HB4®

WHITE PAPER

HB4® White Paper – Version 2.0
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Introduction

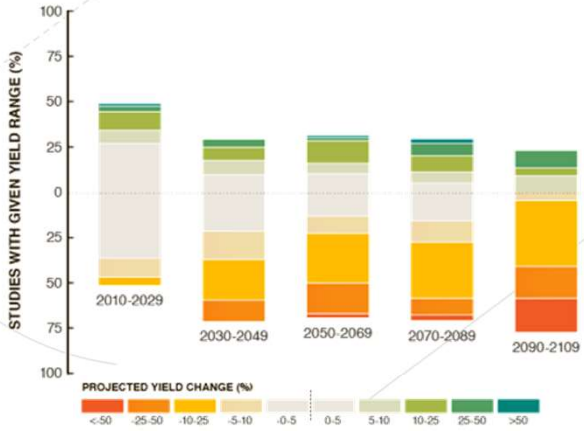
The latest Intergovernmental Panel on Climate Change Report indicates with high confidence that "Climate change, including increases in frequency and intensity of extremes, has adversely impacted food security and terrestrial ecosystems as well as contributed to desertification and land degradation in many regions". At the same time, land use, including deforestation, agriculture, and ruminant livestock, account for one quarter of anthropogenic greenhouse gas (GHG) emissions. While climate change will have an impact on crop´s yields and nutritional value, decreased agricultural outputs will fail to meet demands as population grows in the following decades. Consequently, agriculture faces a major challenge: to enhance the resilience of global food systems and at the same time move towards carbon neutrality.

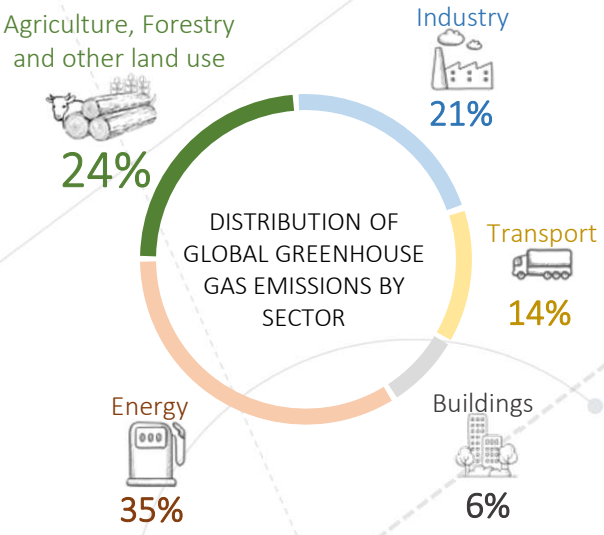
The unprecedented challenge of preserving our global environment today means we can no longer afford to increase agriculture production at a cost to environmental stability. This scenario leaves humanity with basically three avenues to reconcile agricultural productivity with environmental sustainability: reduce food waste, shift towards less meat intensive diets in the developed world, and use the existing resources more sustainably.

Most studies agree that climate change impacts on crop yield will be negative from the 2030s onwards and nearly half of those predict yield reductions greater than 10% beyond 2050. Since 2003 Bioceres has been developing a technology that provides yield enhancement under drought to soybean and wheat, two highly complementary crops. This white paper summarizes this 16-years-long product development journey, and it proposes a strategy to reach out to consumers that are actively seeking more sustainable produced food at no premium price.

The effect of climate change on crops yield

The figure summarizes studies that predict climate change impact on yields. Most studies indicate significant negative impacts from 2030 and beyond.





Challinor AJ, Watson J, Lobell DB, Howden SM, Smith DR, Chhetri N. **2014**. "A meta-analysis of crop yield under climate change and adaptation". *Nature Climate Change* 4: 287 – 291
IPPC report, 2014

Excutive Summary

In 2003 Bioceres initiated a collaboration with a research group lead by Dr. Raquel Chan from the Universidad Nacional del Litoral (UNL) and Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET). The objective of the collaboration was to characterize the role of the *hahb-4* gene, a sunflower transcription factor that they had recently discovered. Of particular interest to Bioceres was the role of the gene in the plant's response to drought. The collaboration resulted on several scientific publications and patent families.

After validating the results in soybean-wheat system, Bioceres and its partners further developed the drought tolerance technology, now named HB4®. This name was created as a simplification of the sunflower´s gene name (*hahb-4*). Initially the main effort was directed to the regulatory approvals required in both production and consumption countries. More recently, developing competitive seed varieties has become the priority.

The company intends to broadly out-license the technology to seed companies. However, under its proprietary strategy, the company will commercialize the HB4® technology in a first-to-market product that integrates biological and digital components named EcoSeed. This integrated product is the result of several years of co-development efforts that included developing wheat and soybean varieties for the HB4® targeted areas and novel bacterial strains for region-specific seed treatments. The digital component will provide customers access to a specific set of applications (app.). The most important app will allow customers to monitor a crop's evolution to validate the EcoSeed value proposition.

While there are pending approvals, Bioceres' has initiated a program, named "HB4®-Program", initially oriented to multiply seed with selected farmers. In addition to seed increases, the program is designed to further evaluate the product performance, determine product positioning, and carry out field days to showcase the EcoSeed products to different stakeholders.

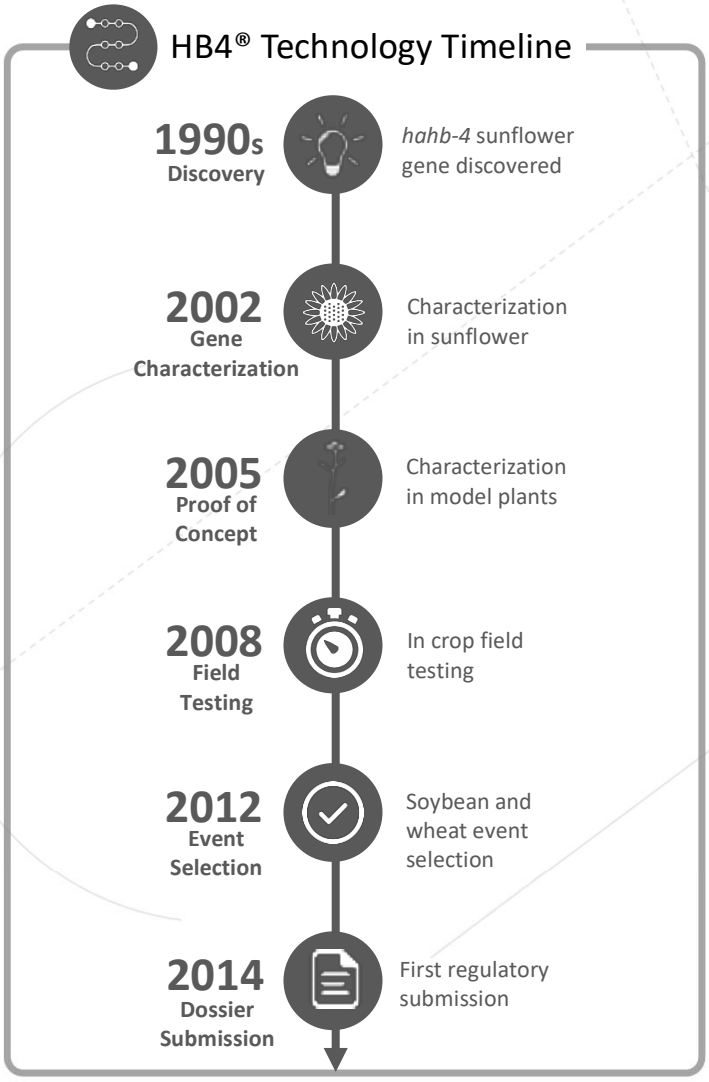
The HB4® Program can also be used as the exclusive grain source for grain processors during the early commercial stages. Finally, we believe HB4® can evolve into a consumer brand.

