Neue gentechnische Verfahren: Kommerzialisierungspipeline im Bereich Pflanzenzüchtung und Lizenzvereinbarungen

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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 noch immer nicht beendet sind,[1] besteht für Unternehmen, die **Cas9** im Pflanzenbereich zu kommerziellen Zwecken nutzen (die Lizenz hierfür stammt von *Corteva/Broad-Institute*) noch immer **keine Rechtssicherheit** (*freedom-to-operate*). Auch aus diesem Grund weichen viele Start-Ups inzwischen auf die Verwendung selbst entwickelter und patentierter (z. B. Cms1) bzw. anderer Cas-Enzyme aus.

Insgesamt befinden sich mindestens **2 Pflanzen**, die mit Hilfe der neuen gentechnischen Verfahren entwickelt wurden, **im Anbau** (in den USA, und Japan). Bei mindestens **3 Pflanzen** ist unklar, ob sie sich noch bzw. schon auf dem Markt befinden. **13 Pflanzen** befinden sich, nach Unternehmensangaben, kurz vor der Markteinführung. Davon werden mindestens **2 Pflanzen** noch 2023 auf den Markt kommen.

Das Produktportfolio der kleineren Start-Ups entwickelt sich nach wie vor dynamisch. Mehrere Unternehmen haben (auch) aus finanziellen Gründen, ihr Geschäftsmodell (erneut) geändert. Auch bei den Start-Ups finden erste Fusionen statt. **27 Projekte** (darunter auch reine Freisetzungs-/Forschungsprojekte) sind **neu hinzugekommen**.

Die oligopolistischen Strukturen auf dem Saatgutmarkt erschweren den Marktzugang für kleinere Unternehmen. Start-Ups weichen daher auf Nischenkulturen (z. B. Leindotter) aus oder gehen verstärkt Kooperationen mit grossen Konzernen ein (z. B. Bayer, im Biokraftstoffbereich mit Mitsubishi, Exxon Mobile).

Die geänderten Zulassungsbedingungen in den USA (SECURE-Richtlinie) erschweren die Recherche der weiteren Marktentwicklung. **Im Jahr 2022 wurden noch 13 *Confirmation Letters* unter der neuen SECURE-Richtlinie eingereicht**.[2]

1 https://www.transgen.de/recht/2721.crispr-streit-patent.html

2 https://www.aphis.usda.gov/aphis/ourfocus/biotechnology/regulatory-processes/confirmations/responses/cr-table

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.) 2 Pflanzen, die bereits angebaut und vermarktet werden:

- Die **«GABA-Tomate»** (erhöhter Gehalt an *Gamma-Amino-Buttersäure*) des Unternehmens *Sanatech Seed*. Anbau: Japan.[3]
- 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).[4] *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.

Bei diesen Pflanzen liessen sich keine Angaben dazu finden, ob sie noch bzw. schon vermarktet werden:

- *Noch auf dem Markt?* **Herbizidresistenter Raps** der Firma *CIBUS*, bei dem unklar ist, ob der Trait durch eine Zufallsmutation oder mittels des RTDS™ (Oligonukleotid-gerichtete Mutagenese) Verfahrens entwickelt wurde.
- *Noch auf dem Markt?* **Soja mit einem veränderten Ölsäuregehalt** der Firma *Calyxt*, die mit TALEN entwickelt wurde. Die Seite der Öl-Marke[5] (calyno.com) funktioniert nicht mehr.

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

4 "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."

5 https://www.transgen.de/aktuell/2724.usa-genom-editierte-sojabohnen-ohne-gentechnik.html

- *Bereits auf dem Markt?* **Mais mit veränderter Stärke** (*waxy corn*) von *Corteva*. *Corteva* gibt auf der Unternehmenshomepage nur an, dass dieser Mais kein GVO sei und daher nicht gekennzeichnet werden müsste.[6]

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

- Ein **Senf mit verbessertem Geschmack** (reduzierten Bitterstoffen) von *Pairwise* soll noch **2023** unter dem Markennamen *Conscious™ Greens*[7] vermarktet werden. *Conscious™ Greens* werden im Salinas Valley in Kalifornien angebaut. In den Wintermonaten findet der Anbau in Yuma, Arizona statt. Der Anbau in Gewächshäusern wird geprüft.[8]
- Für einen von *Corteva* in Kooperation mit dem *CIMMYT* entwickelten **Mais mit einer Resistenz gegen die *Maize Lethal Necrosis Disease*** soll bereits **ab Mitte 2023** erstes Saatgut (in Afrika) verfügbar sein.[9]
- 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

