Rollover Protection on New York Tractors and Farmers' Readiness for Change

J. J. May, J. A. Sorensen, P. A. Burdick,
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ABSTRACT. *Tractor overturns contribute significantly to fatalities in New York State agriculture. On–site inspections a decade ago indicated that approximately 60% of tractors were without effective rollover protection. Our objectives were: to describe the current prevalence and distribution of rollover protective structures (ROPS) on New York farm tractors, to identify characteristics associated with the absence of ROPS, to explore segmenting the New York farm community on readiness for ROPS retrofitting, and to identify demographic characteristics that might assist in this segmenting. A random selection of 644 livestock, dairy, fruit, cash crop, vegetable, and organic farms were contacted for a telephone survey. Of 562 farms (87%) participating, 102 (18.1%) had all tractors equipped with ROPS and 138 (24.6%) had none. A disproportionate number of livestock, cash crop, and organic operations had no ROPS. Rates of ROPS–equipped tractors correlated directly with farm size and annual hours of tractor operation. Older farmers had a lower proportion of ROPS tractors. The presence of a child operator did not affect the proportion of ROPS tractors. After weighting the sample, the total number of non–ROPS tractors in New York is estimated at more than 80,000. In addition to providing key farm demographics, the survey enabled placement of farmers on a "stage of change" continuum related to readiness for retrofitting. Three–quarters of New York farmers are in the "precontemplation" stage of change relative to ROPS retrofitting, and this varies little by size of operation, age of farmer, or the presence of child tractor operators. Stage of change may relate to hours of tractor operation ($p = 0.05$) and does relate to commodity ($p = 0.003$) due primarily to the higher proportion of crop farmers in the earliest stage of change. The goal of retrofitting all New York farm tractors with ROPS appears nearly as daunting as it did a decade ago.*

Keywords. *Agricultural fatalities, Rollover protective structure, ROPS retrofitting, Social marketing, Stages of change, Tractor overturn.*

Among the various occupations in the U.S., agriculture has the dubious distinction of being consistently one of the three most dangerous. In recent years, agriculture's fatality rates have been slightly lower than those of mining; however, agriculture employs roughly seven times as many workers, and thus remains a major public health problem (NSC, 2004).

There are ample data documenting the role of the farm tractor as the leading cause of occupational fatality and serious injury in agriculture. Data reported from the University of Iowa indicate that of all occupational fatalities in agriculture, 32% are related to the

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farm tractor (Donham et al., 1997). In addition, this study found that non−fatal tractor incidents account for 264,651 lost workdays and 10,939 lost−time injuries in the U.S. Other investigators ascribe a higher proportion of all agricultural fatalities to tractors. The majority of these fatalities relate to tractor overturns with attendant severe crush injuries to the operator (Etherton et al., 1991, Murphy and Ambe, 1996).

One particularly tragic aspect of these deaths is that many could have been readily prevented by the use of proven existing technologies. Installation of cabs with rollover protective engineering on virtually all tractors in Sweden has resulted in a marked decline in the fatality rate (Springfeldt et al., 1998). Similar success has been noted in Norway and other European countries (Reynolds and Groves, 2000). In recognition of the efficacy of ROPS technology, ASAE voluntary ROPS standard S318.10 (*ASAE Standards*, 1985) was adopted by tractor manufacturers in 1985 (Myers, 2000). Since that time, in addition to manufacturing nearly all new tractors with ROPS, major manufacturers devoted a number of years in the 1990s to active promotion of retrofitting of older non−ROPS tractors with these structures (New Holland, 1997). Despite these efforts, at least half of America's tractors remain without ROPS. Based on National Safety Council (NSC) data from the late 1990s, it is likely that nearly 2,000 fatalities have resulted from the continued absence of ROPS and seat belts on these tractors over the past decade (NSC, 1997).

The ten directors of the designated National Institute of Occupational Safety and Health (NIOSH) agricultural centers estimate that of the approximately 4.8 million tractors in the U.S., at least half are without ROPS and seat belt protection (NIOSH, 2004). In the Northeast, there are more troubling data. In New York State, a New York Center for Agricultural Medicine and Health (NYCAMH) study done in the early 1990s found an average of slightly less than four tractors per dairy farm (Hill et al., 1992). Extrapolating these 1990s figures to all New York State farms, a conservative estimate of 115,000 tractors on New York farms seemed reasonable, and this is in line with that projected by the 2002 Census of Agriculture (USDA, 2002). Data from three different surveys on New York State farms in the 1990s showed that only slightly more than one−third of New York farm tractors, primarily the newer ones, had ROPS (Hill et al., 1992; Hallman et al., 1997; West and May, 1998). This is despite decades of educational efforts by safety and health experts at both Cornell University and NYCAMH.

