



# **2021 Agricultural Equipment Emissions Inventory**

**Public Webinar**

**Air Quality Planning & Science Division**

**July 15, 2021**

# What is an Emissions Inventory?

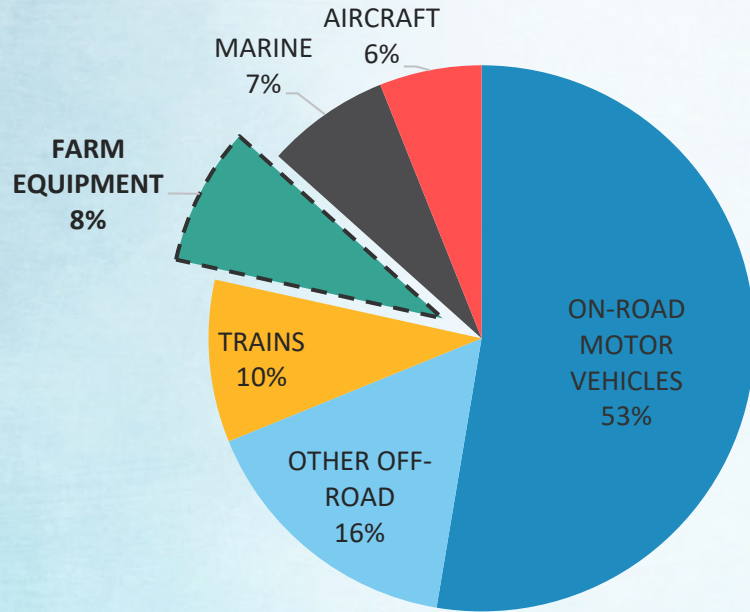
An emissions inventory for an industry sector accounts for:

- *Population* of equipment
- How often it is used (*activity*)
- The equipment *model year* (newer equipment is generally cleaner)
- The region where the equipment is used (generally by *county*)
- The total resulting *emissions* from the equipment

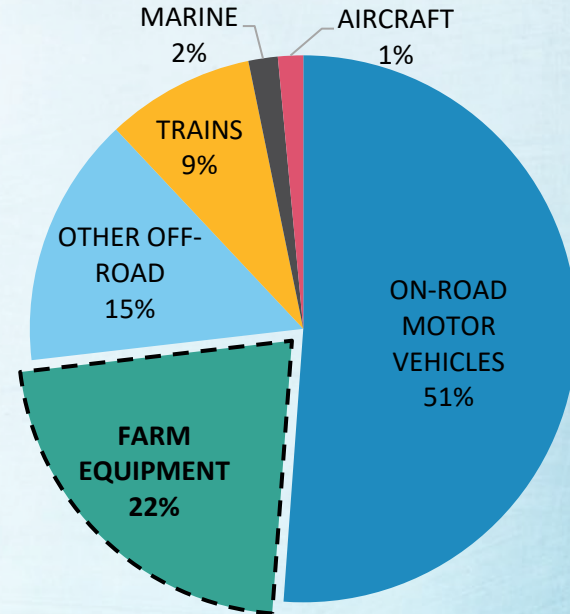
CARB uses emissions inventories to understand where air pollution comes from and to create strategies for emission reductions.

# The Importance of Agricultural Equipment Emissions

## 2020 Statewide Mobile Source NOX Emissions Contribution



## 2020 SJV Mobile Source NOX Emissions Contribution



# Need for an Updated Inventory

- California is the nation's leader in agricultural production, and ag equipment is a large contributor to California's air quality issues.
- Updating the inventory helps:
  - Track the *effectiveness of incentive programs* in cleaning up the ag equipment fleet
  - Provides more accurate and up-to-date emissions inventory information to *improve future air quality modeling and planning efforts*
  - Provides a new snapshot of the equipment allocation geographically to help with *allocation of the latest round of FARMER funding* in September



# Key Inventory Improvements

- **CARB's new 2021 inventory replaces the 2011 ag inventory** and:
  - Updates the **input data vintage** by almost 10 years survey (from 2008 to 2018), USDA Ag Census (from 2007 to 2017), etc.
  - Reflects the latest **USDA Census of Agriculture** and **County Ag Commissioners' data** on California acreage for allocation across the state
  - Utilizes the latest available data on **in-use emissions** of various equipment
  - Reflects the large number of agricultural equipment **incentive projects accomplished** with the assistance of CARB's FARMER program, NRCS and SJV APCD funds, and Moyer funding from 2009 to 2017 in the baseline equipment population reported in the survey data
  - Reflects the latest **farm fuel usage** data reported by EIA

# 2021 Agricultural Equipment Emissions Inventory Development

## Data Sources

- **Statewide survey** of agricultural operations (**equipment**: make/model, fuel type, horsepower, fuel usage and **commodity**: crop type, amount harvested)
- **Farm size data by county**: 2017 USDA Agricultural Census
- **Commodity data by county**: 2018 County Ag Commissioners' Reports
- **Fuel use**: U.S Energy Information Association (EIA) (farm diesel fuel use)
- **Geographic allocation**: NASS 2017 Cropland Data (update county/air district crop allocations)
- **Load Factors**: CARB developed ag equipment-specific load factors in 2008
- **Emission Factors**: CARB's 2017 emission factors

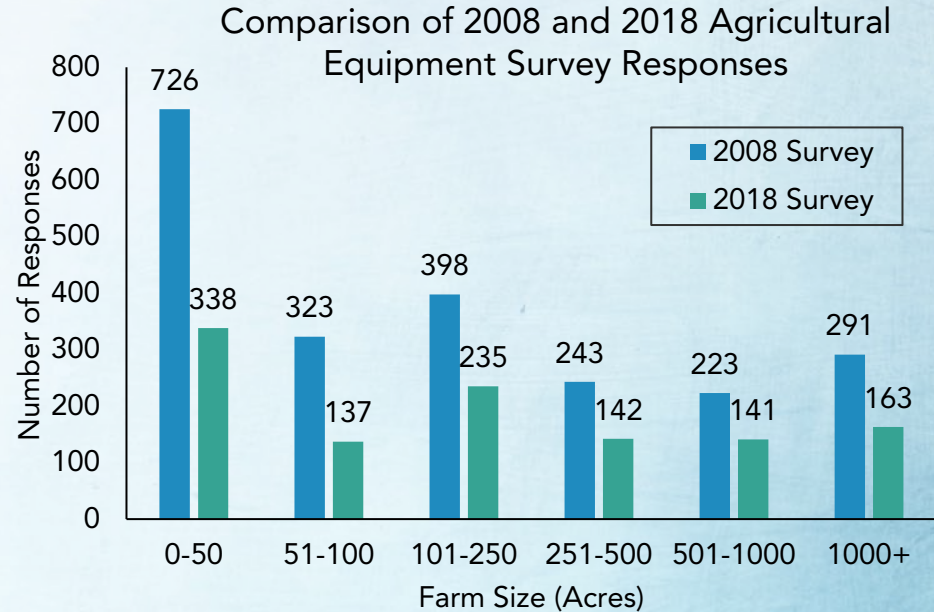
# Statewide Survey

## Statewide Survey

- Contract with CalPoly San Luis Obispo to run the survey and provide anonymized responses to CARB
- Collected equipment and crop data for CY 2018
- Survey was available via paper or online
- Survey timeline: February 8 to May 15, 2019

## Survey Outreach

- Air District APCOs
- County Ag Commissioners
- District Staff
- Farm Bureaus
- Agriculture stakeholders (~80)



