Agricultural Modeling Team (AMT)
Meeting Minutes

August 11th, 2023
09:00 AM – 11:00 AM
Meeting Materials

Summary of Actions and Decisions

Decision: The AMT approved the July meeting minutes.
Action: Look into replacing the current method of expected crop yield (best 3 of 5 for census + annual survey data) with the annual survey data to see if there is a major change.

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 recommendations are working through the partnership. Both the AgWG and WQGIT approved the recommendations in July.
    - Conduct in depth searches for different sales and application data sets.
    - Evaluate differences in data processing.

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

- Approval of the July minutes

Scenario Discussions: Crop Yield trends 09:05-10:55 [110 min (20 min presentation 90 min discussion) (Tom Butler, EPA; Zach Easton, Virginia Tech)]

Tom provided additional information on the current yield data utilized in CAST. Discussions will continue regarding potential methods to improve yield trends, including new data sources and spatial interpolations.

Discussion
Chris Brosch: I want to discuss how you determine expected yield.
Kate Bresaw (in chat): I would like to understand how expected yield is determined as well, so if we could please discuss this at some point, I would appreciate it.
Dave Montali: For the year you had both pieces of information and it was 50/50, does that ratio stay the same? Do you always get 50% of nutrient need to inorganic when you don't have sales data?
Tom Butler: No, the ratio doesn't stay fixed. It is fixed based on the proportion of crop need met.
Ken Staver: If efforts are made to improve nutrient management, if loads are driven by the amount of N relative to the yield, does that mean there is no possibility of improving NM in terms of a fixed ratio?
Tom Butler: With NM, we have a blended rate that is reduced versus the non-NM rate.
Gary Shenk: If you implement NM in the past it doesn't affect the overall amount of nutrients, just the distribution of it. But if you're talking about it in the future it will decrease the application amount because we don't know how much will be sold.
Ken Staver: I'm talking about the 6 or 7 years where we don't have a fixed bucket and we extrapolate.

Olivia Devereux: We never extrapolate the bucket. What we use going forward is the percent of crop need met for the past 5 years.
Ken Staver: Right, we're working on the 2016 fixed number. If someone did something that increased NM implementation in that year, whatever didn't go there had to go somewhere else.
Olivia Devereux: The percent of crop need is calculated and then NM is applied afterwards.
Chris Brosch: When we don't have the fertilizer sales, the amount of fertilizer is dynamic, not static. What you've done by increasing the amount of NM is take acres that look like column '0+1' and convert them into acres that look like '0+2'. The amount of manure stays the same, the amount of fertilizer applied decreases and because we don't have that fertilizer data, that bucket is dynamic and it shrinks.
Ken Staver: There is an issue of worrying about fertilizer sales, but we aren't constrained by fertilizer sales numbers anymore.
Chris Brosch: Yeah, the 2023 simulation is not.
Dave Montali: We'll do this for a few years but then we'll true it up again, and the fertilizer will come back into play.
Ken Staver: What will we do when we get the 2019 data and it's more than we expected?
Olivia Devereux: We do updates every 2 years to incorporate new data.
Chris Brosch: The AMS made a decision to do that.
Ken Staver: It makes sense to me why it's done that way. We're just not constrained. If N use efficiency goes one way or another, your application rate relative to crop yield doesn't change, it's only done with nutrient management. Is that right?
Chris Brosch: No, if you can't report it then some of it will disappear. That's a separate topic.
Olivia Devereux: I think you're trying to say that it's not a constrained bucket after we don't have the data. But NM is a BMP and calculated separately.
Olivia Devereux:Yes, but unlike the other BMPs, NM is not a filtering BMP. It changes the nutrient applied. So the more NM we have since 2016, it will shrink our bucket.
Olivia Devereux: Our hypothetical bucket.
Ken Staver: So finding fertilizer somewhere that increases some loads in other places where they didn't find fertilizer - that issue can't happen?
Olivia Devereux: Yeah.
Chris Brosch: That's an oversimplification. When the new data came in it was constrained from the most recent data being replaced. Those 'true-ups' can have an exacerbating effect on the most recent year that we're looking at.
Dave Montali: I need more understanding of the other things that change when we don't have AAPFCO data. I think it's changes in animals and amount of manure available, changes in yield, and changes in NM.
Jess Rigelman: Yes, we do have annual numbers. Other BMPs that affect this are animal waste management systems, buffers, amount of ag land you can apply it to.
Dave Montali: We will use new annual information with our undefined bucket of inorganic. My idea is to find a simpler way to get annual change in your bucket when you don't have it. Making a drastic change every 5 years doesn't seem like the best way to do it.
Chris Brosch: For those other elements you mentioned, if we don't have data being simulated then it is projected. So it's affecting the "waterbed" in the nutrient spread. The only thing that doesn't affect the waterbed in areas where true annual data doesn't exist is fertilizer sales, that's the only area of swap that isn't affected by that.
Dave Montali: So should we be thinking about simplified ways to project the bucket to make it easier or more understandable?
Tom Butler: We can definitely discuss that. Today I want to focus on crop yield.
Alex Soroka: So the 7 represented here make up what % of annual production?
Tom Butler: In terms of plant available nitrogen we apply it's about 73% and about 43% of the acres overall.
Ken Staver: In MD, fertilizer N applied is 90-95%.