Traditionally, those concerned with agricultural safety, whether coming from an engineering or public health background, have relied heavily on education−based strategies to increase the use of ROPS and seat belts. A review of the National Agricultural Safety Database (NASD) reveals nearly 400 educational products addressing appropriate use of ROPS on farm tractors (NIOSH, 2005). Literally generations of safety specialists have urged American farmers to retrofit tractors with ROPS. Although some success with anecdote−based approaches has recently been described (Cole et al., 1999), there are limited published data demonstrating that education is an effective and efficient approach to this problem. Educational approaches, by definition, assume a deficiency in knowledge of safe behaviors and a clear link between understanding and behavior. However, as noted by Murphy (2003), there are "considerable incongruence and large disconnects between farm people's safety knowledge, values, and practices."

The directors of the ten NIOSH−sponsored agricultural centers have devoted considerable effort to designing a national initiative aimed at addressing tractor fatalities. The document describing this initiative repeatedly notes the importance of "social marketing" approaches as a key component of the initiative (NIOSH, 2004). Social marketing involves "the application of commercial marketing technologies to the analysis, planning, execution, and evaluation of programs designed to influence the

voluntary behavior of target audiences in order to improve their personal welfare and that of their society" (Andreasen, 1995). Rather than focus on educating an audience to change its behavior, the social marketer acknowledges that in many cases the audience is already adequately educated but remains insufficiently persuaded to change behaviors in the face of the perceived costs of doing so. What is needed often is less education and more focus on understanding which segments of the target audience need some other type of intervention to motivate them toward behavior change. This approach has been used with success on such widely divergent issues as use of condoms (Stover and Wagman, 1992), use of oral rehydration solutions in developing nations (Hornick, 1991), and promotion of automobile seat belt use (Cohn, et al., 2002).

A central tenet of social marketing is that target populations can be (in fact, must be) segmented into discrete audiences before interventions are designed. Each of these "audiences" functions under a somewhat different set of motivations and perceptions of costs and benefits. Thus, messages and inducements for one audience may need to be substantially different from those for others. One important way in which these audiences may differ is their "stage of change" (fig. 1; Prochaska et al., 1992). In the "stages of change" model of behavior, there is recognition that significant decisions are seldom undertaken as a single step. Instead, decisions are approached in a stepwise fashion, with specific activities relating to the behavior change occurring at each of these stages. The key initial tasks for the social marketer are to identify the most appropriate portions of the target population and diagnose for each segment its position on the change continuum and the specific needs of each group relative to its stage of change.

Applied to agriculture, this approach differs from the educational approaches noted above, which for the most part tend to view the target population simply as adult vs. child tractor operators. Similar educational messages have traditionally been tailored for either the adult or for the child tractor operator. To undertake a social marketing approach aimed

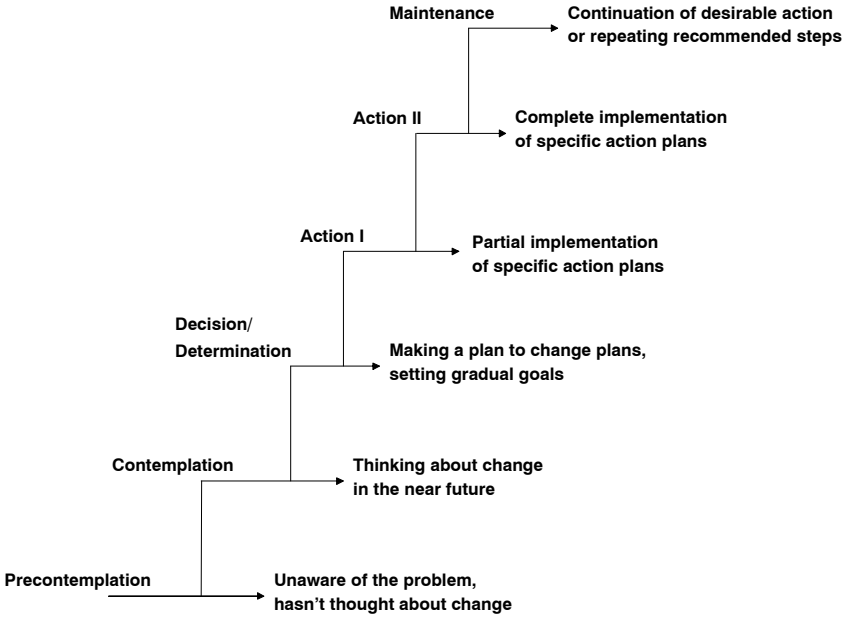

Figure 1. Stages of change (Prochaska et al., 1992).

at enhancing ROPS retrofitting, it must be possible to identify more specific segments of ROPS decision–makers within the agricultural community and to recognize their relative position on the stages of change continuum. This study seeks to learn more about the extent of the unprotected tractor problem on New York farms and to learn about their owners' readiness for change. This study addresses the following questions: (1) What are the prevalence and distribution of New York tractors without rollover protection? (2) What farm/farmer characteristics are associated with having non–ROPS tractors in New York? (3) Is it feasible to segment a population of farmers based on their stage of change relative to ROPS retrofitting? and (4) Can readily identifiable demographic characteristics be used for this segmentation?

