Agricultural Modeling Team (AMT)
Meeting Minutes

September 8th, 2023
09:00 AM – 11:00 AM
Meeting Materials

Summary of Actions and Decisions

Decision: The Ag Modeling Team approved the August meeting minutes.
Action: Group members will compile a comprehensive list of crops with available yield data. These data will be used to further examine methods to calculate expected yields.

Meeting Minutes

Statement of purpose:

To evaluate the crop yield and land uses in CAST and discuss potential alternatives for Phase 7.

Announcements:

- Fertilizer Expert Group Phase 7 recommendations were presented to the MB on September 5th working through the partnership
- Nutrient timing and eligibility are being discussed for use in Phase 6 at the September 21st AgWG meeting.

Introduction: 09:00-09:05 [5 min (Zach Easton, Virginia Tech)]

Approval of August minutes.

Scenario Discussions: Crop Yield trends 09:05- 09:35 [30 min (10 min presentation 20 min discussion) (Tom Butler, EPA; Zach Easton, Virginia Tech)]

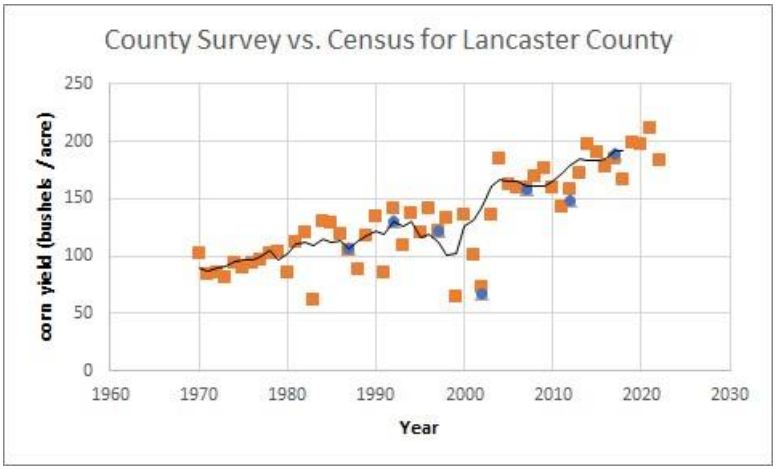
Tom and Zach provided additional information on the current yield data utilized in CAST. Discussions continued regarding potential methods to improve yield trends, including several methods proposed at last month's meeting.

Discussion

Ken Staver: With these last two methods, you start on a specific year, so you might be biased by that particular year. I think the starting point should be an average of 5 years. I'm not crazy about those last two options, but if we use those, we should tie it to an average period instead of a specific year.
Gary Shenk: I agree, Ken. The knowledge contained in the two exponential curves is the fact that it's an exponential curve. it would make sense to use statistics to find the exponential best growth line. We should also think about if it's more likely in the year 2002 and 2003 that fertilizer recommendations and applications took a dip in Lancaster county because there was a drought, or was it more likely that it increased because corn yield was increasing?
Eric Rosenbaum (in chat): Don't think industry increase is a % — data shows around 2-3 bu/A/yr

