New Food Finance

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Proteins as Biological pesticides

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$640m

Company fund-raisings by these selected technologies since 2012

59%

CAGR in fund-raisings since 2015

The Technology

Biological pesticides, also known as biopesticides, are derived from natural organisms or substances and offer an eco-friendly alternative to synthetic chemicals for pest control. Different types of biopesticides include peptide-based, enzyme-based, and PROTAC (proteolysis-targeting chimera) technologies, each offering a unique mechanism for preventing pests and diseases. Following is an overview of each:

1. **Peptide-based mechanism -** Peptide-based pesticides use small protein molecules (peptides) designed to disrupt vital biological processes in pests. These peptides can bind to specific proteins in target organisms, blocking their function and leading to the pest's death or reduced viability.
   - Example - Innatrix develops custom peptide biopesticides that specifically target pest proteins, such as enzymes or receptors, necessary for survival. These peptides are biodegradable, highly specific, and reduce the risk of off-target effects on non-pest organisms.
2. **Enzyme Inhibitors –** Enzyme inhibitor-based pesticides use carefully engineered, small molecule inhibitors to target and break down specific enzymes essential for pest survival. These small molecules are not always proteins, but target specific proteins within the cell and block their function.
   - Example - Agro Design Studio develops molecular-targeted pesticides, which target proteins that are not present in humans, and designs specialized treatments based on their structure.
3. **PROTAC -** PROTACs (proteolysis-targeting chimeras) are a novel technology originally developed for human therapeutics that have been adapted for agriculture. PROTAC molecules bring a target pest protein into proximity with the plant's or pest's own cellular degradation machinery, marking the protein for destruction. This disrupts critical functions in the pest or pathogen, leading to its death.
   - Example - Oerth Bio adapts PROTAC technology for agriculture by developing molecules that can selectively target and degrade pest proteins or plant pathogens, improving crop protection with minimal environmental impact.
4. **Antibody-based -** Antibody-based pesticides use engineered antibodies or antibody-like molecules to target and neutralize pests or pathogens specifically. These antibodies are designed to bind to particular proteins or antigens found on the surface of pests, such as insects or bacteria, thereby inhibiting their function, triggering an immune response, or marking them for destruction.
   - Example - IBI-Ag focuses on developing antibody-based technologies to target agricultural pests. Their antibodies are designed to bind to proteins on the surface of harmful insects or plant pathogens, blocking their ability to cause damage to crops.

Efficacy

The crystalline proteins (Cry) from Bacillus thuringiensis (Bt) account for a large proportion of biological pesticides globally. These Bt genes can be added to a crop to make it more resistant. For example, cotton expressing the Cry gene can achieve higher yields, and a reduction in pesticide use, translating into $30/ha savings.* However, due to a negative public perception of GM crops, this technology has not been widely adopted. One drawback of biological pesticides is that they tend to be slower acting. They are also effective on a narrower spectrum of pests, which can be seen as a bonus, by sparing beneficials, or a problem, if a broader acting pesticide is needed.

Vestaron is a major manufacturer of protein-based biological pesticides. Its SPEAR LED product targets navel orange worm. The biopesticide contains Cry proteins from a specific strain of Bt, which is able to disrupt the gut of insects. Vestaron published research comparing SPEAR LED with Altacor (a Chlorantraniliprole-based chemical pesticide) and Intrepid 2F (a Methoxyfenozide-based chemical pesticide). Applications on varieties of almond and pistachio suggested that SPEAR LED in combination with Intrepid 2F had the same or in some cases greater reduction of navel orange worm compared with a combination of Altacor and Intrepid 2F. Such studies are promising, but may lack repeats of results, or associated statistical analysis. SPEAR LED offers some advantages, such as a 0-day pre-harvest interval, 4-hour re-entry interval, and 0 maximum residue level, indicating its human safety.

Our Taxonomy

New Food Finance categories biological pesticides within its "sustainable inputs for crops" sector. The pesticides are further tagged according to the specific technology, in this case, peptides, enzymes, PROTAC and antibodies.