Chapter 1

HB4® Drought technology

HB4® Drought technology

In 2003 Bioceres initiated a research collaboration with Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina´s main research organization and Universidad Nacional del Litoral (UNL), a local university that hosts an important plant molecular biology research lab. There, a group led by Dr Raquel Chan and Dr Daniel González had discovered the drought tolerance effect of a sunflower gene named *hahb-4*. Based on the group's discovery and additional know how, Bioceres' funded a specific project to develop new *hahb-4* expressing *Arabidopsis thaliana* plants with different promoter elements to test molecular constructs to be later used in crops of interest.



Early attempts to develop drought tolerant crops using biotechnology were focused 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 resulted in plants that could survive with less water but yielded less in optimum growing conditions. However, the only two commercial drought tolerance technologies available today are based on this approach. Monsanto´s utilized a bacterial chaperone for its Drought Guard® corn and PT Perkebunan Nusantara XI's NXI-4T sugarcane uses a bacterial enzyme that catalyzes the production of an osmoprotectant.

A different strategy involves genes responsible for signaling cascades and gene expression regulation. The general 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 for drought tolerance.

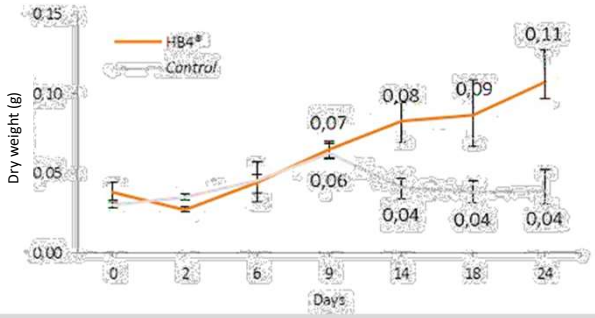
A particularly efficient version of the *hahb-4* gene was identified to provide enhanced efficacy. An additional distinctive element of the technology is the absence of yield drag in high yield conditions. This is in part due to the inducible nature of the promoter elements and the very low expression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

How Does HB4® Work?

Proof of concept in Arabidopsis thaliana

The plants below were subject to drought and irrigated to allow recovery

Salinity test in wheat seedlings



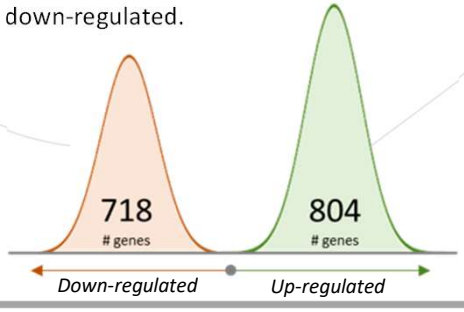
HB4® soybean an its control grown in saline soils

40,5 dS/m
pH 9,5

The effect of drought in HB4® wheat and soybean grown in pots under greenhouses

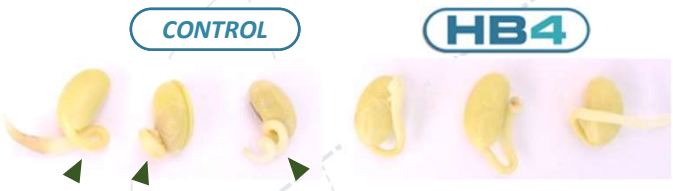
A multigenic response

HB4® acts over multiple response mechanisms. The figure shows the number of differentially expressed genes that are up- or down-regulated.



Ethylene insensitivity

The pictures below show the hooked hypocotyls, a response indicating ethylene sensitivity, of the control - unmodified seeds - while the HB4® seedlings appears normal when treated with ethylene.



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 optimized 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 soybean 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 soybean based on multiple performance and molecular data. Such data were used to complete an intellectual property (IP) portfolio for the technology consisting on three patent families. In parallel, the available information has been published in several recognized scientific journals.

IP Portfolio

The HB4® technology is protected locally and internationally by three patent families.

TRANSCRIPTION FACTOR GENE INDUCED BY WATER DEFICIT CONDITIONS AND ABSCISIC ACID FROM HELIANTHUS ANNUUS, PROMOTER AND TRANSGENIC PLANTS

MODIFIED HELIANTHUS ANNUUS TRANSCRIPTION FACTOR IMPROVES YIELD

SOYBEAN TRANSGENIC EVENT IND-ØØ41Ø-5

WHEAT TRANSGENIC EVENT IND-ØØ412-7

HB4® Scientific Publications

- An Interdisciplinary Approach to Study the Performance of Second-generation Genetically Modified Crops in Field Trials: A Case Study With Soybean and Wheat Carrying the Sunflower HaHB4 Transcription Factor. *Front Plant Sci. Gonzalez F.G., et al.,* **(2020).** *Front Plant Sci.* 6;11:178.
- "Succesful field performance in warm and dry environments of soybean expressing the sunflower transcription factor HaHB4". *Ribichich K.F., et al.* **(2020)**. *J Exp Bot.* 71(10):3142-3156.
- "Field-grown transgenic wheat expressing the sunflower gene HaHB4 significantly outyields the wild type". *Gonzalez FG., et al.* (**2019**) *J Exp Bot.* 70(5):1669-1681.
- "Compositional equivalence of event IND-ØØ412-7 to non-transgenic wheat". Ayala F., et al (**2019**). *Transgenic Res.*28(2): 165-176.
- "HAHB4, a sunflower HD-Zip protein, integrates signals from the jasmonic acid and ethylene pathways during wounding and biotic stress responses". *Manavella PA., et al.* (**2008**) *Plant J.* 56(3):376-88.
- "Hahb-4, a sunflower homeobox-leucine zipper gene, is a developmental regulator and confers drought tolerance to *Arabidopsis thaliana* plants". *Dezar CA., et al.* (**2005**). *Transgenic Res*. 14(4):429-40.
- "Hahb-4, a homeobox-leucine zipper gene potentially involved in ABA-dependent responses to water stress in sunflower". *Gago MG., et al* (**2002**). *Plant Cell and Environment* 25, 633-640.
- A monomer-dimer equilibrium modulates the interaction of the sunflower homeodomain-leucine zipper protein Hahb-4 with DNA" *Palena CM., Gonzalez DH. and Chan RL* (**1999**) *Biochemical Journal* 341 (1), 81-87.
- A cDNA encoding an HD-zip protein from sunflower. *Chan RL. & Gonzalez DH* (**1994**) *Plant physiology* 106 (4), 1687

Once final events were selected in each crop, additional regulatory studies were initiated. Commercialization approvals in each production and consumption territory require extensive safety data. For wheat, the technology is targeted for production and consumption within Latin America as this region is a net wheat importer. However, in the case of soybean and since the region is a net exporter, the regulatory strategy includes seeking import approvals from the main importers, particularly China and the EU.

The Regulatory Process

- Genetically modified organisms are considered regulated material until their safety are confirmed by specialized regulatory agencies.
- Approval requirements include the confirmation of both environmental as well as consumption safety of the transgenic event and derived products.
- Diverse information including agronomic, molecular, compositional, nutritional and environmental features of the event, are required in order to complete the risk assessment processes. Some countries allow differential approvals based on the purpose of use, such us for food, feed or cultivation.
- Each country has its own evaluation process.
- The decision of where to seek regulatory clearance is based on regulatory and market requirements, which are different for each crop and are subject to change based on the market´s behaviors.