Alisha Mulkey: The statistical framework slide - what data was that? County level annual survey data?
Tom Butler: Yes, correct.
Dave Montali: It seems like things don't vary much county to county, other than southern Virginia.
Alex Soroka: That may depend on units though.
Gary Shenk: We probably want to have yields change over time as those increase, but some of the other questions are what do we do when we don't have yield or lbs per yield unit for the other crops. I assume we want to keep the AMS assumption that yields do change over time.
Alex Soroka: Right, and that yields would be based on NASS survey data based on an annual scale. And the current method is to pick the best 3 of 5?
Gary Shenk: Yeah and that's a different question of how we get those values.
Ken Staver: But that's at the heart of it. You don't base your applications on reported yields for each year.
Gary Shenk: Expected yield (blue), average yield (orange) and annual yield (gray) all affect the calculation differently. When they plan their fertilizer applications they are thinking about expected yield. AMT wants to get at: (1) How to take this annual or 5-year data we have and create this expected yield which grows over time? (2) How do we estimate that for crops which we don't have any yield data? And (3) how do we get the average yield used in long term load calculations?
Ken Staver: We have wrestled around the annual yield being a datapoint every 5 years too.
Gary Shenk: Right, for some counties we don't have the annual yield at all, we only have data every 5 years, so we need to figure out how we deal with that.
Ken Staver: Right, but for the vast majority of crops receiving the majority of the N we have the annual data. In the past we've sometimes used the 5 year data for those crops in terms of generating these other 2 lines. Correct?
Gary Shenk: Yeah, what we have generated is the blue line (expected yield). In Phase 7 we want to separate the expected from the average, but the expected yield is the most important for the AMT. I think if you take the best 3 of 5 years and you don't go all the way back to 1950 then you will have a more shallow slope since the first number of years will be the same value.
Ken Staver: Are we discussing the possibility that from now on for the big crops that have annual data we're going to use it? And not use this 3 of 5 data?
Gary Shenk: In my opinion, I don't think we want to use annual data because it's dependent on weather we've had that year. But I think we'd want to use annual data to predict expected yield.
Ken Staver: But in the past we've used 5 year data to project expected yield. Have we stopped doing that? Do we need to discuss that?
Gary Shenk: I think we need to discuss that.
Alex Soroka: We're using the best 3 of 5 census years? I don't think we should do that.
Gary Shenk: Yes, I think the AMS decided to do that.
Alex Soroka: Crop yields have changed substantially in the last 40 years and the best 3 of 5 census years are not sensitive enough to capture that.
Tom Butler: We use both sources of information. For the current yield calculation we utilize both annual and ag census data. There is priority for annual data for the bigger crops where we have that data.
Lisa.Duriancik (in chat): Should expected yield line really be expected if it is so much higher than annual and average?
Gary Shenk (in chat): @Lisa, I really just made up the expected yield line. It is up to the judgment of this group how the expected yield lines up with the rest of the data. I am the least qualified to make that judgment.