# Comparison of 2008 and 2018 Survey Respondents and USDA Acres by Air Basin

Air Basin	Percentage of 2008 Survey Respondents	Percentage of USDA 2007 Acres	Percentage of 2018 Survey Respondents	Percentage of USDA 2017 Acres
San Joaquin Valley	48.6%	53.3%	44.1%	54.2%
Sacramento Valley	22.7%	21.0%	23.7%	19.4%
South Central Coast	5.1%	3.9%	3.6%	3.9%
North Coast	3.7%	0.8%	3.0%	0.8%
North Central Coast	3.7%	3.7%	1.5%	4.3%
Northeast Plateau	3.4%	3.3%	0.6%	3.1%
San Francisco Bay Area	3.1%	2.6%	11.3%	2.7%
San Diego	2.7%	0.9%	2.1%	0.6%
Mountain Counties	2.2%	0.4%	1.8%	0.5%
South Coast	1.4%	2.4%	2.9%	1.9%
Salton Sea	1.2%	5.3%	2.4%	6.3%
Lake County	0.9%	0.2%	2.0%	0.2%
Mojave Desert	0.8%	2.0%	0.7%	1.9%
Great Basin Valleys	0.5%	0.1%	0.3%	0.1%
Lake Tahoe	0.2%	0.0%	0.0%	0.0%

## Overall distribution of survey respondents is similar

- *In the 2008 survey, more than 70% of respondents were from the San Joaquin Valley and Sacramento Valley air basins.*
- *In the 2018 survey, about 68% represented those same air basins.*

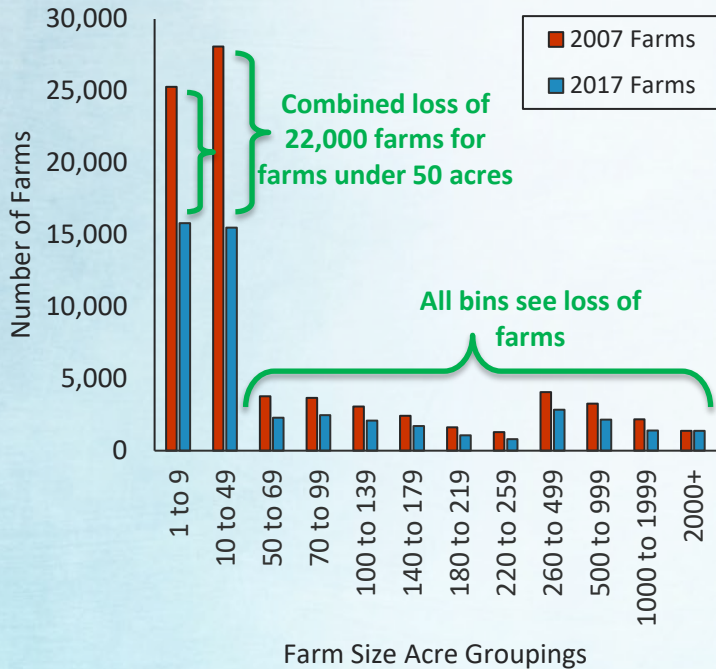
\* These distributions do not translate to emissions



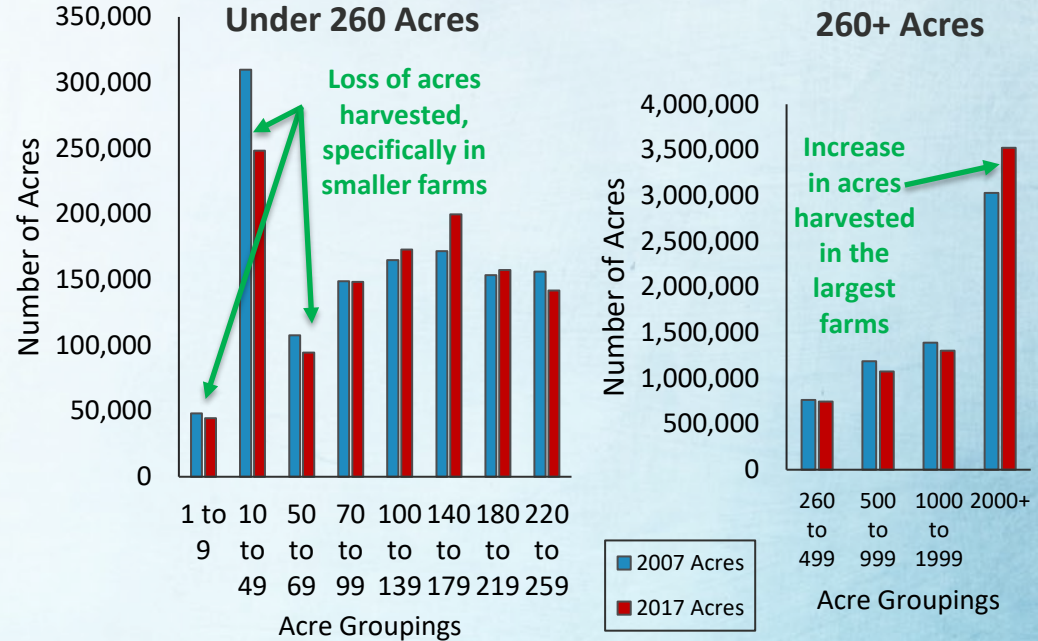
# USDA Ag Census

- USDA Ag census data suggest that almost 22,000 small farms have disappeared since 2007, consolidating acres into larger farms.
- Acres harvested declined 10% from 2002 to 2007, but grew 3% from 2007 to 2017