The average cost of de-regulating a new biotech event is **$ 35 Million**[1]

The overall time needed to discover, develop and register a new biotech trait is **13 years**[1]

*HB4® is **substantially equivalent** to its conventional counterpart*

- The HB4® protein has a long history of safe use.
- Over 70 parameters have been studied in HB4® crops from multiple seasons and locations.
- The HB4® wheat and soybean are compositionally equivalent to their conventional counterparts.[2-3]
- Feeding studies have concluded that HB4® crops are as nutritional as their conventional counterpart.

The tables below illustrate the equivalence of the HB4® events to their conventional counterparts

PROXIMAL ANALYSIS OF HB4® SOYBEAN GRAIN

PARAMETER	VALUE	REFERENCE
ASH	5,7	4,8 – 6,3
CARBOHYDRATES	33,8	31,4 – 38,1
MOISTURE	9,5	7,7 – 11,8
PROTEIN	39,1	36,6 – 43,1
TOTAL FAT	19,9	16,6 – 21,6
ADF	12,5	10,5 – 17,8

FUNCTIONAL ANALYSIS OF HB4® WHEAT GRAIN

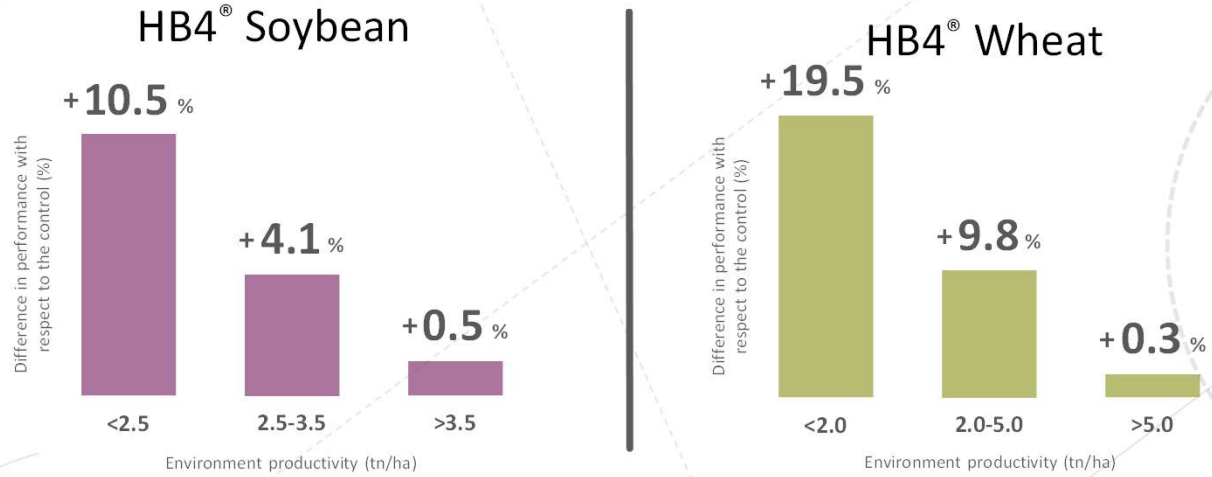
QUALITY PARAMETER	VALUE	REFERENCE
P[4]	76 ± 3,4	53 – 100
L[5]	101 ± 4,6	60 – 167
G[6]	22,3 ± 0,5	17,2 – 28,7
W[7]	257 ± 15	171 – 325
P/L	0,76 ± 0,05	0,34 – 1,54
TEST WEIGHT	74,9 kg/hl	72,5 – 76,9
FLOUR YIELD/ASHES	133 %	135 – 155
GLUTEN	23,3 %	21,7 – 24,6

[1]"The cost and time involved in the discovery, development and authorization of a new plant biotechnology derived trait." (**2011**) Phillips McDougall
[2]"Compositional equivalence of event IND-ØØ412-7 to non-transgenic wheat." Ayala F., et al (**2019**). *Transgenic Res*.28(2): 165-176.
[3] Internal data
[4, 5, 6, 7]"The alveograph handbook." Hamed Faridi and Vladimir F. Rasper (**1987**). **P**: Maximum overpressure; L: Average abscissa at rupture; **G**: Index of swelling; **W**: Deformation energy

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 shown that HB4® technology can improve yields in soybean-wheat systems by between 10-20 %, in adverse years when yields are generally low. Consequently, the same data shown 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.

HB4® Technology Performance

Results of field trials carried out in different environments. The values correspond to a total of 49 trials for soybean and 36 trials for wheat, conducted between 2009 and 2019



Chapter 2

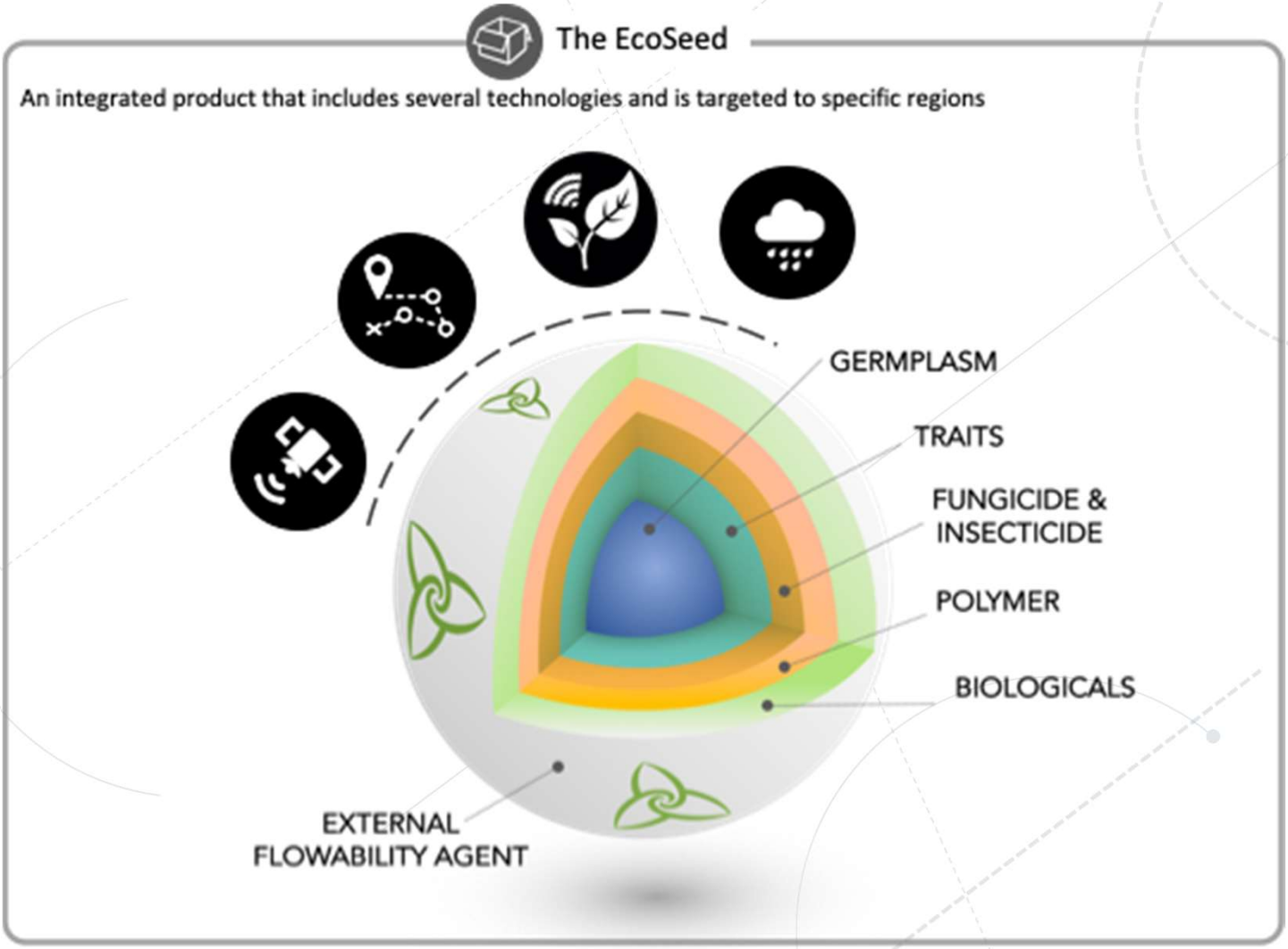
EcoSeed

EcoSeed

Today seeds integrate several technologies including germplasm, traits and seed treatments. Business as usual follows a bundling approach where traits are broadly incorporated on breeding programs and then seeds, excluding hybrids, are treated by farmers or distributors with standard fungicides and insecticides. Bioceres uses a different strategy for its proprietary products. Instead of bundling products together, it co-develops seeds, germplasm and biological seed treatments for specific regions right from the start.

