Neue gentechnische Verfahren: Kommerzialisierungspipeline im Bereich Pflanzenzüchtung und Lizenzvereinbarungen

Quelle: https://gesundpedia.de/images/Acker-Hellerkraut.jpg

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Im Auftrag des Bundesamtes für Umwelt (BAFU)

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Marktentwicklungen im Bereich der neuen Gentechnik

Die wichtigsten Ergebnisse zusammengefasst:

Die Recherche ergab **drei neue Lizenzvereinbarungen**. Da die **Patentstreitigkeiten** über CRISPR-Cas9 auch 2023 noch immer nicht beendet sind,[1] besteht für Unternehmen, die **CRISPR/Cas9** im Pflanzenbereich zu kommerziellen Zwecken nutzen wollen, noch immer **keine Rechtssicherheit** (*freedom-to-operate*): *"… the ownership and licensing of this technology is also a source of legal disputes and controversies among various parties. Anyone who thought gene editing would level the playing field and open a world of new breeding possibilities free from the high costs of working in the GM space might want to think again, thanks to the complicated world of gene editing patents."*[2]

Insgesamt befinden sich mindestens **5 Pflanzen**, die mit Hilfe der neuen gentechnischen Verfahren entwickelt wurden, **im Anbau** (in den USA und Japan). **15 Pflanzen** befinden sich, nach Unternehmensangaben, kurz vor der Markteinführung.

Im April 2023 wurde die **erste mittels CRISPR entwickelte Pflanze in China zum Anbau freigegeben**. Die Sojabohnen mit höherem Ölsäuregehalt von *Shandong BellaGen Biotechnology Co.* erhielten ein Sicherheitszertifikat für fünf Jahre (bis April 2028).[3] *BellaGen* ist das erste Unternehmen in China, das die Nutzung der neuen Gentechnik im Pflanzenbereich im industriellen Massstab einführt.

Das Produktportfolio der kleineren Start-Ups entwickelt sich nach wie vor dynamisch. Einzelne Unternehmen haben (auch) aus finanziellen Gründen, ihr Geschäftsmodell (erneut) geändert. **43 Projekte** (darunter auch reine Freisetzungs-/Forschungsprojekte) sind 2023 **neu hinzugekommen**.

1 https://germination.ca/a-south-korean-company-is-fighting-to-stake-its-claim-in-the-crispr-patent-battle/

2 https://germination.ca/who-owns-crispr-cas9-the-jury-is-out-and-its-making-it-hard-to-do-business/

3 https://www.globaltimes.cn/page/202305/1290182.shtml#:~:text=On%20January%2024%2C%202022%2C%20the,gene%2Dediting%20products%20and%20GM

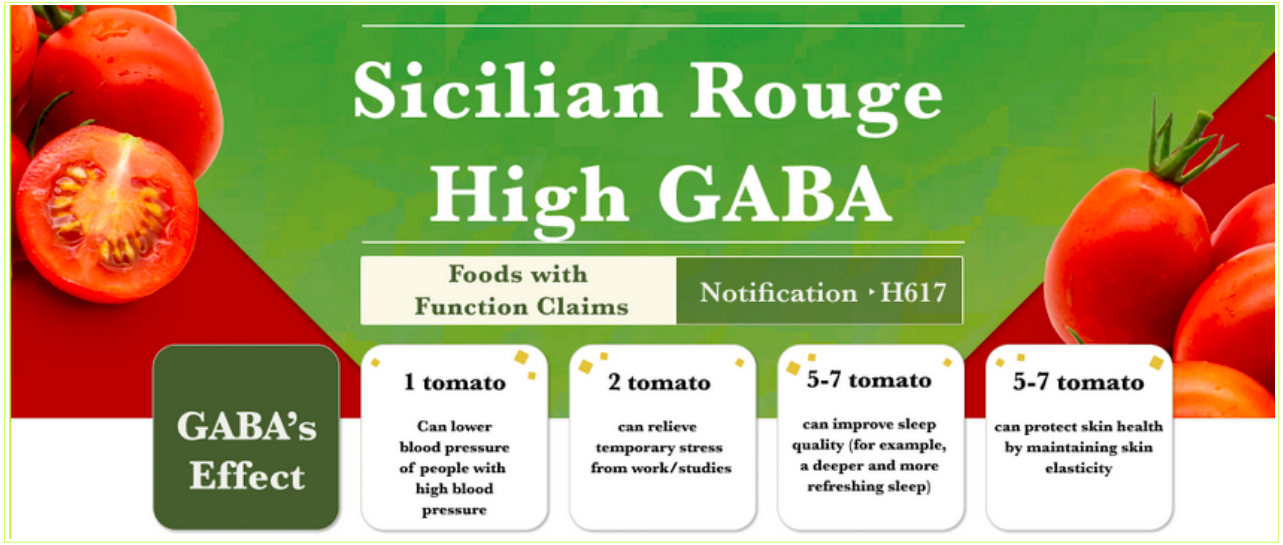
Dr. Eva Gelinsky_ semnar / saatgutpolitik & wissenschaft

1. Welche neuen gv-Pflanzen sind auf dem Markt/stehen kurz vor der Markteinführung?

a) Neue gv-Pflanzen auf dem Markt

Gemäss eigenen Erhebungen gibt es (mind.) 5 Pflanzen, die bereits angebaut und vermarktet werden:

- Die **«GABA-Tomate»** (erhöhter Gehalt an *Gamma-Amino-Buttersäure*) des Unternehmens *Sanatech Seed*. Anbau: Japan.[4] (Quelle der Abb.)[5]



4 Matsuo M and Tachikawa M (2022): Implications and Lessons From the Introduction of Genome-Edited Food-Products in Japan. Front. Genome Ed.

5 https://sanatech-seed.com/en/221226-2/

- Der **GreenVenus™-Salat** des US-Unternehmens *Green Venus* (Ausgründung von *Intrexon*). Der Salat hat ein verlängertes *Shelf-life* und zeigt eine verringerte enzymatische Bräunungsreaktion (an verletzten Blättern). Der Salat ist vermutlich bereits seit 2020 auf dem Markt (Anbau und Vertrieb in den USA).[6] *Green Venus* arbeitet (mit Hilfe ihrer Züchtungsplattform Primavera™) aktuell an fünf weiteren Salatsorten. Diese wurden 2022 bereits in Feldversuchen getestet. Die gesamte Sortenpalette umfasst vier Römersalatsorten und eine Batavia-Sorte. Darüber hinaus arbeitet Green Venus auch an (*non-browning*) Avocado.
- Ein **Senf mit verbessertem Geschmack** (reduzierten Bitterstoffen) von *Pairwise* wurde 2023 unter dem Markennamen *Conscious™ Greens*[7] auf den Markt gebracht. *Conscious™ Greens* ist inzwischen auch in einigen Restaurants der Performance Food Group erhältlich. Im April 2023 hat Health Canada den Senf auf die Liste der "*non-novel foods*" aufgenommen.[8]
- Obwohl keine Angaben zu Anbau oder Anbauumfang vorliegen, ist davon auszugehen, dass der **Mais mit veränderter Stärke** (*waxy corn*) von *Corteva* bereits in verschiedenen Ländern auf dem Acker ist. Der Mais hat Anbauzulassungen in den USA, Kanada, Brasilien, Argentinien, Chile und seit 2023 auch in Japan.[9]
- Ende 2020 wurde ein Importantrag für einen **herbizidresistenten und Insektengift produzierenden Mais (Mais DP915635)** der Firma *Pioneer* (*Corteva*) bei der EFSA eingereicht.[10] Der Mais wurde mittels Transgenese und CRISPR entwickelt. Laut Angaben des Unternehmens haben Freisetzungsversuche in den USA und Kanada stattgefunden. Vermutlich ist der Mais mind. in den USA bereits im Anbau. Der Antrag in der EU bezieht sich auf den Import von Mais für die Nutzung als Lebens- und Futtermittel. Ende 2023 wurde dem Mais vom zuständigen

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6 "In 2020, GreenVenus successfully built open field and controlled environment partnerships to trial and launch their first commercial non browning romaine variety. The variety consistently outperformed the market standards in terms of overall quality and yield and is attracting interest from the $10.7 billion bagged salad market, which led GreenVenus to prioritize its emerging lettuce business."

7 https://consciousfoods.net/conscious-greens

8 https://www.pairwise.com/news/health-canada-gives-pairwises-conscious-greens-a-nod-of-approval

9 https://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=20131

10 https://www.testbiotech.org/sites/default/files/EFSA-Q-2020-00834-EFSA-GMO-NL-2020-172_%20Summary.pdf

wissenschaftlichen Panel bei der EFSA attestiert, er sei so sicher wie konventionell gezüchteter Mais.[11] Ein Zulassungsbescheid für die EU liegt noch nicht vor.

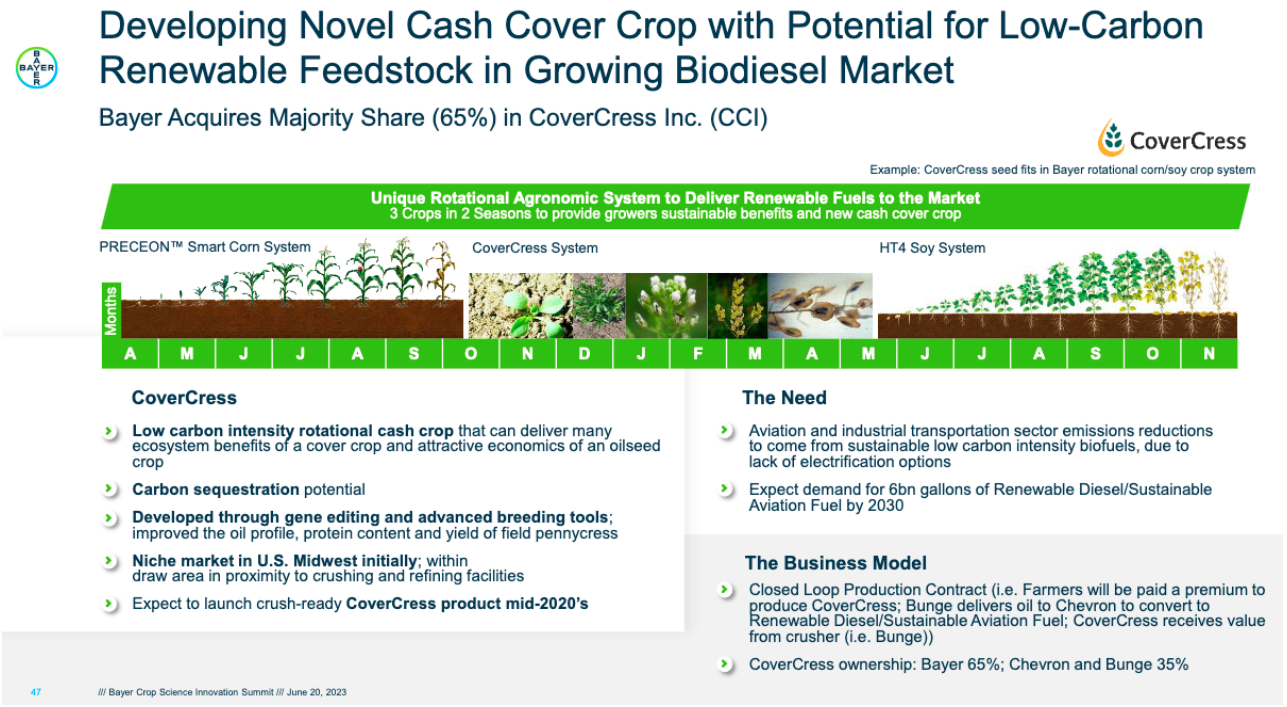
b) Neue gv-Pflanzen, die – gemäss Angaben der entwickelnden Unternehmen – kurz vor der Markteinführung stehen

- Eine von *Calyxt* entwickelte **Luzerne mit reduziertem Lignin-Gehalt** (zur besseren Verdaulichkeit) soll «demnächst» von der *S&W Seed Company* (an die *Calyxt* den Trait lizensiert hat) auf den Markt gebracht werden. Auf der Seite von S&W heisst es: «Unsere künftigen Luzerne-Sorten werden bald IQA™ enthalten, ein durch Gen-Editierung erreichtes Qualitätsmerkmal für Luzerne mit reduziertem Lignin. Es wird in das Keimplasma von Elite-Luzerne integriert, um sowohl den Ertrag als auch die Futterqualität zu verbessern. Die Landwirte haben die Flexibilität, später zu ernten, ohne dass die Futterqualität wie bei herkömmlichen Sorten abnimmt, oder sie können nach ihrem normalen Zeitplan ernten, um potenziell eine höhere RFQ und eine Luzerne mit geringerem Lignin zu erhalten. Dies kann ein erweitertes Erntefenster mit verbesserter Futterqualität bieten. Bitte erkundigen Sie sich bei Alfalfa Partners nach der Verfügbarkeit in Ihrer Region und danach, ob ihr spezifisches Anbauumfeld für eine gentechnisch veränderte Sorte empfindlich sein könnte.»[12] Dieser Hinweis steht bereits seit Ende 2022 auf der Seite von *S&W Seed*.

11 https://efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/j.efsa.2024.8490

12 https://swseedco.com/research-development/iqa-the-next-innovation/

- Der 2023 begonnene **vor-kommerzielle Anbau** eines **Ackerhellerkrauts mit erhöhtem Ölgehalt** von *CoverCress Inc.* soll 2024 fortgesetzt werden.[13] *Bayer* gehören 65% von *CoverCress Inc.* (CCI). 35% von CCI halten *Bunge* und *Chevron*.[14] (Quelle der Abb.)[15]



13 https://www.covercress.com/

14 https://www.bizjournals.com/stlouis/inno/stories/awards/2023/07/18/startup-exit-awards-2023-covercress-acquisition.html?b=1689715584%5E22271606

15 https://www.bayer.com/sites/default/files/2023-06/Bayer%20CS%20Innovation%20Summit%202023_Resource%20Guide.pdf, S. 47

- **Raps mit erhöhter Schotenplatzfestigkeit** (es sind drei Traits mit *Pod Shatter Reduction* in Entwicklung). Nach Angaben von *CIBUS Inc.* wurde der Trait im ersten Quartal 2023 erfolgreich in Elitematerial übertragen.[16] 2023 sollte der Trait in Elitelinien von sechs Saatgutunternehmen übertragen werden. Ob die Markteinführung noch immer für **2025** geplant ist, ist unklar.
- **Raps mit einer Resistenz gegen *Sclerotinia*** (Weissstängeligkeit). Nach Angaben von *CIBUS Inc.* finden bereits Gewächshaus- und Freisetzungsversuche statt. Ob, wie noch Ende 2022 angegeben, der Trait innerhalb der nächsten vier Jahre von verschiedenen Saatgutfirmen in Elitelinien übertragen werden kann, ist unklar.
- **Herbizidresistenter Reis.** Nach Angaben von *CIBUS Inc.* wurden 2023 zwei verschiedene HR-Traits (HT1, 3) in Elitematerial einer führenden US-amerikanischen Saatgutfirma übertragen.[17] Zum Zeitpunkt der Kommerzialisierung schreibt CIBUS: "We expect initial launch of at least one of these traits in the next 2-3 years."[18]
- Eine **Soja mit einem höheren Proteingehalt, einem optimierten Aminosäureprofil und einem geringeren Gehalt an antinutritiven Faktoren** soll nach Angaben von *Corteva* und *Bunge* vor 2030 auf den Markt kommen.[19]
- **Soja mit verschiedenen Traits** (darunter Herbizidtoleranz, Resistenz gegen die Südliche Stinkwanze (*Nezara viridula*)), die vom argentinisch-brasilianischen Unternehmen *Don Mario Semillas* (Teil von *GDM Seeds*) entwickelt wurden, sollen 2025 kommerzialisiert werden.[20]

16 https://www.cibus.com/productivity-traits.php

17 "In 2023, we are preparing to transfer two different herbicide resistance traits in rice in the elite germplasm of a leading North American rice seed company." https://www.wsj.com/articles/calyxt-and-cibus-announce-definitive-merger-agreement-to-create-industry-leading-precision-gene-editing-and-trait-licensing-company-01673955319.

18 https://www.cibus.com/productivity-traits.php

19 https://www.corteva.com/resources/media-center/corteva-and-bunge-announce-collaboration-to-develop-amino-acid-enhanced-soybeans.html

20 https://www.gdmseeds.com/wp-content/uploads/2021/07/GDM-Special-EN.pdf

- Das argentinische Unternehmen *GDM Seeds* plant für 2024/2025 die Markteinführung einer (für Tiere) **besser verdaulichen Soja**. Die Soja hat bereits eine Zulassung (als non-GMO) in Brasilien, Argentinien und Kolumbien.[21]
- Das argentinische Unternehmen *GDM Seeds* plant für 2026/2027 die Markteinführung einer **trockentoleranten Soja**. Die Soja hat bereits eine Zulassung (als non-GMO) in Brasilien, Argentinien und Kolumbien.[22]
- Eine **Soja mit veränderter Fettsäure** steht nach Angaben von *ToolGen Inc.* **kurz vor der Markteinführung**.[23]
- **Verschiedene Kartoffeln mit einem non-browning Trait, reduziertem Solanin-Gehalt und reduziertem Acrylamid** (bei starker Erhitzung) stehen gemäss *ToolGen Inc.* **kurz vor der Markteinführung**. Es sind Lizenzvereinbarungen mit global tätigen Unternehmen geplant, die die Kartoffeln vertreiben.[24]
- Eine **Kartoffel mit non-browning Trait**, die vom argentinischen *Instituto Nacional de Tecnología Agropecuaria (INTA)* entwickelt wurde, steht nach Angaben des Instituts kurz vor der Markteinführung. Die Kartoffel wurde bereits im Freiland getestet und hat eine Zulassung als non-GMO in Argentinien erhalten.[25]
- Für verschiedene **Leindottersorten mit erhöhtem Ölgehalt, früher Reife und Kältetoleranz** laufen umfangreiche Feldversuche. Darüber hinaus hat das Unternehmen *Yiel10 Bioscience* die Saatgutproduktion aufgegleist. Die Flächen hierfür liegen in den USA, Kanada, Argentinien und Chile.[26] Der Leindotter soll für Biokraftstoffe bzw. als proteinreiches Tierfutter verwendet werden. *Yield10 Bioscience* hat darüber hinaus Nicht-Regulierungsbescheide für drei genom-editierte Leindotter-Linien von der Argentinischen *Biosafety* Kommission

21 https://www.gdmseeds.com/wp-content/uploads/2022/12/03.Segunda-soja-DT-ING.pdf, https://www.reuters.com/article/idUSL1N33H0HB/

22 https://www.isaaa.org/kc/cropbiotechupdate/ged/article/default.asp?ID=19979, https://www.reuters.com/article/idUSL1N33H0HB/

23 http://www.toolgen.com/eng/crops

24 "ToolGen employed genome editing to invent enhanced functional potatoes, which were conceived to lower browning and solanin toxin levels and reduce acrylamide. ToolGen plans for continued sales and other business activities by minimizing seed R&D expenditure and making a license agreement with global potato businesses."

25 https://www.potatobusiness.com/agro-news/the-argentinian-inta-is-close-to-releasing-the-first-latin-american-genetically-edited-potato/

erhalten.[27] In der Saison 2022/2023 pflanzte *Yield10* rund 1.000 Hektar Winterleindotter an.[28] *Yield10* möchte für die Anbausaison 2023 etwa 20.000 Hektar mit seinen Frühjahrs- und Winterleindotter-Sorten anbauen, mit dem Ziel einer breiten kommerziellen Einführung innerhalb der nächsten zwei bis drei Jahre.[29] Wie das Unternehmen mitteilte, treibt es auch die Entwicklung von Leindotter-Linien mit erhöhter Omega-3-Fettsäure voran. (Öl und Presskuchen sollen v. a. in Aquakulturen als Futter eingesetzt werden). Der Leindotter wurde bereits in den USA, Kanada und Grossbritannien im Freiland getestet. Erste Gespräche mit potentiellen Kunden des Spezialöls sind angelaufen. Für 2025 plant **Yield10** die Einführung verschiedener herbizidresistenter Leindottersorten.

- Die Markteinführung von einem **Süssstoff**, der aus mittels **Genome-Editing veränderten (Wasser-)Melonen** gewonnen wird, soll gemäss *Elo Life Sciences* 2025 erfolgen.[30]
- Eine **Banane mit non-browning Trait**, die von *Tropic Bioscience* entwickelt wurde, wird bereits in Freisetzungsversuchen in Honduras und auf den Philippinen getestet. Im Mai 2023 hat die Banane einen non-GMO-Bescheid der zuständigen Behörde auf den Philippinen erhalten. Die Banane kann nun eingeführt und auf den Philippinen vermehrt werden.[31]

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26 "Yield10 Bioscience announced that the Company has begun its winter 2022/2023 field test and seed production program for Camelina at sites in the United States, Canada, Argentina and Chile. Yield10's winter 2022/2023 field test program, which is being conducted at more than 20 sites, is intended to evaluate several varieties of elite Camelina by collecting data on agronomical performance, seed yield, oil content, and herbicide tolerance, where applicable." https://www.yield10bio.com/press/yield10-bioscience-begins-winter-2022-2023-field-test-and-seed-production-program

27 "Yield10 Bioscience has received a favorable determination from the Argentine Biosafety Commission (Comisión Nacional de Biotecnología Agropecuaria or "CONABIA") for three CRISPR genome edited Camelina lines. The Company's CRISPR edited Camelina lines covered by the CONABIA ruling are E3902 as well as two distinct C3007 (BADC) Camelina lines developed by Yield10." https://www.seedquest.com/news.php?type=news&id_article=135132&id_region=&id_category=&id_crop

28 https://www.feednavigator.com/Article/2023/08/16/Yield10-camelina-cultivation-program-on-track-Target-markets-include-biofuels-aquaculture-and-PHA-bioplastics

29 https://www.producer.com/news/camelina-company-seeks-farmers-to-grow-crop/

30 https://www.foodnavigator-usa.com/Article/2022/09/09/Elo-to-commercialize-new-high-intensity-plant-based-sweetener-in-2025-with-sweeter-cleaner-taste-than-monk-fruit-extracts

31 https://tropic.bio/tropics-non-browning-gene-edited-banana-cleared-for-production-in-the-philippines/

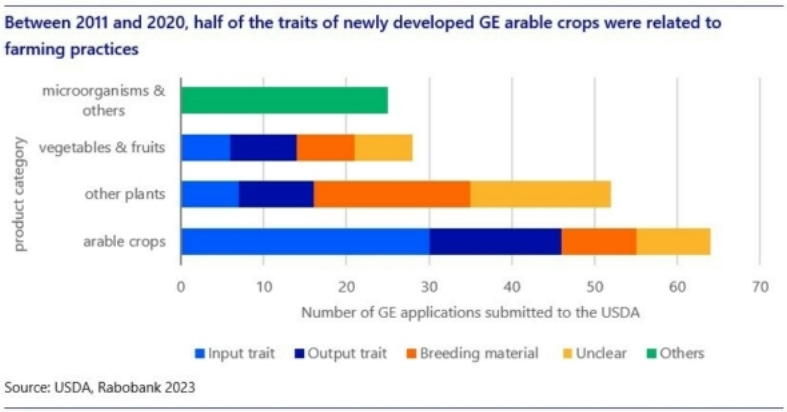
2. Weitere Übersichten/Quellen zur Produktpipeline/Marktentwicklung

Marktübersichten

Frei zugängliche (kostenlose) Marktübersichten gibt es nicht. *RaboResearch* der niederländischen Rabobank hat 2023 zwei Berichte vorgelegt (A Gene-edited Crop Coming to a Market Near You: When Gene-edited Crops Meet the Grain and Oilseed Supply Chain und Speciality Crops To Test Appetite for Gene Editing). Verschiedene Agrarportale (wie Grainnet, WorldGrain und FeedNavigator) und haben über einige der Ergebnisse berichtet:

Ergebnisse:

- "Adoption of gene-edited crop seeds is expected to increase significantly in the next 5 to 10 years, according to a Rabobank report, with adoption rates expected to surpass 50% during that period. "GE technology has the potential to solve issues across the food supply chain for all stakeholders," said Chia-Kai-Kang, farm inputs analyst for Rabobank. "It can increase crop productivity without expanding farmland area, reduce food waste, reduce harmful substances in food, and reduce pesticide use, among other things." The Rabobank report, authored by Kang and Stephen Nicholson, global strategist, Grains & Oilseeds, cautioned that several challenges must be overcome to maximize the potential of GE technology. They include "the complexity of the traits of interest, the often more unstable performance of complex traits, the potential long-term risks such as allergic and toxic reactions, which are difficult to detect in the short term, disruption to trade flows following export bans of GE crops, and access to technology."



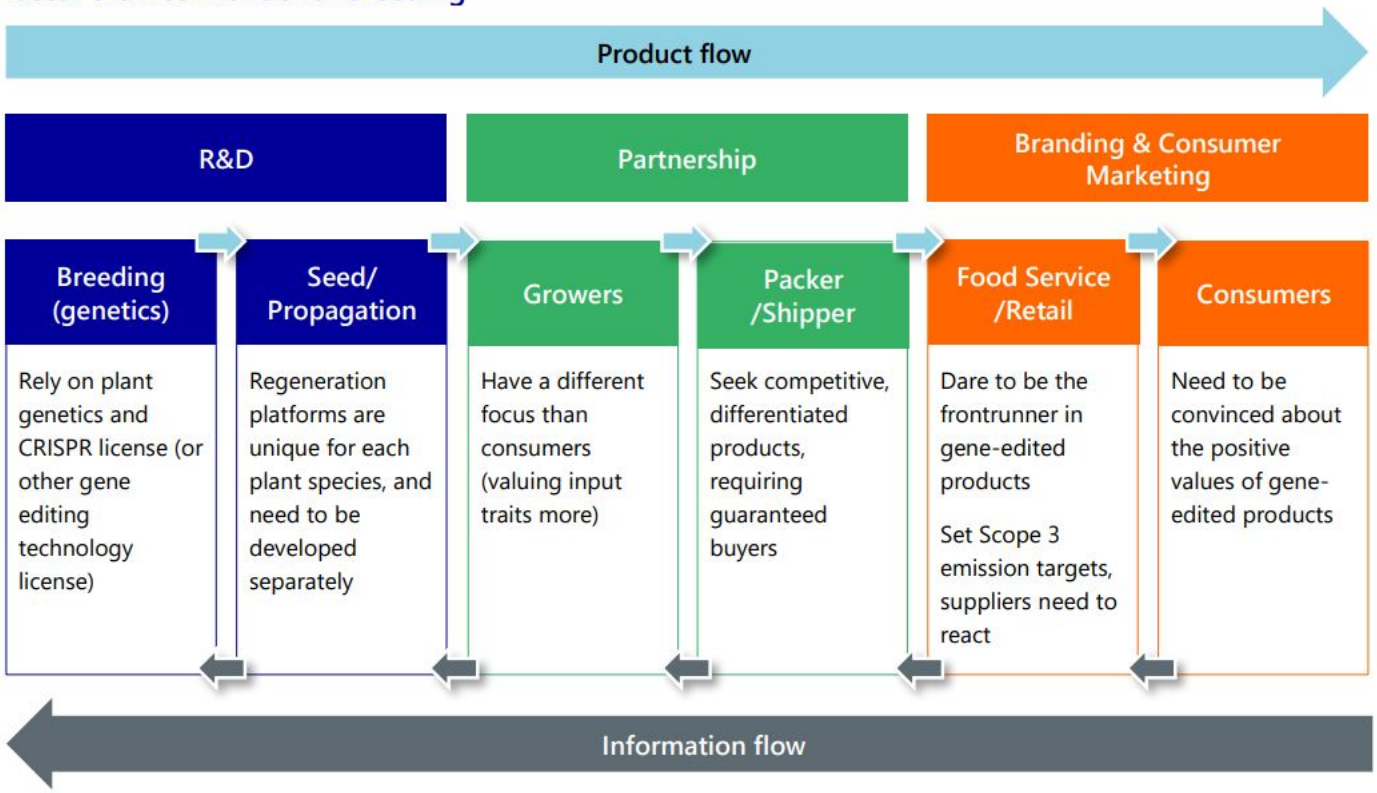
The US has been the frontrunner in terms of GE applications, as it was with genetically modified organisms (GMO). According to the USDA, 169 applications for GE products were submitted in the US from 2011 to 2020.