## 2017 USDA Ag Census: Count of Farms

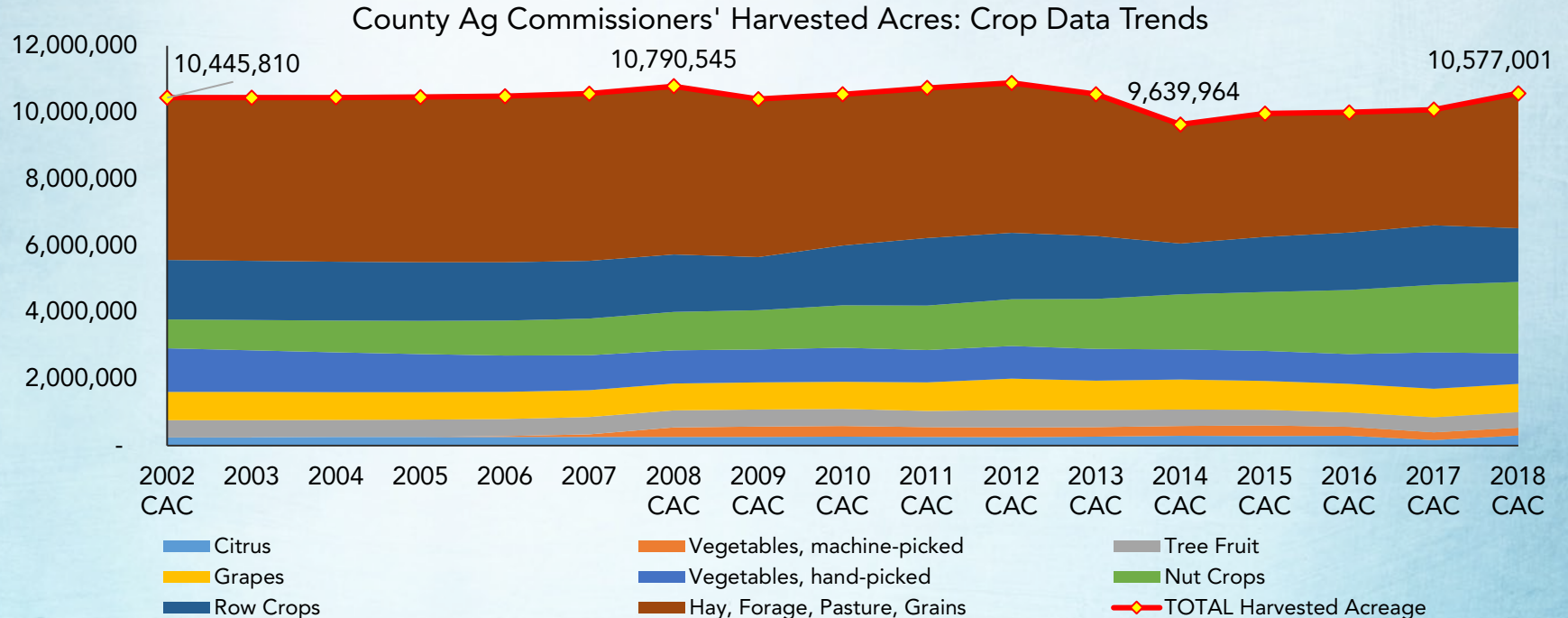


## 2017 USDA Ag Census: Acres Harvested by Farms



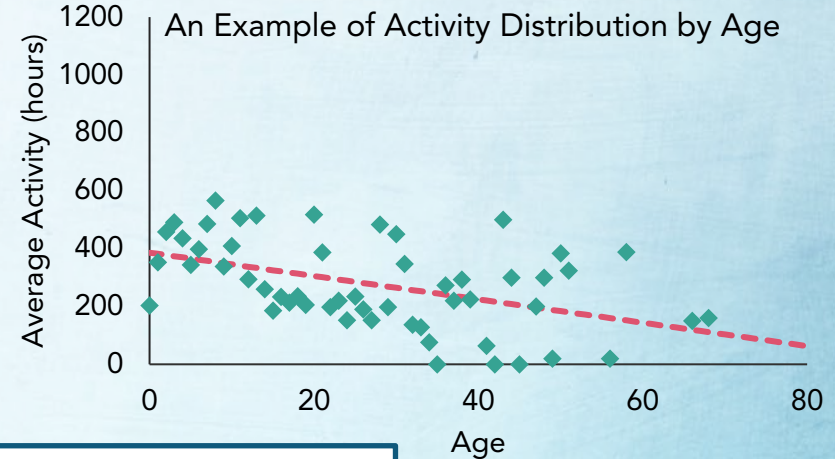
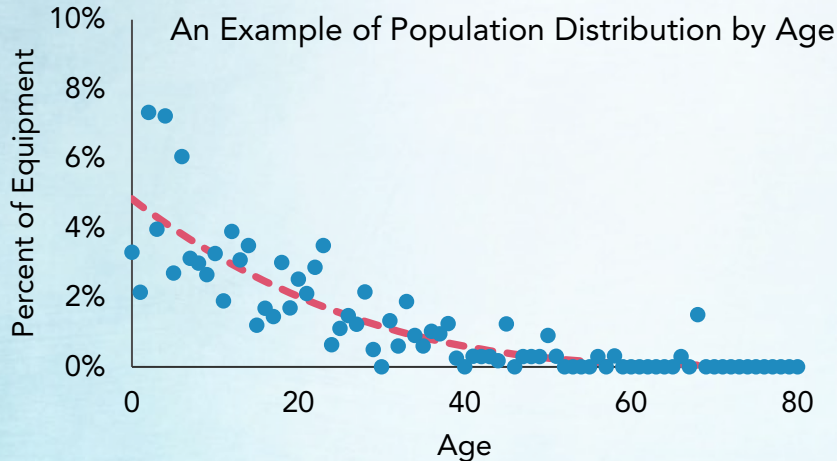
# County Ag Commissioners' Harvested Acres

- Significant growth in **nut crops** (average annual growth of 6.5% over the last 10 years) & **hay, forage, pasture, grains** has declined (annual rate of 2.2 % over the last 10 years).



# Equipment Profile Example

- Equipment is sorted into smaller groups based on similar characteristics (e.g., horsepower bin, farm size bin, or operator type)
- Profile bins were assigned to calculate population age distributions and average activity to create the statewide equipment population



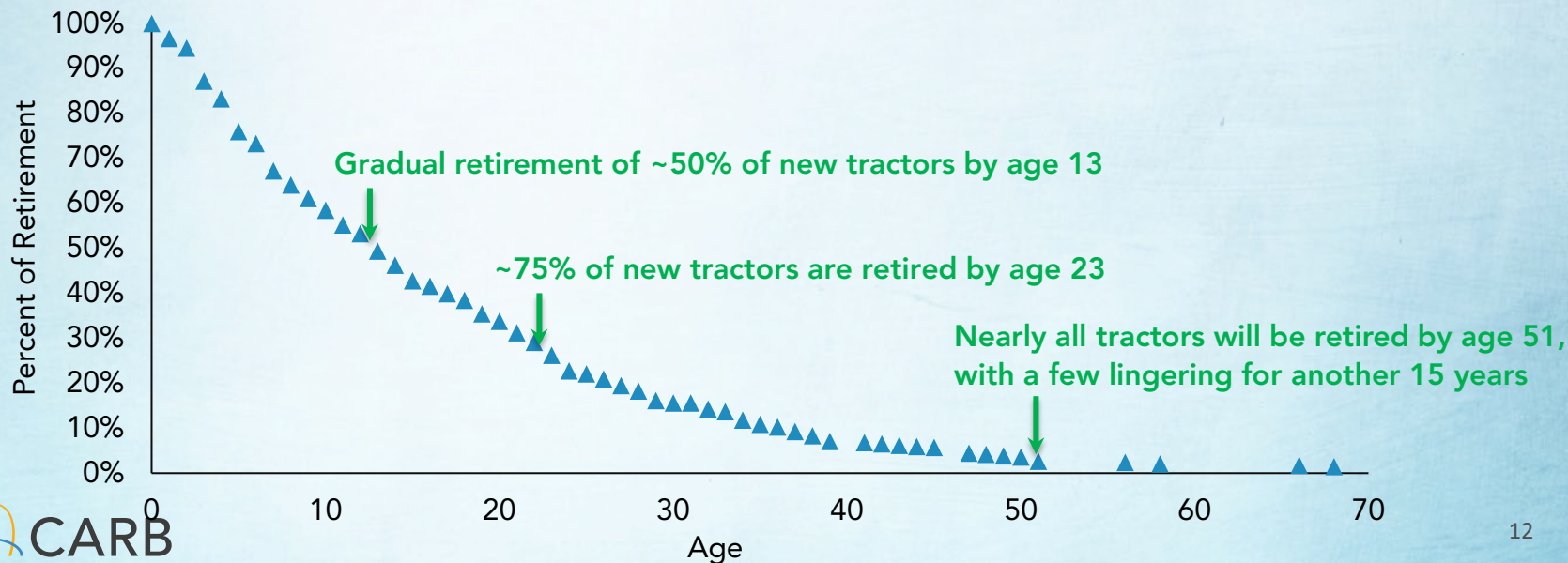


# Retirement Curve Example

This example represents *Producer tractors*:

**100 hp bin for all farm size acres & 175 hp bin for farms up to 500 acres**

- There is a relatively young average age, with many older tractors
- Retired tractors are replaced with new tractors