Events like HB4® can only be launched after a time-consuming breeding process to develop varieties that combine the technology and locally adapted, elite germplasm. Bioceres and its partners have been developing varieties that specifically target areas identified for maximum trait performance. In order to predict performance on all crop growing areas, Bioceres built a prediction model based on HB4® field data. The model considered the historical yield data on each county and predicted the yield difference added by the HB4® technology.

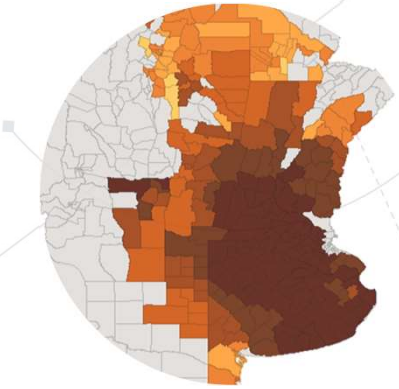
The testing network for the breeding program was specifically designed to validate the performance of the HB4® varieties on the target areas.



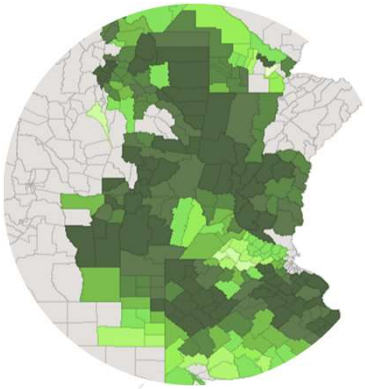
HB4® Target Areas

We obtained the official wheat and soybean production statistics of each county in Argentina published by the Ministry of Agroindustry of Argentina between 2011 and 2016. We used the average yield data of each county to estimate the yield benefit for each county. We then used the average price for the ten-year period ending in 2016 to calculate the expected benefit.

Wheat



Soybean



HB4® U$S/Ha

N/A	N/A
6-13	32-44
13-19	45-49
19-25	50-53
25-32	54-55
32-38	56-58
38-44	59-60
44-51	61-62
51-57	63-64
57-64	65-68

In 2012 Bioceres partnered with Rizobacter to develop plant growth promoting rizobacteria (PGPR) specifically for the HB4® wheat and soybean varieties. Prior to this collaboration, Bioceres has been involved in a soil metagenome project that resulted in the world largest genetic database of soil microorganisms of its day. Bioceres contributed its metagenomics expertise and Rizobacter its microbial product-development know-how. The project included the screening of over 4,500 microorganisms isolated from roots of HB4® varieties. After an in-depth lab characterization of the strains several candidates were tested in field trials over multiple locations and seasons. Four strains were selected for registration. In parallel, fermentation protocols were developed for commercial scale production.

The EcoSeed products also include components from the existing Rizobacter's portfolio. For instance, both the soybean and wheat EcoSeed will be treated with Rizoderma, a biological fungicide. In the case of soybean, the EcoSeed will be treated with the best fitting biofertilizer or inoculant for each region.

Biological Fungicide

Rizoderma

Is the only registered biological fungicide for wheat and soybean seeds in Argentina.

Control

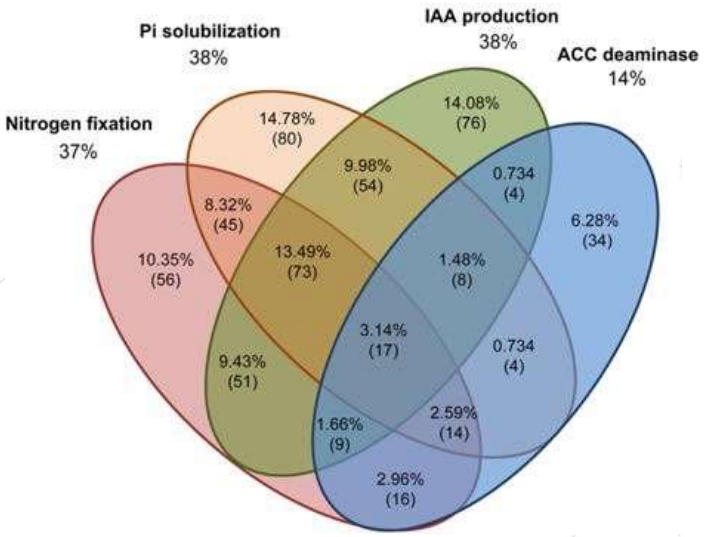
Rizoderma

Based on a *Trichoderma harzianum* strain, effective in combating the development of most important diseases.

Development of Specific PGPR

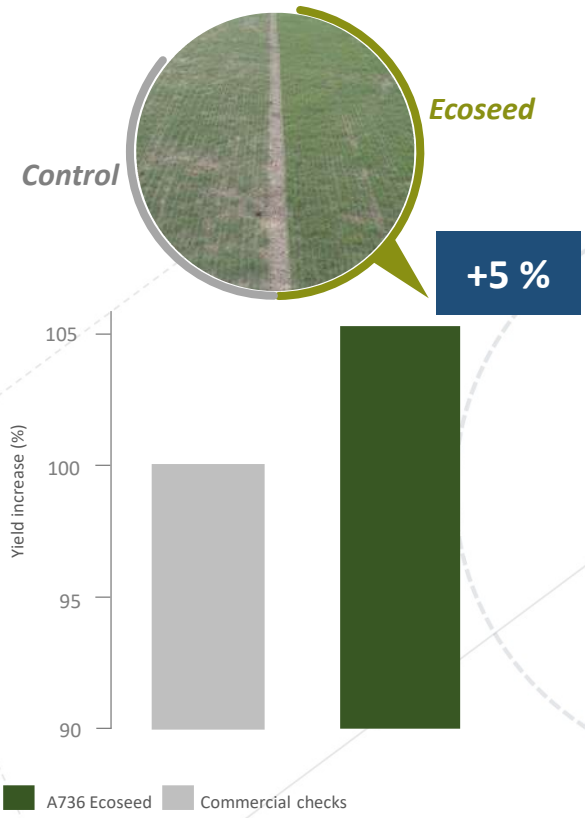
Bioceres co-developed specific biologicals for its HB4® varieties by screening candidate strains on the HB4® targeted areas. After six years and a significant effort, it is currently registering strains that will be included on the EcoSeed products.

The isolated strains where characterized according to four plant growth promoting (PGP) traits.