These applications covered plants that are for human consumption, feed, industrial uses, and some microorganisms for industry. Some of these applications are expected to be commercialized soon."

- "RaboResearch expects that speciality 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. In a controlled or semi-closed system, the environment is less complicated and the response of a gene-edited crop can be better controlled."
- "The first examples of gene-edited speciality crops with output traits are already out there, like (…) a tomato with high levels of gamma-aminobutyric acid (GABA) in Japan. 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 (...). Traits like better storability, reduced need for agrochemical use, and decreased CO_2 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

3. Ergänzende Informationen zu einzelnen Unternehmen

a) CIBUS/Calyxt

Die Fusion der beiden Unternehmen wurde zum 1. Juni abgeschlossen.[32]

Auf der Seite von *CIBUS* heisst es dazu:

- Das landwirtschaftliche Biotech-Unternehmen *CIBUS Inc.* wurde am 1. Juni nach dem Abschluss der zuvor angekündigten Fusion mit *Calyxt* Inc. als Aktiengesellschaft gegründet. (…)
- *CIBUS* ist führend in der Entwicklung von «Produktivitätsmerkmalen» durch Gen-Editing in Saatgut (...). *Calyxt* ist führend auf dem Gebiet des Gene Editing zur Entwicklung nachhaltiger Inhaltsstoffe mit Hilfe von Mikroorganismen. (...) Durch seine Tochtergesellschaft Nucelis nutzt *CIBUS* sein RTDS®-Verfahren für die effiziente Entwicklung innovativer Eigenschaften in Mikroorganismen wie Hefen, Bakterien und Algen, um hochwertige, nachhaltig erzeugte Spezialinhaltsstoffe für die Körperpflege-, Ernährungs-, Geschmacks- und Duftstoffindustrie zu produzieren.
- Das neue Unternehmen verfügt über mehr als 1.000 erteilte oder angemeldete Patente, die ein breites Spektrum grundlegender Technologien für das Gene Editing in der Landwirtschaft abdecken (…)
- In der ersten Jahreshälfte [2023] hat das Unternehmen drei verschiedene Traits in zwei verschiedene Kulturen übertragen und schliesst derzeit den Bau seiner ersten *Trait-Machine* ab, bei der es sich um die «erste eigenständige halbautomatische Trait-Produktion der Agrarindustrie» handelt.
- «Die *Trait-Machine* von *CIBUS* ist ein entscheidender Durchbruch in der Züchtungstechnologie», sagte Gerhard Prante, stellvertretender Vorsitzender von *CIBUS* und ehemaliges Mitglied des Aufsichtsrats von *Bayer CropScience*. «Die Fähigkeit, ein komplexes Merkmal direkt

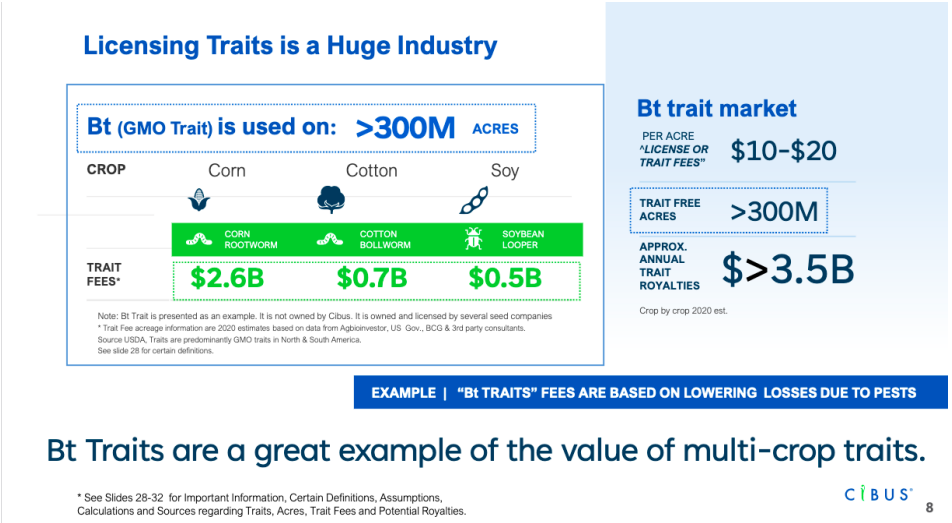
32 https://www.cibus.com/pdfs/articles/SDBJ-Cibus-Cements-Itself-as-Industry-Leader-with-Calyxt-Merger.pdf

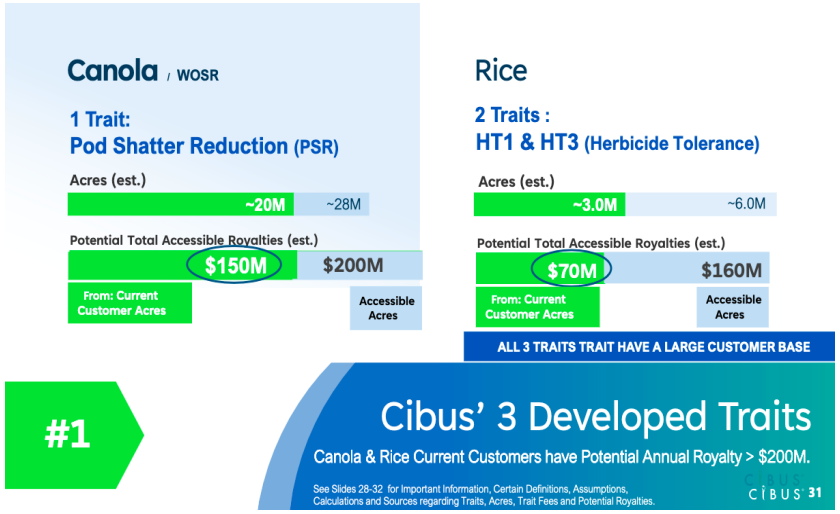
im Elite-Keimplasma eines Kunden zu bearbeiten und dem Kunden eine marktreife Pflanze zu liefern, ist einzigartig. Sie verändert grundlegend die Zeit für die Entwicklung neuer Traits und die Zeit für den Kunden, einen Trait zu vermarkten, sobald er entwickelt ist.»[33]

In einem wissenschaftlichen Artikel beschreibt *CIBUS* am Beispiel Raps detaillierter, wie das Verfahren funktioniert:

Walker A, Narváez-Vásquez J, Mozoruk J, Niu Z, Luginbühl P, Sanders S, Schöpke C, Sauer N, Radtke J, Gocal G, et al. Industrial Scale Gene Editing in *Brassica napus*. *International Journal of Plant Biology*. 2023; 14(4):1064-1077. https://doi.org/10.3390/ijpb14040077

In einer Investorenpräsentation macht CIBUS darauf aufmerksam, welches finanzielle Potential die Lizenzierung von Traits haben kann. Als Massstab wird hier der (transgene) Bt-Trait aufgeführt:





33 Quelle: https://www.cibus.com/pdfs/Cibus-Closes-Calyxt-Deal-San-Diego-Business-Journal.pdf (DeepL-Übersetzung)

b) Corteva

Trotz wachsender Probleme mit herbizidresistenten Unkräutern, scheinen Unternehmen wie *Corteva* weiterhin an ihrem Kerngeschäft festzuhalten: der Entwicklung neuer (transgener) herbizidresistenter Pflanzen (siehe z. B. die Investorenpräsentation von Mai 2023).

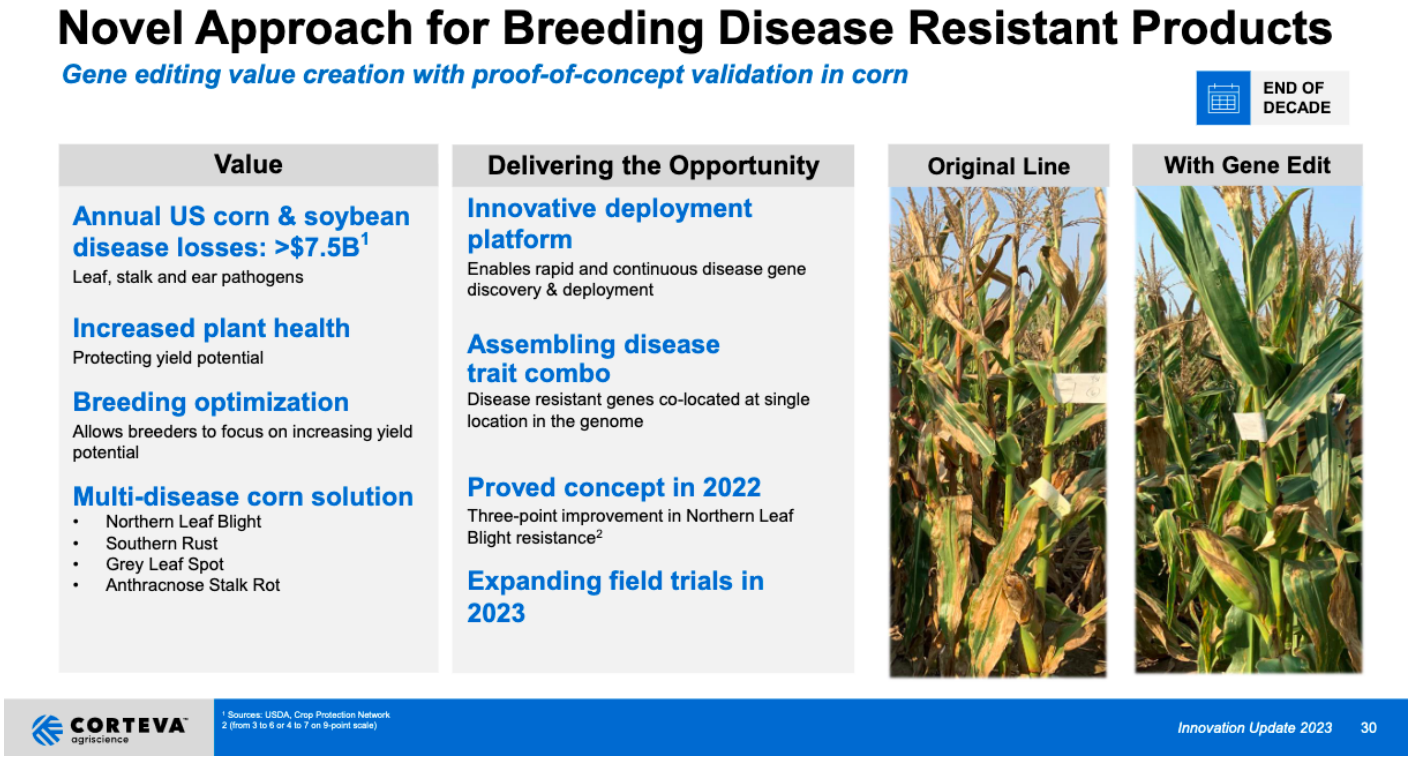
Die Investorenpräsentation von Corteva vermittelt insgesamt den Eindruck, dass die Forschung & Entwicklung von Genome-Editing bislang (ähnlich wie die Firmenakquise und Entwicklung von *Biologicals*) zwar wichtig ist, es sich aber (noch) nicht um den zentralen Bereich im Unternehmen handelt.

Zu Genome-Editing führte *Corteva* im Rahmen der Investorenpräsentation aus:[34]

"Corteva has a leadership position in gene editing and we are focused on creating new value from this platform. By removing evolutionary constraints, gene editing simplifies the breeding and creation of improved products. To effectively deliver products from gene editing, it takes more than just a CRISPR-Cas enzyme to make a product. It is necessary to have elite germplasm, high throughput elite line transformation, deep genomics knowledge powered by artificial intelligence algorithms, high capacity field testing and advantage route to market. Corteva has all of these components along with our own proprietary CRISPR platform and strong intellectual property position. Through our strategic choices, we have aligned on where we will play and how we will win in this space. With our recent biologics acquisitions, we see gene editing having a significant role in the enhancement of microbial products. Strategically, we are expanding product concepts and accelerating innovation, and increasing our investment in our gene editing platform as global regulatory policy continues to take shape. (…) we are collaborating to bring gene-edited soybeans to Europe to expand their plant-based protein production. These projects demonstrate the technical capability of our platform while also helping shape the global regulatory conversation about gene editing.

34 Quelle: Transkript der Präsentation, S. 16.

Moving to Slide 30. I want to highlight how Corteva is using gene editing to transform the development of disease-resistant plants. (…) Using corn as a pilot, we have identified a pipeline of native genes to target major disease problems. We have successfully enhanced these genes to improve the level of disease resistance. Finally, we have consolidated these genes into a single super locus that greatly simplifies the breeding and development of products with disease resistance. In 2022, we demonstrated this concept works in corn for Northern corn leaf blight and are advancing this concept for additional diseases. (…) We can quickly make improvements without negatively impacting other characteristics."[35]



35 Siehe auch: https://bsppjournals.onlinelibrary.wiley.com/doi/10.1111/mpp.13319

c) Benson Hill

Das Unternehmen *Benson Hill*, das einige Jahre als Vorzeige-Startup gehandelt wurde,[36] ist in finanziellen Schwierigkeiten:[37] "Benson Hill, which went public two years ago at a value of more than $1 billion, is now worth just $61 million in investors' eyes. Executives have said they are weighing alternatives that could include going private or selling to a larger company."

Benson Hill hatte zunächst auf den Markt für Fleischersatzprodukte gesetzt. Solange Unternehmen wie *Impossible Foods* hoch gehandelt wurden, schien dies vernünftig zu sein. Aktuell ist der Absatz von Fleischalternativen jedoch rückläufig. *JBS* hat entsprechende Projekte abgebrochen. Ein Analyst bezeichnet den Veggie-Burger-Pionier *Beyond Meat* als «Überlebenskünstler». Derzeit werden nur 4 % der US-Sojabohnenernte für den menschlichen Verzehr verwendet. Die Industrie hatte erwartet, dass diese Zahl schnell steigen würde, aber das ist nicht der Fall.

Benson Hill wird sein Sojageschäft daher auf den Bereich Tierfutter verlagern. Die zunächst für den Lebensmittelsektor aufgebauten Verarbeitungsanlagen von Soja wurden bzw. werden verkauft: "For Benson Hill, the answer is to accelerate its entry into the much larger livestock feed market. The company expects to begin commercial planting in 2025 of a new soybean variety that delivers more protein and is easier for animals to digest.[38] For the livestock market (…) it makes sense to partner with large processing firms and ditch the do-it-yourself model. "The closed loop model was always aimed at food." "Our way forward was always that we would be moving to an asset-light model as we moved into these larger categories." Selling the processing plants also will let Benson Hill eliminate debt and meet its liquidity needs for more than a year."

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36 "Benson Hill's growth and emergence was a showpiece for the collaborative ecosystem that's been built in St. Louis to support innovation generally, and ag tech specifically," said Donn Rubin, chief executive of industry group BioSTL." (https://www.stltoday.com/news/local/business/nicklaus-benson-hill-a-unicorn-no-more-restructures-amid-market-pressures/article_306b548c-8405-11ee-beb0-5f1774e6fb1a.html)

37 https://s28.q4cdn.com/858570331/files/doc_financials/2023/q3/Benson-Hill_3Q23_Earnings-Presentation_9-November-2023.pdf

38 https://bensonhill.com/2024/01/04/benson-hill-announces-gains-in-soybean-breeding-program-introduces-five-2024-soybean-varieties-delivering-higher-protein-and-improved-yield-potential/

Das Unternehmen verfolgt nach wie vor eine Doppelstrategie: Zum einen werden z. B. Sojasorten konventionell entwickelt und als Non-GMO zertifiziert. Für diese Sorten hat *Benson Hill* nun auch die internationale Zertifizierung der ProTerra-Stiftung erhalten.

Parallel wird auch Genome-Editing eingesetzt, z. B.: APHIS-Antrag (2023) für eine Soja mit «verbesserter Produktivität».

Neue wissenschaftliche Studie (mit Beteiligung von *Benson Hill*) zu einem neuen Cas-Enzym: Dmytrenko, O., Neumann, G.C., Hallmark, T. *et al.* Cas12a2 elicits abortive infection through RNA-triggered destruction of dsDNA. *Nature* **613**, 588–594 (2023). https://doi.org/10.1038/s41586-022-05559-3

d) Inari

Inari (gegründet 2016, Sitz in Cambridge, Massachusetts) gehört zu den Startup-Unternehmen aus dem Bereich der neuen gentechnischen Verfahren. Das Unternehmen hat Investitionen von der Risikokapitalgesellschaft Flagship Pioneering erhalten (*Flagship Pioneering* hat auch in das Pharma- und Biotech-Unternehmen Moderna investiert). *Inari* arbeitet vor allem mit *Cash Crops* und möchte – z. B. bei Mais – eine Ertragssteigerung von 10 – 20 % und eine Reduzierung des Wasser- und Stickstoffverbrauchs um 40 % erreichen. *Inari* setzt u. a. auf Multiplexing und nutzt dazu auch Verfahren der künstlichen Intelligenz. Mit einer eigens entwickelten (und patentierten) Software erforscht *Inari* genetische Interaktionen anstelle einzelner Gene, um mit CRISPR mehrere Gene auf einmal zu verändern. (Quelle: Modern Solutions for the Agriculture Industry Using CRISPR Gene Editing).

Darüber hinaus kombiniert *Inari* «herkömmliche» gv-Traits mit Genome Editing[39] und meldet diese Kombinationen zum Patent an.

Im Oktober 2023 wurde bekannt, dass ***Corteva* gegen *Inari* Klage** erhoben hat. Der Vorwurf: **Diebstahl intellektuellen Eigentums**.[40]

- Corteva is suing a Massachusetts-based startup for allegedly stealing the technology behind its seeds.
- The agriculture behemoth filed a lawsuit last week accusing gene-editing company Inari Agriculture of smuggling Corteva's seeds into Europe, making small changes to the biotech traits, and then applying for a U.S. patent.
- Corteva is seeking monetary damages and for a judge to prohibit the startup from taking steps to commercialize seeds based on the crop science giant's products. Inari did not immediately respond to a request for comment.

39 https://www.seedquest.com/news.php?type=news&id_article=135300&id_region=&id_category=&id_crop

40 https://www.agriculturedive.com/news/corteva-lawsuit-inari-steal-seeds-gene-editing/695605/

Inari arbeitet, ebenso wie *Bayer CropScience*, *Corteva* und *Stine Seeds* an der Entwicklung von Zwergmaissorten.[41]

> *Bayer* hat *Corteva* überholt und bringt bereits Pflanzen auf den Markt (in den USA). Die Hybriden sind konventionell gezüchtet: "Bayer has used conventional breeding to create three short hybrid varieties that were tested for the U.S. market this summer and are now being harvested by about 300 farmers."
>
> Auch *Corteva* setzt zunächst auf konventionelle Züchtung: "Corteva, which owns the famous seed company Pioneer Hi-Bred International, is aiming for similar results with its conventionally bred short corn, which it hopes will be ready for market in a few years."
>
> Ebenfalls erhältlich sind Sorten (vermutlich konventionell gezüchtet) von *Stine Seeds*: "Stine Seed, based in Iowa, already sells short corn in the United States. Its varieties are not planted on a large scale, in part because Stine is a relatively small producer of corn seed. But Stine says its hybrids can exceed the yield of tall corn by up to 10% in optimal conditions."
>
> *Bayer* versucht den Entwicklungsprozess u. a. mittels Transgenese zu beschleunigen: "Breeding shortness into an existing variety of corn typically takes 5 years or more. To shortcut this process, Bayer has turned to genetic engineering."
>
> *Bayer* (in Kooperation mit *Pairwise*, siehe e)) und *Corteva* nutzen auch CRISPR, aber: "To speed up the process, **Bayer and other companies are working on short corn made with gene editing**, an approach that can alter gibberellin without adding genes from other species. Corn varieties created this way will face fewer regulatory hurdles in the U.S. and some other countries, **but they're still years away.**"[42]

Inari arbeitet ebenfalls an einem mittels CRISPR **entwickelten Zwergmais**. Es finden **seit 2023 Freisetzungsversuche in Belgien** statt. Der Freisetzungsversuch läuft unter dem Titel «R&D Field trial to evaluate the phenotype and yield of maize lines gene edited for reduced height».[43]

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41 https://americanfarmpublications.com/buzz-over-short-stature-corn-has-industry-talking/

42 Alle Zitate aus: https://www.science.org/content/article/shrinking-corn-help-farmers-environment

43 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/BE/23/V1&Cat=gmp, Antrag für 2024: https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/Be/23/V4&Cat=gmp

e) Pairwise

Im August 2023 haben *Bayer* und *Pairwise* bekannt gegeben, dass sie einen neuen Fünfjahresvertrag über mehrere Millionen US-Dollar abschliessen, um Innovationen in der Forschung und Entwicklung von **Kurzhalm-Mais** voranzutreiben.[44]

> «Das neue Forschungsprogramm nutzt die Pairwise-Plattform Fulcrum™ und baut auf dem Erfolg der ersten fünfjährigen Kooperation für die Anbaukulturen Mais, Soja, Weizen, Baumwolle und Raps auf.
>
> Die neue Kooperationsvereinbarung zwischen Pairwise und Bayer konzentriert sich auf die Optimierung und Verbesserung von geneditiertem Kurzhalm-Mais. Dieser Mais soll künftig Bestandteil des neuen Maisanbau-Systems Preceon™ Smart Corn System von Bayer werden. Der innovative Kurzhalm-Mais hat eine 30 bis 40 Prozent niedrigere Wuchshöhe als herkömmlicher Mais. Er bietet zahlreiche Vorteile für die Nachhaltigkeit (…).
>
> Bei der ersten fünfjährigen Kooperation von Bayer und Pairwise standen die Anbaukulturen Mais, Soja, Weizen, Baumwolle und Raps im Zentrum. Sie hatte zum Ziel, auf der gleichen Fläche mit geringerem Mitteleinsatz mehr zu produzieren. Die Partnerschaft endete im Juni 2023 und hat 27 neuartige Pflanzeneigenschaften hervorgebracht, die alle in Versuchsprogramme von Bayer übernommen wurden. Die Partnerschaft lieferte Ergebnisse mit einem erheblichen kommerziellen Wert. Dazu zählen unter anderem editierte Mais-Phänotypen mit 20 Prozent mehr Körnerreihen, die bei gleicher Anbaufläche deutlich höhere Erträge versprechen. Ein weiteres Ergebnis sind editierte Sojabohnen, die besser vor Asiatischem Sojarost geschützt werden. Damit müssen weniger Fungizide zur Bekämpfung der Krankheit eingesetzt werden – bei gleichzeitig höheren Erträgen.
>
> Pairwise hat mit seinen selbst entwickelten Werkzeugen Erfolge bei der maßgeschneiderten Geneditierung ermöglicht. Dazu zählt REDRAW™ (RNA-kodierter DNA-Austausch von Allelen mithilfe von CRISPR), ein präziser Werkzeugkasten mit Templates zum Editieren, mit dem sich kleinste Eingriffe an CRISPR-Zielbereichen durchführen lassen. Ein weiteres Tool ist SHARC™, ein proprietäres Enzym, das sich zum

44 https://www.bayer.com/media/geneditierung-pairwise-und-bayer-starten-neue-zusammenarbeit-ueber-fuenf-jahre-zur-weiterentwicklung-von-kurzhalm-mais/

Schneiden und Editieren eignet. Diese Verfahren werden auch im Rahmen der neuen Kooperation zur Weiterentwicklung von Kurzhalm-Mais zum Einsatz kommen.

„Wir freuen uns auf die weitere Zusammenarbeit mit Bayer, mit der wir einen Beitrag zum innovativen Smart Corn System leisten wollen", sagt Tom Adams, Mitgründer und CEO von Pairwise. „Die enge Partnerschaft mit Bayer bei dieser Maisrevolution gibt uns die Reichweite im Markt, um unsere Technologieinnovationen noch schneller an die größte Herausforderung unserer Zeit anzupassen, nämlich den Klimawandel."

Pairwise hat bereits erfolgreich bewiesen, dass mithilfe von CRISPR und anderen neuen Technologien neue Produkte schneller auf den Markt gebracht werden können. So hat Pairwise kürzlich mit dem Romanasalat Conscious™ Greens sein erstes Produkt für die US-amerikanische Gastronomie eingeführt. Durch den führenden Einsatz von Spitzentechnologien und der Effizienz der unternehmenseigenen Fulcrum-Plattform benötigte das Produkt von der Konzeption bis zur Kommerzialisierung nur vier Jahre.»

f) ToolGen.

ToolGen, ein südkoreanisches Biotechnologieunternehmen, hat sich in den **CRISPR-Patentstreit** eingeschaltet und stellt nun die Ansprüche zweier prominenter Forschungseinrichtungen in Frage: die des *Broad Institute* des *MIT* und *Harvard* sowie jene der *University of California, Berkeley (UCB)*.

ToolGen behauptet, dass es die Verwendung von CRISPR in eukaryotischen Zellen, wie Tier- und Pflanzenzellen, vor dem *Broad Institute* und der *UCB* erfunden hat. Eukaryontische Zellen sind die Grundlage der meisten lebenden Organismen, und die Fähigkeit, ihre Genome zu bearbeiten, ist für die Anwendung von CRISPR entscheidend. *ToolGen* reichte seinen Patentantrag nach eigenen Angaben im Oktober 2012 ein, während das *Broad Institute* im Dezember 2012 und UCB im März 2013 den Antrag stellten.[45]

Zum Patentstreit rund um CRISPR/Cas9 siehe auch: Who Owns CRISPR-Cas9? The Jury is Out, and it's Making it Hard to do Business

- *ToolGen* hat im Dezember 2023 Nulla Bio, einem weiteren südkoreanischen Biotechunternehmen eine **CRISPR-Lizenz** erteilt: "Through this agreement, Nulla Bio will obtain the right to use CRISPR-Cas9 technology to develop, produce, license, and sell functional crops and ToolGen will obtain royalty revenue.

  ToolGen exclusively owns the original CRISPR-Cas9 patent in Korea. Consequently, companies seeking to utilize CRISPR-Cas9 technology are required to undergo a technology transfer process facilitated by ToolGen.

  Nulla Bio is a gene editing crop development company founded in March 2022 by Kim Jae-yean, Professor of the College of Life Sciences at Gyeongsang National University.

