Azotic has developed a natural nitrogen fixing seed coating technology. It provides a sustainable solution to fertiliser overuse and nitrogen pollution.

The technology, which is based on a food-grade bacterium derived from sugarcane, is environmentally friendly and applies to all major crops. It provides a cost benefit to the grower through reduced fertiliser costs and improved yields.

The technology is patent protected and Azotic is progressing with commercial development. Azotic has a highly experienced management team with proven experience in the development and commercialisation of new technologies within agriculture.
Azotic's N-Fix technology is based on a beneficial bacterium *Gluconacetobacter diazotrophicus* (Gd) for coating plant seeds in order to create a symbiotic relationship within the plant enabling it to substitute the nitrogen it normally takes up from the soil with atmospheric nitrogen – thus reducing dependency on nitrogen fertilisers. Gd is an endophytic bacterium that actually works. This nitrogen-fixing bacterium (N-Fix) is a patented disruptive technology which will have a huge impact on agriculture – the bacterium fixes nitrogen intracellularly within crop plants. It is neither genetic modification (GM) nor bioengineering.

This unique technology is applied to the seed and spreads systemically through the plant, enabling the organism to form a symbiotic relationship with the plant, thereby converting atmospheric nitrogen into a form that the plant can use. It allows the bacterium to potentially colonise every plant cell.

### Azotic’s N-Fix technology has the following benefits:

- Reduced nitrogen fertiliser usage by up to 50% – lower farming costs.
- Increases crop yields and enhances quality – greater farm revenue.
- Sustainable nitrogen for agriculture supports cleaner food - greener food, cleaner water.
- Market demand – food groups/supermarkets pursuing sustainability and food safety.
- It contains no toxins and is environmentally friendly - less nitrogen pollution.
- Comply with government restrictions on nitrogen fertiliser usage – maintain yields.

### Climate Smart Agriculture

The continued production and use of synthetic nitrogen based fertilisers is no longer sustainable. Climate smart agriculture will depend on the greater use of biological nitrogen fixation (BNF) in order to feed the worlds burgeoning population. N-Fix will make a significant contribution to provide a sustainable natural BNF alternative to synthetic nitrogen fertilisers.

Azotic’s natural nitrogen fixing technology is a perfect fit. N-Fix provides a sustainable solution to fertiliser overuse and nitrogen pollution as well as improving plant efficiency and increasing yields. Sustainable agriculture will depend on the greater use of biological nitrogen fixation at a time when more food is needed to feed an increasing population.

### Commercialisation

Azotic is developing a robust commercial formulation which will change the way that people grow food. N-Fix is a sustainable product which improves agricultural productivity. It has a definite competitive advantage as no other research or commercial group has yet to demonstrate intracellular colonisation of Gd.

Azotic will commercialise products based on this innovative platform technology through appropriate partnerships in R&D, licence agreements and other routes to market. Our initial focus is on rice, wheat, maize (corn) and soybean. Our nitrogen fixing products will be crop specific and it is anticipated that the first product will be market ready in 2019.

Azotic is interested in finding new partners/collaborators.

### Azotic North America

Azotic North America is responsible for commercialisation in the US and Canada, under the brand name of Envita.

### UK and Ireland

Gleadell Agriculture is collaborating with Azotic Technologies to develop and market Natural Plant Nutrition (NPN4) nitrogen-fixing technology across the UK and Ireland.

### Field Trials

Intracellular colonisation and nitrogen fixation have been proven to work in the laboratory and through field trials. Azotic’s initial N-Fix product, a liquid seed inoculant, has been tested and validated by external contract research organisations ("CROs"). N-Fix’s efficacy has been proven on key crops such as maize, wheat in the UK, USA, Canada, Germany, Belgium, France and rice in Vietnam, Thailand and the Philippines.

The field trials have proven that:

- It is straight forward to apply as a seed coating.
- Increases the yield for significantly less cost.
- Reduces the need for synthetic nitrogen fertilisers by up to 50%.
- N-Fix treated crops, when combined with the use of N fertilisers, can attain higher than expected yields.

*N-FIX® is a registered trademark of Azotic Technologies Ltd.*
Rice

A product based on the N-Fix technology has been developed for rice with an optimised dose, formulation and delivery process. Field validation of the formulation and delivery method that fits well with existing seed priming systems has demonstrated that N-Fix has the ability to reduce nitrogen fertiliser application and farmers operating costs while also increasing crop yield.

A series of independent field trials on rice were carried out by accredited contract research organisations. During 2017 three trials were carried out in Vietnam and three trials in Thailand. Four other trials were carried out during the 2017/18 dry season, two in Thailand and two in the Philippines.

Vietnam

Direct Sowing
The graph presents an average of two trials with direct sowing. Result is an increase in yield of 23% when Gd was used at 100% fertilisation level. When the nitrogen level was decreased to 50-60% an increase in yield of 35% was observed.

Transplanting
The graph presents the results of transplant trial. The result is an increase in yield of 9% when Gd was used at 100% fertilisation level but this increased when the nitrogen level was decreased to 75% (an increase in yield with 14%).

Overall response was a mean average 19% yield increase across all the field trials.

Thailand

At each trial in Thailand N-Fix had a positive effect on yield. In Sankhaburi the increase in yield was more pronounced and was also statistically significant.

