Prevalence of ROPS-Equipped Tractors on Minority Operated Farms in the US

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Abstract

Objectives: To examine the prevalence of Roll-Over Protective Structures (ROPS) on farm tractors used on minority farming operations in the US, and compare the results to those for the general US farm population.

Methods: The study used data covering calendar year 2003 collected for the National Institute for Occupational Safety and Health (NIOSH) by the US Department of Agriculture (USDA), National Agricultural Statistics Service (NASS), from a sample of 15,656 racial minority farm operators across the US. The survey included demographic information about the farm and farm operator, and basic information on the total number of farm tractors and farm tractors with ROPS used on the farm operation. ROPS prevalence rates for all farm operations were obtained from a similar survey conducted for NIOSH by NASS covering the calendar year 2004 for all farms in the US. This survey involved a sample of 25,000 farm operators.

Results: Results indicate that ROPS prevalence rates on minority farming operations follow similar patterns to ROPS prevalence rates on US farm operations in general. Demographic characteristics associated with the prevalence of ROPS equipped tractors on farms included a lower prevalence of ROPS on farms with operators over the age of 65-years, a lower prevalence of ROPS on small acreage farms, and lower ROPS prevalence rates for part-time farms compared to full-time farms. The race of the operator had little impact on ROPS prevalence rates when these other demographic characteristics were considered.

Specific potential: Understanding the relationship between ROPS use on farms and basic farm and farm operator demographics has the potential to efficiently target areas for ROPS promotion programs across the US. Understanding these relationships for minority operations and how they compare to all farming operations in the US allows for further refinement of these targeting efforts.

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Introduction

Agricultural tractor overturn deaths have been an identified problem for farm operators in the United States (US) since the 1920s, and continue to be the leading cause of agricultural occupational deaths to this day. There was an average of 200 tractor-related fatalities annually in the US between 1992 and 2005, with tractor overturn fatalities accounting for about one-half of these (NIOSH, 2006). The Roll-Over Protective Structure (ROPS) was developed to protect tractor operators from death and disability due to tractor overturns by providing a protective zone for the tractor operator in the event of a tractor overturn. ROPS are most effective when used in conjunction with a seatbelt, which keeps the tractor operator inside the protective zone during an overturn.

The effectiveness of ROPS has been well documented (Lehtola et al., 1994; Springfeldt et al., 1998; Thelin, 1998; Reynolds and Groves, 2000; Myers et al., 2008). The National Institute for Occupational Safety and Health (NIOSH) has estimated that fatality rates due to tractor overturns could be reduced a minimum of 71% (NIOSH, 1993) if all tractors were equipped with ROPS. Increasing the use of ROPS on tractors has long been a recognized public health need (NCASH, 1989; NIOSH, 1992) and has been shown to be a cost effective means of reducing fatalities from tractor overturns (Kelsey and Jenkins, 1991; Myers and Snyder, 1995; Pana-Cryan and Myers, 2000; Owusu-Edusei and Biddle, 2007).

The most effective effort to increase the use of ROPS to date was taken by the American Society of Agricultural Engineers (ASAE—now known as the American Society of Agricultural and Biological Engineers, or ASABE) (Myers, 2003; Myers, 2004; Loringer and Myers, 2008). In 1985, the then ASAE adopted a voluntary standard that encouraged tractor manufacturers to install ROPS and seatbelts as standard equipment on all new tractors for use in the US market (ASAE Standards, 1985). All major tractor manufacturers agreed to adopt this standard, and since 1986, nearly all new agricultural tractors sold in the US have been equipped with ROPS.

It was anticipated that the voluntary ROPS standards would lead to a decrease in the number and rate of tractor turnover deaths on US farms. Yet by the late 1990s, tractor overturn fatality rates had not decreased dramatically because of the large number of older tractors in use on US farms that were not equipped with ROPS (Myers, 2003; NIOSH, 2006). A recent study by Loringer and Myers (2008) found that the prevalence of ROPS on farm operations across the US had only reached 51% in 2004. Furthermore, the study found that factors such as having a low farm value of sales, farming less than 301 acres, farming on a part-time basis, and having a primary operator over the age of 54 years were associated with a low prevalence of ROPS-equipped tractors on farms.

One limitation to the Loringer and Myers study was the lack of information on ROPS usage patterns for the roughly 61,000 racial minority farm operators in the US (NASS, 2004). The purposes of this study were to assess the overall prevalence of ROPS-equipped tractors on US farms where the primary operator was a racial minority, to see if the prevalence of ROPS-equipped tractors was associated with the same farm demographic characteristics identified for the general farm operator population by Loringer and Myers (2008), and to compare the 2003 findings for racial minority operations to 2004 findings for the general farm operator population.

Methods

Estimates of tractors and ROPS-equipped tractors in use on US racial minority operated farms were derived from the NIOSH Minority Farm Operator Occupational Injury Surveillance of Production Agriculture (M-OISPA) survey for the calendar year 2003. Tractor information for the general farming population was obtained from the 2004 OISPA. Both the M-OISPA and the OISPA surveys were computer-assisted telephone interview surveys of a random sample of farming operators across the US. Both surveys were conducted for NIOSH by the US Department of Agriculture, National Agricultural Statistics Services (NASS). Participation in OISPA surveys was voluntary.