  Nulla Bio has secured gene editing technology that can modify its genome code and is creating a diverse product portfolio such as climate change response and health-functional tomatoes and hemp based on its breeding platform technology."[46]

45 https://germination.ca/a-south-korean-company-is-fighting-to-stake-its-claim-in-the-crispr-patent-battle/

46 https://www.koreabiomed.com/news/articleView.html?idxno=22850

g) Yield10 Bioscience

Im Januar 2023 haben *Yield10 Bioscience* und ***Mitsubishi*** ein ***Memorandum of understanding*** unterzeichnet: "Yield10 Bioscience, Inc. (…), an agricultural bioscience company, (…) announced that it has signed with Mitsubishi Corporation ("Mitsubishi") a Memorandum of Understanding ("MOU") to evaluate the establishment of a partnership to supply, offtake and market Camelina as a low-carbon feedstock oil for biofuels. Mitsubishi Corporation recently announced its aim to mass produce sustainable aviation fuel to decarbonize commercial aviation."[47]

- Die Eigenschaften von Leindotter ähneln jenen von Raps, Flachs und Färberdistel. Das Öl kann als kohlenstoffarmer Rohstoff für Biokraftstoffe und das Mehl als Tierfutter verwendet werden. Die im Leindottersamen enthaltenen natürlichen Polyesterpolymere können für die Herstellung von biologisch abbaubaren Biokunststoffen verwendet werden.
- Yield10 hat in verschiedenen Bundesstaaten in den USA **Freisetzungsversuche** durchgeführt, unter anderem in Illinois und Iowa. In Idaho sowie in Alberta und Manitoba, Kanada, wurden etwa 1.000 Hektar Leindotter-Winterversuche angelegt.
- Das Unternehmen sieht grosse Chancen im Central Corn Belt. Sie arbeiten aktiv daran, Beziehungen zu Unternehmen zu knüpfen, die die Leindottersamen übernehmen und weiterverarbeiten können. Dann könne das gesamte Programm hochgefahren werden.
- In Gesprächen mit Landwirten habe das Unternehmen den Eindruck gewonnen, dass sie Leindotter als eine grosse Chance betrachten, wenn die Pflanzen mit einer Herbizidresistenz ausgestattet und die Wertschöpfungskette etabliert sei.[48] **Die herbizidresistenten Sorten sollen ab 2025 verfügbar sein**.[49]

47 https://www.yield10bio.com/press/yield10-bioscience-and-mitsubishi-corporation-sign-mou-to-evaluate-the-establishment-of-a-partnership-to-supply-offtake-and-market-camelina-as-a-feedstock-oil-for-biofuel

48 https://farmworldonline.com/News/NewsArticle.asp?newsid=33241

49 https://www.feednavigator.com/Article/2023/08/16/Yield10-camelina-cultivation-program-on-track-Target-markets-include-biofuels-aquaculture-and-PHA-bioplastics

h) GDM Seeds

Zur argentinischen *GDM-Gruppe* gehören verschiedene Unternehmen, darunter *Don Mario Semillas*.

GDM beschäftigt heute 1.200 Mitarbeiter, erzielt einen Umsatz von etwa 500 Millionen US-Dollar pro Jahr und investiert 25 % in Forschung und Entwicklung. Das Unternehmen hält 70 % des argentinischen Marktes und 48 % des südamerikanischen Marktes, wobei es in Brasilien, dem weltweit führenden Erzeuger und Exporteur von Ölsaaten, eine führende Position einnimmt.

In den letzten Jahren hat das Unternehmen mit seinen verschiedenen Handelsmarken in 15 weitere Länder auf 5 Kontinenten expandiert. Etwa 40 % der 125 Millionen Hektar, die weltweit mit Sojabohnen bepflanzt sind, tragen GDM-Genetik. Seit 2019 ist GDM auch in China aktiv, der historischen Wiege und dem wichtigsten Zielland der Sojabohne. Das Unternehmen gewinnt auch Marktanteile auf dem wettbewerbsintensiven nordamerikanischen Markt. Das Unternehmen vermarktet Mais in drei Ländern: Argentinien, den Vereinigten Staaten und Brasilien - und Weizen in zwei Ländern: Argentinien und den Vereinigten Staaten. Jetzt sollen auch Sonnenblume in Europa angebaut werden.[50]

GDM hat mit Hilfe von **CRISPR eine trockenheitstolerante Sojabohne** entwickelt. Diese erhielt 2022 die Zulassung für die kommerzielle Nutzung in Argentinien, Brasilien und Kolumbien. Darüber hinaus hat GDM mittels **CRISPR eine besser verdauliche Soja** entwickelt. Diese wurde 2023 ebenfalls in Argentinien, Brasilien und Kolumbien zugelassen.

Neue gv-Soja mit verschiedenen Traits (darunter Herbizidtoleranz, Resistenz gegen die Südliche Stinkwanze (*Nezara viridula*)), die vom argentinisch-brasilianischen Unternehmen *Don Mario Semillas* (Teil von *GDM Seeds*) entwickelt wurden, **sollen 2025 kommerzialisiert werden**.[51]

GDM ist nur ein Beispiel für einen sich **sehr dynamisch entwickelnden Markt für CRISPR-Pflanzen in Lateinamerika**.

Für eine Zusammenfassung siehe: Latin America: a biotech laboratory and world champion in GMOs and gene editing

50 https://www.gatewaytosouthamerica-newsblog.com/the-owners-of-the-main-argentine-soybean-seed-company-bought-60000-hectares-for-usd-195-million-from-an-australian-investor/

51 https://www.gdmseeds.com/wp-content/uploads/2021/07/GDM-Special-EN.pdf

Tabelle 1: Neue GV-Pflanzen, die bereits auf dem Markt sind und/oder in der Kommerzialisierungspipeline

(UPDATE Stand: Januar 2024, Neue Einträge sind unterstrichen)

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Raps	Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz	***Cibus Inc.*** (USA)[1]	APHIS-Bescheid 2020 We have initiated editing our herbicide resistance trait in Canola (HT2) with greenhouse trait confirmation ongoing.	Gewächshaus-versuche und 1 Jahr Freiland[2]

1 https://www.cibus.com/ Gelb markierte Unternehmensnamen: Zusatzinformationen in der Einleitung.

2 https://investor.cibus.com/static-files/8300dee4-2176-4a17-b9a1-5fdbcd292564

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Raps	Rapid Trait Development System (RTDS™), ODM	Pod Shatter Reduction (PSR)	***Cibus Inc.*** (USA), Farmers Business Network (FBN) (CAN)	APHIS-Bescheid 2020 The U.S. Patent Office granted the company a patent for its pod shatter reduction (PSR) trait. PSR is our lead Cibus Powered™ trait product. We made the first transfers of a customer's elite germplasm with the edited PSR trait in Q1 2023. We expect to transfer the PSR Trait in the elite germplasm to up to 6 companies in 2023.[3]	Ja, 5 Jahre
Raps	Rapid Trait Development System (RTDS™), ODM	Krankheitsresistenz gegen *Sclerotinia*, Weissstängeligkeit[4]	***Cibus Inc.*** (USA)	APHIS-Bescheid 2020[5] We are very encouraged by our initial field trials for our initial mode of action for *Sclerotinia* (white mold) resistance in Canola and winter oilseed rape. Green house trait confirmation and field work for the additional modes of action are ongoing. This trait is particularly important because, if successful, we believe it will be the first commercially available gene edited trait for disease in any crop.	Ja, 2 Jahre

3 https://www.cibus.com/productivity-traits.php

4 https://www.cibus.com/pdfs/articles/Western-Producer-Cibus-Sclerotinia-20230706.pdf

5 https://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=18566

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Raps	Rapid Trait Development System (RTDS™), ODM	Effiziente Stickstoff-Verwertung	***Cibus Inc.*** (USA)	We have licensed in initial traits for nitrogen use efficiency in Canola and we expect to initiate the editing process in Canola by the end of 2023.	Nein
Raps	CRISPR-Cas9	Verbesserte Rapsschrot-Qualität (u. a. höherer Protein-Gehalt)	**Corteva** (USA)[6]	APHIS-Bescheid 2020 2024: Keine neue Informationen gefunden. Auch gegenüber Investoren gibt es nur sehr allgemeine Aussagen zum Gene-Editing-Programm von Corteva.[7]	Ja
Soja	Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz	***Cibus Inc.*** *(USA)*	Our herbicide resistance trait for Soybean is the same herbicide resistance trait we are developing in Canola. We have initiated editing this herbicide resistance trait (HT2) in Canola with greenhouse trait confirmation ongoing. We expect to initiate editing for this HT trait in Soybean as soon as our Soybean platform is developed.[8]	Nein

6 https://www.dtnpf.com/agriculture/web/ag/crops/article/2021/02/22/designer-crops

7 https://investors.corteva.com/static-files/c023a381-083e-4c92-8614-941419d4615a

8 https://www.cibus.com/productivity-traits.php

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja **NEU**	Rapid Trait Development System (RTDS™), ODM	Krankheitsresistenz (Sklerotina)	***Cibus Inc.*** *(USA)*	We are very encouraged by our initial field trials for our initial trait for *Sclerotinia* (white mold) resistance in Canola and winter Oilseed Rape. We expect to initiate editing our Sclerotinia trait in Soybean as soon as our Soybean platform is developed.	Nein
Soja **NEU**	Rapid Trait Development System (RTDS™), ODM	Nematoden-resistenz	***Cibus Inc.*** *(USA)*	Soybean Cyst Nematode is an incredibly damaging pest of Soybean in most Soybean growing areas of the America's that is capable of reducing yields dramatically. It is a key target of our trait development plans.	Nein

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja	CRISPR/Cas9 Argentine startup Bioheuris is focused on weed control. They developed a technological platform with CRISPR gene editing for the herbicide tolerance trait.	Herbizidresistenz (Verschiedene Traits)	**Bioheuris** (ARG, USA), **Santa Rosa Semillas** (ARG), **Grupo Don Mario** (ARG)	Kommerzialisierung geplant. Arbeit an 6 verschiedenen HR-Traits. Anfrage bei der APHIS 2021 (Secure).[9] Weitere Anfrage 2022 (ev. neuer Trait).[10] Nichtregulierungsbescheid erteilt.[11] Zwei weitere APHIS-Bescheide 2023 a)[12], b)[13] (Anträge auf Überprüfung des Regulierungsstatus) They work on several extensive crops such as soybeans, corn, rice, cotton, alfalfa, sorghum, peanuts, and sunflowers. In 2022, it was highlighted by StartUs Insights among the top five agro-tech startups in the world, and also, after closing a Series A investment round for $4 million, they moved their laboratories to the United States.[14]	Unklar

9 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/20-317-01cr_a2.pdf

10 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-269-01cr-request.pdf

11 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/20-317-01cr_response_signed.pdf

12 https://www.aphis.usda.gov/brs/pdf/rsr/23-216-01rsr-submission.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/23-216-01rsr-review-response.pdf

13 https://www.aphis.usda.gov/brs/pdf/rsr/23-219-01rsr.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/23-219-01rsr-response.pdf

14 https://allianceforscience.org/blog/2023/02/latin-america-a-biotech-laboratory-and-world-champion-in-gmos-and-gene-editing/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja	CRISPR/Cas9 (SDN2)	Drought tolerance[15]	**Corteva** (USA), **Agricultural Research Corporation (EMBRAPA)** (BRA)[16]	Three main research projects were initiated in 2019 and leverage CRISPR-Cas9 gene-editing technology for trait development: **Drought-tolerant soybeans** Water stress and nematode infestation have become severe in certain areas of Brazil. This project focuses on providing drought-tolerant soybeans to farmers while also supporting sustainable production.[17]	Nein

15 https://research.ncsu.edu/ges/files/2021/12/Alexandre-Nepomecuno-NCSU-IDB-BID-Gene-Editing-02Dec21.pdf (Folie 24)

16 https://publications.iadb.org/publications/english/document/Genome-Editing-in-Latin-America-Regional-Regulatory-Overview.pdf

17 https://www.openinnovation.corteva.com/innovation-stories/Delivering-Powerful-Solutions-to-Brazilian-Farmers.html

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja **NEU**	CRISPR/Cas9	Root-knot nematode-resistant soybeans	**Corteva** (USA), **Agricultural Research Corporation (EMBRAPA)** (BRA)[18]	Three main research projects were initiated in 2019 and leverage CRISPR-Cas9 gene-editing technology for trait development: **Root-knot nematode-resistant soybeans** As a result of the collaboration with Embrapa, Corteva has developed a novel method for efficiently screening candidate root disease resistance genes. Together the organizations are helping to provide insights into future breeding and biotech solutions for nematode resistance.[19]	Nein

18 https://publications.iadb.org/publications/english/document/Genome-Editing-in-Latin-America-Regional-Regulatory-Overview.pdf

19 https://www.openinnovation.corteva.com/innovation-stories/Delivering-Powerful-Solutions-to-Brazilian-Farmers.html

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja **NEU**	CRISPR/Cas9	Control of undesirable post-harvest darkening of common bean seed coat	**Corteva** (USA), **Agricultural Research Corporation (EMBRAPA)** (BRA)[20]	Three main research projects were initiated in 2019 and leverage CRISPR-Cas9 gene-editing technology for trait development: **Control of undesirable post-harvest darkening of common bean seed coat** The common bean is a staple food in Brazil. Consumers are highly selective against an undesirable dark color which can occur during post-harvest storage. This collaborative work will support common-bean growers, who are usually smallholder farmers, eager to reduce this undesirable trait.[21]	Nein
Soja	CRISPR/Cas9 (SDN1)	Anti-nutritional Factors	**Corteva** (USA), **Agricultural Research Corporation (EMBRAPA)** (BRA)	The National Biosafety Technical Commission (CTNBio) considered, in an extraordinary meeting on September 1st, that the soy genome editing, conducted by Embrapa with the CRISPR technique, to deactivate some anti-nutritional factors, results in conventional soy, therefore, non-transgenic.[22]	Unklar

20 https://publications.iadb.org/publications/english/document/Genome-Editing-in-Latin-America-Regional-Regulatory-Overview.pdf

21 https://www.openinnovation.corteva.com/innovation-stories/Delivering-Powerful-Solutions-to-Brazilian-Farmers.html

22 https://news.agropages.com/News/NewsDetail---44098.htm

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja	CRISPR	Greater protein content, optimized amino acid profiles, and lower levels of anti-nutritional factors	**Corteva** (USA), Bunge (USA) The companies have a multi-year collaboration to develop and commercialize soybean varieties	The companies expect to commercialize these soybean varieties by late this decade.[23]	Ja
Soja	CRISPR	Erhöhter Proteingehalt, Soja soll u. a. in Aquakulturen als Fischfutter genutzt werden. “Amfora is developing soybean varieties that can be used in plant-based meat and other high-value applications without the need for a capital intensive and costly concentration process.”	**Amfora** (USA), **Corteva** (USA) Amfora arbeitet zusätzlich an High-Protein Erbsen als Fleischersatz.	Unklar, ob sich APHIS-Bescheid von 2020 auch auf diese Sojalinien bezieht. “The United Soybean Board awarded $1 million to Amfora, Inc., (…), to continue the development of soybean varieties with increased protein content.” “… new investment ($7) from the global player and stock listed company BayWa AG and Leaps by Bayer and Spruce Capital Partners invested $6 million”.[24] Kein Update der Amfora-Homepage seit 2021.	Unklar

23 https://www.corteva.com/resources/media-center/corteva-and-bunge-announce-collaboration-to-develop-amino-acid-enhanced-soybeans.html

24 https://www.amforainc.com/copy-of-news-4-12-17-2

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja	CRISPR-Cas9	Erhöhter Protein- und Ölgehalt	**Corteva** (USA)	APHIS-Bescheid 2020 In einer Investorenpräsentation (2023) heisst es: “Finally, we are collaborating to bring gene-edited soybeans to Europe to expand their plant-based protein production.” Unklar, ob dieses Projekt gemeint ist.[25]	Ja
Soja	CRISPR	Verschiedene Traits: Resistenz gegen Südliche Stinkwanze (*Nezara viridula),* Herbizidtoleranz, Trockentoleranz	**DonMario Semillas** (ARG, BRA)[26], gehört zur **GDM Group** (ARG)(diese plant einen Ausbau der Geschäftstätigkeiten in China, USA, Europa)[27]	Kommerzialisierung geplant ab 2025	Unklar

25 https://investors.corteva.com/static-files/c023a381-083e-4c92-8614-941419d4615a

27 https://www.gdmseeds.com/wp-content/uploads/2021/07/GDM-Special-EN.pdf

26 https://publications.iadb.org/publications/english/document/Genome-Editing-in-Latin-America-Regional-Regulatory-Overview.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja **NEU**	CRISPR	Trockenheits-toleranz	**Agricultural Research Corporation (EMBRAPA)** (BRA)	Im Sojaanbau haben Forscher von Embrapa Soja-Gene verändert, um eine Soja mit Trockenheitstoleranz zu erhalten, die die CTNBio-Bewertung bestanden hat und als nicht gentechnisch verändert (nicht-transgen) gilt. Diese Soja kann nun auf dem Feld getestet werden, um die Wirksamkeit des eingeführten Merkmals zu beweisen. Dieselbe Strategie verfolgte das Unternehmen GDM, das ebenfalls eine Sojabohne entwickelte, die für dieses Merkmal editiert wurde. (DeepL-Übersetzung)[28]	Unklar

28 https://seednews.com.br/artigos/4384-ferramentas-biotecnologicas-de-ultima-geracao-podem-contribuir-para-obtencao-de-plantas-mais-adaptadas-a-mudancas-climaticas-edicao-janeiro-2024

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja **NEU**	CRISPR	Stilllegung eines anti-nutritional factor	**Agricultural Research Corporation (EMBRAPA)** (BRA) EMBRAPA has a broad range of crops — such as soybean, corn, and wheat — that are being improved with CRISPR, highlighting the traits of elimination of anti-nutritional compounds, better oil quality, and drought tolerance.	2022: Zulassung als non-GMO gemäss CTNBio. Embrapa kann die genetische Eigenschaft in ihre anderen Sorten einführen, die an verschiedene Produktionsregionen angepasst sind. Die Veränderung der Soja-DNA wurde jedoch bereits an einer hochproduktiven Sorte vorgenommen. Die veränderte Sorte ist bereit für die Registrierung und Vermarktung.[29]	Ja
Soja	CRISPR	Nematoden-resistenz	**Evogene** (ISR), **TMG – Tropical Melhoramento & Genética** (BRA)[30] Zusammenarbeit besteht seit 2018[31]	APHIS-Bescheid 2020 „Evogene plans to import and move Edited SCN-Resistant Soybean within the United States“ Evogene arbeitet nicht mehr zu Soja. Projekt wurde vermutlich an TMG abgegeben. Dort kein Update verfügbar.	Geplant (Brasilien)

29 https://www.embrapa.br/busca-de-noticias/-/noticia/73468020/ctnbio-aprova-soja-da-embrapa-com-genoma-editado-para-reduzir-fatores-antinutricionais

30 https://publications.iadb.org/publications/english/document/Genome-Editing-in-Latin-America-Regional-Regulatory-Overview.pdf

31 https://evogene.com/press_release/evogene-and-tmg-announce-collaboration-to-develop-nematode-resistant-soybean-through-genome-editing/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja	CRISPR-Cas9	Veränderte Fettsäurezu sammensetzung (*High-oleic*) ToolGen developed high oleic acid soybean, a new cultivar that edited the FAD2 gene to substantially reduce linoleic acid, the main factor of the unhealthy trans-fat formation while increasing the level of oleic acid to even over that of olive oil.	**ToolGen Inc.** (KOR)	APHIS-Bescheid 2020. Kommerzialisierung geplant. In Phase III (kurz vor Kommerzialisierung). Keine Änderung 2023.[32] “ToolGen is cultivating diverse sales channels and waging business activities, including producing high oleic soybean and trans-fat-free soybean oil.”[33]	Ja
Soja	CRISPR-Cas9	Herbizidresistenz	**ToolGen Inc.** (KOR)	Zwischen Phase I und II. Keine Änderung 2023.[34]	Unklar
Soja	CRISPR-Cas9	Essential amino acid enhanced soy	**ToolGen Inc.** (KOR)	Zwischen Phase I und II. Keine Änderung 2023.[35]	Unklar

32 http://www.toolgen.com/eng/crops
33 http://www.toolgen.com/eng/business/business_04.jsp
34 http://www.toolgen.com/eng/crops
35 http://www.toolgen.com/eng/crops

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja	Vermutlich CRISPR[36]	Keine Angabe (*Confidential Business Information* Inari is using predictive research and gene editing in an effort to reach some key benchmarks: Increase the yield in corn, soybeans and wheat by as much as 20%; decrease the water needed to grow corn 40%; and decrease the nitrogen needed for corn growth 40%.	**Inari Agriculture Inc.** (USA) 1st Choice Seeds ist eines der Testunternehmen.[37] Unique commercial relationships with Independent Seed Companies (ISCs) selling directly to farmers. Superior feedback loop between Inari and farmers via ISCs, informing future products. Strategic partnerships with leading seed and produce companies enabling market expansion in new crops and regions.[38]	APHIS-Bescheid 2020. Kommerzialisierung geplant. “Inari, the SEEDesign™ company, announced a strategic collaboration with Mertec, LLC and M.S. Technologies, LLC that enables access to a genetic base from Stine’s industry-leading soybean breeding program to accelerate the development of unique and competitive products.” Inari kombiniert herkömmliche Gentechnik mit Genome Editing. Anfang 2023 Patenterteilung für Transgenic INHT31 soybean plants comprising an edited MON-89788 soybean trait, delivering a weed management solution.[39]	Ja

36 https://inari.com/our-technology/

37 https://www.ibj.com/articles/2023-innovation-issue-inari-aims-to-boost-crop-yields-through-unique-gene-editing-technology

38 https://inari.com/seeddesign

39 https://www.seedquest.com/news.php?type=news&id_article=135300&id_region=&id_category=&id_crop

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja	CRISPR-Cas9	Multiple traits	Forage Genetics (USA), **Yield10Bioscience** (USA)	Forage Genetics research license expired due to their discontinuation of R&D investment in forage sorghum.[40]	Unklar
Soja **NEU**	Genome-Editing (Ohne weitere Spezifizierung)	Trockentoleranz	**GDM** (ARG)	In December 2022, GDM, an Argentinean company working on improving soybeans, announced that Brazil's National Technical Biosafety Commission (CNTBio) has approved its first gene-edited drought tolerant soybean. André Beló, manager of new technologies at GDM, said that the gene-edited soybean was approved by CNTBio in Brazil in May, and greenlighted by the Argentine government in November. The company plans to commercialize the variety in Brazil during the 2027/28 harvest. In January 2023, GDM announced the approval of their gene-edited soybeans in Colombia.[41] The drought-tolerant soy requires further testing and may be commercially launched in 2026/2027.[42]	Ja

40 https://ir.yield10bio.com/static-files/5e2cb123-1be6-40cf-9a56-1d90f2bfb52a

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja **NEU**	Genome-Editing (Ohne weitere Spezifizierung)	Trocken- und Hitzetoleranz	**GDM** (ARG)	The company had the second edited soy classified by CTNBio (Comissão Técnica Nacional de Biossegurança - National Technical Commission on Biosafety), an entity linked to the Ministry of Science, Technology, Innovations, and Communication, responsible for implementing the new National Biosafety Policy regarding certain Genetically Modified Organisms (GMOs) as non-GMO in May of this year and on November 25 in Argentina. The variety was developed to be more drought and heat tolerant.[43]	Ja

41 https://www.isaaa.org/kc/cropbiotechupdate/ged/article/default.asp?ID=19979

42 https://www.reuters.com/article/idUSL1N33H0HB/

43 https://www.gdmseeds.com/wp-content/uploads/2022/12/03.Segunda-soja-DT-ING.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja **NEU**	Genome-Editing (Ohne weitere Spezifizierung)	Greater nutritional value because it has fewer raffinose and stachyose sugars, indigestible by monogastric animals, such as poultry, pigs, and humans	**GDM** (ARG)	The company continues to produce larger volumes of seeds of this variety for final validations before the commercial launch. Zulassung (als non-GMO): Brasilien, Argentinien, Kolumbien. The next step is to intensify contacts with local companies interested in using this soybean.[44] The low-sugar soy designed to help animal digestion could be launched in 2024/2025.[45]	Ja
Soja **NEU**	CRISPR-Cas9	High-Oleic	**Shandong BellaGen Biotechnology Co.** (CHN)	In April 2023, China's Ministry of Agriculture and Rural Affairs (MOA) issued its first safety certificate for plant gene editing for a high oleic acid soybean by Shandong BellaGen Biotechnology Co. BellaGen is the first company in China to initiate industrial-scale plant gene editing. Approval is expected soon for the general development of gene-edited soybeans.[46]	Ja

44 https://www.gdmseeds.com/wp-content/uploads/2022/12/03.Segunda-soja-DT-ING.pdf

45 https://www.reuters.com/article/idUSL1N33H0HB/

46 https://crispr-gene-editing-regs-tracker.geneticliteracyproject.org/china-crops-food/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja	CRISPR	Altered Seed Morphology and Composition	**Benson Hill** (USA)	APHIS-Bescheid (Confirmation letter)[47] 2023: 12x Briefwechsel und APHIS-Bescheide (Confirmation letter), gleicher Trait, unterschiedliche Linien.[48]	Unklar
Soja	CRISPR	Verbesserter Geschmack	**Benson Hill** (USA)	APHIS-Bescheid (Confirmation letter)[49] 2023: 3x Briefwechsel und APHIS-Bescheide (Confirmation letter), gleicher Trait, unterschiedliche Linien[50]	Unklar
Soja	CRISPR	Herbizidresistenz	**Bioheuris** (ARG, USA), **Santa Rosa Semillas** (ARG), **Grupo Don Mario** (ARG), **ACA** (ARG)[51]	2023: APHIS-Bescheid (Confirmation letter)[52]	Unklar

47 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-207-01cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-207-02cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-207-03cr-request.pdf

48 Beispiellinie: https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-275-01cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-275-01cr-signed-response.pdf. Weitere Dokumente hier: https://www.aphis.usda.gov/aphis/ourfocus/biotechnology/regulatory-processes/confirmations/responses/cr-table

49 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-207-04cr-request.pdf

50 Beispiellinie: https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-268-03cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-268-03cr-signed-response.pdf. Weitere Dokumente hier: https://www.aphis.usda.gov/aphis/ourfocus/biotechnology/regulatory-processes/confirmations/responses/cr-table

51 https://www.bioheuris.com/en/what-we-do/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Baumwolle **NEU**	CRISPR-Cas9	Herbizidresistenz	**Bioheuris** (ARG, USA)	APHIS-Bescheid[53] (Antrag auf Überprüfung des Regulierungsstatus) 2022 bereits APHIS-Bescheid (Confirmation letter), gleicher Trait[54]	Nein
Mais	CRISPR	Resistenz gegen *Maize Lethal Necrosis Disease*	**Corteva** (USA), CIMMYT (MEX)[55]	Maissorten sollen für afrikanische Kleinbauern entwickelt werden: “By 2025, subject to compliance with regulatory procedures, commercial seeds of the gene-edited MLN-resistant elite maize hybrids will be available to up to 20,000 smallholder farmers for approximately 40,000 hectares of planting.”[56] Investorenpräsentation, Folie 29:[57] “In most of these examples, Corteva is doing the gene editing technical work and collaborated on field testing and evaluations. In the disease resistance space, we have enhanced local germplasm in Africa to be resistant to maize leaf necrosis, which is a virus that can wipe out maize production.”	Ja Gemäss Zeitplan sollte das erste Maissaatgut bereits Mitte 2023 erhältlich sein.[58]

52 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-269-01cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-269-01cr-response-signed.pdf

53 https://www.aphis.usda.gov/brs/pdf/rsr/23-216-02rsr.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/23-216-02rsr-response.pdf

54 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-269-02cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-269-02cr-response-signed.pdf

