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Precision Agriculture: Using Technology to Increase Northern Bobwhite Populations and Farm Revenue

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In a landscape dominated by tall corn and lush soybeans it's not always easy to point out the most productive land from the least. In fact, field productivity (i.e., crop yield) is highly variable for many of reasons. It is usually easiest to see near field edges. We've all seen shorter crops near a tree line or next to a turn row. It's a no brainer that the yield is often lower in these areas. But what's not so obvious is how much lower. Any farmer worth his salt can tell you where the best and worst areas of his fields are but it takes a little help from technology to put a number on it and assign an economic value. Precision agriculture technology can put a dollar sign on how much revenue is lost on marginal farmland and show how profitability varies spatially. Researchers at Mississippi State University (MSU) have gone a step further and used this technology to simultaneously increase farm revenue and bobwhite populations through informed conservation practice delivery.

Figure 1 – Northern bobwhite (Colinus virginianus) male.
Photo credit: Mark McConnell

Historically, northern bobwhites (Figure 1) and agriculture went hand in hand. Fields were smaller, farmers left the margins near tree lines idle, there were more weeds and more bugs and quail thrived in this utopian, early successional environment. We've all heard an 'old timer' talk about hunting hedgerows and field edges around agriculture fields. It wasn't that long ago that some of the best bobwhite hunting in the southeast was in and around the margins of crop fields. Of course, things are quite different now. The fields are larger, everything is planted, weeds are controlled, and we've become particular good at growing productive crops and nothing else. Feeding a growing human population doesn't come without costs. But intensive agriculture also comes with better technology and the opportunity to farm more efficiently. Ironically, the same technology that we use to increase agricultural productivity can now be used to increase bobwhite populations.

Figure 2 – In-cab precision agriculture system. Photo Credit: modernfarmer.com

From soil maps to variable rate applicators, precision agriculture can easily be described as using technology to farm smarter. Add to that a combination of global positioning systems (GPS) affixed to combines with yield monitors and an in-cab computer and you've got the most efficient, advanced farming system known to man (Figure 2)!

This technology allows farmers to identify low yielding areas and apply just the right amount of inputs in the right places to maximize yield, reduce inputs and time, therefore reducing cost. But there are often areas of a field where yield is consistently so low that it is not profitable to farm, given the costs of inputs. In fact, on many of these areas the farmer may be losing money by farming it. These low yielding, revenue negative areas provide an opportunity for bobwhite restoration in landscapes dominated by production agriculture.

Of all the tools in the arsenal of precision agriculture technology, one is particularly useful for bobwhite managers: yield monitors. A combine with a yield monitor and a GPS can change the way we manage quail in agricultural landscapes. Here's how it works. As the combine harvests grain a GPS unit records the exact location of grain yield (bushels/acre) in the field, illustrating where and by how much yield varies across a field (Figure 3).

Figure 3 – GPS yield monitor collecting spatially explicit yield data. Photo credit: innovativegis.com

This yield map is the first step to identifying potential habitat for bobwhite. But yield doesn't tell the whole story. By accounting for the cost of production (e.g., seed, fertilizer, diesel, labor, time, etc.) and the commodity price ($/bushel) we can figure out how profit varies across a field. We then create a profitability map (Figure 4).