6 "The characteristics in CRISPR-produced Waxy Corn could occur in nature or be produced with conventional breeding. Waxy Corn is not a GMO and therefore does not require that labeling." (https://www.corteva.com/our-impact/innovation/crispr/faqs.html)

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

8 https://consciousfoods.net/process

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

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.»[10]

- Für ein **Ackerhellerkraut mit erhöhtem Ölgehalt** bereitet *CoverCress Inc.* einen **vor-kommerziellen Anbau** in ausgewählten Regionen vor (Aussaat: **Herbst 2023**).[11] *Bayer, Bunge* und *Chevron* planen eine 65%-ige Mehrheitsbeteiligung an *CoverCress Inc.* (CCI). 35% von CCI sollen weiter *Bunge* und *Chevron* gehören.[12]
- **Raps mit erhöhter Schotenplatzfestigkeit** (es sind drei Traits mit *Pod Shatter Reduction* in Entwicklung). Nach Angaben von *CIBUS* soll der Trait in diesem Jahr in verschiedene Elitelinien von fünf verschiedenen Saatgutunternehmen übertragen werden.[13] Die Markteinführung ist für **2025** geplant.[14]
- **Raps mit einer Resistenz gegen *Sclerotinia*** (Weissstängeligkeit). Nach Angaben von *CIBUS* laufen bereits Freisetzungsversuche. Innerhalb der nächsten vier Jahre soll der Trait von verschiedenen Saatgutfirmen in Elitelinien übertragen worden sein. Die Markteinführung ist in Kanada geplant.[15]
- **Herbizidresistenter Reis.** Nach Angaben von *CIBUS* sollen 2023 zwei verschiedene HR-Traits in Elitematerial einer führenden US-amerikanischen Saatgutfirma übertragen werden.[16] Weitere Angaben zum Zeitpunkt der Kommerzialisierung gibt es nicht.

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10 https://alfalfapartners.com/iqa/

11 https://www.covercress.com/farmers.cfm

12 https://www.agrarheute.com/pflanze/zwischenfruechte/fuer-biodiesel-konzerne-genveraendertem-ackerhellerkraut-planen-596344

13 "In 2023 we are preparing to transfer our first product: a pod shatter reduction trait in canola in the elite germplasms of five different canola seed companies." (https://www.wsj.com/articles/calyxt-and-cibus-announce-definitive-merger-agreement-to-create-industry-leading-precision-gene-editing-and-trait-licensing-company-01673955319)

14 "We're running trials in the field all the time, so this is not a research project. It's a commercial launch line we're on, heading to 2025." (https://www.producer.com/crops/shattering-design-to-release-ahead-of-combine/)

15 https://www.producer.com/crops/sclerotinia-resistant-genetics-for-non-gm-canola-crop/

- Eine **Soja mit veränderter Fettsäure** steht nach Angaben von *ToolGen Inc.* **kurz vor der Markteinführung**.[17]
- **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 Kartoffeln vertreiben.[18]
- 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.[19] Der Leindotter soll für Biokraftstoffe bzw. als proteinreiches Tierfutter verwendet werden.[20] *Yield10 Bioscience* hat darüber hinaus Nicht-Regulierungsbescheide für drei genom-editierte Leindotter-Linien von der Argentinischen Biosafety Kommission erhalten.[21]

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16 "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).

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

18 "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."