55 https://publications.jrc.ec.europa.eu/repository/handle/JRC123830, S. 21

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Mais Mais DP915635 **Im Anbau**	CRISPR, Transgenese	Mais DP915635 der Firma Pioneer (assoziiert mit Corteva) ist resistent gegen das Herbizid Glufosinat und produziert ein Insektengift, das in bestimmten Farnen zu finden ist, die auf Bäumen wachsen	**Corteva** (USA)	2020 Antrag auf Importzulassung (food & feed) bei EFSA[59] November 2023: Positive scientific opinion veröffentlicht. Noch keine Zulassung[60]	Ja (USA, Kanada)

56 https://www.cimmyt.org/projects/mln-gene-editing-project/

57 https://investors.corteva.com/static-files/2986689f-fbf9-4c02-a7eb-a97995ad5fc0

58 https://repository.cimmyt.org/bitstream/handle/10883/21893/64898.pdf?sequence=1&isAllowed=y

59 https://www.testbiotech.org/sites/default/files/EFSA-Q-2020-00834-EFSA-GMO-NL-2020-172_%20Summary.pdf, https://www.testbiotech.org/pressemitteilung/erster-zulassungsantrag-fuer-crispr-pflanzen-in-eu

60 https://efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/j.efsa.2024.8490

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Mais	CRISPR (Cas-Enzym undeklariert, patentiert von Inari) SEEDesign™ a) Predictive Design: creating an editing blueprint through deep learning and machine learning b) Multiplex editing toolkit: facilitating multiple edits across multiple genes[61]	Keine Angabe (*Confidential Business Information*) Efficiency improvements: product pipeline includes fertilizer and water use Yield increase: projecting +20% in Inari's current crops vs. historical increases of ~1% per year	**Inari Agriculture Inc.** (USA)	APHIS-Bescheid 2020. Kommerzialisierung geplant. "The combination of Inari's novel predictive design and advanced multiplex gene editing technology with Beck's established corn research and breeding program will increase product testing capabilities and expand both companies' capacity for innovation."[62] Inari kombiniert herkömmliche Gentechnik mit Genome Editing. Anfang 2023 Patenterteilung für Transgenic INIR6 corn plants comprising an edited DP-4114 corn trait, delivering insect protection.[63]	Unklar
Mais **NEU**	CRISPR (Cas-Enzym undeklariert, patentiert von Inari)	Verkürzte Stängellänge	**Inari Agriculture Inc.** (USA)	APHIS-Bescheid 2023[64] (Antrag auf Überprüfung des Regulierungsstatus) Freisetzungsversuch in Belgien läuft unter dem Titel «R&D Field trial to evaluate the phenotype and yield of maize lines gene edited for reduced height»	Ja, Belgien 15/04/2023 to 30/11/2023[65] & neuer Antrag für 2024[66]

61 https://inari.com/seeddesign

62 https://inari.com/news/inari-and-becks-announce-strategic-collaboration-to-accelerate-farmer-access-to-gene-editing-innovation

63 https://www.seedquest.com/news.php?type=news&id_article=135300&id_region=&id_category=&id_crop

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Mais **Im Anbau**	CRISPR-Cas9	Veränderte Stärkezusammen-setzung (waxy corn)	**Corteva** (USA)	APHIS-Bescheid 2016 Anbauzulassung in den USA, Kanada, Brasilien, Argentinien, Chile[67] und Japan.[68]	Ja
Mais	CRISPR-Cas9	Trockenheits-toleranz und Ertragsstabilität	**Corteva** (USA)	APHIS-Bescheid 2020. 2024: Keine neuen Informationen erhältlich.	USA, ab 2016
Mais	CRISPR-Cas9	Höheres Ertragspotential (*enhanced yield potential*)	**Corteva** (USA)	APHIS-Bescheid 2020 2024: Keine neuen Informationen erhältlich.	Unklar
Mais	CRISPR-Cas9	Höherer Kornertrag (*increased grain yield*)	**Corteva** (USA)	APHIS-Bescheid 2020 2024: Keine neuen Informationen erhältlich.	Unklar

64 https://www.aphis.usda.gov/brs/pdf/rsr/23-101-01rsr-submission.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/23-101-01rsr-review-response.pdf

65 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/BE/23/V1&Cat=gmp

66 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/Be/23/V4&Cat=gmp

67 https://www.ohnegentechnik.org/artikel/nicht-zugelassene-gentechnik-staerke-koennte-unerkannt-nach-europa-gelangen

68 https://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=20131

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Mais	CRISPR	Pilzresistenz	**Evogene** (ISR),[69] **Bayer Crop Science** (DEU) Wenn, dann wird Bayer den Mais vermarkten. Evogene arbeitet über die Tochtergesellschaft Casterra Ag, Ltd. nur noch an Rhizinus.[70]	Forschung & Entwicklung “Evogene Ltd., a leading computational biology company targeting to revolutionize life-science product discovery and development across multiple market segments, announced today that Bayer will pay Evogene an amount of $3.5 million under their joint seed traits collaboration agreement. Under the collaboration agreement, Evogene provided Bayer with a license to genes discovered to address specific seed traits, for use in corn, soy, cotton, and canola. The payment is part of a restructuring of the patent filing, prosecution, and maintenance obligations under the collaboration.”[71]	Geplant
Mais	CRISPR-Cas9	Herbizidresistenz	**ToolGen Inc.** (KOR)	Zwischen Phase I und II. Keine Änderung 2023.[72]	Unklar

69 https://www.prnewswire.com/news-releases/evogene-amends-its-collaboration-agreement-with-bayer-to-include-genome-editing-targets-300885511.html

70 https://evogene.com/wp-content/uploads/2023/05/Casterra_company_presentation_May_2023_FINAL.pdf

71 https://www.en.krishakjagat.org/investment-startups/evogene-to-receive-3-5-million-payment-related-to-patent-portfolio-under-its-existing-seed-traits-collaboration-with-bayer/

72 http://www.toolgen.com/eng/crops

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Mais **NEU**	Genome-Editing (nicht weiter spezifiziert)	Production of Anthocyanin in response to pathogen infection	**INSIGNIUM AgTech** (USA)	APHIS-Bescheid 2023.[73] (Antrag auf Überprüfung des Regulierungsstatus) Patentantrag läuft. Corn will be modified to produce anthocyanin in response to pathogen infection via placement of a gene responsible for activating anthocyanin biosynthesis downstream of a pathogen-responsive promoter.	Ja Our plants have been field tested for two years[74]
Mais **NEU**	CRISPR	Altered yield characteristics	**Inari Agriculture Inc.** (USA)	2023: APHIS-Bescheid (Confirmation letter)[75]	Unklar
Mais **NEU**	CRISPR	Maize haploid inducer line	**Syngenta Seeds LLC** (CHN, CH)	APHIS-Bescheid (Confirmation letter)[76]	Unklar

73 https://www.aphis.usda.gov/brs/pdf/rsr/23-087-01rsr-submission.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/23-087-01rsr-review-response.pdf

74 https://www.insignumagtech.com/

75 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-209-02cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-209-02cr-signed-response.pdf

76 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-062-01cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-062-01cr-response-signed.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Reis	CRISPR-Cas9	Resistant to bacterial blight disease[77]	International Rice Research Institute (IRRI), International Center of Tropical Agriculture (CIAT)[78]	Zulassung in den USA und Kolumbien.[79] Anbau unklar. Wissenschaftliche Publikation erschienen.[80] “Kenya evaluates applications for the import of transgene-free lines on a case-by-case basis, thus it will be necessary to prepare suitable documentation for import. In parallel, it is planned to use the hybrid Cas9/Cpf1 strategy to expand the resistant germplasm to other rice varieties grown in African countries to be able to meet consumer-farmer preferences. This project aims to ultimately provide the material to small-scale producers. It will also be necessary to continue monitoring disease and Xoo populations.”	Unklar

77 http://www.knowledgebank.irri.org/decision-tools/rice-doctor/rice-doctor-fact-sheets/item/bacterial-blight

78 https://www.nature.com/articles/s41587-019-0267-z, https://publications.jrc.ec.europa.eu/repository/handle/JRC123830, S. 21

79 https://geneticliteracyproject.org/2021/08/02/gene-edited-crops-made-in-latin-america-for-latin-american-needs/

80 https://pubmed.ncbi.nlm.nih.gov/37337668/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Reis	Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz (HT 1)	***Cibus Inc.*** *(USA)*	APHIS-Bescheid 2020 In April 2023, we transferred our two herbicide traits in Rice to a customer in their elite germplasm for commercial development. We expect initial launch of at least one of these traits in the next 2-3 years.[81]	Ja
Reis	Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz (HT 3)	***Cibus Inc.*** *(USA)*	APHIS-Bescheid 2020 In April 2023, we transferred our two herbicide traits in Rice to a customer in their elite germplasm for commercial development. We expect initial launch of at least one of these traits in the next 2-3 years.	Ja The second herbicide tolerance trait entering field trials 2022[82]
Reis	Rapid Trait Development System (RTDS™), ODM	Krankheitsresistenz	***Cibus Inc.*** *(USA)*	Disease resistance is an incredibly important need for Rice farmers that may avoid multiple fungicide applications per year. It is a key target of our trait development plans.[83]	Nein

81 https://www.cibus.com/productivity-traits.php

82 https://www.cibus.com/our-crops.php

83 https://www.cibus.com/productivity-traits.php

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Reis	Rapid Trait Development System (RTDS™), ODM	Effiziente Stickstoff-Verwertung	***Cibus Inc.*** (USA)	We have initiated the editing process for our initial mode of action. We expect Nutrient Use Efficiency to comprise multiple modes of action. We will update as we progress on this important target.	Nein
Kartoffel	CRISPR-Cas9	Resistenz gegen Schwarzfleckigkeit („non-browning“)	**Simplot Plant Sciences** (USA)	APHIS-Bescheid 2020.[84] Kommerzialisierung geplant. Vermutlich werden auch diese Kartoffeln unter der Marke „Innate“ vertrieben. Simplot has executed a joint intellectual property licensing agreement with Corteva Agriscience, Agriculture Division of DowDuPont, and the Broad Institute of MIT and Harvard for foundational CRISPR-Cas9 and related gene editing tools. The technology provides Simplot with another avenue to bring desirable traits forward in potatoes.[85] Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.[86]	Geplant

84 https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-01_air_inquiry_cbidel.pdf, https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-01_air_response_signed.pdf

85 https://www.innatepotatoes.com/technology

86 https://www.innatepotatoes.com/news

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Kartoffel	CRISPR-Cas9	Reduzierter Gehalt an Glykoalkaloiden (u. a. Solanin) **und** Resistenz gegen Schwarzfleckigkeit („non-browning“)	**Simplot Plant Sciences** (USA)	APHIS-Bescheid 2020.[87] Kommerzialisierung geplant Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.	Geplant
Kartoffel	CRISPR-Cas9	Reduzierter Gehalt an Glykoalkaloiden (u. a. Solanin)	**Simplot Plant Sciences** (USA)	APHIS-Bescheid 2020.[88] Kommerzialisierung geplant Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.	Unklar
Kartoffel	CRISPR-Cas9	Erzeugung von Selbstinkompatibilität	**Simplot Plant Sciences** (USA)	APHIS-Bescheid 2020.[89] Kommerzialisierung geplant Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.	Unklar

87 https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-06_air_inquiry_cbidel.pdf, https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-06_air_response_signed.pdf

88 https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-02_air_inquiry_cbidel.pdf, https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-02_air_response_signed.pdf

89 https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-34_air_inquiry_cbidel_a1.pdf, https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-34_air_response_signed.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Kartoffel	CRISPR-Cas9	Erhöhter Ertrag (Knollenbildung)	**Simplot Plant Sciences** (USA), **Yield10Bioscience** (USA) Extended Simplot research license[90]	APHIS-Bescheid 2020. Kommerzialisierung geplant. Seit 2019 Forschungszusammenarbeit mit Yield10Bioscience “to evaluate three novel yield traits in potato.” Unklar, ob diese traits hier Verwendung finden.[91] Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021. Auch kein Update bei Yield10Bioscience.	Unklar
Kartoffel	CRISPR-Cas9	Verbesserte Lagereigenschaften bei kühlen Temperaturen (reduzierte vakuoläre Invertasen)	**Simplot Plant Sciences** (USA)	APHIS-Bescheid 2020.[92] Kommerzialisierung geplant. Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.	Unklar

90 https://ir.yield10bio.com/static-files/5e2cb123-1be6-40cf-9a56-1d90f2bfb52a

91 https://ir.yield10bio.com/static-files/cb2ac804-60e9-440c-8b91-b449941643a3, https://www.agribusinessglobal.com/agrochemicals/seeds-traits/yield10-bioscience-simplot-partner-to-evaluate-gene-editing-in-potatoes/

92 https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-33_air_inquiry_a1_cbidel.pdf, https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-33_air_response_signed.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Kartoffel	GEiGS® (Gene-Editing, RNAi)	Non-browning	**Tropic Bioscience** (GBR)	APHIS-Bescheid 2021[93], Siehe auch[94] Unklar, ob Tropic Bioscience das Projekt noch weiterverfolgt. Gemäss ihrer Homepage arbeiten sie nur noch an Bananen, Kaffee, Reis.	Unklar
Kartoffel	CRISPR-Cas9	Enhanced functional potato Zwei Traits: Acrylamide suppressed potatoes und Solanine supressed potato	**ToolGen Inc.** (KOR)	Zwischen Phase II und Phase III. Keine Änderung 2023.[95]	Unklar

93 https://www.tropicbioscience.com/usda-aphis, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/21-141-01cr-a2-revised-final-signed.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/21-141-01cr-response-signed.pdf

94 https://tropic.bio/tropic-biosciences-obtains-positive-response-from-usda-aphis-on-regulatory-status-of-a-product-developed-using-its-geigs-gene-editing-induced-gene-silencing-technology/

95 http://www.toolgen.com/eng/crops

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Kartoffel **NEU**	Genome-Editing (Ohne weitere Spezifizierung)	The potato was modified to alter the tuber sugar profile via reduction or loss of vacuolar invertase gene expression, resulting in decreased vacuolar invertase protein expression and less hydrolysis of sucrose to glucose and fructose	**Ohaolo Genetics Inc.** (USA)[96]	APHIS-Bescheid 2023[97] (Antrag auf Überprüfung des Regulierungsstatus) Ohalo was operating under stealth for the past four years.[98]	Unklar
Kartoffel **NEU**	Genome-Editing (Ohne weitere Spezifizierung)	Erhöhte Konzentration von Beta-Carotin	**Ohaolo Genetics Inc.** (USA)[99]	APHIS-Bescheid 2023[100] (Antrag auf Überprüfung des Regulierungsstatus) Ohalo was operating under stealth for the past four years.	Unklar

96 https://ohalogenetics.com/

97 https://www.aphis.usda.gov/brs/pdf/rsr/23-081-01rsr-submission.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/23-081-01rsr-review-response.pdf

98 https://thespoon.tech/gene-edited-food-startup-ohalo-emerges-from-stealth-as-agtech-pioneer-dave-friedberg-takes-the-helm/, siehe auch: https://synthetic.com/ohalo-genetics-emerges-from-stealth/

99 https://ohalogenetics.com/

100 https://www.aphis.usda.gov/brs/pdf/rsr/22-224-01rsr-review-submission.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/22-224-01rsr-review-response.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Kartoffel **NEU**	CRISPR-Cas9	Non-browning[101]	**Instituto Nacional de Tecnología Agropecuaria (INTA)** (ARG)	This GE potato is already in its second field trial as requested by INASE, and will enter the varietal registry after the third field trial.[102] The edited potato has already been submitted to the Instancia de Consulta Previa before the Argentine regulatory authority, which concluded that the product is considered conventional because it does not have genes from other distant organisms, which means that the potato should not follow the regulatory framework designated for transgenic crops.[103]	Ja
Tomate	CRISPR (Cas-Enzym undeklariert, patentiert von Inari) Inari nutzt Genome Editing wohl für Multiplexing. Sie haben dazu 2022 ein White Paper veröffentlicht.[104]	Keine Angabe (*Confidential Business Information*)	**Inari Agriculture Inc.** (USA)	APHIS-Bescheid 2020. Kommerzialisierung geplant.[105] Unklar, ob Inari noch an Tomaten arbeitet. Der Schwerpunkt liegt auf Weizen, Soja und Mais. Auf der Seite des WEF wird behauptet: Inari has already delivered over 90% productivity in tomatoes.[106]	Unklar

101 https://repositorio.inta.gob.ar/bitstream/handle/20.500.12123/9298/INTA_CRBsAsSur_EEABalcarce_Gonzalez-MN_Comparative_analysis_delivery.pdf?sequence=1&isAllowed=y

102 https://allianceforscience.org/blog/2023/02/latin-america-a-biotech-laboratory-and-world-champion-in-gmos-and-gene-editing/,

103 https://www.potatobusiness.com/agro-news/the-argentinian-inta-is-close-to-releasing-the-first-latin-american-genetically-edited-potato/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Tomate **Im Anbau** **Sicilian Rouge high GABA**	CRISPR-Cas9 Matsuo M and Tachikawa M (2022): Implications and Lessons From the Introduction of Genome-Edited Food Products in Japan. Front. Genome Ed.[107]	Erhöhter Gehalt an Gamma-Amino-Buttersäure (GABA) The Sicilian Rouge High GABA tomato, developed by Sanatech Seed Co.,Ltd., was accepted by the Consumer Affairs Agency (CAA) as a food with functional claim on 30 November 2022 (Notification: H617)[108]	**Sanatech Seed** (JAPAN) “Sanatech first tested the appetite of consumers in Japan for the genome-edited fruit in May 2021 when it sent free seedling CRISPR-edited tomato plants to about 4,200 home gardeners who had requested them.”	APHIS-Bescheid 2020. Zulasssung Japan Dezember 2020. **Kommerzialisierung in Japan seit Frühjahr 2021.** “Encouraged by the positive demand, the company started direct internet sales of fresh tomatoes in September and a month later took orders for seedlings for next growing season.”[109]	Ja
Paprika	CRISPR-Cas9	Trockenheits-toleranz	**ToolGen Inc.** (KOR)	Zwischen Phase I und Phase II. Keine Änderung 2023.[110]	Unklar

104 https://inari.com/remote-media/Multiplex-Gene-Editing-White-Paper_11-2022.pdf

105 https://inari.com/news/inari-and-becks-announce-strategic-collaboration-to-accelerate-farmer-access-to-gene-editing-innovation

106 https://www.weforum.org/organizations/inari-agriculture

107 https://fjfsdata01prod.blob.core.windows.net/articles/files/899154/pubmed-zip/.versions/2/.package-entries/fgeed-04-899154-r1/fgeed-04-899154.pdf?sv=2018-03-28&sr=b&sig=fqDr9c%2Fe8iDDc6jrJ%2BqgrJ2%2BSr4HwdfF7UCe7SVpcUM%3D&se=2022-12-19T08%3A04%3A30Z&sp=r&rscd=attachment%3B%20filename%2A%3DUTF-8%27%27fgeed-04-899154.pdf

108 https://sanatech-seed.com/en/221226-2/

109 https://www.nature.com/articles/d41587-021-00026-2, https://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=19024

110 http://www.toolgen.com/eng/crops

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Chinakohl	CRISPR-Cas9	Soft rot tolerant	**ToolGen Inc.** (KOR)	Zwischen Phase I und Phase II.[111] Keine Änderung 2023.[112]	Unklar
Avocado	Genome Editing – ohne weitere Angaben	Unklar („*Confidential Business Information*“) Vermutlich non-browning	**GreenVenus** (USA) Firmenausgründung von Intrexon, die den nicht-bräunenden GreenVenus™-Salat entwickelt haben[113]	APHIS-Bescheid 2020.[114] Kommerzialisierung geplant. Mai 2023: GV announces a groundbreaking achievement in avocado gene editing and plant regeneration. GreenVenus's scientists have successfully modified a key gene associated with fruit browning, opening new possibilities for producing higher-quality avocados.[115]	Unklar
Avocado	CRISPR-Cas9	Non-browning	**J. R. Simplot** (USA)	APHIS-Bescheid 2020.[116] Kommerzialisierung geplant Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.	Unklar

111 http://www.toolgen.com/eng/business/business_04.jsp

112 http://www.toolgen.com/eng/crops

113 http://www.greenvenus.com/#news

114 https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-163-01_air_inquiry_a1_cbidel.pdf, https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-163-01_air_response_signed.pdf

115 https://www.greenvenus.com/wp-content/uploads/2023/06/GreenVenus-LLC-Achieves-Breakthrough-in-Avocado-Gene-Editing.pdf, https://podcasts.apple.com/us/podcast/happy-green-guacamole-the-non-browning-avocado-dr/id1006329802?i=1000617338808

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Erdbeere	CRISPR-Cas9	Remontierende Erdbeere/mehr Ertrag durch 2x Blüte-/Fruchtbildung	**J. R. Simplot** (USA), ev. mit **Plant Sciences Inc. (PSI)** (USA)	APHIS-Bescheid 2020.[117] Kommerzialisierung geplant Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.	Unklar
Erdbeere	CRISPR-Cas9	Improved shelf life	**J. R. Simplot** (USA), **Plant Sciences Inc. (PSI)** (USA)	"We expect to launch the first commercially available, gene edited strawberry in the coming years. PSI will provide its proprietary strawberry germplasm, plant growing expertise, and lead the commercialization of successful varieties."[118] Through our collaboration with Simplot, we are implementing gene editing across all of our strawberry breeding programs to bring to market fruit with traits that would otherwise take a lifetime to achieve through traditional breeding methods.[119]	Nein

116 https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-35_air_inquiry_a2_cbidel.pdf, https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-35_air_response_signed.pdf

117 https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-05_air_inquiry_a1_cbidel.pdf, https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-05_air_response_signed.pdf

118 https://simplot.com/company/news/j-r-simplot-company-and-plant-sciences-inc

119 https://plantsciences.com/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Banane	GEiGS® (Gene-editing, RNAi)[120]	Verlängertes Shelf-life	**Tropic Bioscience** (GBR)	With the new round of funding, the company, which was founded in 2016, will begin testing its new varieties globally.[121] APHIS-Bescheid (Confirmation letter)[122]	Ja
Banane	GEiGS® (Gene-editing, RNAi)	Resistenz gegen TR4	**Tropic Bioscience** (GBR)	Tropic has ambitious plans to expand its current field trials significantly throughout 2023. They aim to reach additional countries across Latin America and the Philippines, bringing the transformative power of GEiGS® to more farmers and communities. By doing so, Tropic strives to eradicate TR4 and other devastating diseases, heralding a new era of sustainable agriculture.[123]	Ja

120 https://www.geigs.com/

121 https://www.geigs.com/

122 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/21-356-01cr-cbidel-a4.pdf

123 https://tropic.bio/empowering-growers-with-a-sustainable-solution-against-banana-panama-disease-tr4/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Banane **Vor-kommerzieller Anbau**	GEiGS® (Gene-editing, RNAi)	Non-browning	**Tropic Bioscience** (GBR)	APHIS-Bescheid 2023[124] (Antrag auf Überprüfung des Regulierungsstatus) May 2023: the Philippines have given the non-browning banana from tropic a non-GMO exemption. This crop can now be imported and propagated freely in the Philippines.[125]	Ja
Orange	CRISPR	Toleranz gegen Zitruskrebs (*Xanthonomas citri*)	**Soil Culture Solutions, LLC (Soilcea)** (USA)	APHIS-Bescheid 2020 2021: Neue Forschungsgelder erhalten[126] Soilcea is in the process of partnering with growers and nurseries to rapidly test and distribute the edited trees.[127] 2023: Kein Update verfügbar.	Geplant

124 https://www.aphis.usda.gov/brs/pdf/rsr/22-238-01rsr-submission.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/22-238-01rsr-review-response.pdf

125 https://tropic.bio/tropics-non-browning-gene-edited-banana-cleared-for-production-in-the-philippines/

126 https://www.sbir.gov/node/2082193

127 https://www.aiche.org/resources/publications/cep/2022/july/catalyzing-commercialization-gene-editing-promises-new-disease-resistant-citrus-trees

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Weintraube **NEU**	CRISPR	Wine grape cultivars that possess natural preservation properties, diminishing or negating the need for sulfites as preservatives during winemaking.	**GreenVenus** (USA)	The achievement resulted from a collaboration between GreenVenus and the Ralph M. Parsons Foundation Plant Transformation Facility in the College of Agriculture and Environmental Sciences at UC Davis, who developed a breakthrough platform that allows for the regeneration of gene-edited plants from single cells of multiple grape varieties.[128]	Unklar
Wassermelone (& andere Melonenarten)	ARCUS® genome-editing technology *We figured out a way to take that pathway from the monk fruit* [that produces the sweet component mogroside V, a triterpenoid glycoside 200-300 times sweeter than sucrose] *and put it into crops that you can grow in your backyard.*	Natürlicher Süssstoff auf Wassermelonen-Basis Markteinführung für 2025 geplant	**Elo Life Sciences** (USA) (Tochtergesellschaft von Precision BioScience)[129] “Melon is our bio factory for the first generation of our sweetener, but… there are some other crops that we’re thinking through that that might be of interest [as biofactories][130]	Elo achieved proof of concept with its ZeroMelon™ watermelon-based sweetener program and advanced the program to greenhouse trials. This program is intended to leverage ARCUS to develop a scalable low-calorie sweetener.[131] Elo hat für das Projekt neue Gelder eingeworben.[132]	Gewächshaus

128 https://www.greenvenus.com/wp-content/uploads/2023/08/GreenVenus-Improves-Wine-Grape-Genetics.pdf

129 https://investor.precisionbiosciences.com/news-releases/news-release-details/precision-biosciences-completes-spin-out-elo-life-systems/

130 https://www.foodnavigator-usa.com/Article/2022/09/09/Elo-to-commercialize-new-high-intensity-plant-based-sweetener-in-2025-with-sweeter-cleaner-taste-than-monk-fruit-extracts

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Leindotter	CRISPR (Multiplexing)	Erhöhter Ölgehalt Trait C3007, C3010, C3012	**Yield10 Bioscience** (USA), University of Missouri (USA)	APHIS-Bescheid 2020 Weitere Traits in Arbeit: Using the GRAIN platform, we identified four new targets that may impact seed development and/or oil content including C3020, which produced a 10% increase in seed oil content when engineered with increased activity in Camelina. Data obtained from increasing activity of the other three targets, C3019, C3021, and C3022 indicates these represent good targets for CRISPR genome-editing.	Ja

131 https://elolife.ag/pipeline/, https://investor.precisionbiosciences.com/static-files/2de94543-7e05-4ffe-bf72-17e268cbefe4

132 https://vegconomist.com/investments-finance/elo-series-a-sweetener-watermelons/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Leindotter **Vor-kommerzieller Anbau**	CRISPR (Multiplexing) „the triple-edited Camelina plant lines are based on an oil biosynthesis pathway engineered directly into the plant – all based upon CRISPR genome editing.“	Erhöhter Ölgehalt The Camelina line we have designated E3902 contains CRISPR edits of C3008a, C3008b and C3009	**Yield10 Bioscience** (USA)	APHIS-Bescheid 2018 Zulassung Argentinien[133] In the 2022/2023 season, Yield10 planted around 1,000 acres of winter Camelina, which has been or is currently being harvested. “In addition, we secured the target production acres for planting spring 2023 but did not disclose the number of acres.[134] Yield 10 is looking to get about 20,000 acres of its spring and winter camelina varieties in the ground for the 2023 growing season, with the goal of a broad commercial rollout within the next two to three years.[135]	Ja

133 https://www.seedquest.com/news.php?type=news&id_article=135132&id_region=&id_category=&id_crop=

134 https://www.feednavigator.com/Article/2023/08/16/Yield10-camelina-cultivation-program-on-track-Target-markets-include-biofuels-aquaculture-and-PHA-bioplastics

135 https://www.producer.com/news/camelina-company-seeks-farmers-to-grow-crop/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Leindotter	CRISPR	Erhöhter Ertrag Trait C3003, C3004 C3003 is an algal gene, in-licensed from the University of Massachusetts. Based on our research, C3004 in Camelina resulted in a significant increase in plant growth and vigor, increased branching and seed yield, and in some cases, increased individual seed weight.	**Yield10 Bioscience** (USA)	Yield10Bioscience hat 2021 einen Nichtregulierungs-bescheid der APHIS für Leindotter-Linien erhalten. Unklar, um welche Linien mit welchen Eigenschaften es sich handelt (CBI).[136]	Ja

136 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/20-358-01cr_request_cbidel_a2.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/20-358-01cr_response_signed.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Leindotter	CRISPR	Erhöhter Ölgehalt (Omega-3-Fettsäure) Öl soll v. a. in Aquakulturen als Futter eingesetzt werden	Rothamsted Research (GBR), **Yield10Bioscience** (USA) We are collaborating with the Rothamsted Institute, who are developing engineered Camelina lines that produce approximately 20% of EPA + DHA fatty acids, similar to the composition of Northern Hemisphere fish oil.[137] Yield10 has exercised its option to finalise an exclusive global, commercial licence to advanced omega-3 production technology from Rothamsted Research Limited.[138]	Yield10Bioscience plant Markteinführung in Chile.[139] The company said it is advancing the development of Camelina lines to produce the EPA component of omega-3, conducting field trials and seed scale-up activities, and expects to engage in commercial discussions with potential customers for the high-value specialty oil this year.[140] Yield 10 B. filed a request for a Regulatory Status Review ("RSR") with USDA-APHIS Biotechnology Regulatory Services ("BRS") under "SECURE" Rule for proprietary elite Camelina sativa ("Camelina") varieties designed to produce seed oil containing both essential omega-3 fatty acids eicosapentaenoic acid ("EPA") and docosahexaenoic acid ("DHA").[141]	Ja, GBR seit 2018 Verlängert bis 2023 A number of these Camelina lines have been successfully field-tested for four years at different locations in the UK, Canada, and the US, and oil samples have been produced for salmon and human feeding studies.