Dave Montali: For 7 crops we have annual data and it seems like we want to use that. Is it a possibility to try and relay the other crops to those 7? For example, if we have data for barely and say buckwheat acts the same, can we use the same rate of change?
Alex Soroka: I think that's a good idea. Maybe we can ask the state departments of ag to see if those can be related. For example, are the yield changes seen in rye over the past 40 years similar to barely or wheat in terms of percentage change over time?
Alisha Mulkey: Not sure if we have data to answer that question, but we could think about it anecdotally.
Ken Staver: If you get down to the small acreage stuff, I think most of the stuff gets put in specialty crop high and specialty crop low. Not sure how much deeper we want to sort all of that out.
Chris Brosch: I think it matters to specific states. The industry is telling us that for corn we know the average annual rate of increase, so why is demand for fertilizer different when demand for fertilizer is driven by yield, which we know the increase for? So I think we should choose a point in time and then talk about how to apply the industry average annual increase and document that. And involve the industry that produces those estimates and pieces of historical data because professionals react to those values.
Alex Soroka: Are you suggesting that for only crops that use 5 year census data or also annual data?
Chris Brosch: For the crops we have most data for, we need an alternative approach. For crops we have less data, we can try to find a different approach, but maybe need to be prepared to fall back on the data we're already using because consequences are small.
Ken Staver: I think annual survey data captures what's going on in the industry and overall yield trends. We know it's problematic using the 5 year data for corn, but I think we have to stay tied to survey data. Don't think we can just start in 1985 and use some industry 3% per year number to make all this work.
Chris Brosch: We could look at a year that is closer to present. For corn/other crop types there is a percent per year as expected genetic gain which has relevance on expected yield but not actual yield because of weather. Could pick a perfect weather year for county/states and then build forward or backwards using a linear function.
Ken Staver: When I do a NM plan in MD I have to demonstrate that I can grow the yields I'm fertilizing for. I have to have actual field data, I can't say that expected yield is higher than I've ever grown. In MD our expected yield is tied to what we actually grow.
Chris Brosch: But in the model, everything is averaged. And in real life you're responding to a regulation. Need to simulate an average condition and a non-BMP condition too.
Ken Staver: I feel like it has to be tied to the annual data in some way.
Chris Brosch: Agreed. Actual yield of a year that is recent is probably something that we can all agree is the best place to start and then we can discuss how to simulate backwards and recommend values where we don't have data. For the big crops an average annual linear rate is better than a convoluted nutrient management stepwise function for the model. For NM plans stepwise is great. But not for the model.
Robert D. Sabo (in chat): I think it's simplest to apply the same smoothing procedure on Census and hybrid NASS/CENSUS time series to get at the expected yield. It will be better for NASS/CENSUS time series, but the Census crops will be reasonable. Also, the Census only crops are generally a small component of the mass balance.
Ken Staver: Well we need to decide whether or not we're using the best 3 of 5 census (5-year) data or best 3 of 5 annual surveys.
Chris Brosch: Hard to know which crop types are using which logic. Maybe we can look into that. But the 3 of 5, even using average annual data from NASS, isn't working.
Robert D. Sabo (in chat): Seems like we all agree the 3 of 5 rule is not the way to go.
Ken Staver: Well it doesn't work with the census, but it's not terrible with the survey.
Chris Brosch: I think there is still a lag with the survey.