For the M-OISPA, the sample size was 15,656 farm operators. Data were collected between March and May of 2004. Sampling weights were calculated based on the number of racial minority farm operators reported in the 2002 US Census of Agriculture (NASS, 2004). The responses were originally stratified by race within six designated NASS census weight classes (adjustment factors to account for non-list farms in the 2002 Census of Agriculture). The racial categories were Black, Native American, Asian, and Multiple Races. Operators who reported that their operation had gone out of business in the M-OISPA survey were retained in the weighting process because they were in the 2002 census counts. Because racial minority groups were heavily clustered geographically, the final sample weights were post-stratified by the respondent's race and census weight class within nine geographic regions defined by the US Bureau of the Census (BOC) (BOC, 1975). Because of reporting restrictions, data from the New England and the Mid-Atlantic states were combined for all analyses.

For the 2004 OISPA, the original sample size was 25,000 farm operators stratified by the same nine BOC geographic regions described previously. Samples were equally allocated within regions. Data were collected between February and April of 2005. Sampling weights were post-stratified based on the number of farms responding within three broad "value of sales" categories (<$10,000; $10,000-$99,999; >$99,999). Value of sales was selected for the post-stratification process because it had been found in previous data to be strongly associated with a number of farm demographic variables, reducing the impact of non-response for the survey. Farm counts within the 27 strata were obtained from 2004 farm numbers published by NASS (2005). Out of business farms were not retained in the weighting process because the 2004 farm numbers published by NASS already accounted for farms no longer in business.

For both surveys, a farm was defined as any operation with $1,000 or more of gross agricultural production within a calendar year. The type of farming operation was classified using an existing NASS coding system based on the North American Industrial Classification System. The only farms excluded from the surveys were very large swine confinement operations. The tractor portion of the survey requested the respondent provide information on the number of tractors on the farm and how many tractors were equipped with ROPS. Confidence intervals for percentages were derived using standard equations for a stratified simple random sample (Cochran, 1977) with programs developed using the Statistical Analysis System (SAS).

Logistic regression models were fit for both the M-OISPA and OISPA survey data using software available from the SAS Institute (SAS, 2003). The dependent variable for each model was the percentage of farm tractors without ROPS. The independent variables used in the models were: race (M-OISPA only), age of the operator, acreage, full- or part-time status of the operation, type of farming operation (e.g., grain, cotton, beef, dairy), and region. Because region and type of farming operation were categorical variables with no underlying ordinal scale, the comparison group used to calculate odds ratios was the default categories selected by the statistical software. All models were constructed using the weighted survey results. Only farms with no missing values for the dependent and independent variables were used. Type III tests of significance and odds ratios were all obtained using SAS Proc SurveyLogistic.

Results

A total of 10,197 minority operators responded to the 2003 M-OISPA survey, of which 9,500 were still farming. This gave a crude survey response rate of 65.1%. Of the 5,459 non-respondents, 5,137 were due to a failure to reach the farm operator by telephone during the survey period. Only 322 operators refused to participate in the survey once contacted. If non-contacts are removed, the adjusted response rate for contacted operators was 96.9%. The crude response rates by race ranged from a low of 53.1% for Asians to a high of 69.4% for Blacks. Native Americans and farm operators reporting to be of multiple races each had crude response rates above 63%.

For the 2004 survey of all farm operations, 16,707 farm operators responded to the survey for a crude response rate of 66.8%. Of the 8,761 non-respondents, 4,650 were due to a failure to reach the farm operator by telephone during the survey period. A total of 3,643 operators refused to participate in the survey once contacted. If non-contacts are removed, the adjusted response rate for contacted operators was 82.1%. The crude response rates by value of sales categories were similar, ranging from a low of 62.1% for farms with less than $10,000 of sales to a high of 66.9% for farms with sales between $10,000 and $99,999.

***Basic demographics*:** In 2003, there were an estimated 56,881 minority operated farms (Table 1). Blacks accounted for the largest number of these farms (46.7%), followed by Native Americans (25.6%), and Asians (15.1%). These minority operators reported an estimated 78,725 farm tractors, of which 49.3% were reported to have a ROPS. Black

Table 1. Demographic characteristics and farm tractor estimates for racial minority operated farms in the US by race, 2003.

Variable	Category	Blacks	Native American	Asian	Multiple Races	Total
Farms	In-business	26,565	14,566	8,577	7,174	56,881
Operator Age	Average	58.5	51.7	51.0	53.3	55.0
Full- or Part-Time	Full-Time	3,973	3,643	3,532	1,866	13,014
	Part-Time	21,789	10,617	4,612	5,185	42,203
	Unknown	803	306	433	123	1,665
Acreage	1-100	19,708	8,481	6,714	4,513	39,416
	101-300	4,616	2,947	851	1,456	9,870
	301-500	748	876	190	423	2,237
	501-700	237	370	102	151	860
	700-999	63	287	62	138	550
	>999	114	1,191	178	315	1,798
	Unknown	1,079	414	480	178	2,151
Type of Farm	Crop	7,643	3,493	6,569	2,340	20,045
	Livestock	17,585	10,579	1,505	4,636	34,305
	Unknown	1,337	494	503	198	2,532
Region	Northeast	231	216	169	304	920
	East North Central	448	688	168	577	1,881
	West North Central	324	1,373	113	646	2,456
	South Atlantic	7,567	1,146	742	607	10,062
	East South Central	8,518	753	172	591	10,034
	West South Central	8,992	6,384	470	2,369	18,215
	Mountain	453	2,208	288	448	3,397
	Pacific	333	1,798	6,454	1,632	10,217
Tractors	ROPS	16,229	10,708	6,810	5,046	38,792
	Non-ROPS	19,092	9,800	5,642	5,400	39,934
	Total	35,321	20,507	12,452	10,445	78,725
	Average	1.33	1.41	1.45	1.46	1.38

