



Introduction from the CEO

A year ago, I reflected on how the rising price of nitrogen fertilisers would serve to focus minds:

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Would it prove the beginning of the end for 'big bag' nitrogen?

Little did I know how much higher those prices would rise. However, I did pledge that Legume Technology would continue working towards its ambition to help farmers replace artificial nitrogen with 'in-field' nitrogen fixation for their crops.

Twelve months later, we've made good progress towards that goal. We've experienced an unprecedented increase in demand, effectively doubling sales for our vindication of our position

Further evidence of the renewed confidence and investment from that partnership will become apparent in 2023, with the commissioning of our new production fermenter being the most visible: a development that will help us not just meet this increasing demand, but allow quicker, deeper, more radical innovation than we've ever been able to achieve before.

There's more on that later in this issue, alongside examples of how that innovation will play out: some early hints of the product development pipeline you can expect to see in the months and years ahead.

Thank you to all our customers for your support and confidence in Legume Technology during 2022. We wish you all a peaceful holiday season and join you in looking ahead to the opportunities a new year brings.

Dr Bruce Knight
Founder and Managing Director

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FROM THE LAB

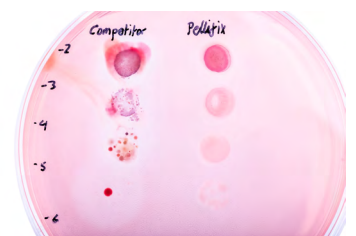
A busy time for production means a busy time for the lab too, says Mike Thomas.

Spring is when the world wants our products, which means the last quarter of the year is our busiest. The production team is at full capacity to turn out products in great volume - and that translates into a busy time for the lab team, too.

But not on research and development tasks. In this quarter, we're focused almost exclusively on quality control. It's an important aspect for Legume Technology and one that we can't leave to chance. We've spent a lot of time and effort raising the game in inoculants, demonstrating how - if you pay attention at every step of production - they really do deliver what we say. Unfortunately, that's not the case with all inoculants; poor quality products still pervade the marketplace. So, for us, quality control is essential: we want to say with complete confidence that not only do our products contain what we say, but that they're also capable of doing what we say they do.

Thus our stringent quality control processes. These are applied at several stages. For example, we check the sterility of the peat that we use as

And we'll repeat this check throughout the production process, to ensure that there is no breakdown in our axenic approach. Importantly, if we do identify a weak link somewhere, this precision approach will allow us both to fix it, and if necessary to write off a problem batch so that no substandard product ever leaves the site, bound for a customer.



Example of a contaminated competitor inoculant product against sterile PELIFIX

” **Despite the focus on QC right now, we've some exciting R&D projects underway too, including a new biostimulant planned for cereal crops.**

This will be heading out for spring trials in 2023, in wheat and barley. Also in the pipeline is a completely new product, based on the *Azospirillum* bacteria. A plant-growth promoting bacteria, *Azospirillum* can fix nitrogen and improve nitrogen-use efficiency. It's also been associated with other plant-growth promoting effects, such as auxin production.

We're certainly not the first to look at it; it's currently one of the best studied genus of rhizobacteria, and is already widely used in South America.

NEW ROLE FOR DR MIKE THOMAS



We're very pleased to announce that Mike is taking on the role of Legume Technology's Research and Development Manager, effective immediately.

Mike joined us just a year ago and has quickly become a valued member of the technical team, not least with his expertise and in-depth knowledge of the labyrinthine regulatory process.

"It's wonderful news for me," Mike says. "While the new title won't change a lot of my day-to-day work, it will give me more opportunities to delve deeper into biostimulant research and lead LT's drive to bring new and novel products to market.

"I'm particularly excited to be able to draw on my own experience of biostimulants and inoculants in cereals, rice and

wheat specifically, and bring this knowledge to bear on the LT development pipeline."

Dr Bruce Knight, Legume Technology's CEO, says he's delighted to see Mike take on a more prominent role in the company's R&D function. "At its heart, Legume Technology is an R&D-led company. Mike's understanding of biostimulants – their performance in the lab and field, and their regulatory requirements – ensures we're well-placed to continue our pursuit of R&D excellence."

Congratulations to Mike from everyone here!

From the Factory



In our last newsletter, we welcomed David Hosking to the team in his new role as Legume Technology's Production Manager. Now, six months after joining, we prised him away from the production line to find out how he's settling in, and what we can look forward to in 2023.

November and December are undoubtedly the busiest months for the production unit: we're at full pelt to get product made, packed and shipped ahead of spring planting. From that perspective, the summer proved a gentle introduction not only to the company and the team, but also to build knowledge of, and speak with, many of our customers. It's been great getting to know everyone.

