

Net Monetary Benefit of Cost-Effective Rollover Protective Structures (CROPS): An Estimate of the Potential Benefits of the CROPS Research Project

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ABSTRACT. *This study builds on an earlier study to examine the net monetary benefit of installing cost-effective rollover protective structures (CROPS) instead of utilizing existing ROPS retrofits for all estimated non-ROPS tractors in the year 2004. With the conservative estimates used in the analyses, results indicate that compared to the baseline option (no protective structure), the Install-ROPS option results in a loss of \$310 million to society, while the Install-CROPS option results in a net monetary benefit of \$276 million over a 20-year period. A comprehensive sensitivity analysis indicated that, for the extreme values (estimates) used, the estimated net monetary benefit is most sensitive to the probability of tractor overturn. Break-even analysis indicated that the unit cost of intervention for the Install-CROPS option can increase by about 58% and still be able to pay for itself. Even when the minimal unit cost of intervention for ROPS is used, the payback period is reduced substantially for the Install-CROPS option, by almost half the payback period. Finally, compared to existing ROPS retrofits, the net monetary benefit is \$586 million, representing an estimate of the potential benefits of the CROPS research.*

Keywords. *Cohort analysis, Cost-benefits analysis, CROPS, Net monetary benefit, ROPS.*

Research has been broadly defined as a well-documented systematic investigative process, which may include (but is not limited to) testing, designing, developing, and evaluating subjects and/or objects to add to the current knowledge in a particular field. In the area of occupational safety and health, research has been the leading tool for the laudable advances in the improvement of safety and health conditions in the workplace. However, estimating the potential benefits of a research project has not been done in many cases, primarily because some of the benefits may not be known. Even for those benefits that are obvious, it is a challenge to estimate them in monetary terms. Research at all levels requires some form of resource use (time and almost certainly physical and mental effort), which may be difficult to value in monetary terms.

Cost-effective rollover protective structures (CROPS) are model-specific rollover protective structures (ROPS) that are being designed and developed at the National Institute for Occupational Safety and Health (NIOSH) in Morgantown, West Virginia.

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The project concept is to develop and evaluate protective structures that are as effective as existing ROPS retrofits, but less costly. Harris et al. (2002) developed and evaluated CROPS (weld-free ROPS constructed with common structural elements and fasteners), which are designs tailored to specific tractor models. Designs for Ford 3000 and Ford 4000 models have been tested successfully, according to the static testing procedures of the ROPS consensus performance standard, SAE J2194 (Harris et al., 2005). The estimated unit cost of CROPS was \$290 (\$300 in 2004 dollars), according to a ROPS manufacturer. To date, designs developed can be installed by one person (Harris et al., 2005) in about an hour (expert opinion). The component is referred to as “cost-effective ROPS,” implying that it is as effective as existing ROPS, but much less costly.

The CROPS research is important for the agricultural community and society as a whole because tractor overturns continue to be a major cause of agriculture-related injuries. The U.S. Department of Labor reported more than 1,000 deaths from tractor overturns between 1992 and 2004 (USDOL, 2004). ROPS have been proven to be the major intervention, with an estimated prevention rate ranging from 75% when seatbelts are not used (CDC, 1995) to 99% when seatbelts are used (Morgan et al., 2002). Reynolds and Groves (2000) and Myers (2003) estimated that about half of the 4.8 million tractors used in production agriculture in the U.S. do not have ROPS installed, posing an occupational safety and health problem. Of the 2.4 million estimated non-ROPS tractors, about 45% are retrofittable, according to estimates from Pana-Cryan and Myers (2000) and based on the method developed by Myers and Snyder (1995).

This study builds on a previous study on CROPS (Owusu-Edusei and Biddle, 2007b) to track costs and effects of retrofitting all of the estimated retrofittable non-ROPS tractors with ROPS and CROPS and compares the economic costs and benefits of the two in monetary terms. The resulting net monetary benefit of CROPS over ROPS is imputed as the potential monetary benefits of the CROPS research project. In view of the broad nature of the study and to be consistent with the earlier study, four assumptions have been adopted:

1. All the retrofittable tractors are models with adequate axle housing geometry or structural strength.
2. All the CROPS installed are as effective as the manufacturers’ ROPS retrofits.
3. The unit cost of CROPS not yet designed and developed would be the same as the current ones.
4. Depreciation and maintenance costs are negligible.

