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

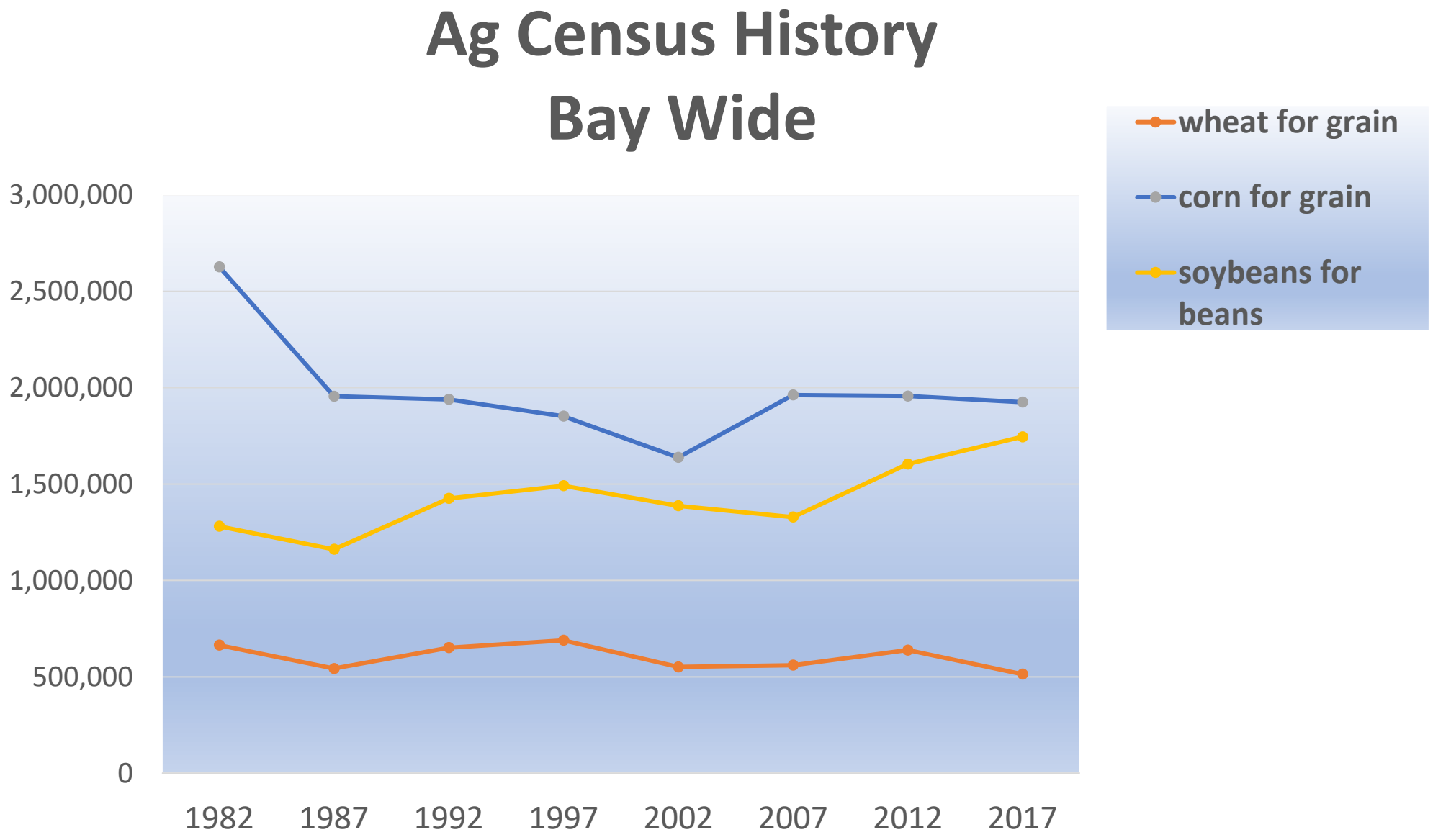
- Animal and Crop data at available geographic scale from 1982-2012
  - projected to 2017 using 4 different projection methods & compared with 2017 Ag census information from NASS.

