NC-1195 minutes 2015

Carrie Laboski called the meeting to order at 8:30 on March 3 and reviewed the proposed agenda. Afternoon discussion was re-ordered to prioritize discussing project renewal, paper, and funding proposal ideas. Agenda was approved.

Each member introduced themselves and summarized their program. Attending were Fabian Fernandez, Carrie Laboski, John Sawyer, Mike Castellano, Beatrix Haggard, Rhae Drijber, Jac Varco, Peter Scharf.

Members unanimously welcomed and voted in favor of Jac Varco as a new member of the committee.

Minutes from 2014 were reviewed. Beatrix made a motion to approve the minutes, seconded by Fabian, unanimously approved.

Rhae Drijber nominated John Sawyer to be the new member-at-large. Peter Scharf seconded. All voted in favor of John for this position except for John, who voted against but accepted the office anyway.

Possible dates for the 2016 meeting were discussed and then tabled for later.

Sue Blodgett, administrative advisor, was not able to attend the meeting.

USDA report

We called Ray Knighton in Washington for a USDA report. USDA has a budget for the new year. Slight increase in competitive program dollars, request for applications just came out with slightly higher money availability. The Foundational Program, Natural Resources and Environment has two programs that might be of interest to this group: N & P cycling, Agroecosystems. Priority to host a workshop/summit on N & P, up to $350,000, want a synthesis of work that's been funded over the last 10-12 years. SERA-46 is a new group looking at reducing nutrient loading in the Mississippi River Basin; working with Gulf Hypoxia Task Force on both outreach and research, helping Task Force keep up to date with strategies for agriculture. State nutrient reduction strategies are a key point. Last year a Federal group convened in D.C. to analyze how much N & P work had been done in the last 12 years by USDA, EPA, USGS, found over 20,000 projects that had been supported. Workgroups also looked at monitoring needs, policy, technology transfer. EPA is supposed to issue a report and then submit a review article to a journal.

Ag & Food Research Initiative has a new Water for Agriculture challenge area; new in 2014, offered in 2015 again. Also have a Climate Variability & Change challenge area.

They are in the fifth year of CAP project funding, will retire this program and have increased funding available for other activities. Bioenergy, Natural Resource, and Environment went from $9 million to almost $13 million.

Dave Mengel arrived during Ray's report.

Ray mentioned that we need to renew the committee this year. Recommends that we start pulling together appendices and so on now.

Ray's opinion for the next 5 years of nitrogen at the federal level is that agriculture needs to step up its game plan with regard to nutrients. How can we dramatically change what happens with nutrients on the landscape? Increase nutrient use efficiency in plant-animal production systems. Think outside the box about how this can be done. Need more than tweaks. New ways to recycle nutrients, comprehensive approach; possibly life cycle analysis of a production system. Change the boundaries of the way we think about the problem. Not just the field—how much nutrient was applied, how much was removed—but look beyond the field to the larger system. Think about nutrients the same way we've thought about carbon cycling. Look at policy options, possible parallels with carbon policy that could be applied to nitrogen or phosphorus. New technologies coming down the line that allow nutrients to be put on later in the production cycle, better job of getting them to the plant when they're needed. He thinks we'll see a dramatic shift in the whole plant-animal production debate, including human diet; possible reduction in meat consumption.

Mike asked Ray about 50% decrease in nutrient loss, suggesting that it can't be done with 4Rs—would targeting be dramatic enough to meet guidelines? Ray said that the 2014 cycle was very disappointing in terms of proposals submitted. Will be difficult to get a 45% load reduction (as in Task Force plan) with current approaches. Politically some groups say we must do it without reducing yield or regulating fertilizer, makes it even harder. What about injecting nutrients directly into plants? Has been done in orchard crops. Interesting new robotics could make it possible—robots pollinating fruit crops in greenhouses. Drones, quarter-scale aircraft show potential. Nanotechnology to change the surfaces of the plant leaf to help scavenge ammonia from the atmosphere? Wants basic science, fits in the foundational program. Management practices also important. Fertigation can increase nutrient use efficiency. Amazed by how much fall application of N fertilizer still happens. He thinks we'll see regulation of nutrients through the Clean Air Act before we will through the Clean Water Act. Looking at all kinds of nitrogen as sources of NOx. Need to have the science in place to help producers adapt. There was a request to reduce N emissions affecting Rocky Mountain National Park, a plan was put in place, agriculture has not come anywhere close to meeting it. Similarly haven't come anywhere close to hitting targets in Mississippi River Basin.

