More Maximum Return to Nitrogen (MRTN): How is this N rec calculated?

Jack Wilcox: 00:17
You're listening to Advancing Nitrogen Smart, the podcast series from University of Minnesota Extension. I'm Jack Wilcox, communications generalist here at Extension.

Jack Wilcox: 00:26
Today we're going to talk in more detail about the MRTN or the maximum return to nitrogen approach to corn and rate guidelines.

Jack Wilcox: 00:34
Here with me are Daniel Kaiser, nutrient management specialist with Extension and Brad Carlson, Extension educator. Dan, talk to us about how the MRTN is actually calculated.

Dan Kaiser: 00:44
So the MRTN, that's kind of a little bit of a history lesson here, dates back to the early 2000s. It was developed by two scientists, John Sawyer Iowa State University and then, Doctor. Emerson Navziger at the University of Illinois were two of the main people that really pushed this forward, out of a lot of conversations with some of the regional faculty working on nitrogen across the North Central growing region. The reason for this at that point in time was there were some questions regarding the fluctuations in well, mainly what it was, was natural gas prices which was causing changes or causing increases in the prices of nitrogen, whether or not we should be accounting for some of that in the nitrogen guidelines because, I mean, at that point in time, they were seeing a lot of the things we see now is that most of the systems that we had in place that incorporated yield goal or expected yield or something like that in the decision weren't accurate in predicting the optimal N rate within a given field. So they were looking at just essentially a similar set of terminology to base their nitrogen guidelines on all those states.

Dan Kaiser: 02:00
I think the intention always was that states would have their own nitrogen guidelines based on the MRTN. We just use the same system to calculate the numbers. So a lot of this was just to get more consistency which I think a lot of growers like to see especially if you're on a state line. There's always questions on why when I cross the border even though my soils are the same, does guidelines change drastically when it goes across the state lines? And we don't really can't answer that other than the fact that essentially it's the data sets that are involved with developing these guidelines are different.

Dan Kaiser: 02:32

When we've looked at combining things, it always hasn't shown to be able to increase consistency with a combined set of guidelines. But it does incorporate economics and the MRTN or the maximum return to nitrogen, we're looking at marginal economics is really what we're looking at there is we're looking at essentially every increment of nitrogen, what is the increment increase in crop yield? We're not looking at the maximum yield within the given field, which if you want to talk about overall productivity, that's a separate story. But what we're really looking at is whether or not that investment in nitrogen is returning us the same investment in increasing crop value. And when you start looking at the MRTN, I know there's a lot of, you know, people that have issues with it, but when we're looking at adjusting our management with the maximum return to nitrogen approach, we're generally adjusting within the last two to 3% of yield produced because we're really looking at adjusting our rates, you know, within the area at the upper end of the response curve within a given field.

Dan Kaiser: 03:34
The thing about it always, everybody asks about credits too and, you know, since we're these MRTN uses or it's comprised of, it's developed based on a database of individual crop trials that when we're conducting the studies in either corn, soybean or corn corn and giving recommendations for each of those systems, you don't need to worry about a credit because that credit really has been I think a bit suspect and I think we could have a whole another podcast talking about that crediting aspects and you know, and how accurate is because we really don't know. Mean a lot of times with the continuous corn. It's the credit what we perceive for the McCoran soybean is just more of the penalty that we get from the tie up or the mobilization nitrogen from the corn residue. So, you know, we look at it with this type of system is to me, the benefit is I can easily change it over time and I think that's really the the key is to make sure we have recent data and, you know, it's being a database driven system. It has some some general advantage over just essentially kind of to me just was more, I don't if I'd say made up but it really was, if you look at a lot of the the previous data, just there wasn't a whole lot behind it where you could go back and identify where those numbers came from.

Brad Carlson: 04:47
Yeah, if you went back to 2005 when this was rolled out and I was I had already been an extension for ten years at that point, you you mentioned, Dan, that we never really expected this to change the fact that there were going to be different recommendations across states and we would expect that. As you go south, find less soil organic matter and that's because of how much warmer it is and the length of growing season. As you go south and east, we see a lot more precipitation. And so we do indeed expect there to be different recommendations in different states. But one of the problems back then was it wasn't even so much as farmers were looking up and saying, well, what does Iowa recommend compared to what do we recommend in Minnesota?

