Bumps in spring wheat yields following a perennial phase

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In the February 2017 issue of NGPRL INTEGRATOR Newsletter, Ryan Crossingham, Farm & Ranch Guide Assistant Editor, interviewed NGPRL soil scientist Dr. Mark Liebig about the potential for perennials to provide ecosystem services, particularly soil-derived services that, over the long-term, may help buffer extreme climate events. Strategically planting perennials on areas of the farm that are most susceptible to perturbations can also help introduce diversity onto the farmscape that may otherwise be lacking.

Although it is generally accepted that planting perennials can provide a suite of ecosystem services, less information exists that will help producers with perennial planting management decisions. A producer interested in planting perennial forages on their farm may have questions related to the length of time the perennial phase should be in place in order to see yield bumps in the subsequent cash crop or which forages to utilize in their operation. To help address these and other related questions, USDA-ARS scientist conducted an experiment at the Northern Great Plains Research Laboratory near Mandan.

Conducted between 2006 and 2014, the study had three primary objectives: 1) to determine how long a perennial phase should be in place before seeing yield advantages, 2) to determine how long yield advantages persist following conversion from perennial forages to an annual cash crop, and 3) to evaluate three different perennial forages planted alone and in combination for their ability to maximize cash crop yields.

In total, five perennial forages and forage combinations were evaluated, alfalfa alone (variety 'Admiral'), intermediate (pubescent) wheatgrass alone (variety 'Manska'), switchgrass alone (variety 'Sunburst'), an alfalfa-wheatgrass mixture, and an alfalfa-switchgrass mixture. Perennial forages were grown for 2, 3, 4, or 5 years then converted to an annual spring wheat rotation. An annual crop rotation check of continuous spring wheat fertilized annually with 60 pounds per acre of nitrogen was used for comparison. Nitrogen fertilizer was not applied to spring wheat plots after they were converted from perrennials.

Figure 1 summarizes the overall findings. Data are displayed as a yield ratio whereby values greater than 1 indicate a spring wheat yield bump when compared to the continuous annually fertilized spring wheat check. Initial findings indicated a perennial phase should be in place a minimum of three years before comparable yields to continuous spring wheat were achieved. However, significant yield bumps were not achieved until after four years of a perennial phase. There was a 20% bump in spring wheat yield after four years of alfalfa forage planted as a monoculture and an 8% bump after four years of an alfalfa-switchgrass mixture. However, an analysis of forage composition indicated alfalfa outcompeted switchgrass and, therefore, the alfalfa-switchgrass combination was comprised primarily of alfalfa.

After five years in a perennial phase, yield bumps further increased. There was a 45% and 25% bump in spring wheat yields after five years of alfalfa monoculture and alfalfa-switchgrass, respectively. Interestingly, five years in an alfalfa-wheatgrass perennial phase resulted in a 14% spring wheat