Fabian asked Ray about the place of looking at the more traditional management technologies. Is there room for that? Ray says that yes, there are opportunities and that known BMPs can result in higher efficiencies than our producers are currently hitting. Extension role, promoting more realistic yield goals, better information to back statements and how current management impacts air and water quality. Balance yield with environmental issues. Better job of recycling nutrients, storing them there for the next crop. Get away from replacement---example in water with deficit irrigation scheduling. How much stress can be experienced while still maintaining yield? Better job of recycling what's already there to allow lower applications. Wants to invest in more transformative areas. Changing the microbiology?

Carrie asked whether there are opportunities within the RFAs for coordinated educational programs—multi-state, demonstration projects, getting what we know out to the producers. Associated media campaigns. Ray says that there has been pushback from the Land Grant University system against larger & more integrated programs that would allow states to really work together. Comments submitted as a multi-state group would be more valuable than as individuals and would help them to support this type of effort in future RFAs. Would need input for 2016 RFA within the next several months. In Air Quality program there was a strong provision for integrating efforts over states, based on stakeholder input supporting that. Part of the reason for hosting a workshop/summit is to generate the information and interest to carve out a new Challenge Area in nutrients and agriculture. This would support larger and more integrated projects. Conservation Innovation Grants could be very useful.

State reports

Beatrix Haggard gave the first state report on nitrogen in Louisiana, co-authors Josh Lofton and Brenda Tubana. Producers were unhappy with current LSU N rates, saying they were too low. They had on-farm demonstrations of N rate on corn, N rates from 150 to 225 at 2 non-irrigated sites. Optimal N rates were top rate (225) at one site and 180 at the other, yields near 200. At 2 irrigated sites, rates ranged from 287 to 368 at one site, 200 to 350 at the other. The most profitable N rate was the lowest (287) at one site (225 bushel yield), and the highest (350) at the other site (262 bushel yield). N was UAN injected at V3. Carrie asked about putting N into the irrigation water. And about denitrification loss on clay soils, which most or all of these demos were on. Beatrix says that there is a lot of denitrification. Rhae brought up whether drip irrigation would work, Jack said few people do this and companies doing this are not surviving. Carrie asked whether we might move away from cropping N-vulnerable soils such as clays and sands.

On-station N rate experiments were done at Winnsboro (silt loam), optimal N rate was about 240 but yield was only 120—planted very late. This is one reason why producers are disbelieving of station research—lower yields than they get. LSU recommends 180 to 240. At St. Joseph (clay alluvial soil), yield with no N fertilizer was essentially zero (less than 5), got excessive rain, was flooded after planting, also got 30 inches over winter. Best N rate was again 240, yield again 120.

N source study at Winnsboro gave better yields. Agrotain Urea and Super U appeared to be highest yield, approaching 250 bushels. Lowest were untreated urea, urea with Nutrisphere, urea with Instinct—around 150 bushels. ESN was intermediate. Yields were similar in 2013. Experiment was irrigated. At St. Joseph, not much difference between sources except that plan urea and ESN at the "low" N rate (240) yielded less. Top yields were around 170. Agrotain plus and Instinct with UAN did not help much in a separate experiment.

Josh did a residue experiment, the most dramatic result is that no-till yielded less at the low N rate of 200 on the silt loam station, going to 250 and 300 increased yield of no-till corn up to around 220. Other residue management systems (burned, mowed, tilled, stale seedbed) did not respond to N rate from 200 to 300 and yielded similarly to no-till with 300 lb N/acre.

Another experiment combined cover crop and nitrogen rate (210, 240, 270). Yield was lowest with rye + radish, but rye alone and radish alone were similar to no cover. Yield with crimson clover and winter pea cover crops appeared to be higher (about 220) than with no cover (about 190). With zero nitrogen, rye + radish gave the lowest yield (50), fallow gave 115, crimson clover gave 160. Study followed 5 years of soybean. Radish similar to fallow; vetch, rye, winter pea, berseem clover were intermediate between fallow and crimson clover.

V3-tassel N split gave 212 bushels, all applied at V3 gave 197 on station. No benefit to Agrotain used on N applied at tassel.

Jac Varco gave the next state report from Mississippi. He says producers are pushing N rates up, shooting for very (unrealistically?) high yields. Producers don't want to let him do on-farm work that includes zero-N plots. Showed a photo of zero-N strip, high variability in appearance. In knee- to thigh-high corn, half rate (120) has almost no variability in color visible.