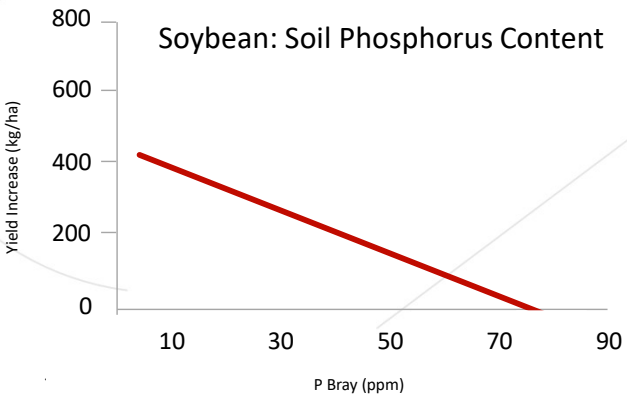


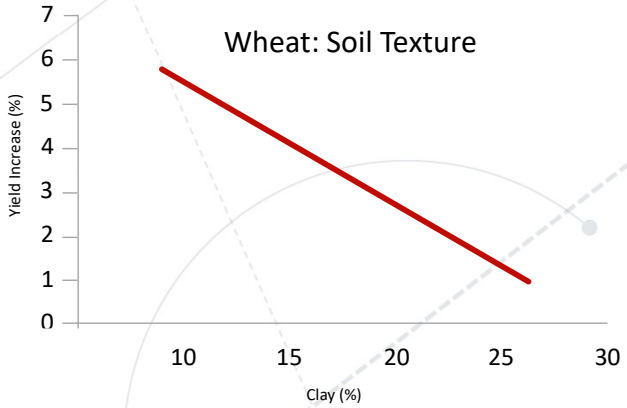
Venn-Diagram showing the isolates that presented each of the possible combinations for the four different PGP evaluated traits. Values are presented in relative abundance (percentage) and as absolute number of isolates (in parenthesis).

HB4® wheat yield increase due to specific PGPR



Response of selected PGPR to different soil environments in Wheat and Soybean





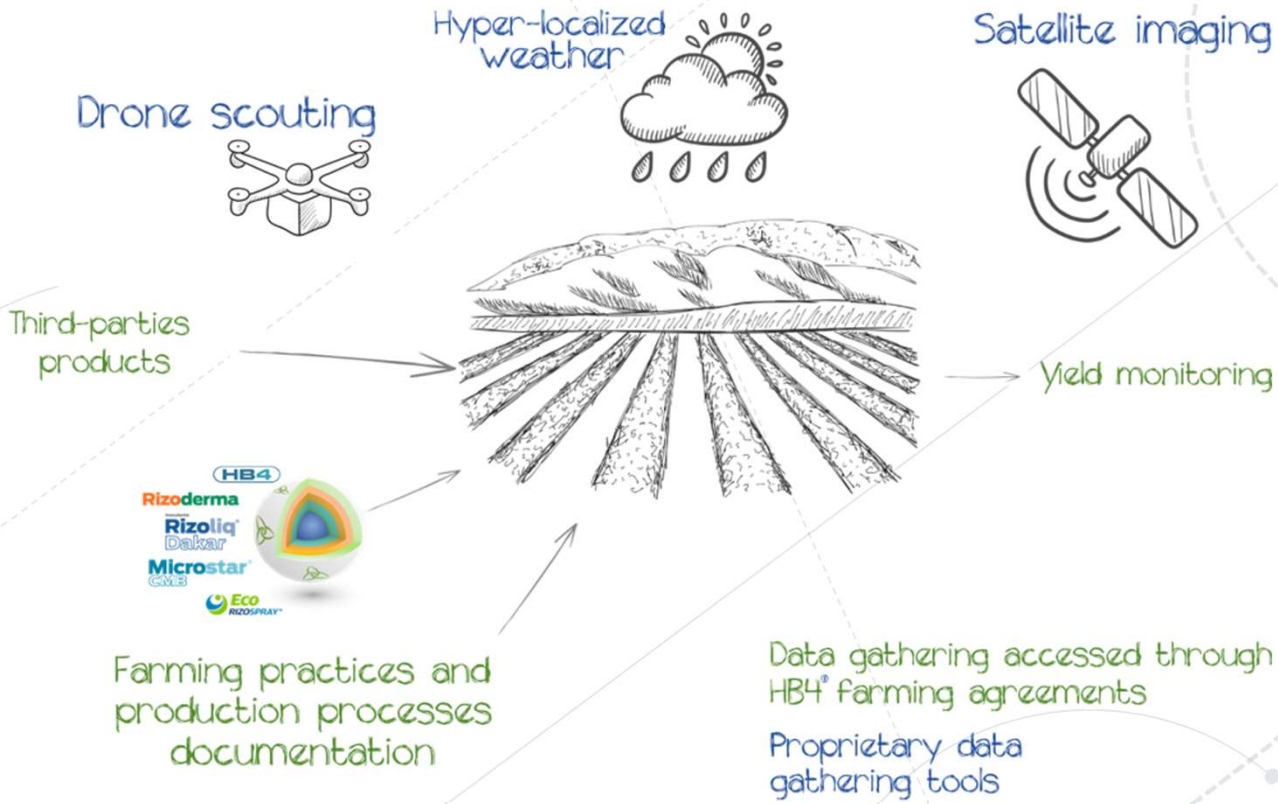
Integrated analysis of root microbiomes of soybean and wheat from agricultural fields. Rascovan, N. and Carboneto, B. (2016) Scientific Reports | 6:28084

In addition to seed treatments, the EcoSeed products include access to digital apps. Initially, farmers sowing EcoSeed will have access to a satellite-based crop image app, a weather monitor app and a crop scouting app. The purpose of these apps, particularly the crop image app, is to provide a tool to observe performance differences between fields planted with the EcoSeed and neighboring fields without the technology package. At this stage the digital apps are designed to provide customer support.

The digital apps included on the EcoSeed are expected to become the initial digital contact between Bioceres and farmers. The platform can facilitate recording field activities, equipment data integration and refine products positioning based on field performance. It is expected that the digital interaction will provide traceability for an identity preserved productions system in the future.

Digital platform

Bioceres and its partners will provide, a digital platform of IT tools to manage data from different sources and transform it into useful information.



EcoWheat

EcoWheat

In 2012 Bioceres and Florimond Desprez created a JV named Trigall Genetics to develop HB4® wheat varieties. These varieties and the associated regulatory effort are targeted to the South American region. The business model for HB4® wheat is not based on trait licenses to breeding companies but rather on licensing finished varieties.

EcoWheat Timeline

2010 **Breeding** — Initiate HB4® wheat breeding program with candidate events

2012 **Selection** — Selected the HB4® wheat event

2013 **Develop** — Initiated specific PGPR screening for the HB4® wheat

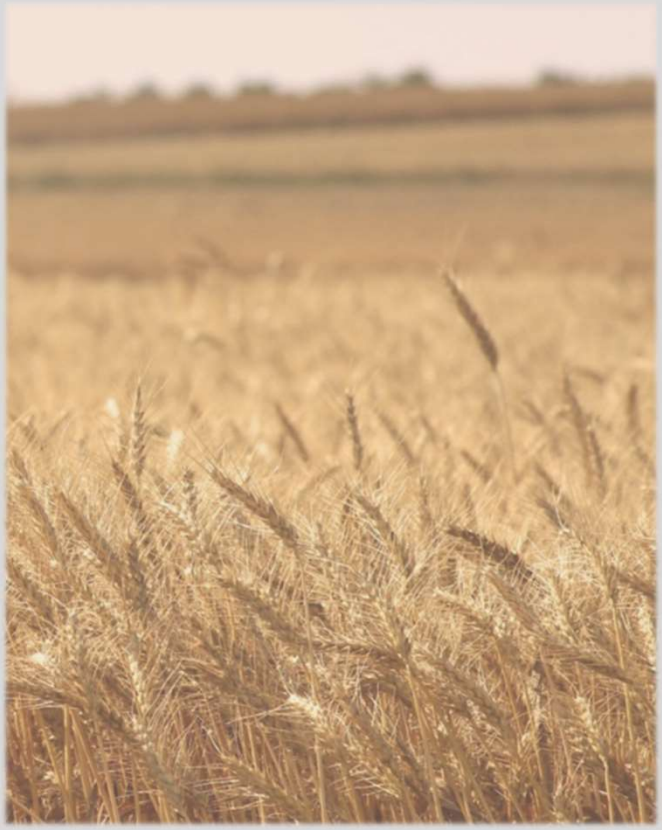
2015 **Testing** — First Ecoseed field trial

To develop elite HB4® wheat varieties, we initiated an accelerated-marker-assisted breeding program. The output of this program was tested on all the target areas with favorable results, particularly in high yielding environments, when EcoWheat continued to show yield advantages.

