Agricultural Modeling Team (AMT) Meeting

January 12th, 2024
09:00 AM – 11:00 AM
Meeting Materials

Summary of Actions and Decisions

Decision: The AMT approved the December meeting minutes.

Action: Provide feedback to Tom (butler.thomas01@epa.gov) on the time for Ag Modeling Team office hours (8 – 9 AM prior to our monthly meeting time).

Action: Tom Butler, EPA, will work with the CBPO & CAST team to address the following requests made from the group:

1. Continue providing updates on crop yields.
2. Distribute the data file specifying CAST inputs for livestock duration in different environments, as well as current manure generation and nutrient concentration values.
3. Discuss the possibility of in-person meetings with state representatives to streamline various data requests for CAST.
4. Provide updates on the impact of changing land use loading rates in CAST.

Action: Group members are asked to provide feedback on the following topics via email (butler.thomas01@epa.gov) or during the Feb 9 AMT meeting:

1. Which parameters we can use with existing data to improve the calculation of manure acres. Some questions include:
    a. Has the relationship between animal units and manure acres changed?
    b. Should we attempt to determine individual curves for different animal types?
    c. Should we attempt to set these numbers with a relationship between the CAST animal units and manure acres?
    d. Should we use plant available nitrogen (PAN) rather than total N to change this relationship?
2. Whether changes should be made to the existing livestock duration in different environments, manure generation, and nutrient concentration values.

Meeting Minutes

Statement of purpose:

To evaluate the crop yield and loading rates/ratios in CAST and discuss potential alternatives for Phase 7.

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

Announcements:

- **Decision:** The AMT approved the December meeting minutes.
- Beyond 2025 Clean Water Subgroup Listening Session:
    - **Thursday, February 1, 2024**
    - 10:00 a.m. – 12:00 p.m.

    - More information: https://www.chesapeakebay.net/what/event/clean-water-beyond-2025-listening-session
- BMP Excess presentations:
    - [Tentative] Land Use Work Group March 2024 meeting
    - See recap email for additional information about BMP Excess
- Ag Modeling Team office hours
    - Optional meeting time from 8 - 9am on the second Friday of each month to walk through upcoming topics. If you have feedback on changing the day/time, please reach out to Tom.
- Phase 7 office hours
    - ONE TIME February 5th 12:30-02:00
    - Gather feedback from our partners on what they want to hear about at the February WQGIT meeting with regard to Phase 7 (P7) modeling progress and/or concerns that P7 is missing something important to them.

Crop Yield trends 09:05- 09:25 [20 min (5 min presentation 15 min discussion) (Joseph Delesantro, ORISE)]

Joseph provided a recap on the importance of Crop Yield data in CAST and discussed the progress being made to improve long term crop yields. This includes multiple potential approaches for estimating yields from the Five-Year Census of Agriculture using correlations to crops with existing annual yield data. This was an informational update only.

Discussion

Alex Soroka: Is the time period for precipitation an annual temperature or focused by the crops' typical growing cycle?

Joseph Delesantro: This is annual. Subsetting this to a growing period is very doable if we want to do that.

Alex Soroka: We were looking at relationships between land surface greenness and biomass production for cereal cover crops and we found a strong relationship if we focused on certain months in winter. We might get a better fit if we focus on growing season. I'll send you the work we did with Dean Hively out of USGS/ARS.

Dave Montali: I don't understand the downward trend in yield for changing cropland area for sweet potato.

Joseph Delesantro: I think it might have to do with them being specialty crops. People growing crop X for yield are doing it in certain regions, and people outside of that region are just growing it as specialty crops, which might be why the yield trends downward.

Chris Brosch: That sounds right. We could look at the critical mass of acres to determine that. Might just be niche markets on lower yielding varieties.

Dave Montali: That seems plausible but we should be careful about saying a crop has a negative yield.

Joseph Delesantro: Yeah, we can take a look at the acreage and see if it matches the crop yield to determine if it's an indicator.