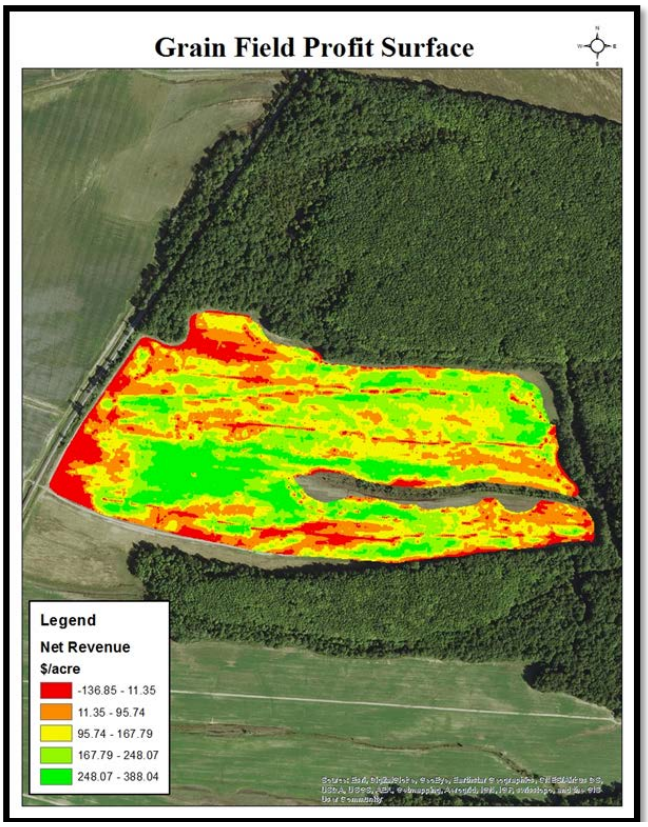

Figure 4 – Profitability map illustrating variable revenue on a grain field.

Now, instead of just seeing how yield varies, we see how *profit* varies across a field. As you can see in Figure 4, some areas of a field, often near the edges, farmers are actually losing money. This can be attributed to soil type, soil compaction, and competition for sunlight, water, and nutrients from adjacent forests. Often this ground is reducing the overall profitability of a field. Now that we have identified where the least productive ground is, we can develop a way to increase the economic potential of these areas and the field as a whole while also creating bobwhite habitat. Fortunately, the United States Department of Agriculture (USDA) offers several conservation programs, administered by the Farm Service Agency that pay landowners a rental fee to establish herbaceous field buffers and provide extensive cost-share assistance for establishment and maintenance (Figure 5).

When you consider the money saved from not farming low yielding areas and then add to that the rental fees and sign-up incentives for establishing buffers, the profitability of a field can actually increase by farming less acreage. The idea of increasing farm revenue by farming less acreage, while also increasing bobwhite populations is novel but relatively simple.

Researchers at MSU developed an approach that uses precision agriculture technology to evaluate the economic opportunities of different conservation buffer widths on field profitability. They also looked at how bobwhites respond to this new habitat in the landscape. They used Conservation Practice 33, Habitat Buffers for

Figure 5 – Conservation buffer established on low yielding field edge. Photo credit: Wes Burger, MSU

Upland Birds (CP-33) for this research because it was designed specifically to restore bobwhite populations in agricultural landscapes. Their results were pretty exciting! They found that by targeting the lowest yielding field edges with CP-33 buffers, the profitability of the whole field went up.

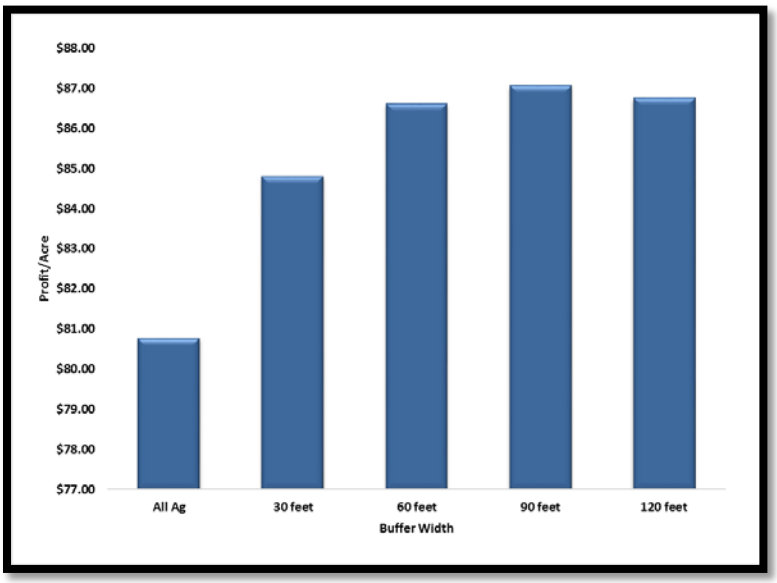

Figure 6 – Economic advantage of different conservation buffer widths on a soybean field.