Who is Florimond Deprez?

Is an independent and family-owned company founded on 1830, carrying on breeding and seed production activities, meeting the expectations of the Ag sector. The group is the world leader in sugar beet seed and is among the leaders in cereals seed.

FLORIMOND DESPREZ



The regulatory strategy for HB4® wheat is a two stage approach. On the first stage it includes deregulation for production and consumption in Argentina, Uruguay and Paraguay and for consumption only in Brazil and the USA. Additional wheat growing territories will be targeted on the second stage once commercial production is initiated in Argentina.

Under Bioceres proprietary channel, the HB4® varieties will be commercialized within the integrated product, the EcoWheat. The seed treatments for EcoWheat will include a specifically developed PGPR, a biological fungicide (Rizoderma) and an insecticide. The initial PGPR options are an *Acidovorax* strain for sandy soils and a *Bacillus* strain for clay or loam soils.

HB4® Wheat Regulatory Status

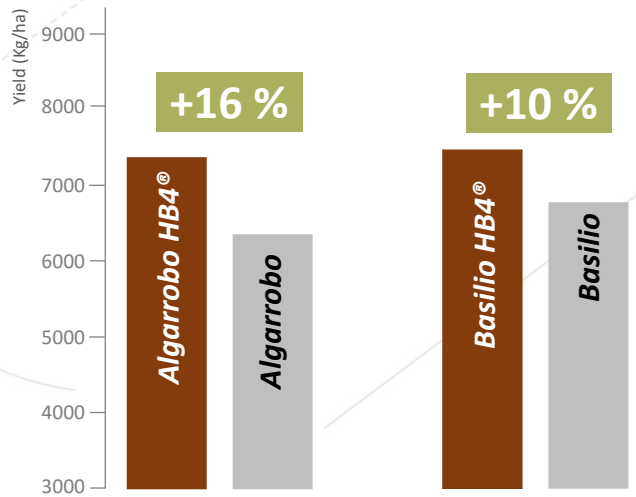
	FOOD & FEED		PRODUCTION	
COUNTRY	SUBMISSION YEAR	APPROVAL YEAR	SUBMISSION YEAR	APPROVAL YEAR
ARGENTINA	2014	2016[1]	2014	2016[2]
URUGUAY	2015	-	2015	-
BRAZIL	2019	-	-	-
PARAGUAY	2016	-	2018	-
USA	2018	-	-	-

[1] Refers to SENASA positive office action. Commercial approval still pending
[2] Refers to CONABIA positive office action. Commercial approval still pending

HB4® Wheat Performance

Algarrobo and Basilio are top selling varieties in Argentina and Uruguay. These varieties have been converted to carry the HB4® trait and evaluated in a high productivity environment. Significant yield benefits have been observed for HB4® Algarrobo and HB4® Basilio.

HB4® advanced lines performance at Balcarce



EcoSoy

EcoSoy

Verdeca, a JV created in 2012 between Bioceres and Arcadia Biosciences, is developing soybean varieties that incorporate the HB4® technology. At the same time, Verdeca is pursuing a broad regulatory effort in the Americas as production territories, and on key soybean-consuming markets like China and the EU.

Eco Soy Timeline

2010 Breeding — Initiate HB4® soybean breeding program

2013 Selection — Selected the HB4® soybean event

2014 Develop — Initiated specific PGPR screening for the HB4® soybean

2016 Testing — First Ecoseed field trial

The HB4® trait has been licensed to soybean seed market leaders like Don Mario and TMG to maximize trait penetration in South America. However, Bioceres Semillas, Verdeca's preferred licensee will be the first to reach the market with its EcoSoy integrated product. Similarly, to the EcoWheat, EcoSoy takes advantage of Rizobacter's biological treatments portfolio, carries novel bacterial strains developed specifically for the HB4® varieties and provides access to digital agriculture apps.

Who is Arcadia Biosciences?

A Nasdaq listed company that is focused on developing products based on biotechnology. With an expertise on GM and non GM breeding, they have developed traits in several crops

Arcadia BIOSCIENCES

Soybean Inoculants

Rizobacter is the market leader for soybean inoculants. Over the past decades it has generated a broad range of products. Most recently Rizobacter launched Rizoliq Dakar®, an inoculant with enhanced performance under drought and heat. This product fits very well with the HB4® soybean target area and will be included on the corresponding EcoSoy product.

- Mitigates main problems during inoculation
- Higher nodules, nodular dry mass and vegetative biomass.
- Tolerates below optimal conditions of storage and planting.

Performance of the HB4® technology on elite germplasm has been observed on proprietary as well as third parties breeding programs. Recent results from trials conducted in Brazil point at yield increases of around 20%.

EcoSoy has been broadly field tested since 2016 and the regional positioning of the initial varieties has been defined. These EcoSoy products integrate specific PGPRs, Rizobacter's legacy inoculants, including stress tolerant formulations for drought prone areas and a biofungicide. Initially the PGPRs will be two *Pseudomonas* strains, one that performs under low soil phosphorus levels and the other provides benefits during the early crop development stages, while both facilitate crop establishment.

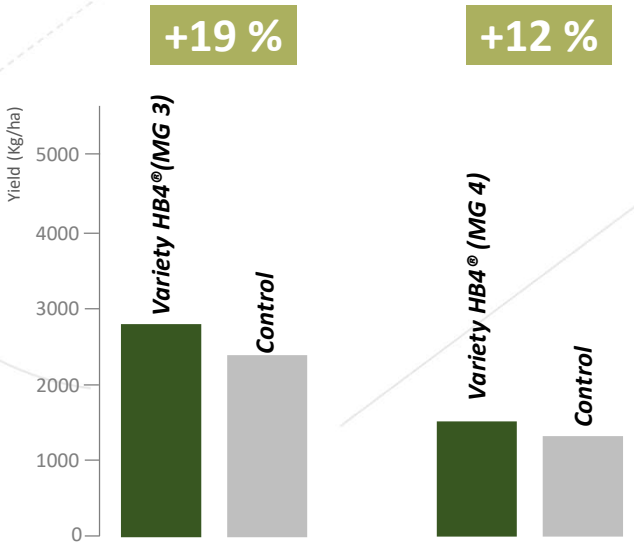
HB4® Soybean Regulatory Status

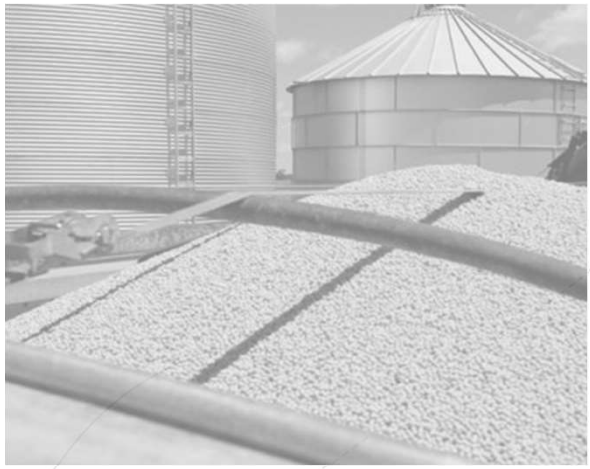
	FOOD & FEED		PRODUCTION	
COUNTRY	SUBMISSION YEAR	APPROVAL YEAR	SUBMISSION YEAR	APPROVAL YEAR
ARGENTINA	2014	2015	2014	2015
URUGUAY	2015	-	2015	-
BRAZIL	2018	2019	2018	2019
BOLIVIA	2018	-	2019	-
PARAGUAY	2018	2019	2018	2019
USA	2016	2017	2016	2019
CANADA	2018	-	2018	-
CHINA	2016	-	-	-
INDIA	2019	-	-	-

HB4® Soybean Performance

The performance of the trait in converted varieties is showing significant benefits, particularly on this low yielding production areas in Argentina.