137 https://www.yield10bio.com/crop-science/novel-crop-traits

138 https://www.fishfarmingexpert.com/gm-camelina-omega-3-rothamsted-research/bioscience-company-harvests-the-rights-to-uk-developed-omega-3-camelina/1581900

139 https://ir.yield10bio.com/static-files/cb2ac804-60e9-440c-8b91-b449941643a3

140 https://www.feednavigator.com/Article/2023/08/16/Yield10-camelina-cultivation-program-on-track-Target-markets-include-biofuels-aquaculture-and-PHA-bioplastics

141 https://www.yield10bio.com/press/yield10-bioscience-files-request-for-regulatory-status-review-with-usda-aphis-for-camelina-designed-to-produce-the-epa-and-dha-components-of-omega-3-oil

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Leindotter	CRISPR	Nutzung als Bioplastik. Traits C3014 and C3015 The stability of Camelina seeds at ambient temperatures allows them to be readily harvested, transported, and stored prior to processing, making them the ideal site in a plant for producing PHA plastics.[142]	**Yield10Bioscience** (USA)	Forschung & Entwicklung “Yield10 designed traits C3014 and C3015 to produce PHA bioplastic as a third seed product in Camelina.”[143] “Biodegradable plastics could become more plentiful and cost-effective as Camelina plants are reprogrammed to produce a biodegradable material called polyhydroxyalkanoates, better known as PHAs”.	Ja “Yield10 is scaling up its two best PHA Camelina lines at sites in the U.S. and Canada. Results of field tests in 2020 achieved a proof-of-concept milestone for a plant-based route of production for PHA”.[144]

142 https://www.yield10bio.com/crop-science/novel-crop-traits

143 https://www.yield10bio.com/crop-science/novel-crop-traits, https://ir.yield10bio.com/static-files/cb2ac804-60e9-440c-8b91-b449941643a3

144 https://finance.yahoo.com/news/yield10-bioscience-begins-2021-field-123000539.html, https://ir.yield10bio.com/node/15526/pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Leindotter	CRISPR	C4000 Trait Series Using our Trait Factory, we have identified the C4004 to C4027 series of transcription factor genes that are down-regulated in our high-photosynthesis engineered switchgrass plants as well as several new gene targets related to our lead C3003 yield trait.	**Yield10Bioscience** (USA)	We have proven that traits from the C4000 series can significantly increase photosynthetic efficiency, above-ground biomass, and below-ground biomass production in our switchgrass plants engineered to overexpress the transcription factors. The traits in this series and the proof points we are generating create partnership opportunities that enable us to further the development of these traits in major commercial food, feed, and forage crops.	Unklar

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Leindotter **NEU**	CRISPR Transgenese	Erhöhter Ölgehalt, Herbizidresistenz (Glufosinat)	**Yield10 Bioscience** (USA)	APHIS-Bescheid 2022[145] Our approach to developing elite Camelina varieties is based on introducing new traits into the crop to benefit growers. We believe glufosinate tolerant Camelina will provide growers with new options for weed management allowing Camelina to fit seamlessly into crop rotations driving commercial adoption. We are building seed inventory of our spring glufosinate tolerant Camelina to support commercial launch as early as 2025 to support grower contracts to produce low-carbon feedstock oil for the biofuel market.[146]	Ja

145 https://www.aphis.usda.gov/brs/pdf/rsr/22-174-01rsr-submission.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/22-174-01rsr-review-response.pdf

146 https://www.yield10bio.com/press/usda-aphis-determines-that-yield10-biosciences-glufosinate-tolerant-camelina-may-be-planted-and-bred-in-the-united-states

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Leindotter **NEU**	CRISPR Transgenese	Erhöhter Ölgehalt, 2-fache Herbizidresistenz Sorten für Winter- und Frühjahrsanbau	**Yield10 Bioscience** (USA)	APHIS-Bescheid 2023[147] (Antrag auf Überprüfung des Regulierungsstatus) Yield10 is developing stacked HT Camelina varieties with tolerance to the application of glufosinate, a Group 10 herbicide used to control broadleaf weeds, as well as tolerance to soil residues of Group 2 herbicides, specifically including tolerance to both imidazolinones ("IMIs") and sulfonylureas ("SUs"). Group 2 herbicides are commonly used to manage weeds in cereal and pulse crop rotations and can persist in the soil for months following use. Yield10 is executing a program to develop and commercialize spring and winter Camelina varieties with stacked herbicide tolerance traits to achieve large-acreage adoption of the crop in North America.[148]	Ja Yield 10 Bioscience announced positive results in the first field test of stacked herbicide tolerance ("HT") traits in Camelina.
Erbse, gelb **NEU**	CRISPR	Altered Antinutrient Composition	**Benson Hill** (USA)	2x APHIS-Bescheid 2023 (Confirmation letter)[149] Gleicher Trait, unterschiedliche Linien.	Unklar

147 https://www.aphis.usda.gov/brs/pdf/rsr/23-096-01rsr-submission.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/23-096-01rsr-review-response.pdf

148 https://www.yield10bio.com/press/usda-aphis-determines-that-yield10-biosciences-stacked-herbicide-tolerant-camelina-may-be-planted-and-bred-in-the-united-states

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Acker-Hellerkraut (*Thlaspi arvense)* **Vor-kommerzieller Anbau**	CRISPR	Veränderter/ erhöhter Ölgehalt im Samen (Kultur wird als Gründüngung über den Winter angebaut, Öl als Speiseöl, Bioenergie, Samen vermahlen als Tierfutter)	**CoverCress Inc.** (USA) Bayer gehören 65%, Bunge und Chevron 35% von CoverCress.[150] Organisation der Wertschöpfungs-kette.[151] Expect to launch crush-ready CoverCress product mid-2020's[152]	APHIS-Bescheid 2020 Illinois State University has entered a licensing agreement with CoverCress, Inc. for use of the *fae1* germplasm.[153] CCI is preparing for a pre-commercial demonstration of the CoverCress crop in select geographies for the 2023/2024 season.[154] Weiterer APHIS-Bescheid für neuen Trait: the pennycress was modified to impart lowered erucic acid in seeds via reduction or loss of fatty acid elongation 1 (FAE1) and to confer lowered fiber in seeds via reduction or loss of transparent testa 8 (TT8).[155]	Ja .

149 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-305-01cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-305-01cr-signed-response.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-305-02cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-305-02cr-signed-response.pdf

150 https://www.bizjournals.com/stlouis/inno/stories/awards/2023/07/18/startup-exit-awards-2023-covercress-acquisition.html?b=1689715584%5E22271606

151 https://www.covercress.com/farm-to-fuel-supply-chain.cfm

152 https://www.bayer.com/sites/default/files/2023-06/Bayer%20CS%20Innovation%20Summit%202023_Resource%20Guide.pdf (S. 47)

153 https://www.frontiersin.org/articles/10.3389/fpls.2021.652319/full, https://portal.nifa.usda.gov/web/crisprojectpages/1014980-advancing-field-pennycress-as-a-new-oilseed-biofuels-feedstock-that-does-not-require-new-land-commitments.html, https://www.biofuelsdigest.com/bdigest/2021/01/17/covercress-inc-and-university-partners-selected-as-start-up-inventor-of-the-year/

154 https://www.covercress.com/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Acker-Hellerkraut (Thlaspi arvense) **NEU**	CRISPR	Altered Seed Composition Altered Pod Composition	**CoverCress Inc.** (USA)	2023: 3x APHIS-Bescheide (Confirmation letters) für «Altered Seed Composition», 2x APHIS-Bescheide (Confirmation letters) für Altered Pod Composition[156]	Unklar
Salat **Green Venus™ (Romana Salat)** **Im Anbau**	Combination of genome editing technology (nicht näher spezifiziert) and traditional breeding techniques GreenVenus, LLC's romaine lettuce variety 'GVR-108XL' has edits to five polyphenol oxidase (PPO) genes, which are enzymes responsible for damage-related browning in fruits and vegetables, and negatively affect the shelf life of products such as pre-cut salads.[157]	Verlängertes Shelf-life, verringerte enzymatische Bräunungsreaktion (an verletzten Blättern)	**Green Venus** (USA) Für die Sorte wurde US-Patentschutz angemeldet[158] & 2022 erteilt.[159]	APHIS-Bescheid 2019. Green Venus has confirmed they will advance five new lettuce varieties to the field trial phase in 2022 through the application of their precision breeding platform, Primavera™. The complete lineup of varieties will include four romaine types and one Batavia type. In 2020, GreenVenus successfully built open field and controlled environment partnerships to trial and launch their first commercial non browning romaine variety. The variety consistently outperformed the market standards in terms of overall quality and yield and is attracting interest from the $10.7 billion bagged salad market, which led GreenVenus to prioritize its emerging lettuce business.[160]	USA, ab 2019

155 https://www.aphis.usda.gov/brs/pdf/rsr/22-069-01rsr-submission.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/22-069-01rsr-review-response.pdf

156 Beispieldokument: https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-142-01cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-142-01cr-signed-response.pdf. Weitere Dokumente: https://www.aphis.usda.gov/aphis/ourfocus/biotechnology/regulatory-processes/confirmations/responses/cr-table

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Senf (Mustard Green) **Conscious™ Greens** **Im Anbau**	CRISPR-Cas12a Mai 2023: launch of Fulcrum™ Platform[161] Wissenschaftliche Publikation zum Verfahren[162] Kommentar zur Regulierungsdebatte in Nature[163]	Verbesserter Geschmack Neuer Trait? Veränderte Schärfe und Textur	**Pairwise Plants** (USA), Vertrieb u. a. durch Performance Foodservice[164] und RSquared Fresh Solutions[165] Conscious™ Greens will be grown in the Salinas Valley, California, a place often referred to as "America's salad bowl." In the winter months, our Greens will be grown in Yuma, Arizona.[166]	APHIS-Bescheid 2020. Weiterer APHIS-Bescheid 2023[167] für neuen Trait? (Antrag auf Überprüfung des Regulierungsstatus) April 2023: Health Canada has added Pairwise's gene edited mustard greens to its list of "non-novel" foods.[168] Eigene Webseite der neuen Marke.[169] Salad is now available in select restaurants and outlets in the Performance Food Group's (PFG) operator network, including locations in Springfield, Mass., Minneapolis-St. Paul, and St. Louis.[170]	Ja

157 https://www.jdsupra.com/legalnews/usda-s-pvp-system-embraces-transgenic-5069271/

158 https://apps.ams.usda.gov/CMS/AdobeImages/202000361.pdf

159 https://www.troutman.com/insights/troutman-pepper-helps-greenvenus-llc-secure-certificate-protection-for-a-gene-edited-lettuce-variety-under-plant-variety-protection-act.html, https://apps.ams.usda.gov/CMS/AdobeImages/202000361.pdf

160 https://www.greenvenus.com/wp-content/uploads/2022/01/GreenVenus-Expands-Non-Browning-Lettuce-Portfolio.pdf

161 https://www.pairwise.com/news/pairwises-fulcrum-platform-creates-pivot-point-for-enterprise-scale-gene-editing

162 https://www.mdpi.com/2223-7747/11/19/2494/htm

163 https://www.nature.com/articles/s41477-023-01403-2

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Alfalfa/ Luzerne **IQ™ Alfalfa**	TALEN	Verbesserte Nährstoff-zusammensetzung, bessere Verdaulichkeit, hohe Erträge	**S&W Seed Company** (USA) S&W hat Exklusivlizenz für Saatgutvertrieb in den USA und mehreren Regionen ausserhalb der Vereinigten Staaten mit Ausnahme der Europäischen Union, des Vereinigten Königreichs, der Ukraine, Russlands und Indiens.[171] Trait wurde von Calyxt entwickelt (Calyxt ist jetzt Teil von Cibus Inc.).	APHIS-Bescheid 2017 S&W: we made progress with our IQ™ Alfalfa. Our future alfalfa varieties will soon include IQA™, a reduced lignin alfalfa quality trait, achieved through gene editing. It's integrated into elite alfalfa germplasm for both yield and improved forage quality performance. (…) Please consult with Alfalfa Partners for availability in your region and whether your specific growing environment may be sensitive to a gene-edited trait.[172]	Ja

164 https://performancefoodservice.com/Products-and-Services/Our-Family-of-Brands/Peak-Fresh-Produce/Veridi-Baby-Blend-by-Conscious-Greens

165 https://www.pairwise.com/news/conscious-foods-a-pairwise-brand-partners-with-food-broker-rsquared-fresh-solutions-in-retail-channel

166 https://consciousfoods.net/process

167 https://www.aphis.usda.gov/brs/pdf/rsr/22-159-01rsr-submission.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/22-159-01rsr-review-response.pdf

168 https://www.pairwise.com/news/health-canada-gives-pairwises-conscious-greens-a-nod-of-approval

169 https://consciousfoods.net/conscious-greens

170 https://www.pairwise.com/news/pairwise-introduces-conscious-greens-into-u.s.-restaurants

171 https://ir.calyxt.com/sec-filings/annual-reports/content/0001564590-21-010976/0001564590-21-010976.pdf, https://www.marketwatch.com/press-release/sw-announces-first-quarter-fiscal-2022-financial-results-2021-11-11?siteid=bigcharts&dist=bigcharts&tesla=y

172 https://swseedco.com/research-development/iqa-the-next-innovation/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Weizen **NEU**	CRISPR	Mehltauresistenz	Chinese Academy of Sciences (CHN)	Scientists at the Chinese Academy of Sciences have used multiplexed CRISPR genome editing to achieve robust disease resistance in wheat without any growth defects. The results of this study are published in *Nature*.[173] Approval is expected soon on a wheat variety resistant to a fungal disease called powdery mildew.[174]	Ja
Sorghum	CRISPR	Herbizidresistenz	**Bioheuris** (ARG, USA), **Tobin** (ARG) In partnership with Tobin, a leader in sorghum breeding and seed production.[175]	Es sind 5 verschiedene HR-Traits in Arbeit. 2022: APHIS-Bescheid (Confirmation letter)[176] 2023: APHIS-Bescheid (Confirmation letter)[177]	Unklar

173 https://english.cas.cn/head/202202/t20220210_300634.shtml

174 https://crispr-gene-editing-regs-tracker.geneticliteracyproject.org/china-crops-food/

175 https://www.bioheuris.com/en/what-we-do/

176 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-201-01cr-request.pdf

177 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-329-01cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-329-01cr-response-signed.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Zuckerrübe **NEU**	GEiGS® (Gene Editing induced Gene Silencing)	The program is set to develop high-performance sugar beet varieties that can sustainably withstand viral diseases, doing away with the need for environmentally damaging pesticides	**Tropic Bioscience** (GBR), British Sugar (GBR)	British Sugar and Tropic announce strategic collaboration to sustainably tackle devastating disease of sugar beet	Nein
Zuckerrohr Canaflex I **NEU**	CRISPR	Bessere Verdaulichkeit	**Agricultural Research Corporation (EMBRAPA, Agroenergia)** (BRA)	Cana Flex I ist das Ergebnis der Ausschaltung des Gens, das für die Steifigkeit der pflanzlichen Zellwand verantwortlich ist. Diese Struktur wurde verändert und wies eine bessere "Verdaulichkeit" auf, d. h. eine bessere Zugänglichkeit für den Angriff der Enzyme während der enzymatischen Hydrolyse, dem chemischen Prozess, der die Verbindungen aus der Pflanzenbiomasse extrahiert. 2021: Zulassung als non-GMO gemäss der Nationalen Technischen Kommission für Biosicherheit (CTNBio).[178]	Ja

178 https://www.embrapa.br/busca-de-noticias/-/noticia/66969890/ciencia-brasileira-desenvolve-primeira-cana-editada-nao-transgenica-do-mundo

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Zuckerrohr Canaflex II **NEU**	CRISPR	Erhöhter Saccharosegehalt	**Agricultural Research Corporation (EMBRAPA, Agroenergia)** (BRA)	Die zweite Sorte wurde durch das Ausschalten eines Gens im Pflanzengewebe erzeugt, was zu einer erheblichen Steigerung der Saccharoseproduktion in den Stängeln der Modellpflanze Setaria viridis führte. Cana Flex II zeigte einen Anstieg der Saccharose in den Stängeln um bis zu 15 Prozent, 200 Prozent mehr Saccharose in den Blättern und 12 Prozent mehr Glukose, die während der Verzuckerung freigesetzt wird. 2021: Zulassung als non-GMO gemäss der Nationalen Technischen Kommission für Biosicherheit (CTNBio).[179]	Ja

179 https://www.embrapa.br/busca-de-noticias/-/noticia/66969890/ciencia-brasileira-desenvolve-primeira-cana-editada-nao-transgenica-do-mundo

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Rizinus **NEU**	Erste Sorten wurden konventionell entwickelt, künftige Pflanzen ev. mit CRISPR Casterra's castor seeds were developed using Evogene's computational GeneRator AI and ChemPass AI platforms, proprietary germplasm data and "unparalleled genetics knowledge.[180]	4 to 6 times higher yield than wild type castor plants and generate 50% castor oil yields compared to natural varieties generating 30% to 40%, and do so under difficult growing conditions	**Casterra** (ISR), Tochterunternehmen von **Evogene** (ISR) Evogene's wholly-owned subsidiary Casterra Ag has received initial purchase orders worth $11.3 million for its proprietary castor plant seeds, which will be used for biofuel production in Africa. Castor oil is increasingly seen as a green biofuel in Europe, with EU regulations requiring 14% of transportation fuels to be biofuels by 2030.	In discussing Casterra's potential other development plans, Mr. Ronen discussed Casterra's ability to use Evogene's leading-edge *CRISPR* and/or *RNAi technology*, to genomically modify castor plants in order to produce specific characteristics, such as castor oil with more suitable characteristics for the aviation market versus the automobile industry, and even potentially developing a castor plant, which may be suitable for animal feed. Ronen explained that Casterra might be able to produce a castor plant without ricin, which is toxic, which would then allow the use of the protein part of the castor plant, which is the cake left after crushing, for use as animal feed.[181]	Ja

180 https://evogene.com/wp-content/uploads/2023/05/Casterra_company_presentation_May_2023_FINAL.pdf

181 https://seekingalpha.com/article/4615412-evogene-subsidiary-casterra-11-3m-sale-of-castor-plant-seeds-may-be-tip-of-iceberg

Tabelle 2: Neue GV-Pflanzen in der Forschungs- und Entwicklungspipeline

(UPDATE Stand: Dezember 2022, Neue Einträge sind unterstrichen)

→ Produkte, deren Kommerzialisierung wahrscheinlich ist, sind in der ersten Spalte grau hinterlegt

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Soja The research license with **Bayer** is scheduled to expire in December[182]	CRISPR	Yield gene C3004, C3003	**Yield10 Bioscience** (USA), **Bayer Crop Science** (DEU) 2023: Kein Update verfügbar.	Forschung & Entwicklung „Under the amended research license, Bayer will have access to these new developments from Yield10's C3004 program and new advanced technology related to the C3004 trait and its potential to increase seed yield.“[183]	Unklar

182 https://www.zonebourse.com/cours/action/YIELD10-BIOSCIENCE-INC-39016366/actualite/Transcript-Yield10-Bioscience-Inc-Q3-2022-Earnings-Call-Nov-14-2022-42313329/

183 https://ir.yield10bio.com/static-files/cb2ac804-60e9-440c-8b91-b449941643a3

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Soja	CRISPR	Multiple Traits, “GDM plans to work with Yield10 yield traits within its research and development program for soybean as a strategy to improve soybean yield performance and sustainability”.	**Yield10 Bioscience** (USA), **GDM** (ARG)	Forschung & Entwicklung, 3-jährige Forschungs-zusammenarbeit (2020 - 2023)[184] 2023: Kein Update verfügbar.	Unklar
Soja, Mais **NEU**	CRISPR, GEiGS® Technology (Gene-Editing, RNAi)	Krankheitsresistenzen	**Corteva,** (USA), **Tropic Bioscience** (GBR)	Tropic Announces collaboration with Corteva Agriscience to develop disease resistance traits in Corn and Soybean.[185]	Nein
Reis	CRISPR	Erhöhter Proteingehalt Kein Update der Homepage seit 2021.	**Amfora** (USA)	Forschung & Entwicklung Unklar, ob Amfora noch an Reis arbeitet. Keine Hinweise auf der Homepage[186]	Unklar

184 https://ir.yield10bio.com/static-files/cb2ac804-60e9-440c-8b91-b449941643a3, https://www.globenewswire.com/en/news-release/2020/08/11/2076385/34378/en/Yield10-Bioscience-Signs-Research-Agreement-with-GDM-to-Evaluate-New-Yield-Traits-in-Soybean.html

185 https://tropic.bio/tropic-announces-collaboration-with-corteva-agriscience-utilizing-tropics-groundbreaking-geigs-technology-to-develop-robust-disease-resistance-traits-in-corn-and-soybean/

186 https://www.amforainc.com/copy-of-technology

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Reis **NEU**	GEiGS® Technology (Gene-Editing, RNAi)	Resistance to rice blast	**Tropic Bioscience** (GBR)	We create natural resistance to rice blast, a disease which is estimated to destroy enough rice to feed more than 60 million people annually. Preserving rice fields creates more food and supports a more stable and sustainable income for farmers in vulnerable communities.[187]	Unklar
Reis **NEU**	GEiGS® Technology (Gene-Editing, RNAi)	Erhöhter Ertrag	**Tropic Bioscience** (GBR)	Our rice plants have the potential to significantly reduce greenhouse gas emissions per calorie, through increased yields. Here's to the rice revolution.[188]	Unklar

187 https://tropic.bio/rice/

188 https://tropic.bio/rice/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Reis	CRISPR	Herbizidresistenz We recently started a development program with Itá Caabó from Adecoagro group, one of the main food and renewable energy companies in South America and the largest rice breeder and producer in Argentina, to optimize integrated management of rice through gene editing of elite varieties and hybrids.	**Bioheuris** (ARG, USA), **Itá Caabo** (Group Adecocagro)	2022: APHIS-Bescheid (Confirmation letter)[189] 2023: 3x APHIS-Bescheid (Confirmation letter)[190]	Unklar
Reis	CRISPR	New rice varieties which deliver higher yields and are more resilient against biotic and abiotic stresses	**Corteva** (USA), International Rice Institute (IRRI) (PHL)[191]	Forschung & Entwicklung 2023: Kein Update verfügbar.	Unklar
Reis	CRISPR	Altered Reproductive Function	**Syngenta** (CHN, CH)	2022: APHIS-Bescheid (Confirmation letter)[192] 2023: Kein Update verfügbar.	Nein

189 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-276-01cr-request.pdf

190 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-033-02cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-033-02cr-response-signed.pdf

191 https://publications.jrc.ec.europa.eu/repository/handle/JRC123830, S. 21

192 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-250-01cr-request.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Weizen	Rapid Trait Development System (RTDS™), ODM	We expect to develop a family of traits for corn focusing initially on nutrient use efficiency, disease and herbicide tolerance	***Cibus Inc.*** (USA)	We expect to have our RTDS breeding platform in Wheat developed by the end of 2024.[193]	Nein
Weizen	CRISPR	Reduzierter Acrylamid-Gehalt Preliminary results from … field trials of gene-edited (GE) wheat have indicated there's no yield or other agronomic penalty from the precision breeding technique.[194]	Rothamsted Research (GBR) has been granted permission by Defra to run a series of field trials of wheat that has been genome edited.	The Hertfordshire-based experiments will be the first field trials of CRISPR edited wheat anywhere in the UK or Europe.[195] 2023: The results of … field trial of a gene edited (GE) variety of wheat have shown a significant reduction of the potential carcinogen acrylamide when the flour is baked.[196] Wissenschaftliche Publikation erschienen[197]	September 2021 bis Dezember 2026

193 https://www.cibus.com/productivity-traits.php

194 https://www.fwi.co.uk/arable/variety-selection/europes-first-gene-edited-wheat-trials-see-breakthrough

195 https://www.rothamsted.ac.uk/news/genome-edited-wheat-field-trial-gets-go-ahead-uk-government, https://www.rothamsted.ac.uk/news/genome-edited-wheat-reduce-cancer-risk-bread-and-toast, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1010792/rothamsted-research-21-R08-01-consent.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Weizen	CRISPR	Erhöhter Proteingehalt, für Aquakulturen “wheat gluten to supplement fishmeal in aquaculture feed formulations”	**Amfora** (USA)	Forschung & Entwicklung[198] Kein Update der Homepage seit 2021.	Unklar
Weizen	CRISPR Genome Editing auf Ebene von Mitochondrien und Organellen	Hybridweizen “Our company’s hybridization technology allows the production of non-GM hybrid seeds in crop plants that are currently mostly non-hybrid such as wheat.”	***Napigen*** (USA)	Forschung & Entwicklung[199] Kein Update der Seite seit 2022.	Unklar
Weizen	CRISPR	Krankheitsresistenz, Ertrag/Ertragsstabilität	**Corteva** (USA) 2023: Kein Update verfügbar.	„Broad R & D Investigations“[200]	Unklar

196 https://www.rothamsted.ac.uk/news/results-are-gene-edited-wheat-field-trial-delivers, https://www.isaaa.org/kc/cropbiotechupdate/ged/article/default.asp?ID=20047

197 https://onlinelibrary.wiley.com/doi/10.1111/pbi.14026

198 https://www.amforainc.com/copy-of-technology

199 https://napigen.com/what-we-do

200 https://www.dtnpf.com/agriculture/web/ag/crops/article/2021/02/22/designer-crops