Methods

Telephone Survey

With the assistance of social marketing consultants and members of the farm community, a survey questionnaire was designed with three specific aims: to describe participating farms' tractors, to define the farm and farmer according to particular demographic characteristics, and to define a farm owner's stage of change relative to ROPS retrofitting of all farm tractors. The entire questionnaire was administered in a five– to seven–minute telephone call. The survey instrument was pilot–tested on 17 farmer volunteers from a variety of commodities and further revised.

Previous surveys of the New York farm community have divided it by major commodity groups: dairy, livestock, fruit, vegetable, and cash crop (Hwang et al., 2000). We used these commodity groups for this study. Samples were randomly drawn from lists of New York farms by commodity as provided by either specific commodity groups or by the New York State Department of Agriculture and Markets' Agricultural Statistical Service (NASS–NY). Once randomized, farms were contacted in sequential fashion until 80 or more qualifying farms were obtained for each of the commodities. Information was collected on the number of acres worked by cash crop, fruit, organic (see below), and vegetable farmers and the total number of animals for livestock and dairy farms in order to segment each commodity strata into large and small during the analysis phase. Respondents were farm owners and, when these were not available, the person answering the call was asked whether they were familiar enough with farm operations to answer survey questions. If so, they were asked to identify their affiliation with the farm (e.g., farm wife, farm supervisor, etc.).

Early in the course of the survey, it became apparent that organic farms (regardless of specific commodity) were likely to represent a distinct segment within the farm community. Thus, the survey was expanded to include 40 organic producers (of any commodity) randomly selected from the listing of New York organic farmers. The smaller sample size was selected based on the likelihood that all of these farms would be relatively small operations.

The Mary Imogene Bassett Hospital Institutional Review Board approved this study.

Inclusion Criteria

Any agricultural operation having membership in one of the statewide commodity groups of interest or listed with NASS–NY was included in the randomization. Farms found to be no longer in active production were excluded from any data collection. If a farm had ROPS on all tractors by virtue of purchase (i.e., the farmer had never retrofitted a tractor with ROPS), we gathered data on the farm. However, since the focus of desired behavior change in this study is retrofitting tractors currently lacking ROPS, these farms

did not qualify for the stage of change portion of the analysis. In these situations, we continued recruiting farms until we reached the target numbers described above for each commodity.

Stages of Change

The questionnaire responses allowed the investigators to place a subject in one of seven potential stages of change. Figure 2 demonstrates the basic structure of the questionnaire and the logic used in assigning each farmer to a specific stage of change.

The above strategy reflects modifications of the traditional stages of change that we believe are more suitable for the situation of ROPS retrofitting. Several of the stages have been subdivided to better describe the potential social marketing audiences in the New York farm community. The usual "maintenance" stage of change has limited significance for ROPS retrofit social marketing and has been dropped.

Data Management and Analysis

Telephone responses were entered onto hard copy and subsequently reviewed by both the telephone interviewer and one of the investigators (Sorensen). Data forms were double−entered into SAS (SAS Institute, Inc., Cary, N.C.). For analysis of size, farms were aggregated based on being either below or above the median size of the farms being sampled in a given commodity. Similarly, farmers were aggregated by age based on the median reported age.

Differences between continuous or interval−scale measures with respect to two classification levels, for example, mean age of farm owner with respect to size of respective farm (large or small), were analyzed using Student's t−test. Differences among continuous measures with respect to three or more classification levels, for example, mean annual hours of tractor usage with respect to "no ROPS, some ROPS, or all ROPS" on farm tractors, were determined using single−factor analysis of variance (ANOVA). Relationships between pairs of continuous or interval−scale measures, for example, age of farm owner and respective percentage of farm tractors with ROPS, were explored with

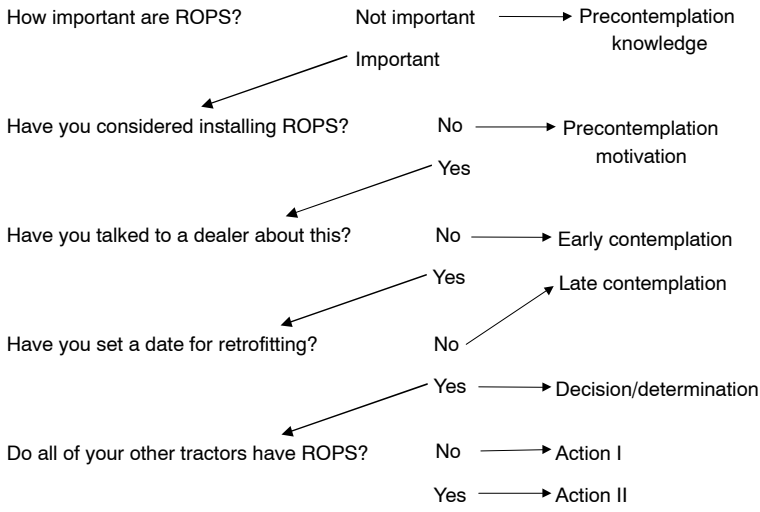

Figure 2. Stage of change assessment.

