New Food Finance

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Crop Trait Development – Genetic Manipulation

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$1.9B

PacBio tops company fund-raisings

$7.1B

Total funds raised by 111 companies in our "Sustainable Crop Traits" theme

The Technology

Genetic manipulation of crops involves modifying the genetic makeup of crops to introduce desirable traits such as increased yield, disease resistance, drought tolerance, or enhanced nutritional content. This is achieved by directly altering or inserting genes into a plant's genome or by breeding techniques. Genetic manipulation is widely used, and dates back thousands of years, from selectively breeding for particular traits over time, to modern technologies for manipulating genetic material. Examples:

Lab-Based Techniques:

- **CRISPR/Cas9:** This is a precise tool that allows scientists to edit specific genes in a crop's DNA, enabling targeted trait development, such as resistance to pests or improved photosynthesis. Examples of agtech companies using gene editing include GreenVenus (lettuce and avocado), Benson Hill (soy), Calyxt (canola and rice) and Origin Agritech (corn).
- **Gene Cloning and Insertion:** Involves isolating desirable genes from other organisms and introducing them into a crop's DNA to express traits like herbicide tolerance or resistance to pathogens. Examples of companies using such genetic modification (GM) include RF Gene (corn, rice and soy) and Nath Bio-Genes (cotton, rice and maize).
- **Marker-Assisted Selection (MAS):** This method uses molecular markers to select plants with favourable genes without physically modifying the genome. It speeds up the traditional breeding process by identifying desired traits at the DNA level. Companies genetic market technology include RAGT (maize, wheat and rape seed) and Aaryagen (tomatoes, okra, rice and maize).
- **RNA Interference (RNAi):** This technique silences specific genes to prevent the expression of unwanted traits, such as susceptibility to viruses or production of allergens. Companies using RNA Interference include Tropic Biosciences.

On-Site Techniques:

- Bioinformatics: Portable tools in the field now assist in analyzing the expression of inserted genes in real time, helping to monitor how traits manifest during different stages of growth.
- Phenotyping: Portable sensors and imaging technologies help measure traits like growth rates, water use efficiency, and photosynthesis in genetically modified crops directly in the field, reducing reliance on lab testing.

Our Taxonomy

These technologies are mainly classified into genetic engineering which includes the lab-based techniques which directly change the genetic makeup of a crop. The other group is genetic modification which includes the On-Site technique which instead of directly editing the crop genetics slowly alters the crops through selective breeding, these are slower but more cost-effective.

Environmental Benefits

Genetic manipulation in crop trait development offers several environmental benefits. By creating crops with enhanced resistance to diseases, pests, and drought, it reduces the need for chemical pesticides, fertilizers, and water. Drought-resistant crops, for instance, use water more efficiently, conserving resources, as well as building climate resilience. Pest-resistant crops decrease pesticide runoff, promoting healthier ecosystems. Genetic engineering also aids in the development of nutrient-rich crops, helping to fight malnutrition sustainably while reducing agricultural land use and deforestation.

This analysis is for information and educational purposes only and is not intended to be read as investment advice

Figure 1. Investment by Selected Technology, “Sustainable crop breeding”

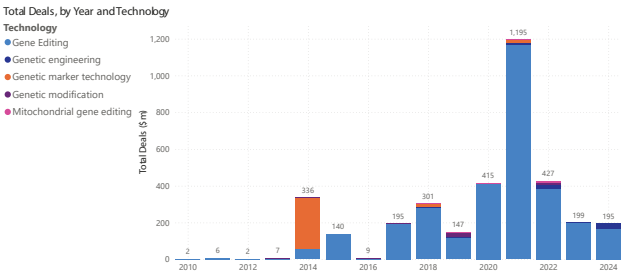

Figure 2. Total investment in top 10 technologies, “Sustainable Crop Breeding”

