Economic Impact of a Premature Death from a Tractor Rollover and an Estimate of ROPS Prevalence on Iowa Tractors

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1 Executive Summary

With the heightened risk of injury and/or death to Iowa agricultural producers from unsafe equipment, Decision Innovation Solutions has been asked to conduct an analysis addressing two key aspects of continuing to operate tractors without ROPS; these are to estimate:

- The economic impact of a primary farm operator prematurely dying from a tractor rollover at age 58, which is the average age of principal operators in Iowa.
- The approximate number of tractors built prior to 1986 in Iowa that do not have an installed ROPS.

Economic Impact of a Premature Death

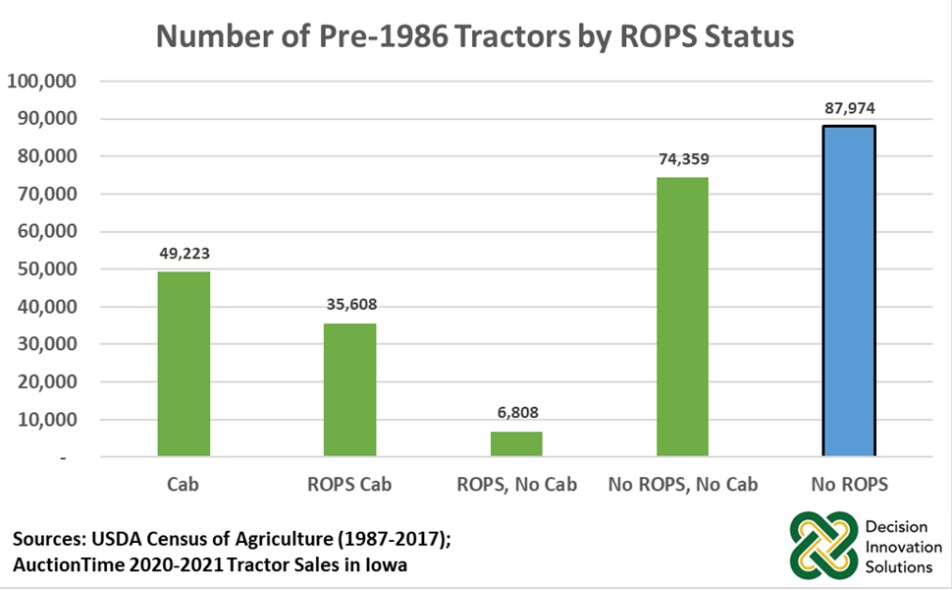
As shown in the following tables, the combined impacts of a one-time 20% reduction in farm purchases and a 50% reduction in household expenditures over 7 years are estimated to cause a reduction of 3.6 jobs, $186,306 in labor income, $354,999 in value-added and $741,962 in output. Furthermore, the reduction in cumulative local, state, and federal taxes paid is $59,299.

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	(0.3)	$ (35,084)	$ (69,153)	$ (216,486)
Indirect Effect	(0.6)	$ (29,050)	$ (52,047)	$ (111,949)
Induced Effect	(2.7)	$ (122,173)	$ (233,799)	$ (413,527)
Total Effect	(3.6)	$ (186,306)	$ (354,999)	$ (741,962)

Impact Type	Total Tax Impact
Direct Effect	$ 1,889
Indirect Effect	$ (10,357)
Induced Effect	$ (50,831)
Total Effect	$ (59,299)

Number of Pre-1986 Iowa Tractors without ROPS

While an estimated 42,416 tractors in Iowa do have a ROPS of some type (“ROPS Cab” plus “ROPS, No Cab”), an estimated 87,974 (67.5% of estimated total) tractors in Iowa do not have a ROPS of any type.



2 Introduction

According to the National Institute for Occupational Safety and Health (NIOSH 2016), agriculture ranks among the most hazardous industries. Farmers are at very high risk for both fatal and nonfatal injuries. Farming is one of the few industries in which family members (who often share the work and live on the premises) are also at risk for fatal and nonfatal injuries. Consider the following:

- Approximately 5,858,000 operators and full-time workers were employed in production agriculture in the U.S. in 2017. For Iowa this number was 218,689[1].
- Approximately 1.4 to 2.1 million hired crop workers are employed annually on crop farms in the U.S.[2]
- An estimated 893,000 youth resided on farms in 2014, with about 455,430 youth performing farm work. In addition to the youth who live on farms, an estimated 266,000 youth were hired to work on U.S. farms in 2014 (see footnote 2).

In 2019, 410 farmers and farm workers died from a work-related injury, resulting in a fatality rate of 19.4 deaths per 100,000 workers. Transportation incidents, which include tractor overturns were the leading cause of death for these farmers and farm workers (see footnote 2).

As indicated in Figure 1, over the last three years agriculture[3] has not been the riskiest occupation. The total number of deaths in the construction industry (958) was the largest in 2020. Deaths in agriculture from work-related injuries fell about 11% to 481 in 2020 compared with the previous year. However, the same year, agriculture's death rate was the highest (20.5 deaths per 100,00 workers), followed by the death rate in transportation and warehousing (12.6 per 100,000 workers) (see Figure 2).