Brad Carlson: 05:32

It was also a situation where different states were actually using different methods, you know, and there was starting to be questions like, well, if you did it the way they did it, you know, would you come up with their results instead of your results? Which in a lot of cases it was no. But nevertheless, you know, part of this also was trying to just simply get it to be uniform across the states as far as how this was being done. You know, I think that there was some thought at least at one point about combining state datasets related to similar soil types and then starting to make more regional differences. I think the problem with that is it just took a lot of labor and time, you know, and then in some cases, some of those regions didn't have a lot of data and then in addition to that, you know, some of those fertility specialists were saying things like, Yeah, but when I look at my data from outside of that region, it looks the same as the stuff in the region so I don't see any justification for separating it.

Brad Carlson: 06:27
It all just got really kind of complicated, you know, and I don't doubt that we're probably, headed somewhere in the future where we may be advancing beyond this. But at this point in time, this is what we've got and it actually has worked pretty well because, you know, as you said, Dan, this is driving off of actual research data. And when farmers say like, well, you can't tell me my corn is yielding 250 bushels an acre, it doesn't need more nitrogen. Yes, it does. However, it's not linear, it's not 1.2 times the bushels and the actual data, recent new data from rate trials is going into the database.

Brad Carlson: 07:09
And so we've seen those numbers have advanced over the years. They are not the same as they were back in 2005 and so, this system actually does accommodate that fairly well.

Dan Kaiser: 07:22
Well, one of the things you've got to understand about the rate trials is that, I mean, I'm sure a lot of you have seen that, you know, we do a lot of work at the university where we have multiple rates, you know, six to eight rates of nitrogen replicated multiple times to develop these curves that develop this relationship that's kind of a diminishing return relationship or what we call a quadratic plateau. Essentially, as you increase rate for the initial rates that we apply, we tend to get very large returns in terms of the additional bushels per unit of N applied. That tends to diminish over time or it tends to plateau and flatten where it achieves a peak now. Sometimes we get actually what we call quadratic situations where once it reaches a peak, it'll actually decline a bit for yield but that's pretty rare particularly for nitrogen because corn is not the same as other crops that tend to have some sort of it can have some penalty for over application where it just kind of tends to leave the nitrogen in the field if you don't effectively utilize it. But again, you know, that increase is what we call that marginal return or that increase per unit time.

Dan Kaiser: 08:28

And, Brad mentioned that 1.2 times yield goal and the thing that really irritates me about these yield factors is the fact that it doesn't really matter. I mean, when it comes to these factors because really a lot of these factors are more dependent on the maximum yield you can achieve and that's kind of where we separate, we talk about nitrogen use efficiency versus this marginal return to end that we get with the MRTN because I've seen situations in fields where I get the different yield potentials but I get the same overall response to N so my overall return or that I'm getting for every pound applied is the same but my NUE is gonna be much less in areas that might be limited by some other factor and that's really kind of the key is I think everybody thinks that, you know, with nitrogen I have unlimited yield potential but that's not the case because we know that there are other factors that impact yield like, you know, water or disease or insects, those types of things that can cap your yield potential within the field which affects some of those factors like that 1.2 because if I get a poor yield, it's gonna take I'm gonna get more nitrogen per pound versus if I can get a higher yield where I get better utilization of the nitrogen, We apply as long as the rates are the same.

Dan Kaiser: 09:46
So that's really the big thing about this is, you know, we have to decouple these things and the thinking that, you know, my predecessors did a good job of getting people to think about fertilizer application and these things were key at those points in time when we didn't understand a lot of things or have the data that we have that it made sense to use some of these factors times your yield goal to make your nitrogen guidelines, but that's just not the case anymore. I mean, I think we've got the we know more about what's going on. It's not a perfect system, but it's it's still better at least having some data behind it. So if you've got an environmental group that, you know, comes in and says, well, where did you know, where does this recommendation come from? We can actually point to the methodology and the data that's based on the guidelines we have.

Brad Carlson: 10:33
And I think what's important to recognize, Dan, is you said that the overall yield may be very different in a field, however, the response to nitrogen might be the exact same. Farmers realize they've got better soils and poorer soils. And you can't take a poorer soil and fertilize your way into it being a better soil. On the same token, we know that when we do a nitrogen rate trial, obviously, there is a plot out there with zero nitrogen. You're going to grow some corn with zero nitrogen and the only place that nitrogen really comes from other than some token amounts that fall from the sky is from whatever is produced from the organic matter in the soil.