19 "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)

20 "Yield10 has contracted with growers to plant Camelina varieties E3902 (spring, high oil), WDH3 (winter, early maturing) and WDH2 (winter, cold tolerant) to produce commercial seed. This activity is intended to increase commercial inventory of Camelina seed available for growers' contracts for future planting of Camelina used to produce low-carbon intensity feedstock oil for the biofuel market and high-protein meal for the animal feed market." (https://www.yield10bio.com/crop-science/novel-crop-traits)

- Die Markteinführung von einem **Süssstoff**, der aus mittels **Genome-Editing veränderten (Wasser-)Melonen** gewonnen wird, soll gemäss *Elo Life Sciences* 2025 erfolgen.[22]
- Eine **Banane mit verlängertem Shelf-life**, die von *Tropic Bioscience* entwickelt wurde, wird bereits in Freisetzungsversuchen in Honduras und auf den Philippinen getestet. Nach Angaben des Unternehmens könnte die Markteinführung – wenn alles klappt – **in zwei bis drei Jahren** erfolgen. 2022 hat *Tropic Bioscience* einen Nicht-Regulierungsbescheid der USDA-Aphis für die Banane erhalten.[23]
- Die von *Soil Culture Solutions, LLC (Soilcea)* entwickelte **Orange mit einer Resistenz gegen Zitruskrebs** (*Xanthonomas citri*) steht nach Angaben des Unternehmens bald vor der Markteinführung: *Soilcea* ist derzeit dabei, Partnerschaften mit Züchtern und Baumschulen einzugehen, um die neuen Bäume rasch zu testen und mit dem Vertrieb zu beginnen.[24]

21 "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)

22 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

23 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/21-356-01cr-response-signed.pdf

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

2. Weitere Übersichten/Quellen zur Produktpipeline/Marktentwicklung

a) Produktpipeline (incl. Patente)

Ricroch, A. E., Martin-Laffon, J., Rault, B., Pallares, V., C., Kuntz, M. 2022: Next biotechnological plants for adressing global challanges: The contribution of transgenesis and new breeding technqiues. In: New Biotechnology, Vol. 66, 25 January 2022, Pages 25 – 35, doi.org/10.1016/j.nbt.2021.09.001

Der Artikel fasst die Ergebnisse einer umfangreicheren Recherche zusammen. Berücksichtigt werden sowohl transgene, als auch gen-editierte Traits (Merkmale), die in mindestens einem Land zugelassen und/oder vermarktet werden oder die in den USA einen nicht regulierten Status haben, sowie die entsprechenden Patente weltweit. Um das Innovationspotenzial für den Globalen Süden einzuschätzen, werden ausserdem Freisetzungsversuche in Afrika aufgeführt. Die gesammelten Daten werden in verschiedene Anwendungskategorien eingeteilt, darunter agronomische Verbesserungen, industrielle und medizinische Nutzung, d. h. Herstellung rekombinanter therapeutischer Moleküle oder Impfstoffe (auch gegen Covid-19). **Die Daten zeigen, dass das Genome-Editing eine wirksame Ergänzung zur «klassischen» Transgenese zu sein scheint, deren Einsatz kaum rückläufig ist; ein Trend, der auch in der Patentlandschaft beobachtet werden kann.** Dennoch stellen die Autor:innen einen zunehmenden Einsatz von Gene Editing fest. Im Vergleich zur Transgenese hat das Gen-Editing bei einigen Pflanzenarten den Anteil der zugelassenen, nicht regulierten oder vermarkteten Produkte erhöht und bei anderen verringert. Ein ähnlich differenzierter Trend ist bei den Züchtungsmerkmalen zu beobachten. Das Gene Editing hat auch das Entstehen neuer privater Unternehmen begünstigt. China, und hier vor allem der öffentliche Sektor, dominiert bei den Patentanmeldungen, nicht aber bei den zugelassenen/vermarkteten Produkte. Hier dominieren die USA. Die Daten deuten darauf hin, dass das regulatorische Umfeld Innovationen begünstigt oder behindert.

Der Artikel von Ricroch et al. (bzw. das Daten-Begleitmaterial) führt keine konkreten Angaben zu tatsächlich angebauten/vermarkteten Pflanzen auf. Die Angaben zum Nicht-Regulierungsstatus reichen nur bis 2021. Die vorliegende Recherche ist daher in dieser Hinsicht aktueller und präziser.

b) Marktübersichten

S&P Global Commodity Insights hat am 17. Januar 2023 einen kurzen Marktbericht veröffentlicht: Gene-edited crops market growth spurred by regulatory progress and approvals

Ergebnisse:

- There are currently more than 500 products are being developed worldwide using the technology and are at different stages of product development, ranging from basic research to advanced R&D and near-commercialization. *[Diese Zahl (500 Produkte) stammt vermutlich aus der Datenbank von EU-Sage, siehe auch SeedQuest. Die Datenbank umfasst auch Forschungsliteratur. Konkrete Angaben zum Stand der Kommerzialisierung fehlen.]*[25]
- Currently, the private sector contributes to 43% of the total product development, with 5% of the products at the pre-commercialization stage and 49% in the advanced research phase. The most active companies in the agricultural gene-editing space are *Corteva Agriscience, Yield10 Bioscience, Benson Hill, Arcadia Biosciences, Calyxt* and *Inari Agriculture*.
- In the private sector, there are two types of players in gene-editing; large multinational seed companies and small gene-editing focused companies. Small gene-editing companies face challenges from limited market presence, lower financial and technical resources, limited R&D locations, and seed storage facilities, and they need collaborations with third parties to commercialize their products. Hence, we are observing a change in their business strategies, especially in row crops, due to competition with large players.
- Unlike genetically modified organisms (GMOs), where trait development is focused on cereals and oilseeds crops, in gene-editing the research focus is more diversified by crops and traits, with around 23% of the products being developed for the vegetable segment, 7% for fruits and 3% each for ornamentals, legumes, and forage and grasses.
- In vegetables, GABA tomatoes have already been commercialized in Japan by *Sanatech Seed* in 2021. In 2023, *Pairwise*'s gene-edited green leafy vegetable range, Conscious™ Foods, modified to enhance the palatability, flavor and colors for healthy snacking options, is

25 "The database does neither give information on the stage of development of the crop plant, nor on the existence of the intention to develop the described crop plants to be marketed." (https://www.eu-sage.eu/genome-search)

expected to enter the USA market through retail channels and restaurants. However, 55% of the products belong to the grains and oilseed categories, both still dominating the product development by crops.

- Through gene-editing, companies are not only diversifying crops but are also developing a variety of traits for biotic stress tolerance and modified composition, plant yield and abiotic stress tolerance, which was restricted to input-oriented traits in the case of GMOs. Traits are also being developed for bioenergy crops using gene-editing, and companies are also developing partnerships in the bioenergy space.
- Examples of such alliances in alternate energy crops are: pennycress with *Bayer* (majority stakeholder) + *Bunge* + *Chevron*; ... camelina with *Sustainable Oils* (owned by GCEH) + *World Energy* + *ExxonMobil* (25% stake in GCEH) + several agribusiness companies.

3. Ergänzende Informationen zu einzelnen Unternehmen

a) Cibus/Calyxt

Am 17. Januar 2023 gaben Cibus und Calyxt ihre Fusion bekannt.[26]

"Calyxt, Inc., a plant-based synthetic biology company, and Cibus, a leader in precision gene editing in agriculture, today announced that **both companies have entered into a definitive merger agreement under which Calyxt and Cibus will merge in an all-stock transaction.** The merger will create a new industry-leading company that combines the two pioneers in agriculture- based gene editing and establishes one of the world's most sophisticated facilities for trait development and next-generation plant breeding.

> The combined company will be a leader in two key applications for gene editing in agriculture:
>
> **1. Productivity Traits:** Productivity traits are a key basis of competition in the "seed and trait" business. The key focus of Cibus' patented gene editing platform, the Rapid Trait Development SystemTM (RTDS®), is the development of a new class of productivity traits in seeds addressing the sustainability of farming by increasing crop yields and reducing inputs such as fungicides, herbicides, pesticides, and fertilizers.
>
> **2. Renewable Low-Carbon Ingredients:** Gene editing is a key tool in the development of sustainable low-carbon ingredients that can replace fossil fuel-based ingredients and diesel fuel. This is a key pillar of the Net Carbon Zero Climate 2040 goals and the global movement to reduce greenhouse gas emissions."

In einer weiteren Quelle heisst es:

"Both Cibus and Calyxt are working on sustainable ingredient development. But it hasn't been a smooth road for either company in recent times.

26 https://calyxt.com/calyxt-and-cibus-announce-definitive-merger-agreement-to-create-industry-leading-precision-gene-editing-and-trait-licensing-company/

Calyxt went public in 2018 but has operated at a loss for over four years. Last year, Nasdaq granted the company a 180-day extension to regain compliance after it fell in danger of delisting.

