

Implementation of Video Image Analysis Technology for Beef Grading Augmentation
Glen Dolezal

[1]Our next presenter is Dr. Glen Dolezal from Cargill Meat Solutions to discuss implementation of video image analysis technology for beef grading augmentation. Glen joined Cargill in 1999 as their Director of New Technology Applications, and his current responsibilities involve research and development support for procurement operations and marketing, corporate beef grading oversight, and beef tenderness commitment. Help me welcome Glen Dolezal. Thank you very much Deb. It's a pleasure to be here and to be invited to participate in this, and I'd like to represent a little bit following Eric on some topics relative to the pork side, share with you some of the things at least that we're doing and that we are seeing the beef industry doing as well. The common theme here, and you heard Eric say it first, is the same old standards. Well, fortunately, later on in this program today, we have the Chief of Standardization. We are happy to say that on the beef side he is changing some standards and moving us forward, and I think Marty is going to share that with us. Let's see if we can try this from back here. You bet. I think it's going to work.

[2]I've been with Cargill now for about seven years, and I think the company - and back in my Oklahoma State tenure, we were asked to do some cutting tests and so forth with them relative to instrument assessment, but Cargill has utilized some form of instrument grading on the beef side for over fifteen years. The most recent version of instrument grading is the RMS system that many of you are familiar with. We install that in all six of our major finished steer and heifer North American plants as of May of 2000. So, that should read, on the next line, that for the past six plus years, not just five, we've used this full vision-based, full-color instrument to obtain key measures at the time we present carcasses for grading. So, we focus primarily on the cold camera, the one on the rib-eye, twelfth to thirteenth rib interface. We started or Cargill started with the hot camera as well that took an image of the hot side as it departed the harvest floor. Really, that knowledge was developed in High River, Alberta, in the Cargill plant in Alberta, and at that point in time, in the Canadian beef industry, there wasn't an abundance of fat, especially whether it be marbling or external fat, and so, you could get quite a bit of contour or confirmation and shape with the hot camera. We found, since then, particularly in applying that in the United States, that we account for the vast majority of all the variation we want to for endpoints or trades of interest using the cold camera. So, we discontinued the use of that particular device.

[3]This is actually the RMS camera as we have it set up in our Schuyler, Nebraska, facility. This lady happens to be our first shift operator. North American wide, we collect over twenty-seven thousand images daily. Our success rate averages ninety-seven percent. Our goal for this fiscal year, which started in June, is to get ninety-eight percent or more of all carcasses that we present for grading viably scanned. That is an error-free scan relative to the vision system, but you can see that it gives you a wealth of information relative to rib-eye size, relative to external fat cover, relative to lean and fat color, marbling amount, distribution, and numerous other factors.

[4]To be able to pull this off again, we rely a lot upon the assistance of our Systems Team, and Bruce Winegar is our key individual. He's actually in the audience here today, but he has developed a wealth of information that we gather and marry to these images. He has also developed a tool that if we mistrace rib-eyes we can actually retrace them offline electronically using computers. Now, Bruce allows us at Cargill to store these J-peg images for about two weeks, and then, we purge them, but we save all of the numbers that we collect from these images forever in our data warehouse, and we link that back to the feed yard, back to individual... I.D. numbers, back to our individual buyers, individual plants, and the list goes on. So, it's a very powerful tool relative to a mass of data collection.

[5]We feel that's important to link up as we go to individual animal I.D. in the beef industry and so forth. We patented the radio frequency approach to identification in our plants going from harvest through and up to..., and so, that's a

primary linkage that if we do get cattle with electronic I.D. ear tags, we can link that with our RF system and attach vision data and so forth to it, and so, it's a very important tool as we move forward for data flow, both pre-harvest and post-harvest, whatever the need may be. Bruce also developed a tool for us that we call a tagger screen. This is in time with all the carcasses as they move by our grading stand, and so, our taggers get key information to base their sorting decisions upon relative to carcass weights, relative to rib-eye sizes, relative to lean color, minimum marbling amounts, and we have found that once you develop this particular tool it helps us tremendously reduce the errors in sorting accuracy that we have in our plants, and so, it's a key step to bring sameness relative to achieving comparable composition of brands that you offer in the marketplace relative to the industry. It's a big, big tool.