Gary Shenk: Agree with Robert in the chat. Statisticians could probably help us with this and get some ideas on how to take the annual yield line to best create the expected and average yield lines. The thing this group needs to do more than anything else is distribute the fertilizer. The load goals are not based on weather. They are based on a weather average model (CAST).
Ken Staver: The orange line is going to stay tied to reported yield data in some way because it's based on what is actually grown, so you can average it. That is what goes into calculation for loads.
Olivia Devereux: We have a weather averaged model so we're not looking at what is actually grown.
Robert D. Sabo (in chat): I think orange line thru time is more straight forward to find an agreement, the blue line is trickier.
Gary Shenk (in chat): @robert. Agreed. We can calculate the orange line, but this group needs judgment to create the blue. We need both.
Ken Staver: An alternative could just be to use the best 3 of 5 to get a linear regression instead of the stepwise function. Also, if the blue line gets steeper and the orange line is fixed by what we grow, and the fertilizer bucket isn't fixed, then that will lead to problems. The more you separate the blue and orange, the worse the losses look.
Gary Shenk: When there is a fertilizer bucket, it hardly matters if we use the blue or orange line. But projecting it into the future, it will make a little bit of a difference, but it's only a fraction over the expected application. So if we had a fraction of 100% of the blue line, if we were using the orange line it would be 120% over. Separation in reality is what creates a lot of the runoff, but the way that it's calculated, I don't know if moving the blue line around would create more loads in the future.
Ken Staver: If you say to the folks working on NM if we reduce our N applied per bushel harvested from 1.1 to 1.05 lbs - should that be a goal, will that make a difference?
Gary Shenk: NM application does precisely that.
Ken Staver: If you look holistically, the whole effort is about more N in the crop and less N not in the crop. But states are trying to figure out what this means in the end. Economic reality will constrain what we do but it does seem like a worthwhile thing to say if we reduce our N application by X amount, what that means in projected loads.
Robert D. Sabo (in chat): The fertilizer bucket is ideally constrained by fertilizer sales so it's only proportionally allocated, correct?
Gary Shenk (in chat): @robert, yes
Thomas Butler (in chat): Robert, it is based off the filling of crop need
Robert D. Sabo (in chat): @gary so it's not big deal if the expected yield is too high if it ends up being a relative distribution. The average yields (orange line) can give us the average mass balance and NUE under average conditions through time. You can also calculate actual mass balance and NUE for transparency.
Chris Brosch: I want a yield that tracks what we understand the annual improvements are because that will be a more accurate attraction of fertilizer than what we're simulating right now. Where we tether it and what other data points we use is all up for consideration.
Ken Staver: Not sure what you mean by tether. Won't you just fit the curves to the data.
Chris Brosch: There are curves that exist based on data at a larger scale than the Chesapeake Bay, but the Chesapeake Bay is stuck. I trust that average annual increase and this method to simulate expected yields.
Dave Montali: Is the value of 3% accepted widely as the annual increase in yield for corn? If so, is that rate of change applicable across the whole modeling period or starting at a certain point?
Gary Shenk: I think the 3% was calculated from the same information that we have.
Ken Staver: NASS annual surveys show a 2-3% increase. The survey data is capturing what you're talking about in the industry Chris.