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Weizen	CRISPR	Hybridweizen	**Corteva** (USA) 2023: Kein Update verfügbar.	Zeitpunkt der Kommerzialisierung unklar. Keine aktuellen Informationen verfügbar[201]	USA, ab 2016
Weizen	CRISPR, RNAi	Gluten“freier“ Weizen Currently, there are two main research centres in the EU developing low-gluten, celiac-safe wheat varieties with gene editing (SDN-1 type CRISPR/Cas targeted mutation) Alle Details zum Projekt im ausführlichen JRC-Report[202]	Institute for Sustainable Agriculture in Cordoba (ESP), **PBL Technologies** (GBR)[203]	Neue wiss. Publikation[204] The CSIC gliadin-reduction technology is the subject of pending patent applications filed by CSIC and is available for licensing from PBL.[205]	Ja 2023–2025

201 https://www.dtnpf.com/agriculture/web/ag/crops/article/2021/02/22/designer-crops

202 https://publications.jrc.ec.europa.eu/repository/bitstream/JRC131711/JRC131711_01.pdf

203 https://www.pbltechnology.com/about-us

204 https://www.frontiersin.org/articles/10.3389/fpls.2021.663653/full

205 https://s3.eu-west-2.amazonaws.com/netmatters-cockpit-assets-production/plant-bioscience/2022/11/25/6380dee47495810.512-Reduced-Gliadin-Wheat-Tech-Sheet-24.11.22.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Weizen **NEU**	CRISPR	Gluten“freier“ Weizen Alle Details zum Projekt im ausführlichen JRC-Report[206]	Plant Breeding group at Wageningen University & Research (WUR), John Bingham Laboratory (GBR)	The WUR group designed a gene-edited wheat targeting alpha and gamma gliadins to achieve a variety safe for CD. These lines are at proof-of-concept stage and still contain too many epitopes that need to be knocked out to be safe for celiac patients	Nein

206 https://publications.jrc.ec.europa.eu/repository/bitstream/JRC131711/JRC131711_01.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Weizen Der erste „Proof of Concept“-Einsatz zur praktischen Erprobung der Technologie im Projekt erfolgte im Sommerweizen. In einem zweiten Schritt werden nun die gewonnenen Erkenntnisse auf den Winterweizen übertragen. Die Tätigkeiten im Winterweizen wurden bereits begonnen.[207] Wie auch im PILTON-Sommerweizen werden die Pflanzen zunächst editiert, um im Gewächshaus anschließend auf ihre Toleranz gegenüber verschiedenen pilzlichen Schaderregern getestet zu werden. Tragfähige Ergebnisse werden im Herbst/Winter 2023 vorliegen.[208]	CRISPR Projekt PILTON (seit 2020)	Pilztoleranz Weizenpflanzen mit verbesserter, multipler und dauerhafter Pilztoleranz	Träger: Gemeinschaft zur Förderung von Pflanzen-innovation e. V. (GFPi)	Forschung & Entwicklung, Gewächshaus-versuche laufen[209] Beteiligt: knapp 60 Züchtungsunternehmen: neben Bayer, Syngenta, KWS, Weizen-, Raps-, Kartoffel- und Rebenzüchter sowie Biotechnologie-Startups und Südzucker.	Geplant In zwei Berichten gibt es Updates zum Stand der Forschung[210]

207 https://pilton.bdp-online.de/2023/05/26/update-5/

208 https://pilton.bdp-online.de/wp-content/uploads/2023/03/2023_01-inform-Pilton-proof-of-concept.pdf

209 https://pilton.bdp-online.de/2021/08/12/update-3/

210 https://european-seed.com/2022/11/pilton-for-fast-track-breeding-the-way-must-be-paved/, https://european-seed.com/2022/11/aims-of-the-joint-research-project-pilton/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Weizen **NEU**	CRISPR (Cas-Enzym undeklariert, patentiert von Inari) SEEDesign™ a) Predictive Design: creating an editing blueprint through deep learning and machine learning b) Multiplex editing toolkit: facilitating multiple edits across multiple genes[211]	Yield increase	**Inari Agriculture Inc.** (USA), **InterGrain** (AUS)	Together, InterGrain and Inari are targeting a 10-15 percent increase in wheat yield potential, in addition to more efficient use of inputs.[212]	Unklar
Leindotter	CRISPR	Erhöhte Omega-3-Fettsäure	Rothamsted Research (GBR) Neuer Freisetzungs-antrag 2023 (UK)[213]	Under the government's new Qualifying Higher Plant (QHP) status - the post-EU non-GM classification for GE crops, plants can be sown anywhere on Rothamsted's farm.	Aussaat im Mai 2022[214]

211 https://inari.com/seeddesign

212 https://inari.com/intergrain-and-inari-launch-collaboration-to-deliver-step-change-in-wheat-yield-potential/

213 https://www.gov.uk/government/publications/genetically-modified-organisms-rothamsted-research-23r0801

214 https://www.transgen.de/datenbank/pflanzen/2203.leindotter.html

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Leindotter	CRISPR-Cas9	High oil yield, quick maturity, herbicide tolerance,[215] drought tolerance, and other desirable traits Syngenta Seeds and Sustainable Oils, Inc. have entered into a new agreement to sell Camelina sativa (camelina) seed. Camelina seed will be sold through Syngenta's AgriPro® dealer network in a vertical marketing model.[216]	**Sustainable Oils** (USA), Kooperationen mit **World Energy** und **ExxonMobil** (USA) Tochtergesellschaft von Global Clean Energy Holdings Inc.[217]	August 2022: Sustainable Oils, Inc. announced a joint licensing agreement with Corteva Agriscience and the Broad Institute of MIT and Harvard for CRISPR-Cas9 and related gene editing tools to further develop their patented camelina varieties.[218]	Nein
Mais	Rapid Trait Development System (RTDS™), ODM	We expect to develop a family of traits for corn focusing initially on nutrient use efficiency, disease and herbicide tolerance.	***Cibus Inc.*** *(USA)*	We expect to have our RTDS breeding and Trait Machine platform in Corn developed by the end of 2025.	Nein
Mais	CRISPR	Herbizidresistenz	**Bioheuris** (ARG, USA) 2023: Kein Update verfügbar.	In our maize program we are creating novel traits to manage weeds.	Nein

215 https://susoils.com/news/global-clean-energy-announces-advancements-in-herbicide-resistant-camelina-varieties
216 https://susoils.com/news/syngenta-seeds-sustainable-oils-announce-commercial-agreement-to-sell-camelina-seed
217 https://www.gceholdings.com/
218 https://susoils.com/news/crispr-cas9-license-agreement

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Mais	CRISPR To speed up the process, Bayer and other companies [incl. Corteva] are working on short corn made with gene editing, an approach that can alter gibberellin without adding genes from other species. Corn varieties created this way will face fewer regulatory hurdles in the U.S. and some other countries, but they're still years away.[219]	Verkürzte Stängellänge Bayers Preceon™ Smart Corn System Am gleichen Trait arbeiten auch Corteva, Stine Seeds und Inari.[220]	**Bayer CropScience** (GER), **Pairwise** (USA)[221]	Bayer has used conventional breeding to create three short hybrid varieties that were tested for the U.S. market this summer (2023) and are now being harvested by about 300 farmers. Bayer arbeitet darüber hinaus an transgenen Maissorten.[222]	Nein

219 https://www.science.org/content/article/shrinking-corn-help-farmers-environment

220 https://americanfarmpublications.com/buzz-over-short-stature-corn-has-industry-talking/

221 https://www.pairwise.com/news/gene-editing-pairwise-and-bayer-start-new-five-year-multi-million-dollar-collaboration-to-further-advance-short-stature-corn

222 https://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=20286

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Mais	CRISPR	Resistenz gegen Blattfleckenkrankheit (Northern Corn Leaf Blight) Wissenschaftlicher Artikel zu Krankheitsresistenz in Mais erschienen.[223]	**Corteva** (USA)	APHIS-Bescheid 2018[224] Using corn as a pilot, we have identified a pipeline of native genes to target major disease problems. We have successfully enhanced these genes to improve the level of disease resistance.[225]	Ja, sollen 2023 ausgeweitet werden
Mais	CRISPR (CRISPR-Cpf1/Cms1) CropOS™ platform: combines machine learning & big data with genome editing and plant biology	Photosynthetic efficiency trait, Ertragssteigerung	***Benson Hill*** (USA), **Beck's** (USA)	Forschung & Entwicklung, anticipate filing a regulatory dossier with the USDA by 2021.[226] 2023: Unklar, ob dieses Projekt noch aktuell ist.	Nein (Elitelinien: ja)

223 https://bsppjournals.onlinelibrary.wiley.com/doi/10.1111/mpp.13319

224 https://www.dtnpf.com/agriculture/web/ag/crops/article/2021/02/22/designer-crops

225 https://www.corteva.com/resources/media-center/corteva-announces-plant-breeding-innovation-to-combat-corn-disease.html

226 https://bensonhill.com/#real-results, https://www.foodmanufacturing.com/capital-investment/news/21427448/crop-genomics-developer-benson-hill-to-go-public-through-spac-merger

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Mais	CRISPR SDN-1	Scientific field evaluation of maize with an impaired DNA-repair mechanism	Vlaams Instituut voor Biotechnologie (VIB) (BEL)	Freisetzungs-versuche seit 2017, erst seit 2018 im EU-GMO Register 2023: Kein Update verfügbar.	2017-2019 Noch kein Final Report verfügbar.[227]
Mais	CRISPR SDN-1	Scientific field evaluation of maize with improved digestibility	Vlaams Instituut voor Biotechnologie (VIB) (BEL)	The genetically modified maize plants have an altered composition of their cell wall resulting from the introduction of a mutation in the CCR1 and/or CCR3 genes. These mutations lead to the inactivation of these genes. The plants have up to 20% less lignin in their cell walls which is expected to contribute to a better digestibility of the maize thereby improving the feed conversion rate.	Proposed period of release: 15/04/2022 to 31/10/2023 2023: Kein Update verfügbar[228] Kein Final Report

227 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/BE/18/V8&Cat=gmp, https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/BE/19/V1&Cat=gmp

228 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/BE/22/V2&Cat=gmp

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Mais	CRISPR SDN-1	Scientific field evaluation of maize with modified growth characteristics	Vlaams Instituut voor Biotechnologie (VIB) (BEL)	The genetically modified maize plants have a mutation in the gene coding for a histon linkerprotein which leads to the inactivation of the gene. As a result, the plants have a significantlybetter growth during periods of drought.	Proposed period of release: 15/04/2022 to 31/10/2024 2023: Kein Update verfügbar[229]
Mais	CRISPR SDN-1	Scientific field evaluation of maize with increased resistance against DNA damage causing environmental stress	Vlaams Instituut voor Biotechnologie (VIB) (BEL)	The genetically modified maize plants have a significantly better growth under environmental stress conditions that lead to DNA damage.	Proposed period of release: 15/04/2022 to 31/10/2024 2023: Kein Update verfügbar[230]
Gerste	CRISPR	Altered Germination	Hartwick College, Center for Craft Food & Beverage (USA)	Anfrage nach Regulierungsstatus (Confirmation letter, SECURE) bei USDA[231]	Nein 2023: Kein Update verfügbar

229 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/BE/22/V3&Cat=gmp
230 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/BE/22/V1&Cat=gmp
231 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-130-01cr-a2-request.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Kartoffel	CRISPR Transgenese	Potato with altered resistance to pathogens The long-term goal of the research is to gain knowledge about resistance to pathogens and how the plants' own sensitivity and resistance mechanisms work. The purpose of the release is to evaluate agricultural value, including resistance traits, under field conditions. We will also identify any morphological abnormalities, produce field-grown material for laboratory testing, and produce seed for next year's field trials.	Swedish University of Agricultural Sciences SLU, Department of Plant Protection Biology (SWE)	Freisetzungsversuch The experiment is only for research purposes. 2023: Kein Update verfügbar.[232]	2021 to 2025

232 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/SE/21/3359&Cat=gmp

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Kartoffel **NEU**	CRISPR	CrisprCAS modified potato with altered starch properties	**KMC Amba** (DNK), University of Copenhagen (DNK)	The purpose of the release is to test the properties of the Waxy Wotan in agricultural land. Purpose is also to see the amount of modified starch and the quality of the starch, expected as a "Clean Label" product, and the growth of the plant.[233]	01/05/2023 to 30/09/2023
Kartoffel **NEU**	CRISPR	CrisprCAS modified potato with altered sensitvity to blight	**KMC Amba** (DNK), University of Copenhagen (DNK)	Short term goal is to evaluate the changed sensitivity to blight under field conditions with the expectation of a long term goal of reducing the use of fungicides in potatoes.[234]	15/05/2023 to 30/09/2023
Kartoffel **NEU**	CRISPR	Potato with altered resistance to pathogens or yield	SLU, Plant protection Biology (SWE)	The trial is for research purposes only.[235]	15/05/2023 to 15/10/2027

233 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/DK/55/Waxy%20Wotan&Cat=gmp

234 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/DK/54/StDMR6-1%20LoF%20Ydun&Cat=gmp

235 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/SE/23/3093&Cat=gmp

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Kartoffel	CRISPR	Vorhandene Abwehrebenen der Kartoffel verstärken, neue Abwehrmechanismen gegen diverse Schaderreger etablieren.	Verbundprojekt ADLATUS (gefördert vom BMEL)	Forschung & Entwicklung[236] 2023: Kein Update verfügbar	Geplant
Kartoffel	CRISPR	Veränderter Stärkegehalt	**Lyckeby Starch AB** (SWE) 2023: Kein Update verfügbar.	Forschung & Entwicklung Long-term goals are variety testing and marketing.[237]	2019 bis 2023
Kartoffel	CRISPR RNAi	Potato with altered resistance to pathogens	Swedish University of Agricultural Sciences SLU, Department of Plant Protection Biology (SWE) 2023: Kein Update verfügbar.	The long-term goal is late blight and early blight resistance and to gain knowledge about plant resistance mechanisms. The experiment is only for research purposes.[238]	2020 bis 2024

236 https://www.bmel.de/SharedDocs/Pressemitteilungen/DE/2020/236-widerstandsfaehige-kulturpflanzen.html
237 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/SE/19/5614&Cat=gmp
238 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/SE/20/1726&Cat=gmp

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Kartoffel **NEU**	CRISPR-Cas9	Drei Traits: Potato with decrease in antinutritionel compounds. Potato with tailored starch quality. Potato with decreased susceptibility to pathogens	Sveriges Lantbruks-universitet, Umeå Plant Science Centre, Skoglig genetik och växtfysiolog (SWE)	The purpose of the release is to study any morphological changes that may arise via somatic variation as a result of in-vitro cultivation. … Long-term goals are variety testing and marketing.	10/04/2023 to 15/11/2027[239]
Kartoffel	Cisgenese RNAi Once any changes to the UK regulations have been made, it might take 5 year for lines like ours to become available for producers and consumers. It would then be important to ensure that each crop is properly labelled to enable consumer choice.[240]	Resistenz gegen Kraut- und Knollenfäule, Kartoffelzystennematoden, geringere Anfälligkeit gegen Druckstellen Sorten: Maris Piper, Agria	TSL Potato Partnership Project (The Sainsbury Laboratory), University of Leeds (GBR), **J. R. Simplot**, **BioPotatoes UK Ltd** (USA, GBR)[241]	PiperPlus 1.0, is ready to be commercialized when the UK puts in place workable regulation for crops improved with the genetic modification (GM) method.[242]	Seit 2016 „We hope to be able to test advanced lines in field trials in 2019, 2020 and 2021, at 3 locations and identify the best line for commercial deployment.”

239 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/SE/22/23780&Cat=gmp

240 http://www.tsl.ac.uk/news/blight-resistant-maris-piper/

241 http://www.biopotatoes.com/aboutbp.html

242 https://www.tsl.ac.uk/news/piperplus-upgrade-2, https://www.tsl.ac.uk/news/blight-resistant-maris-piper,

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Kartoffel **NEU**	Genome Editing (Ohne weitere Spezifizierung)	Altered Tuber Quality (bruising resistant)	**Phytoform Labs Ltd.** (GBR, USA)[243] Spin-off von Rothamsted Research	APHIS-Bescheid (Confirmation letter)[244]	Unklar
Erbse, gelb	Genome Editing – ohne weitere Angaben CropOS™ platform: combines machine learning & big data with genome editing and plant biology	Verbesserter Geschmack	**Benson Hill** (USA)	APHIS-Bescheid 2020 2023: Kein Update verfügbar.	Unklar
Tomate	CRISPR	Erhöhter Vitamin D-Gehalt Übersichtsartikel mit Hinweis auf weitere Forschungsprojekte, die am gleichen Trait arbeiten.[245]	John Innes Center (UK)	Researchers in Professor Cathie Martin's group at the John Innes Centre used CRISPR-Cas9 gene editing to make revisions to the genetic code of tomato plants so that provitamin D3 accumulates in the tomato fruit.[246]	Unklar

243 https://www.phytoformlabs.com/about-us

244 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-060-01cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-060-01cr-signed-response.pdf

245 https://www.genengnews.com/topics/genome-editing/taste-the-sun-gene-editing-produces-vitamin-d-enhanced-tomatoes/

246 https://www.norwichresearchpark.com/gene-edited-tomatoes-could-be-a-new-source-of-vitamin-d

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Tomate	CRISPR	Früchte lösen sich ohne Stielansatz beim Pflücken Wissenschaftliche Publikation erschienen[247]	University of Florida, Horticultural Sciences (USA)	APHIS-Bescheid 2018. Weiterer APHIS-Bescheid 2020 für neue Tomaten-Zuchtlinien (mit dem gleichen Trait)[248]	Ja Ergebnisse der Freisetzungs-versuche wurden veröffentlicht[249]
Tomate	CRISPR	Performing a proof-of-concept of a new method of rapid and efficient gene editing in a tomato plant[250]	UC Davis Plant Biology Department (USA), **TechAccel** (USA) TechAccel nutzt Gene editing für die Entwicklung von disease-resistant crop varieties	TechAccel arbeitet u. a. mit Benson Hill zusammen[251] 2023: Kein Update verfügbar.	Geplant

247 https://link.springer.com/article/10.1007/s13580-022-00489-5

248 https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/19-282-01-a3-air-inquiry-cbidel.pdf, https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/19-282-01-air-response-signed.pdf

249 https://link.springer.com/article/10.1007/s13580-022-00489-5

250 https://biology.ucdavis.edu/news/stair-grant-funds-plant-biologists-efforts-create-cheaper-crispr-tech

251 https://techaccel.net/portfolio/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Alfalfa/Luzerne	CRISPR	Herbizidresistenz “We combine Synthetic Biology and Gene Editing to develop herbicide resistant crops. Heurik™, one of our technology platforms, integrates rational design and directed evolution to identify mutations which confers herbicide tolerance. Swap™ is the platform that introduces these mutations in crops using gene editing. The main advantages of this strategy is reducing development costs and time to market of our products. This is because we can work with elite lines and edit more than one gene at a time.”	**Bioheuris** (ARG, USA) 2023: Kein Update verfügbar.	Forschung & Entwicklung. Es sind 3 verschiedene HR-Traits in Arbeit.[252] Currently, the focus of our alfalfa innovation program is the generation of integrated weed management systems in high-productivity cultivars.[253] Anfrage nach Regulierungs-status (Confirmation letter, SECURE) bei der USDA[254]	Unklar

252 https://www.bioheuris.com/en/what-we-do/

253 https://www.bioheuris.com/en/what-we-do/

254 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-151-01cr-cbidel-a3-request.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Baumwolle	CRISPR	Herbizidresistenz	**Bioheuris** (ARG, USA), **Gensus** (ARG)	APHIS-Bescheid 2023[255] “With Gensus, the Argentine cotton seed company, we are developing herbicides resistant varieties to combat weeds, which, in addition to reducing yield, contaminate cotton lint, reducing its quality.”[256]	Unklar
Sorghum	CRISPR	Improved disease resistance, nutritional value and enhanced resilience to biotic stresses[257] Wissenschaftliche Publikation erschienen.[258]	**Corteva** (USA), Donald Danforth Plant Science Center (USA)	Forschung & Entwicklung To combat Striga, a parasitic weed without the use of herbicides, we have helped create sorghum that is resistant to Striga.[259]	Field trials of the new variety are scheduled for later this year

255 https://www.aphis.usda.gov/brs/pdf/rsr/23-216-02rsr.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/23-216-02rsr-response.pdf

256 https://www.bioheuris.com/en/what-we-do/

257https://www.corteva.com/our-impact/innovation/crispr/our-promise.html, https://www.pioneer.com/home/site/about/news-media/news-releases/template.CONTENT/guid.4AFC64D7-C550-96AF-405B-73B8C7879F29

258 https://pubmed.ncbi.nlm.nih.gov/32047036/

259 https://www.corteva.com/who-we-are/outlook/securing-food-through-sorghum.html, https://www.nature.com/articles/d41586-024-00176-8?utm_medium=Social&utm_campaign=nature&utm_source=Twitter#Echobox=1706260106

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Sorghum, (Perl-)Hirse	CRISPR	Productivity and quality improvements In some parts of the world, pearl millet flour is an important food staple. We have improved the quality and longevity of pearl millet flour by reducing the rancidity in the flour.[260]	**Corteva** (USA), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) (IND)[261]	Forschung & Entwicklung	Unklar
Sorghum	CRISPR	Multiple Traits, non-exclusive research license to evaluate five novel yield traits in forage sorghum[262]	**Yield10 Bioscience** (USA), **Forage Genetics** (USA) 2023: Kein Update verfügbar.	Forschung & Entwicklung Based on the field results obtained from our work with Camelina traits, we execute non-exclusive research licenses, enabling companies to evolve our traits within crops of interest.[263]	Unklar

260 https://investors.corteva.com/static-files/c023a381-083e-4c92-8614-941419d4615a

261 https://www.icrisat.org/icrisat-and-corteva-agriscience-agriculture-division-of-dowdupont-collaborate-for-sharing-advanced-breeding-technologies-to-improve-crops-that-feed-millions/

262 https://ir.yield10bio.com/static-files/cb2ac804-60e9-440c-8b91-b449941643a3, https://www.globenewswire.com/en/news-release/2018/09/21/1574300/34378/en/Yield10-Bioscience-Grants-Research-License-to-Forage-Genetics-to-Evaluate-Novel-Yield-Traits-in-Sorghum.html

263 https://www.yield10bio.com/commitment/performance-traits#more

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Cassava	CRISPR	Krankheitsresistenz	**Corteva** (USA), Donald Danforth Plant Science Center (USA), Virus Resistant Cassava for Africa (VIRCA)[264] 2023: Kein Update verfügbar.	Forschung & Entwicklung Forscher:innen (u. a. der ETH Zürich) weisen auf Schwierigkeiten bei Resistenzzüchtung mit CRISPR in Cassava hin.[265]	Wahrscheinlich (Kenia, Uganda)
Teff **NEU**	CRISPR-Cas9	Verkürzte Stängellänge	Donald Danforth Plant Science Center (USA)	APHIS-Bescheid 2023[266]	Unklar

264 https://publications.jrc.ec.europa.eu/repository/handle/JRC123830, S. 21, https://allianceforscience.cornell.edu/blog/2021/08/gene-editing-key-to-improving-africas-staple-crops/, https://geneticliteracyproject.org/2022/09/13/crispr-tackles-deadly-cassava-mosaic-virus-disease/

265 https://www.researchgate.net/profile/Devang-Mehta-3/publication/324963638_CRISPR-Cas9_interference_in_cassava_linked_to_the_evolution_of_editing-resistant_geminiviruses/links/5b02c4af4585154aeb06e99b/CRISPR-Cas9-interference-in-cassava-linked-to-the-evolution-of-editing-resistant-geminiviruses.pdf?origin=publication_detail

266 https://www.aphis.usda.gov/brs/pdf/rsr/22-013-01rsr-review-submission.pdf, https://www.aphis.usda.gov/brs/pdf/rsr/22-013-01rsr-review-response.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Straucherbse (*Cajanus cajan)*	CRISPR-Cas9	Herbizidresistenz This project aims to deliver (a) Herbicides resistant superior haplotypes; (b) Identify and use of homologs in pigeonpea genome for genome editing; (c) Generation of constructs with promoters, terminators and vectors for expression of Cas9 cassettes that may be extrapolated for other legumes/dicots; (d) The genome-edited lines with double herbicide tolerant trait shall be made available to researchers for further use in their crop improvement programmes. Growers will use these new technologies in combinations to fill in efficacy gaps of diversified weeds.[267]	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Centre for Genetic Engineering and Biotechnology (ICGEB)	Both institutes jointly submitted and won a competitive grant from Department of Biotechnology (DBT), Government of India entitled “Developing double herbicide tolerant pigeonpea for improved Weed management employing two pronged approach: haplotype mining in native germplasm and CRISPR/Cas9 mediated genome editing”. 2023: Kein Update verfügbar.	Nein
Sonnenblume	CRISPR	Herbizidresistenz 2023: Kein Update verfügbar.	**Bioheuris** (ARG, USA), **Argenetics** (ARG)	With the seed company Argenetics, we recently started a project to improve the integrated management of weeds in this crop.	Nein

267 https://www.seedquest.com/news.php?type=news&id_article=135985&id_region=&id_category=&id_crop=

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Erdnuss	CRISPR	Herbizidresistenz 2023: Kein Update verfügbar.	**Bioheuris** (ARG, USA)	Our research program seeks to develop safe and efficient ways to control them while protecting the crop.	Nein
Banane	ARCUS® genome-editing technology	The aim is to co-develop banana varieties resistant to FOC TR4[268] 2023: Kein Update verfügbar.	**Elo Life Sciences** (USA), **Dole** (USA)	Elo also entered into a Research, Development, and Commercialization Agreement with Dole, utilizing proprietary computational biology workflows and the ARCUS genome editing platform.[269]	Nein

268 https://elolife.com/dole-partners-with-elo-life-systems-to-save-the-banana/

269 https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-07_air_inquiry_a3_a2_cbidel.pdf, https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-168-07_air_response_signed.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Kaffee	GEiGS® (Gene-Editing, RNAi)	Koffeinfreier Kaffee Video verfügbar[270]	**Tropic Bioscience** (GBR)	We create natural low caffeine coffee by turning off the caffeine-producing genes within the bean. In replacing the usual aggressive chemical decaffeination process, we create coffee that is healthier and tastier for the consumer and easier on the supply chain.[271]	Geplant
Kaffee **NEU**	GEiGS® (Gene-Editing, RNAi)	Improved solubilty	**Tropic Bioscience** (GBR)	We develop coffee varieties for better instant coffee. Improving the solubility of the bean means higher quality, tastier coffee at lower processing temperatures - so, a lower energy cost for the planet.[272]	Unklar

270 https://www.bloomberg.com/news/articles/2022-09-30/video-the-global-fight-to-save-coffee-from-climate-change?leadSource=uverify%20wall

271 https://tropic.bio/coffee/

272 https://tropic.bio/coffee/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Kichererbse	ARCUS® genome-editing technology	Kichererbsenprotein als Fleischersatz, Kichererbse als «klimaangepasste» Pflanze 2023: Kein Update verfügbar.	**Elo Life Sciences** (AUS), Queensland University of Technology (AUS)[273]	Elo's ClimateSmart Chickpea program addresses the effect of climate change as a foundational trait for the plant-based protein industry. Edited chickpea plants were successfully created at a subsidiary of Elo in Australia. Genotypic and phenotypic screens are in progress.[274]	Nein

273 https://www.austrade.gov.au/ArticleDocuments/2833/elo-life-systems-case-study.pdf.aspx

