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A New Key to Sustainable Farming: A New Wave of Pesticides has the Potential to Change Farming

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How do humans feed the world? How do we ensure all 7.8 billion people get fed? Mass production of crops. As humans are required to provide for an increasing global population, agricultural technology has to improve. However, with this production of crops comes pests. Locusts, japanese beetles, harlequin beetles, corn rootworms, and stink bugs are some of the most common insects that are destructive in agriculture. The way we control them is through pesticides. Chemical pesticides are the most common source of treating pests and are not without their benefits. The major one is that they can recover 30 to 40 percent of total crop losses worldwide. However, they have their drawbacks. According to the National Institute of Health, applying these chemical pesticides causes much environmental harm. Contamination of soil, turf, and other vegetation and eutrophication of waterways are just some downsides of chemical pesticides.

Another negative side effect is that these pesticides can harm other organisms like birds, fish, beneficial insects, and non-target plants. The way these pesticides can spread to them is by the food chain. Pesticides' main effect is that they reduce the fertility of the target species. The goal is not to kill a species but to reduce its population. So, examining how their populations are declining is crucial when looking at the non-target species. A study examining the effects of neonicotinoid insecticides found they spread through the soil food chain, affecting the predator beetles and impairing/killing them at rates greater than 60 percent.

Furthermore, these pesticides remain in our ecological systems for decades after application. When conditions in soil are such that there is not much sun, water, or microbes, the pesticides that reside take longer to break down. They can persist in the soil for years after they are applied.

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These pesticides are less effective than they used to be. This is due to the resistance that pests are gaining to our most common pesticides. According to the USDA, genetics and intensive application of insecticides are responsible for the rapid development of resistance in insects and mites. The species resistant to these pesticides live on and pass their resistance trait to their offspring. So, with the environmental risks of pesticides growing and the pest's resistance to them rising, we need a new way to control pests while maintaining our high crop demands. This need is being met in the form of biopesticides.

While there is no formal definition for biopesticides, they are generally considered pesticides that use non-toxicological mechanisms, limiting their ecological impact. These pesticides include biochemical pesticides, microbial pesticides, and genetically modified protectants.

Multiple benefits result from using these biopesticides. One of the main ones is that they are decomposable. This is the main benefit of biochemical pesticides. Their formation is usually made from living organisms and the structure of their metabolism. They also are not known to damage the ecological systems they apply to, meaning they do not linger in the ecosystem. This is because of the microorganisms within the pesticides. They become nutrients in the soil and decompose into small molecules.

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Another benefit is these biopesticides make it difficult for pests to produce resistance. This is because of the mechanisms these biopesticides target. Generally, when a pesticide targets a pest, it has five different areas it can target: the nervous system, the production of energy, the output of cuticles, the endocrine system, and the water balance. Most chemical pesticides are narrow-specific, targeting one of these five areas. With biopesticides, their targets are non-specific, so they target a broad spectrum of areas within the pest. Specifically, microbial pesticides have this effect. For example, fungi in crops, which kill certain weeds and other fungi, which kill other insects. This makes it more difficult for the pest to develop resistance from generation to generation.

So if biopesticides excel in the areas where chemical pesticides fail, why have they not been used yet? Why are they just now appearing in the agriculture industry? One main reason is safety. With new products, especially ones that change how a product has been done for a long time, significant testing must be done to ensure the product's safety. The Environmental Protection Agency (EPA) does not have a formal definition of biopesticides, and the typical approval process for a pesticide is about six years.

Furthermore, these biopesticides are much more labor-intensive than their chemical counterparts. Previously restricted resources, supplies, and long production processes bottlenecked the rollout of biopesticides. Finally, the emergence of the field of biosynthesis (the generation of natural products through enzymatic reactions, e.g., cellular metabolism). New tools and ways of constructing biological models are coming out daily, and the agricultural industry is racing behind.

Despite this slow rollout of biopesticides, progress is being made. According to the National Library of Medicine, by 2025, the global market for biopesticides is expected to grow from five percent to more than 20 percent, with an anticipated growth rate of 16 percent per year. This means the growth of biopesticides could skyrocket in the next few years.

Overall, the future for biopesticides looks bright. With the products slowly coming out of their bottleneck and overwhelming benefits, they will soon be seen in farms worldwide. This will eventually lead to a more sustainable and profitable agriculture market, which benefits the earth. • • •

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