Agriculture Census Projections

Chesapeake Bay Watershed

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Agriculture Workgroup
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Review: Background

- CAST-19
  - 2017 Ag Census data incorporated into the land use & animal numbers.
  - Under/Over projecting few crop categories.
    - Example: Full-season soybeans

- CAST-21 Workplan
  - Investigate alternatives to the current methods for forecasting agricultural land uses & animals & propose options for Partnership consideration.

- Current schedule calls for all updates to CAST-21 to be finalized **Sept 2021** and changes to projection methods are requested by **March 2021**

Review: Historical Data

- Projections use data recommended by AMS for Phase 6 Watershed Model (CAST) and approved through AgWG, Water Quality GIT, etc.

- 1982 through 2012 Ag Census information
  - 2017 with 4 projections methods.
  - 2017 Ag Census data

- For crops, projections are by Land use at the county scale. Land use categories are then proportioned to individual Crop types according to latest Census of Agriculture.

- broilers, turkeys, pullets, and hogs
  - annual Census production numbers by state.
  - State numbers are then proportioned to individual counties according to latest Ag Census

- All other animals
  - 5-year Census inventory numbers by County

Review: 4 Possible Projection Methods

- Linear regression (Method 1): Linear trend forecasting is used to impose a line of best fit to time series historical data.
- Linear regression (Method 2) + Applying the trend to recent census year.
- Double exponential smoothing(Alpha=0.8 beta=0.2). This is current algorithm we use in CAST 19

$$Ft = a^* At\text{-}1 + (1- a) * (Ft\text{-}1 + Tt\text{-}1)$$

$$Tt = b^* (At\text{-}1\text{-}Ft\text{-}1) + (1- b) * Tt\text{-}1$$

$$AFt = Ft + Tt$$

- At = Actual county value as reported by Ag Census
- Ft = Unadjusted forecast (before trend)
- Tt = Estimated trend
- AFt = Trend-adjusted forecast
- *a*= Alpha value is the weight placed upon the most recent Ag Census value
- *b*= Beta value is the weight placed upon the long-term trend in Ag Census values

- Double exponential smoothing (Alpha=0.9 and beta=0.1). Gives even more weightage to recent census years.

Review: Methodology

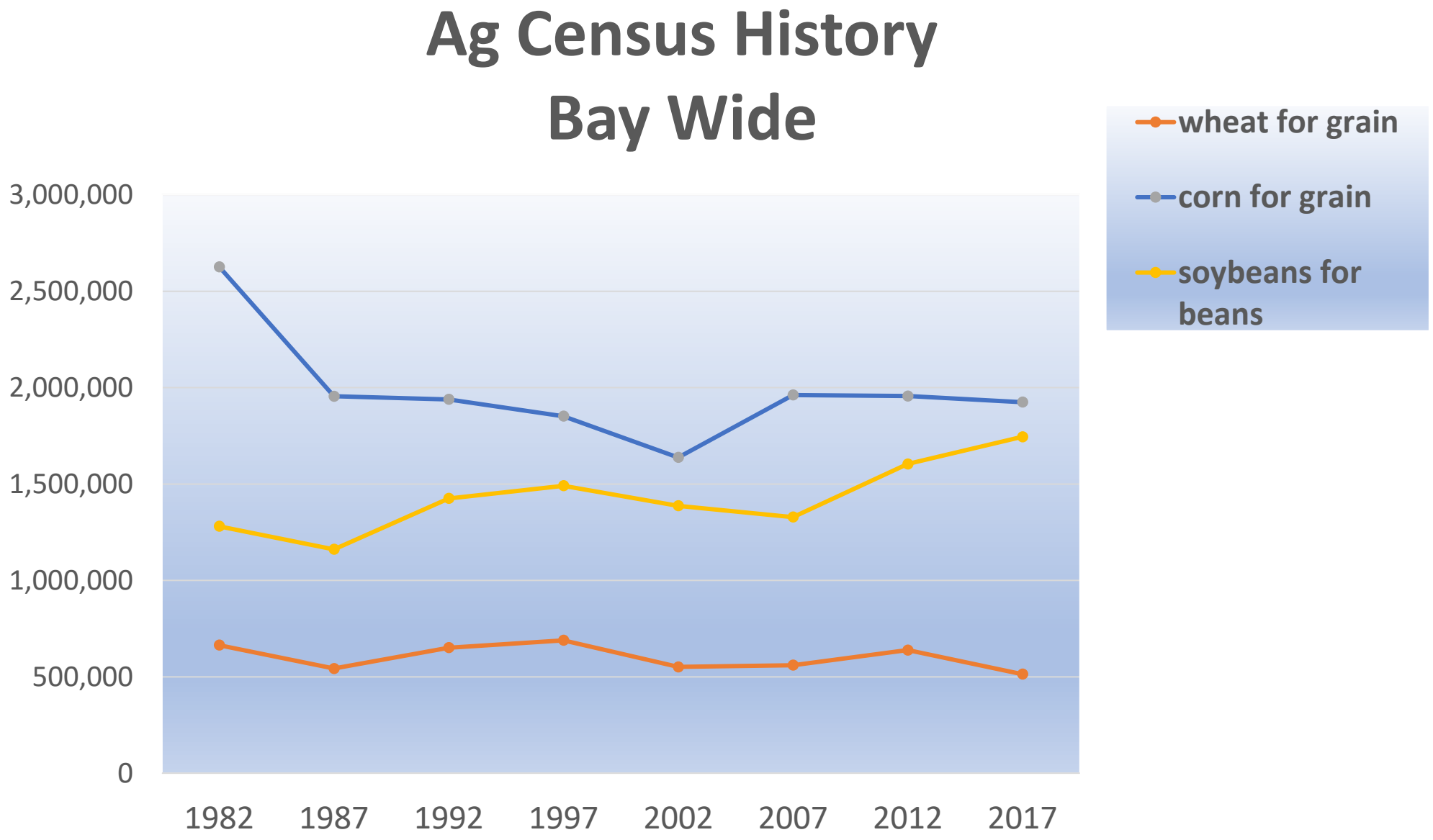
- Animal and Crop data at available geographic scale from 1982-2012
  - projected to 2017 using 4 different projection methods & compared with 2017 Ag census information from NASS.