He's working on remote sensing and proximal sensing as tools for managing N. Especially Yara N-Sensor.

Corn N rate test 0, 80, 160, 240. Yield clearly highest at 240, around 200 bushels, starting to flatten out a little at 240. Sensor readings taken when corn is 18 inches tall. Clear trend with N rate for all 3 indices he's looking at.

Working on N stabilizers with injected UAN and broadcast urea. Mostly applied at V3. Not much difference in chlorophyll meter or leaf N, but differences in grain N—higher with split (V3, V5), Agrotain + UAN, Agrotain + Instinct + UAN, lower with urea with or without Agrotain. Grain N was 60 to 85% of applied N. Yield with no N 55 bu. Urea 142, Urea + Agrotain 152, injected UAN 182, no significant differences with any UAN additives or split.

N injected in the middles gave a lower N content in corn. Irrigation water may have caused N loss.

Peter Scharf gave the next state report from Missouri. He started with an April photo showing 7-inch-deep erosion furrows where they had fall chisel plowed, next to a plot with no erosion that had not been tilled and had a rye cover crop on it. The erosion was the result of a 5-inch rainfall in April.

He presented results from a nitrogen and drainage experiment, focusing on the effects of nitrogen treatments. Nitrogen treatments are variable-rate sidedress based on canopy sensors vs 140 lb N/acre applied pre-plant (this is the MRTN rate). Over the past two years, the sensor-based N management treatment has had 18 bushels/acre higher yield, 4.5 ppm lower nitrate in drainage water, and 50% less nitrous oxide production than the pre-plant 140 N treatment.

Peter showed an aerial photo showing severely N-deficient corn fields that he took in northern Iowa in July 2014 and discussed the issue of N loss in wet weather. He showed a Midwest Regional Climate Center map of the area with more than 16 inches of rain April through June 2013, and a trend graph that he developed from similar maps for the period 1900 through 2013. The trend analysis showed that there was no trend from 1900 through 1980, with an average of 80,000 square miles above 16 inches of rain April through June. Since 1980, there has been an increasing trend up to the current average of 200,000 square miles.

Peter finished by showing results from two small-plot nitrogen experiments that he is conducting. One compares 8 different N rate and timing systems in continuous no-till corn. This experiment was started in 2007. In the wet years of 2008, 2009, 2010, and 2013 the three sidedress N systems greatly out-yielded the preplant N systems. Since the beginning of the experiment, the canopy-sensor-based sidedress N system has produced 254 bushels/acre more yield than the best pre-plant N system, and has used 164 lb N/acre less fertilizer.

The second experiment includes 8 different N fertilizer materials and 7 different times of application ranging from April to July. All plots received a single application of N at a rate of 140 lb N/acre. In 2013, fall anhydrous ammonia (October or December) performed poorly, yielding barely more than the unfertilized treatment. All N sources were applied in February, April, May, and June. Across N sources, yield was 20 bushels/acre higher when N was applied in June than when it was applied in May, and 49 bushels/acre higher when N was applied in June than when N was applied in early April. Spring of 2013 was wet and clearly a lot of N was lost when applied far in advance of the main crop N uptake months of June and July. In 2014, there was not much difference in yield between April and June application timings, but yields were 30 bushels higher for April applications of dry and liquid N fertilizers than for February applications of the same fertilizers.

Mike Castellano gave the first state report from Iowa. He focused on nitrous oxide production from corn-soybean. N was injected UAN. N rates of 0, 135, 225 were used on corn. Nitrous oxide emission from corn was higher than from soybean in 2011 and 2013, but not in 2012 which was a dry year. N rate affected nitrous oxide production in all 3 years. Nitrous oxide with N was considerably higher than without N. In all three years, nitrous oxide was higher with 225 kg N/ha than with 135, but not significantly higher when evaluated with ANOVA (likely would have been higher with regression) and not proportionally higher. There was discussion about how this contrasts with a number of reports in the literature showing that nitrous oxide usually increases linearly with N rate, and quite often more than linearly. In 2013, nitrous oxide emission from soybean was higher in plots that had received higher N rates in the previous corn year.

A firestorm of discussion ensued about how corn-soybean systems in Iowa can be managed to limit nitrous oxide production and nitrate in drainage water.