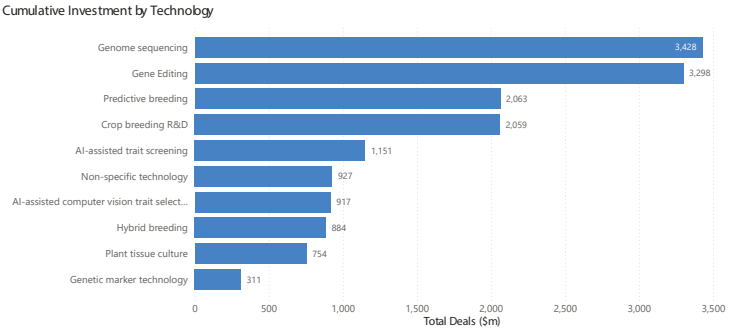

Figure 3. Techniques to Genetically Manipulate Crops

	Traditional breeding	Mutagenesis	RNA interference	Transgenics	Gene editing
Description	Crossing plants and selecting offspring	Exposing seeds to chemicals or radiation	Switching off selected genes with RNA	Inserting selected genes using recombinant DNA methods	Deleting and adding genes using engineered nucleases (CRISPR, TALENs, etc.)
Outcome	Desired genes inserted with other genetic material	Random changes in genome, usually unpredictable	Targeted gene(s) switched off or 'silenced'	Only gene(s) inserted at desired locations selected	Desired gene(s) deleted only at known locations
Example crops	Almost all crops	Grapefruit, rice, wheat	Squash, apple, tomato, potato	Corn, peas, cotton - many other crops	Wheat, corn, mushroom, peas, banana
Number of genes affected	Few genes to whole genomes	100 - 1,000	1 - dozens	1 - 8	1 or more
Regulation	No safety testing required; **Unregulated**	No safety testing required; **Unregulated**	Safety testing required; **Highly regulated**	Safety testing required; **Highly regulated**	Safety testing required depending on jurisdiction; **Mixed regulations**
Example Companies	**The international Rice Research Institute** breeds over 400 rice varieties for improved productivity.	**Key Gene** use precision mutation and other technologies to improve crop traits.	**Tropic Bioscience -** Use micro RNA to improve disease resistance.	**Soils Agroscience** designs and produces transgenic plants.	**Pairwise** uses CRISPR-Cas9 to develop healthier foods.

Figure 4. Top 10 companies by fund-raisings, "Sustainable crop breeding"

Name	Description	Total Deals ($m)
PacBio	PacBio (NASDAQ: PACB) is a life science technology R&D company specialising in advanced sequencing solutions, to help scientists and clinical researchers resolve genetically complex problems, in human germline sequencing, plant and animal sciences, infectious disease, microbiology and oncology. The company's products and technologies stem from two core technologies, namely its HiFi long-read sequencing, and its short-read sequencing technologies. In the agricultural field, the company says that its HiFi sequencing delivers genomic data that can assist crop or livestock breeding, genetic engineering, and pest and disease mitigation.	1,942.71
Benson Hill	Plant breeding and seed innovation company that uses gene editing, predictive breeding and crop acceleration, coupled with AI and machine learning, through its CropOS branded platform, to find the genes associated with particular traits and attributes more quickly, with a focus on flavour, nutrient density and sustainability. Examples include higher protein soy, and crop varieties with higher omega 9 content.	1,381.21
Inari	Inari is a seed design company which has two key technology platforms, predictive design and gene editing, to achieve its target goals to increase yields significantly, without an increase in use of nitrogen, and to reduce nitrogen use without sacrificing yield, and to reduce water use. The idea of predictive design is to narrow down what changes to the crop genome may lead to particular changes in crop performance. Inari's predictive design engine uses ML and human interpretation to understand how genes interact with each other, digitally “in silico”, as well as at the plant cell level, and at the plant level. Gene editing is the process of then altering the genome, to favour particular traits, for example using the gene editing tool, Crispr.	627.00
Sun World International	Sun World is a crop breeder and variety developer focused today on grapes and stone fruit, using technologies including hybridisation, tissue culture and germplasm screening.	445.00
Nong Woo Bio Company	This Korean company says it combines cutting-edge biotechnology with cross-breeding technology to foster high value-added varieties. Its biotechnology includes genetic marker-assisted backcross breeding, to develop elite in-bred lines prior to cross-breeding hybrids.	275.42
Cibus	The company says it has developed a proprietary family of non-transgenic, gene-editing technologies, with the goal of leading New Breeding Technologies based on precision gene editing, with a product focus on traits that enable farmers to have higher yields and reduce the use of the Crop Protection chemicals and fertilizers. The company says it licenses the intellectual property associated with each trait product to seed companies for trait or license fees.	269.00
CSIRO	A well-funded Australian research organisation which conducts research into innovation in the agriculture and other sectors. Crop breeding includes developing canola with high levels of omega-3. Protein production includes the development of facilities for process optimisation. Livestock breeding includes marker-assisted breeding to select desirable traits. Farm decision support tools include leveraging of lab-based soil testing, and the organisation's historical meteorological data.	235.00
Yield10 Bioscience	Yield10 says it is producing camelina varieties to produce low-carbon feedstocks for vegetable oils, land-based omega-3, bio-plastics and biofuels. Its core platform is its Gene Ranking Artificial Intelligence Network, a genomic library which mines big data sets and prioritizes actionable gene targets to improve crop productivity. It says its objective is to identify novel yield traits that act at a fundamental level in crop metabolism, including through gene editing, to enable the broad deployment of target traits across multiple crop types, including disease and herbicide resistance in Camelina.	225.80
Arcadia Biosciences	Arcadia Biosciences is focused on the development of agronomic traits that improve the environment and enhance human health, including by gene editing. It does this by isolating certain traits, demonstrating these in a fast-growing model plant, and then commercialising them via dedicated crops. The company's goodwheat brand is based off a wheat variety with a higher protein and fibre content. The company is also working on other traits for water use and nitrogen use efficiency.	221.39
Pairwise	Pairwise says it uses CRISPR and gene editing techniques to deliver gene edited products, under its branded Fulcrum platform. It is expecting to bring its first CRISPR-edited food products to the market in the U.S. in 2023. The company wants to use CRISPR both to create healthier consumer foods, under its Conscious Foods brand, and also to advance plant-based business opportunities. The company says CRISPR is about adding traits from other varieties to existing elite lines, and that this starts with understanding what DNA sequences control what traits. In a five-year collaboration with Bayer, Pairwise used its Fulcrum platform to develop a new, higher yielding corn phenotype, which is currently being tested. The company says it is also interested in climate tolerant and less resource-intensive or resistant varieties.	155.00