Biodiversity & Agriculture

Crop Dependence on Biodiversity

With genetically modified crops, sophisticated machinery, and satellite monitoring of fields, technology has transformed how farmers produce food. These technological advances, while enormously important to agricultural productivity, can make it more difficult to identify that growing food is still inherently a process governed by Nature. While farms may appear as vast expanses of uniformity with rows upon rows of one or a few crops, even the most apparently bland farm landscapes house a remarkable diversity of organisms. In addition, the crops themselves have been bred from a diverse lineage of related varieties. These forms of biodiversity, both among and within species, are vital to growing food.

For each plant species grown as a crop we eat, untold numbers of other species participate in its success. A cubic meter of soil houses an enormous abundance of life, on the order of several billion living organisms. One function of these microbes is to help fix nitrogen, an essential plant nutrient, into the soil. Mycorrhizae, a group of fungi that create vast underground scaffoldings (the length of mycorrhizal strands contained in a cubic meter of soil would measure more than a thousand miles if stretched out end to end (Pennisi 2004)) provide an additional service. The fungal strands attach onto plant roots from which they draw nutrients and water. In so doing, they prevent soil erosion, and have been shown to be capable of binding toxic heavy metals such as cadmium, thus preventing their absorption into the edible parts of crops. Soil organisms are not all microscopic of course. That same cubic meter of soil also holds tens of thousands of insects, worms, and burrowing vertebrates, all of which shape and renew the soil.

The diversity that nurtures crops extends above ground as well. Beneficial insects, such as Green Lacewings whose larvae eat a variety of plant parasites, protect crops against infestations. Another 100,000 species, including insects, birds, and other animals, serve as pollinators. Each year about $15 billion of crops rely on bees for pollination in the U.S. and studies show that the percentage of food crops dependent on pollination is rising (Aizen 2008). Yet, populations of pollinators, particularly honeybees, are in sharp decline. In 2006, losses of up to 70 percent of hives were reported in 24 states across the U.S.

Pesticides and the Loss of Biodiversity

More than 1 billion pounds of pesticides were applied to crops in the U.S. in 2000 (EPA, 2001) many of them known to be toxic to both pests and non-pests alike. Ironically, some have been shown to harm organisms known to protect crops from pests, such as frogs and salamanders. Atrazine, the second most widely used pesticide in the U.S., and the most widely used in the world, can impair fertility in frogs and salamanders at concentrations commonly found on farms. (Hayes 2002, 2003). Persistent application of pesticides also creates resistance and new chemicals must routinely be invented to keep pace. This "pesticide treadmill" may trample many beneficial organisms, such as mycorrhizae, insects, and pollinators.

Functions of Crop Biodiversity

Approximately 75 percent of the world's food supply is provided for by only twelve species of plants, according to the U.N.'s Food and Agriculture Organization. In addition, trends indicate that our agricultural crop base is becoming ever less diverse, either from disuse or outright loss of particular plant varieties. China grows ten-fold fewer varieties of rice today than it did 50 years ago, and Mexico has lost 80% of its maize diversity since 1930. In the United States, more than 80% of corn, cabbage, apple and pea varieties known at the start of the 20th century are now extinct. Along with the varieties lost are the traits, encoded in their genes, some of which may have provided for defenses against pests or infection, or tolerance to adverse conditions such as heat, drought, or salt.

These losses pose increasing risks to our food supply given the effects of climate change. Homogeneous crops of genetically similar plants, selected for their ability to thrive in specific conditions, are at greater risk when conditions fluctuate, as under extreme weather conditions forecast by climate change scenarios. In contrast, genetically diverse crops that may not produce yields as great as monoculture crops under normal conditions are more likely to provide adequate, or perhaps greater, yields in adverse conditions.

Even under normal circumstances, diversity in the field can benefit crops. Research from Yunnan Provence in China has shown that mixing varieties of rice in the same field can both reduce pathogen burden and boost yields. In a report from 2000, researchers showed that by growing disease resistant varieties alongside disease-susceptible varieties of glutinous rice (desired for its culinary attributes), the rate of a rice pathogen known as rice blast disease, decreased 94% and yield of the glutinous rice variety increased 89%.

The diversity of crop varieties, in short, is an insurance policy to protect against future uncertainty in agriculture. In recognition of this fact, recent efforts have begun to preserve seed diversity, such as the Svalbard International Seed Vault, the Millennium Seed Bank Project, and the Seed Savers Exchange.

The world food supply has never been so robust nor as precarious as it is today. Yields are at levels that would have seemed impossible fifty years ago, while at the same time the practices that have enabled those yields have put significant stress upon the biodiversity which underpins agriculture. Arguably, the greatest challenge to feeding the world going forward will be to innovate agriculture without irrevocably damaging, or outright losing, the biodiversity that sustains it.

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