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The Hazards of Monoculture

As in the natural world, greater diversity in both farm crops and our gut microbes leads to better outcomes.

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Drive through the Midwest during the summertime and you'll pass through what seems like a green sea of corn, row upon row. As the acres roll by, it's not hard to believe that American farms have always looked this way.

Actually, huge acreages of single crops, or monocultures, have existed for little more than half a century. This has reduced the number of species living together, a concept known as biodiversity. Many people know about biodiversity reductions in the natural world—less animal life through habitat loss, for example. But reduced farm biodiversity poses its own set of ills, including a loss of beneficial microbes in the soil.

Microbe loss doesn't end on the farm. Our bodies also harbor microbes, known collectively as the human microbiome, which is challenged by our modern way of life. And we are now learning how harmful it can be when these microbes are disrupted.

Fewer Crops, Poorer Soil

World War II brought the need to feed military and civilian populations with fewer farmers. "There are a lot of different products you can get out of corn and soy, so that resulted in our focusing on these crops," says Kristine Nichols, PhD, chief scientist at the Rodale Institute in Kutztown, Pennsylvania (**rodaleinstitute.org**). "After the war, we had a lot of new chemicals and technology that made it easier to continue to produce these monocultures." That meant reliance on corn, soy, cotton and wheat, along with monocultures of pigs, poultry and cattle.

"Throughout history overdependence on one or two crops has had disastrous consequences," says Danielle Nierenberg, president of Food Tank, a food policy group (**foodtank.com**). One example is the 19th century Great Famine in Ireland: Blight ravaged the potato crop that much of the population lived on, leading to mass starvation and emigration.

Crop failure is only one of the dangers presented by monoculture, which "has a lot of environmental impacts because of fossil-fuel pollution," says Nierenberg. Noting that farm runoff leads to the annual formation in the Gulf of Mexico "of a dead zone roughly the size of New Jersey," she adds that monoculture "can destroy the soil microbiota, drive out bird populations, kill beneficial insects like ladybugs." Nichols adds, "When diversity declines, our soil health declines. The availability of nutrients declines. You

lose soil because the microbes help to bind it. You lose water; it doesn't infiltrate into the soil as well."

Inner Disruptions

A similar loss of diversity is seen in the human microbiome, a potent influence on health because of the "incredibly, incredibly vast" amount of information it contains, says neurologist David Perlmutter, MD, author of Grain Brain and Brain Maker (Little, Brown).

Attacks on the microbiome start early. More children are being born via caesarean section, which means they aren't exposed to microbes in the birth canal. And many kids aren't breastfed, another source of healthful organisms.

One major factor is "we are just freaked out about germs," says Perlmutter. This leads to the overuse of antibacterial agents. "You think about the natural oils your body makes, and then we use some harsh cleanser that disrupts the microbiome on our skin," says Robynne Chutkan, MD, founder of the Digestive Center for Women in Chevy Chase, Maryland, and author of The Microbiome Solution (Avery).

The war on germs extends to an overreliance on antibiotics. In one study, a single course of antibiotics altered gut microbes for up to a year (mBio 11/10/15). These drugs also make their way into the food supply from agriculture, where they're used to fatten animals faster. And proton pump inhibitors can change the microbial mix in the upper digestive tract through their effect of reducing stomach acid.

Diet affects the microbiome in other ways. In a 2010 Proceedings of the National Academy of Sciences study, researchers saw differences in the microbes found in European children and those from a rural village in the African country of Burkina Faso. The European children, eating a low-fiber diet high in sugar and fat, had more of a bacterial class called Firmicutes, which promotes weight gain. In the African children's systems, a bacterial family called Bacteroidetes, linked to lower weight levels,

predominated. The African kids, eating a diet high in fiber and non-animal protein, also had more diverse microbiomes.

Microbial disruptions within the intestines cause more than just digestive difficulties. These organisms "actually control us," says Gerard Mullin, MD, associate professor of medicine at Johns Hopkins Hospital and author of The Gut Balance Revolution (Rodale). "The microbiome affects our bodies, our minds, our physiologies." He says poor microbial diversity weakens the bowel wall's ability to keep harmful substances out of the blood. Such substances create inflammation and increase the risk of autoimmune disease, allergies, diabetes, Alzheimer's and many other disorders.

