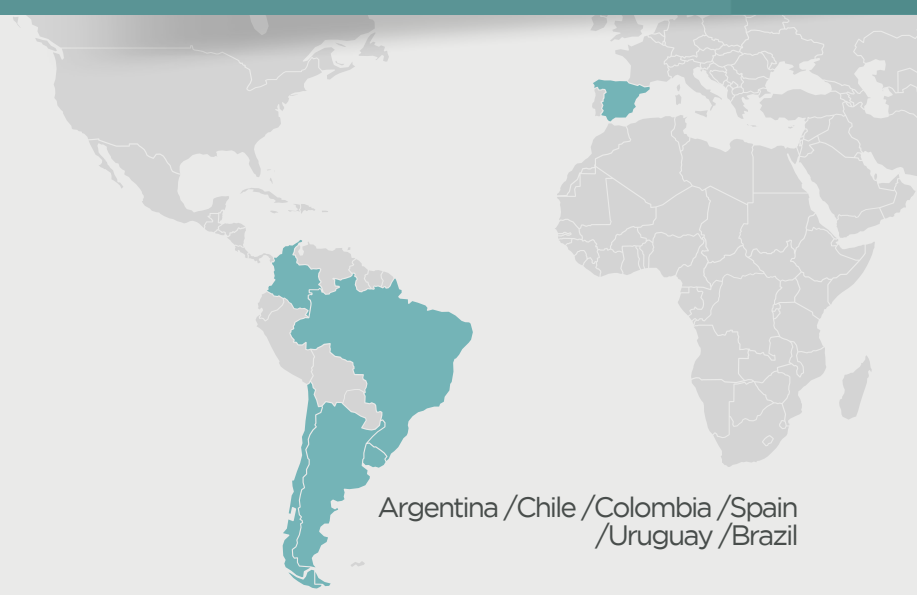
INSTITUTO NACIONAL DE TECNOLOGÍA AGROPECUARIA, ARGENTINA

Greater agricultural production with lower nitrous oxide emission

Inoculants that fix nitrogen can also release it as a greenhouse gas. The project identified the genes responsible and obtained strains that cut those emissions by up to two orders of magnitude.



-20 %
N2O emissions in broadacre crops

-3 %
Nitrogen fertilization cost in broadacre crops

-60 %
Glyphosate residues in soil

+5 %
Productivity in broadacre crops

+6
Countries engaged in genetic improvement

+8
Supported doctoral theses

+50
Glyphosate-tolerant strains obtained

+20
Peer-reviewed publications

Improving the genetics of traditional bioinputs

Initiative

The project brought together institutions from Argentina, Brazil, Chile, Colombia, Spain and Uruguay to improve the environmental performance of inoculants without giving up their agronomic efficacy. Work began by sequencing and analysing the genomes of the commercial and regional inoculants most used in the region, which identified soybean and alfalfa products as the priority targets for improvement. Spontaneous mutants were then obtained and, in a second stage, strains edited with CRISPR/Cas9 in key denitrification genes, particularly napA and napC, associated with nitrate reductase activity. Each improved strain was then assessed for agronomic performance.

Editing one gene in the inoculant, not introducing foreign genetic material

Tech solution

The strategy intervenes in the metabolic route by which the bacterium turns nitrogen into nitrous oxide. Introducing point substitutions in genes such as napA leaves the strain without nitrate reductase activity and therefore without emissions, while it keeps its capacity to nodulate and fix nitrogen. Because the editing adds no genetic material from another species, the resulting product is not a transgenic one: Argentina's national agricultural biotechnology advisory commission ruled that one of the inoculants edited in the project contains no new combination of genetic material and can be treated as non-regulated. That ruling matters as much as the biological result, since it defines the route by which these biologicals can reach the market, and it sets a precedent for edited inoculants across the region.

MORE INFO

Impacts and Results

The improved strains cut nitrous oxide emissions by roughly two orders of magnitude in alfalfa rhizobia and by close to 90 % in soybean rhizobia edited in napA. Among the CRISPR/Cas9-edited soybean clones, 36 % showed a marked reduction in nitrate reductase activity. The environmental gain was not paid for in yield: in alfalfa the low-emission mutants kept productivity and nodulation on a par with the commercial inoculant, and in soybean strains such as GR5 and MGD1 improved nitrogen content and glyphosate tolerance. More than 50 glyphosate-tolerant strains were obtained, five beneficial microorganisms were extended to new crops, and 20 peer-reviewed papers were published.

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