farm operators reported the highest number of total farm tractors (35,321), although the highest average number of tractors were reported by multi-race operators (1.46 tractors per farm) and Asian operators (1.45 tractors per farm).

With respect to other demographic factors, Black farm operators tended to be older on average than other racial groups (58.5 years of age), were concentrated geographically throughout the southern US, were operating primarily livestock operations (66.2%), and had the lowest percentage of full-time farming operations among the four racial groups (15.0%) (Table 1). Native Americans were geographically the most evenly distributed

racial group, although the majority of Native American farm operators were located west of the Mississippi. Like Blacks, Native American farms were primarily part-time operations (72.9%), and were primarily livestock operations (72.6%). Asian farm operators reported the lowest average age among the racial groups (51 years of age). Geographically, Asians were concentrated heavily in the Pacific region of the US (75.2%), were more likely to operate crop farms (76.6%), and had the highest percentage of farms operated on a full-time basis (41.2%). Multi-race operators were geographically located mostly in the West South Central and Pacific regions of the US, and like Black and Native American operators, were primarily part-time (72.3%), and livestock operators (64.6%). All racial groups operated primarily small acreage farms with each group reporting 58% or more of their operations being 1-100 acres in size.

For the general farm operator population, there were an estimated 2,113,470 farms in 2004 (Table 2). There were an estimated 3,961,000 tractors in use on farms, for an average of 1.87 tractors per farm. ROPS were estimated to be present on 51% of these tractors. The average age of farm operators was 54.4 years. Most of the farms were identified as livestock operations (56.4%), and reported to be part-time operations (71.2%). The majority of all farms in the US were reported to be between 1 and 100 acres (60%).

ROPS Prevalence Rates by Demographic Characteristics: Table 3 provides estimates of the number of tractors and the percentage with ROPS on racial minority farms by major demographic characteristics. About half of all tractors used on racial minority farms were equipped with ROPS in 2003. Black farm operators accounted for the highest number of tractors, but reported the lowest proportion of tractors with ROPS (45.9%). Asian and Native American operators both reported ROPS prevalence rates above 50%. The prevalence of ROPS equipped tractors decreased as the age group of the farm operator increased, with farmers over the age of 64 years having the lowest ROPS prevalence rate (40.6%). All other age groups reported a ROPS prevalence of 50% or greater.

Sixty-four percent of the tractors in use on minority farming operations were reported on part-time farms (Table 3). The proportion of these tractors on part-time farms that were equipped with ROPS was 44.2%. Full-time operations reported significantly higher percentages of their farm tractors being equipped with ROPS (58.4%). Farms reported to be greater than 100 acres in size had ROPS prevalence rates above 50.0%, while farms 1 to 100 acres in size reported a ROPS prevalence of 43.1%. These farms below 101 acres account for 57% of the tractors on minority operations. Finally, minority operated crop farms reported higher ROPS prevalence rates than minority operated livestock operations (52% and 48% respectively).

For all farming operations, the same general patterns described for racial minority operators were found (Table 3): ROPS were reported on 51% of all tractors; ROPS prevalence decreased as the reported age group of the primary farm operator increased; full-time operations reported significantly higher prevalence of ROPS equipped tractors than part-time operations; ROPS prevalence rates were highest on farms with 1000 or

Table 2. Demographic characteristics and farm tractor estimates for all farming operations in the US, 2004.

Variable	Category	Total
Farms	In-business	2,113,470
Operator Age	Average	54.1
Full- or Part-Time	Full-Time	559,181
	Part-Time	1,504,138
	Unknown	50,151
Acreage	1-100	1,267,276
	101-300	412,123
	301-500	127,400
	501-700	61,707
	700-999	46,084
	>999	137,672
	Unknown	61,208
Farm Group	Crop	850,825
	Livestock	1,191,290
	Unknown	71,355
Region	Northeast	132,250
	East North Central	335,422
	West North Central	454,078
	South Atlantic	252,581
	East South Central	257,863
	West South Central	384,056
	Mountain	134,663
	Pacific	162,558
Tractors	ROPS	2,020,207
	Non-ROPS	1,940,617
	Total	3,960,824
	Average	1.87

Table 3. Estimated number of tractors and ROPS prevalence rates on racial minority operated farms (2003) and all farms (2004) in the US by major demographic characteristics.