Following Owusu-Edusei and Biddle (2007b), this study tracks the effects of installing CROPS on all the estimated retrofittable tractors (accounting for the annual attrition rate due to aging) and estimates the effects (fatal and non-fatal injuries prevented) over a 20-year period from a societal perspective. The result is compared with installing existing ROPS retrofits to determine the net monetary benefit (NMB). The intervention proposed in this study includes the use of seatbelts. However, as recommended by tractor manufacturers (Deere, 1994), it is assumed in this study that non-ROPS tractor operators do not use seatbelts.

Methods

Three options are modeled in this study using TreeAge software (TreeAge Software, Inc., Williamstown, Mass.): no protective structure (do-nothing), Install-ROPS, and Install-CROPS. The costs and benefits of each option are estimated using Markov cohort analyses over a 20-year period (2004 through 2023). Markov analysis allows researchers to accumulate the discounted effects in each year over a specified analytic horizon. For

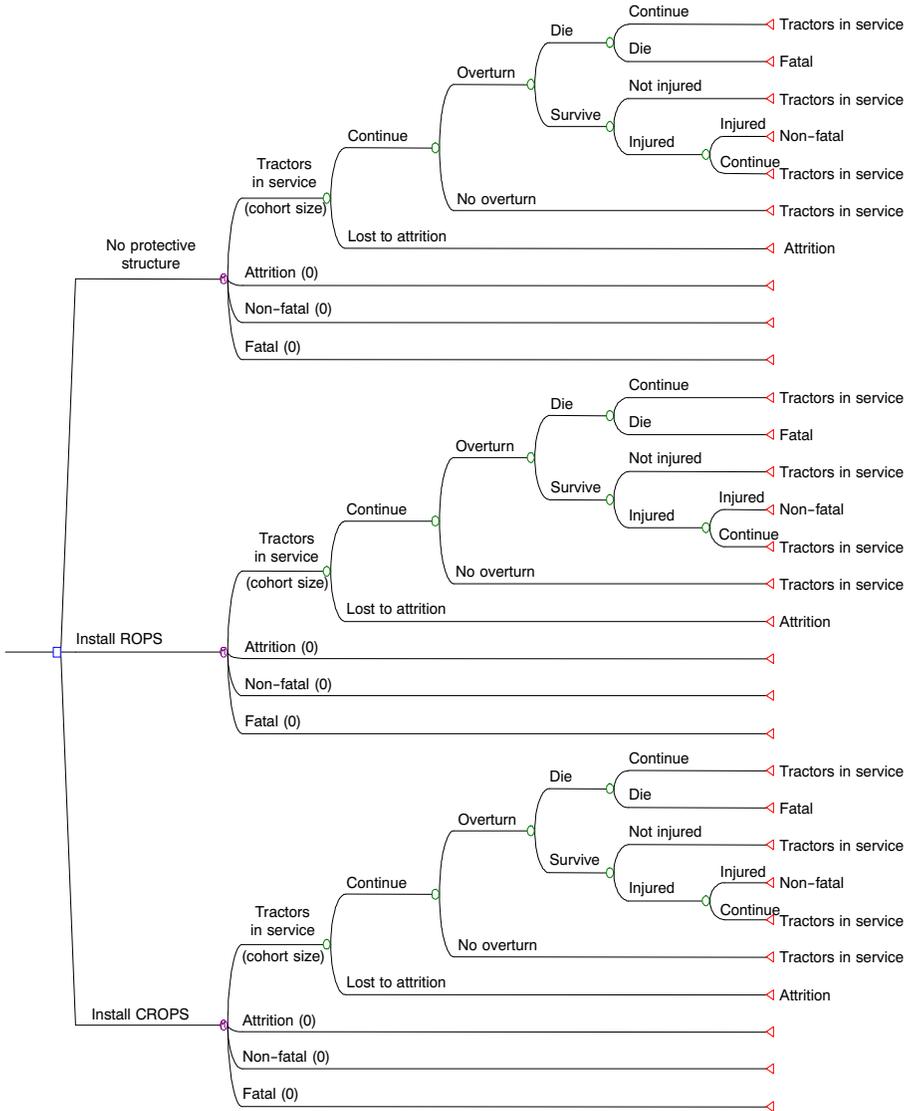


Figure 1. Markov decision tree with three alternatives.