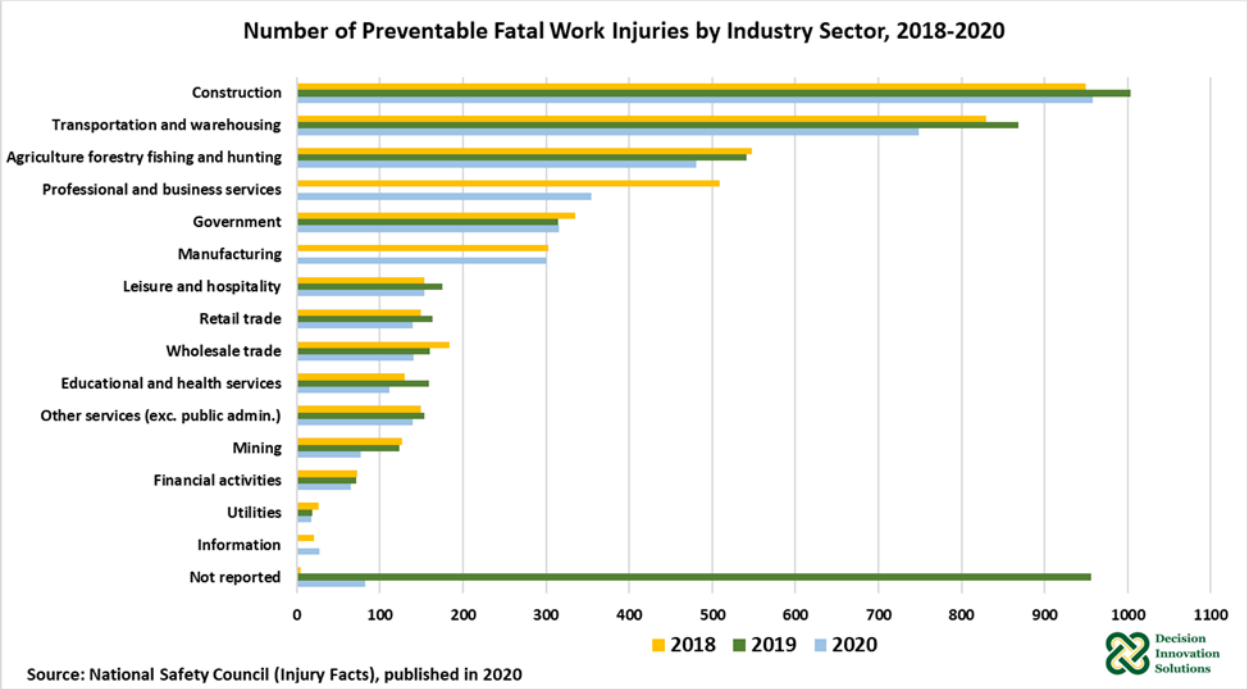


Figure 1. Number of Preventable Fatal Work Injuries by Industry Sector, 2018-2020

[1] USDA-NASS Census of Agriculture 2017.
[2] Agricultural Safety, NIOSH, CDC. Agricultural Safety | NIOSH | CDC
[3] Agriculture includes forestry, fishing, and hunting.

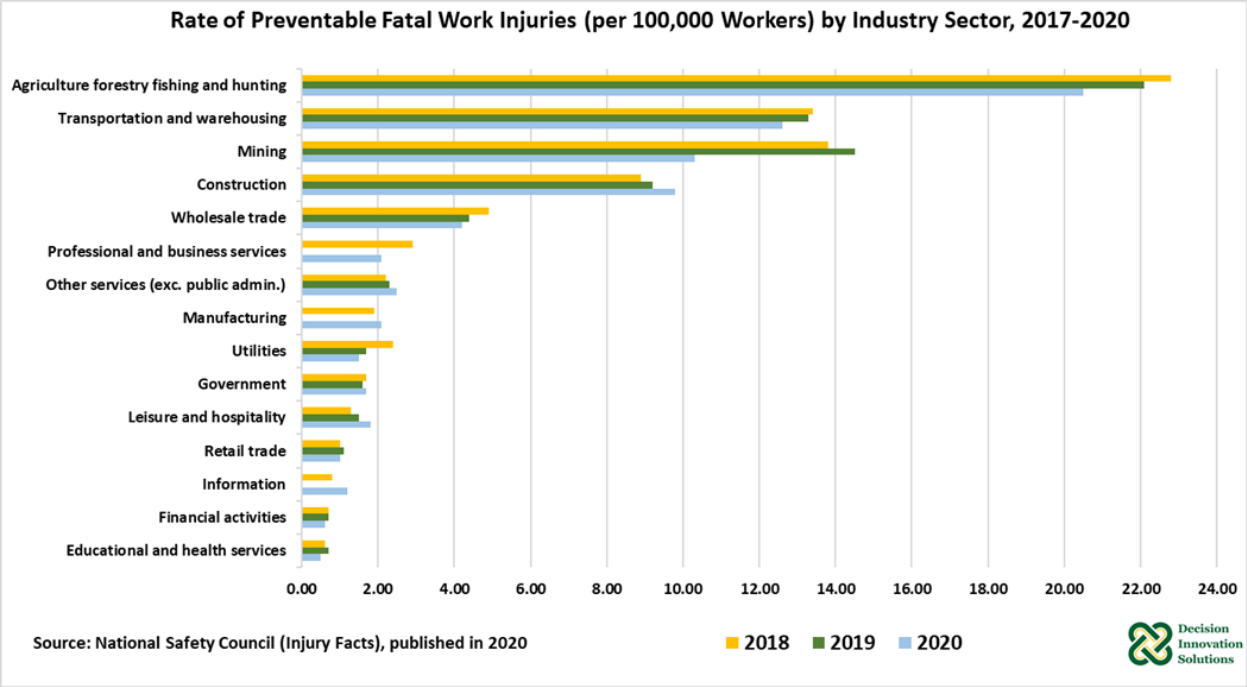


Figure 2. Rate of Preventable Fatal Work Injuries (per 100,000 Workers) by Industry Sector, 2017-2020

According to the National Institute for Occupational Safety and Health, the most effective way to prevent tractor overturn deaths is the use of a Roll-Over Protective Structure (ROPS) with a seatbelt. In 2014, 62% of tractors used on farms in the US were equipped with ROPS. If ROPS were placed on all tractors used on US farms manufactured since the mid-1960's, the prevalence of ROPS-equipped tractors could be increased to over 80%.

With the heightened risk of injury and/or death to Iowa agricultural producers from unsafe equipment, Decision Innovation Solutions has been asked to conduct an analysis addressing two key aspects of continuing to operate tractors without ROPS; these are to estimate:

- The economic impact of a primary farm operator prematurely dying from a tractor rollover at age 58, which is the average age of principal operators in Iowa.
- The approximate number of tractors built prior to 1986 in Iowa that do not have an installed ROPS.