Brad Carlson: 11:14
And I mean even under in sandy soils, under center pivot irrigation, you're still going to get some yield that may be bad but some yield at zero nitrogen. One of the kind of the emerging areas that we've been investigating a lot of is the ability to use that zero nitrogen rate to potentially predict if we're going over or under, that's a story for another day. However, in the

same token, that is a factor as far as what you're getting at zero. And farmers also realize you can't just keep pouring nitrogen on and keep getting increasing yield. At some point, it doesn't produce any additional yield.

Brad Carlson: 12:00
So it does really, what it comes down to is finding where that inflection point is where it's really no longer producing one to one for the dollar you spend. In a lot of cases, the yield penalty for being slightly under that is not real significant, you know, because if you're looking at the, you know, if you want to figure, if you want to figure $5 corn, you know, if only producing a bushel an acre, you know, it's just you can't even really evaluate that, you know. So, the price of nitrogen compared to that, it's just not that sensitive when you get to the plateau point on the response curve?

Dan Kaiser: 12:53
So, I mean, MRTN is really pretty simple in how we calculate the optimal N rate. I mean, it's really only three factors. It's the, you know, we need to know two things. We need to know the price of corn which, you know, typically, there's always been some argument in terms of what you use in terms of the price of corn. What I generally would recommend is if you've got a target point in terms of what you're marketing your corn at, say, it's fall delivery or something like that, use that and then the cost per pound of n.

Dan Kaiser: 13:20
And what that gives you is a ratio. The calculator itself for every pound of n applied, it'll generate the fertilizer cost based on the price per unit n and then it'll generate the yield return, which is, you know, it's based on the response curve. And the way that it generates response curves, so the database will have, let's say, 80 locations in it. What it does is I just all that database has in it is the factors that are important generating that curve. So what it'll do then is it'll give an estimated yield in return for every pound event applied up to the database set when it was initially developed was at about 240 pounds of n.

Dan Kaiser: 14:01
I've kind of extended that out to 300 pounds for that calculation. So then what it does is it'll average all those those returns across all those those 80 locations into one column and then it'll generate the MRTN which is essentially just the difference in the return to the corn yield you're getting minus the fertilizer cost. And what that does is it'll generate a peak which is that the maximum return to N in a net return curve. And you can play around with this. If you go to the Core and N Rate Calculator website, you can get some of these graphs to kinda look at some of that data.

Dan Kaiser: 14:36
But again, it's generating a marginal return. So I've had one person that was trying to figure out what the exact the absolute yield was based on that data and he was struggling because he was coming back with about, you know, 120 to 150 bushel to the acre but that's not

accounting for the yield at zero n which is a completely different story. So again, it's just looking at return. So it's making sure essentially that if we're investing a dollar in fertilizer that at that MRTN level, we can get a dollar back in crop yield from that investment. Again, not looking at the maximum return at that given area for your maximum yield potential, that's a whole different strategy itself.

Dan Kaiser: 15:21
You can set play around with this. The price ratio, if you look at it generally, in most years, it's about point one. It's what tend things tend to moderate at but realize that, you know, that's probably gonna be closer to what it is for the price of anhydrous. So if you've got some other sources like urea UAN, it's probably gonna be slightly higher. I actually in our recommendations, I've developed tables and I'm actually using, you know, four price ratios for the table values for those that don't wanna go and look at the calculator which are like point zero seven five, point one, point one two five and point one five because that equates to $4 corn at $30.40, 50 and 60¢ per pound event.

Dan Kaiser: 16:03
It's kind of what I've tried at least the data I provide that's in tabular form goes into that. But again, the main thing is how you generate your crop price is I think the key. You know, what I generally do is look at what you're trying to market it at and as your target point for generating those ratios. And if you don't really know, again, you know, the point one is a good one to go and stick with in terms of a planning.

Brad Carlson: 16:24
It was interesting if you went back to, as we mentioned before, Dan, that the MRTN method came part of the reason it came about was a run up in nitrogen prices and the questions about should we be adjusting nitrogen recommendations because of the price. And certainly, there's factors involved with the supply and demand of nitrogen but in general, and we had not really investigated the pricing dynamics of fertilizer in the marketplace extensively previously, maybe some people had and knew this, but at least I think the fertility world was a little surprised when we finally got fifteen, twenty years under our belt to realize that the price of nitrogen pretty well tracked the price of corn every single year and that maybe it wasn't so contingent on supply and demand of nitrogen so much as there's just pricing fundamentals going on in the fertilizer industry. And of course, from one year to the next, there are some issues. There's hurricanes that knock out production plants or cause transportation issues. And then there's sudden spikes in corn price.

