Cost-Effectiveness of a ROPS Social Marketing Campaign

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ABSTRACT. *Tractor rollovers are the most frequent cause of death in the farm community. Rollover protection structures (ROPS) can prevent the injuries and fatalities associated with these events; however, almost half of U.S. farms lack these essential devices. One promising strategy for increasing ROPS use is social marketing. The purpose of this study was to assess the costs associated with the New York ROPS Social Marketing Campaign in relation to the cost of fatalities and injuries averted as a result of the campaign to determine whether cost savings could be demonstrated in the initial years of program implementation. A total of 524 farmers who had retrofitted a tractor through the program were mailed a survey to assess the number of rollovers or close calls that occurred since ROPS installation. Responses were obtained from 382 farmers, two of whom indicated that they had a potential fatality/injury scenario since retrofitting their tractor through the program. The cost savings associated with the intervention was estimated using a decision-tree analysis adapted from Myers and Pana-Cryan with appropriate consumer price index adjustments. The data were compared to the cost of the New York ROPS Social Marketing Campaign to arrive at an associated cost-savings estimate relative to the intervention. This study indicates that a net savings will likely be demonstrated within the third year of the New York ROPS Social Marketing initiative. These data may provide evidence for researchers hoping to generate support from state and private agencies for similar initiatives.*

Keywords. *Cost-benefit analysis, Fatalities, Injury, Intervention, Rollover protective structures, ROPS, Tractors.*

There are currently ample research data that identify tractor rollovers as the most frequent cause of death in the agricultural community (Myers, 1998; Myers et al., 1998; NIOSH, 2004; Loringer and Myers, 2008). These deaths occur when a tractor rolls onto its side or over backwards, crushing the operator under the weight of the tractor. The presence of hilly terrain, ditches, and front-end loaders, or activities related to hauling wagons and skidding logs, can quite often lead to a rollover (Hallman, 1994-2000; NIOSH, 2002-2008). However, the undeniable theme in the great majority of these rollover deaths is the absence of a rollover protective structure

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(ROPS). These devices are 99% effective when used with a seatbelt (NIOSH, 2004). If ROPS were installed on all unprotected tractors, rollover deaths could largely be eliminated. However, according to the USDA National Agricultural Statistics Service (NASS) 2006 Farm and Ranch Survey, approximately 41% of U.S. tractors are not equipped with ROPS (NASS, 2008). Data from the National Institute for Occupational Safety and Health (NIOSH) indicate that the average annual increase in the number of ROPS-protected tractors is roughly 1.2% (Myers, 2009). In order to significantly reduce the rate of rollover deaths, researchers predict that roughly 75% to 80% of U.S. tractors would need to have a ROPS (Springfeldt, 1996; Springfeldt et al., 1998; Thelin, 1998). If these predictions are correct and current rates of annual increase in ROPS protection hold true, it will take roughly 15 to 20 years to reach acceptable levels of ROPS protection. In the meantime, another 1600 to 2200 tractor operators will needlessly lose their lives.

There is currently no national program to increase the proportion of ROPS-protected tractors in the U.S. However, there are various state-based programs in operation (e.g., Iowa, North Carolina, Virginia) that seek to promote ROPS retrofitting, as well as a number of public health initiatives that have sought to do the same. The state-based programs are sponsored by Farm Bureaus (member-funded organizations that attempt to represent farmers' political and economic concerns) and provide \$150 to \$300 toward the purchase of a ROPS. The Virginia program was launched in 1994, and the Iowa program was launched in 2003. Although data on the number of tractors retrofitted through the North Carolina program were not available, the Virginia and Iowa programs have collectively retrofitted roughly 406 tractors in total (B. Stone, personal communication, 2009. Richmond, Va.: Virginia Farm Bureau).

Previous public health interventions (Struttman et al., 2001; Morgan et al., 2002; Myers et al., 2004) have largely involved educational or community awareness campaigns. Unfortunately, these measures have not led to marked increases in ROPS installation (Myers, 2009). This is not surprising in light of research conducted in the New York farm community (Sorensen et al., 2006), which indicated that knowledge of rollover risk and ROPS efficacy did not sufficiently motivate farmers to consider retrofitting.

Previous research also indicated that finances may not be the only barrier to retrofitting. Research conducted by Hallman (2005) indicated that approximately 20% of farmers offered 100% of the cost to retrofit would still not retrofit an unprotected tractor. Roughly 40% of New York farmers surveyed in a separate study were similarly resistant despite offers of 100% rebates (Kelsey et al., 1996).