Pearson's correlation (r) and, when warranted, further developed using linear least squares regression analysis.

Differences in proportion with respect to nominal categorical measures, for example, proportion of tractors with or without ROPS with respect to farm commodity, were analyzed using the χ^2 test. Two−way contingency tables employing at least one ordinal categorical measure, for example, children using tractors (yes or no) and stage of change (1, 2, 3, 4, 5, 6, 7), were analyzed using the Cochran−Mantel−Haenszel χ^2 test.

When deemed appropriate, continuous measures were re−cast as categorical measures as per their median or quartile cutoff points, and then subjected to analytic methods as described above. Such an approach was used, for example, to determine "large or small" farm size from median acreage or number of livestock, or to determine a four−level classification from the quartile ages of farm owners. In addition, the stage of change scale was sometimes utilized as either a categorical or an interval−scale measure, such that results garnered in one analytic venue were corroborated with results from another. For example, while comparing scales of readiness to change between large and small farms, the Cochran−Mantel−Haenszel χ^2 test was used while treating stage of change as a categorical measure; Student's t−test was used while treating stage of change as an interval−scale measure.

Continuous and categorical analyses, as previously described, were typically carried out within each distinct farm commodity group (dairy, livestock, cash crops, vegetables, fruit, and organic).

Estimation of New York Tractor Numbers

To improve efficiency and still ensure adequate numbers for analysis of each commodity, this survey did not sample commodities in proportion to their actual distribution within New York agriculture. To estimate the actual numbers of tractors (with and without ROPS) in the state, current data on the number of farms in each commodity and the total number of farms in the state were obtained from the New York Agricultural Statistical Service (S. Ropel, New York State Department of Agriculture and Markets, personal communication, 25 April 2005). To calculate tractor totals, the number of farms in each commodity group was multiplied by the mean numbers of tractors and tractors without ROPS per farm for that group.

Results

A total of 644 randomly selected New York farmers were contacted by telephone. Of these, 562 (87%) agreed to participate in the study by answering the questionnaire. The characteristics of these are described in table 1.

Distribution of Tractors and ROPS

Participating farms had a total of 3,269 tractors. A suitable cab or ROPS structure (as indicated by an engraved ASAE designation) was present on 1,741 (53%) of these tractors. The majority of the study farms (57.3%) had some, but not all tractors equipped with ROPS (table 2).

A considerably higher proportion of the "no ROPS" operations (fig. 3) were livestock, organic, and cash crop farms. This difference among the commodity strata was significant by χ_2 test ($p < 0.0001$).

In examining the percent of tractors with ROPS for each commodity (fig. 4), a similar pattern emerges: high percentages for dairy and vegetables, and the lowest values among livestock and cash crops. For all commodities, ROPS are more common on farms above

Table 1. Characteristics of the tractor cohort.

No.	Age[a]	Acres[a]	No. of Live–stock[a]	Tractor Hours[a]	Percent with Children on Tractors	Tractors			
						Total	Non–ROPS Total	No. per Farm[a]	Non–ROPS per Farm[a]
All farmers									
562	54.3	378.6	227.1	2183	17.9	3269	1529	5.8	2.7
	±0.57	±48.9	±27.0	±177				±0.22	±0.13
Dairy farmers									
102	50.2	––	372.1	3117	18.2	622	227	6.1	2.2
	±1.27		±50.1	±332				±0.29	±0.18
Livestock farmers									
120	55.7	––	102.9	846	21.6	366	227	3.1	1.9
	±1.28		±95.7	±96				±0.19	±0.17
Cash crop farmers									
99	61.4	199.3	––	568	18.1	312	207	3.2	2.1
	±1.15	±31.0		±90				±0.21	±0.16
Fruit farmers									
86	54.9	225.9	––	2673	15.4	624	335	7.3	3.9
	±1.44	±49.7		±382				±0.57	±0.40
Vegetable farmers									
98	51.0	811.4	––	4905	17.5	1145	423	11.7	4.3
	±1.28	±141.1		±755				±0.71	±0.46
Organic farmers									
57	50.4	65.2	––	767	10.2	200	110	3.6	2.0
	±1.59	±19.3		±102				±0.33	±0.26

[a] Mean ±standard error of the mean.

Table 2. Distribution of ROPS farms.

	Farms		Tractors	
	Number (562 total)	Percent.	Number (3269 total)	Percent.
No ROPS	138	24.6	391	11.9
Some ROPS	322	57.3	2405	73.6
All ROPS	102	18.1	473	14.5

the median size (56% ±2%) than those below (39% ±2%) the median ($p < 0.0001$ by Student's t–test).