# Equipment Groupings for Supplemental Data

- Survey data from the 2011 inventory was adjusted and used as supplemental data
- Data were adjusted by age and activity to preserve trends seen in the 2021 inventory survey

Agricultural Sector	2018 Responses	2008 Responses	2008 Groupings to be Supplemented	2018 Sufficient Data (no adjustments)
Producer	283	1552	<ul style="list-style-type: none"> <li>• All Others (non-tractor/non-ATV)</li> </ul>	<ul style="list-style-type: none"> <li>• Tractors</li> <li>• ATVs</li> </ul>
Custom Operator	41	151	<ul style="list-style-type: none"> <li>• Tractors</li> <li>• ATVs</li> <li>• All Others</li> </ul>	
First Processor	6	52	<ul style="list-style-type: none"> <li>• All Equipment</li> </ul>	
Rental	4	11	<ul style="list-style-type: none"> <li>• All Equipment</li> </ul>	

# Statewide Scaling: Simplified Example

Commodity bin: Nut Farm  
Farm Size bin: 250 acre bin (100 to 250 acres)  
Equipment bin: tractors in 100 hp bin (76 to 100 hp)

\*not based on real numbers

## To calculate Acres per equipment

Raw Survey Responses: Two 80 horsepower tractors (100 hp bin) used on a 200-acres nut farm (250 acre bin)

$$\frac{200 \text{ acres}}{2 \text{ tractors}} = \frac{100 \text{ acres}}{1 \text{ tractor}}$$

## To scale Acreage data

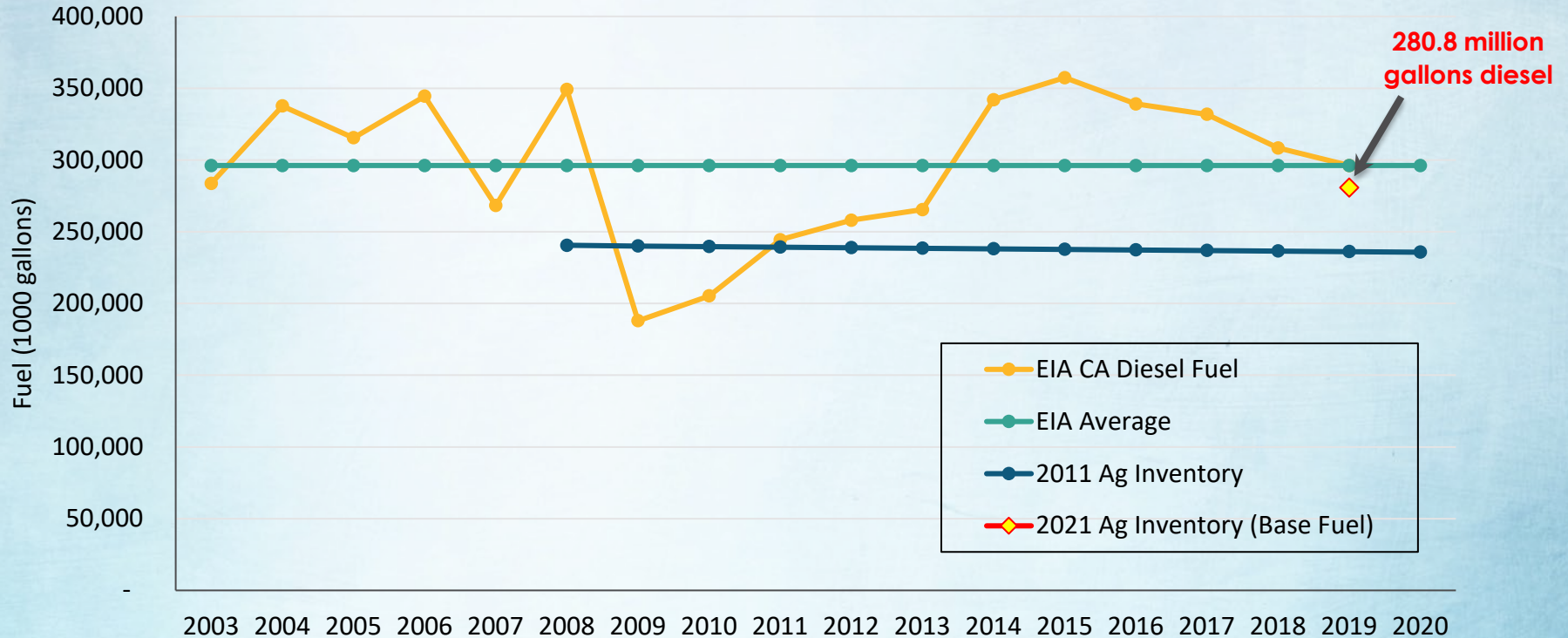
Total harvested acres for this bin: 45,000 acres

$$\frac{45,000 \text{ acres}}{100 \text{ acres} / 1 \text{ tractor}} = 450 \text{ tractors}$$

**Result: 450 tractors in the 100 hp bin for nut farms between 100 and 250 acres**

- If farms have multiple commodities, it is assumed equipment is shared by more than one commodity. Harvested acreage data is at the county level.

# Energy Information Association (EIA) Diesel Farm Fuel



\* Ag inventory fuel is less than EIA Average due to considerations for ag pumps and anti-frost wind machines

# Crop Growth Rates

- 2011 ag inventory growth rates came from the SWAP Model
- 2021 ag inventory growth rates use historical County Ag Commissioners' Data
  - Reduction of harvested acres
  - Improved efficiency in equipment per acre also leads to reductions

Commodity Group	2011 Inventory Growth Rate	2021 Inventory Growth Rate
Beef Cows	0.0%	-1.6%
Citrus	-0.1%	-1.6%
Grapes	0.0%	-1.6%
Hay, Forage, Pasture, Grains	-0.4%	-1.6%
Milk Cows	0.0%	-1.0%
Nursery, Greenhouse, Floriculture	0.0%	-0.7%
Nut Crops	0.0%	0.2%
Poultry	0.0%	0.2%
Row Crops	-0.5%	-1.2%
Tree Fruit	0.0%	-1.3%
Vegetables, hand-picked	0.2%	-1.3%
Vegetables, machine-picked	0.1%	-1.6%
Equipment Rental	-0.2%	-1.6%




# County Spatial Allocation

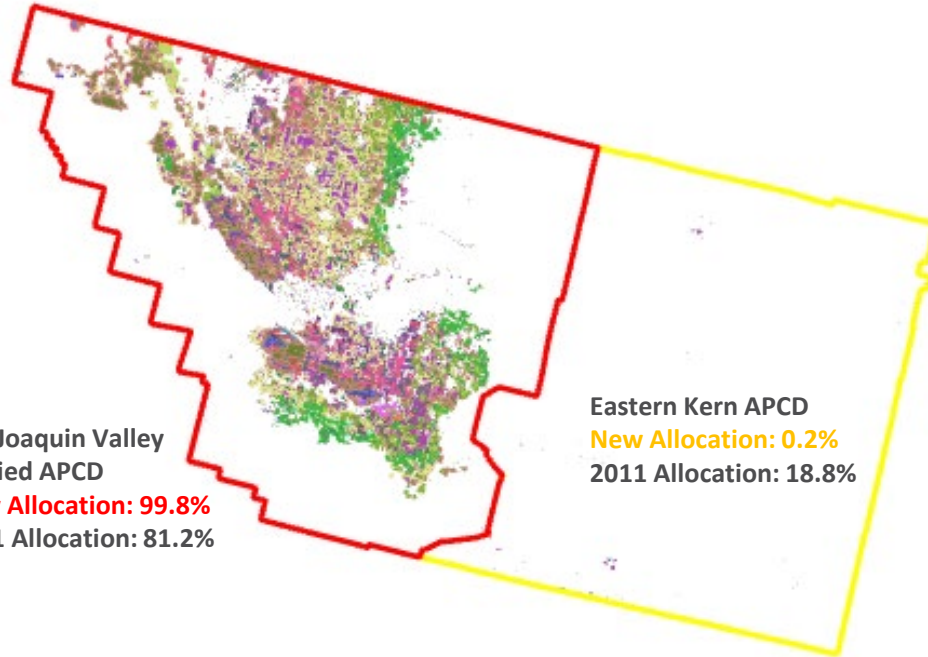
- Every county that is *split* across air districts was updated based on CropScape\* satellite data (by percent of county acres in each air district)
- This methodology is a *significant improvement* over previous work

