

# University of Minnesota Nutrient Management Podcast Episode “Manure nitrogen guidelines”

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(Music)

## **Paul McDivitt:**

Welcome back to University of Minnesota Extension's Nutrient Management Podcast. I'm your host Paul McDivitt, communication specialist here at U of M Extension. Today on the podcast we're talking about our manure nitrogen guidelines. We have three members of Extension's Nutrient Management team. Can you each give us a quick introduction?

## **Dan Kaiser:**

This is Daniel Kaiser. I am a nutrient management specialist with the University of Minnesota out of the Twin Cities campus. My area of expertise is with the corn nitrogen guidelines as well as the fertilizer guidelines for many of our agronomic crops.

## **Melissa Wilson:**

I'm Melissa Wilson. I'm the Manure Management Specialist at the University of Minnesota in the Department of Soil, Water, and Climate.

## **Fabian Fernandez:**

And I am Fabian Fernandez also in the St. Paul Campus, Soil, Water and Climate Department in the area of Nitrogen Management and Water Quality.

## **Paul McDivitt:**

Great. Starting off, what are the most important considerations when making a nutrient management plan for manure application?

**Melissa Wilson:**

One of the big things that you want to start with is taking a test because that will allow you to know what you have to work with and also taking soil tests as well. That way you know kind of what's in the bank and what you need to add to the soil. These are probably the two key factors for thinking about how you're going to plan your manure management.

**Dan Kaiser:**

And one thing with the manure being a very variable source when it comes to some of the nitrogen and phosphorus, it's one of the things, Melissa, just the test I think is very important because you can go in and look at book values but we know that there can be some significant variation. And in some of these book values have been, I don't know, Melissa, they've been around for a while. I know you've been kind of-

**Melissa Wilson:**

Yeah, at least 20 years in some cases.

**Dan Kaiser:**

I know you've been involved with and I've also in kind of some earlier days here in Minnesota, I was working with one of the larger dairies that was having some challenges with their nitrogen management, just because they were using some of the values in the system they were using was a sand separated system which if you look at a lot of the guidelines at that point, there really wasn't that type of system actually in the guidelines. It's one of the things that having a test as a starting point, I think is a really good thing at least to really know where you're at because we know that's one of the issues with manure. It's really easy to over apply, and particularly with nutrients such as phosphorus. The soil tests and the having the actual test itself of the manure sample can really go a long ways to having you put that manure where it's really needed in the field where you're going to get the most out of that particular whatever source of manure you have.

**Fabian Fernandez:**

And then from nitrogen also an important thing to do when trying to figure out a plan for manure is if there is nitrogen that has been applied that was in inorganic fertilizers to account for that. There is not typically a very good way to account for that simply by taking a soil sample and measuring how much nitrogen is in there. And so if you have applied or planning to apply nitrogen as a starter or some other way account for that nitrogen in your calculations.

**Melissa Wilson:**

That's a good point Fabian. Sometimes people don't realize or forget that nitrogen comes with the disodium phosphate and some of the phosphorus that you've put on for starter fertilizers. It is important to take that into consideration.

**Dan Kaiser:**

It's one of the things that I know we do tend to see every once in a while are questions from growers in years, just looking at availability and wondering if you can take a soil test to determine how much nitrogen is actually there in the spring, if you fall applied manure. And it's really challenging and particularly with a nutrient source that has organic nitrogen, which takes a while to mineralize and our winters really tend to stop that process, which it's good for our soils because that's how we've built up our organic matter in our soils. But in terms of sources like manure, it really will slow down that process. That's the main challenge with the source, particularly any organic sources of nutrients that need to mineralize nitrogen out. Really the challenge really is being able to get a good assessment of that and we really don't have a way to do that once it's applied.

**Dan Kaiser:**

Starting with the soil tests in with that manure test is really the best you're going to be able to do to at least make your initial plan. Then beyond that if we're looking at say, seasons where we would look at some sort of in-season assessment if we need to come back in with a sidedress then we need to look at some other options for that, because it's just a tricky one just that organic source particularly if you started to get a lot of bedded pack manures, knowing what the availability is going to be out of some of those that may not have a high amount of inorganic nitrogen say that we get maybe out of a pit manure, which is a little bit easier because the higher the inorganic N the more it's going to behave like a fertilizer source that you apply from a commercial fertilizer vendor.

**Melissa Wilson:**

And Dan, I believe you've done some of the like pre-plant soil nitrate testing. If the manure has been applied within 11 months, the pre-plant soil nitrogen test isn't really a good predictor, is that correct? But if it's over 12 months applied, then it might be a better predictor of what you can get?