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[7]At Cargill, we have a high confidence in vision grading technology, and I can't say this strongly enough, but we feel - we feel so convinced and strong about vision technology that we manage our beef business each and every day of operation off of this information. It's very, very key. We look at fat yields. We look at buyer performance. We look at a lot of things. We can slice the pie finely. Do we look at the USDA grade mix? Do we look at our premiums? You bet we do. Do we look at discounts? Yes, but within your Grade 3, within your Grade 2, within choice. We rely upon instrument technology to give us more details to make refined calculations and to base decisions from. Obviously, we use it for most all qualitative and quantitative traits. There are exceptions. It can't replace the humans. If it would do that, we'd remove our taggers today. We employ as many taggers in all of our beef plants as we do USDA graders, and that's an expense as well, and so, accordingly, there are certain traits, again, that you just don't pick up. You've got to catch those outs, and so, we really think of it more as a tool to help augment decisions, whether they be our own or USDA's, and that's the way that we want to move and the way that we want to promote it.

[8]Let's look at some of the uses. We assess carcass merit for individual feed yards, ranches, and even lots within individual feed yards. There is not a week that goes by each year that I don't get an email or a phone call from Deb at Oklahoma State or Ty Lawrence at West Texas A&M or the University of Arkansas Extension Steer Feed Out, and the same thing at Oklahoma State or some other university or researcher or producer looking for individual data related to the camera on cattle that they are interested in, and that's great. Our stance on that is if the cattle are individually identified, we don't mind sharing individual carcass data with you. If you don't have them individually identified, why share the individual data? We'll give you the lot average. To really add meaning to it, we need individual I.D., and so, that's really the demand that we usually make. We just finished, on Thursday and Friday, with our Annual Cattle Buyers' Meeting. We have fifty buyers in Wichita, and we set new goals, targets, scorecards for them this forthcoming fiscal year, and so, we use this vision camera as a performance scorecard for each of the buyers. They are forced to estimate the percentages of vision yield grades; one, two, three, four, five, not USDA, vision. We hold them to vision marbling, and so, we are moving to that as far as detail, and I'll try to explain some of those opportunities to you later in the talk. We measure opportunities for each of our beef plants. Are you holding enough re-grades; the right re-grades? Are you sorting correctly in the boxes? We track accuracy, repeatability, and sameness on ninety-seven percent or more of all carcasses that we present to approximately fifty USDA graders that operate in our facilities throughout the year, and so, we scorecard each individual grader. There are fifty in our plants in any given day, but the rotation system that the USDA has in Kansas is the worst. You've got a revolving door of grader rotation, and that's why the number jumps up more and reaches fifty. We manage our fab floor yields based on detail measurements from these cameras. So, we like to know fab yield expectations for every tenth of a vision camera yield grade, not a whole yield grade but every tenth. There is a lot of noise in averages, and so, he can slice the pie more finely. It's a neat way to do it. It's a neat way to separate carcass performance, expected performance from workmanship knowing the weight of products that are

generated each and every shift in the boxes that are weighed at the other end of the floor, and last but not least and a very important point, it enables us to offer unique and progressive solutions through our branded beef programs for our customers, and we think that's a strong wave of the future and something that's needed.

[9]Being a member for quite some time of AMSA, I knew I better show a little data, not just some word slides and some theory or some background, and this is one week's production, one week in April in two different plants, and I've denoted them Plant A and B. A is kind of in the south. B is sort of in the north of the United States, but I want to show this example relative to data that we try to look at, data that we try to measure in things that as an industry we want help on to move forward with technology. Plant A harvested and graded twenty-five thousand six hundred and four head that week. Plant B worked one day less, and they had about eighteen thousand carcasses. This is the average adjusted percent marbling relative to the camera. Yes, you could do it with a marbling score, and that's where the camera companies are moving with the help of standardization, but that's like an ether extract. So, there was two point four-seven percent marbling in Plant A; two point eight-eight in Plant B. The log average would tell you, hopefully, Plant B graded more choice in prime than Plant A. If you draw a line in the sand using this somewhat trend of an ether extract, the camera would have estimated Plant A to grade forty-seven percent and Plant B to grade just shy of sixty-five percent. What was the actual performance by USDA graders, and again, we cleaned the data up for L* values relative to color. Our taggers are to designate correctly for hard bones and other things. So, you remove those outs from this database, but in Plant A, they actually graded forty-one point one percent. Plant B graded seventy point five. So, we felt that Plant A's performance was at a six point three percent disadvantage on choice or higher. Plant B was at about a six percent advantage, and I think that's the theme to take from this. If we went to total instrument-based or instrument-augmented grading tomorrow, we really feel that it's going to be a wash. In certain areas, we are going to back up. In other areas, we are going to move forward, but the important point is that it's going to be consistent throughout, and that's where we want to get. So, not a good report card for Plant A compared to Plant B. What about the carcasses that were in disagreement? Disagreement is a two-way street. Some the camera thought was lower than graded and some the camera thought should have been graded higher than were actually graded. In Plant A, that was a little over four thousand head; Plant B, three thousand head. So, let's say twenty percent, either up or down. If you use the choice select spread of eight dollars per hundred, which today is a laughing joke, it was twenty-three dollars per hundred yesterday. So, multiply the economics here by about three, but twenty percent in disagreement. The dollars per head, assuming an eight weight carcass, is about a twenty-five dollars disadvantage in Plant A; forty-four dollars to the good in Plant B. If you extrapolate that to all head presented for grading, you are talking about either four or nine dollars per head. You are talking about hundreds of thousands of dollars, and again, this is just two plants, just a week in time, and so, it's very, very important, and as that choice select spread, as we said, today is twenty-three dollars per hundred, it's huge, and so, you've got to stay on top of it, and that's why packers employ taggers and everything else.