Air District	2011 Inventory	2021 Inventory
Bay Area AQMD	4.01%	5.1%
Mojave Desert AQMD	0.14%	1.74%
Northern Sonoma County APCD	0.30%	1.50%
South Coast AQMD	2.84%	1.37%
El Dorado County APCD	0.30%	0.48%
Placer County APCD	0.35%	0.74%
Antelope Valley AQMD	0.01%	0.33%
Kern County APCD	1.10%	0.01%

# Example: Kern County

Percent of Statewide Allocation

Air District	Old 2011 Inventory	New 2021 Inventory
KERN COUNTY APCD 	1.10%	<b>0.01%</b>



San Joaquin Valley  
Unified APCD  
**New Allocation: 99.8%**  
2011 Allocation: 81.2%

Eastern Kern APCD  
**New Allocation: 0.2%**  
2011 Allocation: 18.8%



# Comparison of 2008 and 2017 County Acres

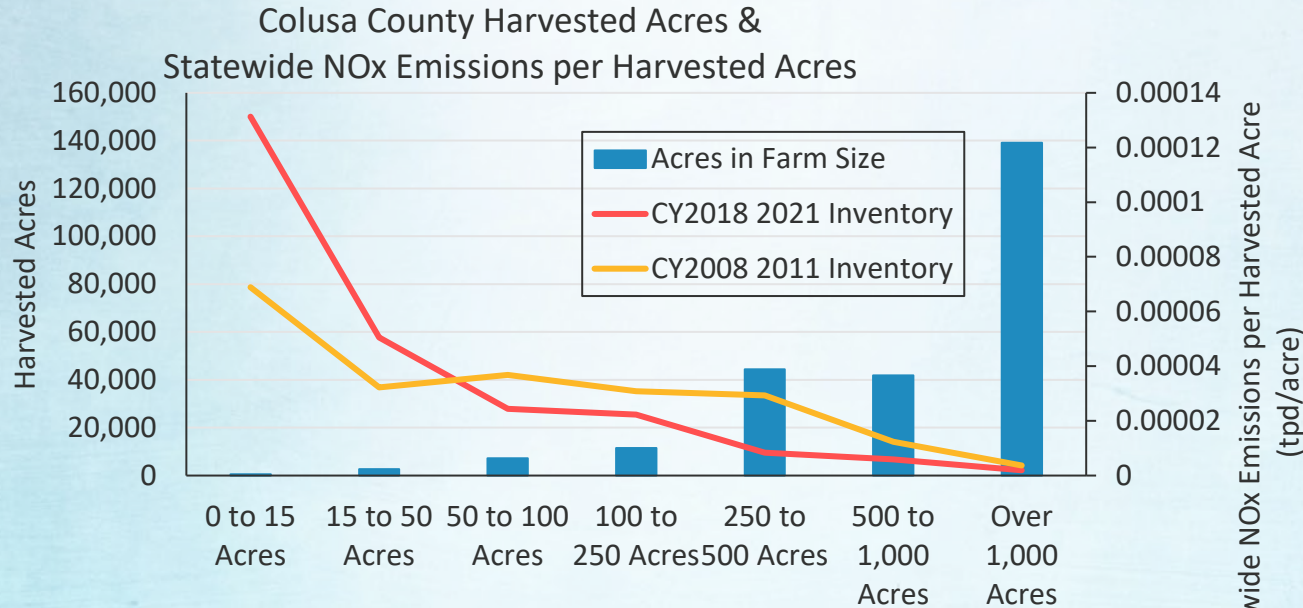
County	Basin	Air District	2008 Percent of County Acres*	2017 Percent of County Acres**
El Dorado	Lake Tahoe	El Dorado APCD	0.00%	0.45%
El Dorado	Mountain Counties	El Dorado APCD	100.00%	99.55%
Kern	Mojave Desert	Kern APCD	18.80%	0.19%
Kern	San Joaquin Valley	San Joaquin Valley AQMD	81.20%	99.81%
Los Angeles	Mojave Desert	Antelope Valley APCD	2.00%	97.75%
Los Angeles	South Coast	South Coast AQMD	98.00%	2.25%
Placer	Lake Tahoe	Placer County APCD	0.00%	0.00%
Placer	Mountain Counties	Placer County APCD	12.00%	0.31%
Placer	Sacramento Valley	Placer County APCD	88.00%	99.69%
Riverside	Mojave Desert	Mojave Desert AQMD	1.58%	42.47%
Riverside	Mojave Desert	South Coast AQMD	0.22%	0.01%
Riverside	Salton Sea	South Coast AQMD	19.50%	24.82%
Riverside	South Coast	South Coast AQMD	78.70%	32.71%
San Bernardino	Mojave Desert	Mojave Desert AQMD	19.00%	95.56%
San Bernardino	South Coast	South Coast AQMD	81.00%	4.44%
Solano	San Francisco Bay Area	Bay Area AQMD	0.00%	10.53%
Solano	Sacramento Valley	Yolo-Solano AQMD	100.00%	89.47%
Sonoma	San Francisco Bay Area	Bay Area AQMD	84.01%	52.42%
Sonoma	North Coast	Sonoma Northern AQMD	15.99%	47.58%

\* 2011 inventory used 2008 population

\*\* 2021 inventory uses updated county spatial allocation based on USDA's NASS 2017 Cropland Data Layer, which best matches USDA's 2017 Ag Census

# Importance of Farm Size

- Counties with primarily **large farms** show **decreased emissions**, and counties with **farms under 250 acres** tend to show **increased emissions**.
- It will be key, particularly in counties with many small farms, to figure out ways to *accelerate equipment turnover* on small to medium farms.