Robert D. Sabo (in chat): The "industry curves" with starting average periods would only be needed if we don't have CENSUS or Survey data for a given crop of interest
Tom Butler: Yeah we can look at that if we move forward with this.
Ben Hushon: Coming out of a drought, farmers tend to not have as much money, so in general it'd be safe to say there would be less applied, but I'm not sure if we could say by how much.
Ken Staver: My experience on P and K is that there's definitely carryover, but N isn't thought of to carry over as much. Not part of NM plans in Maryland. Grain prices also play a role. It's complicated.
Ben Hushon: Agree that N doesn't carry over. But in general we have sales data that all N, P, and K are down following a drought year.
Mark Dubin (in chat): Gary - The NMP recommendation would continue to use the average value (3 out of 5 for example) despite the one year of depressed yields. It would affect the average of course slightly.
Chris Brosch (in chat): Ben is 100% right. Ken is also right, but his point is more theoretical and Ben's comment is the practical reaction in the industry.
Tim Larson (in chat): Does anyone have a theory why the 5yr census yields are so different than the 1yr survey yields?
Tom Butler: My understanding is that the 5 year census years coincide with droughts, in addition to having fewer data points then the annual data.
Robert D. Sabo (in chat): Could we see the census corn yield time series, just reported yields?
Tom Butler: Yeah it's shown in the graph.
Chris Brosch (in chat): Those correlations are high where crops share a season with corn. I'm not sure we can compare perennials and small grains that grow in different seasons for understanding.
Tom Butler: Good point, thanks Chris.
Chris Brosch: This data isn't great. Wouldn't want to use that to model anything.
Mark Dubin (in chat): Given the level of variability of yields over time, the Census data is not sufficient to represent the true yields. Annual data is better, but there's a question about the availability of that data. Annual data we are currently using is what we can find in all 6 states, but there's other data that isn't shown in all 6 states, for example, cotton. Annual reports by state are hugely important.
Robert D. Sabo (in chat): I am going to double check Census and survey values real quick.
Tom Butler: Next steps will be looking at those crops. We have an analyst who might be coming on soon who can help us with that.
Gary Shenk: We have an ORISE fellow coming on, excellent with data management and nutrient transport. As part of the modeling team, he will be working on the data for this group and sensitivities.
Ken Staver: Can we get an assessment of the extent of acreage we don't have data on?
Tom Butler: Sure.
Mark Dubin: I think it's increasing over time.
Chris Brosch (in chat): Increasing crop diversity is not "worse".
Ken Staver: I meant the percentage of farmers reporting to NASS is worse. Not crop diversity.
Chris Brosch: Yeah, I would like to talk to them again. While response rate has dropped, and crop diversity is increasing, through that period the tools that NASS has presumably improved and ability for farmers to track the data has improved, so I actually have more confidence in the current data.
Ken Staver: Agreed.

Mark Dubin: The first step is to figure out how to use the data we already have available. How we improve that data would be the next step.
Gary Shenk: I think everyone would be in favor of using all the data. First thing is to describe what we've got and then see how we can use the data on actual yield to understand expected yield and then make decisions accordingly.
Chris Brosch (in chat): Suggestion for Tom. I think the correlation could be useful to find crops that share a season with Corn and Wheat separately to identify those that don't follow closely.
Helen Golimowski (in chat): @Thomas Butler I have used QuickStats to pull census and survey yield data from NASS and would be happy to help if you need anything or would like a list of the crop types that are reported annually.
Robert D. Sabo (in chat): Just wanted to note that some individuals suggested that the Census data was not useful or inaccurate, but I would like to express this may be overstated. I just generated a time series with Census (blue circles) and the NASS survey (orange squares); and there is a pretty strong correspondence. This graphic also has a five year moving average line for the survey data:



Mark Dubin (in chat): Robert - The annual NASS report for the Census of Ag years would be the same, however, the limited number of data points leads to a more inaccurate representation of yields over time as Tom's tables previously demonstrative. It's not that the Census of Ag data is inaccurate for the year published, but not sufficient for the task we are focused on. Thanks!
Robert D. Sabo (in chat): Definitely agreed on years matching... however, I am unsure if Census observations are grossly deviating from NASS survey trends. The blue dots (CENSUS years) largely follow the 5 year average of the survey (orange squares). The only deviation is the 2002 drought. thanks!

Background on Load calculations 09:35-09:55 [20 min (10 min presentation 10 min discussion) (Gary Shenk, USGS)]

Gary helped connect our previous work on crop yields to the way nutrient loads are calculated. He gave a short presentation outlining the role of inputs in the load's calculation.

Discussion
Ken Staver: In terms of your input, is that based on yield?
Gary Shenk: As the AMS calculated it, the yield goes into 4 different parts of sensitivity - manure application, fertilizer application, fixation and crop uptake. Will talk about that later.