		Racial Minorities, 2003			All Farms, 2004		
Variable	Category	Tractors	% ROPS	% ROPS 95% C.I.	Tractors	% ROPS	% ROPS 95% C.I.
Race	Black	35,321	45.9%	± 1.1%	---	---	
	Native American	20,507	52.2%	± 1.5%	---	---	
	Asian	12,452	54.7%	± 2.2%	---	---	
	Multiple Race	10,445	48.3%	± 2.2%	---	---	
Age of Operator	<34	2,974	57.4%	± 3.8%	162,641	59.9%	± 4.1%
	35-44	10,039	56.9%	± 2.2%	586,682	57.5%	± 2.2%
	45-54	22,060	51.3%	± 1.5%	1,066,962	52.0%	± 1.6%
	55-64	20,366	50.9%	± 1.5%	1,026,294	50.4%	± 1.6%
	65+	21,501	40.6%	± 1.4%	999,719	44.6%	± 1.6%
	Unknown	1,785	54.2%	---	118,526	57.2%	---
Full- or Part-Time	Full-time	27,875	58.4%	± 1.6%	1,757,475	61.8%	± 1.3%
	Part-time	50,619	44.2%	± 0.9%	2,189,519	42.4%	± 1.0%
	Unknown	231	54.2%	---	13,830	29.8%	---
Acreage	1-100	45,217	43.1%	± 0.9%	1,624,020	39.4%	± 1.1%
	101-300	18,117	54.4%	± 1.8%	932,262	47.7%	± 1.7%
	301-500	5,443	59.1%	± 3.7%	397,024	57.8%	± 2.8%
	501-700	2,290	59.7%	± 6.0%	213,349	63.2%	± 4.0%
	700-999	1,540	63.5%	± 7.5%	163,616	62.8%	± 4.8%
	>999	5,369	66.6%	± 4.0%	590,559	75.3%	± 2.3%
	Unknown	749	41.7%	---	39,993	58.1%	---
Type of Farm	Crops	32,913	52.1%	± 1.3%	1,827,285	53.2%	± 1.2%
	Livestock	44,771	47.5%	± 1.0%	2,094,147	49.3%	± 1.1%
	Unknown	1,041	34.4%	---	39,393	35.5%	---
	Total	78,725	49.3%	± 0.8%	3,960,824	51.0%	± 0.8%

more acres; and crop operations reported a higher percentage of ROPS equipped tractors than did livestock operations.

***Logistic Regression Results*:** Table 4 presents the unadjusted odds ratios for the proportion of tractors without ROPS on racial minority operations in 2003 and all farming operations in 2004 for the individual variables of race, operator age, acreage, full- or part-time operation, region, and type of farm. For the racial minority operations, Asian and Native American had lower unadjusted odds ratios than Black operators and farm operators of multiple races. The unadjusted odds ratios by age of the farm operator were similar for both racial minority operations and all farm operations with the oldest age group (65 years of age and older) having the highest risk, followed by farm operators

Table 4. Unadjusted odds ratios for the prevalence of tractors without ROPS for the independent variables race, age of the operator, full- or part-time operation, acreage, region, and type of farm for US minority farm operations and the general US farm.

		Racial Minorities, 2003			All Farms, 2004		
Variable	Category	Unadjusted Odds Ratio	Lower 95% Limit	Upper 95% Limit	Unadjusted Odds Ratio	Lower 95% Limit	Upper 95% Limit
Race	Black	1.11	0.99	1.25	---		
	Native American	**0.87**	**0.77**	**0.98**	---		
	Asian	**0.76**	**0.66**	**0.87**	---		
	Multiple Race	1.00	---	---	---		
Age of Operator	<34	1.00	---	---	1.00	---	---
	35-44	1.06	0.84	1.33	1.12	0.94	1.34
	45-54	**1.32**	**1.07**	**1.64**	**1.39**	**1.18**	**1.64**
	55-64	**1.35**	**1.09**	**1.67**	**1.48**	**1.25**	**1.75**
	65+	**2.04**	**1.65**	**2.53**	**1.84**	**1.55**	**2.18**
Full- or Part-Time	Full-time	1.00	---	---	1.00	---	---
	Part-time	**1.73**	**1.61**	**1.87**	**2.16**	**2.30**	**2.04**
Acreage	1-100	**2.52**	**2.20**	**2.88**	**4.68**	**4.28**	**5.12**
	101-300	**1.63**	**1.41**	**1.88**	**3.33**	**3.04**	**3.6**
	301-500	**1.34**	**1.13**	**1.61**	**2.34**	**2.01**	**2.49**
	501-700	**1.28**	**1.01**	**1.62**	**1.83**	**1.60**	**2.08**
	700-999	1.11	0.85	1.43	**1.81**	**1.56**	**2.09**
	>999	1.00	---	---	1.00	---	---
Region	Northeast	**2.08**	**1.52**	**2.84**	**1.78**	**1.59**	**2.00**
	East North Central	**1.61**	**1.33**	**1.96**	**1.79**	**1.58**	**2.02**
	West North Central	1.02	0.88	1.18	**1.27**	**1.13**	**1.43**
	South Atlantic	**1.27**	**1.13**	**1.43**	**1.20**	**1.04**	**1.39**
	East South Central	**1.31**	**1.17**	**1.48**	**1.19**	**1.02**	**1.39**
	West South Central	1.00	---	---	1.00	---	---
	Mountain	1.11	0.94	1.31	**1.16**	**1.02**	**1.32**
	Pacific	0.96	0.86	1.07	**1.22**	**1.07**	**1.38**

Bolded Odds Ratios have a 95% confidence interval that does not include 1.