- A *Rank* for each Crop/Animal category for each method at a Bay Wide(can drill down to State or County) scale determined based on absolute % difference from the real 2017 Ag Census data. (1= best)

- Method with least *Rank* is considered the best among 4 methods to predict 2017 based on the History available.

- This result will be used for projecting data beyond 2017.

Review


Ag Census History
Bay Wide
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1982
1987
1992
1997
2002
2007
2012
2017
wheat for grain
corn for grain
soybeans for beans

Review

Corn for Grain Bay Wide				
ProjectionMethod	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	1,924,881	1,671,956	13.14	4
Linear Projection_Method2	1,924,881	1,875,514	2.56	1
Dbl Exp. Smoothing -0802 **Alpha = 0.8**	1,924,881	1,807,299	6.11	2
Dbl Exp. Smoothing -0901 Alpha = 0.9	1,924,881	1,766,142	8.25	3

*current method

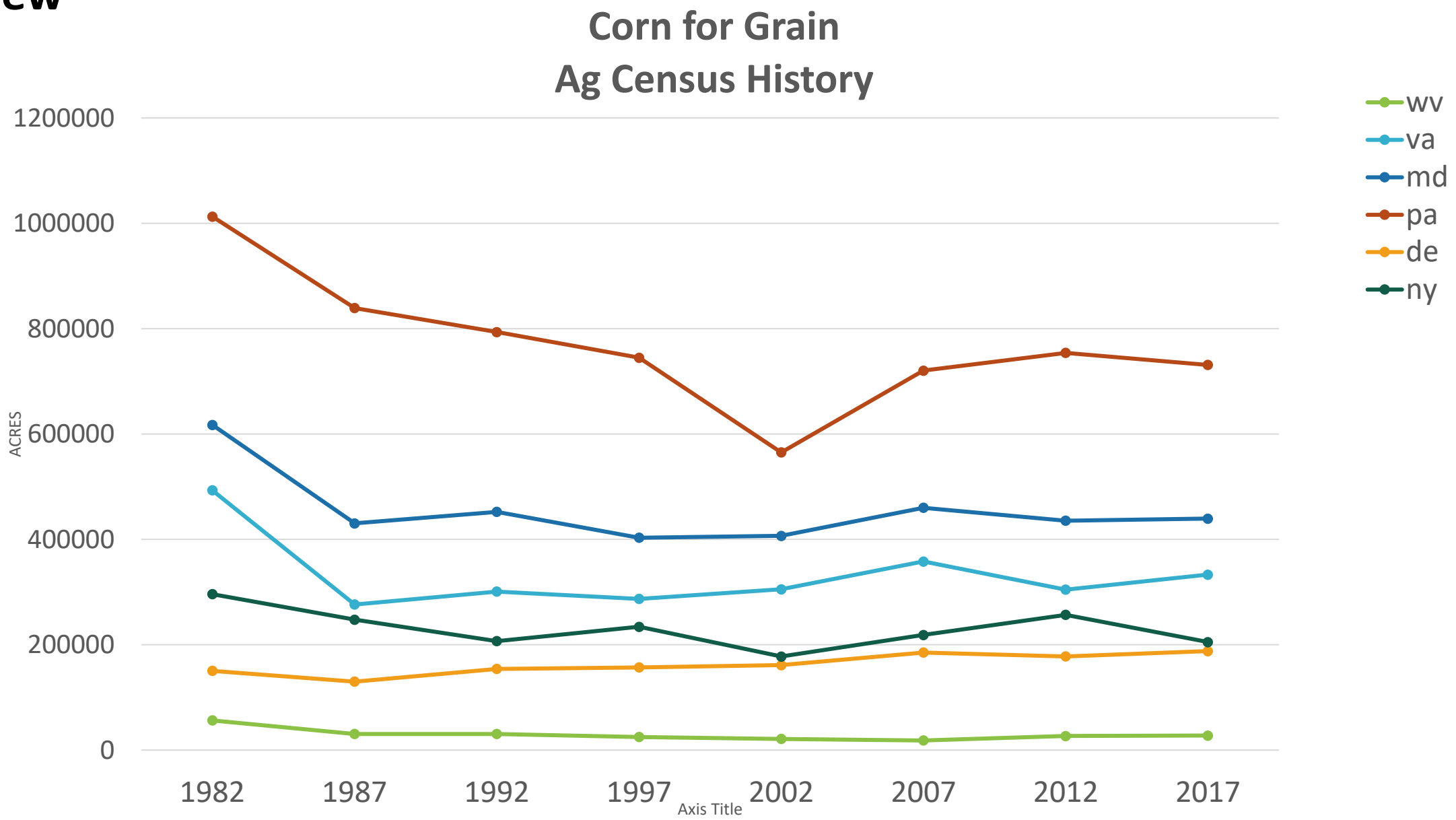
Review

Soybeans Bay Wide				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	1,744,873	1,566,056	10.25	4
Linear Projection_Method2	1,744,873	1,650,180	5.43	1
***Dbl Exp. Smoothing - 0802* Alpha = 0.8**	1,744,873	1,621,050	7.10	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	1,744,873	1,647,056	5.61	2

Review