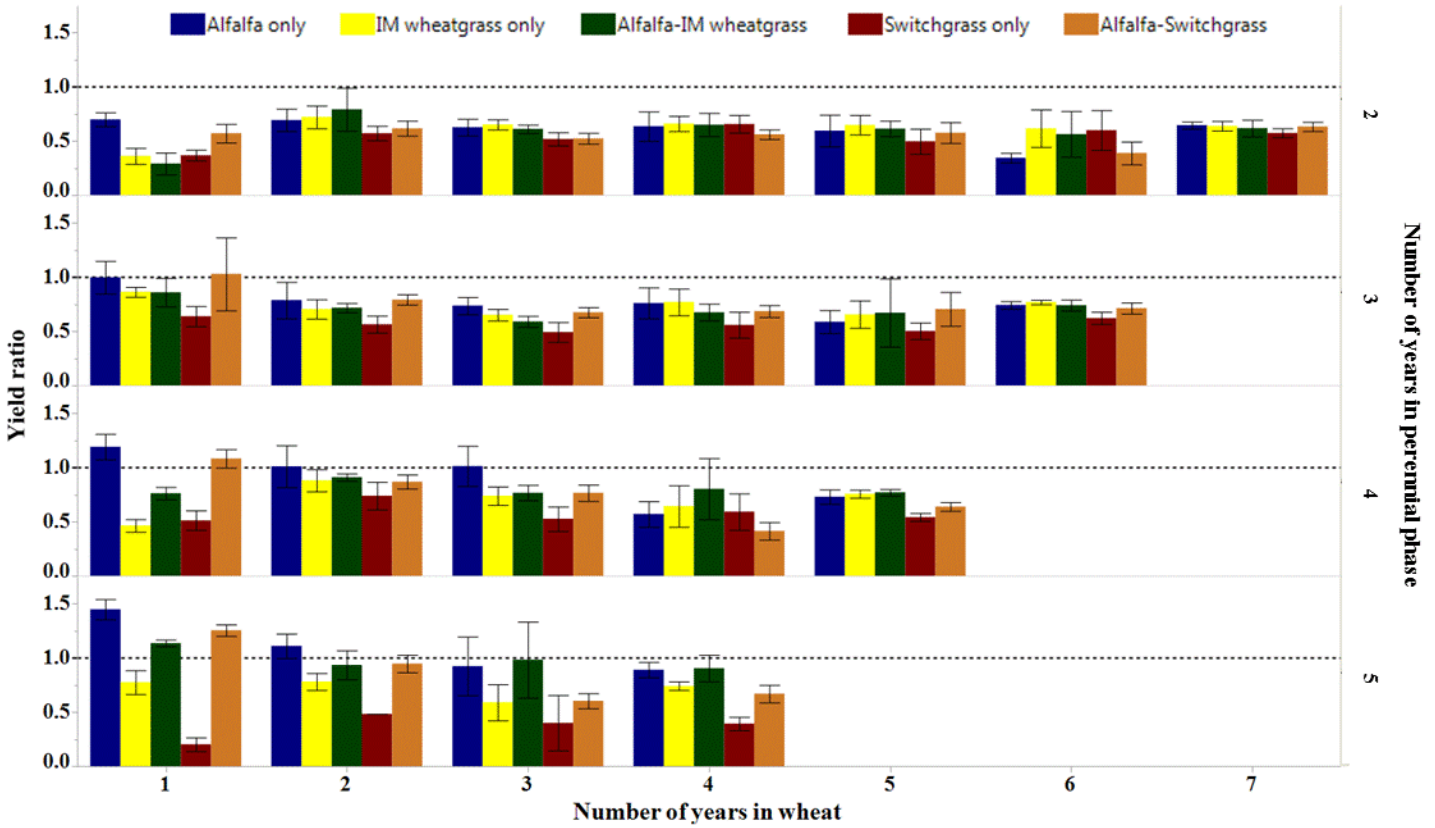

Fig 1. Spring wheat production as a ratio of spring wheat yield following conversion from a perennial forage phase to spring wheat yield in a continuous spring wheat rotation fertilized annually with 60 lbs N (left y-axis) by perennial forage phase duration (right y-axis) and number of years in wheat following conversion from the perennial phase (x-axis). A ratio of 1, represented by dashed horizontal lines, indicates spring wheat yield following a perennial phase is equivalent to spring wheat yield in a continuous spring wheat rotation and a ratio greater than 1 indicates a yield bump following a perennial phase.

yield bump, which, unlike the alfalfa-switchgrass combination, had a more significant contribution from wheatgrass in composition.

Additionally, alfalfa-wheatgrass continued to be a beneficial mixture over the duration of the study. Although yield bumps did not persist after the first conversion year following a 5-year alfalfa-wheatgrass phase, yields were 98% and 91% of the continuous spring wheat check after three and four years of conversion, respectively, and without any added nitrogen fertilizer. These ratios were comparable, and sometimes higher, to those of spring wheat yields following an alfalfa monoculture phase.