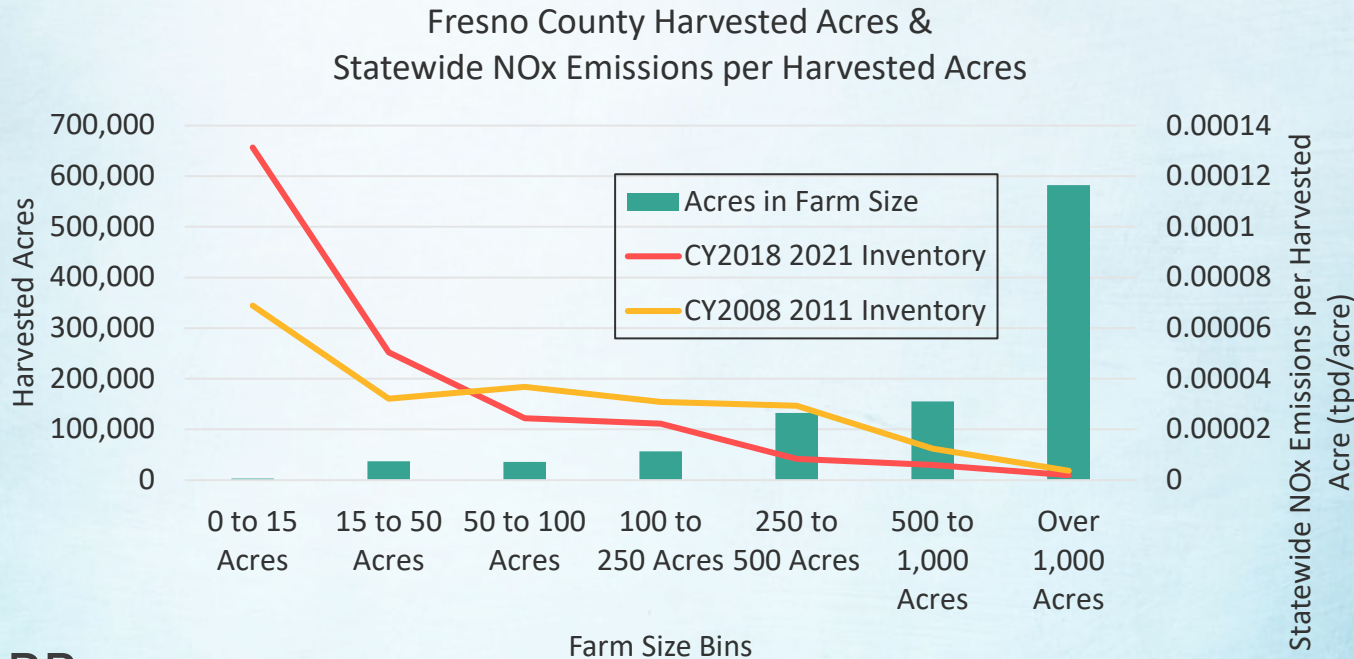
The survey showed

- **Increased activity** for *smaller farms* and older equipment
  - **emissions are increasing**
- *Larger farms* have **high activity** and are getting **new equipment** faster. Also, they have less equipment and **less equipment** per acre.
  - **lower emissions per acre**

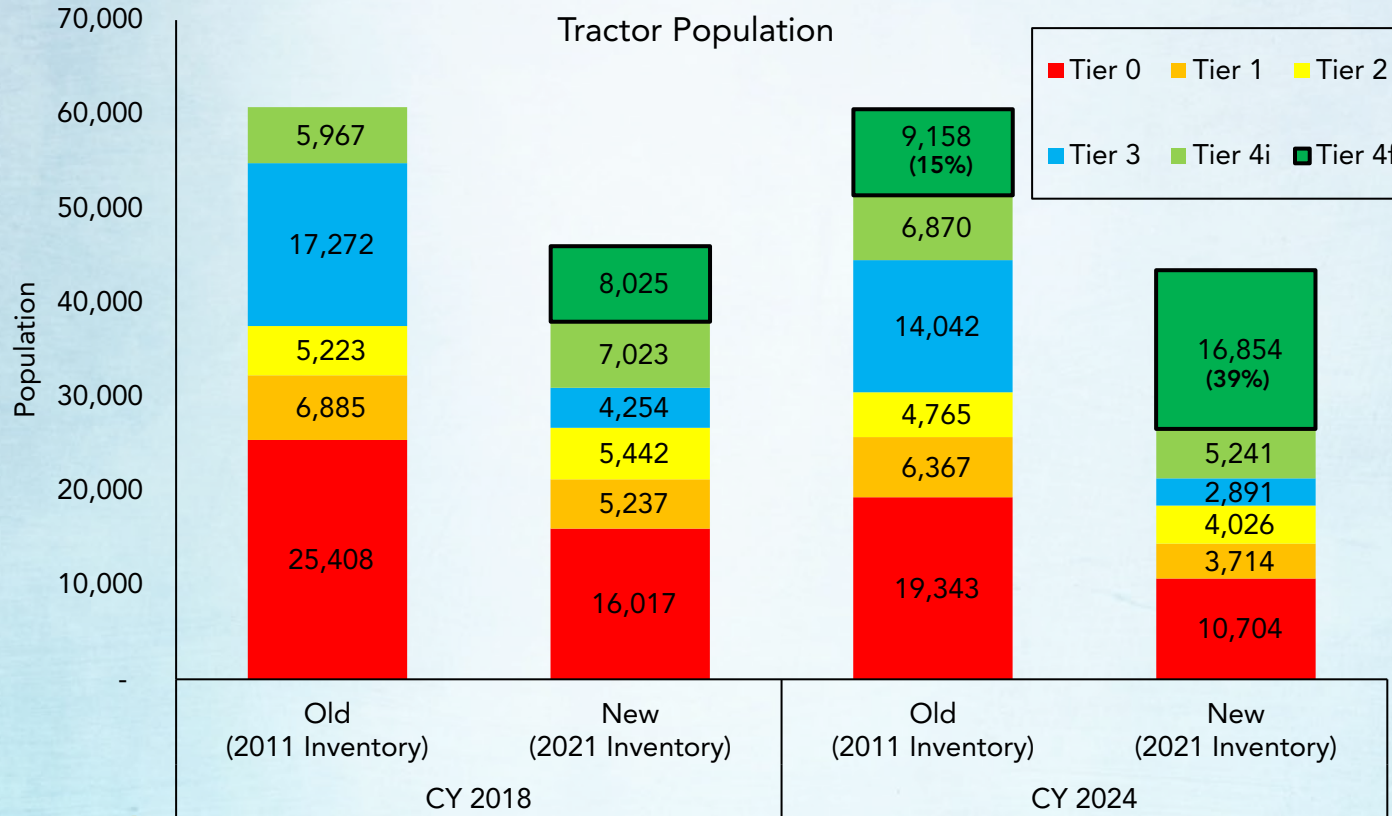


# Second Example: Fresno County

- Large farms show reduced emission contribution, while smaller farms (under 250 acres) have increased emissions.