Table 4 (continued). Unadjusted odds ratios for the prevalence of tractors without ROPS for the independent variables race, age of the operator, full- or part-time operation, acreage, region, and type of farm for US minority farm operations and the general US farm.

		Racial Minorities, 2003			All Farms, 2004		
Variable	Category	Unadjusted Odds Ratio	Lower 95% Limit	Upper 95% Limit	Unadjusted Odds Ratio	Lower 95% Limit	Upper 95% Limit
Type of Farm	Grain	**0.74**	**0.62**	**0.90**	**0.78**	**0.64**	**0.95**
	Tobacco	**2.05**	**1.58**	**2.66**	**1.42**	**1.07**	**1.89**
	Cotton	**0.70**	**0.50**	**0.98**	**0.20**	**0.16**	**0.33**
	Vegetables, melons	1.00	***	***	1.00	***	***
	Fruit, nuts	1.14	0.94	1.38	**1.31**	**1.04**	**1.67**
	Nursery	0.77	0.58	1.02	0.93	0.68	1.27
	Other crop	0.90	0.73	1.10	**1.24**	**1.01**	**1.55**
	Beef	**1.19**	**1.02**	**1.39**	1.06	0.87	1.30
	Dairy	**0.71**	**0.51**	**0.99**	0.92	0.74	1.13
	Hogs	**1.75**	**1.18**	**2.60**	0.98	0.72	1.34
	Sheep, goats	0.80	0.54	1.19	**1.53**	**1.10**	**2.11**
	Equine	0.95	0.73	1.23	1.27	0.99	1.62
	Poultry, egg	1.24	0.90	1.71	0.83	0.61	1.13
	Other livestock	1.35	0.90	2.03	1.02	0.73	1.44

Bolded Odds Ratios have a 95% confidence interval that does not include 1.

55 to 64 years of age, then farm operators 45-54 years of age. Both farm operation groups had significant unadjusted odds ratios for part-time farm operations compared to full-time operations.

For the independent variable acreage, both groups had significant unadjusted odds ratios for farms 1 to 100 acres in size, 101-300 acres in size, 301-500 acres in size, and 500-700 acres in size when compared to farms over 999 acres in size. These odds ratios for smaller acreage farms were consistently 1.4 to 1.9 times greater for all farming operations than seen for racial minority farm operations. In addition, the all farm operation group had a significantly higher unadjusted odds ratio for farms 701-999 acres in size compared to all farm operations greater than 999 acres in size. By region of the country, both the racial minority operations and the all farm operations group had significant unadjusted odds ratios for the Northeast, East North Central, South Atlantic, and East South Central regions compared to the Southwest region. The all farm operation group also had significant unadjusted odds ratios for the West North Central, Mountain, and Pacific regions as well when compared to the West South Central region.

For type of farming operation, both the racial minority operations and the all farm operations groups had elevated unadjusted odds ratios for tobacco farms, and lower unadjusted odds ratios for grain and cotton operations when compared to vegetable and melon operations. The minority farm operations also had significantly higher unadjusted

odds ratios for beef and hog operations, and a lower unadjusted odds ratio for dairy operations compared to vegetable and melon operations. Finally, fruit and nut operations, other crop operations, and sheep and goat operations all had elevated unadjusted odds ratios for the all farm operations group when compared to vegetable and melon operations.

Table 5 presents the multivariate logistic regression results for the proportion of tractors without ROPS on racial minority operations. All main effects variables were included in the model along with all two-way interactions of the main effects. The outcome of the model found that the main effects variables of race and full- or part-time operation were not significant, while all other main effects variables were significant. Table 6 provides the logistic regression results for the 2004 survey data of all farm operators. All main effects were significant

Table 5. Multivariate logistic regression results for the proportion of tractors on racial minority farms in the US without ROPS, and the independent variables of race, operator age, full- or part-time operation, acreage, farm type, and region, 2003.

Effect	df	Wald χ^2	pr> χ2
Race	3	5.3529	0.1477
Operator age	**4**	**50.8017**	**<0.0001**
Full or part	1	2.5371	0.1112
Acreage	**5**	**169.5095**	**<0.0001**
Farm type	**13**	**598.2144**	**<0.0001**
Region	**7**	**210.5078**	**<0.0001**
Race*Operator age	12	13.4980	0.3339
Race*Full or part	**3**	**8.8901**	**0.0308**
Race*Acreage	**15**	**43.1455**	**0.0001**
Race*Farm type	**38**	**164.7334**	**<.0001**
Race*Region	21	24.2763	0.2799
Operator age*full or part	4	4.0311	0.4018
Operator age*acreage	**20**	**41.0744**	**0.0036**
Operator age*Farm type	**52**	**180.8288**	**<.0001**
Operator age*Region	**28**	**49.2129**	**0.0079**
Full or part*Acreage	**5**	**12.9327**	**0.0240**
Full or part*Farm type	13	8.3566	0.8196
Full or part*Region	**7**	**24.2763**	**0.0027**
Acreage*Farm type	**60**	**2011.2744**	**<.0001**
Acreage*Region	**35**	**365.7175**	**0.0387**
Farm type*Region	**83**	**1539.5985**	**<.0001**

Rows in bold are statistically significant at $\alpha = 0.05$.