each option, two subjects (the operator and his tractor) are tracked in this study. Each tractor is assumed to be operated for a specified number of hours each year, i.e., the average annual operation time. As in the previous study (Owusu-Edusei and Biddle, 2007b), a stable dynamic cohort in this study implies that operators are allowed to come in and go out at the beginning of each cycle or year, and the number of tractors in operation is stable for each particular year. Exits are balanced by entries so that the cohort size is consistent with the estimated existing number of retrofittable tractors for each year. Tractors that cause fatal injuries and do not retire are operated by another operator in the next year to keep the cohort size stable for that year. It is assumed in this study that the value of life is the same for all operators.

The model starts with a cohort size of the number of the estimated retrofittable non-ROPS tractors for the year 2004 (1,065,164) with annual attrition rates adopted from Pana-Cryan and Myers (2000) and based on the method described by Myers and Snyder (1995). Annual attrition rates account for the retirement of tractors due to aging, which are accumulated in the absorption state labeled “attrition.” There are no costs in the attrition state. The scrap values of retired tractors are not accounted for in the model. For any particular number of tractors that start a cycle, a proportion of them have overturn incidents based on the national estimate of the annual probability of overturn reported by Pana-Cryan and Myers (2000). It is assumed in this study that no serious damage occurs to the tractors (which would cause them to leave the program prematurely) after overturn, so all tractors (overturn or no overturn) are fed back into the system to begin the next cycle to maintain consistency with the estimated number in operation for each year (fig. 1). Damage costs are accounted for in the cost of injuries estimate used.

In the event of an overturn, the tractor operator may die (fatal injury) or survive the overturn. Surviving operators may be injured (non-fatal injury) or not. If there is no overturn, then the operator remains healthy. There are no effects associated with those who remain healthy; therefore, the model does not keep track of them. Instead, the numbers of fatal and non-fatal injuries are tracked and accumulated in non-fatal and fatal absorption states (fig. 1). Costs of injuries are not included in this model; only effects are tracked. The only cost included in this study is the initial cost of the intervention, which is obtained by multiplying the total number of estimated retrofittable tractors by the unit cost of intervention. In addition, initial costs (the only difference between the three options) are incurred for the Install-ROPS and Install-CROPS options only, i.e., ROPS and CROPS are installed at the beginning of 2004. Thus, the costs are not discounted.

Data

Estimates from published literature, ROPS manufacturers, and expert opinion are used in this study because actual values are either hard to collect or do not exist in the literature. Sources and values used are presented below.

Willingness-to-Pay Estimates

Willingness-to-pay estimates specifically for injuries resulting from tractor overturns do not exist. The most closely related types of injuries for which current validated estimates exist are the willingness-to-pay estimates for motor vehicle accidents reported by the National Safety Council (NSC, 2005) in 2004 dollars. According to the NSC report, willingness-to-pay estimates are based on the comprehensive costs concept, which includes “the value of lost quality of life which was obtained through empirical studies of what people actually pay to reduce their safety and health risks,” and the report recommends that, where feasible, they should be used for cost-benefit analyses. This is because other estimates (such as the human capital or foregone income estimates) substantially underestimate the benefit of preventing injuries; it ignores intangible costs.

The estimates are \$3,760,000 for a fatal injury, \$188,000 for an incapacitating injury, and \$48,200 for a non-incapacitating injury. Injury classification in this study is different from those for which the report has estimates, so the most conservative estimates are used for all non-fatal injuries, i.e., \$48,200. Although this will underestimate the final results, it will provide a conservative estimate of the potential net monetary benefit of the CROPS intervention. In addition, the average economic cost of fatal injury (\$1,130,000) is used as the conservative willingness-to-pay estimate. The economic cost of non-fatal injury is not changed because there is no substantial difference between the willingness-to-pay value used and the economic cost estimate.

Cohort Size

Cohort size is adopted from Myers and Pana-Cryan (2000) using the method proposed by Myers and Snyder (1995). For the year 2004, the estimated number of tractors is 1,065,164. Myers and Snyder (1995) concluded that their estimates are conservative. Therefore, a sensitivity analysis is conducted with a starting cohort size of 1,500,000 as the number of retrofittable tractors to examine how that affects the net monetary benefit (NMB).

