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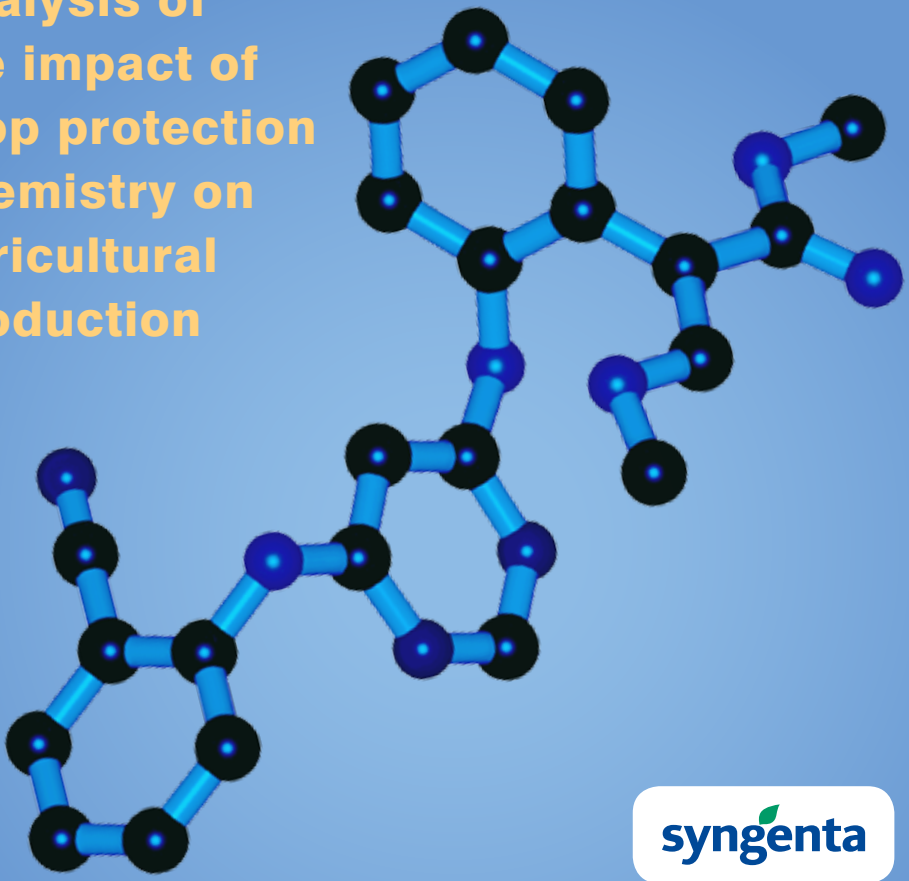
Biosciences

Technology Strategy Board

Driving Innovation

How the agriculture and food industry profits from innovation

Analysis of the impact of crop protection chemistry on agricultural production



syngenta

Analysis of the impact of crop protection chemistry on agricultural production: azoxystrobin as a case-study

Agriculture is heavily dependent on inputs such as fertilisers, herbicides, insecticides and fungicides which provide a crucial role to boosting and maintaining crop yields, ensuring an affordable food supply in the UK. Pesticides have a substantial impact on crop yields and it is estimated that without crop protection products up to 200% extra land would be required to produce the same amount of food in the UK[1]. Studies have highlighted the critical role of crop protection products on global agriculture, helping growers increase yields by 21.6% (wheat), 37.3% (maize), 39.6% (rice) and 53.2% (cotton) towards their theoretical maximum[2].

The UK has developed and manufactured a range of crop protection chemicals that have a significant presence in the global market. The pyrethroid family of insecticides was discovered at Rothamsted Research in the 1960's and 70's. At the time of their discovery they offered many advantages over other products on the market, including: greater efficacy at lower application rates; less persistence in the environment; less prone to bioaccumulation in organisms; safer than existing insecticides with very low mammalian toxicity. Pyrethroid discovery and manufacture has made a significant contribution to the UK economy – the global market for pyrethroids is worth $7 billion p.a. and accounts for c. 17% of all insecticide sales.