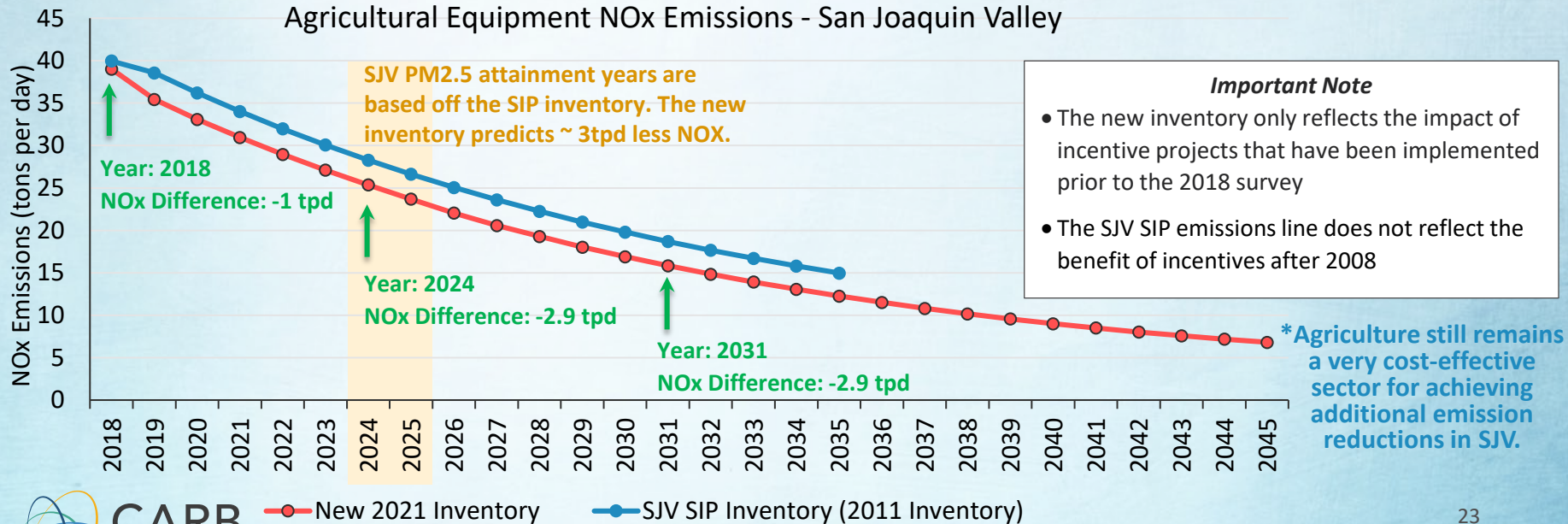
# Findings in the San Joaquin Valley



- 2011 inventory projections include incentive projects
- 2021 inventory projections only include incentive projects reported in the survey data

# Updated Emissions in the San Joaquin Valley

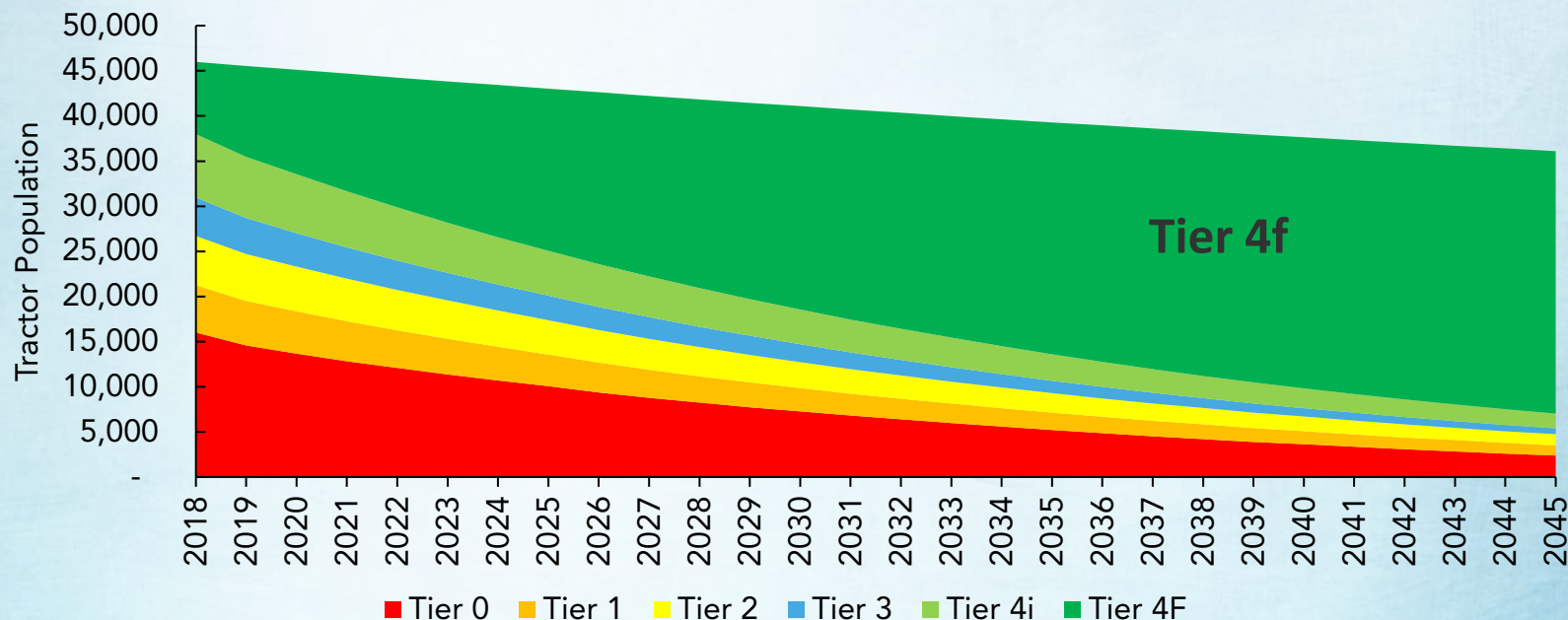
- The new inventory does not show a significant change in SJV allocation of statewide acreage or equipment (i.e., 56% with the new inventory as compared to 55% from the previous inventory)
- SJV NOx contribution has decreased slightly, and smaller districts see some changes due to harvested acreage reports shifting over the last 10 years.





# Statewide Tractor Population

- Inventory forecasts a minor decrease in acreage, and fewer tractors per acre, for overall reduced population (-0.9% per year). However, majority of emissions reductions are due to natural turnover.



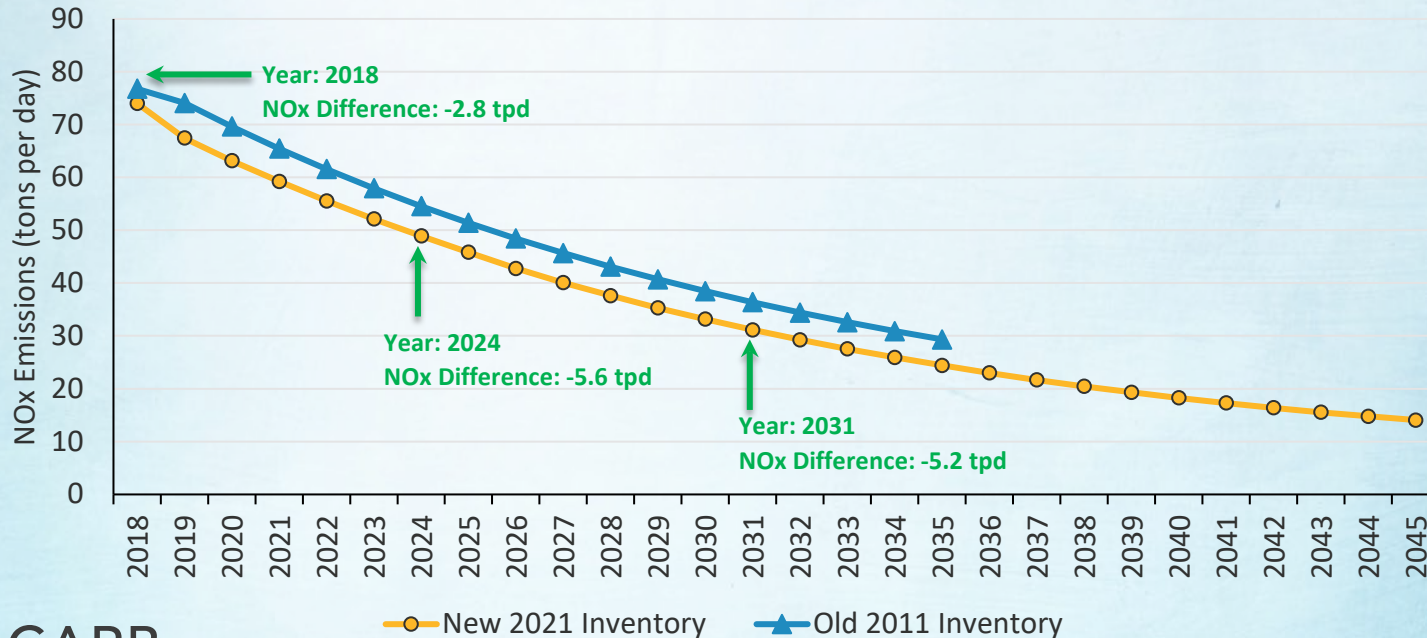
The projection only accounts for accelerated turnover that has occurred prior to the 2018 survey