274 https://elolife.ag/pipeline/, https://investor.precisionbiosciences.com/static-files/2de94543-7e05-4ffe-bf72-17e268cbefe4

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Tabak	CRISPR-Cas9	The tobacco plants to be released carry mutations (deletions and insertions) in different combinations of endogenous genes of the SPL family (SPL and FT-SPL lines), endogenous FT5 genes (FT and FT-SPL lines), endogenous MPO1 genes (MPO lines) or endogenous BBL genes (BBL lines). The mutations have been generated using the CRISPR / Cas9 system. These plants do not contain any transgene.[275]	Instituto de Biología Molecular y Celular de Plantas, Agencia Estatal Consejo Superior de Investigaciones Científicas (ESP)	Forschung. Finaler Bericht liegt vor.[276]	01.03.2021 bis 31.10.2021 CTAEX Experimental field, Villafranco del Guadiana, Badajoz (950m^2)
Orange	CRISPR	Krankheitsresistenz 2023: Kein Update verfügbar.	University of Florida, Institute of Food and Agricultural Sciences Citrus Research and Education Center (USA)	2022: APHIS-Bescheid (Confirmation letter)[277]	Nein

275 https://gmoinfo.jrc.ec.europa.eu/gmp_report.aspx?CurNot=B/ES/21/01

276 https://webgate.ec.europa.eu/fip/GMO_Registers/files/finalreports/B-ES-21-01-Final-Report.pdf?dt=110123125122

277 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-311-01cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-311-01cr-response-signed.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Orange	TALEN	Toleranz gegen Zitruskrebs (*Xanthonomas citri*). Patentanmeldung (Anspruch auf Resistenzgen) läuft 2023: Kein Update verfügbar. Unklar, ob 2Blades noch an Orangen arbeitet.	**2Blades Foundation** (USA)	Forschung & Entwicklung. "We are testing three different independent mechanisms of resistance that are effective against *Xanthomonas* pathogens in other systems. ... 3) We are using gene-editing techniques to alter a susceptibility gene which is known to confer bacterial resistance in other plants."[278]	Geplant
Apfel	Cisgenese	Erhöhter Anthocyan-Gehalt	Stichting Dienst Land-bouwkundig Onderzoek (DLO) et al. (NLD)	Forschung[279] 2023: Kein Update verfügbar.	NL, 2016 - 2026

278 https://2blades.org/projects-and-technology/projects/citrus-canker/

279 http://gmoinfo.jrc.ec.europa.eu/gmp_report.aspx?CurNot=B/NL/15/L01

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Physalis	CRISPR	Verschiedene: Fruchtgrösse, Vorerntefruchtfall, Invasivität	Physalis Improvement Project, Boyce Thompson Institute (USA)	Forschung & Entwicklung. 2020 Start eines Community Science Project[280] Über Twitter erfährt man, dass auch 2022 Pflanzungen stattgefunden haben.[281] 2023: Keine Updates auf der Webseite.	Ja

280 https://btiscience.org/our-research/bti-physalis-project-2/

281 https://twitter.com/EliseTomaszews1/status/1532815989976481793

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Brombeere	CRISPR	Kernlose Brombeeren, ev. weitere Traits in Arbeit	**Pairwise Plants** (USA), Plant Sciences Inc. (USA) Kooperation mit North Carolina State University[282]	Partnership with the USDA, N.C. State University and some other universities to study the genetics of caneberries (i.e. blackberries and raspberries)[283] 2022: 2x APHIS-Bescheide (Confirmation letters)[284] 2023: 8x APHIS-Bescheide (Confirmation letters)[285]	Unklar

282 https://www.pairwise.com/news/pairwise-collaborates-with-north-carolina-state-university-on-caneberry-research

283 https://www.growingproduce.com/fruits/is-gene-editing-the-new-horizon-for-berry-crop-improvement/

284 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-213-01cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-213-03cr-request.pdf

285 Beispieldokumente: https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-072-08cr-request.pdf, https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/23-072-08cr-signed-response.pdf. Weitere Dokumente: https://www.aphis.usda.gov/aphis/ourfocus/biotechnology/regulatory-processes/confirmations/responses/cr-table

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Kirsche	CRISPR	Kirschen ohne Steine	**Pairwise Plants** (USA)	Near the end of this decade, we plan to sell pitless cherries in grocery stores. If you're wondering why it takes so long, it's because we have to grow a new variety of cherry trees![286] 2023: Kein Update verfügbar.	Unklar
Erdbeere	Cisgenese, TALEN	Ertragssteigerung, verbessertes *Shelf life*, erhöhter Zuckergehalt, Krankheitsresistenz	**J. R. Simplot** (USA) 2023: Kein Update verfügbar.	Forschung & Entwicklung Patentanmeldung (USA), 2018[287]	Ja, ab 2015
Rutenhirse, Switchgras (*Panicum virgatum* L.)	CRISPR	Nutzung als Bioenergiepflanze Projektbeschreibung[288] Interview mit der Entwicklerin[289]	University of Georgia, College of Agricultural & Environmental Sciences, Center for Applied Genetic Technologies (USA)	APHIS-Bescheid 2020. (Zeitgleich erging APHIS-Bescheid für gv-Rutenhirse, wahrscheinlich mit den gleichen Eigenschaften)[290]	Geplant

286 https://consciousfoods.net/process

287 http://www.freepatentsonline.com/20180092319.pdf

288 https://genomicscience.energy.gov/wp-content/uploads/2022/01/Tuskan_IllaBerenguer_8_Revised.pdf

289 https://research.uga.edu/news/katrien-devos-building-sustainable-transportation-on-fields-of-grass/, https://research.uga.edu/news/growing-our-gas-uga-moving-biofuels-closer-to-market/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Pappel *(Populus sp. and hybrids)* **NEU**	CRISPR	Nutzung als Bioenergiepflanze A multidisciplinary team of researchers at the University of Georgia and two partner institutions have been awarded a $15.8 million grant over five years from the U.S. Department of Energy to reengineer poplar trees (Populus sp. and hybrids) to be used as a sustainable energy source.[291]	University of Georgia, College of Agricultural & Environmental Sciences, Center for Applied Genetic Technologies (USA)	Forschung und Entwicklung.	Nein
Eukalyptus	CRISPR-Cas9	FuturaGene intends to apply the gene editing technology to research and develop new varieties of eucalyptus that are more productive, resistant to diseases and pests and have improved fiber properties. In addition, the company aims for the new varieties to be more resilient to climate change and to serve as an alternative to products derived from fossil fuels.	**FuturaGene** (USA)	Ende 2021 wurde der Abschluss einer Lizenz zur Nutzung von CRISPR-Cas9 bekannt gegeben.[292] Wissenschaftliche Publikation erschienen.[293]	Nein

290 https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-062-04_air_cbidel.pdf, https://www.aphis.usda.gov/biotechnology/downloads/reg_loi/20-062-04_air_response_signed.pdf

291 https://news.uga.edu/research-team-receives-15-8m-to-modify-poplar-for-bioproducts/, https://research.uga.edu/news/growing-our-gas-uga-moving-biofuels-closer-to-market/

292 https://www.businesswire.com/news/home/20211208005555/en/FuturaGene-Secures-License-to-CRISPR-Cas9-Technology-to-Develop-Sustainable-Varieties-of-Eucalyptus-with-Improved-Productivity-Stress-Resistance-and-Fiber-Quality

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Grau-Pappel	CRISPR	Changes in lignin with directed mutagenesis	**SweTree Technologies AB** (SWE) 2023: Kein Update verfügbar.	The aim of this experiment is to field test plants with CRISPR/Cas9-generated mutations that give a reduced level of lignin while maintaining normal growth of the plant, which have been shown in greenhouse experiments.[294]	Proposed period of release: 01/05/2022 to 31/12/2026
Kanadische Schwarzpappel **NEU**	CRISPR Transgenese	Increased drought stress tolerance, Increased production of wood biomass by increased growth 3 - Prolongation, Changes in lignin with directed mutagenesis - Prolongation.	**SweTree Technologies AB** (SWE)	The purpose of prolongation of previous trial permits is to gain a deeper understanding of variation between lines and to confirm positive data generated at previous release sites.[295]	01/04/2024 to 31/12/2028
Arabidopsis **NEU**	CRISPR	Photosynthesis and hormone biology	Umeå University, Dept. of chemistry (SWE)	Basic research on photosynthesis and hormone biology.[296]	01/06/2023 to 30/09/2027

293 https://onlinelibrary.wiley.com/doi/full/10.1002/pld3.507

294 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/SE/21/22027&Cat=gmp

295 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/SE/23/21689&Cat=gmp

296 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/SE/23/4198&Cat=gmp

Anmerkungen:

a) Verfahren – zur besseren Unterscheidbarkeit farbig markiert: ODM = Oligonukleotid-gerichtete Mutagenese / CRISPR = Clustered Regularly Interspaced Short Palindromic Repeats / ZFN = Zinkfinger-Nuklease-Verfahren / TALEN = Transcription activator-like effector nuclease / Intragenese / Cisgenese / RNAi = RNA-Interferenz / Pfropfen auf GV-Unterlage / Meganukleasen

b) *Unternehmen* (kursiv)= *Entwickler der Technologie;* **Unternehmen** (fett) **= Anwender**; (kursiv und fett) = ***Unternehmen & Entwickler***

c) Unternehmen gelb hinterlegt = Zusatzinformationen im Begleitdokument.

d) Forschung & Entwicklung = angewandte Forschung (→ Kommerzialisierung wird wahrscheinlich angestrebt)

e) Reine Forschungsprojekte sind in dieser Tabelle nur aufgeführt, wenn, sofern bekannt, Freisetzungsversuche damit verbunden sind.

Lizenzvereinbarungen und Kooperationen

zwischen Züchtungs- und Biotech-Unternehmen – Start-Ups – Forschungseinrichtungen/Universitäten

im Bereich der neuen gentechnischen Verfahren – landwirtschaftliche Anwendungen (2005 – 2024)

(UPDATE Stand: Januar 2024, neue Einträge sind unterstrichen)

→ Die Einträge betreffend Landwirtschaft aus der CRISPR Licenses Dataverse (der *New York Law School*) sind in der Tabelle aufgenommen. Die Datensammlung enthält *"redacted and unreacted copies of IP license agreements in the CRISPR gene editing space, as well as press releases containing substantive information about confidential licenses." Einträge in der Datenbank reichen nur bis 2017.*

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
ToolGen (KOR)	Nullabio (KOR)	CRISPR-Cas9	2023-12	*«ToolGen gab bekannt, dass es eine Vereinbarung zur Übertragung seiner CRISPR-Cas9-Gen-Editierungstechnologie an Nullabio, ein Unternehmen für Gen-Editierung von Nutzpflanzen, unterzeichnet hat.Im Rahmen der Vereinbarung erhält Nullabio das Recht, Toolgens CRISPR-Cas9-Geneditierungstechnologie auf Nutzpflanzen anzuwenden, um klimarelevante und gesundheitsfördernde Nutzpflanzen zu entwickeln, zu produzieren, zu lizenzieren und auf dem Weltmarkt zu vertreiben, und Toolgen erhält Lizenzgebühren, die gemäß der Vereinbarung zwischen den beiden Unternehmen nicht bekannt gegeben werden.»*	84, 85

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
2Blades (USA)	NAPIGEN (USA)	TALEN	2023-10	“2Blades announced today the completion of a non-exclusive license agreement with NAPIGEN for access to 2Blades’ TALEN technology for applications in organellar genome editing. The editing of plant mitochondrial and chloroplast genomes opens new opportunities for altering traits in crop plants that have not yet been easily targeted by conventional methods (e.g., CRISR/cas9), and which have significant implications for improved crop nutrition, growth, and yield.”	82
Corteva Agriscience (USA) *Broad Institute (USA)*	Harpe Bioherbicide Solutions, Inc. (USA)	CRISPR-Cas9	2023-09	“Harpe Bioherbicide Solutions, Inc., an agricultural technology company focused on providing natural and sustainable herbicide solutions, announced today that it has executed a joint intellectual property licensing agreement with Corteva Agriscience and the Broad Institute of MIT and Harvard for foundational CRISPR-Cas9 and related gene editing tools to further research and develop Harpe Bioherbicide tolerant crop systems.”	83
Merck KgaA, Life Science division, MilliporeSigma	*BetterSeeds Ltd. (ISR)*	CRISPR	2022-03	"Merck KGaA, a leading multinational Pharmaceutical company, has signed through its *Life Science* division, MilliporeSigma, a unique collaboration and license agreement with an Israeli AgTech company to demonstrate the utility of its proprietary CRISPR genome-editing tools in agricultural uses. The agreement licenses its foundational CRISPR intellectual property to Israeli BetterSeeds Ltd., a disruptive company that uses genome editing technology including CRISPR to develop new breeds of plants.”	79

Lizenzgeber	*Lizenznehmer*	*Verfahren*	*Jahr-Monat*	*Verwendungszweck*	*Quelle*
Corteva Agriscience (USA) *Broad Institute (USA)*	*Sustainable Oils (USA)*	CRISPR-Cas9	2022-08	“Sustainable Oils, Inc., a wholly owned subsidiary of Global Clean Energy Holdings, Inc., an ultra-low carbon renewable fuel company that will use nonfood camelina as their primary fuel source material, today announced a joint licensing agreement with Corteva Agriscience and the Broad Institute of MIT and Harvard for CRISPR-Cas9 and related gene editing tools to further develop their patented camelina varieties.“	81
Corteva Agriscience (USA) *Broad Institute (USA)*	*FuturaGene (USA)*	CRISPR-Cas9	2021-12	“FuturaGene, a wholly owned subsidiary of world-leading eucalyptus pulp producer, Suzano, will use patented genome editing technology from global pure-play agriculture company, Corteva Agriscience, and non-profit research organization, the Broad Institute of MIT and Harvard, to develop new, improved eucalyptus varieties. FuturaGene intends to apply the gene editing technology to research and develop new varieties of eucalyptus that are more productive, resistant to diseases and pests and have improved fiber properties. In addition, the company aims for the new varieties to be more resilient to climate change and to serve as an alternative to products derived from fossil fuels. FuturaGene has the option to convert the worldwide research license to cover commercial applications.”	80

Lizenzgeber	*Lizenznehmer*	*Verfahren*	*Jahr-Monat*	*Verwendungszweck*	*Quelle*
Corteva Agriscience (USA) *Broad Institute (USA)*	*Bejo (NL)*	CRISPR-Cas9	2021-05	“Dutch vegetable seed breeder Bejo has entered into a non-exclusive research and commercial license agreement with global agriculture company Corteva Agriscience and the Broad Institute of MIT and Harvard, a U.S.-based biomedical and genomic research center. Through the agreement, Bejo will access CRISPR-Cas9 intellectual property for genome editing for agricultural use, allowing research work and programs as well as potential future commercial applications. For the time being, however, following the development in legislation Bejo will use CRISPR-Cas9-technology for research purpose only..”	78
Tropic Bioscience	*BASF*	GEiGS™ (Gene Editing induced Gene Silencing)	2020-07	“Tropic Biosciences announces their research agreement with BASF to utilize Tropic’s ground-breaking GEiGS™ (Gene Editing induced Gene Silencing) technology to develop traits to address growers’ most critical challenges in protecting crops. The collaboration applies the Tropic Bioscience GEiGS™ platform within BASF’s strategic crop varieties and utilizes BASF’s expertise in the development of agricultural traits. GEiGS™ technology utilizes established genome editing tools to make precise and specific changes to only a few nucleotides within non-coding genomic locations of a host organism. These changes redirect RNA interference (RNAi, also Gene Silencing) activity of non-coding genes towards target genes, including those belonging to pathogens and pests. The approach does not depend on the introduction of foreign genes into the host genome.”	75

Lizenzgeber	*Lizenznehmer*	*Verfahren*	*Jahr-Monat*	*Verwendungszweck*	*Quelle*
University of Minnesota (USA)	*Calyxt (USA)*	Fast-TrACC	2020-04	Calyxt “has licensed a new method to help increase plant gene editing efficiency from the University of Minnesota. The method has the potential to reduce the time needed to edit plants from approximately one year to several months. This breakthrough, co-invented by Dan Voytas, Ph.D., the co-founder of Calyxt and the University of Minnesota Professor of Genetics, Cell Biology and Development (…) This new technology could help Calyxt bring consumer-desired products, like better tasting plant proteins, to the market faster.”	72, 73, 74
Broad Institute of MIT and Harvard	*Monsanto Company/BAYER Crop Science*	CRISPR-Cpf1	2020-03	“Monsanto Company announced that it has reached **a new global licensing agreement** with the Broad Institute of MIT and Harvard for the use of the novel CRISPR-Cpf1 genome-editing technology in agriculture. (…) Over the last year, Monsanto has licensed multiple genome-editing technologies – including a separate license from the Broad Institute for use of the CRISPR-Cas9 system in agriculture – to develop a leading portfolio of tools in this field. The intellectual property around the CRISPR-Cpf1 system is independent from the CRISPR-Cas patent estate, and this CRISPR-Cpf1 license provides Monsanto with another valuable tool for genome editing in this rapidly advancing field of science. Under the new agreement announced, the Broad Institute grants Monsanto a worldwide non-exclusive license for agricultural applications of the CRISPR-Cpf1 system. Additional terms of the agreement were not disclosed.”	77

Lizenzgeber	*Lizenznehmer*	*Verfahren*	*Jahr-Monat*	*Verwendungszweck*	*Quelle*
Corteva Agriscience (USA) *Broad Institute (USA)*	*Vilmorin & Cie (FRA)*	CRISPR-Cas9	2019-12	"This **non-exclusive license agreement** grants Vilmorin & Cie access to certain CRISPR-Cas9 patents covering genome editing tools for agricultural use. The license agreement covers all Vilmorin & Cie's research work and programs as well as potential commercial applications. Vilmorin & Cie will be able to deploy this technology for both its Field Seeds and Vegetable Seeds activities."	69, 70, 76
Benson Hill Biosystems (USA)	*Rice Tec (USA)*	CRISPR-Cms1	2019-06	"...announcing the **licensing agreement** for the use of Benson Hill's technologies as part of RiceTec's rice research and development operations."	62
Corteva Agriscience (USA) *Broad Institute (USA)*	*Amfora (USA)*	CRISPR-Cas9	2019-04	"Amfora, a biotechnology company, announced it has reached a **non-exclusive research and commercial license agreement** with Corteva Agriscience™, the Agriculture Division of DowDuPont™, and the Broad Institute of MIT and Harvard. Through the agreement, Amfora will use intellectual property covering CRISPR-Cas9 and related gene editing tools to develop a portfolio of gene-edited crops with increased protein content."	64
Cold Spring Harbour (USA)	*Inari (USA)*	CRISPR-based tool for editing promoters	2019-04	"… announced today an exclusive licensing agreement with partner Inari, a company that is advancing plant breeding by tapping nature's genetic diversity. The technology developed by CSHL Professor and Howard Hughes Medical Institute Investigator Zachary Lippman allows Inari to tailor plant architecture and other traits in crops, improving productivity and quality to fit local environmental conditions."	65, 67

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Massachusetts General Hospital (USA)	*Pairwise (USA)*	CRISPR	2019-03	“The agreement with MGH reflects Pairwise’s commitment to finding and applying the right tools to deliver best-in-class solutions. Pairwise has the **exclusive license** to specific MGH CRISPR technology and will further develop applications for agriculture.“	63
Broad Institute (USA)	*Pairwise (USA)*	CRISPR-Cas9, -Cas12	2019-03	“The agreement with the Broad Institute gives Pairwise a license to the Cas9 and Cas12 (including both Cas12a/Cpf1 and Cas12b/C2c1) patent portfolios for use in plants and agriculture. The Broad Institute licenses are **non-exclusive** and adhere to the Broad Institutes’s ethical restrictions for agricultural use, which prohibit using CRISPR for gene drive, sterile seeds, or tobacco products for human use.“	63
University of California (USA)	*Inari (USA)*	Patents that describe key epigenetic pathways in plants and methods based on CRISPR for altering DNA methylation and gene regulation.	2019-02	“Inari, a company that is revolutionizing plant breeding by tapping natural genetic diversity, announced it has secured **exclusive patent licenses** for epigenetics from the University of California, Los Angeles (UCLA). The agreement, through UCLA's Technology Development Group, gives Inari access to tools that will positively influence crop performance without altering a plant's genetic code.”	66, 67
Broad Institute (USA)	*Vilmorin & Cie (FRA)*	CRISPR-Cpf1	2018-12	“..at the beginning of fiscal year 2018-2019, Vilmorin & Cie signed an agreement enabling it to broaden its range of technologies, by accessing the CRISPR genome editing technique, in order to use it in all its breeding work, both for Vegetable Seeds and Field Seeds. For this purpose, Vilmorin & Cie signed an agreement with the Broad Institute of MIT and Harvard biomedical and genomcis	69, 71

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				research center located in Cambridge in the United States. This agreement grants Vilmorin & Cie access to the technique known as CRISPR-Cpf1; it covers uses both for purposes of research and for potential commercial applications.”	
Two Blades Foundation (2Blades) (USA)	*Epicrop Technologies Inc. (USA)*	TAL code technology	2018-11	**Non-exclusive licence agreement.** “We are pleased to be able to utilize this technology in our research t**o improve yields and stress tolerance in crops**” said Michael Fromm, CEO of Epicrop. “Research with this technology will help us to more efficiently optimize our conventional breeding methods **for improving epigenetics in crops**. Epigenetics is a form of biological information that has always been present in plants, and can be improved by plant breeding as we learn what features are most beneficial for higher stress tolerance and yields in the farmer’s field. It may seem surprising, to those more familiar with gene editing and other methods, that our epigenetic breeding methods produce plants that do not contain any changes to their genome sequence or introduce any foreign DNA sequences. Epigenetic improvements are analogous to a ‘software update’ that helps the plant’s natural genetics perform better without changing the ‘hardware’ of the genetic sequences.”	61
Broad Institute (USA)	*BASF (DEU)*	CRISPR-Cpf1	2018-10	“BASF has attained a **global, non-exclusive licensing agreement** with the Broad Institute of MIT and Harvard for the use of CRISPR-Cpf1 genome editing technology t**o improve products in agricultural** and industrial microbiology **applications**.“	57

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Corteva Agriscience™, Agriculture Division of DowDuPont™, Broad Institute (USA)	*J. R. Simplot (USA)*	CRISPR-Cas9 and related gene editing tools	2018-08	“Comprehensive intellectual property rights allow entities to apply scientific tools as widely as possible. To enable such access, Corteva Agriscience™ and Broad Institute have agreed on a joint **non-exclusive licensing framework for agricultural use**. The license to Simplot represents the first time that Corteva Agriscience™ and Broad Institute have jointly provided a license of CRISPR-Cas9 genome editing tools to an agricultural company.”	58
Corteva Agriscience™, Agriculture Division of DowDuPont™, Broad Institute (USA)	*Yield10Bioscience (USA)*	CRISPR-Cas9	2018-08	“For the **use of CRISPR-Cas9 genome-editing technology for crops**. The joint license covers intellectual property consisting of approximately 48 patents and patent applications on CRISPR-Cas9 technology controlled by the Broad Institute and Pioneer. Under the agreement, Yield10 has the option to renew the license on an annual basis and the right to convert the research license to a commercial license in the future, subject to customary conditions as specified in the agreement.”	59
Corteva Agriscience™, Agriculture Division of DowDuPont™, Broad Institute (USA)	*ICRISAT, The International Crops Research Institute for the Semi-Arid Tropics (India)*	CRISPR-Cas9	2018-04	“The **technology sharing** includes CRISPR-Cas gene editing, adapting transformation techniques to new crops, and applying knowledge of plant biochemical pathways with the goal of productivity and quality improvements for crops that feed millions of people. DuPont Pioneer, now part of Corteva Agriscience™, will provide access to intellectual property, material and know-how related to CRISPR-Cas and plant transformation.”	68

Lizenzgeber	*Lizenznehmer*	*Verfahren*	*Jahr-Monat*	*Verwendungszweck*	*Quelle*
Precision BioScience (USA)	*Cargill (USA)*	ARCUS® genome-editing technology	2018-02	"Together, the partners are using Precision's ARCUS® genome-editing technology **to further reduce saturated fat in canola oil**, putting Cargill at the forefront of a next-generation innovation. (…) This commitment to saturated fat reduction led to Cargill's partnership with Precision BioSciences in 2014. Since then, the two companies have worked together to lower saturate levels in canola oil, leveraging Cargill's expertise in gene identification, and Precision BioSciences' unique technology that edits the targeted genes."	60
Broad Institute (USA)	*Syngenta* (China, CH)	CRISPR-Cas9	2017-11	"Syngenta announced (...) it has attained a non-exclusive IP license from the Broad Institute of MIT and Harvard for **CRISPR-Cas9 genome-editing technology for agricultural applications**. CRISPR-Cas9 genome editing technology complements Syngenta's already robust plant breeding innovation toolbox. **Syngenta is applying this technology in multiple crops, including corn, wheat, tomato, rice and sunflower**."	48

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
Broad Institute (USA) **+** *to jointly provide* ***non-exclusive licenses to foundational CRISPR-Cas9 intellectual property*** *under their respective control* ***for use in commercial agricultural research and product development***	*DuPont Pioneer (USA)*	CRISPR-Cas9	2017-10	"DuPont Pioneer and the Broad Institute of MIT and Harvard announced (...) that they have reached an agreement to **jointly provide non-exclusive licenses to foundational CRISPR-Cas9 intellectual property under their respective control for use in commercial agricultural research and product development**. These two major CRISPR-Cas9 license holders are coming together with the shared goal of enabling all entities wanting to apply the technology for agricultural applications with a full range of CRISPR-Cas9 tools. Such foundational intellectual property (IP) for CRISPR-Cas9 technology **will be freely available to universities and nonprofit organizations for academic research**. (…)"	55
Broad Institute (USA)	*Arcadia Bioscience Inc. (USA)*	CRISPR-Cas9	2017-09	"Arcadia Biosciences, Inc. (...), an agricultural technology company, announced (...) that it has signed a **global licensing agreement** with the Broad Institute of MIT and Harvard **for research use of the CRISPR- Cas9 genome-editing technology in agriculture**. The technology will enable Arcadia to accelerate the research and development of its agricultural nutrition and productivity traits."	51

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ToolGen (USA)	*Monsanto (USA)*	CRISPR-technology platform	2017-08	“Monsanto and ToolGen, a biotechnology company specializing in genome editing, have reached a **global licensing agreement for the use of ToolGen’s CRISPR technology platform to develop agricultural products**. ToolGen is an early pioneer in gene editing research. The license provides Monsanto with access to ToolGen’s comprehensive suite of CRISPR intellectual property for use in plants. This agreement further expands Monsanto’s broad portfolio of gene-editing tools that can be used to develop improved and sustainable crops.”	54
DuPont Pioneer (USA)	*ERS Genomics*	CRISPR-Cas	2017-06	“DuPont Pioneer (DuPont) and ERS Genomics (ERS) announced a **technology license agreement** whereby **DuPont gains exclusive rights to the ERS patent portfolio covering CRISPR-Cas genome editing technology for all agricultural uses and applications in plants**. (...) **Pioneer is applying CRISPR-Cas as an advanced plant breeding tool to develop seed products for greater environmental resiliency, productivity and sustainability**. Pioneer has defined CRISPR-Cas guiding principles, which include helping enable others wanting to develop agricultural products using CRISPR-Cas by providing access to its IP, technology capabilities, infrastructure and scientific expertise.”	53