To present the results of the analysis, this report is organized as follows:

- Description of adopted methodology for both aspects of the research
- Presentation of results
- Discussion and summary of implications of results

3 Methodology

This analysis was completed with a combination of the 2019 IMPLAN dataset, data from the USDA 2017 Census of Agriculture, and other USDA NASS and USDA ERS sources. The IMPLAN modeling system and Microsoft Excel were used for calculating and tabulating the results of this analysis. While the 2019 IMPLAN dataset was used to calculate the economic impact results, these results have been adjusted to 2022 dollars using inflation factors within the IMPLAN modeling system. Results show throughout this report are presented using these common economic modeling terms:

- **Sales (Output)**
  - The broadest measure of economic activity – sometimes referred to as "output"
- **Value-Added**
  - Sales (output) minus the costs of inputs
- **Employment (Jobs)**
  - A measure of job positions without regard to whether they are full-time equivalents
- **Labor Income**
  - The sum of proprietor income and employee compensation
  - A subcomponent of value-added

3.1 Economic Impact of a Premature Death from Tractor Rollover

3.1.1 Scenario Definition

The defined scenario is that a primary farm operator prematurely dies from a tractor rollover at age 58, which is the average age of principal operators in Iowa according to the 2017 Census of Agriculture. This leads to the following assumed response by remaining family members[4]:

- There is no farm succession plan in place, which implies a major disruption to farm operations
- The surviving spouse reduces household expenditures due to being left without at least a portion of their normal/expected income and a smaller household
- No life insurance policy on the deceased primary farm operator
- Assume a reduction in purchases for the farm in the short term (1 year) due to disruption
- In the absence of their spouse, the child and their family leave their (and spouse's if working) current employment, leases the farm and assumes the responsibilities of the farm from the widow(er)
- The child's lease payments cover the widow(er)'s (reduced) living expenses

The approach used to answer the research question is to model the loss of household income from the primary wage-earner's accidental death, which would be defined as the difference between the net farm income prior to their death and the lease payments to the widow(er) from the child. In our opinion, it is a safe assumption that after the child fully assumes farming responsibilities farm-related expenditures will return to the same level as prior to the parent's death (meaning that there is only a 1-year reduction in farm expenditures). Assuming a typical Iowa corn/soybean farm, the process for modeling reduced farm purchases and reduced household expenditures within IMPLAN is detailed below.

[4] While not directly quantified in this study, repairs to damaged equipment will almost certainly be incurred. Additionally, the surviving spouse may sell the farm equipment, which then requires the child to rent or buy equipment.

3.1.2 Reduced Farm Purchases

To model reduced farm purchases in year one within the IMPLAN modeling system, it is necessary to first obtain the industry "per worker" values for Sector 1 (Oilseed Farming) and Sector 2 (Grain Farming) and reduce these values by 20 percent. These figures are found in the "Industry Averages" section of "Study Area Data" on the online version of IMPLAN. Table 1 shows the default "per worker" values for Sectors 1 and 2.

Table 1, Default Values per Worker by Sector

	Sector 1 (Oilseed Farming)	Sector 2 (Grain Farming)
Output	$ 1,172,782	$ 485,608
Value Added	$ 509,081	$ 66,878
Labor Income	$ 214,104	$ 62,917
Other Property Type Income	$ 292,277	$ 70,766
Tax on Production and Imports	$ 2,699	$ (66,805)
Intermediate Expenditures	$ 663,701	$ 418,730

Table 2 shows the assumed reduction in "per worker" values in year one. The reductions in intermediate expenditures are assumed to be the direct effects of a premature death from a tractor rollover, which are used as the inputs in IMPLAN to calculate the indirect and induced effects of this reduction. All estimated impacts are included in the Results section of this report.

Table 2, Assumed Reduction in Purchases

	Sector 1 (Oilseed Farming)	Sector 2 (Grain Farming)
Output	$ 234,556	$ 97,122
Value Added	$ 101,816	$ 13,376
Labor Income	$ 42,821	$ 12,583
Other Property Type Income	$ 58,455	$ 14,153
Tax on Production and Imports	$ 540	$ (13,361)
Intermediate Expenditures	**$ 132,740**	**$ 83,746**

3.1.3 Reduced Household Expenditures

The second component of this analysis deals with the effects of reduced household expenditures by the surviving spouse. For this component, it is assumed that the farmer dies at 58, the average age for a principal producer in Iowa according to the USDA 2017 Census of Agriculture. It is also assumed that the farmer would have retired at age 65[5], resulting in 7 years of lost income.

Figure 3 shows real (inflation adjusted) net cash income statistics for corn and soybean farms from 2012 to 2021. Under the assumption of a 50/50 split between corn and soybeans, we calculate an average for projecting net cash income per farm for what would have been the lost income for ages 58-65 of the deceased primary farm operator. This average net cash income is $162,520; half of this is $81,260, which is used as the model input.

[5] According to the USDA 2017 Census of Agriculture, 12% of principal producers are age 65 or older, which indicates that this is likely a conservative estimate.