**Dan Kaiser:**

I would say a lot of it will depend on really what you're expecting for maybe a two year or a second year N credit. If there is something out there that's going to give you more of an N credit like a bedded pack that might take longer to release then you're going to more of an issue. I think giving it 12 months is probably what you want to do. And that's one of the things that I'm looking for some sites for the spring to look at the PPNT test to specifically get into some situations with manure to see if potentially we could do that. And that's one of the things we're really looking for is trying not to target sites that have had recent applications because it's tricky. And if you look at at least the pre-plant nitrate test itself, there is a decision tree we have in terms of when it's applicable. And a lot of times with manure it's one of the things you want to avoid.

**Dan Kaiser:**

And I know Fabian, even with the pre-sidedress nitrate test, I know we can have some issues and we don't really have a good set of guidelines for that. That's one of the things to watch out for, if you're looking at some of these nitrate tests just to know whether or not if you're using manure whether or not it's going to give you an accurate result. The pre-sidedress I know does come up every once in a while, because we do have some co-ops or some people actually using that test to help them decide whether or not to apply nitrogen fertilizer.

**Fabian Fernandez:**

Yeah. It's tricky because even with inorganic fertilizers, sometimes those tests if you have applied inorganic fertilizer it's typically they're not very good at helping you too much. But coming back to the first question that where we started the podcast today, I think one important consideration is to figure out when you're applying that manure too. Because like inorganic fertilizers where they're, most of them typically are, available right at the moment of application, manure takes time. And so looking at when you're applying that manure and when it's going to be available and what happens in terms of

growing season conditions or fall, winter conditions that may increase or decrease the mineralization process of that material is very important.

**Melissa Wilson:**

And this is especially important for our solid manures that tend to have a higher proportion of the organic nitrogen. It takes longer for those to break down versus some of our finishing swine manures, which are in the most part ammonia. Those almost do act like a fertilizer, inorganic fertilizer, as soon as you apply it. Definitely the different manure types and thinking about when you're going to apply them can play a role too.

**Dan Kaiser:**

And one thing about the ammonia too, it's completely different. And I don't know Melissa if you'd have the same assessment. If you're dealing with anhydrous ammonia versus ammonia in manure, you don't have the same things going on if you're knifing manure in the soil that you would have with anhydrous that might slow down some of the biological process just because of the anhydrous nature of the anhydrous ammonia. You're not going to have that. And even with salt in the manner we don't see that same effect. Your conversion rate, we would expect to be slightly faster with manure with ammonium versus something like anhydrous ammonia.

**Dan Kaiser:**

I don't know if it would be the same as urea, but we know it'll convert relatively quickly. That's one of the things that it's in a good form where it's at. It does have some tendencies to volatilize. It's one of the things to watch out for but the conversion rates can be quicker. That's one of the bigger challenges particularly with early applications. And why cover crops are suggested is to try to capture some of the nitrate that might be forming out of that manure if you're applying earlier in the fall, just to get the pits empty at that point in time.

**Fabian Fernandez:**

And Dan you mentioned the volatilization and that's another thing that I was thinking that it's very important that you figure out what kind of nutrient management you want to do for manure, the injection or somehow incorporating the manure should be a very important part of that because you can end up losing quite a bit of nitrogen through volatilization if you don't incorporate it.

**Paul McDivitt:**

Is it possible to put a value on the nutrients in manure?

**Melissa Wilson:**

It certainly is possible. We in fact have a manure nutrient value calculator. It is tricky though because sometimes it really depends on what do you need. Because manure comes with all of the nutrients, including the micronutrients but if you don't need phosphorus because your soils are high soil phosphorus testing, then you don't really assign a value to the phosphorus in manure then. That is one thing that's nice about our calculators. You can add in the kinds of things that you need from the manure and it will place a value on those. It kind of puts all of the value together but it really depends on individual situations.

**Fabian Fernandez:**

The other thing, aside from the nutrients also that I think is important and unfortunately it's very difficult to really put a value in is the carbon contributions that manure gives to the soil in terms of building up the organic matter of that soil and the biological activity of that soil that can impact nutrient availability from the soil supply, can impact water infiltration and things like that. Those are some of the other things that are more, I guess intangible, they're very difficult to measure and to quantify but they are also important.