Wheat for Grain Bay Wide				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	513,622	531,774	3.53	1
Linear Projection_Method2	513,622	599,978	16.81	4
Dbl Exp. Smoothing - 0802 **Alpha = 0.8**	513,622	580,066	12.94	2
Dbl Exp. Smoothing -0901 Alpha = 0.9	513,622	589,933	14.86	3

Review


Corn for Grain
Ag Census History
1200000
1000000
800000
600000
400000
200000
0
ACRES
1982
1987
1992
1997
2002
2007
2012
2017
Axis Title
wv
va
md
pa
de
ny

Review

Corn for Grain WV				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	27,679	13,685	50.56	4
Linear Projection_Method2	27,679	22,514	18.66	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	27,679	18,584	32.86	2
Dbl Exp. Smoothing -0901 Alpha = 0.9	27,679	17,773	35.79	3

Corn for Grain VA				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	333,188	283,286	14.98	2
Linear Projection_Method2	333,188	291,099	12.63	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	333,188	277,281	16.78	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	333,188	261,288	21.58	4

Corn for Grain MD				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	439,538	382,565	12.96	4
Linear Projection_Method2	439,538	418,074	4.88	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	439,538	400,619	8.85	2
Dbl Exp. Smoothing -0901 Alpha = 0.9	439,538	387,136	11.92	3

