Agricultural Modeling Team (AMT) Meeting

June 14th
09:00 AM – 11:00 AM
Meeting Materials

Summary of Actions and Decisions

Decision: The AMT approved the May 2024 meeting minutes.
Action: Provide comments and feedback to Tom (butler.thomas01@epa.gov) on the method of calculating the acres of grain, with and without manure, in CAST.

Meeting Minutes

Statement of Purpose:
To discuss development of new ways to evaluate the crop yield and a potential alternative for the current manure acres calculation for Phase 7.

Introduction/Recap: 09:00-09:15 [15 min (Zach Easton, Virginia Tech)]

Zach asked for approval of the minutes.
- **Decision:** The AMT approved the May 2024 meeting minutes

Crop Yield trends 09:15- 10:15 [60 min (20 min presentation 40 min discussion) (Joseph Delesantro, ORISE)]

Joseph presented on his work improving yields in the largest crops across the Chesapeake Bay Watershed, through a review and discussion of the progress being made to improve long term crop yields. Discussion.

Discussion

Bill Keeling: This curve just seems to keep going up up, up, and up. Is there ever a point where you meet diminishing returns of inputs to yield in your curve?

Joseph Delesantro: We are doing this for many different crops. There are certainly crops where the yield doesn't keep going up, up, and up or the yield is stabilized, or the yield doesn't actually change over time at all. How we project crop yields into the future, that would be a different discussion, a different decision. Right now, we are just talking about how to capture that expected yield application. So, in this example, we're showing something that keeps going up, up, and up. Generally speaking, that's true when we look at the data for things like corn, soy wheat, but there are crops hay, potato, tobacco, where yields are either flat or actually decreasing.

Bill Keeling: Well, things like cotton and tobacco, you don't normally do a lot of fertilization and you'd be looking at a 50-pound rate versus a 150-pound rate in order to hit your yield expectations with some crops. If you put too much nitrogen down, you don't get a cotton yield. All you get is vegetative growth.

Joseph Delesantro: Yes, that's right. We have this pounds of nitrogen per yield unit that is meant to capture that difference in the nutrient applied per the yield unit of that specific crop. So, maybe that's something I should have highlighted here with this equation. We're applying this

for each individual crop. Each individual crop has a different nutrient application per yield unit and that number is variable over time, dependent on several factors, including fertilizer sales.

Bill Keeling (in chat): Can I ask what defines small grain hay? Is it small grains chopped for feed or straw cut after small grain harvested for grain? Which NASS category is being called small grain hay?

Olivia Devereux (in chat): Small grains and grains is the CAST load source name. It includes the following NASS categories: barley for grain, rye for grain, buckwheat, emmer and spelt, canola, triticale, oats for grain, wheat for grain. These data are in the Detailed Crop and Turfgrass Source Data here. Scroll down to the second blue button https://cast.chesapeakebay.net/Home/SourceData

Jessica Rigelman (in chat): Ag census has an item called "small grain hay, Harvested (acres)". This is the CAST crop. The name has changed slightly over the years, but small grain hay is an individual item in the ag census.

Bill Keeling (in chat): That was not the question. If small grain hay is in the other hay load source, is it really hay?

Jessica Rigelman (in chat): Small grain hay is in the other hay load source in CAST.

Olivia Devereux (in chat): Small grain hay is the NASS name, and it is in the CAST load sources. NASS says this, "Hay, other dry hay. Data shown represent acreage and dry tons of hay harvested from clover, fescue, lespedeza, timothy, Bermuda grass, Sudangrass, sorghum hay, and other types of legumes (excluding alfalfa) and tame grasses. Data include small grains harvested for hay including barley, oats, rye, and wheat as well as wild hay". NASS excludes straw, corn and sorghum silage from hay.

Tom Butler: There's been a sidebar about what's in the small grains harvested for grain. Olivia's put some answers there, and Jess has elaborated on that, so I want to make sure that is discussed properly. Bill, did you want to vocalize?

Bill Keeling: There was a listing across earlier that I was curious about, because I saw small grain hay. Is that in the hay category, other hay? Is it in the small grains and grain? I understand small grains cut for grain is in small grain and grain, but I'm not quite sure what is being described in small grain hay. Is it small grain cut for a forage or is it straw cut after small grains have been cut for grain? Straw is not hay.

Joseph Delesantro: So that is the designation used by the census, and I can't tell you exactly what that is.

Ken Staver: I'll talk from the farmer side. You interpret the question the best you can, but generally, if you harvested the grain, what you're making is straw. It's not hay. I'm not saying that someone didn't misinterpret that question somewhere. So somewhere somebody called it hay when it was straw. But it's cut to feed cattle as opposed to being bedding or mushroom compost. Hay, it's cut to be feed, and it's cut while it's green, and it's cut before the grain matures. So, it's a feed crop not a straw crop.

Bill Keeling: Yeah, that's what I'm getting at is whether that is being interpreted correctly out of the NASS data. Also, with pasture listed there, are you figuring yields for pasture?

Joseph Delesantro: No, we're not figuring yields for pasture with this part of the work. This is only covering crops for which we have reported yields. I think that we could have discussions on how to deal with pasture separately, but this is not the method that we intend to use for pasture. Is that right, Tom?

Tom Butler: Yeah, that's right. This is not addressing pasture in that same way.

Bill Keeling: Well, I would argue it should be. If you are, for example, expecting 5 tons of forage yield, then you can do the same curves for looking at expected yield to inputs, regardless of

where the inputs come from. It's still the same as figuring it for other hay and leguminous hay. Do you have a yield for those that you're looking at fertilizing for? You're looking at tons of grass being raised per acre.