Rice yield results for the Thai rice trials commissioned during 2017/18. Dotted line represents yield at recommended fertiliser N level.
**Philippines**

In the Philippines, N-Fix had a positive effect on yield and the increase observed was statistically significant for both trials.

**Overall results for Thailand and the Philippines**

- Overall, the N-Fix treated yields were significantly higher ($p \leq 0.001$) than the untreated at every N level.
- Across all of the trials and N levels, the N-Fix treated plots yielded 17% more than the control, with a 1 t/ha (29%) increase being seen at 50% N.
- The maximum yield increases observed were 34% at 0% N, 57% at 50% N and 15% at 100% N.

These results clearly demonstrate the potential of Azotic’s N-Fix technology in improving attainable yield increases on rice whilst reducing N fertiliser applications by up to 50%. Furthermore, when combining N-Fix and full recommended N fertiliser a significant increase of 7% equivalent to 0.3 t/ha was observed in both Thailand and the Philippines field trials.

**Average across trials rice yield for the 2017/18 growing season.**

Dotted line represents yield at recommended fertiliser N level.

---

**Rice yield results for the Philippines rice trials commissioned during 2017/18.**

Dotted line represents yield at recommended fertiliser N level.
Maize (Corn)

USA - Iowa, Illinois, Nebraska (average) 2015-2017
- N-Fix trials were carried out in Sparta, Illinois, Dana, Iowa, and York, Nebraska.
- Plots treated with N-Fix had a 0.5 ton/ha yield increase over control plots.
- N-Fix-treated plots trended towards a higher yield at every N level.

USA - Dana, Iowa 2017
- Higher yield in both N-Fix treatments compared to the untreated control (p<0.001).
- For the on-seed treatment, yield was increased by 50.8% at 0 N, 3.5% at 25 N, 9.4% at 50 N, 6.6% at 75 N, and 14.7% at 100 N.
- The yield bump with the in-furrow treatment was similar to that of the on-seed treatment except at 100% N where the in-furrow yield was similar to the untreated yield.

4 German and 1 Belgium trials (average) 2014
Independent field trials in Belgium and Germany in 2014 showed:
- Belgian results indicate an overall potential reduction in nitrogen fertiliser of 40% without suffering any yield penalty.
- German results indicated an overall potential reduction in nitrogen fertiliser of 95% without suffering any yield penalty.
- Average yield benefits across the various N levels resulted in an increase in yield of between 7% in Belgium and 21% in Germany.
**Soybean**

**USA - Dana, Iowa 2017**
- Highly significantly yield increase in N-Fix treatment compared to control at both N levels ($p<0.001$).
- The yield increase was 29% at 0 N and 8.4% at 44.8 kg N/ha when using N-Fix.

![Dana Soybean Yield Graph](image1)

**USA - York, Nebraska 2017**
- Higher yield in the N-Fix treatment compared to the control at both N levels - this difference was not statistically significant ($p=0.131$).
- The yield increases were 4.2% at 0 N and 0.7% at 44.8 kg N/ha.

![York Nebraska Soybean Yield Graph](image2)
Spring Wheat

2 UK, Germany and USA 2015

- For spring wheat across sites and N levels, N-Fix increased yield by 7% (460 kg/ha) and demonstrated a potential for N-fertiliser savings of up to 61% with no reduction in yield.
- The yield increases were 4.2% at 0 N and 0.7% at 44.8 kg N/ha.

Dotted line represents yield at recommended fertiliser N level.

UK 2015

Spring wheat seed untreated and treated with N-Fix was sown in Spring 2015 in Shropshire, England. The crop was fertilised at different proportions of the recommended rate of N based on variety, region and availability of soil nitrogen.

The results show:

- Across N levels, N-Fix crops showed an average yield increase of 15%, but at zero N and full N this increase was 20% and 10% respectively. The results indicate that for the N-Fix treated crop it is possible to reduce N fertiliser application by up to 85% and still achieve the same yield as a fully fertilised crop (see dotted line on graph).
- At zero N, N-Fix gives the same seed yield as 50% of the recommended N fertiliser rate (ca. 120 kg per hectare).
- At 25% N, the N-Fix yield (7 t/ha) is greater than the full N control (6.7 t/ha).
- The yield plateau is at 50% (ca. 60 kg/ha) for the untreated control. This means at a 50% reduction in N fertiliser, N-Fix gives a yield that is around 1 tonne per hectare higher than the full recommended rate of N.

Dotted line represents yield at recommended fertiliser N level.
Wheat
USA Wisconsin 2016-2017
- Yield was significantly impacted by N-Fix treatment ($p<0.001$) and N fertiliser ($p<0.001$).
- Yield was increased by 7.4% at 100% N, 8.7% at 75% N, 6.4% at 50% N, 2.7% at 25% N, and 4.7% at 0% N.

France Organic Wheat 2017
The trials focused on organic wheat and organic milling wheat.

The summary results are:
- The average increase in yield at 0% was 0.57 t/ha (13.5%).
- The average increase in yield at 100% N was 0.33 t/ha (6.8%).

The significant yield increase at 0% N would be huge in an organic crop (MN). The yield results of the organic trial, with both treatments ($P<0.002$) and N levels ($P<0.001$) being statistically significant.