Table 6. Multivariate logistic regression results for the proportion of tractors on all farms in the US without ROPS, and the independent variables of operator age, full- or part-time operation, acreage, farm type, and region, 2004.

Effect	df	Wald χ^2	pr> χ2
Operator age	**4**	**13.6896**	**0.0084**
Full or part	**1**	**5.5408**	**0.0186**
Acreage	**5**	**53.6939**	**<0.0001**
Farm type	**13**	**33.6711**	**0.0013**
Region	7	0.6759	0.9985
Operator age*full or part	4	3.0377	0.5515
Operator age*Acreage	**20**	**53.5812**	**<.0001**
Operator age*Farm type	**52**	**73.7980**	**.0251**
Operator age*Region	**28**	**80.5024**	**<.0001**
Full or part*Acreage	5	4.0007	0.5493
Full or part*Farm type	**13**	**40.9642**	**<.0001**
Full or part*Region	**7**	**20.1741**	**0.0052**
Acreage*Farm type	**64**	**148.3900**	**<.0001**
Acreage*Region	**35**	**120.2501**	**<.0001**
Farm type*Region	**83**	**177.2407**	**<.0001**

Rows in bold are statistically significant at $\alpha = 0.05$.

Main effects models, which retained significant main effect variables from Tables 5 and 6, but dropped all interaction terms, were constructed for the 2003 racial minority farm operation data and the 2004 all farm operations data. The adjusted odds ratios from these models are provided in Table 7 for both groups.

The adjusted odds ratios by farm operator age group and acreage did not change much from the unadjusted estimates. For the variable region, the adjusted odds ratios did change after adjusting for the other independent variables in the logistic models. The adjusted regional odds ratios were found to be more consistent between the two groups than the unadjusted odds ratios. The Northeast, East North Central, West North Central, and Mountain regions were all found to have elevated adjusted odds ratios when compared to the West South Central region. For the all farm operation group, the Pacific region was also found to have an elevated adjusted odds ratio compared to the West South Central region.

For type of farm, there were 4 farm types operated by racial minorities that had adjusted odds ratios statistically higher than the reference group of vegetable and melon farms: tobacco farms, fruit and nut operations, beef operations, and hog operations. For the general farm operator model, only one type of farm had an adjusted odds ratio statistically different from the reference group of vegetable and melon farms: tobacco farms. Cotton operations had an adjusted odds ratio lower than vegetable and melon farms in the all farm operation group. The confidence intervals of the racial minority operations and the all farm operations adjusted odds ratios overlapped for each of the 13

Table 7. Adjusted Odds Ratios for the significant logistic regression main effects for US minority farm operators and the general US farm population for the dependent outcome of non-ROPS tractors per farm: 2003 M-OISPA and 2004 OISPA surveys.

		Racial Minority, 2003			All Farms, 2004		
Variable	Category	Adjusted Odds Ratio	Lower 95% Limit	Upper 95% Limit	Adjusted Odds Ratio	Lower 95% Limit	Upper 95% Limit
Age of Operator	<34	1.00	***	***	1.00	***	***
	35-44	1.02	0.81	1.30	1.12	0.93	1.35
	45-54	**1.32**	**1.06**	**1.66**	**1.34**	**1.13**	**1.60**
	55-64	**1.34**	**1.07**	**1.68**	**1.35**	**1.13**	**1.61**
	65+	**1.95**	**1.56**	**2.45**	**1.74**	**1.45**	**2.08**
Full- or Part-Time	Part-time	---	---	---	**1.35**	**1.24**	**1.45**
	Full-time	---	---	---	1.00	***	***
Acreage	1-100	**2.65**	**2.27**	**3.09**	**4.27**	**3.80**	**4.80**
	101-300	**1.68**	**1.43**	**1.97**	**2.89**	**2.60**	**3.20**
	301-500	**1.43**	**1.19**	**1.73**	**2.02**	**1.80**	**2.26**
	501-700	**1.34**	**1.06**	**1.72**	**1.78**	**1.57**	**2.06**
	701-999	1.17	0.90	1.53	**1.69**	**1.45**	**1.96**
	>999	1.00	***	***	1.00	***	***
Region	Northeast	**2.82**	**2.07**	**3.85**	**1.74**	**1.53**	**1.99**
	East North Central	**2.10**	**1.70**	**2.58**	**2.30**	**2.00**	**2.65**
	West North Central	**1.48**	**1.26**	**1.72**	**2.05**	**1.79**	**2.34**
	South Atlantic	1.13	1.00	1.28	1.06	.90	1.24
	East South Central	1.12	.99	1.27	1.00	.846	1.18
	West South Central	1.00	***	***	1.00	***	***
	Mountain	**1.60**	**1.34**	**1.91**	**1.65**	**1.42**	**1.90**
	Pacific	1.06	0.90	1.24	**1.28**	**1.11**	**1.49**
Type of Farm	Grain	0.85	.69	1.04	0.87	0.71	1.07
	Tobacco	**1.99**	**1.51**	**2.61**	**1.84**	**1.37**	**2.49**
	Cotton	.89	.63	1.27	**0.54**	**0.32**	**0.90**
	Vegetables, melons	1.00	***	***	1.00	***	***
	Fruit, nuts	**1.32**	**1.08**	**1.61**	1.22	0.95	1.56
	Nursery	0.78	0.58	1.05	0.79	0.57	1.10
	Other crop	0.97	.79	1.19	1.02	0.82	1.27
	Beef	**1.35**	**1.13**	**1.60**	1.09	0.89	1.34
	Dairy	0.71	0.50	1.01	1.06	0.85	1.31
	Hogs	**1.81**	**1.22**	**2.68**	0.98	0.72	1.35
	Sheep, goats	0.73	.50	1.07	1.15	0.83	1.60
	Equine	0.84	0.69	1.04	0.91	0.71	1.17
	Poultry, egg	1.32	0.95	1.83	0.97	0.71	1.32
	Other livestock	1.40	0.93	2.10	0.86	0.61	1.22