- 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

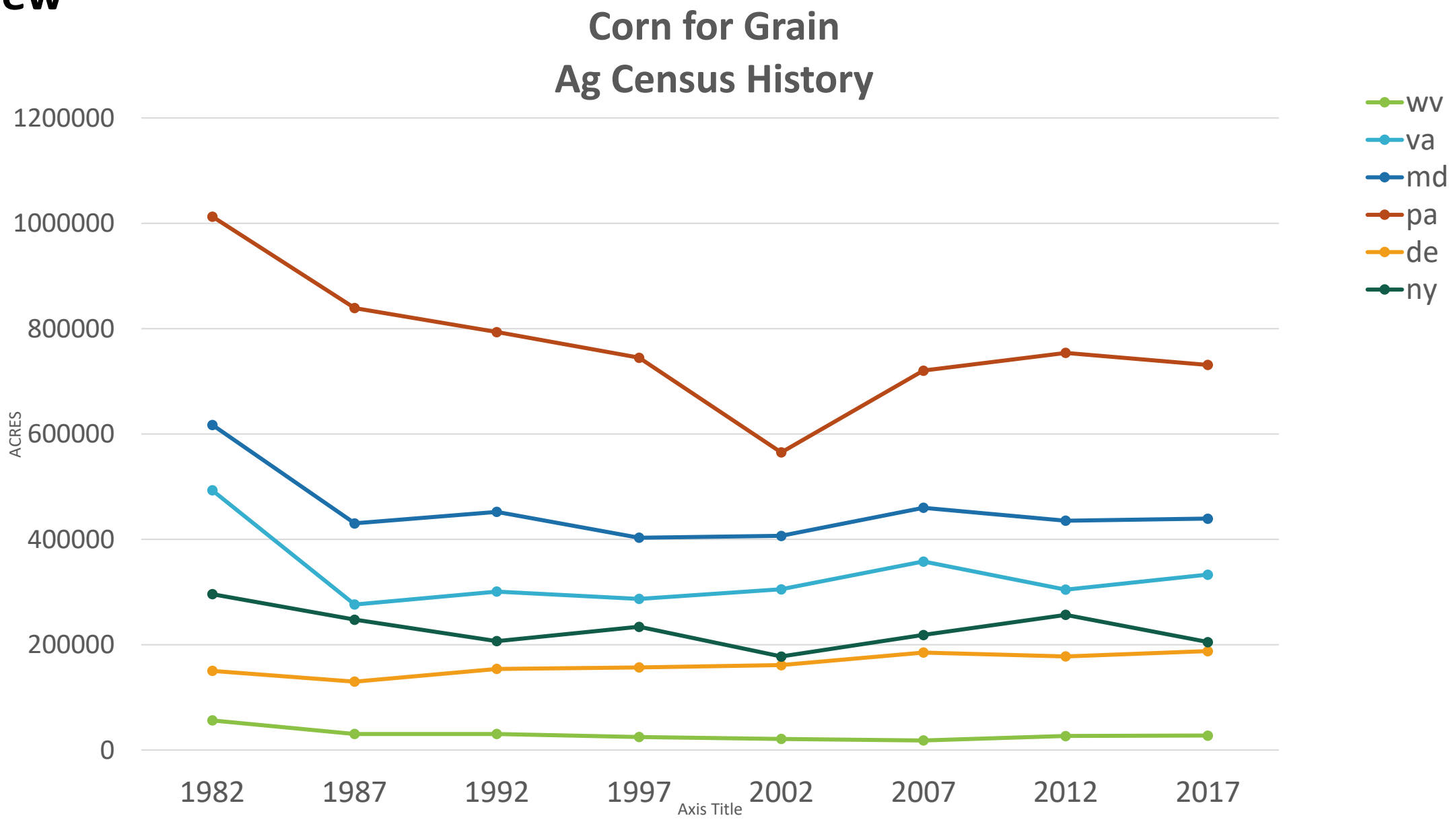
Review

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

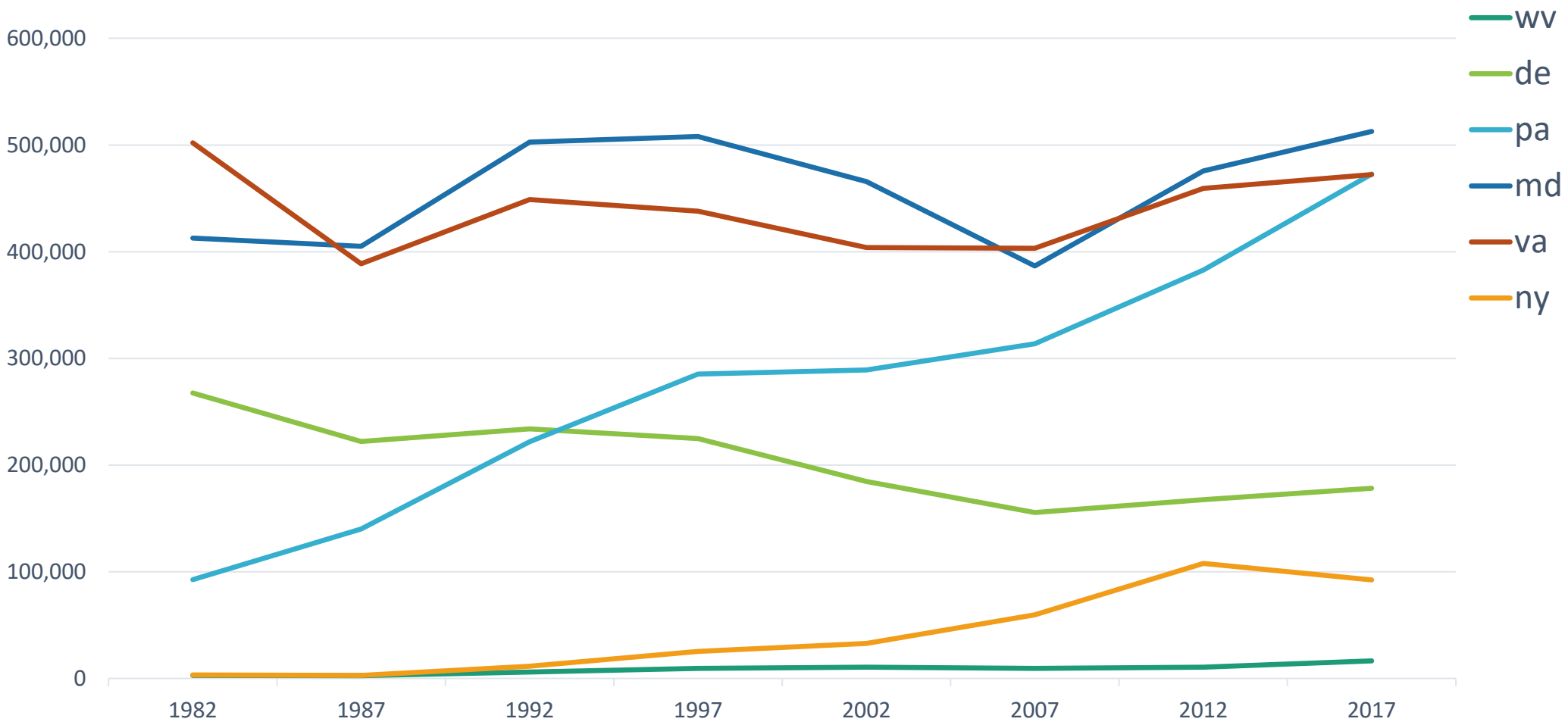
Corn for Grain NY				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	205,160	204,860	0.15	1
Linear Projection_Method2	205,160	249,562	21.64	4
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	205,160	239,535	16.76	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	205,160	238,500	16.25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