Joseph Delesantro: Right. Yes, we do have the yields for those other types of hay. I would say that, oftentimes, we don't see a lot of change in time from 1950 to present in the hay yield. So, for a lot of the hay yields, we'll just be using an average as opposed to trying to apply a trend. There essentially is no trend in time for a lot of those hay yields. I certainly think that, when we open up the discussion on how to deal with pasture, that could be an option for how to approach it.

Tom Butler: I think that it's a discussion for a different day. I don't mean to be dismissive. I know you've been advocating for hays and pastures here, so I want to acknowledge that as a concern. We do want to look at that, understanding that this is used differently for predominantly the row crops.

Olivia Devereux: Bill, I put a lot of information in the chat going back to the ag census original questionnaire and the NASS definition, so you might want to take a look at that. Kind of a first principles how does NASS define it, not getting at the work that Joseph has done.

Joseph Delesantro: Thanks, Olivia.

Ken Staver: The dilemma we have is it was decided to go to this fertilizer sales approach that gives us so many pounds of nitrogen and phosphorous to deal with, but nitrogen especially. The key thing in the model estimating loads is the difference between the applied N, which we now have a fixed amount of to deal with, and the yield. If we are underestimating yield, we are overestimating the surplus of N per acre, and the model is overestimating loads. So, that's where this all pinches. If we don't get yield right, we don't get the difference between the applied and the taken-up N right in the model. This is especially noteworthy because, in the last ten years, the way it currently looks like with the model is that we are applying much more N per unit of yield, and that is pushing up the loads on a bunch of our major crops. So, it could be real. It could be we are underestimating yield. It could be the fertilizer sales data has problems.

Gary Shenk: I was going to agree with Ken and make a slight modification or amplification of something. It's not the absolute value of the application relative to the uptake that matters, because the total crop load over the long term is calibrated to monitoring data. What matters is how that difference changes over time. Instead of going back a few months, I think we're looking at a trend in fertilizer sales that was rising faster than the trend we had in yield. That trend in yield was lower than it should have been because of the method of best three out of five, and we only had a certain number of points to choose from. So, this is fixing that problem.

Bill Keeling: I'll just throw out that using the NASS data in relation to yield impacts, the expected acreages and how it is interpreted, can result in some very unrealistic outcomes. For example, there's a county in Pennsylvania for 2023 that has over 4,000 pounds per acre coming off the pasture. I don't believe that and it's because the acreage has gone from about 1000 acres to 0 in one year. There are ramifications of using the sources that we're using when it comes to real world application.

Tom Butler: Bill, is the suggestion to move away from NASS and supplement it?

Bill Keeling: What I've suggested is that they do a review of their outputs before they release them upon us. If you have anomalous or strange outputs, like if you for years have had a land use or a load source and all the sudden it goes to zero, that they investigate those anomalies before they produce output that they give to us at the state to deal with that makes no sense. I don't necessarily have a replacement for the NASS data, as limited as it is. Part of my issue with trying to produce another model is we are trying to refine the outputs of the model without

updating the inputs we have. We are still using statewide fertilizer sales and expecting to do something with that that is meaningful.

Joseph Delesantro: I can't speak to the fertilizer sales data or to the Chesapeake Bay Program CAST. But I will say, from this specific work with the AMT, that is a concern that I am very sensitive to. I created this suite of 7 different metrics that allows me to look for those anomalies and then either iterate on the method to deal with those anomalies, or to handle them by a case-to-case basis. I think that will be our approach moving forward at least within the AMT.

Ruth Cassilly: I wanted to make two comments. One in response to Bill, the second is to the comment that our expected yield is not going up as fast as our fertilizer sales and that that's a problem. I don't know if this is possible, but we're having more intense storms and rainfall and there is the possibility that, because of the storms we've been having, farmers are reapplying to make sure they didn't lose fertilizer and it's going to result in a lack of yield. So, I'm wondering, are we factoring in behavioral considerations into the reasons why fertilizer sales data may be rising a higher rate than our yields? My second comment to Bill is, we spent two years talking to the states about using the fertilizer sales data and alternatives, including using county level data, so that we could get rid of the bucket method where we sum everything up to the entire watershed and then it disincentivizes things at the county level in terms of nutrient management. The answer we keep getting is no, that is not possible. We can't get more specific data. Unless we can find some alternative to the sales data we are using, and I think that has to come from the states because it needs a policy change at the state level, a viable alternative at this point in time has not been produced.

Olivia Devereux: To add on to what Ruth said about the increasing fertilizer, we've got record acres of cover crops in this watershed, and we don't fertilize cover crops usually. So, by that fact alone, we should see fertilizer going down with less winter wheat being grown, but we're not. We're seeing it go up. I think Ruth's hypothesis is a good one. There might be other things going on, too, but it is food for thought.

Alisha Mulkey (in chat): NM regs. in MD allow nutrient application per expected yield based on documented records. Our compliance is at 80%, so I disagree with the additional inputs based on weather events. Farmers are largely getting smarter about application amount and timing.

Tom Butler: Maybe it's something worthwhile to talk about, potentially writing to NASS. We have some people from USDA here, not NASS necessarily. Maybe we can get in contact with the right person to help us with what their review process might be. I'll try to follow up with you a little bit later with that. I am going to try and draw us back to slide nine that Joseph had. Joseph, I think it's really worth highlighting, what's going on here in terms of the R-squared value. I want to make sure everyone understands what exactly is happening in that slide. You have your variables and that R-squared of 0.74.

