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Speciality Crops To Test Appetite for Gene Editing

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Introduction

The conflicting regulatory standing between the EU and the US has created a bifurcated market for funding gene-editing technologies in agriculture. The current landscape sees a wide array of companies in the US looking to test and deploy these technologies across row crops, as well as growing investment in specialty production systems. Given the regulatory context, industry players are likely to keep the focus on the Americas for now. Still, there are potential avenues of opportunity and preemptive positions that could be taken in the European market too.

Three Types of Regulatory Systems Globally

Gene-editing technology, especially CRISPR, offers the possibility to design a plant without introducing foreign genes, reducing some of the controversy associated with earlier genetically modified organisms (GMOs). (Read more about the impacts of the technology on food and agriculture in Rabobank's report [Gene-editing Technology To Disrupt Food & Agri Systems](#), and about the difference between gene editing and GMOs in [Gene editing in the G&O sector](#)). Foreseeing the enormous impacts gene editing can bring to the current F&A system, countries have formulated their own regulations accordingly. Around the world today there are three types of regulations for gene-edited crops (most countries have different views on gene editing for animals). These approaches are:

1. Treat gene-edited products as conventional products, with a "product"-based evaluation method, as in the US, Canada, Argentina, Uruguay, Colombia, and Japan, for example.
2. Treat gene-edited products as conventional products with a "process"-based evaluation method, an approach taken in Australia, China, and Brazil.
3. Treat gene-edited products as GMO products, as in the EU (excluding the UK, which is formulating new regulations post-Brexit), Mexico, and New Zealand.

A product-based approach looks at the product itself when regulating, while a process-based approach considers how the product was created. How product- or process-based methods will affect gene editing regulation is still unclear. But treating gene-edited products as conventional products will surely have long-term impacts on the whole supply chain. For example, in plant breeding, gene editing can shorten the breeding cycle in crops like corn from eight to ten years down to five to six years, saving R&D costs and aligning more closely with the needs of the supply chain. Additionally, depending on the added traits, a gene-edited crop may impact farmers' allocation of expenses and farm input dynamics. For example, one gene-edited rice variety was proven to have a higher yield in a low-nitrogen environment.^{1,2} Such crops will require less

¹ "CRISPR-Engineered Rice Enhances the Natural Production of Fertilizer." [Genetic Engineering and Biotechnology News, August 9, 2022. Accessed August 24, 2022.](#)
<https://www.genengnews.com/topics/genome-editing/crispr-engineered-rice-enhances-natural-production-of-fertilizer>

² Yan, Dawei, et al. "Genetic modification of flavone biosynthesis in rice enhances biofilm formation of soil diazotrophic bacteria and biological nitrogen fixation." *Plant Biotechnology Journal* (2022): 1-14. doi:10.1111/pbi.13894

fertilizer while maintaining their productivity or even achieving a higher yield. In turn, farmers may choose to shift the fertilizer share of their expenses to seed.

Specialty Crops With Added Output Traits Among the First Gene-edited Market Entrants

We expect that specialty crops (including fruit and vegetables) with output traits will be among the first gene-edited products to hit the market. This will begin in the countries that treat gene-edited products as conventional products. In the longer term, we expect to see these products in Europe as well, particularly in the UK, where the process to change regulation on gene editing has already started.

There are various reasons why specialty crops with output traits are likely to be the first gene-edited crops on the market. When developing varieties, it is usually easier to focus on output traits rather than input traits. This is because input traits generally involve more genes. Output traits of crops, including flavor, color, nutrients, and shelf life, create value for consumers and retailers. Input traits – such as drought stress tolerance, higher yields, and better nutrient use efficiency – create value for growers.

Additionally, compared to row crops, specialty crops are often grown in a more controlled environment, under protective covers, in tunnels or greenhouses, or even in completely controlled indoor farms. Row crops are grown in the open field where they interact with more factors such as weather, soil, and other species. These factors create more risk and uncertainty about how a gene-edited crop will perform. In Argentina, for example, GM wheat yielded only two-thirds the average yield of non-GM wheat.³ In a controlled or semi-closed system, the environment is less complicated and the response of a gene-edited crop can be better controlled.

A Supply Chain Approach Increases the Chance of Success

A supply chain approach will be extremely important for successfully launching new gene-edited varieties with output traits that create value. Developing and delivering new plant varieties is a technical challenge. In addition to that, specialty crops all have their own supply chains, which means companies will need to engage with the right partners along complex produce supply chains for each new product. Every supply chain member, including growers, packers, shippers, and others, would have to cooperate for the business model to be sustainable and profitable. One complicating factor is that for permanent crops, like fruit trees, the required investments for new varieties are relatively large and have long-term horizons due to longer reproduction and propagation cycles. (See the Rabobank report [The Fruit and Nut Breeding Business: Coming to Fruition](#) for more on this subject.)

Growers and other supply chain partners making these (big) investments need to be sure consumers will accept a product developed with gene-editing. Especially because consumer preferences today are increasingly driven by the way a product has been produced.

³ "GMO wheat in Argentina suffers from low yields." GMWatch.org, February 1, 2022. Accessed August 24, 2022. <https://gmwatch.org/en/106-news/latest-news/19976>.