Analytic Horizon

A 20-year period is used in this study to be consistent with previous studies. Following Owusu-Edusei and Biddle (2007a, 2007b), a sensitivity analysis is conducted for 5 through 30 years.

Cost of Intervention

According to Owusu-Edusei and Biddle (2007b), the unit cost of intervention for CROPS is \$450 (in 2004 dollars), which includes a price quote from a ROPS manufacturer (\$300), average cost of shipping and handling (\$140), and opportunity cost of installation time (\$10), all in 2004 dollars. Thus, the overall total cost of the intervention is obtained by multiplying the unit cost (\$450) by the starting cohort size (1,065,164), yielding \$479,323,800, while the start-up cost for existing ROPS retrofits is \$1,065,164,000 at a unit cost of \$1,000, which includes shipping and installation (Scharf et al., 1998). The most recent cost of ROPS retrofits was reported by Myers et al. (2004) at \$647. However, this price does not include shipping and handling. Thus, the estimate reported by Scharf et al. (1998) is still a reasonable estimate after including shipping, handling, and installation costs, in 2004 dollars. A sensitivity analysis is conducted for the average unit cost of intervention up to \$1,000 to account for increases in cost that may be the result of CROPS models designed for larger non-ROPS tractors (higher cost of production) together with increases in shipping and handling costs.

Probability of Overturn

Following Owusu-Edusei and Biddle (2007a), overturn probabilities are computed from estimates reported by Pana-Cryan and Myers (2000) and Cole et al. (2000). Result of the actual-operation-time-adjusted probabilities used in the model are adopted from Owusu-Edusei and Biddle (2007a) and presented in table 1. The probabilities of overturn were the same for the CROPS and ROPS options but different for the do-nothing option because the computed probabilities were based on operation time, which is substantially different according to Myers and Snyder (1995) and Myers et al. (2005). Thus, a scale factor of 1.69 (column four divided by column three in table 1) is used to account for the change in probability resulting from the change in operation time when CROPS and ROPS are installed. The scale factor is varied from 1 through 3 in the sensitivity analyses to determine how it affects the NMB. Although reports do not show three-fold increases, it is used in this study to see how the NMB is sensitive to the change in probabilities.

Social Discount Rate

This research uses a discount rate of 4% to maintain consistency with the discount rate used in previous cost-effectiveness studies conducted on ROPS and CROPS (Owusu-Edusei and Biddle, 2007a, 2007b; Myers et al., 2004; Pana-Cryan and Myers, 2000). All effects are discounted so that all monetary values are in present (2004) values. Sensitivity analysis was conducted for values from 0% to 10% to see how the NMBs are sensitive to the social discount rate. A summary of the variables used and the extreme values used is presented in table 2. Values in parentheses were used for the sensitivity analysis.

Table 1. Calculation of annual probabilities of tractor overturn.^[a]

Annual probability (2000 hours)	Convert probability to rate: -Ln(1-prob)/time	Convert the resulting rate to probability: 1-Exp(-rate*time)	
		Non-ROPS equipped	ROPS equipped
0.00145	0.001451052	0.000172692	0.000291704
0.007604	0.007633058	0.000907921	0.001535422

^[a] Ln is the natural log and Exp is exponential. Time is equal to 1 in the second column, 238/2000 or 0.119 in the third column, and 402/2000 or 0.201 in the fourth column.

Table 2. Variables and sources of estimates used in the study.^[a]

Variable	Value	Source
Willingness-to-pay		
For a fatal injury	\$3,760,000 (\$1,130,000)	NSC, 2005
For a non-fatal injury	\$48,200	NSC, 2005
Analytic horizon	20 (5-30)	Assumed
Starting cohort size (2004)	1,065,164 (1,500,000)	Myers and Snyder, 1995 (assumed)
Cost of intervention		
CROPS	\$450	Manufacturer
ROPS	\$1000 (\$647)	Scharf et al., 1998 (Myers et al., 2004)
Discount rate	0.04 (0.00-0.10)	CDC recommendation
Probability of fatal injury		
Without CROPS	0.09593 (0.4)	Cole et al., 2000 (CDC, 1993)
With CROPS	0.00115 (0.0024)	Springfeldt et al., 1998 (Pratt and Hard, 1998)
Probability of non-fatal injury		
Without CROPS	0.69 (0.83)	Cole et al 2000a (Myers and Pana-Cryan, 2000)
With CROPS	0.17 (0.34)	Springfeldt et al., 1998 (Myers and Pana-Cryan, 2000)
Probability of overturn		
Without CROPS	0.000172692 (0.000907921)	Computed from estimates by Myers and Pana-Cryan, 2000 (Cole and Westneat, 2001)
With CROPS	0.000291704 (0.001535422)	
Scale factor of probabilities	1.69 (1-3)	Computed (assumed)

^[a] All cost estimates are in 2004 dollars.