Mike showed paired watersheds with gas flux measurements and wells near the outlets—one was all corn, one all grassland, a third has 10% grassland near the outlet. Corn had the highest nitrous oxide emissions, but the lowest N2 emissions. Corn shifted the denitrification end-product to nitrous oxide—total denitrification was not different between cropping systems. Mike thinks that more carbon in the grassland systems pushed the denitrification farther to produce N2 because there wasn't enough nitrate to serve as an electron acceptor if it stopped at nitrous oxide. He said that the corn system N2 production is carbon-limited and Rhae said "WHAT?!"

Dave Mengel gave the state report for Kansas. They have focused some effort on N timing for corn. 2013 slightly higher than normal rainfall at Partridge, loam soil with sandy subsoil in southern KS, but 3 events of 2 inches or more. Also 8 irrigations. N timings were planting, V4, late V10, early R1. 154 bushels with starter N only, despite

only 30 lb mineral N in the top 2 feet. Top yield 192 with 60 V4, 120 R1. Other treatments in top group: 60 V4, 180 R1; 180 V4; 60 V4, 130 R1.

Same expt 2014: consistent rainfall first 60 days, mostly 0.5 to 0.75 inches, but yields 128 or less; 85 with only starter N. Best yields are with all N at V10.

Rossville near Topeka in Kansas River valley also has loam over sand, but has some clay lenses at 2-3 feet that perch water. Presence or absence of clay lens is huge factor. 2013 2.2 inch rainfall on May 26. Irrigation starts about V14. Yield with zero N was 194 bushels. Top yield was 239 with 120 at V4. Seven treatments in top group from 230 to 239. Sensor said put on zero at R1 when it had 60 at V4, gave 230 bushel yield; highest net profit in test.

In 2014 top yield was 197 with 20 starter, 60 V4, 180 R1. Yield with 20 starter only was 97. Other yields in top group were: 175, 20 starter and 180 early; 188 with 20 starter and 180 V10; a few others I missed.

At Scandia irrigation comes from surface water ponds. Top yield 233 with 20 starter 60 V4 180 R1. Yield with starter only was 160. Others in top group: 229 with 20 starter 120 v4, 230 with 20 starter 180 V4, 229 with 20 starter 180 V10, 223 with 20 starter 60 V4 120 R1, 225 with 20 starter 120 V10.

Fabian Fernandez gave the state report for Minnesota. Studying drained vs undrained. Drainage in place since 2011. Intensive soil nitrate sampling before fertilization. N rates 0 to 200 by 40 on corn, also 40 pre + 80 V4. Also 120 pre on corn and 40 on soybean. N2O emisssions measured in check, 120 pre, 40 pre + 80 V4. In situ mineralization measured on check (corn & soybean), 120 pre on corn rotated with 0 on soybean, 40 pre on soybean. 2014 EONR drained is 148, yield 187 bushels; EONR undrained is 127, yield again 187. Yield with 0 N is about 145. Soybean yield 65 bushel no N, 60 bushel with N at any time (+/- 1 bushel), significantly lower than with zero N. No effect of drainage on yield.

Mineralization much greater in undrained than drained. Conditions were wet. By late August, mineralization 322 undrained, 99 drained in corn with 120 N; 88 undrained, 22 drained with 40 N on soybean; 29 undrained, 13 drained on corn with 0 N; and 15 undrained 4 drained on soybean with 0 N. They saw a large priming effect from the fertilizer they applied.

Undrained had about 5x the nitrous oxide flux of the drained. Single preplant N application also resulted in more nitrous oxide than split application. Split application also had lower fall nitrate than preplant. Fall nitrate went up steeply from 160 lb N to 200 lb N applied. Also quite steep from 120 to 160 in undrained, less so in drained.

2014 they had 6 sites searching for best sidedress N timing. Three sites had linear yield responses up to the highest N rate used. Becker is a sandy site, 40 bushels with no N linear up to about 100 or 110 with 300 lb N. At V4 had about 80 lb N/acre in the 2nd foot, over 200 lb N/acre in the top foot. Pre-plant N sources at 120 lb N/acre, best was NH3 + NServe to 130. Timing urea with Agrotain, 40 pre + 80 V8 gave almost 150 bushels. Even 40 pre + 80 V4 apparently had a lot of N loss, N limitation, and lower yield ~110. Took 2-foot soil samples 4 times (V4, V8, V12, R1), each time only the most recent (or 2 most recent) applications had elevated soil nitrate & ammonium.

Lamberton same design. Relationship between yield and chlorophyll meter get much better as season progresses (rates of preplant N). Highest (240) N rate is still there at R1 from preplant N treatments, unlike Becker site. NH3 + N-Serve best N source at 120 pre, about 145 bu (same as Becker).