Chris Brosch: I have a question on the hay trend estimate examples. The dramatic upward trajectory in the 2010s is something that probably needs an explanation. The step functions also concern me. The interpretation of max yield expectation - I don't think that should ever decrease. Once you've achieved a certain upper limit, that is an indication of the genetic potential with the current level of technology on the farm, so it shouldn't decrease. But that

doesn't mean the expected yield that the farmer fertilizes towards should grow that quickly. The dips are something we shouldn't be modeling because that's not how budgeting for nutrients work in the real world.
Joseph Delesantro: That's good perspective. For small grain hay - as we evaluate these estimates, we will also take into account the availability or lack of data.
Chris Brosch: This is really exciting to see this level of matching. The 'hay small grain' is the only problem for me. Suggestion to find a parameter for the wheat bushel price. There might have been a change in price where a lot of wheat headed towards the grain market was cut for hay.
Joseph Delesantro: Thank you. Economic predictors are mixed with the environmental data within the literature, but it's a little outside of my wheelhouse. If we have simple economic predictors, such as one we can find in the census data, I'd be interested in looking into that.
Alex Soroka: Nicole from MD is looking at something similar to do with historic MD crop yields from their variety trials and weather, and that may be someone you may want to talk to. Also, from a WQ perspective, we may want to consider taking a residual of actual yield from one of those predicted lines, and the distance from those lines could be an indicator of nutrient use efficiency.
Joseph Delesantro: That might be part of Gopal's dynamic watershed model.
Chris Brosch (in chat): Someone might have a better suggestion, but Chicago SRW futures price is an economic figure worth considering.
Ken Staver: So the problem we're having right now is that we're applying nutrients at a higher rate per yield unit than we were in the past, so yields are going up.
Robert Sabo: That's a valid concern but the extent that fertilizer application rates are constrained by the fertilizer sales data will be key. Tonnage will be relativized based on these yield rates.
Joseph Delesantro: The lbs of nutrients per unit yield - that number will stay constant. What is changing is the expected yield and the acres.
Ken Staver: What's happening in the last 10 years is that lbs of nutrients per unit yield has gone up considerably and is generating higher base loads from our fertilized crops. Somehow the fertilizer quantity is causing that.
Robert D. Sabo (in chat): the fertilizer sales needs to be updated
Chris Brosch: I agree with what you're saying, Ken. I think the context is difficult to discern though. To clarify, are you suggesting that models increase in intensification in the use of nutrients compared to the yield that its producing is problematic to the way we see it in the real world?
Ken Staver: Well there are two separate issues. One is generating higher loads in the model. We're not doing N applications in this graph this way. If the yield doesn't go up to match the fertilizer sales data then the lbs N per unit yield go up and then the EOT loads go up, which they have in the past few years for corn. So this equation does not describe how it's currently done.
Joseph Delesantro: I thought the lbs N per unit yield is provided by the state, right?
Tom Butler: The lbs N per unit yield is set from the last year we have fertilizer data in relation to that crop yield. We're trying to get the expected yield. Ken, the intensification of fertilizer can be a topic at a later date when we talk about fertilizer specifically.
Olivia Devereux (in chat): Fertilizer sales are now through 2020. The yields are from the last Ag Census and annual surveys for major crops.
Robert D. Sabo (in chat): When were the fertilizer sales released? and it's available on CAST? thanks @Olivia Devereux!
Alex Soroka (in chat): Thanks Joseph, this is exciting.

Robert D. Sabo (in chat): fantastic job, Joseph, the actual yield and these other smoothed time series will have a lot of great uses for our community.

Manure Generation and Acres in CAST 09:25-11:00 [35 min (15 min presentation 20 min discussion) (Tom Butler, EPA)]

As a follow up to the December AMT meeting, the group reviewed the processes behind manure generation as well as the calculation which determines manure acres. Tom then facilitated a discussion on potential ways to improve on these items for Phase 7.