Results

Results of the cohort analysis are shown in tables 3 and 4. The values in each column represent the numbers at the end of the year. For a starting cohort size of 1,065,164 (the size at the end of 2003) of the estimated retrofittable tractors at the beginning of 2004, the Install-CROPS and Install-ROPS options prevented 192 (discounted) fatal injuries and 686 (discounted) non-fatal injuries over the 20-year period, yielding a total of 878 injuries (see discounted cumulative effects in tables 3 and 4). Costs and benefits computed indicate that when existing ROPS retrofits are used there is a net cost to society of \$310 million compared to the baseline (do-nothing). However, the Install-CROPS option yields a net benefit of \$276 million.

Benefit-cost ratios (BCR), return on investment (ROI), and net present values (NPV) are presented in table 5. Net present value (NPV) and net monetary benefit (NMB) are used interchangeably in this study because all benefits and costs are in present values.

Table 3. Cohort analysis summary report: no protective structure (do-nothing) option.

Year	Cohort Size (tractors in service)	Cumulative Non-Fatal Injuries	Cumulative Fatal Injuries	Effect: Fatal plus Non-Fatal (discounted)	Cumulative Effect (discounted)
2003	1065164	--	--	--	--
2004	1043623	113	17	125	125
2005	1022082	223	34	118	243
2006	1000541	331	51	111	353
2007	979000	437	67	104	458
2008	957459	540	83	98	556
2009	935918	641	99	92	648
2010	914377	740	114	87	734
2011	892836	836	129	81	815
2012	871295	930	143	76	892
2013	849754	1022	157	71	963
2014	828213	1111	171	67	1030
2015	806672	1198	184	63	1093
2016	785131	1283	197	59	1152
2017	763590	1365	210	55	1206
2018	742049	1445	222	51	1258
2019	720508	1523	234	48	1306
2020	698967	1598	246	45	1350
2021	677426	1672	257	42	1392
2022	655885	1742	268	39	1431
2023	634344	1811	278	36	1467

Table 4. Cohort analysis summary report: Install-ROPS and Install-CROPS options.

Year	Cohort Size (tractors in service)	Cumul- ative Non-Fatal Injuries	Cumul- ative Fatal Injuries	Start-Up Cost (\$)		Effect: Fatal plus Non-Fatal (discounted)	Cumulative Effect (discounted)
				Install CROPS Option	Install ROPS Option		
2003	1065164	--	--	479,323,800	1,065,164,000	--	--
2004	1043623	52	0	--	--	50	50
2005	1022082	103	1	--	--	47	97
2006	1000541	152	1	--	--	44	142
2007	979000	201	1	--	--	42	184
2008	957459	248	2	--	--	39	223
2009	935918	295	2	--	--	37	260
2010	914377	340	2	--	--	35	295
2011	892836	385	3	--	--	33	327
2012	871295	428	3	--	--	31	358
2013	849754	470	3	--	--	29	387
2014	828213	511	3	--	--	27	413
2015	806672	551	4	--	--	25	439
2016	785131	590	4	--	--	24	462
2017	763590	628	4	--	--	22	484
2018	742049	665	5	--	--	21	505
2019	720508	701	5	--	--	19	524
2020	698967	735	5	--	--	18	542
2021	677426	769	5	--	--	17	559
2022	655885	802	5	--	--	16	574
2023	634344	833	6	--	--	14	589

Table 5. Costs and benefits of the Install-ROPS and Install-CROPS options compared to the baseline (no protective structure).^{[a] [b]}

	Install-ROPS	Install-CROPS
Costs		
Unit cost of intervention	\$1,000	\$450
Quantity	1,065,164	1,065,164
Total	\$1,065,164,000	\$479,323,800
Benefits		
Fatal injuries prevented: 192 × \$3,760,000 (\$1,130,000)	\$721,920,000	(\$216,960,000)
Non-fatal injuries prevented: 686 × \$48,200	\$33,065,200	
Total	\$754,985,200	(250,025,200)
Benefit-cost ratio (BCR)	0.7 (0.2)	1.6 (0.5)
Return on investment (ROI)	Negative (negative)	0.6:1 (negative)
Net present value (NPV)	-\$310,178,800 (-\$815,138,800)	\$275,661,400 (-\$229,298,600)

[a] All cost estimates are in 2004 dollars.