Another new study, ESN 180 pre or ESN 60 pre + urea 120 V4 highest yield at 160. Will have drainage but no data this year. Urea 180 pre or split gave 150 bushels. Split applications tend to have higher soil mineral N.

John Sawyer gave the second state report for Iowa. He has compiled results from some different N timing studies on corn, and effects on yield.

30 strip trials 2004-2006. 120 pre vs 60 pre + sensor V15 followed by N between V15 and R1—average total N was 115. Yield was 192 all pre, 185 with 60 pre + 55 near tassel.

2009 study near Ames, preplant ammonium nitrate or SD UAN dribbled yield response curves pretty much lie on top of each other.

2010 opt N rate was 190 and sensor did a good job of identifying that, but still preplant and sidedress response curves lie on top of each other. Wet year but preplant did fine.

2012-2013 preplant or split response curves again lay on top of each other.

2007-2009 N rate & timing for anhydrous ammonia, fall ammonia response curve fell below preplant and sidedress (caught up at high N rates), which fell exactly on top oof each other. 2014 two sites, both preplant and split fall on top of each other and opt N rates are essentially the same. Near 10 inches of rain in June at both sites. Splits had 40 at planting and the rest at V9.

Gyles, Larry, Randy had a N timing study in late 90s, dominantly no yield differences based on timing.

Jim Baker ran fall through July and saw differences based on timing.

Fred Blackmer: yield difference between two sidedress N rates, higher N rate was more beneficial in wetter years.

Fabian commented that later N timing was a benefit only on sandy soils in 2014 in Minnesota, and saw same phenomenon in Illinois.

Will Horwath was unable to attend in person due to flight problems when he reached Denver, but called in to give the California state report. He volunteers to help write the renewal.

Solvita is promoting a test together with Rick Haney. Will is evaluating the test. Interested in whether it can really predict N mineralization. Lots of other soil tests have been tried (and failed). Basis of Solvita/Haney test is soil respiration. $R2 = 0.67$ between carbon mineralized and N mineralized—not linear, N mineralization stops going up at the same rate per C min at the high end. But non-linearity likely to be climatic differences. Wet vs dry, warm vs cold gives 4 quadrants, linear in each quadrant. Highest warm & dry (Texas) or cold & wet (Maine) while lower for cold & dry (Alberta) and warm & wet (Georgia). Strong correlation on 1 soil with manure between 1 day CO2 and 28 day N mineralization.

Fabian calls the Haney test machine the 'random number generator' in his lab.

Took lots of samples from four prime California ag regions, put them in a study. Measured CO2 produced at 6, 24, 72 hours, inorganic N mineralized at days 28, 56, 105, main test at 55% water holding capacity. Total 169 fields; 93 conventional management. Overall near-zero correlation ($r2 = 0.11$) between N mineralized and C mineralized; best with organically managed sites, but still poor. Adding dissolved organic carbon improved the relationship, but still not good. Location across an aridity gradient has a highly significant effect on N mineralization across time.

Cumulative respiration 72 hr was highly dependent on soil water content—usually peacked at 75 to 100% of water-holding capacity, lower either side of that point.

Rhae says that her student (who works for Ward Labs) is looking at Haney test in two long-term trials.

Rhae Drijber gave the state report for Nebraska. Experiment at semi-arid site. How did microorganisms respond to 6 hybrids under 2 water conditions (well-watered or water stress)? More arbuscular-mycorrhizal fungi in water stress environment, also actinomycetes. Different community structure between water status. Based on fatty acid profiles found in the soils. Discriminant analysis also shows clusters by hybrid.

Carrie Laboski presented the final state report—for Wisconsin. Two locations in southwest Wisconsin, Stuben and Wauzeka. Full set of N rates preplant or split. At

Stuben, EONR is 92 pre and 70 split, yield at EONR is 212 pre and 205 split. Soil is dark color at 3-4 foot depth. At Wauzeka, EONR is 124 pre and 106 split, yield at EONR is 202 pre, 199 split. Not tested for significance yet.

Lancaster N timing study with various rates pre, sidedress 18 inches, and pre-tassel. Total 25 treatments. Loess-derived silt loam. Same study at Marshfield, somewhat poorly drained silt loam. Carrie thinks it's actually just poorly drained. Typical N need at Marshfield is 120. Pre is urea broadcast & incorporated. Planted in May.