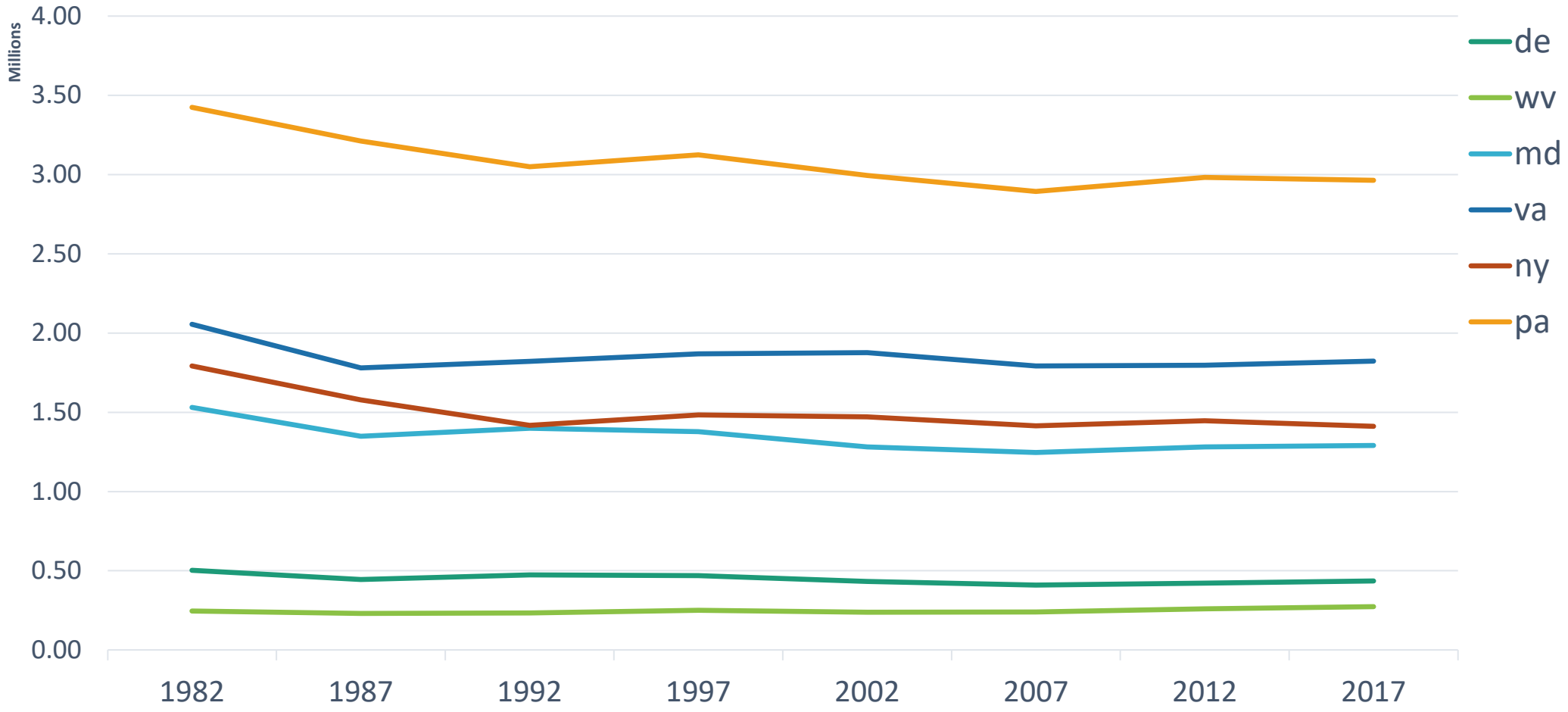
Soybeans MD				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	412,768	467,636	9	4
Linear Projection_Method2	412,768	479,846	6	2
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	412,768	474,942	7	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	412,768	490,091	4	1