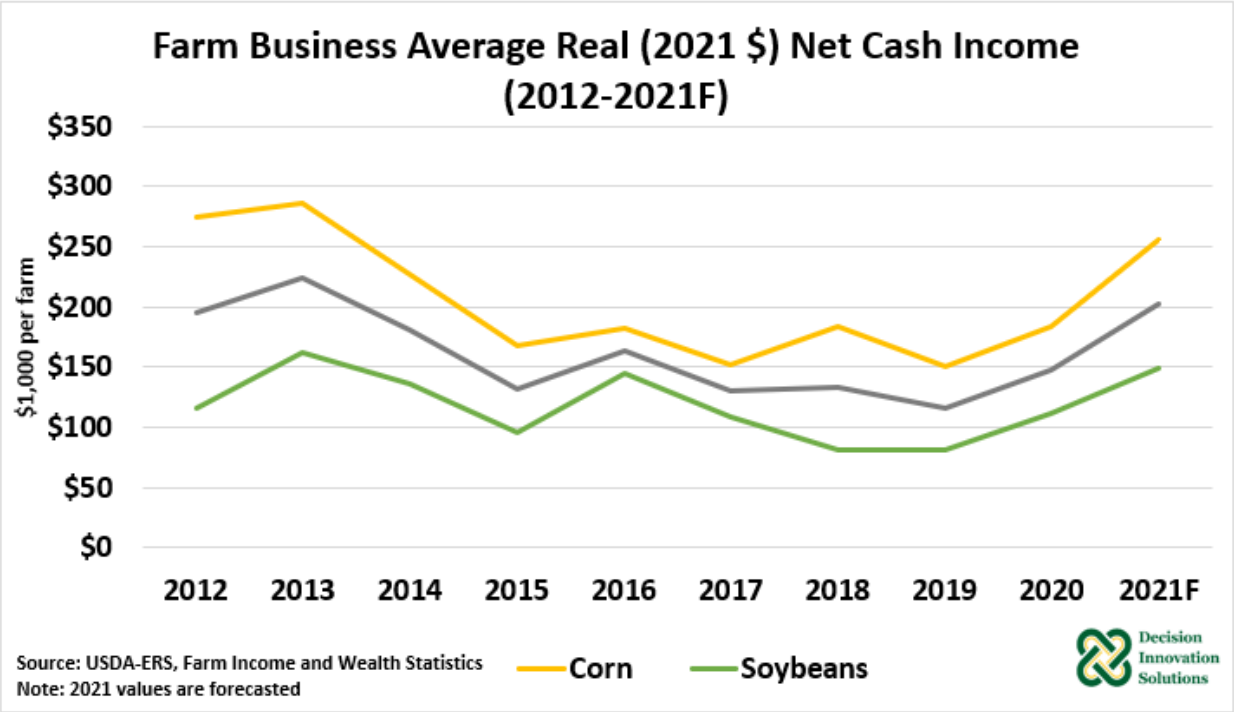


Figure 3, Farm Business Average Net Cash Income, Real Dollars (2012-2021)

The IMPLAN modeling system has a set of household expenditure patterns by size of household income, with the assumption that households of differing income levels spend that income differently. To estimate the impact of reduced household expenditures, we created a "Household Income" event type and reduced the "Households 150-200k" category by $81,260. By definition, household expenditures are considered induced effects, so there are no "direct" or "indirect" effects from reduced household spending. IMPLAN is used to calculate the effects of this household spending reduction, and this first year impact is shown in the Results section of this report.

For the purposes of this analysis, the cumulative impact of all 7 years of this reduction of household expenditures is also considered. To estimate this impact, the effects of each year's reduced household expenditures are estimated using IMPLAN. Using a discount rate of 2.28%[6], these effects are discounted back the first year to create a net present value of the total reduced expenditures impact. This cumulative impact is shown in the Results section of this report.

3.2 Pre-1986 Tractors in Iowa without ROPS

Two methods for estimating the number of pre-1986 tractors in Iowa without ROPS were considered:

- Agricultural producer survey
- Documented sales

[6] This rate was obtained by taking the 30-year average U.S. Treasury Bill rate, which is a common proxy for the risk-free rate of return (see https://corporatefinanceinstitute.com/resources/knowledge/finance/risk-free-rate/).

3.2.1 Agricultural Producer Survey Method

Attempts to conduct a statistically robust survey of Iowa agricultural producers to understand the prevalence of ROPS on pre-1986 tractors in Iowa were not successful. Primary reasons for lack of success were:

1) Those with contact information (Iowa based commodity organizations) for farmers expressed hesitancy and, in some cases, were restricted from sharing this information
2) A low expected response rate leading to results with little explanatory power

3.2.2 Documented Sales Method

Methodology from prior work (estimating the distribution of Iowa planting and harvesting equipment size) was adopted and adapted to estimate the prevalence of pre-1986 tractors in operation without ROPS. The following steps were followed:

1) Determine online auction site(s) would yield sufficient numbers of tractor sales
    a. After reviewing several auction sites, **AuctionTime** was selected as the best option
2) Apply search filters to query relevant results
    a. Geography
        i. Iowa
    b. Year of manufacture
        i. Pre-1986 and 1986 to current
    c. Contains pictures
3) Develop Excel-based template for collecting and summarizing search results
    a. Year
    b. Make/model
    c. Horsepower
    d. Sale location
    e. Sale date
    f. Cab present?
    g. ROPS cab present?
    h. ROPS but no cab (canopy with pillars style) present?
    i. No ROPS and no cab present?
    j. Record additional notes
4) Collect relevant information for each filtered sale (a-j in Step 3)
5) Determine whether a tractor sold on AuctionTime has a legitimate ROPS
    a. Research, by major manufacturer, whether ROPS came standard/optional for tractors manufactured prior to 1986
    b. “All Seasons” cab versus ROPS
    c. “Canopy” style ROPS with visible pillars
6) By date of manufacture, determine universe of Iowa tractors in operation
    a. USDA Census of Agriculture publications released from 1987 to 2017
        i. Tractors, less than 5 Years Old
        ii. Total Tractors - Inventory
    b. Estimate “retirements” of tractors
        i. Not in Iowa (could be in operation outside of Iowa)
7) Compare sales summary with estimated universe of Iowa tractors
8) Summarize results

4 Results

4.1 Economic Impact of a Premature Death from Tractor Rollover

The results of the economic impact study are presented in three formats:

1) A 20% reduction in farm purchases
2) A 50% reduction in household expenditures
3) The combined total of a 20% reduction in farm purchases and a 50% reduction in household expenditures

4.1.1 Reduction in Farm Purchases

Table 3 and Table 4 show the impact of a 20% reduction in farm purchases in the first year following tractor rollover death of the primary farm operator as defined in the Methodology section. As shown, the estimated total impact from reduced farm purchases is a loss of 1.2 jobs, $77,359 in labor income, $145,968 in value-added, and $372,666 in output. The estimated reduction of combined local, state, and federal tax payments is $13,858[7].