In interviews conducted in the New York crop and livestock community, farmers stated that they experience numerous barriers to ROPS retrofitting. These barriers include the cost to retrofit, but also include the logistical difficulty associated with the retrofitting process and a pronounced belief that their tractor operating experience would allow them to control dangerous exposures favorably (Sorenson et al., 2008c). As a result, retrofitting interventions would necessarily have to address each of these barriers effectively to increase retrofitting activity. In 2006, a social marketing campaign, composed of elements described by Andreason (1995) and Sorensen (2008b), was piloted in New York State, which attempted to address each of these barriers by providing: (1) a 70% rebate for the entire cost to retrofit a tractor with a rollbar and seatbelt, (2) toll-free assistance with the retrofitting process, and (3) messages designed to address farmers stated tractor safety concerns (Sorenson et al., 2008b). Comparisons of ROPS sales in the year preceding the launch of the pilot campaign and the year after indicated a ten-fold increase in ROPS purchases. In the first 2.5 years of the program, 600 New York tractors have been retrofitted.

Although these results are promising, persuading other states to adopt similar social marketing campaigns may be difficult due to the plethora of public health concerns that exist in state communities. There is also some question regarding how many tractors need to be retrofitted before an injury or fatality could be prevented, since as in the Northeast, rollover fatalities occur at rate of 8.4 per 100,000 workers (Myers et al., 1998). Additionally, social marketing requires investments in message development, advertising, and promotion, as well as staffing for toll-free hotline assistance.

The purpose of this article is to assess whether, despite initial and continuing financial expenditures, ROPS social marketing campaigns can lead to immediate financial savings relative to negative health outcomes avoided. If this can be demonstrated, then it may be possible to more successfully persuade state governments or even federal program administrators to launch similar initiatives. To address this need, we conducted a cost-effectiveness analysis based on the number of individuals who have retrofitted through the New York program and subsequently avoided injury or fatality. The methods employed in this analysis and the resulting data are presented in the following sections.

Methods

Calculating Campaign Costs

In order to assess the cost of running the New York program, all expenditures related to advertising, staffing, promotional activities, hotline assistance, and rebates were listed and totaled from the program start date (November 2006) to the date of the analysis (March 2009). These program components and their annual associated costs are listed in table 1.

Estimating Fatality/Injury Events

Fatality and injury estimates are based on a survey conducted with program participants who had completed ROPS installation at the end of the second year of the New York ROPS Social Marketing Campaign. These 524 farmers were identified through a query of the program's hotline database and were mailed a survey that asked them to indicate: (1) whether they still owned the tractor, (2) whether the tractor was used for dangerous tasks, (3) whether they felt safer with the ROPS, (4) whether they had a close call or rollover since installing the ROPS, and (5) whether they would be inter-

Table 1. New York program expenditures.

Function	Year 1	Year 2	Year 3 (to March)
Hotline facilitator	$32,600	$32,600	$13,692
Project coordinator[a]	$7,969	$8,258	$3,594
Research assistants	$36,429	$36,429	$15,244
Earned media consultant	$7,000	$3,946	$2,400
Marketing consultants	$18,000	$7,317	$15,112
Promotional materials[b]	$47,000	$47,000	$10,350
Retrofit rebates	$140,345	$154,175	$39,894
Website expenses	$240	$240	$101
Toll-free line	$1,200	$1,200	$504
Annual program costs	$290,783	$291,165	$100,891
Total program costs	--	--	$682,839

[a] 0.2 full-time equivalents for qualitative data gathering and concept development testing.

[b] Paid advertising, raffle items, posters, billboards, counter displays, and promotional items.

ested in retrofitting another tractor. Participants who indicated having had a close call or rollover were contacted by phone, and details of these events were then recorded (table 2). The data from this survey indicated that there were 14 potential near-misses. Information could not be obtained for five of these incidents, and seven of the incidents did not involve definitive overturn scenarios. This left two incidents that could be construed as potential fatality/injury scenarios. These data were used to calculate the expected number of overturns that would have been identified among the group of 599 farmers who had retrofitted by the time the intervention costs were calculated (March 2009). This projected total was then used to compute the cost savings relative to the intervention.