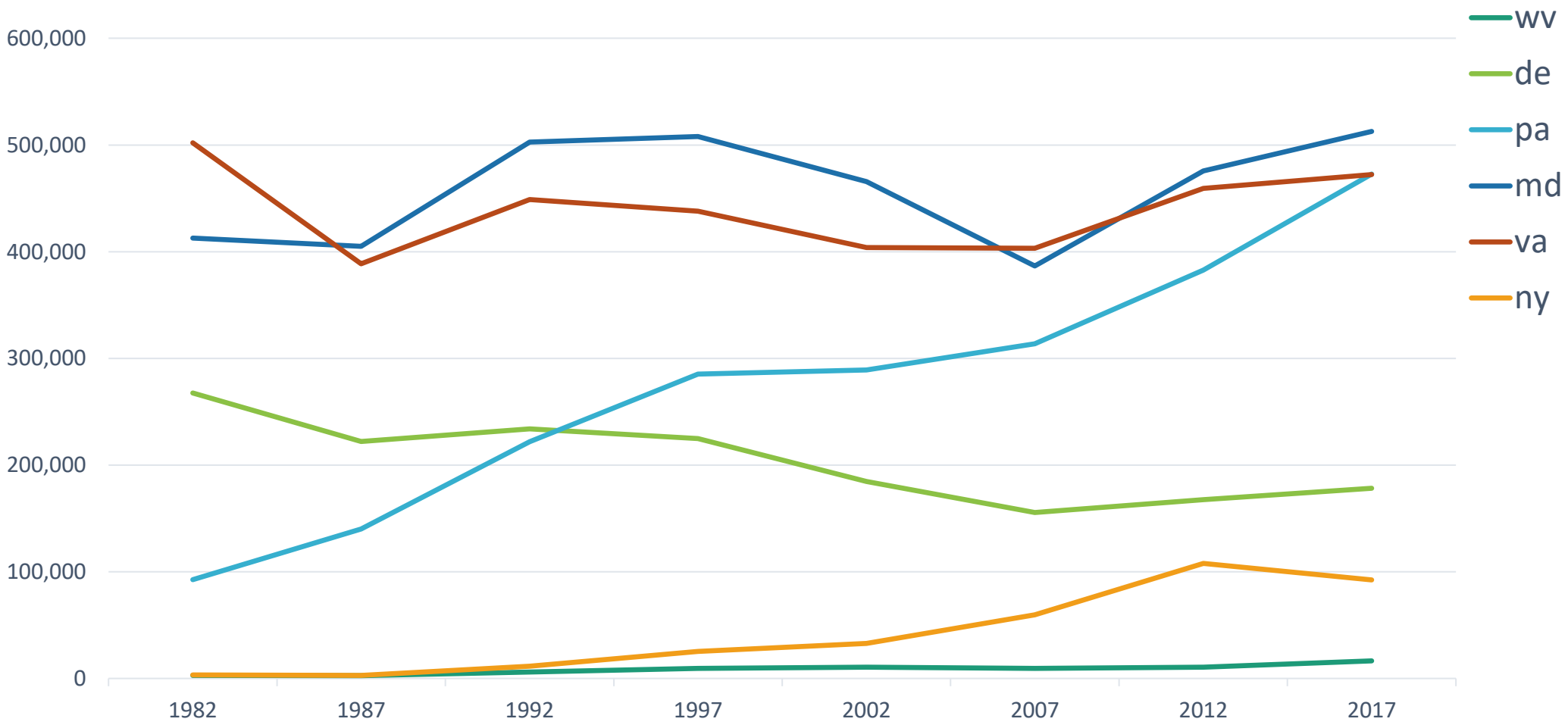
Corn for Grain NY				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	205,160	204,860	0.15	1
Linear Projection_Method2	205,160	249,562	21.64	4
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	205,160	239,535	16.76	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	205,160	238,500	16.25	2

Review

Corn for Grain DE				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	187,963	188,666	0.37	1
Linear Projection_Method2	187,963	184,822	1.67	3
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	187,963	185,138	1.50	2
Dbl Exp. Smoothing -0901 Alpha = 0.9	187,963	183,481	2.38	4

Corn for Grain PA				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	731,353	598,894	18.11	4
Linear Projection_Method2	731,353	709,444	3.00	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	731,353	686,143	6.18	2
Dbl Exp. Smoothing -0901 Alpha = 0.9	731,353	677,964	7.30	3

Soybeans
Ag Census History



Soybeans WV				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	16,441	13,383	19	1
Linear Projection_Method2	16,441	12,098	26	4
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	16,441	12,251	25	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	16,441	12,459	24	2