Calyxt reported revenues of just $42,000 in its third quarter of 2022 — down from $7.8 million in the same quarter of 2021.

Meanwhile, Cibus last raised funding in 2018 with a $70 million Series C. In 2019, the company shelved its IPO paperwork. Combining with Calyxt is a way for the startup to rekindle its plans for going public.

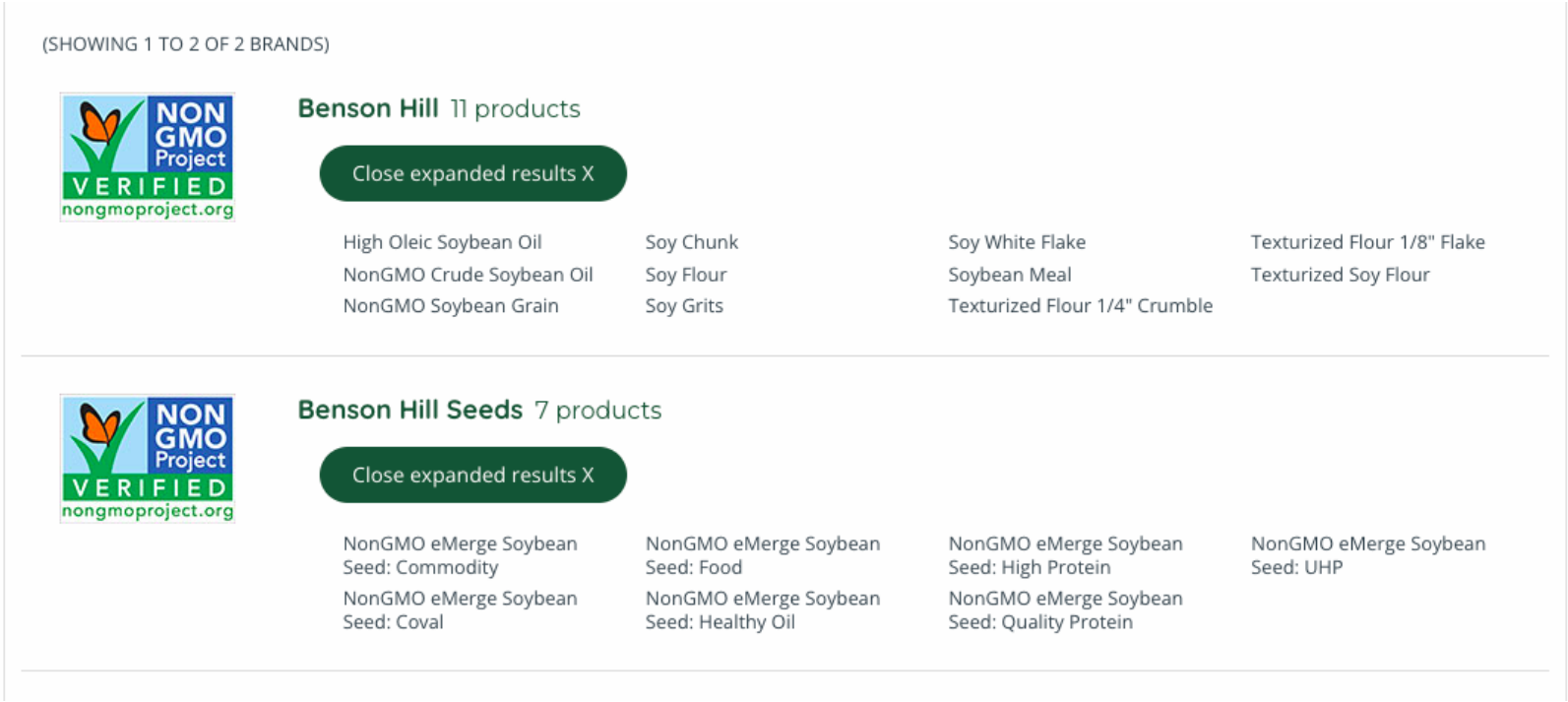
The merger between the two companies is expected to close in the second quarter of 2023. Once complete, the combined company will be called Cibus Inc. Cibus co-founder Rory Riggs will serve as both chairman and CEO."[27]

27 https://agfundernews.com/calyxt-and-cibus-merge-with-the-hopes-of-leading-agricultural-gene-editing

b) Benson Hill

BENSON HILL™
NOURISHING INNOVATION™

Benson Hill scheint neben Genome Editing auch weiterhin konventionell zu züchten (*CropOS® enables proprietary phenotyping, predictive breeding and environmental modeling algorithms*). Eine erste Soja mit veränderter Fettsäure ist auf dem Markt. Die daraus gewonnenen Produkte haben das Non-GMO-Label erhalten.