Ken Staver: Regarding the example of the double crop though - the bay wide average is x amount, but this segment was less. That was because you have lower yields, so you draw less fertilizer?
Gary Shenk: That could be one reason. Another reason could be nutrient management or the amount of fertilizer.
Ken Staver: I thought your amount of fertilizer depends on your yield?
Gary Shenk: Yes, the reason why it's less than average is because you've applied more manure and biosolids, your yield is lower, and/or you're reporting more nutrient management.
Ken Staver: Is that plant available N?
Gary Shenk: It's total N.
Chris Brosch: Is this showing delivered load on the y axis?
Gary Shenk: It's lb for lb, the fraction of EOS average over the entire watershed.
Chris Brosch: So it's accumulation of runoff and leaching losses?
Gary Shenk: Correct.
Chris Brosch: Seems to me like there's too much sensitivity on legume fixation. What did you say was too low?
Gary Shenk: The uptake. And you may be right about fixation. To change that, we should dive into literature that wasn't available for P6.
Ken Staver: You have this relationship between uptake and yields. What does 10 more bushels per acre of yield give you in terms of loads?
Gary Shenk: It goes up.
Ken Staver: What is your increase?
Gary Shenk: It's not always straightforward.
Robert D. Sabo (in chat): Some research groups assume fixation results in a net surplus of zero in soy so fixation=N removal.
Mark Dubin (in chat): I agree that it appears the crop uptake sensitivity is too depressed compared to the other factors.
Chris Brosch (in chat): I think the P sensitivities are still quite good and defensible. Sure would like to concentrate efforts on N and sources.
Cassandra Davis (in chat): Are these sensitivity factors basin-wide?
Gary Shenk: The average sensitivities are basin-wide, but if you're on a higher loading ag crop land use type to begin with, then your sensitivities will be different. They are relative to your average loading rate.
Chris Brosch: Is that consistent with SPARROW?
Gary Shenk: SPARROW doesn't break it out that way. The overall sensitivity for SPARROW is consistent with the number we have, but the sensitivities we have were directly derived from the P5 process-based model.
Victor Clark (in chat): Just a brief reminder that mortality is another part of the inputs, whether as part of the manure input load or as an independent input.
Tim Larson (in chat): Gary can you please share the slides? The ones posted with the meeting link do no include the last 4-5 you presented.
Lisa Duriancik (in chat): With phosphorus, how do you expect that legacy sources are influencing what you are seeing with the mismatch with the model as opposed to just inputs?
Gary Shenk: I absolutely think legacy sources are a big part of that. The way we model includes legacy sources because we model soil P using mass balance over time. We'll get into that later with this group. We have some data from soils and a mass balance, and from that we estimate soil P. So the soil P that is occurring is a result of the legacy.

Ken Staver: For water extractable P (WEP) - is there any kind of soil layering for the top layer? or is it an average?
Gary Shenk: It's WEP that is applied in that year. Not the WEP in the soil.
Chris Brosch (in chat): Gary, how do we interpret the uptake reduction sensitivity? Is the pound of uptake reduction based on the yield?
Gary Shenk: I don't remember exactly how it's done, but there's some relationship between bushels and lbs of N uptake. Would have to double check.
Chris Brosch: I'm trying to think about how much bushel reduction would be needed to yield a whole lb reduced of uptake. And then trying to reconcile that with a 5% sensitivity. It's confusing.
Gary Shenk: Yeah, all of that is up for discussion.
Ken Staver: If we just looked at corn acres and said we wanted to meet this TMDL goal for those acres, could you do the calculation of where the inputs have to be relative to the yield to get the reduction in load?
Gary Shenk: Yes. Given the set of other BMPs that you have, you come up with an application rate that would be required.
Ken Staver: Those other BMPs are optional. Seems like we need to get to a point where we determine how far we're going to go with inputs to reduce loads. The other things are add-ons, but for the fundamental production part, it seems like we need to see how far we can get within an economic reality.
Gary Shenk: That's sort of inherent in the TMDL calculation. Entities are responsible for some fraction of what they *can* do. What they can do is a scenario where you implement all BMPs including nutrient management. At the NM level, how much else can you do is one way to frame that question.
Ken Staver: Or framing it as a step-down function.
Mark Dubin: There is a zero application BMP which is land retirement. and that is something the states utilize.

Background: Land Uses in CAST 09:55-10:15 [20 min (15 min presentation 5 min discussion) (Peter Claggett, USGS)]

Peter introduced the topic of Land Use categories in CAST and set the stage for future discussions.

Discussion
Olivia Devereux (in chat): While USGS will release updates next summer, they won't go into CAST until Phase 7 is released.
Mark Dubin (in chat): Would a barren land use condition for some land uses be temporary, such as hay barren, depending on the timing of the image being taken? If hay barren represents the landscape directly after taking a cutting, or when planted, it would seem to be inaccurate to classify the temporary condition as an annual land use with associated loading.
Peter Claggett: I'm not proposing having cropland barren and cropland herbaceous being separate. The reason we map it that way is because we want someone to be able to collapse the LUs into the original land cover dataset and we don't want to lose that data. But it all gets rolled up into cropland.
Mark Dubin: It'd be helpful to show that on your slides.
Olivia Devereux: A few comments: (1) Just adding that the land use data is just spatial. The LU data from Peter provides the total acres of one category (cropland, pasture, etc.) and the exact