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Broad Institute (USA)	*BASF (Germany)*	CRISPR-Cas9	2017-03	"BASF (...) announced that it has reached a **global licensing agreement** with the Broad Institute of MIT and Harvard for the **use of CRISPR-Cas9 genome-editing technology to improve products in agricultural** and industrial microbiology **applications**."	47
Broad Institute (USA)	*Monsanto (USA)*	CRISPR-Cpf1	2017-03	"Monsanto Company announced that it has reached a new **global licensing agreement** with the Broad Institute of MIT and Harvard for the **use of the novel CRISPR-Cpf1 genome-editing technology in agriculture**. The CRISPR-Cpf1 system represents an exciting advance in genome-editing technology, because it has potential to be a simpler and more precise tool for making targeted improvements in a cell's DNA when compared to the CRISPR-Cas9 system."	52
Two Blades Foundation (2Blades) (USA)	*International Rice Research Institute (IRRI)* (Philippines)	TAL code technology	2016-12	"2Blades and the International Rice Research Institute (IRRI) have signed an agreement to further the cause of global food and nutrition security for the 3.5 billion people who depend on rice for more than 20% of their daily calories. The innovative **licensing agreement will enable IRRI to access leading-edge gene-editing technology, known as Transcription Activator Like (TAL) Effector Code and apply it to targets in rice genomes to increase micronutrient content in polished rice, particularly iron and zinc**. (…) Access to the TAL Code technology will enable IRRI to accelerate its on-going research into high-iron/ high-zinc rice varieties and actively advance viable, rice sector-based solutions to global food and nutrition security issues, including	49

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
				making improved rice varieties available more quickly to smallholder rice farmers. The agreement will positively impact a number of advanced breeding projects currently underway at IRRI.”	
Dow AgroSciences LLC (USA)	*Department of Environment and Primary Industries (DEPI)* via *Agriculture Victoria Services Pty Ltd.* (Australia)	EXZACT™ Precision Technology Platform (ZFN)	2016-12	“Dow AgroSciences announced that Agriculture Victoria's commercial arm, Agriculture Victoria Services Pty Ltd. ("AVS") is taking a commercial license to the EXZACT Precision Technology Platform to continue the development and commercialization of new forage grass varieties to benefit growers in Australia and around the world. ***The commercial license agreement aims at the development of forage grass varieties and related fungal endophytes produced using precision genome editing technologies.*** The license agreement acknowledges the advances Agriculture Victoria has made researching and developing innovative forage products using this gene editing platform that Dow AgroSciences has developed under an exclusive license and collaboration deal in plants with Sangamo BioSciences, Inc.”	46
Dow AgroSciences LLC (USA)	*Monsanto Company* (USA)	EXZACT™ Precision Technology Platform (ZFN)	2016-10	“For ***research and commercial development of new crop solutions*** across Monsanto Company’s research portfolio.”	2
DuPont Pioneer (USA)	*International Maize & Wheat Improvement Center/CIMMYT* (Mexico)	CRISPR-Cas	2016-09	“This collaboration with DuPont Pioneer will allow us ***to provide climate and disease resilient varieties*** more quickly to smallholder farmers in the developing world.” (CIMMYT Director General Martin Kropff)	3

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Broad Institute (USA)	*Monsanto Company* (USA)	CRISPR-Cas	2016-09	"The Broad Institute has decided to make available non-exclusive research and commercial licenses for the ***use of CRISPR technology in agriculture. But with important restrictions.*** These include: Gene Drive, Sterile Seeds, Tobacco."	4, 7
TargetGene Biotechnologies LTD (Israel)	*Monsanto Company* (USA) ← Beteiligung an	RNA-guided gene-editing techniques	2016-06	"Under the agreement, Monsanto has been granted an exclusive license to TargetGene's novel and proprietary "T·GEE" (Genome Editing Engine) platform ***to deliver continuous improvements in agriculture***. Monsanto has also established an equity position in the private Israel-based company."	5
Nomad Bioscience GmbH (D)	*Monsanto Company* (USA)	Gene Editing	2016-06	"… have announced a licensing agreement whereby Monsanto has obtained rights to apply Nomad's proprietary technology to its genome-editing projects ***aimed at enhancement of agricultural crops***. The licensed technology enables more efficient development of edited traits and may be applied across a broad range of genome-editing technologies and project types."	6

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Caribou Bioscience (USA)	*Genus* (USA)	CRISPR-Cas9-technology platform	2016-05	"Genus plc (...), a global pioneer in animal genetics, and Caribou Biosciences, Inc. (...), are pleased to announce a **multi-year strategic collaboration** where **Genus receives a worldwide, exclusive license to Caribou's leading CRISPR-Cas9 gene editing technology platform in certain livestock species**. (…) The agreement gives Genus exclusive access to Caribou's CRISPR-Cas9 technology **for the development of new traits in pigs, cattle and potentially other livestock species**. In addition to an upfront payment, Caribou is eligible to receive regulatory and commercial milestone payments as well as royalties on licensed product sales from Genus. Additional terms of the agreement were not disclosed."	56
Institute of Genetics and Developmental Biology (IGDB), *Chinese Academy of Sciences* (China) via *Plant Bioscience Limited* (PBL) (UK)	*Calyxt, Inc.* (USA)	TALEN	2015-12	"… signed a research collaboration and option to exclusive licenses with Plant Bioscience Limited (PBL) ***for certain new crop plants developed using gene editing*** by the Institute of Genetics and Developmental Biology (IGDB) of the Chinese Academy of Sciences in Beijing. *Plants with new traits in wheat, rice and corn are currently at various stages of development using gene-editing technology and include quality improvement and yield increase traits*."	10

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
Arcadia Biosciences, Inc. (USA)	*Dow AgroSciences LLC* (USA)	EXZACT™ Precision Technology Platform (ZFN)	2015-12	„Arcadia Biosciences, Inc. (...) and Dow AgroSciences LLC (…) announce a strategic collaboration t***o develop and commercialize new breakthrough yield traits and trait stacks in corn***. The collaboration leverages Arcadia's leading platform of abiotic stress traits with Dow AgroSciences' enabling technology platforms, input traits, regulatory capabilities and commercial channels. (…) The collaboration will also utilize Dow AgroSciences' EXZACT™ Precision Technology Platform ***to enhance and accelerate the development of trait stacks.*** Dow AgroSciences has developed the EXZACT™ Precision Technology Platform under an exclusive license and collaboration agreement in plants with Sangamo BioSciences, Inc.“	17
Caribou BioSciences Inc. (USA) ⇄	*DuPont Pioneer* (USA) Kreuzlizenzierung	CRISPR-Cas	2015-10	“DuPont and Caribou have ***cross-licensed their respective patent portfolios***, with DuPont receiving exclusive intellectual property rights for CRISPR-Cas ***technology applications in major row crops***, and non-exclusive rights **in other agricultural and industrial bioscience applications**. … the alliance between DuPont and Caribou involves a multi-year ***research collaboration*** with scientists from the two organizations focused on ***enhancing the breadth, versatility and efficiency of the core CRISPR-Cas toolkit***. DuPont also has made a minority equity investment in Caribou to further strengthen the working relationship.”	9

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Dow AgroSciences (USA)	*Institute of Crop Sciences, Chinese Academy of Agricultural Sciences* (ICS-CAAS) (China)	EXZACT™ Precision Technology platform (ZFN)	2015-08	"Dow AgroSciences LLC (…) has entered into a collaboration agreement with the Institute of Crop Sciences of the Chinese Academy of Agricultural Sciences (ICS-CAAS). Under the agreement, Dow AgroSciences grants ICS-CAAS a royalty-free, non-transferable research and commercialization license for its proprietary ***EXZACT™ Precision Genome Editing Technology to be used in rice in China***. Dow AgroSciences and ICS-CAAS scientists ***will collaboratively develop an industry-leading rice genome editing technology platform.***"	34
Vilnius University, Institute of Biotechnology (Lithuania)	*DuPont Pioneer* (USA)	CRISPR-Cas9	2015-06	"… announced a technology license and ***research collaboration agreement*** with Vilnius University ***to further the technical and commercial utility of guided Cas9 genome editing technology.*** Under the agreement, DuPont receives an exclusive license to Vilnius University intellectual property *for all commercial uses, including in agriculture*."	8

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Dow AgroSciences (USA)	*Department of Environment and Primary Industries (DEPI)* via *Agriculture Victoria Services Pty Ltd.* (Australia)	EXZACT™ Precision Technology platform (ZFN)	2015-05	„The Department of Environment and Primary Industries (DEPI) of the State of Victory, Australia, through its commercial arm, Agriculture Victoria Services Pty Ltd. (AVS), strengthened a ***collaborative agreement to improve the performances of Australian canola varieties***. The project uses the EXZACT™ Precision Genome Editing Technology platform ***to continue developing new varieties of canola with enhanced performance*** designed to benefit farmers in Australia and globally. In addition, AVS will also use the EXZACT™ Precision Genome Editing Technology platform ***to enhance the genetics of crops important to Australian primary producers***.“	40
University of Minnesota (USA)	*Cellectis plant sciences, Inc.* (FRA)	CRISPR-Cas	2015-04	“Cellectis has signed an exclusive license agreement with the University of Minnesota that grants Cellectis the worldwide rights ***to use the technology covered by the patent rights of the family WO/2014/144155 entitled “Engineering Plant Genomes Using CRISPR/Cas Systems”***.”	14
Dow AgroSciences (USA)	*Chinese Academy of Agricultural Sciences* (CAAS) (China)	EXZACT™ Precision Technology platform (ZFN)	2015-03	“CAAS will negotiate a license to Dow AgroSciences’ proprietary EXZACT™ Precision Technology platform and toolkit and collaboratively develop a proposed ***research program with mutual development goals***. Dow AgroSciences and CAAS scientists will also work together to make sure that Dow AgroSciences’ expertise is best combined with CAAS’ expertise ***to accelerate rice research and product development in China***.”	15

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Two Blades Foundation (2Blades) (USA) ⇄	*Cellectis plant sciences, Inc.* (FRA) Kreuzlizenzierung	TAL Nuclease Technologies (TALEN)	2014-12	"...announced the execution of a non-exclusive cross-license agreement relating to TAL nuclease technologies. Pursuant to the agreement, 2Blades receives a license to TALEN™ technology ***for not-for-profit uses***, including use in 2Blades' ***humanitarian efforts to support subsistence farming***, and for certain ***commercial applications related to the disease resistance programs*** of 2Blades. In addition (…) Cellectis plant sciences receives a license under 2Blades' TAL Code technology related to nucleases ***for commercial uses in certain specified crop plants***. Cellectis plant sciences has an option ***to expand its license to additional crops***."	28

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Dow AgroSciences (USA)	*Department of Environment and Primary Industries (DEPI) of the State of Victoria* (Australia)	EXZACT™ Precision Technology platform (ZFN)	2014-08	"Dow AgroSciences (...) and the Department of Environment and Primary Industries (DEPI) of the State of Victoria, announced today several significant steps the organizations are taking together to advance science for agriculture. Dow AgroSciences has worked with DEPI through its commercial arm - Agriculture Victoria Services Pty Ltd. (AVS) - to apply the company's EXZACT™ Precision Technology Platform to improve the performance of canola varieties and is adding a new project. Collaborators since 2009, the organizations are now planning to enter into a seventh project together. The project builds on previous work from the collaboration, and is using the EXZACT™ Precision Genome Editing Technology Platform to continue developing new varieties of canola with enhanced performance designed to benefit farmers in Australia and around the world. This new research project will be based at DEPI's AgriBio research facilities in Bundoora. In addition, AVS has entered into a major **Research License Agreement with Dow AgroSciences to conduct research using the company's proprietary EXZACT Precision Genome Editing Technology Platform to enhance the genetics of crops of importance to Australian primary producers**."	50

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Dow AgroSciences (USA)	*Sigma-Aldrich Corporation* (USA)	Zinc finger nuclease (ZFN) reagents for use with EXZACT™ Precision Technology	2014-05	"Dow AgroSciences LLC (…) and Sigma-Aldrich Corporation (...) announced (…) an exclusive manufacturing license and supply agreement that will allow Sigma-Aldrich to manufacture and supply zinc finger nuclease (ZFN) reagents for use with EXZACT™ Precision Technology. Under the terms of the agreement, ***Sigma-Aldrich will be the exclusive provider of ZFN reagents for use in plants which will be available to Dow AgroSciences, its affiliates and licensees*** of the EXZACT Precision Technology ***to enable precision transformation, trait stacking and targeted mutagenesis in plants***."	19
Precision BioSciences (USA)	*Danziger Innovations LtD.* (USA)	Precision's Directed Nuclease Editor (DNE) gene editing technology	2014-03	„Danziger Innovations Ltd. and Precision BioSciences, Inc., (…) announced that they ***have successfully generated site-specific genome modifications in petunia and jasmine tobacco*** by combining Precision's Directed Nuclease Editor (DNE) gene editing technology with Danziger's MemoGene gene delivery system. This successful research effort was aimed at genetic control of flower color but researchers at Precision and Danziger believe that the approach can be used more broadly to address genome engineering challenges in plants that are recalcitrant to existing transformation methods without requiring the insertion of foreign DNA into the plant genome."	32

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Precision BioSciences (USA)	*Agrivida* (USA)	Directed Nuclease EditorTM (DNE) Technology	2014-03	"Precision BioSciences and Agrivida revealed today that they have entered into a ***trait development collaboration*** based on precise gene modifications made possible by Precision's Directed Nuclease EditorTM (DNE) Technology. The collaboration recently delivered the first modified genes that are the subject of Agrivida ***commercialization efforts in the area of animal nutrition***." (***Corn Traits for Improved Dairy and Beef Nutrition***).	11
Precision BioSciences, Inc. (USA)	*Nova Synthetix* (USA)	Precision's Directed Nuclease Editor (DNE) technology	2014-03	„Nova Synthetix and Precision BioSciences, Inc., (…) announced that they have initiated a joint research effort t***o generate non-GM, ricin-free castor plants*** using Precision's Directed Nuclease Editor (DNE) technology in combination with Nova Synthetix's proprietary plant transformation system. Scientists at Nova Synthetix and Precision also plan to utilize their joint capabilities to generate ***improved castor variants capable of producing user defined oil profiles*** for industrial, biofuel, and feed-directed applications. The companies believe that the successful development of this multi-year research effort will address a significant agricultural need and result in a castor plant that is safer and has far greater market utility."	31

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
Cibus Global (USA)	*Nucelis* (will now become an independent operating unit of Cibus) (USA)	Rapid Trait Development System (RTDS)	2014-01	"Cibus Global (…) said it ***has acquired Nucelis***, which is working in fermentation and bio-based chemicals, including alternative squalane and D2 products. Established in 2010, Nucelis will now become an independent operating unit of Cibus, which employs about 100 people worldwide, and also includes Cibus US LLC and Cibus Europe B.V. ***Nucelis will continue to be the exclusive licensee to Cibus' Rapid Trait Development System (RTDS) technology*** in its key ***product areas of fermentation and bio-based chemicals***."	37
Cellectis plant sciences (FRA) ⇄	*Precision BioSciences* (USA) Kreuzlizenzierung	Meganuclease technology	2014-01	"Precision BioSciences, Inc. and Cellectis SA (…) announced that they have reached an agreement to settle patent litigation involving engineered I-CreI meganuclease technology. As part of the settlement, the companies will ***cross-license certain genome engineering patents*** and drop their ongoing lawsuits and patent challenges. This agreement provides clear freedom to operate for both companies in the engineered I-CreI meganuclease genome engineering field."	30

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
Cellectis plant sciences (FRA)	*Bayer CropScience* (D)	Gene editing	2014-01	"Cellectis plant sciences (…) has signed two new agreements with Bayer CropScience (…) in the areas of seeds, crop protection and non-agricultural pest control, on gene editing in plants. The agreements extend the companies' existing partnership ***to introduce targeted modifications to selected plant genes and genomes***. (…) The first aim of this extended partnership is to collaboratively ***create commercial traits for the canola seed market*** using new technologies developed by Cellectis plant sciences. The second aim is to provide Bayer with access to technologies that enable the directed engineering of plant genomes, such as ***gene stacking and targeted mutagenesis***, for the development of improved crops."	18
Two Blades Foundation (2Blades) (USA)	*DuPont Pioneer* (USA)	TAL Effector Technology (TALEN)	2012-12	"2Blades continues broad license access to its award-winning TAL technology through a non-exclusive license to Dupont Pioneer f***or uses in certain crops***. Improvements to the technology will be granted back for 2Blades' humanitarian projects benefiting subsistence farming."	22
Iowa State University (USA)	*Cellectis plant sciences, Inc.* (FRA)	Inventions related to TAL effector-nucleases (TALENs™) and monomeric TALENs™	2012-10	"Cellectis (…), the genome engineering specialist, announces that it has signed two exclusive license agreements with the Iowa State University that grant Cellectis the worldwide right to use inventions related to TAL effector-nucleases (TALENs™) and monomeric TALENs™. These two exclusive licenses granted to Cellectis cover ***all uses of the TAL technologies in any field***."	26

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
Two Blades Foundation (2Blades) (USA)	*Monsanto Company* (USA)	TAL Nuclease Technologies (TALEN)	2012-09	"2Blades announces the expansion of rights to Monsanto under our non-exclusive license, announced in April, 2012, for ***broader access to the TAL Code technology***. 2Blades will continue to receive a grant back of improvements to the technology for use in 2Blades' humanitarian projects."	43
Two Blades Foundation (2Blades) (USA)	*KWS SAAT AG* (D)	TAL Nuclease Technologies (TALEN)	2012-07	"Two Blades Foundation (2Blades) has completed a non-exclusive license agreement with KWS SAAT AG (KWS) for access to 2Blades' Transcription Activator Like (TAL) effector code technology ***for genome engineering in certain crops***. KWS will grant improvements in the technology back to 2Blades for subsistence farming applications."	42
Two Blades Foundation (2Blades) (USA)	*Bayer CropScience* (D)	TAL Nuclease Technologies (TALEN)	2012-05	"2Blades is pleased to announce completion of a non-exclusive license agreement with Bayer CropScience for the TAL code genome engineering technology. 2Blades will receive improvements to the TAL code for use in its subsistence farming applications."	44
Two Blades Foundation (2Blades) (USA)	*Monsanto Company* (USA)	TAL Nuclease Technologies (TALEN)	2012-04	"The Two Blades Foundation (2Blades) has completed a non-exclusive license agreement with the Monsanto Company for access to the TAL Code technology ***for genome engineering in plants***. … 2Blades will gain access to Monsanto's improvements to the technology for use in 2Blades' humanitarian efforts in support of subsistence farming."	41

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
Two Blades Foundation (2Blades) (USA)	*Syngenta* (CH)	TAL Effector Technology (TALEN)	2012-01	"2Blades announces the signing of a non-exclusive license for the TAL Code technology to Syngenta ***for commercial uses in crop plants***. Syngenta will grant 2Blades access to its improvements to the technology for use in 2Blades' humanitarian efforts to support subsistence farming."	23
Martin-Luther-University Halle-Wittenberg (D) via *Two Blades Foundation (2Blades)* (USA)	*Life Technologies Corporation* (seit 2014 zu: *ThermoFisher Scientific*) (USA)	TAL Effector Technology (TALEN)	2011-10	"The exclusive license, made jointly with the technology inventors [of Martin-Luther-University], will enable Life Technologies to ***develop research tools for all applications,*** as well as for ***commercial non-plant uses***…." ↓	27
Martin-Luther-University Halle-Wittenberg (D)	*Two Blades Foundation (2Blades)* (USA)	TAL Effector Technology (TALEN)	after 2009	"...2Blades retains the rights ***for commercial applications in plants and green algae*** and intends to make licenses broadly available."	27
Dow AgroSciences (USA)	*Oregon State University* (USA)	EXZACT™ Precision Technology platform (ZFN)	2011-05	„Dow AgroSciences LLC (...) and Oregon State University have entered into a research agreement to apply EXZACT™ Precision Technology in trees, with the goal of ***accelerating and enhancing research into tree improvement.*** (…) Researchers at Oregon State University will make modifications to essential genes for flowering and reproduction."	29

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
Bayer CropScience (D)	*KeyGene* (NL)	KeyBase methodology (ODM)	2011-06	„Bayer CropScience and KeyGene have entered into an exclusive trait development agreement. Both companies will combine their expertise in the fields of protoplast technology and targeted molecular mutagenesis ***to create novel traits for crop improvement***. The collaboration will initially focus on the use of KeyGene's new and proprietary KeyBase methodology ***to develop innovative traits for new oilseed rape varieties***. Bayer also has the option to expand the trait development alliance to include KeyBase-mediated development of proprietary Bayer and/or KeyGene traits in ***cotton and rice***."	38
Precision BioSciences Inc. (USA)	*BASF Plant Science* (D)	Directed Nuclease Editor™ (DNE) technology	2011-04	"BASF Plant Science and Precision BioSciences Inc., announced that they have entered into a collaborative agreement ***to create site-specific genome modifications in plants***. The agreement provides BASF Plant Science with non-exclusive access to aspects of Precision BioSciences' proprietary Directed Nuclease Editor™ (DNE) technology, which can be used ***to develop advanced agricultural products***."	35

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
University of Minnesota	*Cellectis* (FRA)	Inventions related to TAL effector-mediated DNA recognition and cleavage (TALEN)	2011-01	"Cellectis (…), the French genome engineering specialist, has announced today that it has signed an exclusive license agreement with the University of Minnesota that grants Cellectis the worldwide right to use inventions related to TAL effector-mediated DNA recognition and cleavage. This revolutionary approach for the targeted modification of genomes was developed by the University of Minnesota and Iowa State University. ***The exclusive license granted to Cellectis covers all uses of the technology in any field***."	25
Dow AgroScience LLC (USA)	*KWS SAAT AG* (D)	EXZACT™ Precision Technology (ZFN)	2010-09	"Dow AgroSciences LLC, a wholly owned subsidiary of The Dow Chemical Company (...), announced today that it has entered into a ***long-term research and product development agreement***, focused on the use of EXZACT™ Precision Technology, with KWS SAAT AG (KWS). Under the terms of the agreement, Dow AgroSciences will provide KWS with a ***commercial license*** option for traits and products developed with EXZACT Precision Technology ***in sugar beets***, as well as ***a research license for use in several row crops***."	39

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
Dow AgroSciences LLC (USA)	*Wageningen UR (University and Research center)* (NL)	EXZACT™ Precision Technology (ZFN)	2010-09	"Dow AgroSciences LLC, a wholly owned subsidiary of The Dow Chemical Company (...), and the Plant Sciences Group of Wageningen UR (University and Research center) have entered into a research agreement to study how EXZACT™ Precision Technology ***can improve the starch quality of potato****, a food and industrial crop of global importance.* (...) This new research will extend (…) [the] functionalities [of the Technology] into potato, a crop that is difficult to breed using conventional methods."	45
Dow AgroSciences LLC (USA)	*Iowa State University* (USA)	EXZACT™ Precision Technology (ZFN)	2010-04	"Dow AgroSciences LLC (...) and Iowa State University have entered into a research agreement to study how EXZACT™ Precision Technology can help ***improve the development of renewable bioproducts in microalgae***. (…) As part of the agreement, researchers at Iowa State University will generate data demonstrating the utility of EXZACT™ in the microalgae Chlamydomonas, a model system for the green technologies that will produce the carbohydrates, lipids or hydrocarbons used in high-energy, renewable bioproducts. Dow AgroSciences is providing its technology as well as access to intellectual property, validated, high-quality zinc-finger reagents, and scientific expertise."	33

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
Dow AgroSciences LLC (USA)	*Keygene N.V.* (NL)	EXZACT™ Precision Technology (ZFN)	2010-01	"… announced today that they have entered into a ***Trait Development Agreement.*** This agreement will allow Dow AgroSciences and KeyGene to combine their experience and technologies ***to develop traits for improved yield in tomatoes***. Under the terms of the agreement, Dow AgroSciences will provide KeyGene with access to EXZACT™ Precision Technology, its experience in targeted genome modification, and research support for use in a program focused on tomato yield enhancement. KeyGene will apply its expertise in molecular breeding, vegetable genetics and tomato protoplast technology to perform the research."	36
Cellectis (FRA)	*Monsanto Company* (USA)	Meganuclease technology	2009-09	"Monsanto Company (...) today announced a non-exclusive research and commercial license agreement with Cellectis S.A. (...) ***for broad use of its meganuclease technology in plants***. (…) Under the agreement, Monsanto will have access to Cellectis' intellectual property on meganucleases and its custom meganuclease production platform. Cellectis will receive an upfront payment of €3 million, and subject to the approval of the Extraordinary General Meeting of Cellectis' shareholders, Monsanto will make an equity investment of €1 million to allow Cellectis to scale the technology for agriculture. Cellectis will also be eligible to receive fees for the development of each meganuclease, success-based milestones and may receive royalties on certain traits commercialized by Monsanto."	16

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
Sangamo BioSciences Inc. (USA)	*Dow AgroSciences* (USA)	Zinc finger technology (ZFP™)	2008-06	"… The license allows Dow AgroSciences to commercialize products incorporating or developed from plant cells using Sangamo's zinc finger DNA-binding protein (ZFP™) technology, in ***agricultural crops, industrial products and plant-derived biopharmaceuticals***. Sangamo and Dow AgroSciences have been collaborating in research to apply ZFP technology to plants under a three-year research and commercial license option agreement initiated in October 2005. (…) In addition to developing its own new products using the ZFP technology, Dow AgroSciences will sublicense the technology to third parties for development of particular products under the trademark name of EXZACT™ Precision Traits. The trademark name emphasizes the specificity and the precision of the technology. It can be used with precision to add new genetic material, delete genes altogether and even regulate or edit native genes."	24
Duke University (USA)	*Precision BioSciences Inc.* (USA)	Directed Nuclease Editor™ (DNE) technology	2006-04	"***Precision BioSciences Secures Exclusive Worldwide License to Duke University's Directed Nuclease Editor Patent and Related Materials.*** Precision BioSciences, Inc., a biotechnology company ***developing a novel platform technology to precisely target genome modifications***, announced (…) that it has signed an exclusive worldwide license for the Directed Nuclease Editor technology developed at the Duke University Medical Center. The license agreement includes the patent application and related materials that have already been developed at Duke."	20

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
Sangamo BioSciences, Inc. (USA)	*Dow AgroSciences LLC* (USA)	Zinc finger technology (ZFP™)	2005-10	"Dow AgroSciences LLC, a wholly owned subsidiary of The Dow Chemical Company (...), and Sangamo BioSciences, Inc. (...) today announced the signing of a Research and Commercial License Agreement. The agreement provides Dow AgroSciences with ***access to Sangamo's proprietary zinc finger DNA-binding protein (ZFP) technology for use in plants and plant cell cultures to develop products in*** areas including, on an exclusive basis, ***plant agriculture and industrial products***, and, on a non-exclusive basis, ***animal health and biopharmaceutical products produced in plants.***"	12
Bayer Crop Science (D) Beteiligung an →	*Arcadia Bioscience* (USA)		2005-01	"Arcadia Biosciences, Inc., develops agricultural products for the improvement of agricultural crops. The company utilizes various technologies, both GM and non-GM, to develop its product portfolio, including precise genetic screening, advanced plant breeding techniques and genetic engineering. ...The main areas in which they are currently active include ***agricultural technologies*** (Nitrogen Use Efficiency, Salt Tolerance and Improved Process Efficiency) and ***health technologies*** (GLA Safflower Oil , Extended Shelf-Life Produce and Improved Nutrition Whole Foods). (…) Together with CMEA, Exeter Life Sciences and Saints Capital, [Bayer has] been involved with Arcadia since 2005."	21

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