Soybeans VA				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	502,035	416,839	12	4
Linear Projection_Method2	502,035	455,183	4	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	502,035	439,786	7	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	502,035	440,058	7	2

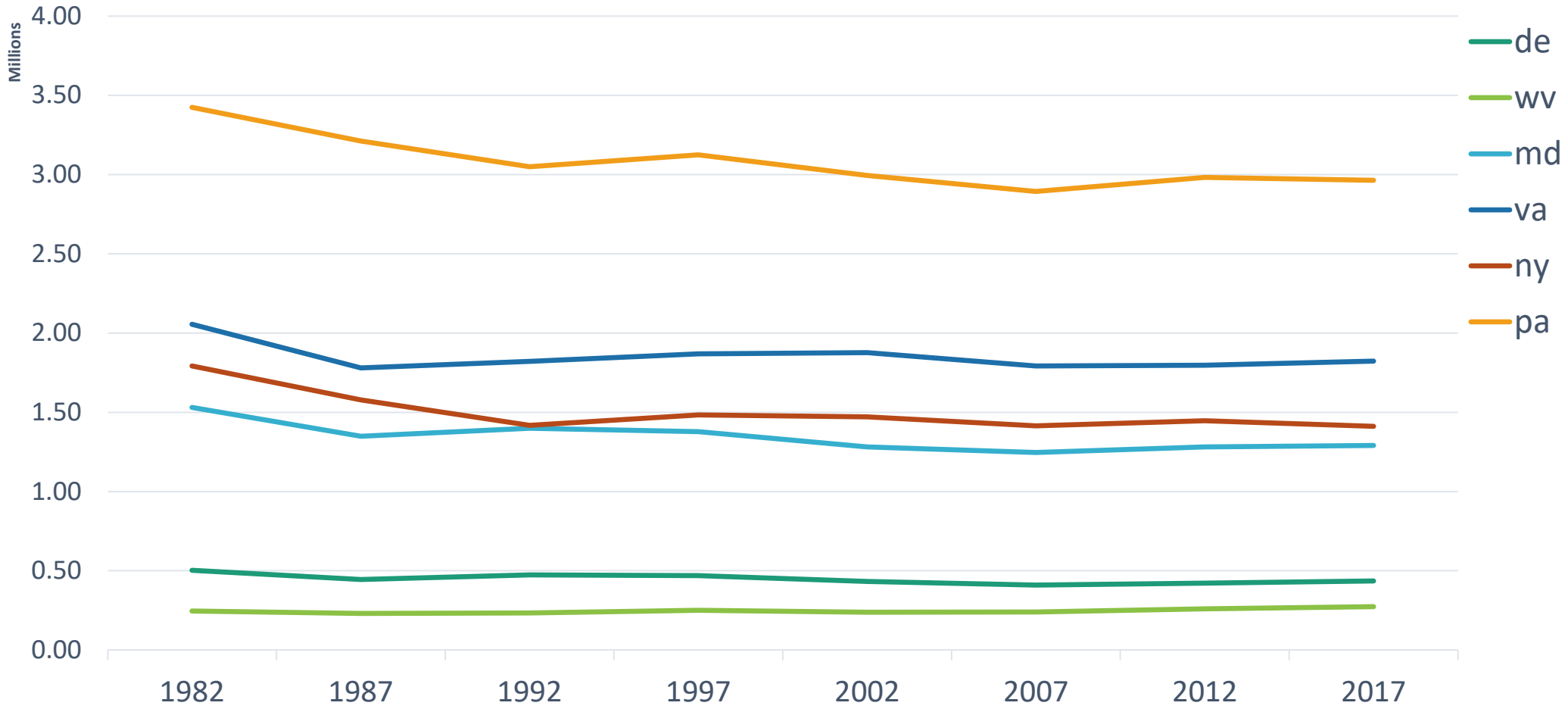
Soybeans MD				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	412,768	467,636	9	4
Linear Projection_Method2	412,768	479,846	6	2
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	412,768	474,942	7	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	412,768	490,091	4	1

Soybeans NY				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	92,340	98,919	7	1
Linear Projection_Method2	92,340	123,879	34	4
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	92,340	117,085	27	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	92,340	116,708	26	2

Soybeans DE				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	178,342	139,138	22	4
Linear Projection_Method2	178,342	150,443	16	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	178,342	146,450	18	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	178,342	149,714	16	2