# Statewide Results

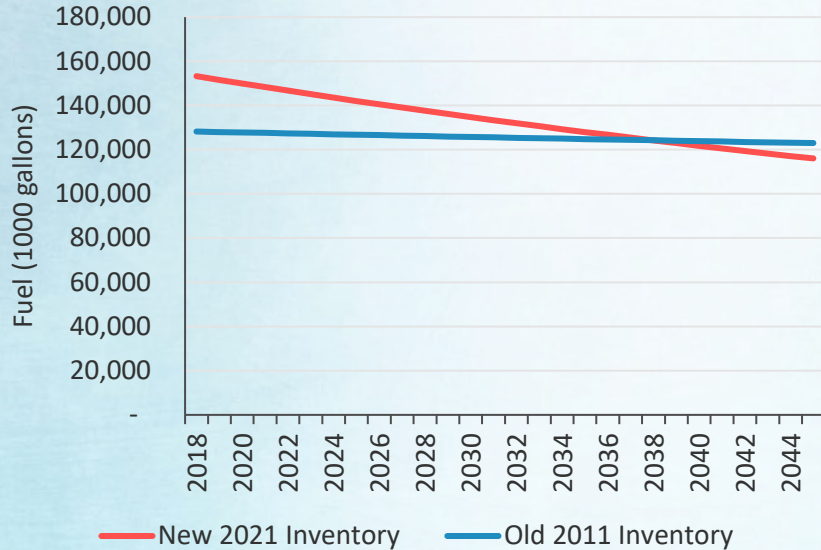
- Although the statewide agricultural fuel use is increase by 19%, the reduced population and additional Tier 4 equipment resulted in lower emissions

## Statewide Agricultural Equipment NOx Emissions

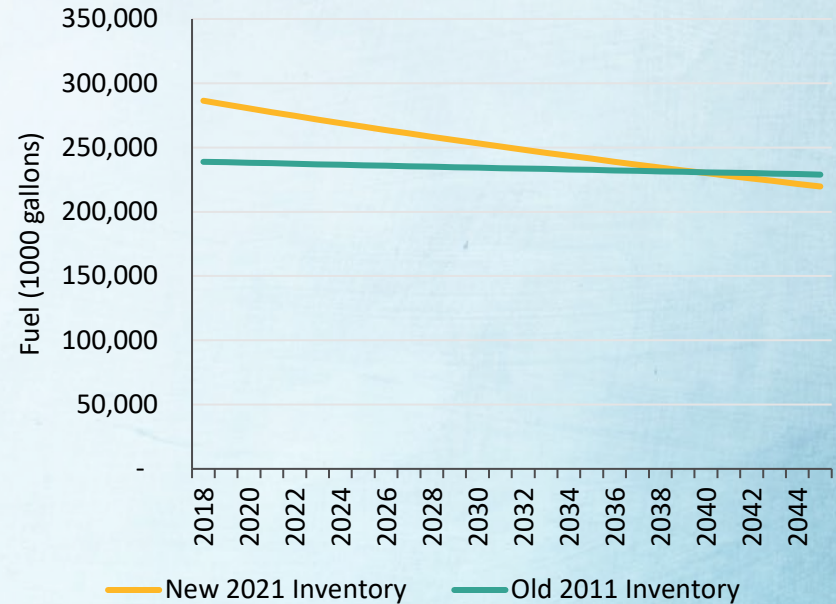


# Fuel Use Projections


## Agricultural Equipment Fuel in the San Joaquin Valley



## Statewide Agricultural Equipment Fuel



# 2020 NOx Emissions by Air District

District	2011 inventory	2021 inventory	District	2011 inventory	2021 inventory
SAN JOAQUIN VALLEY UNIFIED APCD	52.7%	53.0%	NORTH COAST UNIFIED AQMD	0.43%	0.92%
BAY AREA AQMD	4.0%	5.1%	MODOC COUNTY APCD	0.86%	0.91%
FEATHER RIVER AQMD	4.5%	3.1%	SISKIYOU COUNTY APCD	0.88%	0.86%
MONTEREY BAY UNIFIED APCD	2.8%	3.1%	PLACER COUNTY APCD	0.35%	0.74%
SAN DIEGO COUNTY APCD	2.2%	2.9%	SHASTA COUNTY AQMD	0.34%	0.55%
YOLO/SOLANO AQMD	3.4%	2.8%	LAKE COUNTY AQMD	0.53%	0.52%
BUTTE COUNTY AQMD	3.7%	2.6%	LASSEN COUNTY APCD	0.41%	0.49%
VENTURA COUNTY APCD	2.2%	2.3%	EL DORADO COUNTY APCD	0.30%	0.48%
GLENN COUNTY APCD	3.3%	2.3%	NORTHERN SIERRA AQMD	0.25%	0.34%
SAN LUIS OBISPO COUNTY APCD	1.8%	2.1%	ANTELOPE VALLEY AQMD	0.01%	0.33%
IMPERIAL COUNTY APCD	2.2%	1.9%	AMADOR COUNTY APCD	0.17%	0.30%
COLUSA COUNTY APCD	3.2%	1.9%	CALAVERAS COUNTY APCD	0.10%	0.20%
SANTA BARBARA COUNTY APCD	1.3%	1.8%	GREAT BASIN UNIFIED APCD	0.14%	0.16%
MOJAVE DESERT AQMD	0.1%	1.7%	TUOLUMNE COUNTY APCD	0.05%	0.14%
NORTHERN SONOMA COUNTY APCD	0.3%	1.5%	MARIPOSA COUNTY APCD	0.04%	0.12%
SOUTH COAST AQMD	2.8%	1.4%	KERN COUNTY APCD	1.10%	0.01%
TEHAMA COUNTY APCD	1.2%	1.3%	 Districts with more than <a href="#">one percent</a> of statewide NOx emissions		
SACRAMENTO METROPOLITAN AQMD	1.48%	1.15%			
MENDOCINO COUNTY AQMD	0.64%	1.01%			

# 2021 Ag Inventory Summary

## Statewide emissions are lower now than previously assumed due to:

- **Incentive programs** like Moyer, FARMER, SJV's Tractor Replacement Program, and NRCS's Environmental Quality Incentive Program which have accelerated the turnover to clean fleets
- **Consolidation** of the ag industry and the **loss of small farms** which now account for a greater fraction of the overall emissions than before
- **Less equipment per acre** even though there is **higher fuel use**
- Projected **decline** of most crop growth rates
- No significant changes in the **spatial allocation** of emissions between the old and new inventories



# Questions, Comments, Feedback

Technical Documentation is now posted on CARB's website at:

<https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/road-documentation/msei-documentation-road>

**Deadline for Comments: July 30, 2021**

**Julie Schiffman**

Air Quality Planning & Science Division

[Julie.Schiffman@arb.ca.gov](mailto:Julie.Schiffman@arb.ca.gov)