POSSIBLE BREAKTHROUGHS NANOTECH PESTICIDES

Conventional pesticides are strongly associated with environmental degradation and health hazards. This is due to pesticide toxicity, non-biodegradability, the impreciseness of some formulations, and leaching and other losses during application. This combination of side effects and low efficiency is the imperative for rethinking conventional pesticide use – the aim being to halve current losses. Nanotechnology provides promising responses to these multiple challenges. Due to the higher efficacy of nano-active ingredients, it allows for the reduction of pesticide volumes, thus lowering costs while increasing yields.

ANNEX E

Description

"Nanotechnology generally refers to a range of techniques for directly manipulating materials, organisms and systems at a scale of 100 nanometers or less – one nanometer being one-billionth of a meter."[1] "This capability gives us the ability to build materials and devices or shapes and products on that scale."[2] "One of the first nano-industrial applications is the development of nano-chemical pesticides – or nano-pesticides – which are pesticides that contain nano-scale chemical toxins."[3] Characteristics of this new pesticide are: i) increased toxicity, stability or diminished solubility in water as compared to bulk molecules of the same chemical toxins and ii) controlled release of pesticides due to the nanoencapsulation of pesticides.[4] Kuzma and Verhage[5] describe, for instance, a smart pesticide that only releases its pesticide when inhaled by insects. "The higher efficiency avoids the problematic chemical additives that are leading to product bans in a growing number of major markets and results in improved crop yield and reduced environmental impact."[6] However, it is also important to note that the impacts of nanoparticles on the environment and human health are still largely unknown and unpredictable.[7]

[1] Scrinis and Lyons 2010. [2] Sainsce 2009. [3] Kuzma and Verhage 2006. [4] Ibid. [5] Ibid. [6] NanoAll n.d. [7] ETC 2006

Geography

Despite global pesticide use of 2.5 million tonnes per year, production losses as a consequence of plant pests remain in the order of 20-40%.[8] In addition, conventional pesticides are often synonymously mentioned with environmental degradation due to their toxicity, non-biodegradable nature, lack of scientific formulations, leaching and loss during application. The combination of low efficiency and negative side effects of conventional pesticides makes innovative nanopesticides necessary to control pests on the one hand and minimize negative consequences on the other. Nano-based pesticides are promising in this respect as they address both issues. Leading agrochemical companies developing nano-based pesticides are BASF, Bayer Crop Science, Monsanto and Syngenta. However, the marketing of smart pesticides is currently constricted, especially through environmental groups/risk assessors opposing their introduction or potential risks associated with nano-scale materials. Some of the nanopesticides issued on the market recently are mentioned in table 1.

Table 1
Nano-based products on the market[9]

Company	Product	Mechanism
Syngenta	PRIMO MAxx and Karate ZEON	Inhibit neural system
Nano Green	Nano Green	Attacks respiratory apparatus
Agro Nanotechnology Corp.	Nano-Gro	Mimics stress conditions, increasing crop activity and yield

[8]FAO 2011, [9]A detailed overview of other nano-products on the market is provided at http://www.nanotechproject.org/

Energy

- Nanopesticides are applied at smaller volumes and less frequently than conventional pesticides, also resulting in less fuel used for tractor operations.[10]

Water

- As smart pesticides are more effective, they require smaller application volumes than conventional pesticides – less and more precise pesticide use means less non-point water contamination.

Pesticide efficiency and crop productivity

- Nanotechnology promises higher yields and lower input costs by streamlining agricultural management and thereby reducing waste and labor costs.[11]
- Nano-Gro pesticide increased average crop yield by 20% and for some crops even more: sunflower by 50%; rice by 35% and cucumber by 25%.[12]
- Nano Green pesticide increased rice yields by 25%.[13]
- Soybean yields increased 48% with nano-iron oxide particles.[14]

[10] Nano Green Sciences Inc. n.d. [11] Anane-Fenin 2008, [12] Agro Nanotechnology Corporation n.d. [13] Nano Green Sciences Inc. n.d. [14] Sheykhbaglou et al. 2010

Climate change

- Climate change means more pests in certain regions, increasing the need for pesticides.
  - A 1% increase in rainfall raises pesticide treatment costs for corn by 0.45%.[15]
  - A 1% increase in temperature increases pesticide treatment costs for potatoes by 1.41%.[16]

Costs and benefits

- The increased toxicity of nanopesticides and the ability to more precisely control the quantities and conditions under which pesticides are released could result in a reduction of the volume of active compound applied in specific situations, thereby reducing input costs and environmental pollution.[17]
- In the near future, nanostructure catalysts will be available that will increase the efficiency of pesticides and herbicides, allowing lower doses to be used. The higher efficiency of nanostructured pesticides is based on the higher reactive surface area compared to conventional pesticides. Lower doses decrease application costs.[18]

[15]Chen and McCarl 2000, [16]Ibid, [17]Kuzma and Verhage 2006 in Scrinis and Lyons 2010, [18]Joseph and Morrison 2006

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