Environmental Benefits

All these biopesticides (peptide, enzyme, PROTAC) are highly specific, reducing harm to beneficial organisms and biodiversity. They are also comprise natural materials which biodegrade quickly, leaving no harmful residue in the environment. By targeting different biological mechanisms, these technologies offer solutions to combat resistance in pests, providing more sustainable crop protection over time.

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* Paul, S. and Das, S. (2020). Natural insecticidal proteins, the promising bio-control compounds for future crop protection. The Nucleus, [online] 64(1), pp.7-20. doi:https://doi.org/10.1007/s13237-020-00316-1

Figure 1 caption should be - Figure 1. Annual Fund-Raising, 5 Selected Protein-based Biological Pesticide Technologies, $mln

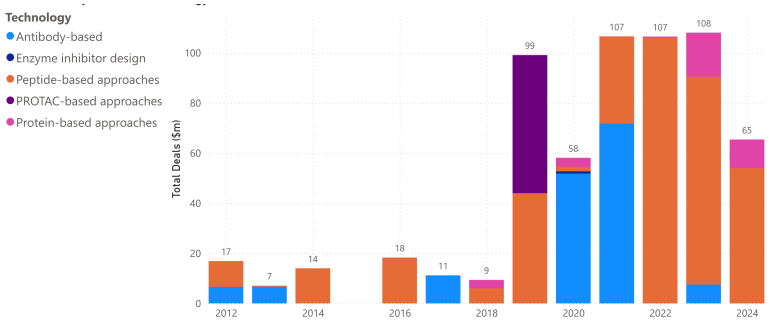

Figure 2. Total Fund-Raising, 5 Selected, Protein-based Biological Pesticide Technologies, $mln

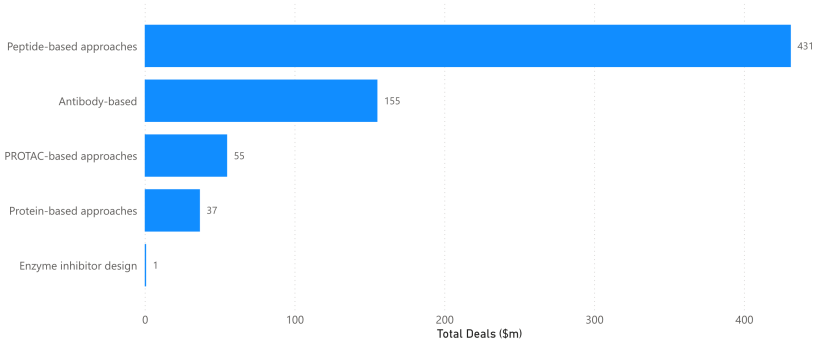

Figure 3. PROTAC - Mechanism of Action

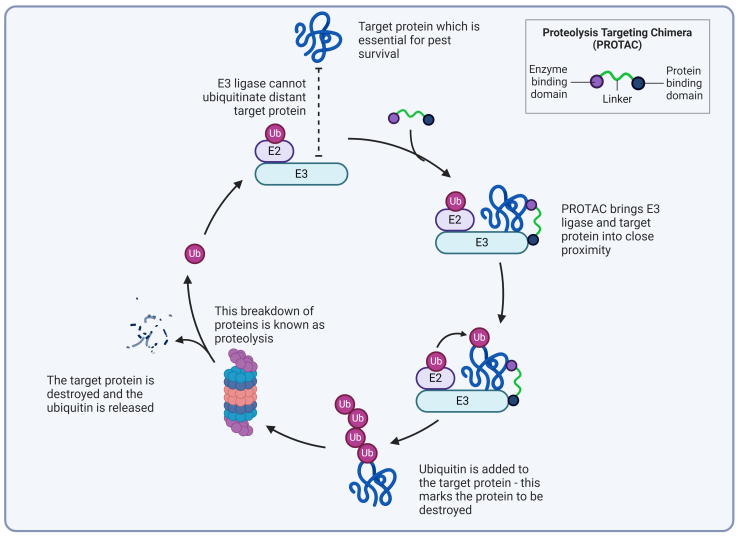

Figure 4. Antibody - Mechanism of Action