Obviously, commodity price has a lot to do with profitability, so they measured field revenue at a range of prices to look at multiple scenarios. For the average corn and soybean prices farmers are facing today, the potential to increase field profitability with targeted conservation buffers exists (Figures 6 and 7). It is very important to point out that the largest buffer scenario did not always produce the highest profit.

This is because most low yield areas are generally near the field edge and as you move closer to the middle of the field, yield and profit goes up. Therefore, at some point, the middle of the field is more profitable than the field edge with or without a buffer. Establishing a conservation buffer in such areas would reduce the profitability of the field.

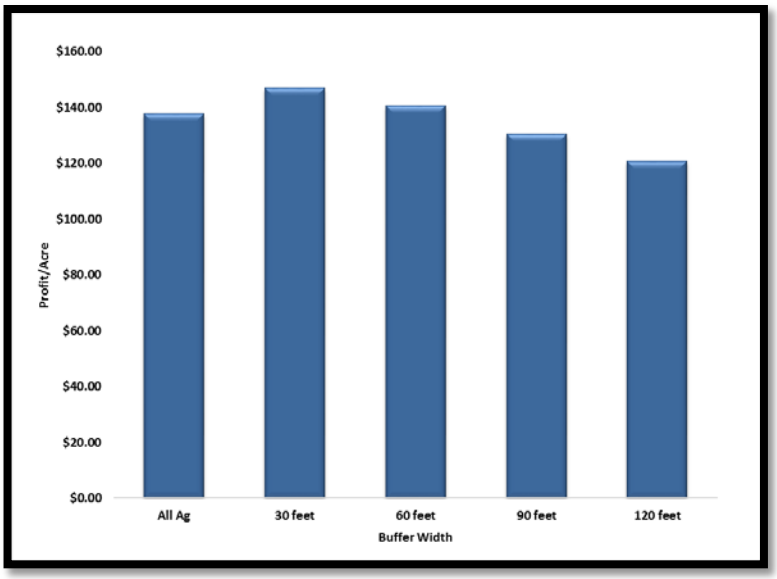

Figure 7 – Economic advantage of different conservation buffer widths on a corn field.

They also simulated bobwhite response to increasing amounts of CP-33 buffers in the landscape and found that as the amount of buffer habitat increases, bobwhite abundance increased disproportionately to the change in land use (Figure 8).

