

Development in crop genetics:

Disease, insect and herbicide tolerance

Technologies in agriculture, and in particular in maize production, continue to advance in leaps and bounds. It is interesting to examine how many disease-, insect- and herbicide-tolerant transgenic traits are registered globally across all agricultural crops. According to the Centre for Environmental Risk Assessment (CERA) database, some 206 traits are available in these categories (www.cera-gmc.org).

Nine virus-resistant traits are available across carnations, papaya, plum, squash, common beans and potatoes. There are 77 insect-resistant traits in maize, cotton, tomato, potato, soya beans and rice. There are 120 herbicide-resistant traits spread across cotton, maize, carnations, canola, soya bean, creeping bent grass, tobacco, common bean, flax, sugar beet, lucerne, rice, chicory and wheat.

Insect resistance and herbicide tolerance clearly dominate, and crops of focus are essentially maize (with 48 insect-resistant traits and 52 herbicide-tolerant traits), soya bean (with three insect-

resistant traits and 17 herbicide-tolerant traits), and cotton (with 20 insect-resistant traits and 20 herbicide-tolerant traits).

Some 92 million hectares of soya beans (83% of all soya beans), 24 million hectares of cotton (75% of all cotton) and 54 million hectares of maize (29% of all maize) are planted with traited varieties and hybrids globally.

DroughtGard™

DroughtGard™ is one of the new traits that holds much promise, especially in maize production regions in South Africa where rainfall is often low, uncertain or erratic. The trait in DroughtGard™ is the world's first drought-tolerant biotechnology trait for maize and is designed to help maize plants better tolerate drought stress and minimise the risk of failure in drought conditions, and was commercialised in the United States (US) in 2013.

Yield gain in hybrids with DroughtGard™ occurs because it slows down the growth of maize hybrids experiencing moisture stresses, such that existing soil moisture is saved for the

critical period of flowering, resulting in less kernel abortion, thus protecting the expected yield.

Nutritional quality traits

This is a more complicated segment to quantify, but traits such as low lignin (to enhance digestibility in livestock) in lucerne, non-browning apples, pro-vitamin A and iron-enriched bananas, vitamins A-, B9- and C-enriched maize, high-content omega 3 fatty acid-enriched canola, beta carotene-enriched rice, and low-saturated/high-oleic fatty acid-enriched soya beans are but a few that are receiving attention currently (Agnès E Ricroch & Marie-Cécile Hénard-Damave, 2016).

CRISPR – a new gene-editing tool

Clustered regularly interspaced short palindromic repeats (CRISPR) is a naturally occurring ancient defence mechanism found in a wide range of bacteria, which evolved to protect them against viral infections. As far as back the 1980s, scientists observed a strange pattern in certain bacterial genomes. One deoxyribonucleic acid (DNA) sequence would be repeated continuously, with unique sequences in between the repeats.

Scientists realised the unique sequences in between the repeats matched the DNA of viruses – specifically viruses that prey on bacteria. CRISPR form part of the bacteria's immune system, keeping parts of the viral DNA of dangerous viruses so it can recognise and defend against such viruses the next time they attack. A second part of the defence mechanism is a set of enzymes called CRISPR-associated (Cas) proteins, which can precisely snip DNA and remove the DNA of invading viruses.

Using this precise gene-editing technology, CRISPR could one day

Canola is one of the GM crops that boasts herbicide-resistant traits.

hold the cure to a number of genetic diseases, although human genetic manipulation is still far from becoming routine. Furthermore, CRISPR could become a major force in ecology and conservation, especially when paired with other molecular biology tools. It could, for example, be used to introduce genes that slowly kill off mosquitos spreading malaria, or genes that slow down the growth of invasive species such as weeds.

Since its 2013 demonstration as a genome-editing tool in *Arabidopsis* and tobacco — two widely used laboratory plants — CRISPR has been tested on crops, including wheat, rice, soya beans, potatoes, sorghum, oranges and tomatoes. It is expected to be used widely in agricultural research applications, including boosting crop resistance to pests and reducing the toll of livestock diseases.

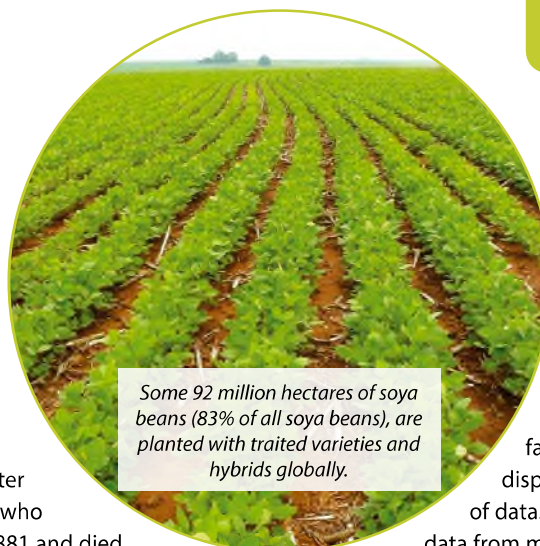
Precision agriculture and big data

Precision farming is not a new concept, and could be defined as “using every acre within its capability and treating it

according to its needs,” according to Hugh Hammond Bennett, widely considered to be the father of soil and water conservation, who was born in 1881 and died in 1961.

Precision agriculture could also be defined as “a management system that is information- and technology-based, is site specific and uses one or more of the following sources of data: soils, crops, nutrients, pests, moisture or yield, for optimum profitability, sustainability and protection of the environment”.

Nonetheless, with the increasing availability of data and tools to generate and interpret data rapidly and cost-effectively, it has become possible to do more in-depth analyses of increasingly smaller parts of a farmer's field. The



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digitisation of this data has made precision farming possible.

With today's equipment that can collect information digitally, farmers have at their disposal huge quantities of data. The ability to use

data from multiple sources to build a 'digital' picture of a production field, enables today's growers to make quality decisions regarding hybrid choices, planting densities, fertilisation requirements etc.

Furthermore, they are able to do this for smaller and increasingly more precise areas in their fields. This leads to optimisation of productivity in each one of a grower's fields, which ultimately leads to a high level of sustainability and productivity. Development in maize genetics and production systems also plays an important role in providing greater food security. 🌱

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