Table 3, Reduction in Farm Purchases Impact Summary

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	(0.3)	$ (35,084)	$ (69,153)	$ (216,486)
Indirect Effect	(0.6)	$ (29,050)	$ (52,047)	$ (111,949)
Induced Effect	(0.3)	$ (13,226)	$ (24,768)	$ (44,231)
Total Effect	(1.2)	$ (77,359)	$ (145,968)	$ (372,666)

Table 4, Reduction in Farm Purchases Tax Impact Summary

Impact Type	Total Tax Impact
Direct Effect	$ 1,889
Indirect Effect	$ (10,357)
Induced Effect	$ (5,390)
Total Effect	$ (13,858)

4.1.2 Reduction in Household Expenditures

As defined in the Methodology section, Table 5 and Table 6 show the estimated impact of a 50% reduction in household expenditures in the first year following the premature death of the primary farm operator due to a tractor rollover. As shown, the total first year impact from reduced household expenditures is an estimated reduction of 0.4 jobs, $16,004 in labor income, $30,687 in value-added, and $54,256 in output. The estimated reduction in total taxes paid is $6,686.

[7] Note that this study was conducted using the 2019 IMPLAN model year. As this year had a substantial increase in government payments to farms (particularly through the Market Facilitation Program), estimated tax impacts for reduced farm purchases are likely conservative.

Table 5, Reduction in Household Expenditures Impact Summary, First Year

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0.0	$ -	$ -	$ -
Indirect Effect	0.0	$ -	$ -	$ -
Induced Effect	(0.4)	$ (16,004)	$ (30,687)	$ (54,256)
Total Effect	(0.4)	$ (16,004)	$ (30,687)	$ (54,256)

Table 6, Reduction in Household Expenditures Tax Impact Summary, First Year

Impact Type	Total Tax Impact
Direct Effect	$ -
Indirect Effect	$ -
Induced Effect	$ (6,686)
Total Effect	$ (6,686)

Table 7 and Table 8 show the estimated cumulative (7-year total) impact of reduced household expenditures as defined in the Methodology section. As shown, the estimated cumulative impact from reduced household expenditures is a reduction of 2.4 jobs[8], $108,947 in labor income, $209,031 in value-added, and $369,296 in output. The estimated reduction in total taxes paid is $45,441.

Table 7, Reduction in Household Expenditures Impact Summary, Cumulative

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0.0	$ -	$ -	$ -
Indirect Effect	0.0	$ -	$ -	$ -
Induced Effect	(2.4)	$ (108,947)	$ (209,031)	$ (369,296)
Total Effect	(2.4)	$ (108,947)	$ (209,031)	$ (369,296)

Table 8, Reduction in Household Expenditures Tax Impact Summary, Cumulative

Impact Type	Total Tax Impact
Direct Effect	$ -
Indirect Effect	$ -
Induced Effect	$ (45,441)
Total Effect	$ (45,441)

4.1.3 Total Scenario Impacts

Table 9 and Table 10 show the estimated combined impacts of a 20% reduction in farm purchases and a 50% reduction in household expenditures in the first year. As shown, the total first-year impact is a reduction of 1.5 jobs, $93,363 in labor income, $176,655 in value-added, and $426,922 in output. The reduction in total taxes paid is $20,545.

[8] Note that, as this is a cumulative effect, the jobs impact is spread out over several years. This impact should not be interpreted as a loss of 2.4 jobs per year.

Table 9, Total Impact Summary, First Year

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	(0.3)	$ (35,084)	$ (69,153)	$ (216,486)
Indirect Effect	(0.6)	$ (29,050)	$ (52,047)	$ (111,949)
Induced Effect	(0.7)	$ (29,229)	$ (55,455)	$ (98,487)
Total Effect	(1.5)	$ (93,363)	$ (176,655)	$ (426,922)

Table 10, Total Tax Impact Summary, First Year

Impact Type	Total Tax Impact
Direct Effect	$ 1,889
Indirect Effect	$ (10,357)
Induced Effect	$ (12,077)
Total Effect	$ (20,545)

Table 11 and Table 12 show the estimated combined impacts of a one-time 20% reduction in farm purchases and a 50% reduction in household expenditures over 7 years. As shown, the total cumulative impact is a reduction of 3.6 jobs[9], $186,306 in labor income, $354,999 in value-added, and $741,962 in output. The reduction in cumulative local, state, and federal taxes paid is $59,299.

Table 11, Total Impact Summary, Cumulative

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	(0.3)	$ (35,084)	$ (69,153)	$ (216,486)
Indirect Effect	(0.6)	$ (29,050)	$ (52,047)	$ (111,949)
Induced Effect	(2.7)	$ (122,173)	$ (233,799)	$ (413,527)
Total Effect	(3.6)	$ (186,306)	$ (354,999)	$ (741,962)

Table 12, Total Tax Impact Summary, Cumulative

Impact Type	Total Tax Impact
Direct Effect	$ 1,889
Indirect Effect	$ (10,357)
Induced Effect	$ (50,831)
Total Effect	$ (59,299)

[9] See Footnote 8

4.2 Estimation of Pre-1986 Operational Tractors without ROPS

As mentioned in the Methodology section, the "Documented Sales" method was adopted. Results from following the outlined methodology are presented here.

4.2.1 Collect Sales Data

The website, AuctionTime was used to download all sales of tractors 1985 and older in Iowa during the 2020-2021 time period. 498 relevant tractor sales were found. Figure 4 shows, by year of manufacture prior to 1986, the number of tractors sold during 2020 and 2021 with regard to presence of a cab, a ROPS cab, an open station ROPS and No ROPS of any kind. Summarized[10] counts by these five categories are (see also Figure 5):

- Cab: **188**, or **37.8%** of total sales
- ROPS Cab: **136**, or **27.3%** of total sales
- ROPS, no Cab: **26**, or **5.2%** of total sales
- No ROPS, No Cab: **284**, or **57.0%** of total sales
- No ROPS[11]: **336**, or **67.5%** of total sales

While Figure 4 is simply a summary of sales on AuctionTime during 2020-2021 and at this stage of the analysis is not intended to be used as a representative sample, it is interesting to note the drop off in "No ROPS, No Cab" designation beginning on sales of tractors manufactured in about 1972. At the same time, the "Cab" and "ROPS Cab" designations become more common. Sales of "Cab" and "ROPS Cab" for tractors manufactured in 1984 and 1985 are likely somewhat non-representative due to lack of sales during the sales time period analyzed.

