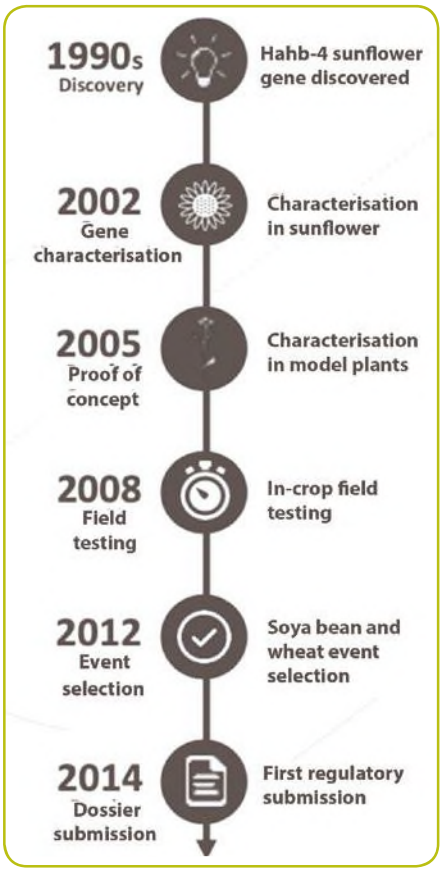
Drought-tolerant sunflower gene
the first of its kind

By Martin Mariani Ventura, global seed and trait manager, Verdeca

In 2003, Bioceres initiated a research collaboration with the National Scientific and Technical Research Council (also known as CONICET), Argentina's main research organisation, and the National University of the Littoral (also known as UNL), a Santa Fe-based university where an essential plant molecular biology research lab is based. There, a group led by Dr Raquel Chan and Dr Daniel González discovered the drought-tolerant effect of a sunflower gene named Hahb-4.

Figure 1: HB4® technology timeline.



Based on the group's discovery and additional know-how, Bioceres funded a project specifically for the development of a new Hahb-4 gene expressing *Arabidopsis thaliana* plants with different promoter elements, to test molecular constructs that would later be used in crops of interest.

Early attempts to develop drought-tolerant crops using biotechnology

Figure 2: How does HB4® work?