Lancaster yield lowest (192) with sidedress only. Preplant only next at 204. Pre + sidedress at 18" 208, Pre + pre-tassel 213. EONR values were high for Pre + in-season (both).

Marshfield sidedress only is again lowest—179 at EONR. PP + sidedress is 182, PP + late is 187, pre only is 194. EONR values are higher for pre only & pre + late (> 200), 160 for sidedress or pre + sidedress.

Next meeting

March 8 and 9 2016 is available with the hotel, government per diem rate at hotel of $106. Would allow Mike to do the Big 12 men's basketball tournament following the meeting. Meeting room will be $325 + tax. John has obtained a contract from the hotel for these dates.

Proposal renewal

We started by discussing the 3 objectives of the existing project. These objectives were tied to an AFRI CAP proposal submitted by the group in 2010 and were tied to 15N work and an ambitious research agenda.

Adding a new objective about understanding soil N mineralization was discussed and agreed on, as was a new title focusing more on nitrogen fertilizer management. The management practice objective was modified to tie it to geographic & climatic variability. Wording was streamlined for all objectives.

Renewal is due by September 15. Carrie suggested an internal deadline of August 15 for the final proof—draft should be sooner to allow comments and suggestions from all members. Carrie says that Will volunteered to assist in writing the renewal, and that she is willing to work with him to produce the first draft. Dave Mengel suggests that all committee members should commit to which objectives they will participate in by April

15 and let Carrie know, so that Carrie and Will have that in hand as they develop the renewal proposal.

Nitrogen Use Efficiency paper proposed at last meeting

We went through the list of measurements identified at the last meeting and noted which of these measurements are essential to support the analyses for this paper.

It was decided to produce a template for members to use by July. Fabian will take the lead on producing this template. December was agreed on as the deadline for members to populate the spreadsheet with their data. Fabian will then compile the data from different states. At the next meeting we will discuss how to analyze the dataset and who will do different parts of the analysis.

Nitrogen timing practices

Peter brought up his informal surveys which showed that less than 5% of corn fields in Missouri received N after planting in 2010 despite excess rain and widespread N deficiency, but that 3 similar surveys in 2013 (the next year with excess rain) gave results ranging from 35 to 50% received N after planting. He thinks that use of in-season N applications on corn has gone up dramatically and asked whether others are seeing this. Minnesota survey—Fabian says that their survey from 2 or 3 years ago showed 9 percent of corn producers used sidedress application of N. There were about 4% more who used a split N application. He thinks the numbers are going up. John concurs that the number of people using in-season N is going up, but he has no idea of what current levels are. Carrie says that there is a little more going on at sidedress time in Wisconsin. She says that sometimes people are calling it sidedress even when they apply all of the N when the corn is only a few inches tall. Dave Mengel says that they have a lot of data showing that even this 2 to 4 week delay of N application can make a big difference, and Peter agreed that he has similar data.

Beatrix reports that for Louisiana, consultants recommend N rates above those recommended by the LSU Ag Center. But all of the producers said, in an LSU survey, that they were following LSU Ag Center recommendations. Normal timing there is to put all on at V3 or possibly put some on at tassel. In general any tasseling applications in LA and MS (per Jac Varco) are in addition to their earlier N—they don't decrease early N applications if they choose to use N applications at the tassel stage.

Market forces and N management

Peter, Dave, and Carrie are going to a meeting about the FieldPrint Calculator tomorrow, which is motivated by a desire to document the environmental footprint of agricultural fields in response to consumer/market pressure. We discussed the larger situation.

Dave Mengel got a call from a woman in Florida who found his picture on the Adapt-N website. She was at a big commercial bakery and they were under pressure from Wal-Mart to provide baked goods that had been produced with minimal greenhouse footprint. He's doing a small project for them using sensors to guide N rate for wheat, with the understanding that it could expand dramatically if it looks promising. Dave thinks that WalMart is doing this to target the urban areas and more sophisticated customer groups. Beatrix says that Kellogg is after the rice farmers in Louisiana to be sustainable for their breakfast cereals, and Wal-Mart wants the same from the cotton farmers for their T-shirts.

Carrie was part of a panel discussion about water & nutrients organized by Pioneer. Another panelist was from Coca-Cola, they use a lot of water and are sensitive to the perception about the quality of the water that they use. Peter was curious whether they're worried about nitrate in the water at their bottling plants. Carrie says she thinks they want to be more sustainable and since corn is a main ingredient, growing corn with better N management should reduce their greenhouse footprint.