[b] Values in parentheses are worst-case estimates using the economic cost of fatal injuries as the lower bound value for willingness-to-pay.

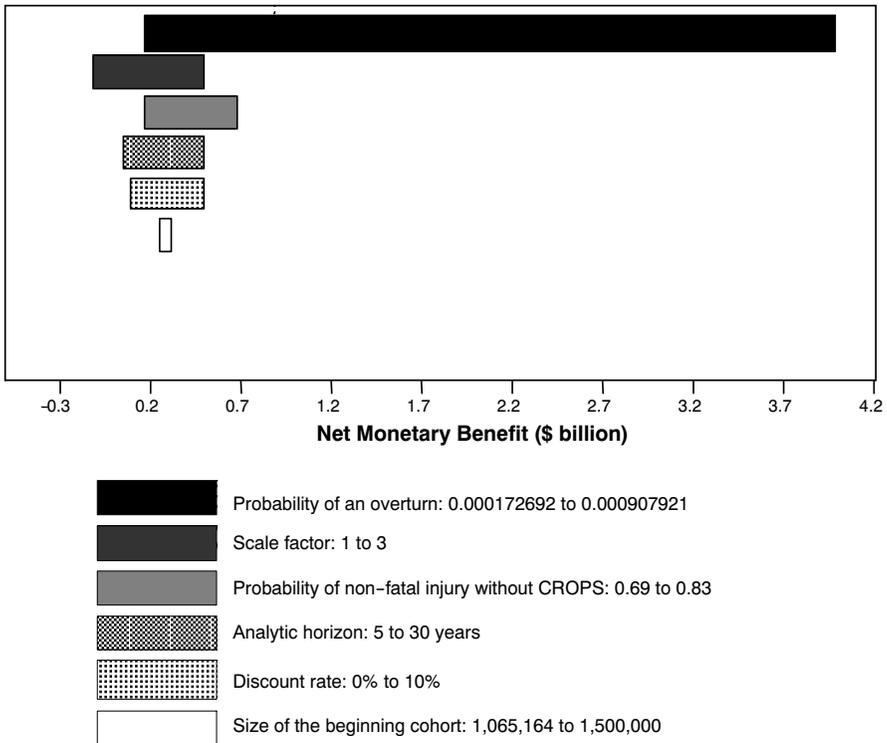


Figure 2. Tornado diagram: One-way sensitivity analysis.

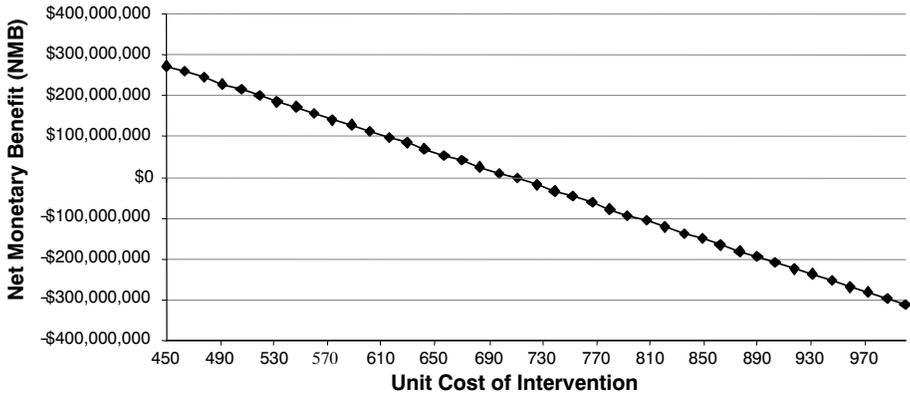


Figure 3. Break-even analysis chart.

