Ecological research suggests greater species diversity can offer more ecosystem services in a variety of ecosystems. But how can this idea be applied in agroecosystems, which have very low diversity?

One idea is to use multiple cover crop species with different functional traits (e.g., weed suppression and nitrogen fixation) to increase the benefits of using cover crops. Researchers at Penn State are currently experimenting with diverse cover crop species mixtures to determine if planting cover crops with different functional traits offers greater value than planting a single cover crop species in between cash crops.

Ebony Murrell, a postdoctoral researcher at Penn State explains that some farmers are already trying this. However, from a researcher’s perspective, she says there are some basic questions that need to be addressed: “If you try to plant an even mixture, do you get an even mixture, and how even is it throughout the season? Do you get a fair representation of the species in the fall and the spring? Does it change between fall and spring?”

Murrell is the lead author of a recent *Agronomy Journal* article that details an experiment where she and her co-authors set out to quantify the competitiveness of different cover crop species planted at different times throughout the year and to identify seeding rates that balance both biomass production and species diversity.

**Intentional Combinations based on Functional Traits**

The three-year experiment was established in 2012 at the Russell E. Larson Agricultural Research Center. The cash crop sequence was maize silage–soybean–winter wheat. The researchers chose six different cover crops: cereal rye, oats, Austrian winter pea, red clover, forage radish, and winter canola. Each species was grown alone, and additional treatments were two three-species mixtures, a four-species mixture, and a mix of all six species.

The cover crop mixtures were intentional combinations based on functional traits. “We have a three-species mixture that’s focused on weed management and a different species mixture that’s focused on nitrogen management,” explains Mitchell Hunter, a Ph.D. candidate at Penn State and co-author of the article. The end goal is to be able to tailor mixtures to meet on-farm needs.
For all treatments, the researchers measured biomass and diversity of the cover crop prior to termination. The team observed differences by season and crop treatment in all years, with some consistent patterns. Cereal rye produced more biomass than expected in mixtures while radish, canola, and clover produced less biomass than expected.

The results of this initial experiment have led to some changes in further research. For example, the researchers had difficulty establishing a mix of species in the fall after corn. “It didn’t matter how diverse of a mixture we planted, we just ended up with [cereal rye],” Hunter says. This is likely due to the climate, and in response, the researchers do not suggest planting cover crop mixtures under these conditions.

Similarly, in mixtures planted after wheat, cereal rye was the dominant species. Hunter explains this led to, “an imbalanced amount of rye relative to the legumes, [which resulted in] a nitrogen deficiency” in the following corn crop. To achieve a greater balance in mixtures, the group has replaced rye with triticale, a less dominant grass species.

Comparing monocultures to mixtures also provided some interesting observations. Murrell describes one species, Austrian winter pea, as “a species that can be very beneficial in that it puts on good biomass, is a great nitrogen fixer, but it has a disadvantage of being a winter-killed species in some locations.” Surprisingly, the winter pea performed better in mixtures than as a monoculture. Murrell says this could be because, “in mixtures, [pea] growth is somewhat suppressed, so it doesn’t put on as much biomass in the fall,” which appeared to reduce the occurrence of winter kill.

‘Farm Tuning’

Using the findings from this initial phase of the study, the researchers are currently pairing work at the experimental station with on-farm testing. Murrell says eight different farms throughout Pennsylvania and New York are planting a five-species cover crop mixture to “see how this mixture performs across different latitudes, gradients, different working farms with different organic management practices to see if we can actually get some kind of blend that would be beneficial to multiple farmers at multiple locations.”

The research team hopes that in collecting data across multiple sites, it will be able to determine which factors are most influential (e.g., growing degree days, soil characteristics, or precipitation) to cover crop mixture performance. Using this knowledge, the team may be able to build a model that tailors cover crop mixtures to desired outcomes based on individual farm conditions.

The group calls the approach “farm tuning.” “We’re really trying to merge these two types of knowledge, the farmer knowledge and the scientific knowledge, to understand how we can get functionally diverse mixtures across a wide range of soil-climate space in the northeast U.S.,” Hunter says.

Dig Deeper

Read the Agronomy Journal article, “Achieving Diverse Cover Crop Mixtures: Effects of Planting Date and Seeding Rate” at www.dx.doi.org/doi:10.2134/agnonj2016.03.0174.