Bolded Odds Ratios have a 95% confidence interval that does not include 1.

farm types. However, hog operations, poultry and egg operations, and other livestock operations did have much higher adjusted odds ratio point estimates compared to the all farm operation results.

Discussion

***Prevalence of ROPS-Equipped Tractors on Racial Minority Farm Operation*:** From a public health perspective, the basic results of this study show that the prevalence of ROPS on racial minority farms was similar in many respects to the general farm operator population, with the possible exception of Black farm operators who had the lowest ROPS prevalence rate of all groups examined (Table 3). While this is promising on the face of it, these results need to be placed in proper perspective. Currently, the ROPS prevalence rate for the general farm operator population is inadequate (Loringer and Myers, 2008).

Studies from Europe suggest that ROPS prevalence rates between 75% and 80% are required before decreases in tractor overturn fatality rates begin to approach zero (Springfeldt,1996; Springfeldt et al., 1998; Thelin, 1998). Data from Sweden further suggest that the decreases in overturn fatalities are not linear with respect to increasing ROPS prevalence rates (Springfeldt et al., 1998; Thelin, 1998). The Swedish data found that fatality rates remained stable for ROPS prevalence rates between 40% and 75%, mirroring the current experience within the US (NIOSH, 2006).

Based on the Swedish data, Myers and Snyder (1995) estimated that the general farm operator population would not be using a sufficient number of ROPS-equipped tractors to have a measurable impact on the tractor fatality rate until sometime in the range of 2017 to 2020. Loringer and Myers (2008) concluded an adequate level of protection could even be slightly longer (sometime between 2024 and 2028). The ROPS prevalence rates found in this study show that racial minority farm operators are at a similar stage of ROPS coverage as other farm operators. If minority operators have a similar ROPS adoption rate as the general farm operator population, then they also are 10 to 20 years away from reaching an adequate protective ROPS prevalence rate on their farm tractors.

***Factors Related to the Prevalence of ROPS-equipped Tractors on Racial Minority Farm Operations*:** The farm demographic characteristics identified by Loringer and Myers (2008) that were related to the prevalence of ROPS-equipped tractors for the general farm operator population are also strong indicators of the prevalence of ROPS equipped tractors on racial minority operated farms (Table 3 and Table 4). The region where the farm is located and the acreage of the farm appear to be the strongest indicators, although the age of the farm operator and the type of farm operation are also useful for assessing ROPS prevalence on minority farms. Race itself was not a significant factor in assessing ROPS prevalence rates after accounting for these other factors.

There is very little information available in the literature on the use of ROPS by minority operators. In a series of focus group interviews with Black farmers from Kentucky,

Mississippi, North Carolina, and Tennessee, Arcury (1997) reported many of these farmers understood the value of safety equipment like ROPS, but that they did not retrofit their older tractors with them. He also found that these Black farmers primarily used older tractors and farm machinery that were not equipped with modern safety devices. Richardson et al. (1997) in a study of agricultural fatalities in North Carolina found the highest fatality rates among Black farmers. They suggested that the small-scale nature of Black operated farms did not provide sufficient sales to allow them, or other farmers with limited resources, the means to invest in newer, safer farm equipment. Sanderson et al. (2006) drew this same conclusion regarding farmers with limited resources in general, concluding that the low prevalence of ROPS on these farms may have more to do with economics and the size of the farming operation than information received in safety and health training encouraging the use of ROPS.

Several state studies of the general farming population have reported increasing ROPS prevalence rates with increasing acres farmed (Browning et al., 1999; May et al., 2006; Sanderson et al., 2006; Wilkins et al., 2003). Wilkins et al. (2003), in a study that looked at ROPS prevalence rates for full- and part-time farms, found the same general pattern of a higher ROPS prevalence rate for full-time operators, although the difference was less than identified here for minority operators.

The age of the farm operator has also been reported to be a strong indicator of the prevalence of ROPS equipped tractors on farms in several state studies of the general farming population (May et al., 2006; Sanderson et al., 2006; Whitman and Field, 1995; Wilkins et al., 2003). A study of senior (over 60) farmers determined that many older farmers saw no need or cost benefit to retrofitting their older tractors with ROPS even though they knew the life-saving value of a ROPS (Whitman and Field, 1995). They concluded that senior farmers perceived operating tractors without ROPS as a moderate risk that was more than offset by their years of experience as tractor operators. These findings by Whitman and Field (1995) for the general farm operator population agree well with findings reported by Arcury (1997) for Black farm operators, who were mostly 50 years of age or older: the operators knew the risks of farming, but made decisions to not remove or reduce these risks on their farms, or in their work practices.