Calculating the Cost of Fatalities/Injuries Averted

In order to calculate the cost of injuries and fatalities both with and without the intervention, a decision-tree analysis was conducted. This analytical method is based on previous research conducted by Myers and Pana-Cryan (Myers and Pana-Cryan, 2000; Pana-Cryan and Myers, 2000). Necessary inputs for the analysis were: (1) the probability of death in the event of a rollover with an unprotected tractor, (2) reduction in the probability of death as the result of using a ROPS-protected tractor, (3) the probability of injury given survival in the event of a rollover without ROPS, (4) reduction in the probability of injury as the result of using a ROPS-protected tractor, and (5) the estimated number of rollovers among the 599 farmers who had retrofittied their tractors. The calculations associated with these inputs are explained below:

Table 2. Near-miss scenarios for individuals who had installed ROPS.

Incident	Description
1[a]	Tractor operator was mowing on a side hill when the right front tire hit a tree stump. The tractor rolled instantly onto its side and would have flipped completely if not for the roll bar. The operator was not wearing his seatbelt.
2[a]	Tractor operator was going down a hill with a wagon loaded with baled hay. The wagon and tractor jack-knifed, and the tractor rolled over. The operator was wearing his seatbelt.
3	Tractor operator was pulling a silage wagon when the wagon and tractor began to slide sideways down a hill. The operator was wearing his seatbelt, without which he was sure he would have been thrown from the tractor and run over.
4	Tractor operator was lifting round bales on a slightly sloped area when the tractor reared up and nearly flipped backwards. The operator was wearing his seatbelt.
5	Tractor operator was cutting on a side hill and hit a woodchuck hole. The tractor went up on its side and nearly rolled over. The operator was wearing his seatbelt.
6	Tractor operator was traveling on a road and drove too close to the edge of the road. The tractor began to slide down the slope sideways and came to a rest when it hit the field.
7	Tractor operator was haying on a steep slope when the tractor began to tip backwards. The operator was wearing his seatbelt and managed to bring the front wheels back to the ground.
8	Tractor operator was mowing hay on a side hill when the discbine[b] caught on a woodchuck hole and caused the tractor to tip up. The operator stated that he was wearing a seatbelt since he had a ROPS, and were it not for the seatbelt, he would have fallen from the tractor.
9	Tractor operator was moving round bales on a hill when his tractor began to slide down a muddy area. The operator was wearing his seatbelt and avoided injury.
10	Tractor operator refused to discuss the circumstances of near-miss.
11	Tractor operator refused to discuss the circumstances of near-miss.
12	Tractor operator refused to discuss the circumstances of near-miss.
13	Farmer could not be reached.
14	Farmer could not be reached.

[a] Entered into cost-effectiveness analysis as potential fatality/injury.

[b] A discbine is a series of round discs with removable blades, used for mowing hay.

1. Probability of death in the event of a rollover with an unprotected tractor

Estimates of the probability of death due to the rollover of a non-ROPS tractor vary widely (Cole et al., 2006). In order to develop the most accurate estimate of the number of non-ROPS tractor deaths, this study used the average of two widely publicized estimates in order to minimize any particular bias that may be associated with them. These were the probability of 0.40 taken from CDC (1993) and 0.08 taken from Cole et al. (2006). The 0.08 estimate is the only population-based stratified random sample estimate of the probability of death due to non-ROPS tractor overturns, but it is not necessarily representative of the U.S. or of other states. The average of these two probabilities is 0.24.

2. Probability of death as the result of rolling a ROPS-protected tractor

The effectiveness of ROPS to prevent deaths is 1.0 (Myers and Pana-Cryan, 2000) when seatbelts are used and 0.95 when seatbelts are not used (CDC, 1993). In the two rollovers observed in our study group, seatbelts were used in one instance. Therefore, the pooled probability used in our calculations required weighting according to this prevalence. Using a base prevalence of death from rollovers without a ROPS as 0.40, the two probabilities of death are:

$$0.40 \times (1.0 - 1.0) = 0 \text{ with seatbelts}$$

$$0.40 \times (1 - 0.95) = 0.02 \text{ without seatbelts}$$

Therefore, the pooled probability of a death resulting from a given rollover in the group of ROPS retrofitters as estimated from the CDC (1993) data is:

$$[(1/2) \times 0] + [(1/2) \times 0.02] = 0.01$$

Cole et al. (2006) estimate this same probability as 0.01087. In keeping with our convention of averaging, this study used a value of 0.010435.

3. Probability of injury given survival in the event of a rollover without ROPS

The probability of 0.83 is taken from NIOSH (1996) and CDC (1993) estimates. We estimate the corresponding number taken from Cole et al. (2006) to be 0.443. Therefore, this study used 0.6365.