number of acres for each crop comes from the percent in the ag census; (2) To establish the feeding space acres, we are using the animal numbers instead of the mapped data. Peter said he could potentially identify those and could be mapped directly which may be more accurate than how we're doing it now as long as we can handle the fact that we can't have animals in our modeling segment where we don't have a barnyard for them or vice versa; and (3) A little bit of the spatial data is changed to make room for other land uses that are reported by states.
Peter Claggett: For poultry in particular, just because we can map all the poultry houses and label them as such doesn't mean they are full of chickens. They could be abandoned or not in use, but the fact that we are mapping them and potentially dairy operations, gives us an opportunity to fine tune mathematical operations relating animal operations to area. So additional research could be done to refine some assumptions as we move into P7.
Chris Brosch: Our concern with spatially identifying farms is about biosecurity and bioterrorism. I don't think that should be minimized. These things are visible from public information sources but consolidating them and applying labels to them - we need to be responsible when we do that.
Peter Claggett: I agree and we're aware that's sensitive information. If that's a collective concern, we've considered a plan B which is to not put it officially in the classification and instead have it as an internal dataset. Would have to discuss how we'd protect that information.
Chris Brosch: Glad to help when you guys have those conversations.
Mark Dubin (in chat): Mapping agricultural facilities with livestock production is not fully straightforward when compared to NASS data. In addition to older facilities which are no longer used as Peter mentioned, they can be reused for alternative livestock production as well as other uses, as well as that NASS reporting of operations can overlap livestock species and include non-commercial operations, i.e. laying operations.
Robert D. Sabo (in chat): The afo/cafo/barn location estimates can help the estimates optimize manure transport programs and placement of manure nutrient inputs into the watershed. However, we would have to ensure privacy is maintained.
Peter Claggett: We are looking into separating hay from pasture but I'm not confident that we can do this or should be putting resources into it. AgWG noted that a lot of the pasture and hay management is intermixed temporally and spatially. If that's the case and there's not a big loading difference, then maybe there isn't a good reason to separate them.
Chris Brosch: Agree that there's too much variability in management to separate them.
Mark Dubin: Agreed.
Gary Shenk: What Peter delivers is not necessarily what goes into the model. Just because it's not in the LU doesn't mean that we can't distinguish between hay and pasture when it gets modified for CAST.
Peter Claggett: Everything is up for discussion for Phase 7. We could use the total footprint of mapped agriculture at 1m resolution as an area constraint. We could also use the cropland footprint to control the total amount of cropland in the watershed or jurisdiction, and crop types would be allocated to where we've mapped that and, separately, all pasture/hay proportions in the census would get allocated to what we map as pasture/hay. With animal operations we could do a similar thing. Need to determine at what hierarchical scales to use as an area constraint to what actually exists.
Robert D. Sabo (in chat): On farmer privacy and safety concerns- one thing USDA Forest Service does for their Forest Inventory Analysis plots is that they fuzz the coordinates for the public facing dataset but use the spatially explicit locations for their internal modeling efforts. USDA releases a fuzzed CAFO map periodically, so there is some precedent to ensure farmer privacy/security.

Combining Ag Census and Satellite-Based Land Use 10:15-10:35 [20 min (5 min presentation 15 min discussion) (Gary Shenk, USGS)]

Gary discussed how the Census of Agriculture and satellite imagery work together to create the land use classifications in CAST.