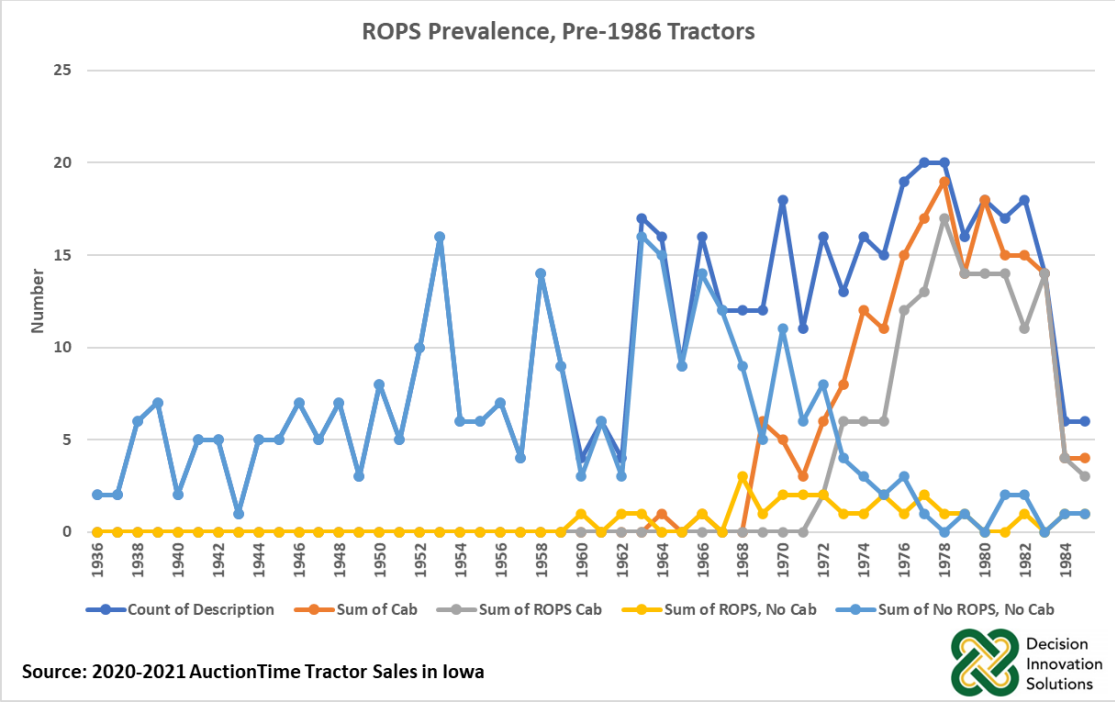


Figure 4, ROPS Prevalence, Pre-1986 Tractors (AuctionTime Sales in Iowa, 2020-2021)

[10] Summed counts and percentages exceed total sales record counts and 100%, respectively, because there is duplication in the "Cab" and "ROPS Cab" categories (i.e., a "ROPS Cab" is also a "Cab").
[11] This number is calculated as the total number of sales minus "ROPS Cab" and "ROPS, No Cab".