4. Probability of injury as the result of rolling a ROPS-protected tractor

The effectiveness of ROPS to prevent injury is 0.88 when seatbelts are used and 0.76 when seatbelts are not used. Using the same reasoning as that applied in the estimation of the pooled probability of death, and using a base prevalence of injury from rollovers without ROPS (given survival) of 0.83, the two probabilities of injury are:

$$0.83 \times (1.0 - 0.88) = 0.0996 \text{ with seatbelts}$$

$$0.83 \times (1 - 0.76) = 0.1992 \text{ without seatbelts}$$

Therefore, the pooled probability of an injury resulting from a rollover in this group of ROPS retrofitters, per CDC (1993) estimate, is:

$$[(1/2) \times 0.0996] + [(1/2) \times 0.1992] = 0.1494$$

We estimate the corresponding probability from Cole et al. (2006) to be 0.247. The average of these two estimates is 0.1982.

5. Estimated number of rollovers among 599 farmers who retrofitted a tractor

Two rollovers were reported among the 382 farmers responding to the survey. Based on the two rollovers occurring in this group of 382, the number that would have been identified among the entire group of 599 retrofitters (382 responders + 142 non-responders + 75 who installed ROPS after the survey and before March 2009) would be: (599/382) × 2 = 3.136 total rollovers.

Based on these inputs, the costs associated with rollover deaths and injuries both with and without the intervention were calculated based on estimates given by Leigh et al. (1992) and Viscusi (1993). These estimates include both direct and indirect costs and are reported in 1997 dollars by Pana-Cryan and Myers (2000). In order to account for inflation, these 1997 estimates were adjusted using the Consumer Price Index (U.S. DOL, 2009).

Results

Based on the inputs and estimates described in the Methods section, the projected costs of deaths and injuries both with and without the intervention are as follows:

Estimation of the Cost of Deaths and Injuries without the Intervention

Cost of deaths:

Number of deaths = 3.136 × 0.24 = 0.7526
Cost of each death in 1997 = $665,361
Cost in 2009 adjusted using CPI = $879,657
Total cost of deaths = 0.7526 × $879,657 = $662,030

Cost of injuries:

Number of non-fatal rollovers: = 3.136 × (1 - 0.24) = 2.3834
Number of injuries = 2.3834 × 0.6365 = 1.517
Cost of each of injury in 1997 = $12,479
Cost in 2009 adjusted using CPI = $16,498
Total cost of injuries = 1.517 × $16,498 = $25,028
Total cost of death/injury without the intervention: $662,030 + $25,028 = $687,058

Estimation of the Cost of Deaths and Injuries with the Intervention

Cost of deaths:

Number of deaths = 3.136 × 0.010435 = 0.0327
Cost of each death in 1997 = $665,361
Cost in 2009 adjusted using CPI = $879,657
Total cost of deaths = 0.0327 × $879,657 = $28,765

Cost of injuries:

Number of non-fatal rollovers: = 3.136 × (1 - 0.010435) = 3.103
Number of injuries = 3.103 × 0.1982 = 0.615
Cost of each of injury in 1997 = $12,479
Cost in 2009 adjusted using CPI = $16,498
Total cost of injuries = 0.615 × $16,498 = $10,146
Total cost of death/injury with the intervention = $28,765 + $10,146 = $38,911

Based on these data, the total cost saving associated with the campaign is estimated by adding the cost of the campaign ($682,839) to the cost of deaths and injuries associated with the intervention ($38,911), which is then subtracted from the cost of deaths and injuries that would have occurred without the intervention ($687,058). These calculations indicate a deficit of $34,692 within 2.5 years of the intervention launch date. Thus, it is estimated that the intervention would begin to show a net cost savings at some point during the third year after launch.

The net one-year differential cost associated with deaths and injuries could be estimated as: ($687,058 - $38,911) / 2.5.

This puts the annualized cost savings at $259,259. Therefore, the total cost savings over ten years are estimated to be $2,592,590. Subtracting the original cost of the intervention ($682,839) leaves a ten-year positive balance of $1,909,751.

Limitations

Although the analysis of the costs and benefits associated with the New York Social Marketing Campaign provide promising evidence that social marketing can be a cost-effective means for addressing tractor overturn fatalities, there are some limitations worth mentioning.

Providing an accurate assessment of the number of overturns that would be seen in the retrofitter population at the time the expense data were calculated (March 2009) proved difficult for two reasons. First, not all of the 524 retrofitters responded to the survey (142 surveys not returned); second, from the time the survey was conducted up to the date that the intervention expense data were tallied, another 75 individuals had installed ROPS on their tractors. Thus, it was necessary to estimate the number of overturns that would have been seen in both the non-responder group and the new retrofitter group based on the ratio seen in the responder group. This assumption would be problematic if there were reason to believe that the non-responders and new retrofitters were more or less likely to roll their tractors than the responders. However, even if we were to take the more conservative estimate of the number of confirmed overturns and base the analysis on intervention expenditures up to March 2009, it is likely that a cost vs. savings analysis would still favor the intervention in a relatively short timeframe, as the costs associated with an overturn and injury are considerable.