**Dan Kaiser:**

And one of the things you really need to look at considering particularly with manure is that if we know that not all the nutrients are readily available, that when we do a calculation, based on manure a lot of times you'll see calculations based on available N. So that's one of the challenges and that can change particularly with bedding type. Particularly you get into beddings with high C-to-N ratios that we don't tend to see some issues with some availability problems with some of the nitrogen being tied up. It's a dynamic source and it becomes a bigger issue. And I don't know, Melissa, how much the calculator takes into some account with that. But if you just talk maybe a little bit more about how or what that calculator is doing, is it looking at available or total N? Or how does it all tend to function?

**Melissa Wilson:**

I believe it does take into account two years of nitrogen. We have our availability factors that we recommend, I believe it incorporates those in there. And it also includes things like application costs, how much it might cost to get that manure applied. Because that will change depending on the manure, right? Something with more liquid that's more dilute and doesn't have as high nutrient density tends to cost more to haul out to the field and get applied than something that's more nutrient dense. It tries to take into consideration all of those different things. And I think it even adds like a value for sulfur because I know that's becoming more and more important for farms in Minnesota too.

**Dan Kaiser:**

And that's one of the questions I've gotten more and more is sulfur. What's the overall availability? And we've tried to look at that. The issue a lot of times when we look at sulfur, it's not a clear cut just because the way we try to look at the availability a lot of time relies on soil tests or some other factors that aren't always as reliable for sulfur availability. Right now I usually say about 65% availability. I don't know Melissa, you're kind of around that same line of the source but it really depends on what form of sulfur is in there because we can see a lot of reduced forms of sulfur that maybe in these maybe hydrogen sulfite or some of these other forms of sulfur that are in there that aren't going to be readily available. That's been the main challenge.

**Dan Kaiser:**

And I think over time with the organic material if you've got a lot of buildup, we're likely probably going to see less of and less of an issue of sulfur. But we do know there's some soils out there that I may know talking to some consultants that are manured, that they're still recommending a small amount of sulfur to start out just because of the availability early in the growing season is still a problem. It's a challenge and that's one of the things that giving a straight answer always isn't the easiest thing to do.

**Dan Kaiser:**

We got to kind of look at the best data we have at this point in terms of availability numbers and sulfur has been, I think kind of the bigger question mark. So there may be some circumstances out there that you may want to watch, particularly in poorly drained soils that you may not be getting as much available sulfur. Maybe a small amount as if you're doing an early sidedress or you're putting down a pre-emerge chemical, it might be a good idea to look at something like an ammonium thiosulfate in a situation where you can supply some sulfur that might counteract some of these availability issues.

**Melissa Wilson:**

Now just remember to account for that nitrogen in that ammonium thiosulfate.

**Dan Kaiser:**

Well, at least it's not that much, it's only 12%. At least it's not quite like some of the other sources. But we know that we've looked at it on some circumstances and I haven't been able to completely replicate it but I'm pretty well convinced it's an issue with the form of sulfur, then also some of our poorly drained soils just don't oxidize those forms very fast to sulfate and that's really what we need to happen. And early in the growing season, if that doesn't happen we know we can run into some problems.

**Fabian Fernandez:**

This also reminds me a little bit of in some springs when it's typically cool and wet relating back to the placement. If the manure is injected, especially if it's deep injected that the crops take a little bit of time to reach the band of manure and nutrients. And so it's sometimes again, when it's cool, wet the crops might look like they are nutrient deficient for a while. And it's not necessary to be alarmed about it but to wait a little bit because we know that things will warm-up and the crops then start growing, start putting deeper roots and they eventually reach to that layer of or zone of fertilizers. And so something to always keep in mind.

**Paul McDivitt:**

How does manure fit in with a maximum return to nitrogen approach used in the current nitrogen fertilizer guidelines?

**Dan Kaiser:**

The big thing about the MRTN approach is that it's really geared towards fertilizer in its development and fertilizer it's a lot easier to look at a price ratio and that's one of the things we talked about in the previous point, putting a value on manure. Certainly if you're buying it and you're paying so much per ton and you can figure out how much available nutrients you have in there, you could put a value on it to potentially then look at where you would be at using the online calculator with the MRTN but it isn't always that simple. One thing that we know with the MRTN is that where we're recommending fertilizer, we're not at the point at which yield is completely maximized, we're typically within about maybe one to

one and a half percent. The difference between the two really accounts for the fact that at that given point, we're not making enough grain to cover the cost of the nitrogen that we're applying extra.

**Dan Kaiser:**

When we look at it in terms of applications, a lot of growers ask us what do we use in terms of a price ratio? And it's really not a straightforward answer. I know that's one of the things that Melissa and I have been talking or me and Fabian we've been talking about a lot in terms of how do we look at the recommendations?