In addition to size and commodity, the age of the farm owner and hours of annual tractor use appear to be predictive of the prevalence of ROPS on a farm (table 3). There was no identifiable relationship between the presence or absence of a young (age <18 years) tractor operator on the farm. In multivariate analysis, the commodity and size of the farms remained significant. When each commodity was specifically examined, size was found to be marginally significant for cash crop farms and highly significant for dairy and vegetable operations. Hours of tractor usage was found to be very highly correlated with farm size and thus retained significance as an independent variable only with organic farms.

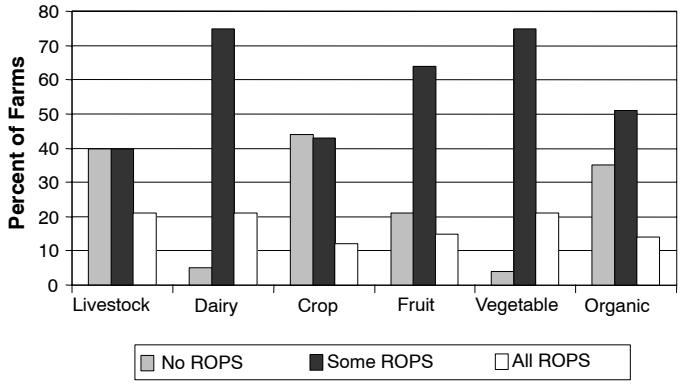

Figure 3. Distribution of ROPS farms by commodity group.

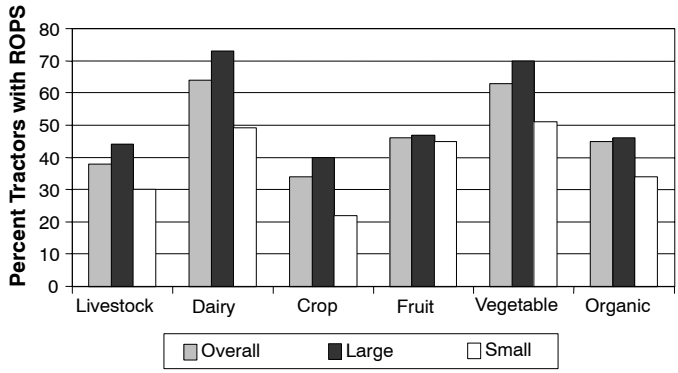

Figure 4. Prevalence of ROPS relative to commodity and farm size.

Estimated Numbers of New York Tractors without ROPS

The distribution of New York's farms by commodity (S. Ropel, New York State Department of Agriculture and Markets, personal communication, 25 April 2005) is noted in table 4. Multiplying the number of farms in a given commodity by the mean number of tractors per farm gives the total number of tractors for that commodity. Similarly, the number of unprotected tractors can be projected by multiplying the number of farms by the mean number of non−ROPS tractors per farm for each of these major commodity groups. There are an estimated 147,000 tractors on the farms of the commodity groups surveyed. Of these, 76,000 (52%) are without ROPS.

Stage of Change Analysis

A total of 102 farms had all tractors equipped with ROPS. On five of these, the farmer had at some point retrofitted one or more of the tractors with ROPS. Thus, 97 farms were excluded because all tractors were ROPS−equipped and none of these tractors had ever been retrofitted with ROPS. The number of farms qualifying for this analysis is reduced to 465. Table 5 shows the characteristics of the study population included in this analysis.

Despite the substantial differences in the distribution of ROPS among New York farmers described above, the stage of change data generally shows homogeneity. The vast majority of the farmers contacted are in the early stages of the change progression (fig. 5).

Table 3. Relation of demographic variables to presence of ROPS.

		% ROPS	p−value
Commodity			<0.0001[a]
	Livestock	39	
	Dairy	63	
	Crop	32	
	Fruit	46	
	Vegetable	63	
	Organic	40	
Farm size			<0.0001[b]
	Large	56	
	Small	39	
Farmer age			<0.0012[b]
	<54 years	50	
	≥54 years	40	
Child operator			<0.5002[b]
	Yes	50	
	No	47	
Annual usage			<0.0001[a]
	<500 hours	33	
	500 to 1000 hours	51	
	1000 to 2500 hours	58	
	>2500 hours	64	

[a] ANOVA F test.
[b] Student's t−test.

Table 4. Estimated numbers of New York tractors.

	No. of Farms	Tractors per Farm	Non−ROPS Tractors per Farm	Projected Total Tractors	Projected Non−ROPS Tractors
Dairy	6,531	6.1	1.9	39,839	12,409
Livestock	9,852	3.1	2.2	30,541	21,674
Cash crop	11,813	3.2	2.1	37,802	24,807
Fruit	2,224	7.3	3.9	16,235	8,674
Vegetable	1,764	11.7	4.3	20,639	7,585
Organic	428	3.6	2.0	1,541	856
All farms	32,612	4.5	2.3	146,597	76,005

Table 5. Study subject characteristics for the stage of change analysis.