Da sie auch weiterhin mit neuer Gentechnik arbeiten (siehe die Einträge in Tabelle 1. und 2.) unterstützen sie das Framework for Responsible Use of Gene Editing in Agriculture:

"The Framework was developed by a multi-stakeholder Coalition that included representatives from food companies, academia, civil society, technology developers, farmers and related associations, including Benson Hill. It outlines a set of principles and commitments that organizations voluntarily follow to demonstrate their willingness to be transparent about their use of gene editing and intentions that benefit the food system, environment, and society as a whole.

The Coalition was formed by The Center for Food Integrity to strive for global understanding and acceptance of the responsible use of gene editing technology in the food system. To learn more about the Coalition, visit geneediting.foodintegrity.org."

c) Inari

Inari (gegründet 2016, Sitz in Cambridge, Massachusetts) gehört zu den Startup-Unternehmen aus dem Bereich der neuen gentechnischen Verfahren. *Inari* arbeitet vor allem mit *Cash Crops* und möchte – z. B. bei Mais – eine Ertragssteigerung von 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 kombinieren sie «herkömmliche» gv-Traits mit Genome Editing:

Inari to bring growers proprietary GM traits in tandem with novel gene edits[28]

Globally, growers are impacted by the dual challenges of growing more food while making the best use of limited resources. New solutions are required if the needs of the people and the planet are to be met. Inari, the SEEDesign™ company, aims to address these challenges using multiplex gene editing with goals of increasing yield by 20% in soybeans and 10% in corn while developing future products that require 40% less water and nitrogen. Now, **by using its proprietary gene editing technology, Inari has created a unique opportunity to deliver proven GM traits in combination with novel gene edits to plants' natural DNA** — unlocking the full potential of seeds for growers and the environment.

Since the beginning of the year, Inari has been granted two U.S. patents related to gene editing GM traits:

- Transgenic INIR6 corn plants comprising an edited DP-4114 corn trait, delivering insect protection
- Transgenic INHT31 soybean plants comprising an edited MON-89788 soybean trait, delivering a weed management solution.

The grant of these patents confirms the uniqueness of the approach and makes it proprietary to Inari. Additionally, Inari has 10 trait-specific patents pending, as well as five concept **patent families pending which cover in general the editing of any GM trait in corn, soybeans, canola and**

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

cotton. The edits have been established **using Inari's proprietary CRISPR-CasS system, and these gene edited GM traits are outside of third-party patents, enabling the path to commercialization.**

"We are proud to be the first company granted patents for gene editing GM traits," said Inari CEO Ponsi Trivisvavet. "Inari can give growers access to the leading GM traits for pest control they have come to rely on, coupled with the sustainability benefits of our unique gene edits — all available through our proprietary technology platform. We aim to commercialize our products in the coming years, providing significant value to our customers and shareholders while delivering on our environmental commitments."

The suite of GM traits to be delivered through gene editing will have the same functionality as those currently on the market, which have been proven effective by growers. Today, more than 90% of corn and soybean crops grown in the U.S. include GM traits. Globally, the commercial seed market is currently valued at $60 billion with more than half derived from GM-traited seeds. Seventeen million farmers across 29 countries deploy GM seeds on nearly 200 million hectares of farmland.

"Inari is focused on using our cutting-edge technology platform to develop novel, value-added seeds for growers," says Trivisvavet. **"GM traits have become a foundational tool for growers over the past 25 years. We are pleased to apply our proprietary technology to bring these solutions to market in a new way**. Our gene editing technology aims to reduce land, water and fertilizer — by packaging this technology with our edited GM traits, we can reach more growers and increase our potential for a positive impact on the planet."