Discussion

Dave Montali: This is unrelated to the nutrient pile and application elsewhere, but I think we should reevaluate the percentage estimates on how much time animals spend in the riparian zone. It should be a non-BMP consideration. We should look for consistencies in growth regions across the states.
Tom Butler: I'll circulate that document to the group so folks can reevaluate it.
Ken Staver: While you're doing that, can you also indicate what the quantity of the loads are instead of percentages?
Tom Butler: Yeah, I can do that.
Dave Montali: I think the idea we had back in Phase 6 is that when the animals are in the riparian zone, what they deposit there is 100% delivered, there is no land to water factor. Someone made the argument that when they deposit on the streambank, the entire load is not being deposited there, there may be some attenuation on the bank next to the streams, so it's more like 70 or 80%.
Olivia Devereux: I'm not sure if everyone on the call is up to speed on the land to river / land to water factors. Maybe we need a briefing on this prior to discussing it.
Tom Butler: I agree, let's get this file out for folks to review and keep it broad for now.
Dave Montali: I agree. I think this is very important though and the process now is better, but I think it needs potential refinements.
Lisa Duriancik (in chat): Why do manure nutrients deposited on pasture not offset commercial fertilizer applied? What is that based on?
Tom Butler: I think it's tied to the nutrient management panel that made that decision.
Mark Dubin: Prior to Phase 6, we were looking at land grant university agronomic recommendation rates. We found that it was directing a very specific amount of inorganic fertilizer onto those pasture acres, so the decision was made for Phase 6 to basically limit those. It better accounts for nutrients being applied from the organic side.
Robert D. Sabo (in chat): I just took a look at the Chesapeake Bay Nutrient Inventory and it looks like the ratio between deposited into stream vs. deposited into pasture and its 0.06 to 0.07 in Rockingham County, VA. I can look up another county if there is interest.
Hunter Landis: Is the total animal units in harvested cropland per county or jurisdiction?
Tom Butler: Per county.
Chris Brosch DDA (in chat): Is the grain with manure acres eq ringing a bell for any of the group veterans?
Dave Montali: We should revisit the equation on the "why is there a range for corn" slide ("relationship between AU/acre and fraction manured acres (MdAIR)" equation).
Chris Brosch: Agree.
Ken Staver: Agree.

Mark Dubin: Looking at this equation, is there any influence for organic nutrients coming into or out of a county? Animal numbers can be influenced on acres or nutrients coming in or out of a county.
Jessica Rigelman: It is not. This equation is used to define the pre-BMP land use.
Ken Staver: What determines what gets manure is how much plant available nutrients are available, so right now there is a perverse outcome if you transport nutrients out of your county, you actually end up with higher N loads, so that's not really not what people want to happen when they transport manure out of their county.
Chris Brosch (in chat): Elizabeth, seeing this is MdAIR based, do you have any advice on if we should revisit this? Any chance this curve may change through time?
Elizabeth Hoffman: The equation came from deliberations in the AMS and all that MD provided was data from AIR to ground truth it. We have a lot of data and other states might have some other data that could be useful as well. I'd have to look at this more closely and the history of it.
Chris Brosch: Alisha might know since she was involved in that.
Ken Staver: All MD did was provide the Y values for those data points. Someone else came up with the X values.
Elizabeth Hoffman: That's correct.
Robert D. Sabo (in chat): Are the blue dots a county value?
Chris Brosch (in chat): That's also very helpful, thanks Ken.
Tom Butler: Any other states that have data, it would be great to get that by the Feb meeting.
Dave Montali: The X axis is from our protocols for getting animal units in harvested cropland. I guess it was just verified by applying our 'model numbers' for x axis to MD observations about the fraction of corn acres receiving manure in their counties or state. I think it's wise to revisit it with any data we have from any state.
Elizabeth Hoffman (in chat): I believe those were statewide as a fraction. But that work was done before me and I don't have the documentation.
Ken Staver: I think what might be more helpful is the application rate of nutrients on manure acres. With the animal data we have in CAST, we can get the plant available N by county. Manure is applied by nutrient availability, so you could get at the acres that way.
Tom Butler: Yeah, that's a good idea. We can look at it both ways.
Ken Staver: Not all animal units are created equal in terms of plant available nutrients to go on cropland. If you have a lot of beef in your county, I wouldn't expect a lot of manure to be applied to cropland. If you're accounting for dairy or poultry, most of those nutrients are actually going to be applied to row crops.
Olivia Devereux: Good point, Ken. For beef, the amount of time in pasture is typically 100% so would likely be going on pasture. If we were to change the amount of time in pasture for some of the animals in locations as Dave suggested, then it'd likely be going on row crops. There are implications either way.
Tom Butler: I'll work on that, Ken.

Loading Rates/Ratios in CAST 10:00-10:55 [55 min (15 min presentation 40 min discussion) (Tom Butler, EPA)]

The group discussed why loading rates and ratios exist within CAST in addition to how they were determined. Tom then led a discussion regarding potential improvements for Phase 7 CAST.