Joseph Delesantro: We have these 23 crops that we have this fairly complete temporal record from the census from, supplemented by the survey, 1950 to present. For each growth region, we apply this multivariate linear model where we use time, different parameters of weather, climate, and some select data from the survey, where appropriate. We are able to predict about 74% of the variation in yields across the watershed weighted by the crop area. So, the amount that each crop covered within the watershed. I would say that this is maybe not the best way to describe how well this method is working, because the R-squared is all about explaining variation in the data and, when there isn't variation in the data, you're going to get a poor R-squared value. Where we have crops like some of the hays, or some of the silages, where the yields just don't really change a whole lot in time, the statistics are going say we're not explaining that variation well and that's not entirely it. It's a different question, really, because

there's just not much variation in those crops. The R-squared is not a perfect way to describe how well this method is working, but I do think it's a conservative way to describe how well this method is working. Maybe we can think about this as we're explaining at least 74% of the variation in crop yields across the watershed.

Joseph Delesantro: One last thing is that the 74% includes some of those anomalies that I was talking about earlier. So, we will go ahead and deal with it on sort of a case-by-case basis as needed.

Candiss Williams (in chat): Nash-Sutcliffe Efficiency may be a better statistical measure.

Tom Butler: It seems like this is a method that can deal with some of the concerns we have with bad data, dealing with some of these anomalies as Jospeh has said, and do a good job based on that R-squared value of working through these annual yields. So, it looks like this might be an overall marked improvement over what was in the model. I just want to highlight that this is, at least in my mind, pretty substantial progress. So, thank you for that, Joseph. I do see Candiss has put in a comment here: "Nash Sutcliffe Efficiency may be better statistical measure". Candiss and Joseph, I don't know if you guys wanted to talk stats right now, or if maybe that was for another time.

Joseph Delesantro: I will look into that. I have several other metrics that I use and that is not one I am aware of. I've also just been looking at the error produced in the method and been looking at an outlier resistant fitting metric as well. I am presenting the R-squared because I think that is a metric that a lot of people have an idea of what it means or are familiar with seeing. Certainly, when I'm iterating on the method, I have actually 7 different metrics that I'm looking at well beyond just the R-squared. I'll go ahead and look up the Nash-Sutcliffe method as well, thank you.

Clint Gill (in chat): DE's fertilizer sales decreased 3.4% in 2023, so the increase in fertilizer sales in 2021 and 2022 might not be a trend that continues.

Ruth Cassilly (in chat): Sorry, I meant to add- study by Dr Matt Houser- TNC through Harry Hughes Center on farmer response to nutrient mgmt. and climate change in Midwest compared to MD- study showed more fertilizer use in Midwest in response to climate change conditions, but not in MD- wondering if that holds true for whole CB watershed.

Manure Acres calculation 10:15-10:55 [60 min (20 min presentation 40 min discussion) (Tom Butler, EPA)]

Tom presented the results of a CAST run with a method of calculating the acres of grain with and without manure, to follow up on previous concerns and examine a potential improvement of acres for each land use. Discussion.

Discussion
Bill Keeling (in chat): What is the assumed incorporation schedule? Are years 2 and 3 residuals accounted for?

Tom Butler: Incorporation, I think, goes more towards the BMP.

Bill Keeling: Your PAN depends on how soon you cut it in. If you're spreading manures and biosolids, you have a 24-hour rate, a 1-to-7-day rate, and a greater than seven-day rate you would apply to supply the amount of nitrogen. The longer it sits on the surface, the more NH ammonia volatilizes. What was assumed in these calculations? Was it immediate incorporation, or what?

Tom Butler: I'll let Olivia take this one because I know she's the expert on how it's done in CAST.

Olivia Devereux: CAST is an annual average model, and each year is independent from any other year. So, what we've done in the past, and could do differently in the future, is look at the amount of residual and average it and use, if there's a three-year period, the average of the three. That's how we've addressed it.

Jess Rigelman: We have the ammonia split out into the field volatilized portion, which would not be plant available when you supply BMPs for manure incorporation and injection. There is less field volatilization and that does become plant available. This was done in 2020, being that's the last year we had fertilizer and, because it's run in the mode where we use the fertilizer buckets, it does incorporate the BMP's. So, if the state did report incorporation or injection, that would be included and, therefore, more of that manure would be plant available. Or more of that nitrogen would be plant available.

Bill Keeling: So, CAST made these curves or is a separate calculation been going on?

Tom Butler: This is not done in CAST. We did this based on the feedback we got from the group to feed into CAST.

Jess Rigelman: CAST supplied data for PAN and crop need to do this separate analysis.

Tom Butler: Great clarification, Jess! Thank you. Bill, is this making sense?

Bill Keeling: I understand what they may have done, but I'm not sure it jives with how PAN is calculated in the field when you're putting an NM plan together and coming up with a rate for someone to spread either biosolids or manure. So, I see it's kind of a disconnect.
I guess I need to see the calculations that are being done by CAST and compare that to what would be done in the field.

Olivia Devereux: Bill, I agree that it is a disconnect with what is done in the field. I think what I would want to know is what is the application in the fields? Then from there we can figure out what the runoff is but not what is the farmer thinking in terms of. I guess I want to know what the overall application is and, in terms of dividing it up, we need to know the nutrient species. The plant available was really kind of a side thing that we know farmers are looking at, but we're really looking at what are each of the species applied overall. We're not doing a crop growth model. I feel like we might be veering in that direction because that's how a farmer is looking at it, and of course they are. We don't need all that detail although, if that's the only way we can get to where we need to be, then then we'll go for it. I'm just trying to come back to focus on what is actually the applied for each of the nutrient species.

Bill Keeling: Coming from the land application world, before I got into government, the rate you apply tons per acre, per biosolid, is dependent on the crop and expected yield. You account for residuals and then you run your PAN calculations depending on when your incorporation is planned. If you know you're not cutting it in, you're going to do greater than seven-day rate, and you run your calculations to determine I need X tons of material per acre spread. They're all interrelated in the real world. All those factors are what set your application rate.

