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Crop Protection Contributions toward Agricultural Productivity

A paper in the series on The Need for Agricultural Innovation to Sustainably Feed the World by 2050

Plant protection is undergoing a revolution driven by

- The biological realities of pesticide resistance developing in target pests;
- Market forces that are beginning to make the development, registration, and use of new pesticides cost prohibitive; and
- Real or perceived side effects of pesticides on nontarget organisms, including humans.

Biological control of plant pathogens is becoming more important with the current sustainability emphasis for agricultural production.

- For effective biological agents to be developed, there is a need for both basic and long-term applied research to be conducted.
- Biological control of arthropod pests using invertebrate agents and biopesticides is increasing steadily.

Treatment of seed or soil at planting (either in-furrow or lay-by) has historically targeted soil-dwelling pests.

- The availability of neonicotinoids has made it possible to treat seed and target insects feeding on roots, stems, and leaves.
- New formulation technologies will also impact seed treatment technologies and the ability for materials to be translocated throughout the plant.
- The general use of nematicides has shifted from applications applied as fumigants or banded row applications to seed treatments as a means of decreasing exposure to applicators and the environment.
- In many instances, fungicide seed treatments are viewed as insurance to protect the seed from pathogens and ensure a good crop stand.

Pest surveillance is an integral component and prerequisite for integrated pest management (IPM) practices.

- The automation of pest management data analysis will continue to improve as more systems are developed for handling larger data sets.
- Use of the RNA interference technology may fit well into IPM systems because it can be highly selective and delivered in many different ways.
- A sustainable approach to managing pests is to establish a pest-resistant crop by planting less susceptible cultivars and using cultural practices that limit pest survival and reproduction while preserving competitors and natural enemies
- Traditional breeding for improved cultivars with resistance or tolerance to plant pathogens and insect pests has been the mainstay of decreasing their impact.

Pest resistance to any pesticide or genetic trait is one of the greatest concerns when a plant protection product is developed, released, and deployed.

- There is an extensive list of plant pathogens around the world that have developed resistance to fungicides, and the list continues to grow.
- Insect resistance management has been one of the post significant concerns related to the use of constitutive plant-incorporated protectants, especially engineered ones.
- Evolution of weed resistance to herbicides has been an issue since the introduction of selective herbicides more than 50 years ago.
- Increased yields and improved crop quality from pesticides and genetically modified crops are well documented since their introductions in the crop protection marketplace.

Present and future trends:

- Rapid sequencing advances now make entire genome sequencing relatively easy and fast
- Continuous improvements will be needed in attractants, trap design and efficiency, scouting methods, and rapid verification of pest occurrence.
- Decision making in pest management will continue to become more complicated, requiring highly trained growers or, more likely, crop advisors.
- The expanding field of agroecology is defining how entire farms can be designed to resist pests, preserve biodiversity, and provide certain ecosystem services.

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