Discussion

Victor Clark (in chat): How are load source input reduction BMPs – such as manure transport -- applied as opposed to others on the model structure graphic you just showed?
Tom Butler: A load source input reduction BMP would change your application rather than your efficiency. They will reduce your input load before you put them down.
Olivia Devereux: The sensitivities are multiplied by the change in inputs, but the BMPs are a reduction and that gets calculated afterwards.
Jess Rigelman: Yes, manure transport would change the input. The manure part of delta input would be changed by lbs per acre of manure applied in that county would be affected by the transport and therefore that input would change.
Tom Butler: We'll be diving into how reducing manure can impact other things like fertilizer later on.
Robert Sabo: For crop removal and uptake - the rate of increase in crop removal is now exceeding the rate of nutrient inputs in cropland. So where does crop removal and uptake come into play? In the delta input section? Are these loading factors evolving through time to capture that nutrient use efficiency?
Olivia Devereux: Yes, in delta inputs. It can change over time.
Chris Brosch: Does it change over time? I know it can, but I thought we just had a single value for corn.
Olivia Devereux: Yes, we haven't had data to tell us otherwise.
Ken Staver: So the rate of N application relative to removal or uptake does change in CAST? It's actually increased monotonically since 2009.
Robert Sabo: When you look at nutrient use efficiency and surplus trends from 1985 onward there has been an improvement in cropland nutrient management, so the source of pollution on cropland is going down through time. Want to make sure that's being captured in this modeling framework. Is the atmospheric deposition loading factor on a specific cropland in CAST or fertilizer loss loading factor evolving through time?
Ken Staver: It is dynamic.
Robert Sabo: One uncertainty in terms of nutrient use efficiency and surplus trends from 2009 and onward is if the fertilizer data has been updated because to my knowledge it is still at 2014.
Olivia Devereux: In CAST23, we updated it to 2020 sales data. I think Robert is talking about nutrient use efficiency which is not where we end up in CAST. He is looking at what the inputs to the land are and not the sensitivities or runoff from the land to the streams.
Robert Sabo: Right. Those will be related to those loading factors, and I just want to ensure how that may account for the change in sensitivity to the shifts in pollution sources.
Olivia Devereux: It should because of the calibration to the water quality monitoring station.
Dave Montali: I think Roberts' issues are ones of sensitivity. Over time, plant uptake is increasing. At the MWG, Gary was open to revisiting the uptake and the sensitivities. The AMT could advise that the uptake is increasing and we can talk to the MWG on how they might address that.
Joseph Delesantro: Once I wrap up crop yields, I'll be taking a look at sensitivities.
Lisa Duriancik (in chat): Monitoring data would include loads attributable to legacy sources. How is this handled for the loads? Is it attributed as part of the ag load by the difference method?
Olivia Devereux (in chat): The purpose of the model is to predict the load under average hydrological conditions given varying BMPs. The prediction includes legacy sources, which some BMPs can address.
Dave Montali: Loads are lagged as well in our dynamic model so percentages of what we put down are lagged over time. If you look back to 1985, the legacy things that might still be there

are a percentage of what they were input as at the time. That's a detailed discussion. Gopal is probably the best person to discuss how loads are lagged over time.
Robert D. Sabo (in chat): I guess it's important, if possible, to ensure farmers are not automatically penalized for having increased crop yields. The fertilizer sales data will be the proof in the pudding but we always have to wait for the sales data to be processed (which there is a lag) which can make tracking progress difficult.
Tom Butler: Yes, we will have to address fertilizer and how it is dealt with.
Dave Montali: Important to recognize what was done for CAST23. we were dealing with a 5-year lag before C23. The new procedure is taking data straight from the states, so hopefully the lag will not be as bad and we can get data more quickly.
Robert D. Sabo (in chat): definitely! Look forward to checking out CAST23!
Dave Montali: I think we should re-examine our amount of manure generation by animals. It comes down to how much manure an animal makes, what the N and P content of that manure is, and other details.
Mark Dubin: I support Dave's comment. I was looking at our data for layers and we're coming up with differences between what we have in Phase 6 inputs and what reality is now. Some of the datasets are getting too old and are not reflective of current practices, so we need to update those.
Chris Brosch: Keeping this next version of the model as mass balanced as possible, we need to really understand and try to improve the way we include fertilizer sales. I worry when some of the members say we need to use that data, because we constrain them right now and it is not easy to use the raw data. It's better to remove the latency but we still do a lot of other things and I think we should improve those things. Also, I was wondering how to interface the state data with this process. It's hard to anticipate what data requests are coming and when. Our data isn't in a malleable enough form to present between meetings. Can we identify folks here that can talk with state data teams to better understand what data we have available and when it needs to be provided?
Tom Butler: Let's schedule an offline call to talk about that.
Elizabeth Hoffman: I agree with Chris. Accessing our data and making it valuable to this group's discussion can be difficult and take time, so a bit of a lead would be helpful.
Chris Brosch: An in-person meeting would be most useful. Would like to share raw data that we can't easily share virtually for legal reasons.
Elizabeth Hoffman (in chat): Maryland would request lead time as well, while we have a lot of data we need time to access it and make it valuable to our discussions here.
Chris Brosch: I would be willing to travel from state to state to share our data if that is easier.
Kate Bresaw: PA needs at least a 30-day advance notice of an in-person meeting if it's going to be out of state.
Dave Montali: I can liaison with our Dept of Ag folks. West VA probably doesn't have a ton of information we could use but we may have some that could be useful depending on the topic.
Tamie Veith (in chat): I don't have any specific data, but I think this sounds like a good plan and might help jurisdictions connect a bit as well.
Ken Staver: We've had a lot of questions about equations today and documentation. A lot of things have been done over the years where you can't get the info you need, so you just work on trying to move forward with the info that we have available, such as NASS. I don't think we can have an in-person meeting where only some people can join, but some people aren't allowed, and where the data is not accessible to all. We will run into another problem of lack of documentation.