Developing new crop protection products

The development of new crop protection products is driven by a number of factors, including:

- Reducing the cost and increasing the efficacy of crop protection products
- Natural adaptation and resistance by pests to existing products
- Reducing the risk associated with pesticide usage, including the reduction of post-use residues to meet increasingly stringent regulation (e.g. 1107/2009/EC; EU Water Framework Directive 2000/60/EC; Sustainable Use Directive 2009/128/EC)

The development process from new compound discovery to registration of a new pesticide typically takes 9 years at a cost of more than $250 million. The process is represented schematically in Figure 1.

Azoxystrobin – the world's largest selling fungicide

Research at Syngenta in the UK developed azoxystrobin from natural compounds present in a fungus found on decaying beech trees. Further work was needed to modify these natural compounds to create a commercially viable product; for example the natural products were UV sensitive and therefore unstable in sunlight. Azoxystrobin emerged as one of the first products from the synthesis, development and regulatory process and was launched in 1996. The manufacture of azoxystrobin is undertaken at Granegemouth and brings significant benefit to the UK economy. **Azoxystrobin is used to treat more than 120 types of crop in around 100 countries with global sales worth just over $1.2 bn in 2010.**

Site of azoxystrobin manufacture at Grangemouth, UK

Enhancing crop yields towards their theoretical maximum

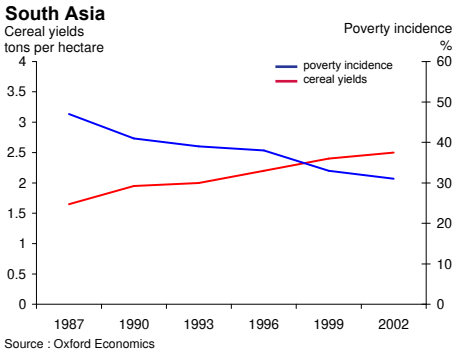
Azoxystrobin provides broad-spectrum disease control and substantial yield and quality improvements on a range of crops, including wheat, potato, leafy vegetables, fruit, soybean and cotton. The application of formulations containing azoxystrobin helps to protect crops against many forms of fungal disease. In Brazil, the commercial formulation Priori Xtra® is used to control leaf rust in the production of 4 million tonnes of soya. If this leaf rust were not controlled, an additional 2 million hectares of land would need to be committed to soya production to make up the yield shortfall. Independent studies have also highlighted the yield benefit delivered by strobilurin treatment through improved photosynthesis capacity (greening effect), increasing wheat yields by up to 9% in Northern European conditions[3].

Maintaining Biodiversity

Protecting crop yield against pests will be critical in the coming decades, where global population is predicted to reach 9 billion by 2050. Crop production will need to increase to meet the changing consumer demands, particularly in the BRIC countries, for meat and dairy products. Effective pesticide use will maximise crop yield from current agricultural land, helping minimise the amount of forest or grassland that needs to be converted to agriculture to meet the increasing demands of the food and feed industries in the coming century.

Crop yields and poverty

Crop protection technology helps to control the many weeds, pests and diseases that affect crops. Increased yield, reduced crop losses in the field from pests and disease, and decreased post-harvest spoilages are some of the key benefits that growers receive as a result of innovation in crop protection. Higher crop yields are also correlated with declines in the incidence of poverty in developing countries, as highlighted in the graph below:

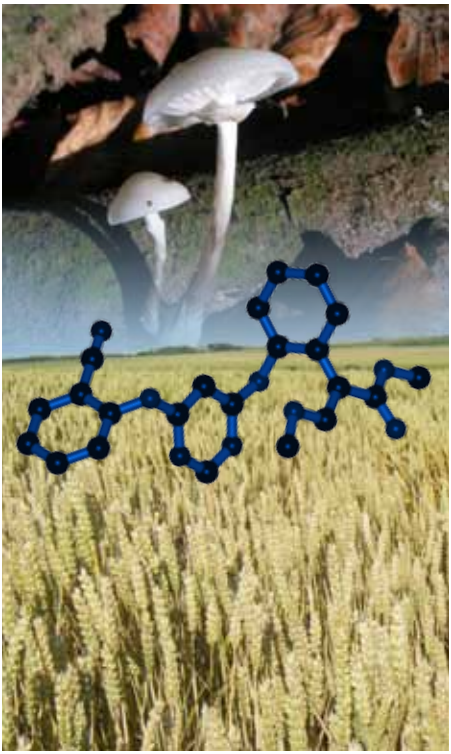


Source : Oxford Economics

Better nutrition boosts both the demand for and the ability to benefit from education, which helps to deliver better lifetime opportunities to the population of low income countries, which can develop increased demand for UK export markets.

Conclusion

The R&D work at Syngenta shows a clear example of how natural products can provide inspiration for the development and manufacture of new crop protection products. Azoxystrobin is now the world's biggest selling crop fungicide and illustrates how knowledge-transfer from the research-base to industry can have significant commercial and societal impact.



[1] Williams, AG, Audsley, E and Sandars, DL (2006) Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities. Main Report. Defra Research project ISO205. Bedford: Cranfield University and Defra.

[2] Oerke EC. The Journal of Agricultural Science (2006) 144(1): 31-43

[3] Beck C, Oerke EC, Dehne HW. Meded Rijksuniv Gent Fak Landbouwkd Toegep Biol Wet (2002) 67(2): 181-7

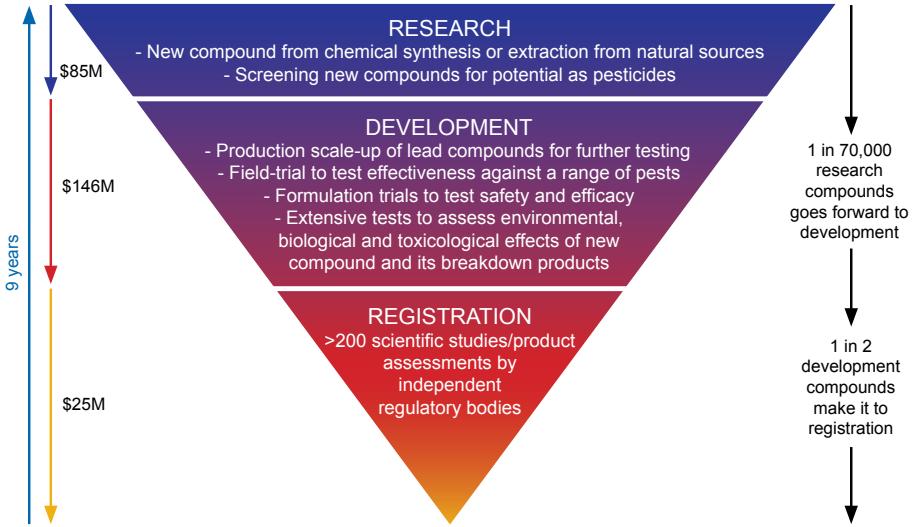


Figure 1. **Developing a new pesticide.** The inverted triangle graphically illustrates the discovery and development cost of a new crop protection product. It takes a minimum of 9 years and >$250M to research, develop and register each new plant protection product.

Based on a similar figure from *The Economic Benefits of Chemistry Research in the UK* (September 2010) reproduced with permission of EPSRC and The Royal Society of Chemistry.

Economic Benefits

The UK based manufacture of azoxystrobin brings substantial benefit to the UK economy and is also helping to ensure global food and feed security. The major economic impacts at UK and international levels include:

- Lowering the price of key agricultural products, including meat and dairy products
- Lowering the cost and increasing the availability of foodstuffs
- Reducing the amount of land required for crop production
- Increasing the land available for other agricultural products
- Reducing pressure to bring ‘wild land’ under cultivation, maintaining the diversity of habitats and biodiversity
- Increasing UK ‘food security’ and reducing dependence on imports
- Increasing disposable income for consumers
- Improving nutrition standards in developing countries

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