Tom Butler: I really do appreciate you bringing that perspective in because that is different than how we're viewing it here. We are calculating our manure based off census or survey values for animals and using that as a proxy for the manure available in each county, recognizing that's kind of a fixed amount for each county. When we are doing this, I think it is from a different perspective in that we have a locked in amount of manure and a locked in yield. We know value A&B, we just need to understand how we get to value C, where it's the application of it. That might be the disconnect overall that you are talking about. In which case, I would encourage others to weigh in as well about if there's a way to bridge that gap or if you know this is sufficient to represent what's happening in the real world. I'm going to pause here and see if that elicits a response.

Seth Mullins (in chat): In a VA NMP injected manure supplies 2x the PAN as a surface app - surface apps apply 2x the manure for the same amount of PAN.

Ken Staver: I think what we're trying to do is go away from the method we've been using that is super coarse and doesn't even acknowledge that different animal unit types produce very different amounts of plant available N, which is how we think in an agronomic world. So, we're going to try to get better. I think what Bill is talking about is even a more refined approach that would be the next step. I guess the main question I have is is this a step in the right direction that's manageable at a large scale in terms of the data availability at the ag watershed modeling level?

Bill Keeling: Yeah, I'll just say that this highlights a disconnect. Manure is handled at a farm scale, not a county scale. As long as we're still trying to manage it at a county scale, we're always going to have some kind of disconnect, no matter how we refine it.

Ken Staver: Right, but the question is can we do a better job basing it on PAN of estimating how many acres in a county get manure, versus doing it based on animal units? It seems to me like the answer to that is yes. We can do an even better job if we brought in all the other information that you have. But, that level of information availability to the whole watershed modeling effort is not available. It just isn't available in any kind of compiled, consistent form.

Bill Keeling: Not across all states.

Tom Butler: Yes, there is a varying level of detail. That is a very good point, and I think that is what we struggle with. The idea is to move from something that we thought was a good metric, animal units, to something that might be a better metric in terms of determining the acres of grain that can get manure versus the acres of grain that don't get manure. That's the two land uses that become the result of this. You know, we stayed with the Maryland data. Again, as everyone's hinted at here, we don't necessarily have that level of detail. We are stuck with the fraction of corn acres that are manured in Maryland because they were the ones who had it and getting that from other places has been a struggle. If we could get that, that's an example of a way to maybe improve that data set. Again, the idea is really to move from animal units to something that is plant available nitrogen which at least now, Bill, if we're talking about it, is a tool that you use in the real world to determine applications not the number animal units that you have on the field. Maybe this is a better thing, overall, even if it is not perfect.

Alisha (in chat): Ruth- the fertilizer sales and application assumptions should be a future agenda item for the AMT, in MDA's opinion. The FEG time was limited, and this group should consider these questions for P7.

Bill Keeling: I would agree because, again, you don't haul liquid hog waste and liquid dairy manure very far. You can set ship litter a lot further on an economic basis. The odds of grains getting fertilized by hog waste and dairy manure are remote compared to other forms and, so, accounting for different forms and formulations should be done.

Tom Butler: I think, in a roundabout way, what I believe we are trying to also touch on with this is, if we switch to PAN, we are in some ways accounting for that animal type. If you have a county with mostly dairy cattle versus a county with mostly broilers, that PAN will be so different that that's going to obviously have a big impact on the acres in that county that are going to get it. So, instead of treating 1,000 pounds of dairy the same as 1,000 pounds of broiler, there's now at least some implicit dealing with those different animal types, which is another justification for doing this. This is all stuff that was discussed and brought to our attention and it's up to everyone here to discuss if it's the right way to go or not. This is informational- we can discuss and decide if it is an improvement or not. But I do appreciate that perspective, Bill.

Bill Keeling: Mirroring Dr. Staver's statement, until we can get farm level data, I guess it is a step in the right direction compared to what we are currently doing, or at least we should evaluate it further to see if it is a good step in the right direction.

Ruth Cassilly: So, it changes where the manure is being put down and some counties get more manure and those counties get less fertilizer, but we still have the same overall amount of fertilizer, correct? So that fertilizer is going to go down, regardless, it will just be shifted to where it happens. Is that correct?

Tom Butler: You bring up a very good point. Yes, it will shift where it goes down. This is one land use, and this is just talking about the acres of that grain with manure, and then the application that happens on that. There are like 8 other land uses off the top of my head that can get fertilizer and manure. So, you'd potentially see that happening where you'd have a shift within the county between those. We haven't talked about it, but it's something we need to. The actual applications occur in kind of a sequential order in CAST. Grains mixed with specialty are going to get their manure first and it's organics then inorganics. So, it will shift things. The implications for how that shifts, and where, are much more detailed. We can obviously look into that, but that is a very good point you bring up because it will shift things around.

Ruth Cassilly: Right, ok. Thanks, Tom.

Dave Montali: Can you go back 5 or 6 slides where you showed West Virginia and the grain with and without manure? Fertilizer goes down for West Virginia and the manure goes up, and overall, more N is going on grain with manure. Statewide, less manure is going on other ag land uses because the total amount of PAN is the same. It's got to go to different land uses, right? Am I interpreting that correctly?

Tom Butler: This is pounds per acre, so this is kind of on a per acre basis. But yes, it would shift where things go. You're not going to change the amount of PAN for manure, that is correct. It stays unique to that county, but that is going to shift fertilizer.

Dave Montali: Got it. I think I got it, thank you!

Clint Gill (in chat): This is before manure transport is factored in, correct?

Tom Butler: I believe it is, but I'll lean on Jess for this.

Jess Rigelman: No, manure transport is factored into this.