Soybeans PA				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	472,752	430,141	9	2
Linear Projection_Method2	472,752	428,731	9	3
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	472,752	430,537	9	1
Dbl Exp. Smoothing -0901 Alpha = 0.9	472,752	438,025	7	4

Harvested Cropland
Ag Census



Harvested Cropland WV				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	273,214	252,169	8	4
Linear Projection_Method2	273,214	261,767	4	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	273,214	258,997	5	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	273,214	260,047	5	2

Harvested Cropland VA				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	1,822,234	1,757,523	4	2
Linear Projection_Method2	1,822,234	1,772,332	3	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	1,822,234	1,749,537	4	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	1,822,234	1,741,618	4	4

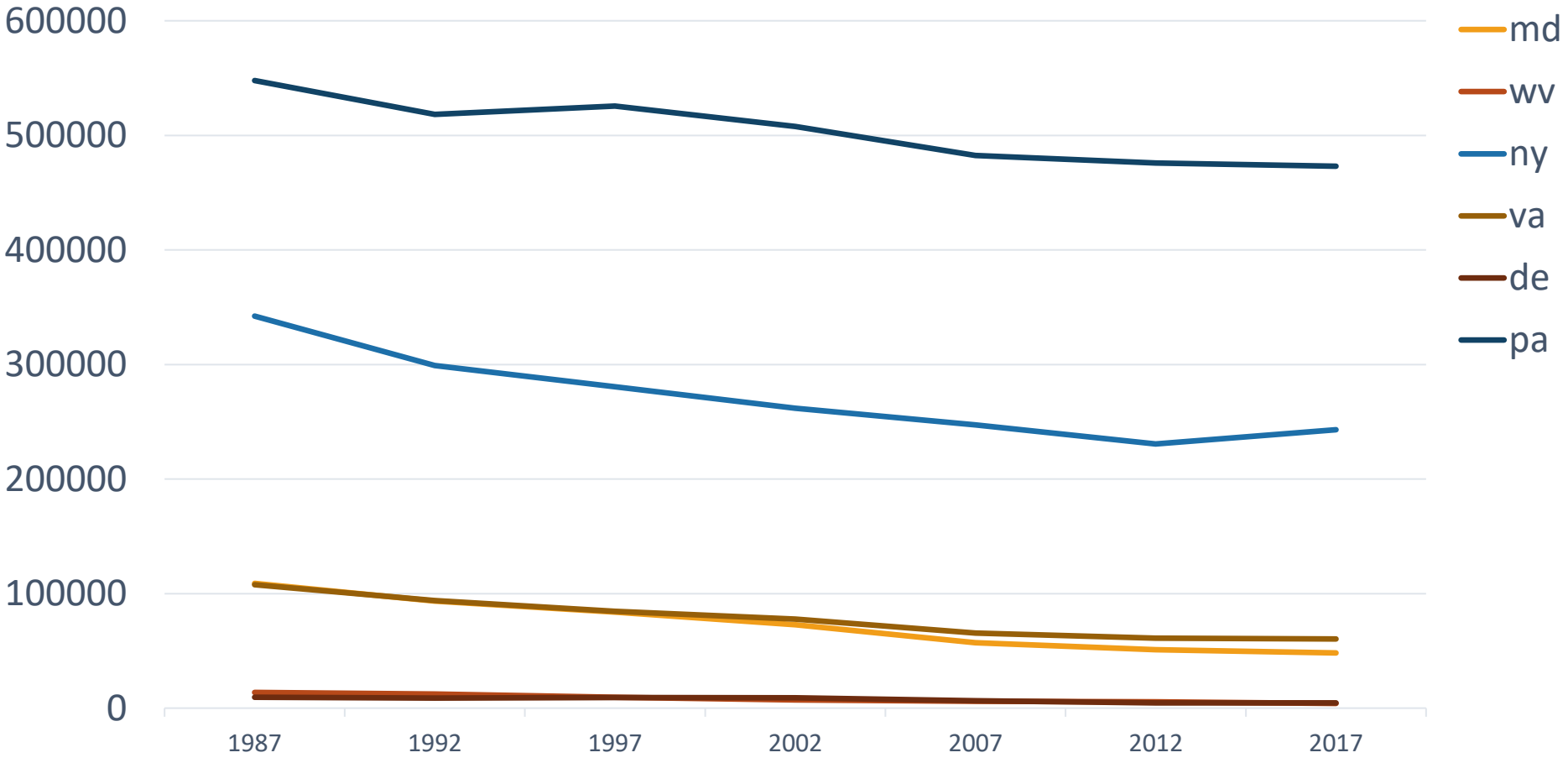
Harvested Cropland MD				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	1,290,212	1,199,329	7	4
Linear Projection_Method2	1,290,212	1,242,745	4	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	1,290,212	1,225,414	5	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	1,290,212	1,227,667	5	2