**Melissa Wilson:**

And generally speaking, we have a lot of data on crop nitrogen needs, and that is what is generating this MRTN calculator. You can find that on the website, I believe Iowa State hosts that. And what we see is how much the crop needs in Minnesota. And based on that and the knowledge that we have that manure is just a little more variable than our commercial fertilizers. We kind of set up at 195 pounds of nitrogen is needed for corn on corn for manure and I believe it's 150 for corn after soybean. And again, that manure is going to be a little variable. We try to account for some of that when we were thinking about these recommendations.

**Dan Kaiser:**

The big thing that we want to really avoid is the environmental issues. And that's one of the things that a lot of times we take flack from grower groups that we're not recommending enough and then you see environmental groups that we're recommending too much. Really what the MRTN one thing that we do know and I know Fabian has got a lot of data on this, if we just go and look at residual nitrate, what's left in the soil after the crop is taken off. If we look at essentially where we see large increases in our residual nitrate it's typically beyond the point at which the MRTN, we reached that at in a particular field because at that given point we know that if we're over-applying that the crop's not utilizing it. So pound for pound we should be leaving that nitrogen in the field.

**Dan Kaiser:**

That was one of the things that when we started looking at what to do with the manure guidelines, we want to stay within the framework of what we have because we don't want to have a situation where we're leaving a lot of residual nitrate in there. And that's kind of where we started looking at it, balancing the environmental aspect with kind of where we're at in our current guidelines to try to come

up with where we're at. Because again, we know that corn is going to respond to nitrogen at a certain point. We just want to make sure that we're not applying beyond that point because that's really where we start to get into environmental issues.

**Melissa Wilson:**

I think one of the other things to consider too is the, with these environmental aspects, is also timing. As we talked a little bit about before, early fall applications are much more likely to convert nitrogen into that nitrate form which can be easily lost. We have to consider not only application rates but also the timing when thinking about these. Some of these manures that have a higher ammonium concentration probably would benefit from being applied closer to the time of application or at the least waiting until the soil temperatures are cold enough to kind of inactivate the soil microbes that would do some of those transformations. Some of our bedded beef packs and things with the high carbon to nitrogen ratio, we don't see that transformation quite as quickly but those liquid manures especially the swine manure that has a high ammonium concentration timing is really critical.

**Fabian Fernandez:**

And this is a, I think an important point and we've been talking about the MRTN calculator that as Dan mentioned, it really is a tool for inorganic fertilizers but the concept behind the response curve, so the agronomic response curve that we obtain to then do the calculations of the economic aspects are kind of two different things. And so for manure, really looking at that response curve that we have based on inorganic fertilizer applications, those are applicable because the plant is not concerned about where the nitrogen came [from]. So as long as that nitrogen that is in the soil is inorganic in an inorganic form, whether it's nitrate or ammonium the plant will use it and will respond to it in the same whether it's inorganic fertilizer or manure.

**Fabian Fernandez:**

And so managing that manure so that it's available and how much of it is available is really an important thing as we've been talking about the challenge with manure obviously is how much of it will be available. And as Melissa you were saying, there are big differences between different sources. And so that's, that's really what it's very important to keep in mind in terms of the nitrogen rate calculator and the two different things. One is the agronomic response and then the economic and the economic it's definitely a completely different situation when it comes to manure versus inorganic fertilizer.

**Dan Kaiser:**

And one thing that we saw recently is particularly in parts of the state the nitrogen rule come out. And we know that a lot of that is geared towards commercial fertilizer but a lot of these as Fabian has said in these fundamentals when it comes down to it are all the same.

**Fabian Fernandez:**

Yeah. I think this is a really important point that you bring up because as the Groundwater Protection Rule came out this fall, I have had a lot of questions about manure and does this apply to manure? And in reality well, the rule itself does not apply to manure, it's only for inorganic fertilizers. But the concept of why this rules came about in terms of protecting groundwater is the same because that manure, if it's inorganic nitrogen, behaves in the environment just the same as it would inorganic fertilizer. And so while under the rule there is no problem in applying manure in a sandy soil or in southeast Minnesota in the fall. In reality, the potential for nitrogen loss is humongous, regardless of what source of nitrogen you're using. And so you should really look at that in terms of a resource and say, "Well, it's probably not the best time to apply it. I will lose nitrogen even though it's manure."

**Dan Kaiser:**

Other than a bedded pack you might see situations where you have a really large organic N content where you see that fairly stable in there with these, any of these sources with a lot of or high amount of inorganic N it's a problem, and there's no silver bullets out there in terms of stabilizing that particularly if you're looking at an early fall application, the nitrification inhibitors, we have good data on that but the data still shows that the best benefits for them are still following some of the same practices we suggest for commercial fertilizers. That's looking at applications after the soil stabilize at 50 degrees and not going with an early application. There's really no way particularly some of these resources with high amounts of inorganic N really to stabilize that all that well to get around some of the loss parameters that we still see with commercial fertilizers.