Brad Carlson: 17:36
Mean, there's things that mess with those ratios. But in general, what we've discovered is that it tends to hold that, as you said with anhydrous, it tends to hold that point one price ratio that, in general, if corn is $5, anhydrous is going to be 50¢ a pound of nitrogen. It's $6.60, 7

dollars 70 cents. From that standpoint, we tend to use the point one price ratio when we talk about nitrogen rate recommendations most of the time because that just simplifies things. And so usually, when we talk about rate, that's kind of where we're at.

Dan Kaiser: 18:10
Yeah. And if you look at anybody, if you're in a presentation sitting there and you've got somebody like me or somebody else talking about economic optimum nitrogen rates, I mean, it's generally going to be the MRTN at the point one price ratio. That's generally what it is. You know, you also see this thing called the rate window. I think Brad brought it up before too.

Dan Kaiser: 18:27
And that's just essentially, we know that we're not in a perfect system, that there is some variation out there and that we have some uncertainty in our values. So what it was decided essentially was to give a rate window which is plus or minus a dollar from the MRTN for reporting values. So for growers looking at, you know, potential risk or something just to kind of give you an idea because we know, again, it's not a perfect system, that there may not be one set number out there that there may be some adjustments that can be made to the optimal rate just based on, you know, growers attitude towards risk. But, you know, realize the fact though, if you look at our data and, you know, the way that the MRTN is calculated that in fact, it's not an average of all the sites. If you look at the the economic optimum nitrogen rate, it's not an average of those 80 sites there that in fact, you know, typically the the number where the the MRTN comes out, it's it's kind of more closer to probably two thirds to maybe even what we call like the 75% confidence interval.

Dan Kaiser: 19:29
So a little bit, you know, airing on the high side for the number of sites where we're representing a vast portion of the sites with that MRTN window. But we know there's there's some variation out there and, you know, for that grower saying, well, you know, you know, I need more nitrogen. I mean, that there might be some certain cases out there that that that's accurate from that because we know that, you know, we're a few sites that there are gonna be above that MRTN. The issue that I've had within the databases, I've tried to sort it out as best I can to try to figure out what's going on in some of these higher responsive sites and there isn't anything clear in terms of things like, you know, growing region in the state or parent material that would come to, you know, potentially being able to separate out some of these sites to give a better MRTN across, you know, forgiven areas in the state. I mean, right now we only have really one region.

Dan Kaiser: 20:21
I think the Red River Valley is my exception. I don't think I would use any of the MRTN than the current calculator. We've had data up there where, you know, if I did use it, I'd recommend going towards the lower end of the profitable range because those sites don't

seem to be as responsive to N but that's the big thing about it is growers would really like, I think, to be more site specific on the recommendations and it's not a perfect scenario in terms of what we have for data to be able to do that.

Brad Carlson: 20:50
Yeah, I kind of tried to mention it before and maybe I got a little rambling, but, the economic optimum end rate, and it's got the rate application window typically is 30 or 40 pounds, realize that's plus or minus a dollar in profitability. That's two tenths of a bushel of corn at $5 you can't even measure that, you know. And so, the sensitivity at the flat part is really not very high. People tend to obsess about that a lot. I mean, really, the key is, did you actually find the flat part at all?

Brad Carlson: 21:24
That's kind of a different story. I think, Dan, you talked about the fact that MRTN database, the rate calculator database, encompasses the majority of sites and it does. Typically, though, if you need a higher N rate, most producers are going to know what those fields are. You shouldn't have to be shooting from the hip on that. So just simply saying, well, I don't like having a 25% risk level or something like that.

Brad Carlson: 21:50
That really doesn't cut it because in general, you know, that number of sites that required a higher N rate, you probably know where those sites are and it's not across the board.

Dan Kaiser: 22:00
Well, here's the thing. I mean, if you look at the database and we've talked about this, that there's really no linkage between the optimal yield at the optimal n rate and the optimal n rate. I mean, it's more of a shotgun pattern. I mean, you can look at the data and you can kinda say, okay, it might be a small trend. But if you look at the actual ability to predict, if you try to use the optimal N rate to predict the or the optimal or the maximum yield to predict the optimal N rate, there's really other far many other factors in there that determine that maximum yield the optimal annual rate within the field.