						Tractors			
No.	Age[a].	Acres[a]	No. of Live−stock[a]	Tractor Hours[a]	Percent with Children on Tractors	Total	Non−ROPS Total	No. per Farm[a]	Non−ROPS per Farm[a]
All farmers									
465	54.3	321	212	2223	19.4	2826	1528	6.1	3.3
	±0.62	±41.5	±28.7	±196.7				±0.24	±0.14
Dairy farmers									
82	50.4	−−	328.4	3321.9	17.6	527	227	6.4	2.8
	±1.42		±52.3	±376.0				±0.32	±0.18

Table 5 (cont.). Study subject characteristics for the stage of change analysis.

No.	Age[a].	Acres[a]	No. of Live–stock[a]	Tractor Hours[a]	Percent with Children on Tractors	Tractors			
						Total	Non–ROPS Total	No. per Farm[a]	Non–ROPS per Farm[a]
Livestock farmers									
95	55.3	––	110.9	793.8	20.4	320	227	3.4	2.4
	±1.45		±24.3	±87.1				±0.22	±0.18
Cash crop farmers									
88	61.6	211.6	––	539.2	18.9	292	207	3.3	2.4
	±1.21	±34.5		±89.2				±0.22	±0.16
Fruit farmers									
74	54.8	194.3	––	2734	15.9	567	335	7.7	4.5
	±1.46	±23.5		±432.4				±0.63	±0.42
Vegetable farmers									
77	50.3	667.3	––	5055.2	16.6	951	422	12.4	5.5
	±1.40	±130.4		±813.7				±0.83	±0.51
Organic farmers									
49	50.8	70.3	––	694.2	10.5	169	110	3.5	2.3
	±1.79	±22.3		±94.1				±0.32	±0.28

[a] Mean ±standard error of the mean.

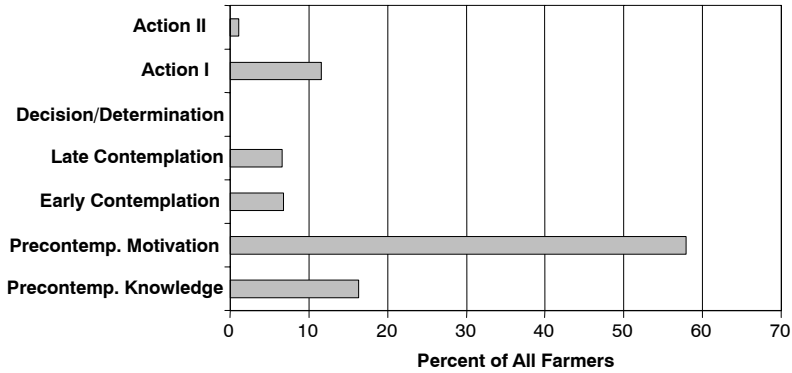

Figure 5. Distribution of New York farmers by stage of change (*n* = 465).

By univariate analysis, the distribution of the stage of change appears to be unrelated to the size of the farm or age of the farmer and not significantly related to the presence of a child tractor operator (table 6). There does appear to be a clear relationship between certain commodities and the farm owner's stage of change relative to ROPS retrofitting of tractors. As can be seen in table 6, the differences primarily relate to the relative excess of cash crop farmers in the earliest change stage, with a corresponding paucity of crop farmers in the later stages. This contrasts mainly with the relatively large number of fruit farmers in the Action I stage. This observation is supported by analysis of variance treating the stage of change as an interval scale variable ($F = 3.66$; $p < 0.003$).

Discussion

Two of our goals dealt with defining the number and distribution of unprotected tractors in New York and defining characteristics associated with this. Some of this information is available in previous publications (cited below) or in the USDA Census of Agriculture (USDA, 2002). However, our data provide new and unique information on the prevalence of ROPS–equipped tractors relative to commodity, farm size, and a variety of other demographic variables. Extrapolating from these data, the commodities studied account for roughly 147,000 tractors across the state. Of these, 76,000 (52%) do not have ROPS. Three–fifths of these are on either crop farms (32.6%) or livestock farms (28.5%), with the next largest category being dairy at 16.3% of all unprotected tractors. The absence of ROPS was more notable on smaller farms, farms owned by older farmers, and farms with fewer overall hours of tractor operation (which correlated closely with size). The presence of at least one child operator on a farm did not seem to influence the likelihood of having ROPS protection.