Thus, the estimated net present value (total net monetary benefit) of the program when compared to installing ROPS is \$586 million (from a net loss of \$310 to a net gain of \$276). There are net losses for both CROPS and ROPS when the lower bound value of the willingness-to-pay is used. However, ROPS results in a net loss of \$815 million compared to a loss of \$229 million when CROPS is adopted, keeping the net gain of CROPS over ROPS the same.

Sensitivity Analysis (SA)

The most appropriate summary of the sensitivity of NMB to the variables used in the analyses, which enables the isolation of the important variables, is the use of a tornado diagram. The horizontal bars in the tornado represent a one-way sensitivity analysis for each variable using its extreme values and keeping all others constant at their base values. The NMB values in the tornado diagram are for the Install-CROPS option only because the relative magnitude of the NMBs will be the same for the Install-ROPS option. A separate SA was conducted on the unit cost of intervention. The tornado diagram indicates that the probability of overturn is the most important variable given the range used (fig. 2), confirming results found in the previous studies (Owusu-Edusei and Biddle, 2007a, 2007b).

The NMB ranged from \$0.2 billion to \$4.0 billion. Another important variable is the relative change in the probability of overturn after installation of a protective structure. The tornado diagram was generated using all the variables in the model. Variables that do not show up on the diagram have relatively negligible impact on NMB.

Break-Even Analysis

Because the focus of this study is on the unit cost of intervention, a one-way sensitivity analysis was conducted on the unit cost of intervention ranging from \$450 to \$1,000. A one-way SA enables us to determine the break-even unit cost of intervention. The results indicate that when the unit cost of intervention is \$710 or greater, there are no net benefits (fig. 3). Thus the break-even unit cost is \$710, a 58% increase in the unit cost of intervention for the Install-CROPS option.

Payback Period

The payback period (time to break-even: NMB = 0) can also be easily obtained from a one-way sensitivity analysis of the NMB on the analytic horizon. Both the Install-ROPS and Install-CROPS options were included in this analysis. When the base unit cost of

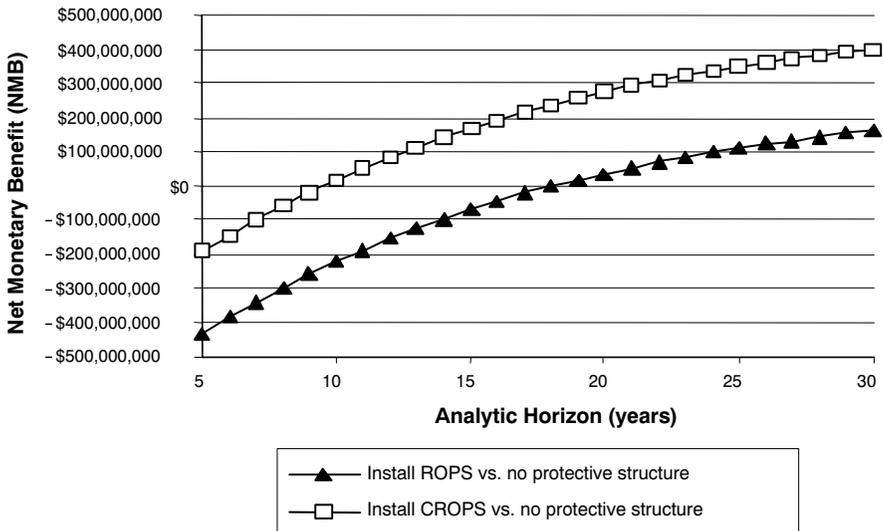


Figure 4. Determining payback period.

ROPS (\$1,000) is used, there is no net benefit. Thus, the unit cost of the Install-ROPS option used in the break-even analysis is \$647, which is the most current figure published for ROPS retrofits (Myers et al., 2004). However, this figure does not include shipping, handling, and installation. The measure of payback period used in this study is a more appropriate procedure because all costs and benefits are in present values. The results indicate that it would take about 10 and 18 years to pay back the Install-CROPS and Install-ROPS options, respectively (fig. 4). Thus, even with the minimal unit cost of intervention for the Install-ROPS option, the payback period is almost halved when the Install-CROPS option is chosen over the Install-ROPS option.