It is also important to note that the estimate of the cost of injuries and fatalities averted is likely conservative due to the limited nature of the survey data. In the survey, 14 of the farmers indicated having had a close call or an overturn. However, three of these individuals refused to provide details about these events, two others could not be reached, and for the six remaining individuals it was impossible to determine whether a fatal event or injury would have occurred had they not had been using a ROPS or seatbelt.

Our estimates were based on research conducted by Leigh et al. (1992) into the costs of occupationally related injuries. However, these estimates are not specific to tractor rollovers and therefore do not, in all likelihood, take into account certain costs that would be specific to rural/farming populations, such as the increased cost of having to transport a rural resident to an urgent care facility or the costs that farm families experience when a vital member of the workforce is injured or unable to work. Our estimates also do not take into account the potential reduction in damage to the tractor that could be avoided due to ROPS installation. Because ROPS are designed to minimize the extent of rollovers, it is possible that damage is reduced even if no one is hurt or killed.

It is also important to note that the calculation of intervention costs did not include the costs associated with the formative research, which was conducted to identify potential motivators and barriers to retrofitting. These costs were not included as they were not directly related to running the intervention and would not be essential costs for other interventions, since this research has already been conducted in the New York and national farm community (Anyaegbunam and McKnight, 2007).

Discussion

Several published research articles consider the cost-effectiveness of ROPS interventions (Myers and Pana-Cryan, 2000; Pana-Cryan and Myers, 2000; Myers et al., 2004). However, no research studies have currently been published on the potential savings in injuries and fatalities averted in relation to a ROPS social marketing intervention. Although it has been demonstrated that social marketing is a viable means for increasing retrofitting activity (Sorenson et al., 2008a; Sorensen et al., 2008b), the costs of these interventions are likely to be higher than an educational campaign or simple rebate disbursement program due to the expense of developing messages, staffing a hotline, conducting promotional activities, and providing promotional materials. As our data indicate, despite these costs and the costs associated with providing financial rebates of 70% (up to $765) of the cost to retrofit, the returns associated with the injuries and fatalities averted are evident.

Perhaps most significantly, this analysis demonstrates that these returns can be seen in the early years of program implementation. Preliminary research in the New York program indicates that roughly 80,000 New York tractors lack ROPS (May et al., 2006), while the number of ROPS that have been installed through the program in 2.5 years has been close to 600. With such a broad gap between needs vs. progress, it was difficult to be optimistic about any gains made by the program. However, as demonstrated by the retrofitters' survey, potentially fatal injury events have already been averted in our retrofitter cohort. One potential explanation for this initial success may be traced to the nature of social marketing interventions that begin by selecting a target segment and tailoring the intervention accordingly. For the New York program, this segment was small crop and livestock farmers. In the initial research, these farmers were shown to have fewer ROPS-protected tractors than other segments of the farm community and, according to data drawn from the hotline database, were the most frequent participants in the program (Viebrock et al., 2007).

In our analyses, we based the cost of fatalities and injuries on both direct and indirect costs. As reported by Leigh et al. (1992), these include medical expenses, insurance administrative fees, property damage, use of police and fire services, potential injuries to third parties, lost wages, losses related to reduced household production, and time lost. In view of these associated costs, many of which are born by society and several of which are industry specific (i.e., insurance agencies), it may be possible to use these data to generate support from state or private organizations for ROPS interventions in other states or regions. In addition, the fact that lives have already been saved may be an additionally attractive feature for legislators or other program stakeholders who can justify the political or financial investments they have made by highlighting the personal stories of these survivors.

Conclusions

Although previous research on the costs vs. benefits of installing ROPS on unprotected tractors has been conducted using a variety of scenarios, the research discussed in this article provides the first analysis of the costs vs. benefits of conducting a ROPS social marketing campaign. Although these campaigns have the potential to be somewhat more expensive than an educational campaign or programs that provide rebates only, the data gathered in our study indicate that these interventions can be cost-effective. Using data gathered from a survey conducted with program retrofitters, as well as estimates of injuries and fatalities and their ensuing costs, the cost of accidents and injuries avoided as a result of the intervention indicate that a net cost savings could be demonstrated within three years of a program's inception.

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