Alex Soroka: Changing to annual data or making this curve match annual data would likely be more realistic in terms of relative distribution of fertilizer.
Ken Staver: It's not clear to me how this curve is used.
Robert Sabo: Is it my understanding that these smoothed lines would fit the need or average yields through time, the orange line from Gary's presentation? I think the question is how we get at the expected yield, the blue line?
Gary Shenk: The blue line, expected yield, attracts the fertilizer. We want both lines to be smoothed, but expected yield will probably be higher than the average yields.
Robert Sabo: Maybe we need to confirm that it's the best 3 of 5 rule is using annual survey data, not 5-year census data?
Tom Butler: What we use now for the best 3 of 5 data is a composite of both census and annual survey data for corn. We usually give priority to annual surveys but I don't know the exact percent. And we have a smoothing process in place for the best 3 of 5.
Ken Staver: Hard to see how you smooth the data and get over 150 bushels per acre yield in 2020.
Tom Butler: Won't go into the smoothing process right now because it's complex, but maybe we can replace it with the information you provided from the annual survey data to see if there is a difference.
Chris Brosch (in chat): We need to truth our method to the industry. We haven't done that. If we are close, great, but if we are even a little low we're shooting Ag in the foot. I'm eager to work on exploring options.
Clint Gill (in chat): Robert, you also mentioned NUE in your typed comments earlier, and I've been thinking about that this whole time. I think there is land grant research going on right now to revise crop recommendations based on updated yields and NUE so it might be profitable to bring some experts in on that.
Robert Sabo: Yeah I agree. Might be worth looking into.
Lisa Duriancik (in chat): @Clint, that project - which I think you are referring to - is called the FRST project between LGUs and ARS and is funded by NRCS. It is currently focused on Phosphorus. I would be happy to arrange for the PD of FRST to present and discuss with this group or we can consider how to engage them with specific questions. They are building an open meta-database also.
Clint Gill (in chat): Thanks Lisa, are they also looking at Nitrogen? If I had to guess I would think that the improved genetics in major crops have led to fewer pounds of N per bushel of yield.
Lisa.Duriancik (in chat): Not N yet.
Clint Gill (in chat): Darn.
Robert Sabo: Wondering if it's even a big deal if you have these ups and downs, as long as they are happening across states and counties? This is a relative distribution.
Gary: I think you're correct, but I don't think that's the case across different areas because some areas have drought and some have a lot of rainfall. So we don't necessarily want to give people a huge drop in load if they've had droughts.
Tom Butler: If we have the 5 year trailing average and then we have the best 3 of 5, could we use the difference between the two to get the difference between the average and expected?
Gary Shenk: Statistically that makes sense. Seems like a good suggestion.
Dave Montali: Do we know that expected is always greater than actual?
Ken Staver: Not always, but it tends to self correct.
Lisa Duriancik (in chat): https://soiltestfrst.org/
Karl Blankenship (in chat): Charlie White at Penn State has a project going looking at creating more dynamic N recommendations for corn applications.
Clint Gill (in chat): I think UD is also participating in that research, that might have been the project I was thinking of. Thanks Karl. But thanks for the link Lisa, I'll keep a good eye on that research.

Alex Soroka: If you look at the change in corn it's gone up by 60% from 1985 in the CB watershed, and same with soybeans and broiler chicken weight, so I'm curious if we should expect that a lot of these crops would have similar sort of change in yield over time.
Dave Montali: Agreed and maybe we can use that information or averages for crops that don't have annual survey data.
Mark Dubin: Might vary for crops that don't have as much value in the economy. So maybe not 60% across the board, but interested in looking into that.
Eric Rosenbaum (in chat): Hybrid rye is slowly replacing some cereal rye acres -- yield is equal to wheat.

Closing –10:55-11:00 (5 minutes)

Adjourn – 11:00

Next Meeting: Friday, September 8th, 2023, from 09:00 - 11:00am.

Participants

Jackie Pickford, CRC
Tom Butler, EPA-CBPO
Zach Easton, VT
Mark Dubin, UME/CBPO
Cassie Davis, NYSDEC
Eric Rosenbaum, Rosetree Consulting, PA4R Alliance
Tyler Trostle, PA DEP
Gary Shenk, USGS@CBPO
Alex Soroka, USGS
Karl Blankenship, Bay Journal
Olivia Devereux, Devereux Consulting
Kristen Bisom, WVCA
Scott Heidel, PA DEP
Elizabeth Hoffman, MDA
Dave Montali, Tetra Tech WV, MWG
Kate Bresaw, PA DEP
Jessica Rigelman, J7 Consulting, CBPO Contractor
Helen Golimowski, Devereux Consulting
Candiss Williams, NRCS
Alisha Mulkey, MDA
Lisa Duriancik, NRCS
Clint Gill, DDA
Tim Larson, VA DCR
Ruth Cassilly, UMD-CBPO
Isabella Bertani, CBPO
Hunter Landis, VA DCR
Chris Brosch, DE
Curt Dell, USDA-ARS
Ken Staver, UMD
Tamie Vieth, USDA

**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
LGU - Land Grant Universities
NM - Nutrient Management
PSC – Principals' Advisory Committee (CBP)
STAC- Scientific & Technical Advisory Committee
TMDL- Total Maximum Daily Load
UD - University of Delaware.
WQGIT- Water Quality Goal Implementation Team