The tractor figures cited above are estimations. They are higher than those projected in the 2002 Census of Agriculture (USDA, 2002), which estimated 112,000 tractors on 33,000 farms. However, it is more likely that our calculations represent an underestimation of both total tractors and total unprotected tractors. The New York State Department of Agriculture and Markets (NYS, 2003) counts a total of 37,000 farms in the state. The commodities studied in this survey accounted for 88% of these farms. The remaining

Table 6. Relation of demographic variables to stage of change.

	Precontemplation		Early	Late	Dec./	Action	Action	
	Knowl. (%)	Motiv. (%)	Contemp. (%)	Contemp. (%)	Det. (%)	I (%)	II (%)	Sig.[a]
Total	16.3	57.9	6.7	6.5	0	11.6	1.1	
Size								0.12
Large	6.8	29.4	5.1	5.1	0	7.9	0	
Small	9.9	28.4	4.1	3.6	0	3.8	1.1	
Age (years)								0.23
<45	2.7	14.1	2	2.7	0	3.5	0.5	
46 to 53	4.7	14.4	1.7	2.2	0	3	0	
54 to 62	3.7	14.6	1.5	1	0	3	0.3	
>62	6.7	11.7	2	1	0	2.7	0.3	
Child operator								0.07
Yes	2.6	10.8	0.7	2.2	0	3	0.2	
No	13.8	47.2	6	4.3	0	8.4	0.9	
Annual usage (hours)								0.05
<500	5.4	19.8	3.4	3	0	1.7	0.7	
500–1000	2	11.1	1.3	1	0	1.7	0.3	
1000–2500	1.7	15.4	1.3	2	0	5.7	0	
>2500	2.7	11.4	2.4	2.4	0	3.7	0	
Commodity								0.003
Dairy	2.4	73.2	4.9	6.1	0	12.2	1.2	
Livestock	8.4	62.1	8.4	10.5	0	9.5	1.1	
Cash crop	31.8	55.7	6.8	1.1	0	3.4	1.1	
Fruit	20.3	45.9	5.4	6.8	0	20.3	1.3	
Vegetable	18.2	53.3	6.5	5.2	0	15.6	1.3	
Organic	18.4	53.1	8.2	10.2	0	10.2	0	

[a] Sig. = significance; Mantel–Haenszel statistic.

farms likely represent an extremely heterogeneous group of generally smaller farms. It is impossible to speculate about these with any hint of accuracy, other than to acknowledge that there are more, possibly somewhat less than 12% more, protected and unprotected tractors in New York than has been calculated. In light of this, 80,000 unprotected tractors appears to be a conservative estimate for New York.

Our figures appear to be generally consistent with previous New York State work. The calculated frequency of unprotected tractors on New York farms has declined somewhat from the rates noted a decade or more ago in a series of other New York studies, several of which used direct on–farm inspection. Data from NYCAMH/Cornell University tracking of New York farm fatalities from 1985 to 1989 showed that 52 (55%) of fatalities related to farm tractors (J. Pollock et al., unpublished data, 1989). Of these tractor fatalities, 27 (52%) related specifically to tractor overturns. In response to these findings, investigators undertook a series of studies in the 1990s to better define the problem. Three of these involved physical inspections of tractors. Initially, a systematic on–farm inspection of all (605) tractors on 136 randomly selected dairy farms across New York State was performed. This survey, which was linked with a concurrent one–on–one training session with each farmer, found appropriate ROPS on 33% of the tractors inspected (Hill et al., 1992). In subsequent work, all tractors offered at a series of farm auctions across the state, a total of 233 tractors, were systematically evaluated against published ASAE standards. Findings here included the presence of ROPS on 32% of tractors inspected (West and May, 1998). The most recent and most extensive study of tractors in New York was in the NIOSH–sponsored New York Farm Family Health and Hazard Survey (FFHHS), which concluded data gathering in the mid–1990s (Hallman et al., 1997). Here, a research team from the NYS Department of Health, Cornell University, and NYCAMH linked extensive health, safety, and attitudinal data collected by telephone interviews with actual on–farm hazard surveys and health screening data. Systematic inspections of the mechanical equipment were done by the Cornell team on a cohort of 580 farms that were selected to reflect the size and commodity distribution of all New York farms. The FFHHS project described a fleet of 2,513 tractors with significant safety defects. This included ROPS being absent on 61.4% tractors and seat belts absent on 28% of those tractors that did have ROPS. Some improvement in the rate of ROPS availability is suggested by these data, with rates of 33% ROPS in the early 1990s rising to 48% of tractors having ROPS in our current data.

Our other two research questions dealt with the farmers' stage of change and possible ways to segment this population. The stage of change portion of our work demonstrates that most New York farmers are not contemplating ROPS retrofitting in the near future. Stage of change appeared to be fairly evenly distributed across most of the commodities and nearly all other farm characteristics. The statistical difference in stage of change noted in table 6 mainly reflects the fact that one commodity (cash crops) is notably less progressed on the change continuum than other commodities. Total tractor hours was the only other farm characteristic that might be indicative of a farmer's individual stage of change. Our findings suggest that appeals to fruit farmers might be based on the observation that one in five have already retrofitted. Cash crop farmers seem less likely to retrofit than other farmers, possibly because of less understanding of the benefits of ROPS. For the social marketer, it is incumbent to better understand why this group is less knowledgeable than their peers in other commodities. It is likely that the approach to this segment must include more direct education before it is likely to be very persuasive. Statistical differences notwithstanding, the stage of change data suggest that, for the most part, other commodity groups are only slightly more inclined than their crop farmer peers to retrofit.