When determining which forage(s) to include in a perennial phase, data suggested alfalfa alone or in combination with a perennial grass, wheatgrass in particular, provides the highest yield bumps. There was an upward trend in yield over the five perennial phase durations included in the study in the first conversion year with alfalfa or alfalfa combinations as compared to grasses alone (Fig. 2). Switchgrass monoculture showed a downward yield trend while wheatgrass monoculture showed an initial increase after two years in a perennial phase then decreased and remained relatively stable. This may be related to persistence of individual grass forage species over the duration of the study, especially switchgrass.

In summary, results from this study indicated a perennial phase should contain a leguminous forage species such as alfalfa and should be in place at least four years before yield bumps occur. An additional year in perennial forage resulted in even higher yield bumps and appeared to have beneficial effects for at least four years following conversion.

Additional analysis will include an economic assessment as well as an evaluation of perennial forage species persistence and forage production stability over time. In this analysis, we evaluated unfertilized spring wheat yields following perennial forages as a ratio relative to the continuous annually

fertilized spring wheat check whereby only values greater than 1 were deemed to have a positive impact on spring wheat yields, i.e. yield bump. However, economic analysis may reveal that values less than 1 may result in greater economic return due to cost savings associated with reduced inputs during the perennial phase.

Franco, J.G., S.E. Duke, J.R. Hendrickson, M.A. Liebig, D.W. Archer, K.A. Nichols, and D.L. Tanaka. Perennial forage type and phase duration impacts on spring wheat yields in a semiarid cropping system (In review).

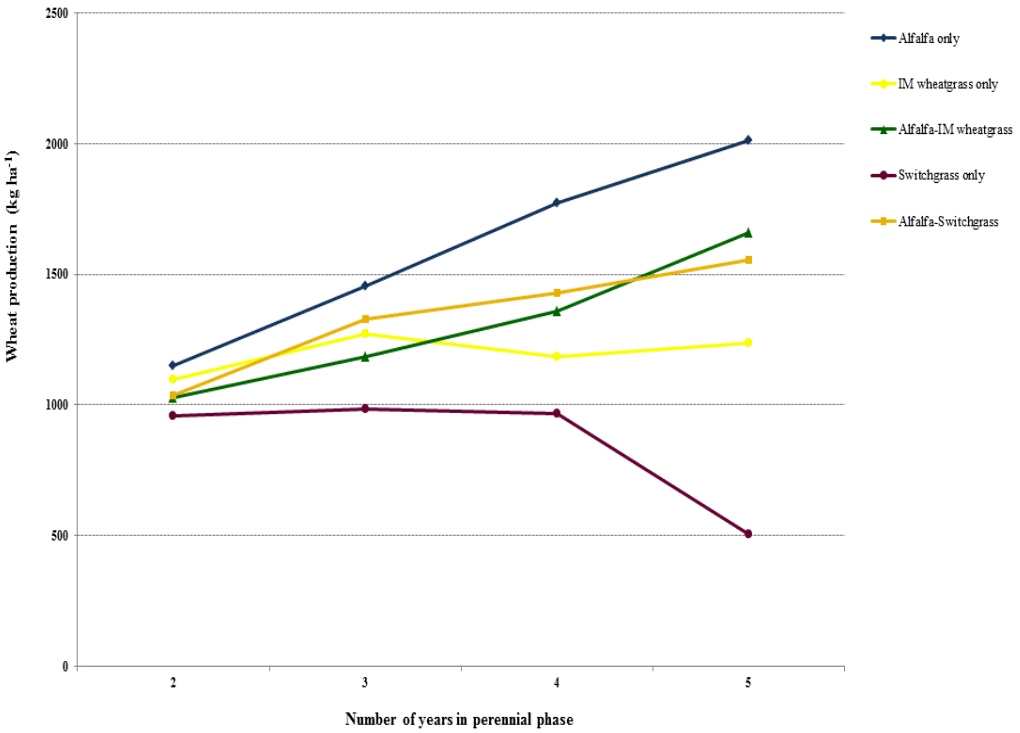

Fig 2. A comparison of spring wheat production (kg ha-1) by forage type and forage combination the first conversion year following perennial forage phases of 2, 3, 4, and 5 years.

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