Tom Butler: That's a great point there. Manure transport being one of the things that really changes that manure availability in a county. I do want to make a quick side note that we do have manure that currently does encompass sources of mortality. That's a separate conversation that we kind of want to bring up at a later date but recognize that we currently do have mortality built into this manure stream. So, it is implicitly in here in case anyone is curious about that. Great point, Clint and Jess, about manure transport. That is a factor that would impact the overall amount in each county, and it could remove it and take it out of use. Again, we have all this information at the county scale. I just showed the two here. If you want it, we can give it to you however you want it at whatever level of detail you want it- watershed, state, county. Just please ask and we can make sure we get that to you so you can look at it however you want, on whatever timeframe you want. It's a lot to look through, so we tried to boil it down as best we could to still show what happens.

Alisha Mulkey (in chat): Does data have other load sources to see movement?

Jess Rigelman (in chat): Yes.

Alisha Mulkey (in chat): Thanks, Jess. Please send MD data.

Tom Butler: Just in case people are asking, or just to clarify what this is, it's asking for the other load sources. These are those other groupings of crops. So, you might have specialty, you might have pulses and soybeans, things of that nature, and we do have those present. We can see

essentially where those nutrients are being applied and how that shifts. Alisha asked for that for Maryland. We can provide that for other states, just ask us and you will get that.

Ken Staver: A couple things came to mind. First, I can't resist saying If the states would be interested in having some kind of input on typical manure application rates for the different animal types, that would be better than any of this. Just because it never happened in the past, I think that door should always stay open as something that could happen in the future, right? That theme got mentioned a couple different times, so there's definitely room for improvement there. This is the kind of thing you do when you don't have that information- you are left trying to figure out what's going on with what you can get. So, I think that's something that should always be an option and would make things better. Then the other one was just, when you show manure application rates going up per acre, it would be interesting to see for phosphorous. What would that mean for phosphorous? We might end up with situations where phosphorous is limiting the manure application, so you need to keep track of that, I guess.

Tom Butler: I believe there is phosphorous data in the sheet. I just picked nitrogen.

Ken Staver: If you start putting on heavier rates and then all the sudden you say, well no, you can't really do this because you are going to get pinged on your plan for phosphorous. But, you know, maybe over a three-year period, it doesn't matter. But it's still something to look at side by side.

Bill Keeling: To mirror what Dr. Staver was saying, if not only the state could provide how they calculate PAN, etc., that's following nutrient management criteria by doing that, then what was done before we had NMs in terms of applying manures. I think we need to characterize the no BMP situation for how manures were handled pre-NM versus how we handle them today, there's a difference.

Tom Butler: Bill, that's a great point. You are talking about a change in behavior over time caused by the policy from no nutrient management with manure application, to manure management. So that maybe, towards the late 80's, we're talking about kind of a fundamental shift and CAST capturing that?

Bill Keeling: Well, there would be a secondary shift, as Dr. Staver pointed out. A lot of manure plans were nitrogen based for many years and soil phosphorous went way up and now phosphorous based planning is a reality. There are changes over time, yes, but in terms of how the model works, you need to have it describe the non-BMP situation as well as the BMP situation correctly.

Tom Butler: Yeah, that's a good point. I'll go back to the point earlier about the data availability. We know what data we are working with; we know it's limited, but if there was a source where we might be able to supplement or get that information about how that change happened over time, I think that's extremely valuable and worth doing. I would ask off the top of people's heads if there were nutrient management plans throughout history, or if there is some record that states might have, or some small pieces of information that could help inform that. It's very good when we get the information, but when we have to implement it with the data we have, we've seen what happens. Sometimes we're using animal units. If we move to PAN, it's better. But we could do better than that even. I would ask if there were instances within states that people might recognize as a data source that we could use. If we are looking at improvements, is there a reasonable cross section for each state that might have some data we could use to show what you're talking about, Bill? I recognize that a lot of this is probably happening, but without the information to back it up over a historic time period. Then we try to do it mathematically, and things might go awry, and we've missed the intent of what we are doing. Then we get stuck in a

trap and it's detrimental from some people's perspectives. I'd really ask people what data is out there that we can actually get?

Bill Keeling: At one point I was with the then Virginia NM program manager and we were looking at a 1970's agronomy guide or book. In other words, what agronomists would be recommending to farmers in the 70's. Then we compared that to what the nutrient management recommendations and standards would indicate you would do and then tried to gauge the difference. I think it might have been part of the one of the nutrient management panels where this was done, but trying to gauge, before we did NM, what NM might do for us in terms of recommendations on fertilization, etc.

Tom Butler: Ok, so then maybe other states have done a similar thing to that. Are there data sets within each state's Department of Agriculture that might speak to that? Obviously, Bill, that sounds like a pretty comprehensive effort to look through your state. You've got those two things you're looking at, probably other components of that, too, right? Or was it just simple?

Bill Keeling: Again, this was years ago. It was probably part of an NM panel because there have been so many, and I've been involved in so much of that. I was just suggesting that maybe we look back in their records and see if there are, historically, such documents we could refer to. So, what were we doing then versus what are we doing now, and what we were doing before that. Kind of set a baseline compared to and, again, try and gauge what we should expect out of doing nutrient management. Just an idea of one way to try to get at this.

Alisha Mulkey (in chat): LGU recommendations have long existed. It's the % of farmers following those recs. That are different in time and place.

Tom Butler: I don't know how to get at that. You guys would know far better than me how to get at that. What information exists? Alisha can you maybe elaborate on that, or is there any way that you could think of that we could look into that?