HB4® advanced lines performance





Chapter 3

HB4®

Program

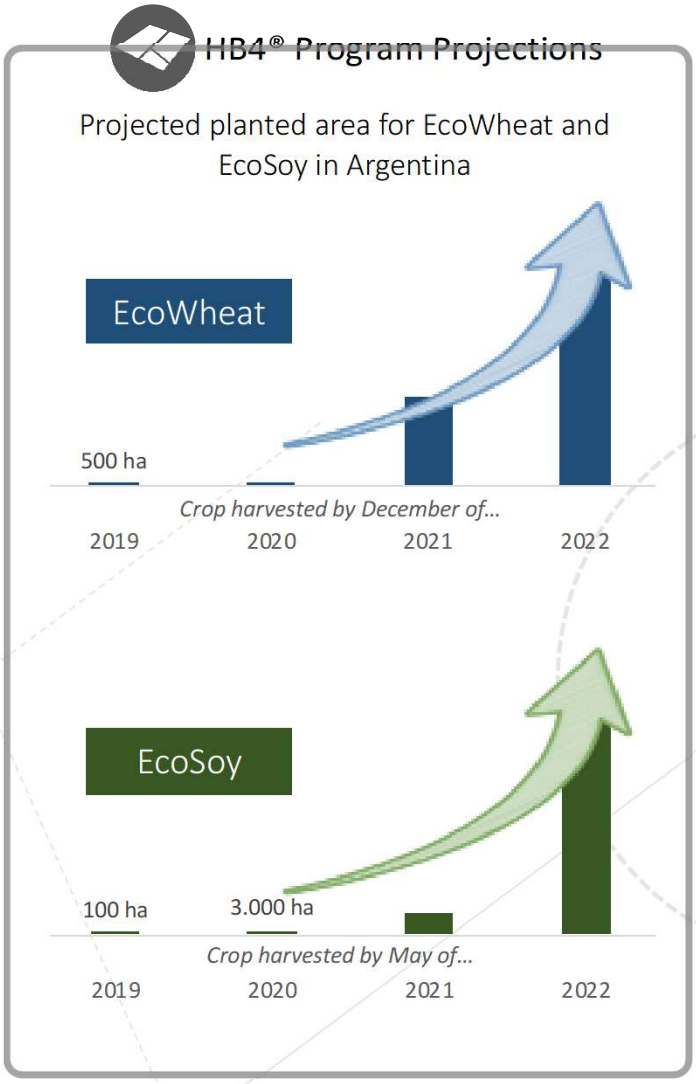
HB4® Program

The HB4® Program is an identity preserved production system for soybean and wheat. It has multiple objectives including expanding seed inventories, allowing farmers to test the HB4® technology, providing fields for demos and validating the products regional positioning. In essence, the program turns farmer from clients to partners.

Bioceres has been showcasing the HB4® technology in a series of field days and by participating on the main Ag shows and conferences. One of the initiatives during those events was the introduction of the HB4® Program consisting on farmers signing up to became early adopters of the HB4® technology in either or both wheat and soybean. As a result of this program today we have a waiting list of farmers willing to plant the EcoSeed products to cover our 2019-21 ramp-up projections. Farmers participating in the program are selected based on (1) field location; (2) historical relationship with Bioceres ´ecosystem; and (3) sustainable farming practices, with priority given to AAPRESID´s ASC certified farmers.

To broadly launch a technology like HB4® a series of regulatory approvals on production territories as well as the main export markets are required. However, having a regulatory clearance in at least one production territory allows for the implementation of an identity preserved or closed loop production strategy. These conditions are currently met for the HB4® soybean trait but not for the HB4® wheat trait. For the later a closed loop system can be implemented only under regulated conditions via permits.

The identity preserved production system requires having contracts with farmers committed to preserve the identity of the crop under a full seed production offtake agreement. If seed quality standards are met, the seed will be stored for the following planting season. However, not all the production will qualify as seed and there will be grain available. The system will include a contract with processors that will be willing to use the grain and channel the processed grain to a selected market. Managing the production system logistics as well as the contractual requirements with farmers, processors and seed treatment plants will require a dedicated team.



Seeds stocks will be always owned by Bioceres and as such, it will implement a quality control process to ensure that the seed to be planted on the following season will meet quality standards. Additionally, a dedicated team will ensure stewardship practices are followed by farmers and processing plants (seed and grain).

Under the HB4® Program, Bioceres provides production technologies to participating farmers. Additional inputs can also be contributed. Particularly products from Rizobacter´s portfolio that further reduce the carbon footprint of the program. For this purpose, microbeaded fertilizers that "spoon-feed" crops or high tech adjuvants that allow reductions in agro-chemicals, are of great value.

Rizobacter's Portfolio

Rizobacter's portfolio is very well positioned to provide most, if not all the inputs required for an environmentally conscious grain production. With a track record of over 40 years commercializing biological inputs, particularly biofertilizers, it is the market leader in soybean biologicals.

Inoculants

Inoculants are broadly used nitrogen-fixing bacteria that promote growth of leguminous crops such as soybean and alfalfa. Recently Rizobacter launched Rizoliq Dakar®, an inoculant with enhanced performance under drought and heat. This product fits very well within EcoSeed products.

Biofertilizers

Biofertilizers contain living microorganisms that colonize the interior of a plant and promote growth by increasing supply or availability of primary nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus and stimulating plant growth through synthesis of growth-promoting substances. The combination of biologicals and chemical fertilizers can maximize crop yields while reducing environmental impact as a result of reduced use of chemicals.

Micro-beaded Fertilizers

We produce and commercialize fertilizers based on chemically formulated micro-beads. As these fertilizers can be applied next to the seed at planting, lower doses are needed than standard fertilizers, with as little as a quarter of traditional application rates. This results in logistical efficiency and environmental benefits.