**Melissa Wilson:**

And one of the things I want to mention is the Groundwater Protection Rule does have the word manure in it, at least I think it refers mostly to making sure again you're accounting for all of those nitrogen sources. And that has been in the feedlot rules. People who deal with manure have always been required to account for all the nitrogen sources. But again, that's an important aspect.

**Paul McDivitt:**

Can you give us an update on current research on the utilization of manure as a nutrient source?

**Melissa Wilson:**

Yeah, we're doing a lot of really fun manure projects and I'm just getting in a lot of yield data so we don't have a lot of good results [from 2020 field data]. But one of the interesting projects we started this year looked at liquid separated dairy manure in a sugar beet rotation. We applied dairy manure at around 1400 gallons per acre and around 9,500 gallons per acre and compared it to whatever fertilizer was needed based on soil tests in the crop. And we did that for both or for all three crops, a corn, soybean and a sugar beet. And so far we got some really nice results. We got high sugar on our manure plots higher than we expected though the purity was a little bit lower and I haven't gotten to statistically analyze it to see if it was enough of a difference that it was significantly different.

**Melissa Wilson:**

And we also have to run it through some of the different sugar beet pricing calculators just to see if the purity would have thrown off some of the price they might get for that sugar. But we were pretty happy with that. And the soybeans looked horrible, that soil has a high pH and a lot of calcium in it. And when you apply an organic material that has lots of potential nitrate you can really drive IDC, Iron Deficiency Chlorosis in soybean. We learned that the hard way, we did not put out a product to help with some of the iron issues and just really killed our soybeans except for where just the P and K fertilizer was applied the soybeans looked fine. It was just where we applied manure. It's kind of a fun project.

**Melissa Wilson:**

We just finished up our third year of our manure nitrogen and phosphorus crediting study. And I haven't gotten to look at the yield for that to see if we had any third year nitrogen credits. We did bedded beef pack, liquid swine manure, two different types of dairy, a raw dairy and then the liquid separated, we did turkey litter and we did composted chicken layer manure. So we've yet to see if we got a third year credit from these but that one is another interesting project that we'll kind of finish up this year and then our last sites we'll finish up next year. Lots of other projects but I'll kind of stop there.

**Fabian Fernandez:**

Yeah. I don't have any projects with manure. I only work with the inorganic, although I do collaborate with Melissa in a few projects that involve manure. And I just want to say that we at the University of Minnesota are very pleased with having Melissa in our midst because of all the work that she's doing with manure. This was an area, it's a very important nutrient or a source of nutrients and we definitely needed your guidance and your research to help us improve the management of these very important resource. Thanks Melissa.

**Melissa Wilson:**

Yeah, thanks. I don't know if you are happy that I'm here because I'm doing research or because you don't have to get your hands as dirty with manure.

**Fabian Fernandez:**

Both of course.

**Paul McDivitt:**

Any last words from the group?

**Dan Kaiser:**

I think the main thing is if you do work with manure a lot is just to kind of stay informed. I think one of the good resources we have is Minnesota Crop News. We try to at least through our Nutrient Management Group to get some of that information out as it's available and where Melissa thinks it's a point at which we can use it for outreach. It's one of the things that it's a good resource. If you want to know what's going on because it is good to have somebody here working on it because we haven't had really anybody look at some of those, particularly those availability guidelines in a while. And that's kind of the key issue with manure is really having accurate availability guidelines is really what's needed in terms of planning. Otherwise, if you don't have that you see some pretty significant yield reductions or over applications. It's good to have somebody here actually doing that and wanting to work on that. That has the time where we all tend to get spread thin in terms of all the rest of the research we have to do.

**Melissa Wilson:**

Yeah. For other research updates, they could follow us on the manure Twitter page, that's @UMNmanure. And I also have a personal Twitter page that I probably post a little more recent updates on research and things like that. I'm @ManureProf and I tried to get Dr. Manure but someone had already taken that so @ManureProf. And don't forget to check out our website for some of the more recent information that we've been trying to get out there. It's [extension.umn.edu/manure](http://extension.umn.edu/manure).

**Paul McDivitt:**

All right. That about does it for the podcast this week. We'd like to thank the Agricultural Fertilizer Research and Education Council (AFREC) for supporting the podcast. Thanks for listening.  
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