Discussion

Tim Larson: If your ag census acreage differs from your LULC acreage, how do you reproportion your LU classes? How do you determine if you take from pasture/hay or developed, etc?
Gary Shenk: For P6, we estimated the uncertainty of both ag census and mapped data. The satellite data for developed only changed a little bit and the ag census changed a lot in order to fit in that area. So the satellite data and classifications have advanced to the point where it's way more accurate, particularly in trends in land use, so the current proposal is to use the absolute values from the satellite data and the ag census would not be used at all for acres, but only used to proportion acres into the land use that we get from satellite.
Olivia Devereux: We're already doing that for agriculture watershed-wide.
Cassie Davis (in chat): That was my understanding too Olivia.
Ruth Cassilly (in chat): Wasn't that (total ag land use acres comes from imagery) a change approved for C21 and so would be the case in C23, but is not the way it is done in C19.
Gary Shenk (in chat): My understanding is that we use the absolute value of the trend, not the absolute value of the land use. We did not change the absolute value of the 2013 data which relied on the true-up procedure
Ken Staver: So is NASS data generally over reporting or under reporting cropland acres?
Peter Claggett: Compared to the ag census, generally about 75% of the counties, we map more acres as agriculture than the ag census reports. Especially in counties like Clearfield county because they have a lot of reclaimed mine lands. The ag census really reflects land in production, better than what we can map because we can't always tell if something is in production from one year to another. In other words, what we're mapping is what's possible to be agriculture and the ag census is saying what land is in production. Also, as of 2013, we mashed together what we've mapped and the ag census. Then we used the change product from 2013-2025, and the change was restricted to what we've mapped, so I think Olivia and Gary are both right but for different parts of the timeline.
Ken Staver: Seems like the uncertainty is higher in some agricultural land uses than it is in others. I would like to think this hay pasture thing is a bit of an ongoing challenge, whereas maybe corn and soybeans not so much. The uncertainty isn't the same with all the land uses, right?
Gary Shenk: Yeah, right.
Ken Staver: When you say ag census - we're just talking about NASS data in general right?
Peter Claggett: I haven't looked at the annual data and compared it to what we've mapped. I've only compared our data to the 5 year census.
Helen Golimowski: The states also report some land uses annually like their construction acres and harvested forest, permitted vs non-permitted feeding space.
Robert D. Sabo (in chat): EPA/ORD, in some of our recent big reports, Census/Surveys/NRI as more of the standard to evaluate spatial and temporal trend for agricultural trends. Remote sensing products are viewed as complementary.
Mark Dubin (in chat): Peter - The annual NASS reports vary significantly by state, and the scale and type of data vary. However, I would recommend reviewing them with your data as they

could provide you with additional data for the years of imagery you are using. Please feel free to reach out. Thanks!

Scenario Discussions: Land Use Categories 10:35-10:55 [20 min (5 min presentation 15 min discussion) (Tom Butler, EPA)]

Tom discussed the current agricultural land uses in CAST and introduced discussion questions about Land Use categories for Phase 7.

Discussion

Ken Staver: A lot of the ag land uses have different loading rates. I think you should have the opportunity to apply the BMPs to the highest loading land uses. It makes sense to target.
Ben Hushon (in chat): Is there a chance of accounting for stabilized applications of commercial nitrogen that reduces loss.
Chris Brosch (in chat): Ben, that's a BMP acting as a NM enhancement.
Mark Dubin (in chat): Ben - The last NMP expert panel considered them and as Chris noted it would be represented as a supplemental BMP.

Closing –10:55-11:00 (5 minutes)

Adjourn – 11:00

Up Next: Friday, October 13th, 2023, from 09:00 - 11:00am.

Participants

Tom Butler, EPA
Jackie Pickford, CRC
Zach Easton, VT
Ben Hushon CCA ag retailer
Cassie Davis, NYSDEC
Gary Shenk, USGS@CBPO
Tyler Trostle, PA DEP
Kristen Bisom, WVCA
Eric Rosenbaum, Rosetree Consulting & PA4R
Nutrient Stewardship Alliance
Seth Mullins, VA DCR
Mark Dubin, UME/CBPO
Karl Blankenship, Bay Journal
Emily Dekar, Upper Susquehanna Coalition
Scott Heidel, PA DEP
Curt Dell, USDA-ARS
Helen Golimowski, Devereux Consulting, CBPO
Candiss Williams
Chris Brosch, DDA
Elizabeth Hoffman, MDA
Hunter Landis, VA DCR
Ruth Cassilly, UMD-CBPO
Tad Williams, VT
Victor Clark, DE Farm Freezers
Lisa Duriankcik, NRCS
Alex Soroka, USGS
Tamie Veith, USDA-ARS
Peter Claggett, USGS-CBPO
Alisha Mulkey, MDA
Kate Bresaw, PA DEP
Robert D Sabo, EPA/ORD
Ken Staver, UMD
Tim Larson, VA DCR
Ashley Hullinger, PA DEP
Olivia Devereux, Devereux Consulting

**Common Acronyms
AgWG- Agriculture Workgroup
AMT- Agricultural Modeling Team (Phase 7)
BMP- Best Management Practice

CAST- Chesapeake Assessment Scenario Tool (user interface for the CBP Watershed Model)
CBP- Chesapeake Bay Program
CBPO- Chesapeake Bay Program Office (houses EPA, federal partners, and various contractors and grantees working towards CBP goals)
CBW-Chesapeake Bay Watershed
CRC- Chesapeake Research Consortium
EPA- [United States] Environmental Protection Agency
K - Potassium
N - Nitrogen
P - Phosphorus
PSC – Principals' Advisory Committee (CBP)
STAC- Scientific & Technical Advisory Committee
TMDL- Total Maximum Daily Load
WQGIT- Water Quality Goal Implementation Team