10%	20	0.00%	0	$0
10-N	137	2.19%	3	0.00%	0	$0
10-S	55	0.00%	0	0.00%	0	$0
State	3,612	3.74%	135	0.28%	10	$1,538,264

[a] Estimated district benefit was calculated by applying the TASS expansion factors to the survey benefit data.

Agricultural damage is not uniformly spatially distributed over the state, as over 53% of statewide damages are concentrated in the northeastern corner of the state. High precipitation levels create favorable fire ant habitats, and naturally those areas of the state generally have the largest damages. Crop selection is also a factor in fire ant damage estimates. Citrus growers reported spending more than ten times the state average on control measures and special application equipment to protect their valuable investment. Producers of lower value agricultural crops find it more cost-effective to accept fire ant induced yield losses instead of attempting to control infestations. Statewide, crop yield loss damages are more than two times larger than control cost expenditures, which suggests that existing control technologies are not cost-effective for agricultural producers producing lower value crops. Areas of the state specializing in corn, soybeans, sorghum, peanuts, and rice generally report higher per acre yield loss damages than other areas of the state. Additional research is needed on understanding crop yield response for these five crops to fire ant density levels, and the rate of fire ant spread. Knowledge of these biophysical relationships will enhance the ability of agricultural economists to target areas of the state where comprehensive fire ant control programs would be cost-effective.

These surveys provide the only comprehensive effort to collect primary data on the economic effects of fire ants. The survey methods and aggregation procedures provide a strong scientific basis for the pest problems and the value of improved management programs.

In addition to the quantitative estimates of costs and control expenditures, both surveys highlight the continuing need for understanding non-monetary implications of the fire ant. It is a research challenge to understand the significance of problems that are not easily put into monetary figures. For example, respondents to these surveys provided input into the non-monetary benefits of effective control of the fire ant. Willingness to pay for effective control averaged $89, substantially below actual household expenditures. The contingent valuation results are puzzling and the conclusions should not be overstated given the stated difficulty of several respondents in answering these questions.

A close working relationship between economists and scientists researching new control technologies and management practices documented the costs, and provided valuable insight into the costs effectiveness and benefits of collaborative programs. This report will serve as a benchmark for future research, measuring the effectiveness of any organized community, county, or statewide control and management programs. The information provided by this study will be valuable to many others, such as entomologists, economists, policymakers, and government officials of Texas. This study and its results will also prove to be valuable to other researchers and areas of the United States where fire ant infestations occur.

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