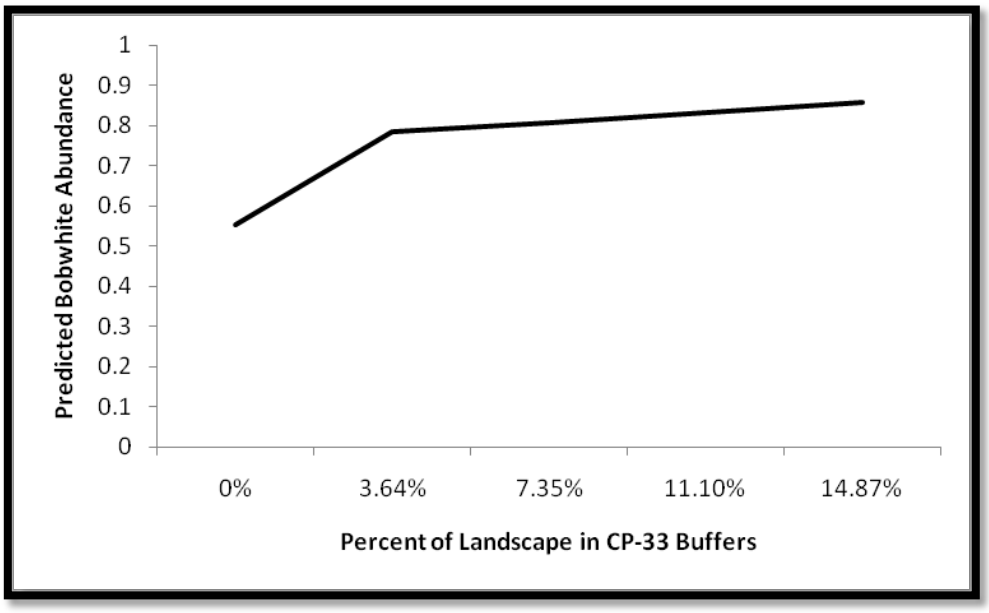

Figure 8 – Increase in bobwhite abundance relative to incremental increase in amount of conservation buffers in landscape (%'s represents 0-ft, 30-ft, 60-ft, 90-ft, and 120-ft buffer widths, respectively).

That means that bobwhite don't just respond to the increase in new habitat acreage created by conservation buffers, but that the addition of the buffers also increases the amount of useable habitat in the landscape. In other words, the buffer produced habitat and it also increased the use of the adjacent crop field.

Another MSU study looked at bobwhite abundance on fields with CP-33 buffers and those without across 14 states for six years. Results showed that although buffers only accounted for about 5-10% of the landscape bobwhite breeding density (males/acre) was up to 2 times greater on CP-33 fields than non-buffered fields, and fall covey density was 1.5 to 2 times greater for buffered fields.

To date this technology has only been used to compare profitability of linear field borders. However, the potential to generate revenue and increase bobwhite populations also exits on center-pivot irrigated fields. The dryland corners of a center-pivot irrigated field that do not receive additional water often create an inconvenience to farmers because of their irregular shape and historically lower yield (Figure 9). Many farmers choose not to farm these areas and use them for some other use (cutting hay, grazing cattle, pine production, food plots, etc.). In 2015, USDA allowed these dryland corners to be enrolled in CP-33, Habitat Buffers for Upland Birds. Now farmers can generate additional revenue by not farming these areas and also create habitat for bobwhite and other birds.

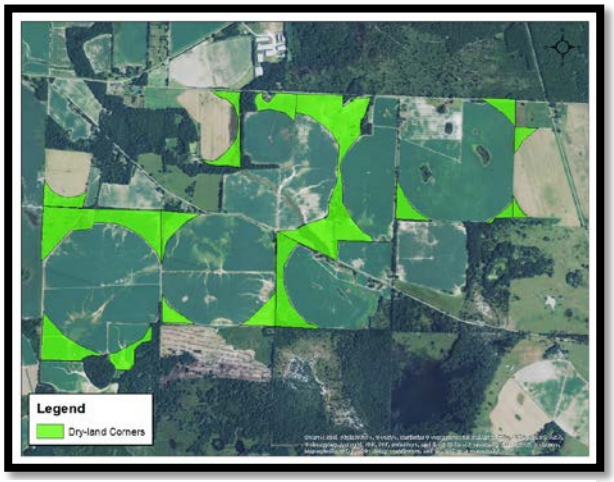

Figure 9 – Dryland corners provide conservation opportunities in agricultural landscapes.

With considerably lower yield in these corners the economic loss can be considerable. Enrolling these areas in CP-33 might increase revenue across the whole field because of the reduced time and inputs to farm these areas in addition to the soil rental rates and additional financial incentives USDA provides for enrollment in conservation buffer practices. Much like linear field buffers, these dryland corners create opportunities to farm less acreage while increasing revenue and creating quality wildlife habitat.

While the benefit of conservation buffers to bobwhite is apparent and well documented throughout the bobwhite range, the use of precision agriculture technology to identify both conservation and economic opportunities is novel to farmers and bobwhite managers. In most scenarios there exists a tradeoff between generating revenue and increasing bobwhite abundance. Precision agriculture technology allows farmers to understand the economic impact of alternative scenarios so they can make an informed decision that optimizes their mutual goals.

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