Dan Kaiser: 22:34
So it becomes kind of an issue and you know, an example of this, if I look at our data set base the way it is right now, if we look at 250 bushel to the acre yields, I mean, we've got situations where it's taken, you know, forty fifty pounds of nitrogen upwards of, you know, other situations where it's taken close to 250. So it's like a 200 pound swing to get the same yield across these given locations. So, know, the question is, can we figure some factors out and why we get this variation? That's kind of, I think the difficulty right now with that is that it isn't just clearly that my yield is a lot higher. And then in fact, if you look at some of your better yielding areas, think I can make the argument from a lot of our data that they probably

are areas that could be a little bit more to less of that rate window versus some of the areas that might be more eroded that might have a little bit lower end supply might need near to the upper end of those, their rate windows.

Dan Kaiser: 23:29
So it's not clear and that's the issue when it comes down to it. Everybody, there's always, you know, seemingly every year I see somebody coming out with their new system, model to look at predicting nitrogen requirement in there. The interesting thing, if you look at economics, any of the research that's out there, I mean, the MRTN tends to come up near the top in terms of economical management of nitrogen. You know, everybody thinks they're smarter and has the better system, but, you know, if you look at it, it think it gives us at least a good starting point and it's just about as good as or better than anything else that until I'm proven otherwise, you know, it's probably the thing we're gonna stick with, you know, for the least this point in time because at least I can defend it with the data I have.

Brad Carlson: 24:12
Well, there's a lot of people who would like to take for instance a yield map and turn that into a rate map like variable rate based on the potential and really you're just doing the 1.2 times your bushels if you're doing that. We've got mountains of evidence that show that for instance some of our lower yielding sites actually need higher rates of nitrogen and so that completely flies in the face of, you know, oh, I'm going apply more in where I had two fifty bushel corn versus where I had two twenty, when in reality maybe your lower yielding sites actually were lower yielding because they needed higher rates of nitrogen. And so when you look at the data, you know, from all those rate trials and you say what was the yield, what was the best yield we got and what was the N rate that corresponded to that, it's a shotgun pattern and you just flat out can't even begin to put a line through that to where you can model that. We talked in the last podcast just briefly about the potential use of crop models, you know, and Dan you alluded to the fact that we can't, we haven't been able to really figure out why sites have different nitrogen response, know, potentially these nitrogen models, maybe we never will figure it out but maybe the models can actually just start teasing out what that different response is on a site by site basis by building a database within a farmer's own fields and looking at past management and past performance and maybe even some of your neighbors or other things relative to the hybrids you use.

Brad Carlson: 25:49
Some of that stuff in the long run may help us better refine that but boy, there's really a mountain of information that would need to be sorted through to until we actually get to being that fine about how we make those rate recommendations.

Dan Kaiser: 26:04
Well, can go on a little tangent in the whole hybrid thing because I know there, you know, companies talk about the different hybrids and how they respond to n. I have no idea where they get that information from. I'm kind of curious if whether or not they're looking at grain

measurements for the amount of n in the the grain and just making a judgment call for the hybrids that have more n that they might be more in responsive. But, know, most cases there, I think, I mean, you might be managing, you know, within five pounds of each other in terms of optimal n rate, which is just, I think, a waste of time trying to chase that because at best, even with all these clever systems everybody has in place with all these creditings and and stuff, I think we're still conceivably right now. I mean, the problem we have is that to consider ourselves being good managers of nitrogen, I mean, looking at all we have in terms of the options, we're looking at probably being somewhere within, you know, plus or minus 30 pounds from the actual optimal enter rate to be considered being doing good management just because there's too much uncertainty involved.

Dan Kaiser: 27:03
And that's the problem with anything that you're using for crediting or anything that you're using to go in and make any tweaks to your nitrogen is that there's always errors associated with those measures. I mean, it isn't, you know, we treat these things as absolutes when these numbers as perfect, but they're always plus or minus. I mean, that's why the rate window's there for the MRTN that, you know, the more numbers you use, the more errors associated that kind of compounds everything where there's less and less uncertainty in the accuracy involved. And I think in, you know, many cases, the starting points are so high, it probably doesn't matter with with what some people are using for their starting points for their rates, but but it's it's just a lot of issues in the uncertainty and I'd like to have a better option. I mean, I hate going and talking about the MRTN and, you know, just saying that, you know, we don't have a good option, particularly when it comes to variable rate and application, but, you know, what do we do?