Chris Brosch: Fair point. I intend to show relationships in our database and specific examples of individual operators. That information cannot be shared publicly. But the people that can join can understand the relationships in the context of their own data and see what common threads we have. When we come back together we can show the aggregated data.
Ken Staver: Can you, for example, aggregate 10,000 acres of NM plans? Would that be a problem to show to the group?
Chris Brosch: It could be a problem.
Tom Butler: Let's talk about this offline.
Elizabeth Hoffman: I think this process would be helpful in the future for revisiting the fertilizer sales data as well. There could be value in meeting with other states, and even across agencies, to ensure consistency in how we define and collect the raw sales data.

Recap/Closing 10:55-11:00 [5 min (Zach Easton, VT)]

Adjourn – 11:00

Upcoming Meetings:

Office Hours: Friday, February 9th, 2024 from 8:00 - 9:00 am.

AMT Meeting: Friday, February 9th, 2024, from 09:00 - 11:00 am.

Participants

Tom Butler, EPA-CBPO
Jackie Pickford, CRC
Scott Heidel, PA DEP
Victor Clark - DE - Farm Freezers
Olivia Devereux, Devereux Consulting
Zach Easton, VT
Arianna Johns VA DEQ
Cassie Davis, NYS DEC
Lisa Duriancik, NRCS
Curt Dell, USDA-ARS, University Park, PA
Helen Golimowski, Devereux Consulting, CBPO
Clint Gill, DDA
Hunter Landis, VA DCR
Chris Brosch DDA
Tyler Trostle, PA DEP
Tad Williams Virginia Tech
Kristen Bisom, WVCA
Alex Soroka USGS
Ken Staver -UMD Wye REC
Joseph Delesantro - CBPO Modeling Team
Elizabeth Hoffman, MDA
Jessica Rigelman, CBPO
Mark Dubin, UME-CBPO
Ruth Cassilly, UMD-CBPO
Kate Bresaw, PADEP
Dave Montali, TetraTech,WV, MWG
Ashley Hullinger, PA DEP
Bo Williams, EPA-CBPO
Patrick Thompson
Epz86759
Tamie Veith, USDA-ARS

**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

EOS - Edge of Stream
EOF - Edge of Field
EOT - Edge of Tide
EPA- [United States] Environmental Protection Agency
FEG - Fertilizer Expert Group
K - Potassium
MdAIR - Maryland Association for Institutional Research
MWG - Modeling Workgroup
N - Nitrogen
NASS - National Agricultural Statistics Service
NM - Nutrient Management
NMP - Nutrient Management Plan
NUE - Nitrogen Use Efficiency
P - Phosphorus
PAN - Plant Available Nitrogen
PSC – Principals' Advisory Committee (CBP)
STAC- Scientific & Technical Advisory Committee
TMDL- Total Maximum Daily Load
SPARROW - SPAtially Referenced Regression On Watershed attributes [USGS model]
WTWG - Watershed Technical Workgroup
WQGIT- Water Quality Goal Implementation Team