Disruption of the intestinal microbiome is called dysbiosis; Chutkan sees signs of it in between 75% and 90% of her patients. In looking at dietary factors, she says, "There are foods that aren't nutritionally dense, and then some of the sprays used on foods can kill germs inside our bodies."

Many of these sprays harm soil microbes as well. "It is quite clear that various agricultural practices, like the use of glyphosate (found in Roundup), are having an incredibly powerful and detrimental effect upon the soil microbiome, globally," says Perlmutter.

Back to the Garden

Returning to a more diverse way of farming is tricky. "Our infrastructure is very much designed around monocultures," says Nichols. "The elevators only have the infrastructure to handle certain kinds of grains. The farmers have to pay for more equipment to grow a diverse crop rotation and they have to ship longer distances."

However, as Nierenberg notes, "There's a move towards true-cost accounting in the food system so that farmers can be paid not just for producing food but for all the other benefits they provide." In addition, she says, "You've seen a growing food movement over the last 15 years," such as the return of organic farming and farmers markets.

In a similar manner, researchers and practitioners are trying to help people fix damaged microbiomes. “There are governmental, publicly traded and private institutions that are very much involved in developing unique and targeted ways of manipulating the microbiome,” says Perlmutter. “I believe these pursuits will provide significant interventions in the next three to five years.”

“Diet is key. We can shape the microbiome through diet,” says Mullin. Cut out highly starchy, overly processed carbs, including sugar, “the primary food sources that sustain the imbalance in the microbial communities in your digestive tract,” Mullin says. (Substituting artificial sweeteners for sugar doesn’t help; these substances have been found to also alter gut microbes.) Instead, Mullin suggests eating foods that contain prebiotics, fibers that help feed the microbiome, such as asparagus, bananas, beans, eggplant, garlic, Jerusalem artichokes (also called sunchokes) and onions. One Journal of Nutrition found that a diet rich in soy protein contributed to a more diverse microbiome. Fermented foods such as sauerkraut and pickled veggies add the microbes themselves, known as probiotics.

Chutkan recommends embracing a “live dirty” lifestyle. “Most of us aren’t rolling around in the mud, so we hardly need to be washing our skin and hair every day, stripping away the oils and bacteria that keep them healthy,” she notes.

Our soils and bodies teem with microbes that are threatened by modern life, including the ways we grow and process our food. Helping these organisms flourish, on the farm and in ourselves, may help reduce the chronic diseases that run rampant in our society. As Mullin puts it, “We need to cultivate these microbes; how we treat them is how we treat us.”

Buddies in the Garden

As with people, some garden plants tend to do better together, while others simply clash. Happy partnerships may work for any number of reasons, such as pest protection or sun shading. In the case of unharmonious pairings, one plant may outcompete the other for nutrients or, as in the example of the black walnut tree, may even produce toxins that can harm its neighbors.

The following are some common plant companions and antagonists. Note that keeping records of each season's results is the best way of finding out which pairs work best in your own garden.

Beans
Friends: cabbage family, carrot, celery, corn, eggplant, marigold, radish, strawberry
Enemies: onion family, pepper, sunflower

Broccoli
Friends: beet, celery, cucumber, dill, onion, potato, rosemary
Enemies: lettuce, pole bean, tomato; also, crucifer (cabbage) family members shouldn't be grown together

Carrot
Friends: lettuce, onion, pea, pepper, tomato, sage
Enemies: dill, parsley

Cucumber
Friends: bean, corn, marigold, nasturtium, pea, tomato
Enemies: melons, potato, sage

Melons
Friends: corn, marigold, nasturtium, sunflower
Enemies: potato

Onion

Friends: beet, cabbage, lettuce, pepper, strawberry
Enemies: bean, pea, sage

Potato
Friends: bean, cabbage family, corn, eggplant, garlic, pea
Enemies: cucumber, tomato, turnip

Tomato
Friends: Asparagus, basil, chives, lettuce, marigold, parsley, pepper
Enemies: cabbage family, corn