Harvested Cropland NY				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	1,411,225	1,327,299	6	4
Linear Projection_Method2	1,411,225	1,399,875	1	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	1,411,225	1,368,907	3	2
Dbl Exp. Smoothing -0901 Alpha = 0.9	1,411,225	1,357,252	4	3

Harvested Cropland DE				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	435,085	399,772	8	4
Linear Projection_Method2	435,085	408,568	6	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	435,085	404,223	7	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	435,085	406,874	6	2

Harvested Cropland PA				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	2,962,718	2,831,848	4	4
Linear Projection_Method2	2,962,718	2,919,697	1	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	2,962,718	2,890,185	2	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	2,962,718	2,894,522	2	2

Dairy
Ag Census



Dairy WV				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	4169	2670	36.0	4
Linear Projection_Method2	4169	3623	13.1	1
***Dbl Exp. Smoothing - 0802* Alpha = 0.8**	4169	3286	21.2	2
Dbl Exp. Smoothing - 0901 Alpha = 0.9	4169	3221	22.7	3

Dairy VA				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	60420	53172	12.0	2
Linear Projection_Method2	60420	53806	10.9	1
***Dbl Exp. Smoothing - 0802* Alpha = 0.8**	60420	52836	12.6	4
Dbl Exp. Smoothing -0901 Alpha = 0.9	60420	52998	12.3	3

Dairy MD				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	48211	36588	24.1	4
Linear Projection_Method2	48211	38840	19.4	1
***Dbl Exp. Smoothing - 0802* Alpha = 0.8**	48211	37679	21.8	3
Dbl Exp. Smoothing - 0901 Alpha = 0.9	48211	37704	21.8	2

Dairy NY				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	243113	198553	18.3	4
Linear Projection_Method2	243113	207677	14.6	1
***Dbl Exp. Smoothing - 0802* Alpha = 0.8**	243113	205199	15.6	2
Dbl Exp. Smoothing -0901 Alpha = 0.9	243113	203553	16.3	3

Dairy DE				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	4560	5051	10.8	2
Linear Projection_Method2	4560	3723	18.4	4
***Dbl Exp. Smoothing - 0802* Alpha = 0.8**	4560	4010	12.1	3
Dbl Exp. Smoothing - 0901 Alpha = 0.9	4560	4093	10.2	1

Dairy PA				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	473018	461575	2.4	4
Linear Projection_Method2	473018	462041	2.3	2
***Dbl Exp. Smoothing - 0802* Alpha = 0.8**	473018	461837	2.4	3
Dbl Exp. Smoothing - 0901 Alpha = 0.9	473018	463125	2.1	1

Projection Method	Average Rank
Linear Projection	2.61
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	2.36
Linear Projection Method 2	2.2
Dbl Exp. Smoothing -0901 Alpha = 0.9	2.45

CONCLUSION & RECOMMENDATION

Conclusion

- No single projection method that works for all states, all land and animal categories.
  - *Important to continue with the partnership decision to use one method across states and across animals and land use types.*
- "Linear Projection applying trend to recent year" (Method 2) is a better projection method.
  - But… only provides slightly better results than what we have now (Dbl. Exp. Smoothing: Alpha = 0.8)

Options

- Option #1: Keep current projection method (Dbl Exp. Smoothing: Alpha = 0.8) **RECOMMENDED**
- Option #2: Change to Linear Projection (Method 2)

Rationale

- 2022 Ag Census data… (we don't know what we don't know – predictions have uncertainty)
- Current method (Dbl. Exp. Smoothing: Alpha = 0.8) was thoroughly tested during Phase 6 development.
- Changing projection method might result in negative consequences for some jurisdictions.
- Data presented is summarized by State. Actual Projections are done at County level and could see more fluctuations if changes are made to current method.