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

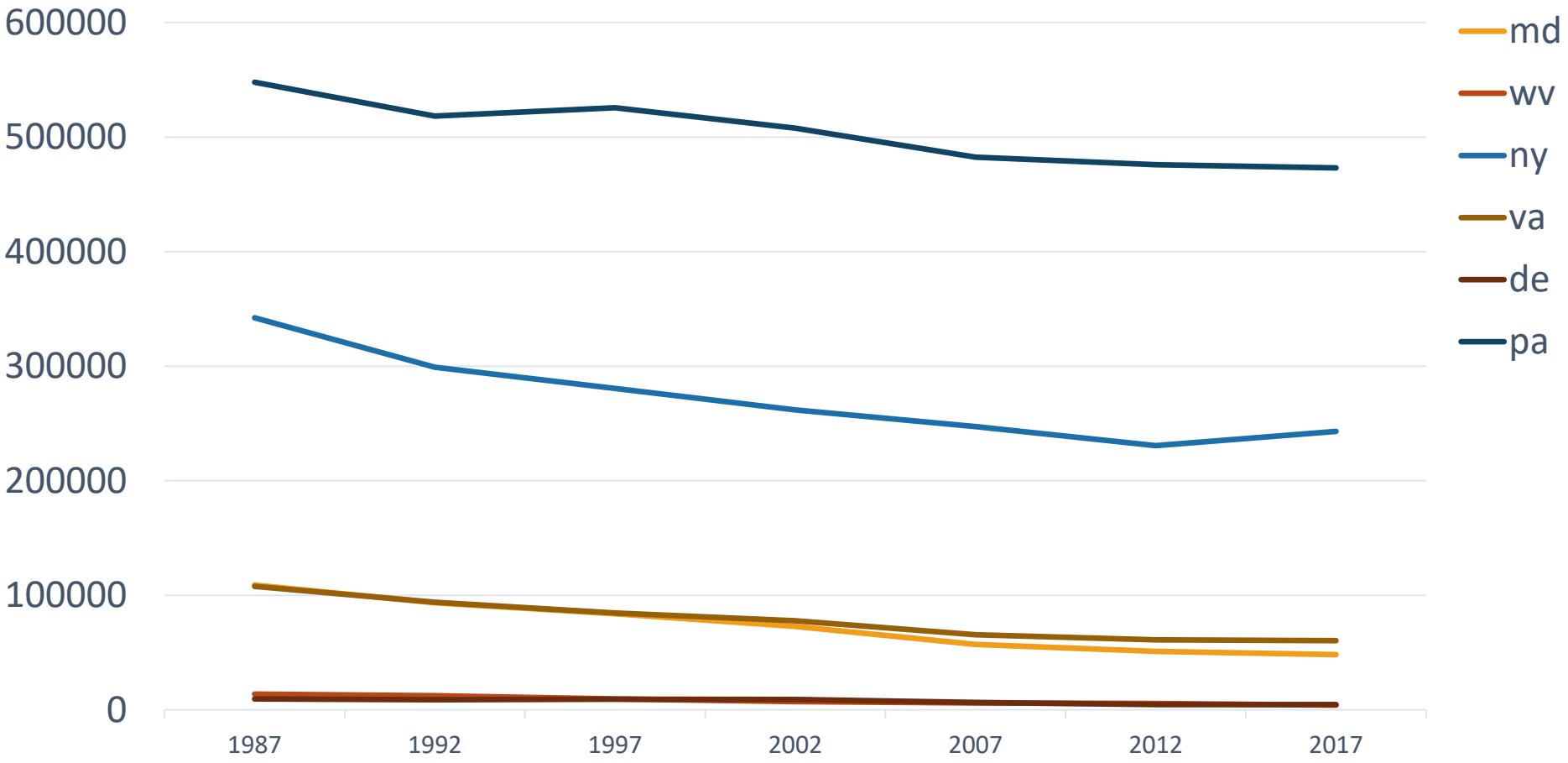
Harvested Cropland MD				
Projection Method	2017 Ag Census	2017 Projected	% Difference	Rank
Linear Projection	1,290,212	1,199,329	7	4
Linear Projection_Method2	1,290,212	1,242,745	4	1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	1,290,212	1,225,414	5	3
Dbl Exp. Smoothing -0901 Alpha = 0.9	1,290,212	1,227,667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

FEBRUARY AgWG ACTION

Interested parties are asked to review the Ag Census Projection Analysis spreadsheet. Please send additional feedback /questions /requests regarding alternate methods of forecasting agricultural data to Sucharith Ravi (sravi@chesapeakebay.net) and Jeff Sweeney (sweeney.jeff@epa.gov) by Monday, March 8. *A decision on how to forecast ag data will be sought on the March call.* **CAST-21 Draft Workplan: Task 2**

FEEDBACK RECEIVED (Abridged)

One of the biggest challenges with using the Ag Census data are the assumptions that have to be made where the census provides "(D)" for a particular crop/animal in a county. It appears from the spreadsheet that this first set of assumptions, to distribute animals/crops to back fill the Ds with data, are already baked in. I wonder if you could reassess the findings, isolating out those "D" areas, to see if they are skewing the results of the 4 forecasting methods?