It's been time well spent. Every production unit has its characteristics and foibles. John Godliman, my predecessor, was invaluable in sharing his knowledge and pointing these out to me, which has seen us through a smooth transition; something I've been very glad to hear the team confirm.

It's fair to say I've also been getting to grips with widening my agricultural knowledge. My expertise lies in fermentation – I began my career in the brewing industry, before moving into industrial yeast production. Part of what attracted me to the role with Legume Technology was the nature of its operations: any kind of fermentation needs to be conducted under hygienic conditions, but here we're talking about axenic culture. It's at the heart of the company's offering: our products are single-strain, and we pride ourselves on that guarantee. It's my role – among others – to ensure that guarantee is maintained. While it's a sheer operational exercise to deliver it, I'm looking forward to further refining my niche, specialist knowledge and applying it to agricultural products, to maintain the high level of customer satisfaction and service that Legume Technology enjoys.

Next year will also see, finally, the much-anticipated new 10,000l fermenter. At ten times the capacity of our existing one, it's going to transform our operational capacity. I can't wait to get my hands on it.

The first batch through it will be a test run – I'll be carefully monitoring all the inputs, its performance, its behaviour and so on, in a bid to understand as quickly as possible the characteristics of this fermenter. We'll need to see how the lessons we've learned from the existing 1,000l unit can be applied to the new one:



David inspecting a part of the new fermenter

- **media selection,**
- **efficacy,**
- **whether the larger volume gives us opportunities for improvement,**
- **and how it will affect our overall approach to production.**

For example,

- **how much longer will it take to cool down,**
- **post-fermentation,**
- **and how do we handle the increase in packing that the larger capacity will deliver?**
- **What effect will this have on other tasks?**

The new fermenter also allows me to have greater freedom with how we use the original fermenter. At the moment, 95% of our production capacity supports our soybean products. Understandably, that ties up a lot of fermentation time. But once we can run LiquiFiX and our other higher volume products through the larger fermenter, I can free up the smaller unit for smaller batches of new products, and other strains.



I'm looking forward to a very productive 2023 in the factory; let me take this opportunity to wish our customers and growers a similarly successful year in the field.

GIVE PEAS A CHANCE



The United Kingdom is both the largest market for peas in Europe, and the largest producer. While not grown on the same scale as wheat or barley, it's nonetheless a significant crop with around 35,000ha of vining peas grown every year, predominantly for freezing. Mike Thomas details a Legume Technology R&D project with its roots in the UK, run in partnership with a major UK pea producer.

This trial was all about **ROOTFiX**; as with the rice trials, we wanted to see how well observations made in the lab stacked up in the field.

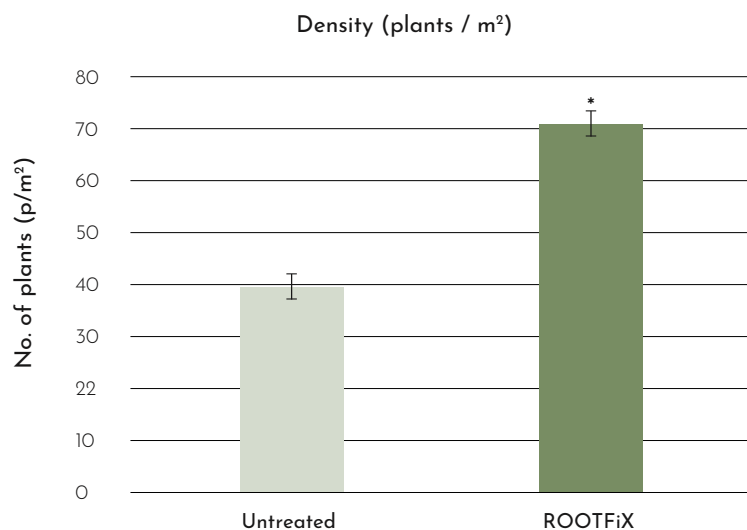
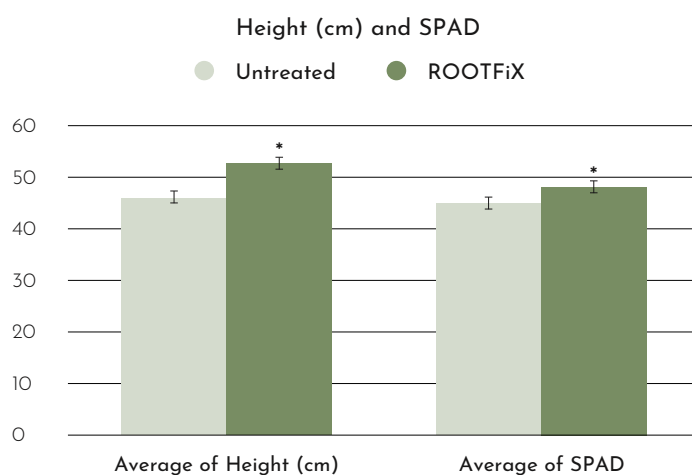
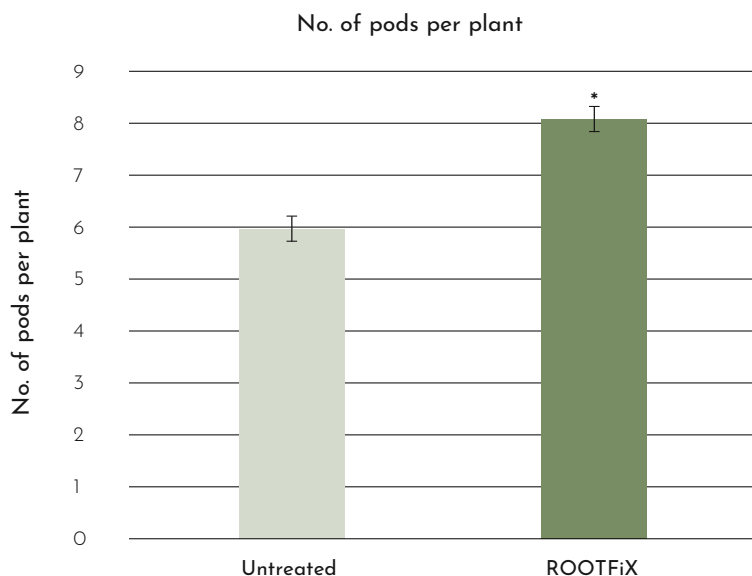
Peas have a short growing period - around 10-12 weeks - which makes strong, early establishment essential. If sown too early, or in adverse soil and weather conditions, they can be prone to emergence failure.