[10]Here are the graders during that week in Plant A, and A-1 is Plant A. One is our electronic coding for that grader all the way down to grader number thirty, but that was the USDA personnel in that plant in any given week. The second column is the number of head presented to them for grade assignment. The third column is the average vision marbling and the standard deviation of the cattle that was presented to them. Then, you have the vision camera estimate of percent choice, the actual USDA assignment of percent choice, and the last column is the difference, and so, as you go through the list, you see that there were some graders - Grader A-1, one of my former students - no, unfortunately not. They are more hard-headed, but Grader 1 aligned perfectly with the instrument, but then, you also find examples of an eight percent above the camera on the second to the last row all the way up to a grader that was eleven percent less than what the camera would have predicted, and again, these things aren't perfect, but when you are talking about thousands of observations here, the trends are very strong, and yes, every one that is two point

five percent marbling may not be choice, but when you add a thousand records, there is a very strong trend line that you need to pay attention to, because it tracks quite well with opportunity. It tracks quite well with actual results. So, I think it's appropriate for this audience. How many of you have ever graded beef, either on a judging team, taught it, whatever the case may be? Let's see a show of hands. I thought this would be appropriate for this audience. Eleven USDA graders or personalities in one plant, in one week, very similar to an AMSA inter-collegiate meat judging contest, and you go down the quality grade rail. The scores vary. Not everyone agrees. It's tough. I'm not saying this is easy, and I'm not saying it's easy for USDA to achieve sameness with their personnel, but it's important relative to delivery. It's important relative to economics. It's important relative to producer feedback.

[11]Plant B; a lot more black, a lot less red on the right-hand side, but again, it varied. Graders B-3 and B-4 had the same amount of marbling, and they varied - the variation in that was a little different, but you notice the camera estimate of percent choice was within one point seven percent, sixty-two one and sixty-three eight, and look, that was two graders quite despair, sixty-five percent versus seventy-three on what they actually popped for the grades, and so, you do get variation that you need to manage and that you need to have actions around and work with USDA to try to solve.

[12]In the industry, we get a lot of reports, whether it's on the government website, whether it be in data shared with cattle sold on a grid or an alliance. This is the average grade for that week for Plant A, and you can see that there is pretty close agreement in choice and select. At the bottom is what the camera would have estimated. The color of the bars then reflect prime through ungraded or no rule that USDA would have hit, and you can see, yes, you get some give and take along the choice/select line. The camera had a few more called choice that the USDA put into select. The camera had some select that the USDA put into choice. It's important. We only scan the lean side of each carcass, and if the trailing side is higher, you would expect some upgrading, and so, it's, again, not a perfect world. There is a little more disparity on the ends. That's human nature. The camera found more prime than were actually stamped, and the camera actually found that we've got a pretty stringent no rule line or select no rule line, and so, you see some disparity there.

[13]Number of head; that translates into thousands of carcasses that have to be reworked for regrades, resorted for fabrication destination codes, things like that. So, it can have a huge impact relative to operations.

[14]The second leg of that is the red meat yield component, and again, we tend to talk a lot, whether it be in a national beef quality audit, whatever the case may be, on averages. You'll notice that there are fewer head in this. We don't assign official USDA yield grades to carcasses that grade below select, and so, that's why I have a reduced number here. I will only use the select or higher carcasses, but you can see that there was agreement on the absolute mean percentage of Yield Grade 2 between whether it was stamped by USDA or called by the camera. USDA found a few more threes than the technology. It was very comparable on fours and fives, and I think it would be a mistake to say that in the last three years the USDA had to work hard on getting more accurate on yield grade assignment, particularly on fours and fives, and you've seen that trend upward to... or more now what the National Beef Quality Audit. We still see a lot of opportunity on the other end; Yield Grade 1. We tend to underestimate ones, whether it's because of the rib-eye carcass weight relationship or the initial few YG.