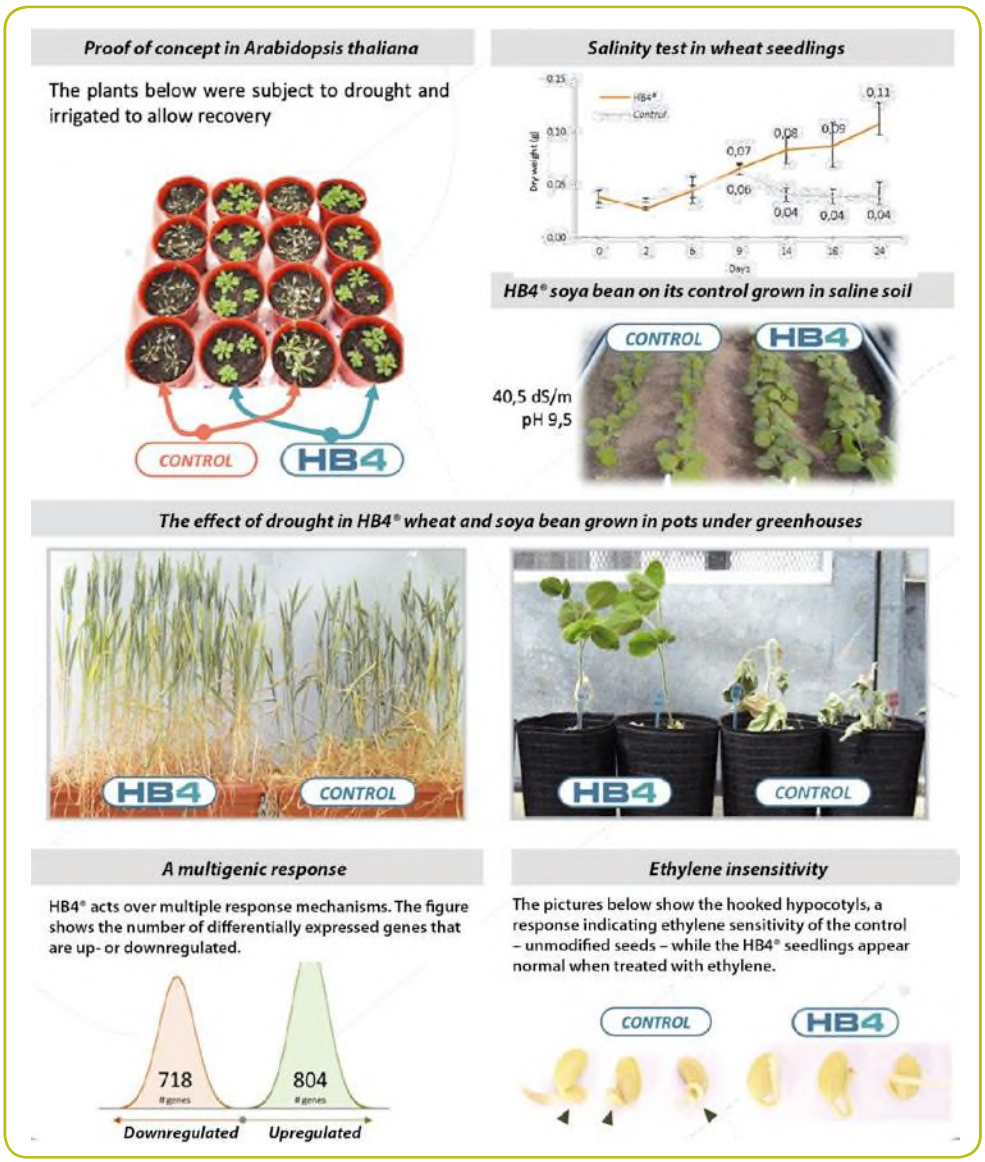
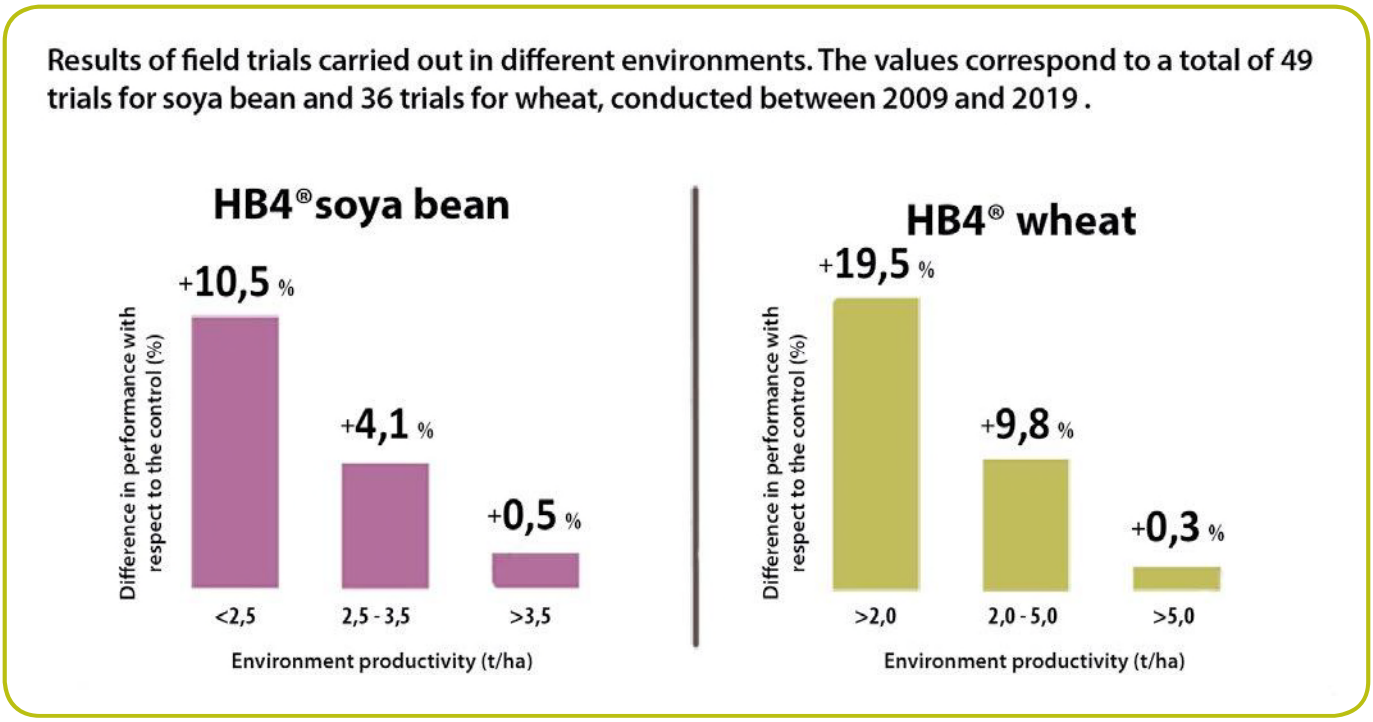