Discussion

Results of this study indicate a net savings of \$586 million over a 20-year period for an estimated cohort size of 1,065,164 tractor operators if the Install-CROPS option is chosen over the Install-ROPS option. The estimates were based on a unit cost of \$450 for CROPS intervention and \$1,000 for existing ROPS retrofits. The break-even unit cost of intervention is \$710, which is about a 58% increase in the unit cost of intervention for CROPS. The reason for the positive net gain to society is the low cost of CROPS, a direct product of the CROPS research project.

Valuing the mental and physical effort that goes into research and development is a daunting task at every level. While the benefits of research and development are obvious, few studies have assigned direct monetary values to them. This study has estimated the value of the CROPS research project at NIOSH. Determining the costs and benefits of projects can help to allocate initial societal resources to those projects that have the best potential to improve the health and safety of workers. It also encourages the expansion of the project to include all the retrofittable non-ROPS models. The break-even unit cost of intervention is also useful information for researchers, decision makers, and ROPS manufacturers. The retirement rate of the target population of tractors highlights the issue of timing: the need to act now. As with most safety and health programs, high-risk

agricultural communities would gain more from such a program given the substantial effect the probability of overturn has on the magnitude of the NMB.

Broad societal implications of the program would have to be examined in detail. For instance, it is not clear what the macro effect of such a broad program would be on steel prices in the short and long run. Distributional and equity-related issues would also have to be addressed if the program is to be funded by the federal government, or any organization for that matter.

Limitations of the Study

As with all models, the reliability of the results from the model used in this study depends on the assumptions and the data used. Thus, the results are good insofar as the estimates are reliable. Data used in this study were collected from various sources, some of which are estimates not derived from raw data, and that is the major limitation of the study. Given the state-of-the-art knowledge in modeling, the comprehensive sensitivity analysis conducted addresses this limitation to some extent. Another limitation is that the model is static; there are no changes in probabilities over time.

Given the perspective and underlying assumptions of this study, a number of implications can be identified from the results. The assumption that all operators would use seatbelts is overly simplistic. This is because some farmers do not use them and might never use them even after installing a ROPS or CROPS. Therefore, some form of encouragement to use seatbelts would have to be an integral part of the program. Thus, even though the results show that there is a net benefit if society pays for the program, more expenses would be incurred to enforce compliance (compliance cost), which was ignored in this study. In addition, some costs would be incurred to locate the retrofittable non-ROPS tractors that are eligible for the program. This limitation does not affect the net benefit of CROPS over ROPS because in either program, ancillary costs (search, compliance, etc.) would have to be accounted for.

Production, shipping, and handling costs for larger tractors would likely be higher. However, it is conceivable that the cost of ROPS for larger tractors would also be higher than the \$1000 used in this study. This observation, together with the sensitivity analysis conducted on the average unit cost of intervention, should reduce the concern about the use of the average unit cost of CROPS for the two models (which are relatively small) for the entire tractor population.

Conclusion

This study estimated the net monetary benefit of installing CROPS instead of existing ROPS retrofits for all estimated retrofittable non-ROPS tractors in the year 2004. With the conservative estimates used in the analyses, the results indicate that compared to the baseline option (no protective structure), the Install-ROPS option results in a loss of \$310 million to society, while the Install-CROPS option results in a net monetary benefit of \$276 million over the 20-year period. Results from the comprehensive sensitivity analyses indicate that, for the extreme values (estimates) used, the probability of overturn is the most important variable that affects the estimated net monetary benefit. Break-even analysis indicates that the unit cost of intervention for the Install-CROPS option can increase by about 58% and still be able to pay for itself. Even when the minimal unit cost of intervention for ROPS is used, the payback period is reduced substantially (almost halved) when the Install CROPS option is adopted. Finally, the results indicate that compared to the existing ROPS retrofits, the net monetary benefit is \$586 million, which represents the potential benefits of the CROPS research project.

In spite of the fact that sensitivity analysis, to some extent, addresses the variability in the estimates used, the results found in this study can be improved by undertaking further research to:

- Find actual or more reliable estimates of the probability of events. The high sensitivity of the NMB to the probability of overturn serves as ample evidence for this need.
- Estimate the willingness-to-pay for all categories of injuries that occur as a result of tractor overturns.
- Assemble detailed information on the injuries that occur with and without ROPS and CROPS. This could help capture the difference in benefit, if any, between ROPS and CROPS.

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