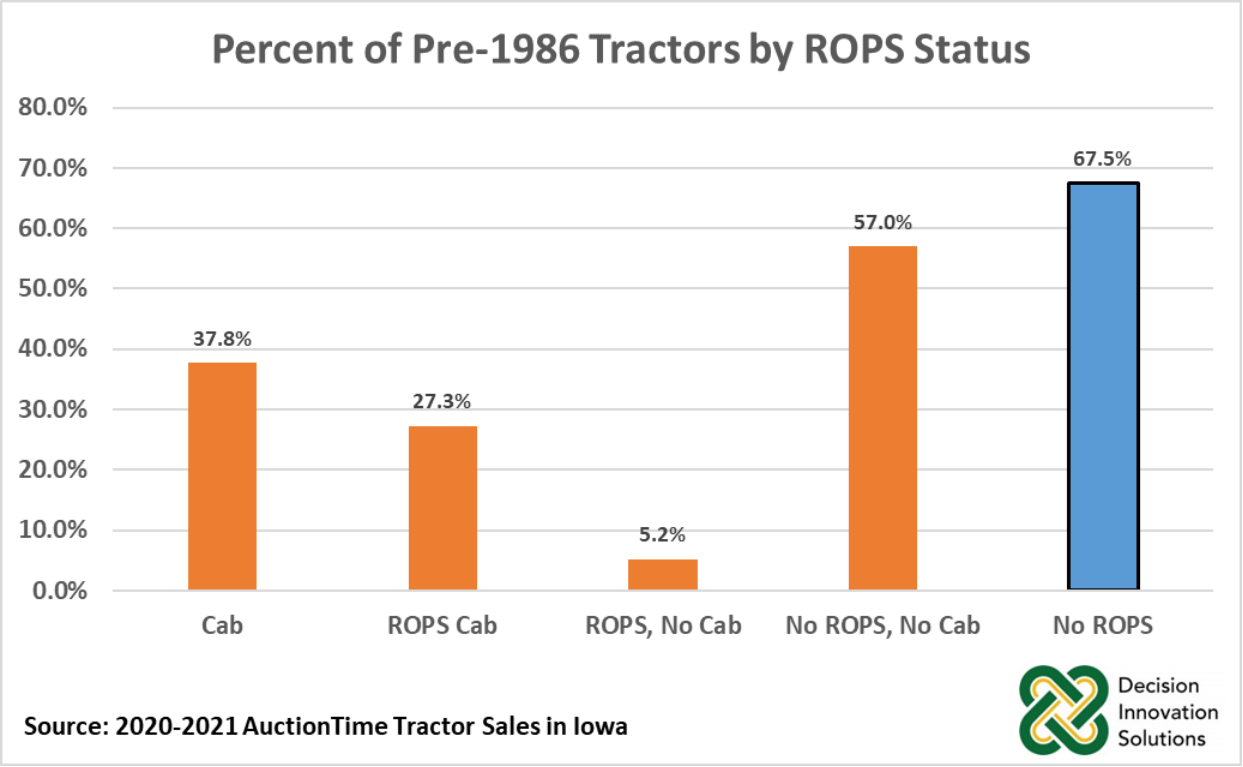


Figure 5, Percent of Pre-1986 Tractors by ROPS Status

4.2.2 Determine Universe of Tractors in Iowa

At five-year intervals, the 1987 through 2017 Census of Agriculture reports estimate the number of total tractors and the number of tractors less than five years old. Using these two data points for all seven (1987, 1992, 1997, 2002, 2007, 2012 and 2017) census reports we solved for the number of tractors manufactured prior to 1987 that are still in Iowa. This was accomplished by starting with the total number of tractors and those which were less than five years old in 1987 and solving for the "loss ratio" that allows each five-year period's tractors to sum to the current (2017) total of tractors. Figure 6 shows the estimated number of tractors still in operation in Iowa as of the end of 2017 for 1987[12] and prior and each subsequent five-year period. The "universe" of tractors not required at time of manufacture to have a ROPS in Iowa still in operation is 130,390, or about 59% of the total tractors in Iowa (221,693). The other 41% are tractors manufactured in 1988 or later.

[12] Due to timing of the Census of Agriculture publications and the year ROPS became mandatory from the factory, there are two "ambiguous" years (1986 and 1987) in our analysis. This analysis effectively assumes tractors manufactured in 1986 and 1987 and were included in the 1987 Census of Agriculture as less than five years old were not required to have ROPS when in fact they were.

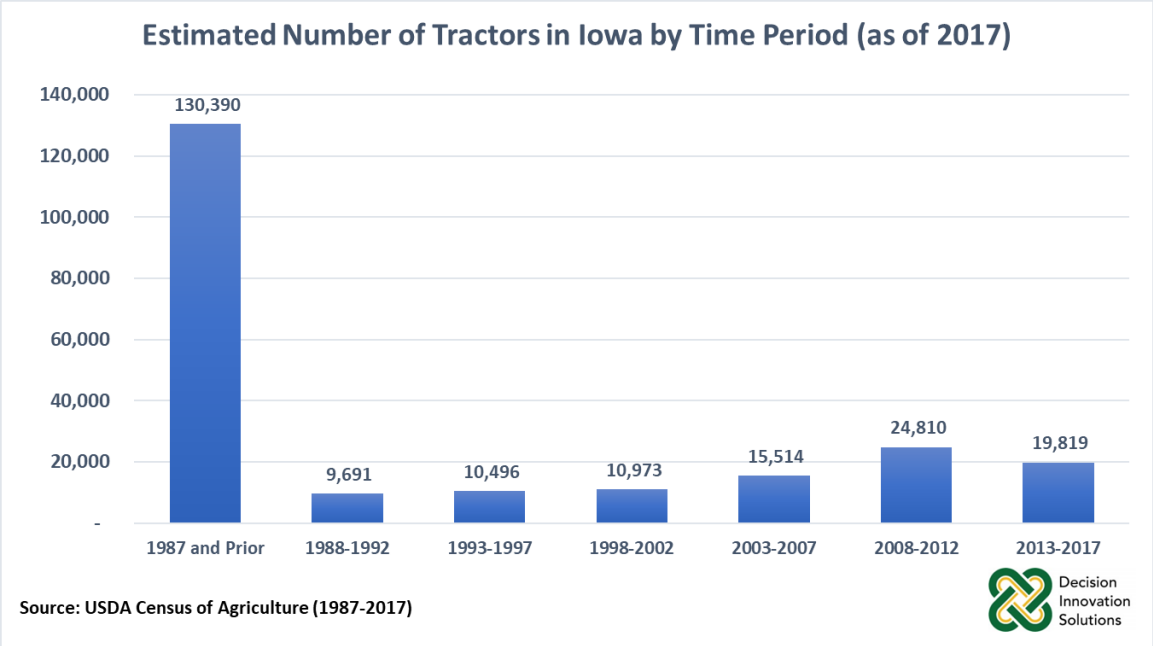


Figure 6, Estimated Number of Tractors in Iowa by Time Period

4.2.3 Compare Collected Data with Universe

To see how representative the sample sales were compared to the estimated totals in the same time periods as shown in Figure 6, we queried all tractor sales in Iowa for all years of manufacture on the AuctionTime website. During 2020 and 2021 a total of 994 tractors manufactured in 2017 and prior were sold in Iowa. Figure 7 shows the comparison of estimated percentages of total inventory of tractors by time period with the corresponding sales of tractors on AuctionTime during 2020 and 2021. The absolute average difference between calculated total inventory and sales on AuctionTime by time period was 2.8%.