Alisha Mulkey: Yeah, I was just agreeing with Bill's statement that, historically, land grant recommendations for application per yield unit has been the standard for decades, right? So, those can certainly be unearthed. I think what the difference is is that every state, even today, has a different group of producers who are subject to that from a regulatory requirement. Then those recommendations have changed in time as we get new and better information with those land grant recommendations. It would certainly take some time but, if I am following Bill's thread, that would be a better place to start because, to the side conversation Ruth and some others and I were having related to fertilizer sales, I still have a lot of concerns about that as the data set. I don't want to derail your agenda for today, but I think there's some other material that could be discussed more thoughtfully, that the states could have both historically and now, that could get us back over to that conversation of actual applications based on crop need.

Tom Butler: That, I think, is useful and we can certainly try and look through documents we've got from nutrient management panels. If there's a file cabinet people might have within your own office that has some good stuff, if you could please briefly look and send anything you have our way, that would be useful for discussion. We can try and maybe compile that if that's something everyone here has the time and is able to do or willing to do.

Olivia Devereux: Tom, I may have missed some part of the discussion, so help me if I miss something. The way the application rates originally came from were the land grant university manuals for each of the states. I actually have them all on my bookshelf behind me on paper. I know they are online now, but is that what you are looking for? I guess I am confused because that's what we used before, so this isn't new. I missed something here, I'm sure.

Tom Butler: You're definitely on track there. I think the part where we're trying to go now, is we want to try and get an idea for how farmers have changed their behavior over time and that

there might be information on stuff like that, and that might be curated somewhere, because I think that is the next step for this.

Joseph Delesantro: That would be not just the recommendation, but the recommendation and the adoption rate, or the adoption in terms of acres of particular crops.

Tom Butler: Yeah.

Olivia Devereux: Ok, I got it now, Tom. Thank you for that clarification. It seems to me that that information is really coming from fertilizer sales data and the number of animals that we know produce manure that must go somewhere, and that's where we get that information.

Tom Butler: I think that that is absolutely correct. I think, and this is maybe a pipe dream here, but people have been talking about if we can get actual application data, rather than the proxy of how we do it, that would be useful.

Dave Montali: Right now, we have the recommendations from the land grant universities being used for the agronomic need of all the stuff that's grown, and we credit, or we use that. If you have nutrient management plan, then we count nutrient management plan as BMPs. If you are talking about trying to make an assumption about what farmers might do that don't have a nutrient management plan, I think that's probably a step too far. I'm very confused about what we are doing here. I think any idea that we could get farm-specific information is a non-starter, just given the privacy stuff and, you know, you've got West Virginia which is a state that has no regulatory ag. I just think that's probably a step too far. If you want to then kind of change what your non nutrient management rate, or that need that we do in CAST, that's probably a step too far, too, because you have to have a whole new nutrient management panel- a BMP expert panel. I don't think we have time for that prior to Phase 7 either.

Bill Keeling: I think what we are saying is, let's look back in time before there was such a thing as nutrient management, at what was recommended back then, and use that as your no BMP kind of application. Versus, later on, when you're doing NM and you want to record the benefit of it, then you would be looking at the more modern land grant university recommendations. Things like foster space planning, etc. It's a before and after thing I brought up, not necessarily a BMP thing per se. I was trying to get at, if we are creating a no action scenario, what should it look like? How do you describe that? Would you use the current university recommendations, or the ones from 1978?

Ruth Cassilly: I agree with Olivia completely, going back to the fertilizer sales data. My interpretation of what's being said in terms of application was trying to get a better handle on sources of fertilizer data. Like what's actually there at a finer scale than watershed and that, maybe, there would be some way to reevaluate the type of data we could get for that and maybe also for manure. So that's kind of my interpretation of what we are really talking about here. Alisha made a comment in the chat about percent of farmers following the actual land grant university recommendations, which is another good point because, again, it goes back to that behavior, which we need that component as well. The bottom line, though, is that we have to keep in mind yields have been increasing over time and the end goal is to keep increasing your yield. So, farmers apply more to increase their yield. Intensifying animal production means we have more manure, and we can't get away from that. We have that there. It isn't going away. If we can get better data for the fertilizer and better data for the manure, I think that's the end goal.

Mark Dubin: Phase 6 nutrient management panel did evaluate the Pre-BMP condition. The recommendations were based on those evaluations, and we did look at studies of what the recommendations were and what the social change was once they were in place. I think that, if

the group is interested, that would be a good place to start because we did a lot of that work already through the Phase 6 recommendations.

Bill Keeling (in chat): Disagree on pasture.

Olivia Devereux (in chat): Here is a resource for fertilizer recommendations from 1998 looking at the years from 1940s to 1998. I have all the 2010 NM recommendations/manuals. https://www.tandfonline.com/doi/abs/10.1080/0010362980937004 0

Tom Butler: For the sake of running out of time, I do want to bring us back here. Thank you for those resources in the chat, Olivia. But, when it comes to looking at essentially this switch, we've gone from that animal units basis and, in this test, we've gone towards PAN. Now this does bring us down the path of, if this is an ok direction to go, how do we deal with the application? Everyone's talking about application. We need to deal with the methods of applying manure. We need to deal with methods of applying fertilizer. We need to have fertilizer buckets, all these things- great points people have made but, just for today, we want to understand for the acres. So, it's the category of grain acres with manure and acres without manure. We currently have them split. That is, foreseeably, how we're going to keep testing things. In terms of that calculation, as a straw poll here, do people feel it is an improvement to stay with the current method of animal units, or go towards this new kind of PAN basis. If I can get any verbal feedback or chat comments on that, I think that's where I want to try and focus this discussion towards the end. For just today, this is kind of old versus new. Animal units versus PAN. Is this a switch that people think is a good one? Is the direction ok? That's the only thing that I'd like to really grill into here.

Mark Dubin: I think this is definitely a step in the right direction. By also incorporating the manure transport data, this more fairly distributes the nutrients as well from an availability of acres. So, I think it is definitely an improvement from where we are now.