And Inari continues to expand its SEEDesign™ platform. Utilizing a two-step approach to technology, Inari uses predictive design to build blueprints for its advanced multiplex gene editing toolbox. From standard on/off editing to more unique regulations of gene expression and proprietary replacement editing, combining tools for multiple changes within a single plant allows Inari to reveal the full potential of every seed.

d) Pairwise

Ein **Senf mit verbessertem Geschmack** (reduzierten Bitterstoffen) von Pairwise soll noch **2023** unter dem Markennamen Conscious™ Greens vermarktet werden.

Pairwise bemüht sich um Transparenz und verweist auf seiner Seite auf die wissenschaftliche Publikation, in der die Veränderung beschrieben wird.[29]

Pairwise Publishes the Science Behind its First Product

The Pairwise team recently published a paper in *Plants* on how CRISPR-Cas12a was deployed to reduce pungency in mustard greens. Pairwise is committed to being transparent about the new breeding techniques that it uses to deliver unique produce varieties that will contribute to the health and well-being of consumers.

> *Karlson, D.; Mojica, J.P.; Poorten, T.J.; Lawit, S.J.; Jali, S.; Chauhan, R.D.; Pham, G.M.; Marri, P.; Guffy, S.L.; Fear, J.M.; Ochsenfeld, C.A.; Chapman, T.A.; Casamali, B.; Venegas, J.P.; Kim, H.J.; Call, A.; Sublett, W.L.; Mathew, L.G.; Shariff, A.; Watts, J.M.; Mann, M.; Hummel, A.; Rapp, R. Targeted Mutagenesis of the Multicopy Myrosinase Gene Family in Allotetraploid Brassica juncea Reduces Pungency in Fresh Leaves across Environments. Plants* ***2022****, 11, 2494.* https://doi.org/10.3390/plants11192494

29 https://www.pairwise.com/about-us/news/pairwise-publishes-the-science-behind-its-first-product

e) Bioheuris

Das Unternehmen aus Argentinien nutzt CRISPR, um ausschliesslich HR-resistente Pflanzen zu entwickeln.

"In **Argentina,** BioHeuris, an expert in weed management, is … working with CRISPR tools to develop next-generation herbicide-resistant soybean, sorghum, alfalfa, rice, and cotton. Created in 2016, BioHeuris accelerates plant breeding to evolve crops faster than weeds. Together with integrated pest management techniques, they expect to develop a sustainable system for numerous crops with varieties available for commercialization by 2026 or 2027."[30]

"The Brazilian regulatory agency has concluded that BioHeuris' CRISPR solution does not produce plants considered GMOs (Genetically Modified Organisms), according to an official decision.Weeds have always been a primary concern for agriculture. Although farmers around the world are spending more than US$23 billion on herbicides to control them annually, new resistant weeds are spreading faster than ever. The problem is partly due to the repeated use of a limited number of herbicides. Argentine biotech start-up BioHeuris hopes to address this issue by bringing farmers **next-generation herbicide-resistant crops using synthetic biology and CRISPR gene editing.** "There are more than 300 registered herbicides. Some of the greener ones control weeds but also damage crops," CEO Lucas Lieber told AgroPages. "With our technology, farmers could start using a more diversified palette of herbicides that are safer for the environment, delaying weed resistance."

The company has just completed a $4m investment from strategic partners and investors that started in 2016 to develop non-GMO herbicide-resistant traits in soybean, rice, cotton, alfalfa, and sorghum.

Using high-throughput protein evolution assays in microorganisms, BioHeuris can mimic in the laboratory in weeks what it would take hundreds of acres and years of field trials to accomplish. With this miniaturized state-of-the-art platform, thousands of plant gene variations can be discovered and ranked by the level of herbicide tolerance they provide."[31]

30 https://geneticliteracyproject.org/2022/06/29/do-agri-businesses-control-agriculture-the-emerging-gene-editing-revolution-in-latin-america-is-challenging-that-belief/

31 https://news.agropages.com/News/NewsDetail---41596.htm

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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Raps **Markenname Falco™**	Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz, Resistant to group-2 sulfonyl-urea	***Cibus*** (USA)[1]	**Anbau**: USA seit 2015, Kanada seit 2019. Unklar, ob Sorten unter der Marke Falco™ noch vertrieben werden.[2]	Ja USA, Kanada (2011), Schweden (vor 2014), UK
Raps	Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz	***Cibus*** (USA)	APHIS-Bescheid 2020	unklar