Figure 3: HB4® technology performance.



were focussed on single-function genes. In many instances, genes from desert thriving plants were used to induce higher synthesis of osmolytes or enzymes involved in scavenging reactive oxygen species. These modifications often produced plants that could survive with less water, but yields were also less even in optimal growing conditions.

The only two commercial drought-tolerant technologies available today are based on this approach. Monsanto utilised a bacterial chaperone for its DroughtGard® maize, and PT Perkebunan Nusantara XI's NXI-4T sugar cane uses a bacterial enzyme that catalyses the production of an osmoprotectant.

A different strategy involves genes responsible for signalling cascades and gene expression regulation.

Where biotech fails, HB4® succeeds

The consensus today is that regulatory genes are likely to provide valuable tools to increase yields under a variety of challenging growing conditions. The Hahb-4 gene is a transcription factor that modulates the expression of several hundred genes and provides drought tolerance, making the HB4® technology unique as there are no similar commercial products available today.

Furthermore, the response driven by the Hahb-4 gene is not related to early stomatal closure, an unsuccessful target during biotech's early attempts to develop drought tolerance.

A particularly efficient version of the Hahb-4 gene was identified to provide enhanced efficacy. An additional distinctive element of the technology is the absence of yield drag in high yield conditions. This is in part due to the inducible nature of the promoter elements and the very low expression levels of the modified Hahb-4 gene, even under severe environmental stress.

Ethylene physiology plays an important role in the decreased yields of crops grown under abiotic stress conditions. HB4® not only decreases ethylene synthesis, but also causes plants to be more insensitive to its effects.

Crop transformations started once greenhouse efficacy with optimised genetic constructs in model plants was completed. Seed from multiple events were multiplied to allow for the first field trials in 2008 and 2009 for wheat and soya bean, respectively. Lead events were selected after several seasons of positive results in field tests.

Final event selections were carried out in 2012 for wheat, and in 2013 for soya bean based on multiple performance and molecular data. Such data was used to complete an intellectual property (IP) portfolio for the technology comprising three patent families. In parallel, the available information has been published in several recognised scientific journals

Verifiable resilience

The modified sunflower Hahb-4 gene augments the plant's adaptability to the environment, thereby enabling a greater grain yield. Field performance data from multiple seasons shows that HB4® technology can improve yields in soya bean to wheat systems by between 10 and 20%, even in unfavourable years when yields are generally low.

Consequently, the same data shows no yield penalty due to the technology in good years, when yields are greater. The combination of these two features makes HB4® technology the first of its kind.

For more information, send an email to contact Martin Mariani Ventura at martin.mariani@verdeca.com.ar.