[15]Here's Plant B. Plant B has historically been a Yield Grade 3 plant. Human nature, get to the middle, don't venture out onto the extremes too much, but again, you see a little more agreement here than you saw on the qualitative side.

[16]Don't be satisfied with just mere percentages. When you break into the devil - the devil is in the details. At the bottom is what the camera would have assigned as a Yield Grade 1, and you'll notice that there is some noise. About forty-five

percent is what the camera called one and the USDA called one. Fifty percent they called twos, and some they called threes. So, you see variation within each of those on placement. Is it perfect? No. This is assuming a blanket KPH; two and a half percent with the technology. It's not adjusting for back fat rigorously, but again, it's a trend line that you need to pay attention to, because you have variation in that trait as well.

[17]Here's Plant B. You see similarities again. Yield Grade 3; pretty strong agreement between the technology on actual percentages and the correct placement of carcasses, and you see more noise as you go to the tails relative to variation and yield grade placement compared to the technology.

[18]So, in those two plants, for that same given week in time, the camera, going to two decimal places relative to yield grade assignment using a standard two and a half percent KPH, would have shown that the USDA, using whole number recorded yield grade, would have been about a third of a yield grade less on the USDA mean compared to the camera mean. If you look at the carcasses that would have moved across yield grade lines and you're buying, in any given week, let's say, in our example, it could be up to thirty percent of our harvest based on committed supplies that are paid based on some carcass merit grid or value system off of those decisions, you can see that about twenty-six to thirty-two percent were in disagreement just using sort of a standard grid price of a three dollar per hundred premium for Yield Grade 2 carcasses, four dollars for a one, and some discounts of sixteen and twenty-five for fours and fives. It's almost a wash at a dollar eighty negative in Plant A to a dollar eighty positive, and it's important, because when you feel questions from suppliers that want to sell based on carcass merit because they've invested a lot in genetics or management, and maybe they only have one pen of cattle, fifty head, and they bring them to you the first week of May every calendar year, and last year, they graded sixty-five percent and two percent Yield Grade 4s, and they come back this year, and they grade thirty-five percent, and they've got twelve percent Yield Grade 4s, and they lost a bunch of money. We feel those questions each and every day, and I'm not saying that they always point to the plan, "How did you chill those? Did you hold regrades?" Everyone is looking for an out, and all I'm saying is that it's important to progress. It's important to major producers who want to do the right thing in the industry, and it's why we need the help of instruments to be able to pull that off, and by the way, all of the quality examples there, that's not even getting to premiums. That's not even getting to certified angus beef or angus pride or sterling silver or any of the other brands that are available, but it's a lot of money, and it can have a huge impact.

[19]well, I want to leave you with a couple of slides relative to some food for thought. I think, often times, you can sort of view things in similarities. Beef grading today is somewhat similar to a shotgun pattern in that each grader has individual preferences, just like we do, for differences in marbling texture or the distribution of marbling, the impact of the color of the lean, carcass maturity, or the yield grade factors. In the center of the pattern, the results are good, when you look at near averages just like we did here this morning. As industry, we feel strongly that we need a laser instead of a shotgun to augment current USDA quality and yield grade assignments and to improve the value determination of carcasses in the beef industry. Moreover, we can't stop here. Just like Eric said, it's the same old standards, and I think you'll hear Marty echo the same thing. We must continue, and we need AMSA scientists to continue to explore other technologies to measure more directly the attributes of meat palatability that are important to our consumers, whether it be in place of or in conjunction with marbling. We think that's very key.

[20]So, relative to Cargill Meat Solutions, we fully support the implementation of instrument-based grading and carcass merit assessment to improve the sameness of USDA grading between states or regions in the United States, among plants within the same region or state, between shifts within plants, and among individual graders within the same shift. We fully support the USDA Meat Grading Standardization Branch and Certification Branches as they move forward to test these technologies and to help us bring it to fruition. We think that's going to be key. We

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appreciate the efforts of all of the scientists in this room and the students that are continuing to help the industry conduct tests to be able to measure this and to help move it forward, and we are looking forward to the day and hope that Marty can get us there by the end of this calendar year.