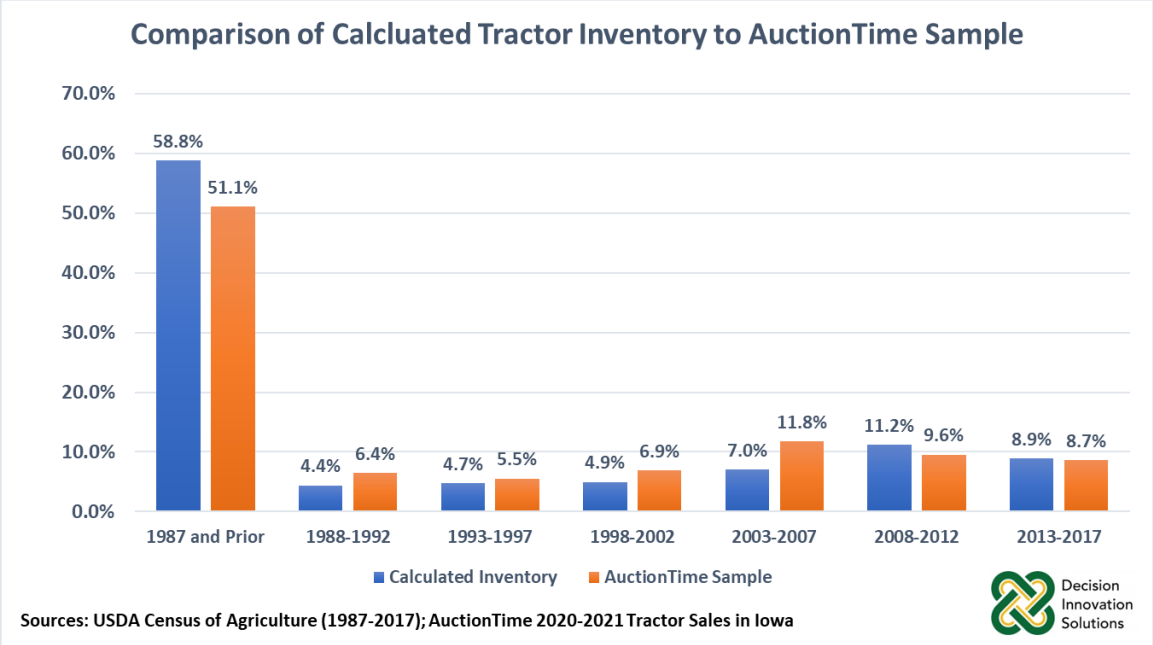


Figure 7, Comparison of Calculated Tractor Inventory to AuctionTime Sample

4.2.4 Estimated Number of Operational Pre-1986 without ROPS

Short of a census-grade survey, there is no method for determining whether the sample sales obtained from AuctionTime are in fact representative of all tractors in Iowa. Additionally, without a costly special survey conducted by the United States Department of Agriculture/National Agricultural Statistics Service, there is no way to determine whether estimates of tractors by age category is completely accurate. Notwithstanding the inability to know with certainty whether these two estimates are accurate, the closeness of the percentages would suggest a very good approximation.

Using a combination of data contained in Figure 6 (130,390 tractors 1987 and prior) and Figure 5 (67.5% of percent of tractors estimated to not have a ROPS of any kind) an estimated:

- 87,974 (67.5% of estimated total) tractors not required at time of manufacture to have a ROPS in Iowa *do not* have a ROPS of any type (see Figure 8).
- 42,416 tractors not required at time of manufacture to have a ROPS in Iowa *do* have a ROPS of some type ("ROPS Cab" plus "ROPS, No Cab").

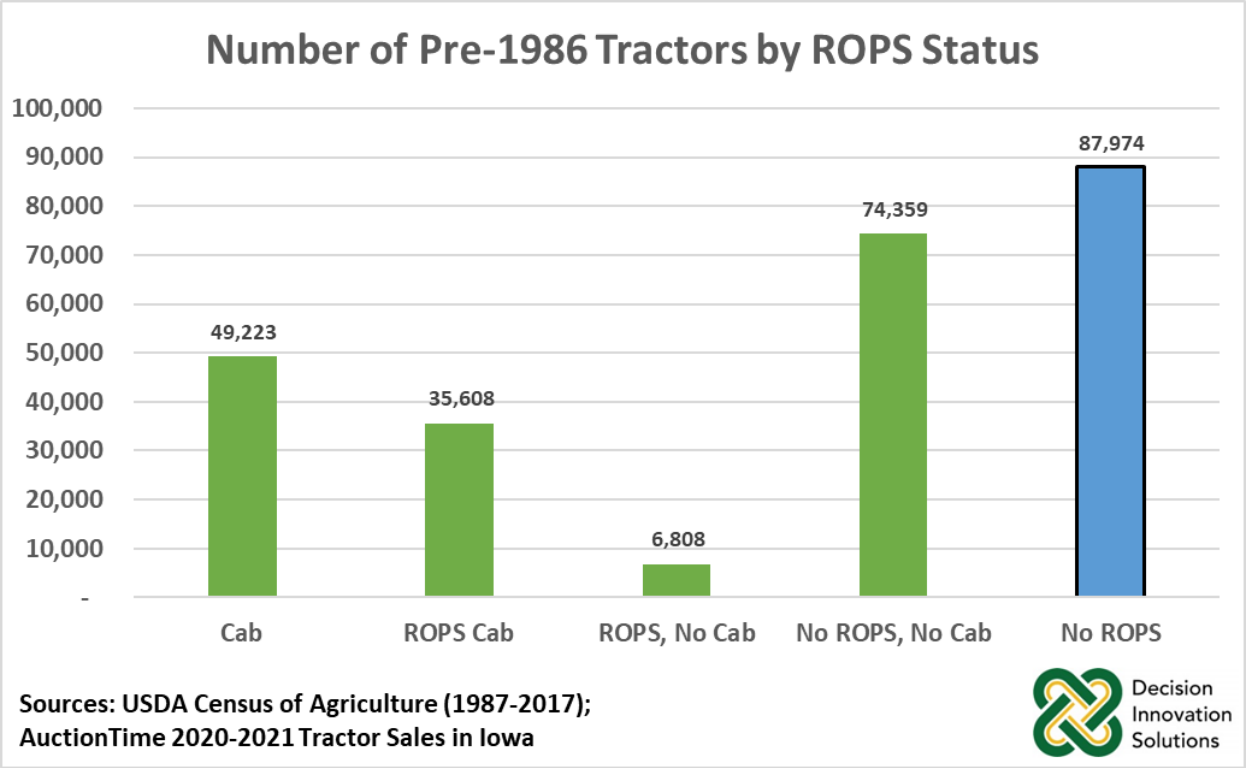


Figure 8, Number of Pre-1986 Tractors by ROPS Status