Tom Butler: That's great feedback. Thank you, Mark.

Alisha Mulkey (in chat): I'd like to look at Jess' data first.

Clint Gill (in chat): I'm going to agree with Alisha, I'd like to crack into the county level data before having an opinion.

Alisha Mulkey (in chat): But it does seem more logical.

Ken Staver: I agree it's a step in the right direction switching from the animal unit thing we've had to the PAN, which is consistent with nutrient management. I am not sure about the X axis on your graph. It's almost like we are commenting on two different things that happened at once. I'm definitely on the animal units per the PAN switch, but I'm not sure about that X axis and the separating grains. People are putting manure on soybeans and soybeans is our second, some places our number one, crop area in some counties. I think that's something that should be captured, because that changes your manure rates on grains. So, it shouldn't be excluded, no matter what the nutrient management people say is a perfect world. We are trying to do a watershed model not a perfect nutrient management planning world model. I'm not sure that's the X axis that is necessarily what we need to have.

Joseph Delesantro: Ken, if I am understanding your comment correctly, we are applying the manure first to the grains. That doesn't exclude specialty and legumes from getting manure. That would be dependent on both the PAN need and the manure PAN in that county.

Bill Keeling (in chat): PAN is worth looking into. Would like to see this over time as manure sources shift. For example, dairy numbers in VA have been dropping for years.

Ken Staver: Right. You've got to be in overload mode before you put much on soybeans.

Joseph Delesantro: That's exactly right. I think that this represents the data fairly well and there's a lot of reporting that shows something like 80% of manure is applied to corn, nationally. So, we think that we're in line with that data by applying first to grains.

Ken Staver: I don't disagree with that. I am just saying it happens for different reasons, and P-based nutrient management has pushed it to happening more. Not so much in dairy country, where maybe its forage dominated with silage and hay and all that. I can't help it. I live where Broiler dominates the manure supplies, and I know it gets used on soybeans in counties that are not overloaded with manure. So, people are buying it and it's going on soybeans for the P and the sulfur and everything else. Overall, I think the one part of the switch I'm totally on board with.

Tom Butler: Yeah, just to note, the grains does include more than just corn, although it is a big part. I think sorghum is in there and there's other stuff. But definitely appreciate that perspective, Ken. Corn is a big one.

Ken Staver: To make another quick comment, someone talked about dairy and hog waste. These don't go far. They're really different than broiler. Maybe if we were going to do some extra effort, we have big areas of the watershed that are dairy, and we know they're putting manure out in the fall and they're growing winter. They're growing winter cereal forages and those are really different systems than where we have broiler litter. That's storable and stackable, and it can be moved further, longer distances. It'd be worth looking at the dairy systems versus the broiler systems, let's say. Carve out two systems. I don't want to make anybody feel left out, but those are two big systems that are really different. So maybe the general approach should be modified for those two different systems.

Jess Rigelman: You saw the application curves and grains is more than just grains and silages. It's double crop, it is other grains and hay. So, we tend to talk about grains in many different ways. Grains with and without manure, but the grains curve here represents 7 land uses.

Tom Butler: Thanks, Jess. That's a very good point. This is something that I think can come secondarily towards the with and without manure. It sounds like we've got a reasonable direction to head by using the PAN. Obviously, we've got Maryland and Delaware who want to see their data for each of their states. Ken, you brought up that X axis and if there might be more information on that. I would ask if any state had information on the fraction of the corn acres that got manure if we could get that.

Ken Staver: I'm wondering about the x axis using that ratio.

Joseph Delesantro: So, are you suggesting that the denominator there, rather than being the green PAN need, should be a harvested crop PAN need?

Ken Staver: Well, I'm not sure. It makes total sense given how much difference there is in plant available and per animal unit to switch from animal unit base system to plant available. I'm thinking a little more focus on that X axis- how you're generating that curve. We got another weird curve which, at very low levels, has a tremendous amount of scatter. Below the one range there is a huge amount of variability. So, I don't know. Animal units to PAN? Yes. How exactly? I think there's more discussion needed I guess is my comment.

Bill Keeling (in chat): There is a difference between PAN and crop need.

Tom Butler: OK. We will try and work with you a little bit to try and figure it out. If anyone has any input on how to do this, we would appreciate getting that, because one of the things that is hand in hand with this is that spread. I think a lot of people have the concern about the spread, the actual application. Obviously, this is the grains category and there are more than just corn and sorghum. There's a lot here, as Jess mentioned. I think it's tied very closely but, for the acres, if we're not totally set on that, that's totally fine. I think if we had suggestions on how to

alter back here to our curve, those would be appreciated. I think a lot of people are starting to lean towards what I've been showing here for this application curve. That is a little bit different, although it is tied to it. I want to keep them related, but not necessarily deal with them simultaneously.

Dave Montali: I was going back to Ken's topic. Why can't we change the numerator without changing the denominator? Why can't we just do the amount of organic PAN over the harvested crop acres, just to see if that would give you a different looking graph? Maybe I am confused, but Ken's point is he likes the shift on the numerator because all animal unit PAN isn't the same. We're trying to say that, when there are more animals in the county for your harvested cropland, more of it goes on. I am just asking the question, why did we change the denominator?

Tom Butler: From acres to PAN?

Dave Montali: Yes, the PAN need.

Joseph Delesantro: As we've talked about in several instances, the acres are not necessarily the best yield unit and we do use acres as the yield unit for some crops, which then enters into that PAN calculation. PAN need is a better representation of the county's demand for manure than the acres of crop land. But there are two shifts- there's this shift in denominator to the PAN and then there's a shift in the denominator from all harvested crop land to grain. I think the shift from all harvested cropland to grain was to help further concentrate the application to that grain first, so that we got these higher minimum applications. You bring up a perfectly reasonable thing for us to test.