Biofungicides

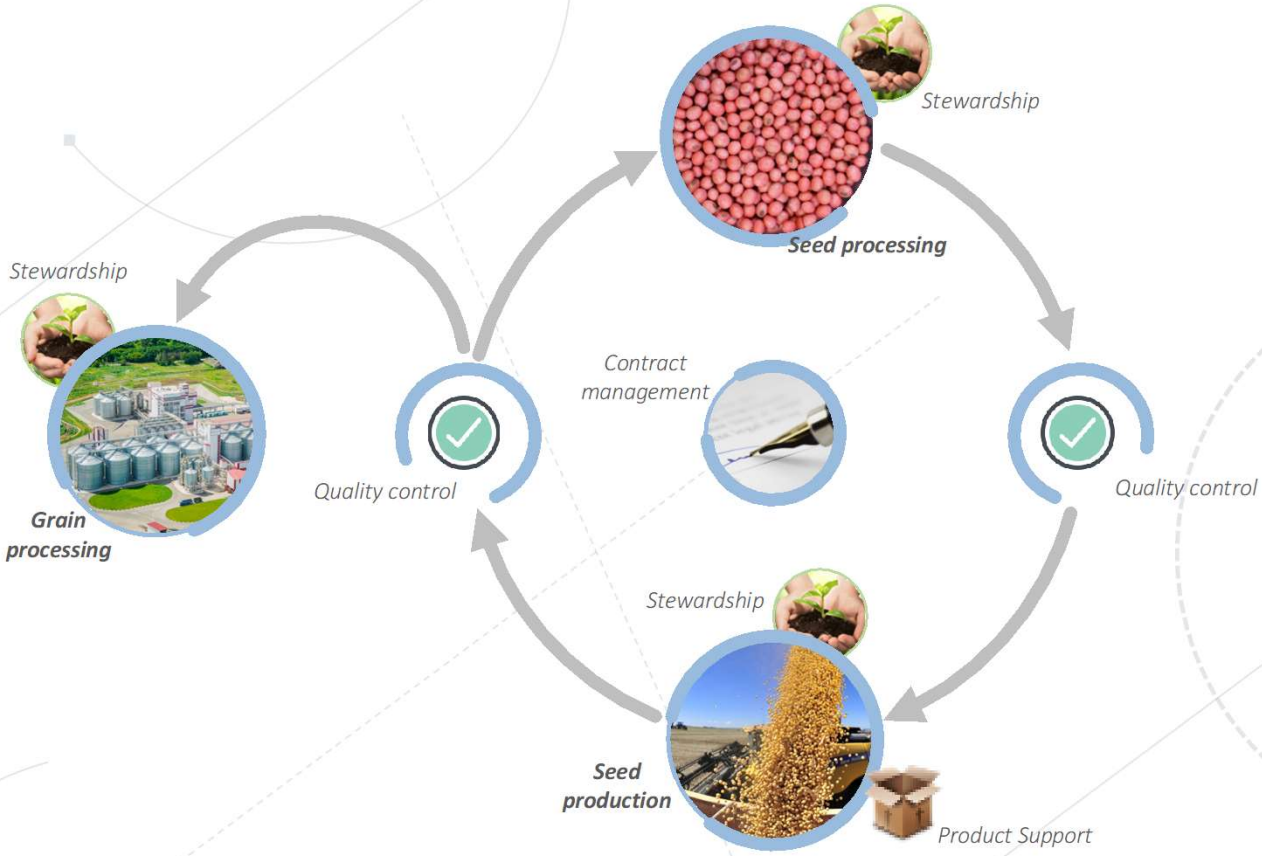
Rizobacter's portfolio includes the first and only biological fungicide registered in Argentina. Its formulation, based on the *Trichoderma harzianum 2 (TH2)* strain, was selected to be effective in combating the development of the most important diseases in winter cereals such as: *Fusarium graminearum, Bipolaris sorokiniana* and *Drechslera tritici-repentis* that dwell in the soil and the seed.
In soybean's case, it efficiently controls the diseases in the seed such as *Cerospora kikuchii, Phomopsis* and *Furarium spp*.

The program will require service providers to record all activities and follow practices that ensure full traceability of the production process. In exchange, the service provider will have access to premium technology.

The program demands a significant financial effort as it requires purchasing all harvested seed or grain. Essentially the system turns farmers from seed clients into service providers. As regulatory clearances are obtained, a more conventional business model could be implemented. Bioceres is developing the contracts framework, including the possibility of implementing smart contracts.

HB4® Program Cycle

Essentially, a closed loop production system for seed bulk up. The system requires stewardship practices and close monitoring of seed quality. Grain processing will be managed with selected processors.



Chapter 4

HB4® As a Consumer Brand

HB4® As a Consumer Brand

Consumers are changing their attitude and preferences toward healthier, cleaner, safer, more sustainable produced food. The thesis of this chapter is that consumers will value goods derived from grains produced under the HB4® program. This program has been aligned to reduce environmental externalities by reducing greenhouse gas emissions, water utilization and exposure to agro-chemical products.

The HB4® technology can work as an insurance, raising yield floors under adverse conditions, without impacting yields in the absence of drought. This yield increase on just the northern soybean growing areas of Argentina would translate to a reduction of one hectare of deforested land for every seven hectares planted with EcoSoy. In other words, the production increase due to additional land in northern Argentina can be fully replaced by planting EcoSoy on the existing land.

Towards Carbon neutral agriculture

Agricultural land can be a net CO_2 source or a net CO_2 sink. The combination of no-till with appropriate crop rotations results in soils absorbing between 1,125 and 1,875 kg of CO_2 per hectare annually. At the mid-point of this range, and taking an average yield increase of 10% for the double crop HB4® program, we can estimate 1,650 Kg of CO_2 net fixed into soil carbon, per year. In average, three hectares under this system will remove the annual emissions of one car . Over 90% of crop production in Argentina is currently done under no-till but with a significant proportion of that area is not under proper crop rotations.

Bioceres´ production proposal includes the selection of farms that currently operate and are certified to be under no-till and use best management practices. Production contracts will ensure that crop rotations are followed by including a summer crop (EcoSoy) and a winter crop (EcoWheat). The incremental yields of the HB4® crops should further increase the soil carbon sequestration opportunity.

Nitrogen fertilizers are significant greenhouse gas emissions contributors. Legumes like soybean absorb atmospheric nitrogen through a symbiotic relationship with bacteria on their roots. Soybeans take almost 50% of their nitrogen requirements from this symbiosis and the rest is provided by the soil mineralization's processes, therefore farmers do not apply nitrogen-based fertilizers on this crop. The use of soybean inoculants enhances atmospheric nitrogen fixation and results in an average 5% yield increase .

Cereals, like wheat are heavily fertilized with different nitrogen sources. Bioceres´ proposes to use starter fertilizer applications placed near the seeds, improving nutrient uptake and biomass yield in comparison with the broadcasting methods. Using micro-granular fertilizers further increase the crops nutrient use efficiency and allow for rate reductions compared to commodity type fertilizers. This rate reductions result in significant impact on CO_2 emissions related to transportation because 20-30 kg of micro-granular fertilizers can replace 80 kg of a commodity fertilizer. In additions to reducing the opportunity for greenhouse gas emissions these products reduce the nutrient runoff to surface water and ground water.

- *Lal R. CAB Reviews Perspectives in Agriculture Veterinary Science Nutrition and Natural Resources 3(030) · June 2008*
- *C. Alvarez et al. / Soil & Tillage Research 142 (2014) 25–31*
- *EPA estimates that the average American car emits 4.6 ton of CO_2 annually. www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle*
- *Collino et al. 2007. Aporte de la FBN a la nutrición de la soja y factores que la limitan en diferentes regiones del país. Actas XXIII Reunión Lationoamericana de Rizobiología. Los Cocos, Córdoba. Argentina.*
- *F. H. Gutiérrez y F. Salvaggioti. In Fertilidad de Suelos y Fertilización de Cultivos. H. E. Echeverría y F. O. García (Ed.). 2014.*

A requirement for farmers to become Bioceres service providers for HB4® branded grain will be that they adhere to best management practices certified by recognized institutions. One such organizations is AAPRESID, an NGO dedicated to promoting sustainable ag-practices with a focus on no-till. Bioceres was conceived by AAPRESID founders so the institutional proximity means that many of our shareholder-farmers are associated to AAPRESID and have their farms certified by them.

The HB4® Program can easily be directed to make Bioceres the exclusive grain provider to a partner processor that will manufacture HB4® branded consumer goods. Such an approach can further refine the identity preserved model to become a fully traceable supply chain capitalizing its implied costs.

The identity Preserved Model

Identity preserved supply chain

HB4® Program

Contracted production

- Best management practices
- Satellite crop monitoring

Partner-Processors

- Raw material differentiated

Consumer

Sell to consumers

- Traceable
- Sustainable
- Affordable

Certified Sustainability

AAPRESID, a recognized NGO promoting sustainable farming practices, particularly no-till, runs a certification program for farmers that adhere to their recommended practices

Aapresid

ASC AGRICULTURA SUSTENTABLE CERTIFICADA