PROCESSES MODULATING THE EMERGENCE OF PATHOGENS IN THE AGROECOSSYSTEM.

Why do pathogens emerge and evolve so quickly in agroecosystems?

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Pathogen emergence and evolution is an increasingly important problem in human, animal and plant medicine. While the processes that drive pathogen evolution are the same in plants and animals, it is easier to study pathogen emergence and evolution in plants. The problem of pathogen evolution began with the domestication of crops ~12,000 years ago but has become more acute in recent times due to dramatic changes in the structure and scale of agricultural ecosystems as they became industrialized. Pathogens emerge and evolve so quickly in agroecosystems because of their modern structure, which is characterized by monocultures grown over a large area, with high plant density and genetic uniformity. Microbes in these agroecosystems exist in vast numbers that can carry all kinds of mutations, including mutations that encode resistance to antibiotics and virulence against resistance genes. The industrial agroecosystem imposes strong selection that favors some mutants over others. Some of the selected mutants will spread to other fields, either naturally or with assistance from humans. We cannot change mutation rates, but we can change how selection operates and sometimes affect the movement of pathogens among fields by changing the agroecosystem itself. Effective quarantines coupled with wise use of agrochemicals and integrated control strategies can clearly slow down the emergence and spread of mutants that carry novel virulence or fungicide resistance. But the root of the problem lies in the lack of diversity in the industrial agroecosystem. The industrial agroecosystem will need to be re-engineered in order to slow down or prevent the emergence of new pathogens. This will require considerable coordination and investment. We can probably retain monocultures and the high resulting efficiencies in food production and processing, but we will need to find ways to reintroduce diversity into farmer's fields. Many possibilities exist, including the already proven technologies of cultivar mixtures and multilines. Genetic engineering could also make an important contribution, but there are many low-technology options that can be deployed without a heavy investment.