We wanted to see whether **ROOTFiX** could prove a valid treatment for crop establishment, so focused on sites where there's been recorded problems with crop establishment or low yields.

This year's trial, over four sites, gave us plenty to think about. All showed betterment and on two sites there was a significant improvement in the crop: an increase in the average number of pods per plant, an improvement in plant density, height and SPAD (a measure of chlorophyll content).

We'll be undertaking further trials to confirm this year's results, and also to try to determine under what conditions **ROOTFiX** might be indicated for use, i.e. what types of soil, or previous crop performance.

We're also interested to see the potential for synergistic effect when using **ROOTFiX** in conjunction with a Rhizobia product such as **LEGUMEFiX**.



Values	Untreated	ROOTFiX	Difference
Height (cm)	45.40	53.14	+17.0%
SPAD	44.47	47.95	+7.8%
Pods per plant	6.02	8.06	+33.9%
Peas per plant	18.4	33.7	+83.1%
Plant density / m ²	39.20	70.80	+80.6%

Putting ROOTFiX into rice

Soybeans, lupin and lucerne will probably be the crops that many of you associate with our products, but we've a far wider crop range in our sights. Mike Thomas explains the findings of an ongoing project to assess the benefits of ROOTFiX in rice.

Phosphate is the second most important plant nutrient after nitrogen. But while it's readily found in soils, it tends to form an insoluble complex inaccessible to plants. Enter *Bacillus*, the extremely useful bacteria that can solubilise nutrients to make them available to the crop. We know this process works in other crops (it's the basis for ROOTFiX); would it work in rice?



WE DEvised A TRIAL

- Growing plants in a vermiculite/sand substrate which was mixed with insoluble phosphate. These plants were then fed with a phosphate-free nutrient solution. Half the plants were also treated with ROOTFiX
- We then subjected the plants to temporary, four-day period of drought.

RESULTS WERE AS WE EXPECTED

- Untreated plants exhibited phosphate stress, while treated plants were observed to exhibit increased plant vigour and growth, because the *Bacillus* allowed them to access the bound-up phosphate.
- We saw that treated plants could better tolerate temporary periods of abiotic stress significantly better than untreated samples.

This will need more work to identify the processes involved, but we think it's partly attributed to better root development and lateral root growth in the *Bacillus*-treated plants: the greater root surface area will improve water absorption, even when water is in short supply.

Rice is already beginning to move away from a paddy system, because of known problems with methane production and water pollution, so finding ways to make rice more tolerant of drought could be very helpful. That's especially the case for major rice-producing regions that do have water resource issues, such as California.

We'll report on the field trials in due course!



HA-PEA CHRISTMAS!

Don't forget to follow us across our social channels for regular industry updates and to find out more about what we're up to.