Prevalence of ROPS-equipped Tractors on Racial Minority Farm Operations Compared to All Farm Operations: The results for racial minority farm operators and those for the general farming population show that the two groups have similar risk profiles with respect to the prevalence of ROPS-equipped tractors on farms (Tables 3-7). The comparison of ROPS prevalence rates (Table 3) and adjusted odds ratios for farm demographic risk factors for non-ROPS equipped tractors on farms (Table 7) lead to the same general conclusions for these two groups with respect to where ROPS prevalence rates are high and low.

These results indicate that one set of demographic characteristics should be effective in targeting areas of the US with low ROPS prevalence rates for both racial minority and other farm operators. All of the identified demographic factors in this study are readily available from the 2002 Census of Agriculture, and will soon be available from the 2007

Census of Agriculture. These census data could be used to screen areas of the US, down to the county level, where there is a high probability of low percentages of ROPS-equipped tractors.

***Actions to Increase the Prevalence of ROPS-Equipped Tractors*:** Currently, there is no nationally organized program in place to increase the number of ROPS-equipped tractors on US farms. Proposals have been presented to increase the percentage of ROPS-equipped tractors through the use of a mixture of approaches (Donham et al., 1998; Karlson and Noren, 1979; Kelsey and Jenkins, 1991; NCASH, 1989; Swenson, 2004). These include using education programs to inform farm operators of the value of ROPS, providing farm operators with an incentive to place ROPS on older farm tractors used on their farms (Donham et al., 1998; NCASH, 1989; Reynolds and Groves, 2000; Hallman, 2005), providing voluntary standards or other programs to encourage farm equipment dealers to retrofit tractors with ROPS before resale to farm operators (Freeman, 1999), purchasing and scrapping older farm tractors without ROPS (Myers and Snyder, 1995; Swenson, 2004), reducing the cost of ROPS retrofit kits (Harris et al., 2002; Harris et al., 2005; Owusu-Edusei and Biddle, 2007), and enacting some form of state or national regulation to require tractors used on farms to be equipped with ROPS after some designated time period (Donham et al., 1998; Karlson and Noren, 1979; Kelsey and Jenkins, 1991; NCASH, 1989; Swenson, 2004). Programs requiring the use of ROPS have been shown to be effective in reducing overturn fatalities in Europe (Springfeldt, 1996; Springfeldt et al., 1998; Thelin, 1998).

To date, these proposals have failed to garner much long lasting support from the agricultural community. Reasons suggested for this include: an aversion among farmers to accept any new form of regulation; and the small farmer's internal assessment that not having a ROPS on a tractor is cost effective given their time and monetary constraints (Sorensen et al., 2008). There have been no studies to assess how minority farm operators view such programs.

The most promising approach attempted to date has been through the use of some form of economic incentive program. A limited incentive program is currently being conducted in the state of New York (Sorensen, 2006) and is showing promise in encouraging farm operators to retrofit older farm tractors. What is not clear is whether minority farm operators would respond in the same fashion to such an incentive program, or how to best approach minority farm operators with such a program. The one major hurdle to expanding incentive programs on a large scale is the cost. Assuming an incentive of $600 per retrofitted tractor, as in New York, a national program would require $1,200,000,000 to retrofit the approximately 2,000,000 tractors without a ROPS.

***Limitations*:** Some of the limitations of this study include the inability to assess the overall impact of the non-respondents to the two surveys. Farm demographic estimates derived from this study agree well with farm data published by NASS, suggesting that the post-stratification of the 2004 survey weights by the value of sales for the farm and post-stratifying the 2003 survey weights by racial census counts within specific regions of the US was successful in reducing the non-response impact. In addition, the results obtained

in this study on the number of farm tractors per farm, the number of tractors with ROPS, and the key farm demographic factors associated with a low prevalence of ROPS on farms, agree well with the past literature. A second limitation is that all the data on farm tractors were self-reported by the farm operator. It was not possible to verify the accuracy of the information being provided by the farm operator.

Conclusions

The prevalence of ROPS-equipped tractors on racial minority farms was found to be similar to those for all farm operations. While there were differences between race-specific ROPS prevalence rates, these differences were explained by differences in farm demographic characteristics between the racial groups. The farm demographic characteristics that best defined the prevalence of ROPS-equipped tractors on minority farms were similar to those identified for all farm operations: age of the operator, acreage farmed, region of the US, and the type of farming operation. Given the ROPS adoption rates found by this study, minority farm operations appear to be one to two decades away from having a ROPS prevalence rate sufficient to decrease tractor overturn fatality rates comparable to the level seen in Europe.

The solution to increasing the number of ROPS-equipped tractors in the US will involve developing a program using a mixture of approaches, including economic incentives and marketing. It is important that such programs include minority farm operators. To do this effectively, research is needed to determine the best methods to approach minority farm operators with ROPS promotion programs.

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