Some of this is not unexpected, based on previous tractor investigations done by the Northeast Center for Agricultural Health (NEC) in the New York farm community. Hallman (2005) reported on the response of farmers to varying levels of cash reimbursement for expenses of ROPS retrofitting a tractor of their choice. Notably, 20% of those offered full reimbursement rejected the offer. Cash incentives exceeding 50% had to be offered before any substantial response was experienced. Kelsey et al. (1996a) have previously reported similar reluctance to retrofit following a series of interviews with New York farmers.

In our current survey, farmers tended to agree that ROPS are important to have on tractors (Sorensen et al., 2006). However, respondents usually seemed to have reasons why they did not feel this applied to their particular situation. Though there is some evidence of variation in stages of change between commodity groups, these are mostly of little interventional significance. These data clearly illustrate why decades of educational initiatives promoting ROPS retrofitting have not proven successful in New York. Those in precontemplation, a clear majority of New York farmers, are for the most part well aware of the safety advantages of ROPS and of the potentially fatal outcomes associated with tractor overturns. They simply do not relate this understanding to their personal situation and thus have little motivation for change. Weinstein's (1988) precaution adoption process describes this situation well in the "stages of belief about susceptibility to harm." In this model, recognition of a general problem and acknowledgement of personal susceptibility to that problem are sequential, but substantially different stages. Movement from the recognition stage to the acknowledgement stage is challenging and often is hampered by a variety of "optimistic biases," i.e., beliefs that one's personal risk is somehow less than that faced by others.

There are several sources of potential error in this study. Most of the sampling was based on commodity group membership lists. All surveyed farms were randomly selected, and the response rate (87%) was high enough to suggest that the results are representative of all listed farms. To the extent that these lists are not representative of the farms in each commodity, these data may be biased. When these lists were not available, lists from NASS–NY were used, necessitating that the surveys be conducted by their telephone interviewers. This change in interview staff may have introduced some inconsistency in the data, though these interviewers were specifically trained and their results overseen by one of the authors (Sorensen). This survey was telephone–based and farmers' responses were not validated by visual inspection. Farmers could have misrepresented their tractor fleet, though this seems unlikely. Somewhat more problematic is ensuring that the cabs and non–cab structures on these tractors actually meet ASAE standards and thus should be counted as ROPS. On occasion, farmers evidenced some uncertainty about this, particularly in the case of some older tractors with cabs. In these situations, farmers were re–contacted after they had a chance to check for the ASAE emblem on the cab signifying compliance with standards.

Several basic decisions were made in the design of this research. Our decision to define farmer age and farm size relative to commodity medians reflects an inability to determine generally accepted criteria regarding when a farm is "large" or when a farmer is "old." Evaluation of our findings would be easier for readers if there were generally accepted criteria to which we could refer for these comparisons. A decision was made to exclude from the stage of change analyses any farms that had all tractors protected with ROPS, unless at least one of these tractors had been ROPS retrofitted by the farmer. This resulted in 97 farms being excluded. These farmers were excluded because we believed them to be outside of the stage of change spectrum. It is possible that some of those excluded may have actually bought a tractor specifically to obtain ROPS protection and thus should have been included in the stage of change analyses. Based on our interactions

with New York farmers, we believe that this would represent a very small fraction of the 97 farmers excluded.

Conclusions

The survey revealed some encouraging findings. There appears to be a trend toward higher rates of ROPS tractors in the state over the past 15 years. The proportion of farms where all tractors were ROPS–equipped (18%) was higher than might have been predicted. Prevalence of ROPS in some commodities proved to be substantially higher than was expected. The vast majority of New York farms (75.4%) have access to at least one tractor with appropriate protection. Though we did not gather this information, Kelsey's (1996b) previous work indicates that New York farmers tend to select these ROPS–equipped machines for most of their more extensive fieldwork. It is unclear whether they chose these tractors for use on hilly or uneven terrain, where they perceive a greater risk of overturn.

The survey also illustrates some considerable challenges for social marketing. There are an estimated 80,000 unprotected tractors in the state, and their owners seem generally unpersuaded that these need to be retrofitted. Even if they were anxious to retrofit, the financial challenge here is considerable; a very conservative estimate for retrofitting even half of these is roughly $20 million. Finally, as Hallman (2005) has found in this state, it is often unlikely that appropriate retrofit kits can be promptly located and installed by dealers.

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