Absent such a reassessment, I suggest some time be invested in first exploring alternatives to the current approach to filling the "(D)" gaps before advancing a decision on the forecasting algorithm. These areas where the census does not provide county scale data seem like the perfect opportunity to seek additional state/local/industry data to inform the process of assigning appropriate data to the county, from which future projections could be based.
-James Martin VA DEQ

Direct Response

We have no control over how NASS is reported. We have tried to work with them previously to no avail. At this time, there are no better alternatives for reporting for the entire watershed than what we have. There have been a couple of pilot studies, however several states expressed these studies not being worth the effort. At this time there is no other good option to make.
-Tim Sexton, VA DCR

FEEDBACK RECEIVED (Abridged)

I support the recommendation with the alpha = 0.8.

The ag census doesn't appear to be always right but it is the consistent set of numbers we have. Farmers like to say they are always wrong too, but NASS at least tries hard to get them. A lot of study goes into them. They are the set of numbers that farmers can find if they want to.

I would like to ask our math guys if they looked at lowering the alpha a little more. If I remember correctly, the farther you take it from 1.0, the less weight it puts on the most recent years of data. The problem with alpha = 0.9 seemed to be too drastic a response to a recent trend in numbers due to drought, supply and demand, or just a major trend in economics in one livestock category. I am not suggesting a lower alpha. I just don't remember them making any reference to running that scenario.
-Dave Graybill

CBPO Response

We have been using alpha=0.8 all along and that was consistent with giving more weightage to recent years, a decision previously made by Ag workgroup. When we initially worked on the Double Exponential smoothing method for Phase 6, we tried few iterations by lowering the alpha value. But, 0.8 was performing better compared to lower values, so we decided on using that value

This time around I haven't looked into lowering alpha values, but I might give it a try and see if that performs any better (now that we have an extra Ag Census data point with 2017).

Updated analysis posted on March 2021 AgWG Calendar Page.

FEEDBACK RECEIVED (Abridged)

The PA vote will be the same as last meeting, that we stick with the Double Exponential Smoothing (DES) forecasting method. The DES method biases to the more recent data which we think leads to a better prediction.

For PA, the "new" linear option would give us higher Corn for Grain acres but otherwise we don't see enough of a difference to justify having to explain why the method is being changed. Adding a current economic forecast component would be the better improvement but even those forecasts seem to be off half the time. The linear trends tend to hold on to the older data which doesn't capture the intensification and increased nutrient use efficiency seen over the past 20 years.
-Frank Schneider, PA SCC

Projection Method	Average Rank (1-5)
Linear Projection Method 1	3.1
***Dbl Exp. Smoothing -0802* Alpha = 0.8**	2.8
Linear Projection Method 2	2.6
Dbl Exp. Smoothing -0901 Alpha = 0.9	2.9
Dbl Exp. Smoothing -0703 Alpha = 0.7	2.8

DECISION

The AgWG is asked to approve a path forward regarding CAST-21 Workplan Task 2: Investigate alternatives to the current methods for forecasting agricultural land uses and animals and propose options for partnership consideration:

Option #1: Keep current projection method
(Dbl. Exp. Smoothing: Alpha = 0.8)

OR

Option #2: Change to Linear Projection (Method 2)

Consensus Continuum

Stop	Hold	Stand Aside	Agreement with Reservations	Endorsement
"I do not agree and feel the need to stand in the way of this decision"	"I believe more work is needed before we make a decision"	"I trust the group and will not block this decision but need to register my disagreement"	"I can live with it"	"I like it"