Dan Kaiser: 28:00
Because if you look at the data, as I go back to the comment I had before is that if you look at when they've tried to do, you know, sensors or soil based, soil tests to try to adjust for rates, you know, generally, if you look at what comes out near the top in terms of performing the best, it's the MRTN. So we just kind of end back at the same thing just because I think where it works really well is the fact that there's actual data that's generating the guidelines. And the more you have, the better your data set is in terms of the overall predictions. So when it comes to research, everybody just said, Well, why do we we don't really need any more NRATE trials? And I could kind of make the argument the opposite that we need as many as we can get because, you know, even when we start talking about AI or some other systems later on being able to help us adjust, I mean, that's all based on the size of the dataset you have and the more data you have, the better in terms of trying to make some of these decisions if that's indeed the way we're gonna go.

Brad Carlson: 28:58

Not to mention you show up and you do a presentation and somebody immediately says, well, that's eight or ten year old data. Give me some new stuff. Well, somebody needed to fund the new research if we're gonna have that.

Dan Kaiser: 29:08
Well, in the dataset too, database, I mean, I'd really like to have at least 30 sites for a good So you're talking about more recent data. That's the problem is if you can't generate a lot, it tends to skew things slightly to whatever your environmental conditions are within the previous year. And you really wanna look at more of a long term average as a starting point instead of trying to be reactive at the previous year because generally, you know, if you look at, you know, some of the situations where really wet years and everybody would be over applying the next year then you if that's a dry year then then you have all this carryover residual nitrate and it becomes a problem. I mean, that's really the thing with nitrogen options you have for making adjustments is really key. Then trying to start at a more reasonable total is really what's more important because you wanna make sure that at least you're kind of at or maybe slightly under applying if you're gonna make in season adjustments because if you're already over applying, the cat's out of the bag, nothing you really can do at that point in terms of taking some of that nitrogen out without some additional expense.

Brad Carlson: 30:12
So let's kind of wrap up, Dan, just by talking a little bit about finding the MRTN, where do you get that from? And as we said before, it's in a database of actual rate response trials and it's available online. The website used to be hosted by Iowa State, they have transitioned since John Sawyer retired and it is now the web address is cornnratecalc.org. Remember there's two N's, there's an N at the end of corn and there's an N at the beginning of Nrate, so cornnratecalc.org. And you can go in there and select your state and you can put in your corn and fertilizer price if you want or you can also kind of do what I suggested and just simply look at the point one price ratio and maybe realize that there's going to be a little fluctuation depending on if you're using urea or if your corn price is a little higher or lower or that kind of a thing.

Brad Carlson: 31:14
Either way, you can go in on that website and find that. As I said before, I sort of discourage you from looking at other states because their soils and growing conditions are different. However, most people probably do end up doing that just to see for curiosity, realize that there are going to be some differences from one state to the next.

Dan Kaiser: 31:35
So, yeah, just do a web search too for corn in rate calculator. It'll generally, you know, with once you weed through all the sponsored links that are always near the top of those web links, so you should find it as one of the top links if you're looking for it. But it does give you the ability too if you wanna do multi price comparison, if you've got sources you wanna look at. I mean, doubt you're gonna see too much difference, you know, if you're dealing with

anhydrous versus urea unless the price differential is is large. But, you know, this is all the rates are all assuming that, you know, essentially that we're following in the other four r best the other three r's for practices that we're not getting loss from some other source.

Dan Kaiser: 32:12
So that's kinda always one of the other things to consider too is we don't build in insurance nitrogen for any of our strategies nor do I think we should be even considering looking at any of this. I know some growers will still talk about that but with the way that we're looking at environmental regulations, I think we wanna at least start off with, you know, something that's more reasonable is really the key for our rates. And then said you've got some sites probably that might need more, maybe you got some sites that need less, that's kind of where we could, you know, link for future some of the past. We talked a little bit about adjusting for adjusting our rates. So that's kind of another thing really for another day to talk about.

Jack Wilcox: 32:49
That was Daniel Kaiser, Extension Nutrient Management Specialist and Brad Carlson, Extension Educator. Thank you guys very much.

Brad Carlson: 32:57
Thanks.

Jack Wilcox: 32:59
Do you have a question about something on your farm? Just send us an email here at nutmgmt@umn.edu. Thanks a lot for listening and we look forward to seeing you next time.

Jack Wilcox: 33:20
Advancing Nitrogen Smart is proud to be supported by the farm families of Minnesota and their corn checkoff investment through Minnesota Corn.