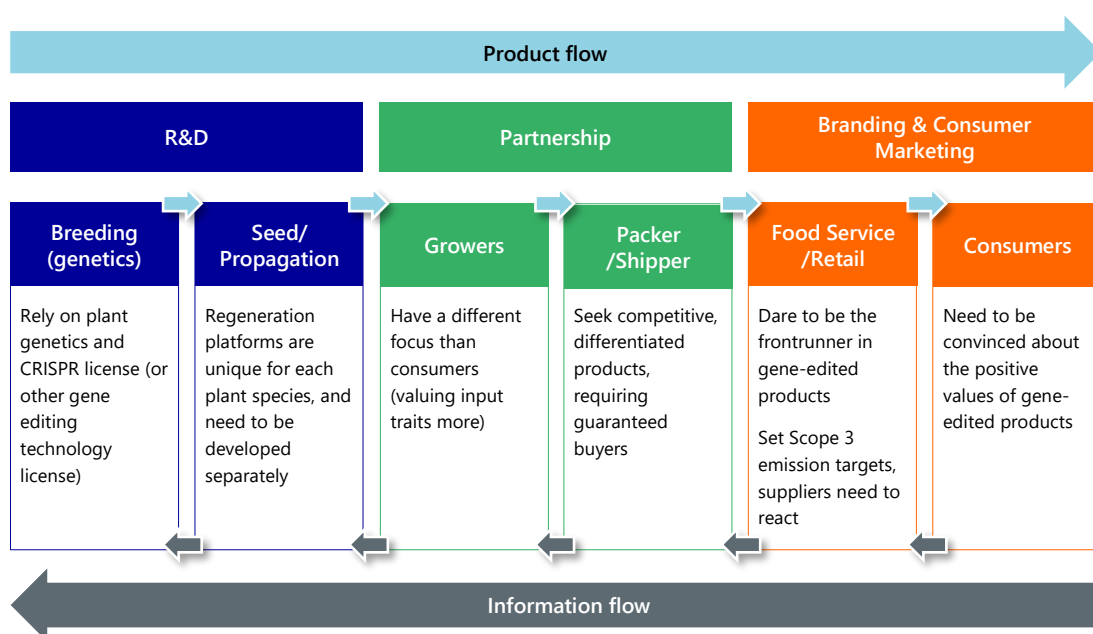
Copy-pasting Successful Business Models

The first examples of gene-edited speciality crops with output traits are already out there, like a tomato with boosted vitamin D that could soon be on UK supermarket shelves,⁴ a tomato with high levels of gamma-aminobutyric acid (GABA) in Japan,⁵ and a mushroom that won't turn brown in US.⁶ And there are more to come.

It's still early days and we cannot yet judge whether these products have passed the test of consumer acceptance. But these first products are certainly interesting 'tests.' Successful business models will be a blueprint for other products and regions to follow. Unsuccessful examples will give second movers useful information on how to approach which markets.

There are different challenges for different players in the F&A supply chain, and some can be answered by breeding (see Figure 1). To develop better varieties, breeders will need information from downstream in the supply chain. One source of information is consumer preference data collected by retailers, for example, about a product's color, shape, shelf-life, etc. Another source of demand, which is expected to impact the fresh produce sector in the near future, is retailers asking suppliers to reduce their Scope 3 (supply chain) emissions (see the Rabobank report [How Food Retailers Are Tackling Their Carbon Footprint](#)). Traits like better storability, reduced need for agrochemical use, and decreased CO2 emissions when growing will be of interest here. In R&D, new products are likely to be developed by new startups, science/academic spin-offs, or companies independent from the current big players in breeding. Existing big players will want to avoid reputational risks and will not want to have their names connected to products that might not be successful. They will want to wait and see what happens first.

Figure 1: Gene editing can speed up feedback loops within supply chains and react to some needs faster than conventional breeding



Source: Harvard Business School, Rabobank 2022

⁴ Ghosh, Pallab. "Gene-edited tomatoes could soon be sold in England." BBC.com, May 23, 2022. Accessed August 24, 2022. <https://www.bbc.com/news/science-environment-61537610>.

⁵ "Japan launches world's first genome-edited tomato." International Service for the Acquisition of Agri-biotech Applications, March 24, 2021. Accessed August 24, 2022. <https://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=18668>

⁶ "Non-browning mushrooms." Pgandp.org. Accessed August 24, 2022. <http://pgandp.org/page475645.html>

The EU has decided to take a conservative approach toward gene editing for various reasons (based on the precautionary principle as it relates to biodiversity risks and unknown effects), while various other regions and countries have taken an approach based on the benefits of gene editing. In the short term we can expect output traits in specialty crops to bloom in the next five years. This could vastly impact the supply chain and production systems, and it could also influence consumers' views of gene-edited products.

Does this mean that input traits and row crops are not on the radar of gene-editing players? Absolutely not! Actually, the successful introduction of an input trait in row crops – for example, one that tackles sustainability issues around chemical crop protection – could drive change in the EU's gene-editing policies. What's more, the war in Ukraine revealed pain points in Europe's food system transition (as detailed in Rabobank's [recent report](#)) and demands solutions. Some issues, such as increased feed, fertilizer, and energy costs, could be partially mitigated by gene editing (for example, with the introduction of crop varieties that are more sustainable, profitable, and productive). It is still too early to judge whether the disruptions caused by the war in Ukraine are structural or transitional, which leaves more uncertainty about the future of gene-editing regulation in the EU. In upcoming articles we will discuss our preliminary views about developing input traits for row crops. Stay tuned!

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