Dave Montali: Ok, it's a testing thing. Yeah, that might be good. But then your other point you just brought up is, rather than do all, if you wanted to keep it focused to the grain, you have the information to make the denominator the grain acres rather than all harvested, right? That's another test or not?

Joseph Delesantro: That's what we have now. You mean in terms of acres? I guess that is something I haven't considered. We haven't tested, but my question would be, with using the acres as the denominator, what the advantage of that would be over the crop need.

Ken Staver: The only reason this is jumping out at me is that I don't quite understand it. I don't think we have a Maryland county that has 8x the manure PAN for the grain need. Our feeling in our counties has always been we can handle the N. We can't handle the P. We're out of balance for our P, but we can't actually handle the manure N. I am seeing this value of eight, so I am not even sure what that X axis is. I'm holding back a little, unless I can't see a decimal point on the screen, but 8x is…I don't think we have that county in Maryland, if this is Maryland data. We need to talk more about that. That's my sense.

> *Post meeting correspondence with Tom Butler clarified this question from Ken that the value he was looking at was 0.8 not 8 leading to a resolution of this concern.*

Tom Butler: Jess, I didn't know if you wanted to pull up, or I can pull up, some other testing stuff because there were a couple of things we did in variations. Joseph and Jess, if you could walk through these a little bit for the group, this might get at some of that stuff.

Bill Keeling: Can I ask a question real quick, what is PAN need? Is that crop need? There's no such thing as a PAN need. PAN is plant available nitrogen you calculate per manure. There's no quote-on-quote need for PAN. It's how much nitrogen are you going to supply from that source, compared to the crop need, or the expected uptake or need per expected yield. Is that what the term is trying to mean?

Joseph Delesantro: It's the crop need, but not in terms of total nitrogen it's in terms of the plant available nitrogen. Especially when we're talking about organics, the total nitrogen is a different number from that PAN.

Jess Rigelman: I think, Bill, you know it as manure eligible crop need or organic eligible crop need.

Bill Keeling: Again, there is just the crop need. It's how much of that is supplied by organic versus inorganic sources.

Jess Rigelman: But a vegetable crop may not be eligible for manure. Therefore, this is the grains and specialty in this, what we're looking at here, manure eligible crops. So, if a crop cannot accept manure or biosolids, then it would not be factored in here.

Bill Keeling: Of course. I was thinking you are talking the need for this particular grain and the grains as listed, right? I understood that. What I'm saying is there's no such thing as a crop PAN need that I am aware of. There's the crop need for nitrogen that's supplied by different sources, one of which can be calculated through a PAN calculation for different forms of manure.

Tom Butler: I think that's just a diction choice here that we made, so let's take that offline.

Bill Keeling: On your graphs, eight what?

Tom Butler: We're going to try and walk through this a little bit here with some of the things we've got and hopefully this can get to some of what people are asking about. Joseph and Jess, if we can have a bit of an overview of some of these and then sign off in two minutes?

Jess Rigelman: Joseph, I'll leave this to you since they are your graphs, but I will shift as needed.

Joseph Delesantro: Here we can take a look at the X axis. On this first plot on the left the denominator is, rather than just the grain, it's the grain and specialty need in the plant available form. We see that, now, we're getting numbers that are maybe more in line with Ken's thinking. Then, if we apply that first partitioning of manure over both grains and specialty, we see that we get minimum applications across crops that are much smaller. We get counties where there are applications of manure to fields that are only supplying 4.5% of the crops need. Our understanding from feedback from this group was that it's very rare that people go through the trouble to apply the manure without it accounting for a larger percentage of the need of that crop. By switching to the grains first on the denominator and the grains first distribution, we increase that minimum application across counties in Maryland, to about 10% of the need. But this might also be something that we need to think about how to express to you all more clearly and do that in a following meeting.

Ken Staver: Yeah, I withdraw my question at this time. Let's take it later.

Tom Butler: If you have comments, please send them in the next week, so it's still fresh in your mind, so we can try and alter this if that's what needs to happen, or at least discuss it.

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

Adjourn – 11:00

Up Next:

Office Hours: Friday, July 12th, 2024, from 8:00 – 9:00 am.

AMT Meeting: Friday, July 12th, 2024, from 09:00 – 11:00 am.

Participants

Thomas Butler, EPA-CBPO

Caroline Kleis, CRC

Zach Easton, VT

Eric Hughes, EPA

Scott Heidel, PA DEP

Curt Dell, USDA-ARS

Ken Staver UMD,WyeREC

Ashley Hullinger, PA DEP

Clint Gill, DDA

Candiss Williams, NRCS

Dave Montali, Tetra Tech, WV, MWG

Jessica Rigelman, CBPO

Dylan Burgevin, MDE

Hunter Landis, DCR

Kristen Bisom, WVCA

Mark Dubin, UMD

Olivia Devereux, Devereux Consulting,CBPO

Tim Larson, Virginia DCR

Karl Blankenship, Bay Journal

Elizabeth Hoffman, MDA

Joseph Delesantro, ORISE Fellow EPA-CBPO

Alisha Mulkey, MDA

Cassie Davis, NYS DEC

Arianna Johns, VA DEQ

Kate Bresaw, PA DEP

Bill Keeling, VADEQ

Emily Dekar, Upper Susquehanna Coalition

Tyler Trostle, PA DEP

Patrick Thompson, Energy Works

Seth Mullins, DCR

Gary Shenk, USGS

**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

PSC – Principals' Advisory Committee (CBP)

PAN- Plant Available Nitrogen

STAC- Scientific & Technical Advisory Committee

TMDL- Total Maximum Daily Load

WQGIT- Water Quality Goal Implementation Team