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

2 Die Seite www.falcoseed.com ist nicht frei zugänglich. Siehe auch: https://www.gmwatch.org/en/106-news/latest-news/20142-has-another-gene-edited-pioneer-crop-disappeared-from-the-market

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Raps	Rapid Trait Development System (RTDS™), ODM	„Shatter tolerance“ (Stabilere Hülsen, die bei der Ernte nicht so leicht zerbrechen) “Cibus has divested its canola seed breeding assets to Farmer’s Business Network (FBN) Canada, a wholly owned subsidiary of FBN, and provided FBN with a license to its canola pod shatter reduction trait upon commercialization.”[3] Our development pipeline includes three traits for Pod Shatter Reduction.	***Cibus*** (USA), Farmers Business Network (FBN) (CAN) Cibus worked with nine seed companies in North America and Europe so they could incorporate the trait into their own varieties.[4]	APHIS-Bescheid 2020 In late June, Cibus’ gene editing platform took another step ahead when the U.S. Patent Office granted the company a patent for its pod shatter reduction (PSR) trait. Cibus customers will plant the first PSR seeds this fall. We are preparing for the commercialization of PSR in the United States and Canada. We are expecting that our pod shatter reduction trait will be one of the first gene-edited traits launched in Europe subject to legislative changes in the UK and EU.[5] In 2023 we are preparing to transfer our first product: a pod shatter reduction trait in canola in the elite germplasms of five different canola seed companies.[6]	Ja “We’re running trials in the field all the time, so this is not a research project. It’s a commercial launch line we’re on, heading to 2025.”[7]

3 https://www.cibus.com/press-release.php?date=102920

4 https://www.producer.com/crops/shattering-design-to-release-ahead-of-combine/

5 https://www.cibus.com/pdfs/articles/SDBJ-cibus-080122.pdf

6 https://www.wsj.com/articles/calyxt-and-cibus-announce-definitive-merger-agreement-to-create-industry-leading-precision-gene-editing-and-trait-licensing-company-01673955319

7 https://www.producer.com/crops/shattering-design-to-release-ahead-of-combine/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Raps	Rapid Trait Development System (RTDS™), ODM	Krankheitsresistenz gegen *Sclerotinia*, Weissstängeligkeit	***Cibus*** (USA)	Nach Angaben von Cibus in der Phase der „Trait Validation“. APHIS-Bescheid 2020[8] “Peter Beetham, president and chief executive officer at Cibus said the new trait is scheduled to undergo more trials this year as they work toward its registration in Canada. It is expected to take about four years until seed companies integrate this gene into their commercial canola varieties in Canada.”[9]	ja
Raps	Rapid Trait Development System (RTDS™), ODM	Effiziente Stickstoff-Verwertung	***Cibus*** (USA)	We are in early discovery stage towards a trait for nitrogen use efficiency in canola and expect to advance this trait to greenhouse and field trials by the mid-2020s.	ja
Raps **NEU**	Rapid Trait Development System (RTDS™), ODM	Insect Control	***Cibus*** (USA)	unklar	unklar

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

9 https://www.producer.com/crops/sclerotinia-resistant-genetics-for-non-gm-canola-crop/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Raps	CRISPR-Cas9	Verbesserte Rapsschrot-Qualität (u. a. höherer Protein-Gehalt)	**Corteva** (USA)[10]	APHIS-Bescheid 2020 Corteva has new products and traits generated by CRISPR in its development pipeline, but none have been commercially released.	ja
Raps	CRISPR-Cas9 Yield10 Bioscience developed GRAIN, a novel gene discovery platform	Erhöhter Ölgehalt Trait C3007	**Yield10Bioscience** (USA) This trait is being tested in the U.S. with a seed company.	APHIS-Bescheid 2020 Yield10 is evaluating canola lines with a CRISPR genome-edited trait which has shown an increase in oil content in canola. In recent greenhouse studies, this trait has resulted in a 4% increase in seed oil production plus increased seed yield. Yield10Bioscience arbeitet nur noch an Leindotter, «Ertrags-Traits» werden an andere Firmen auslizensiert: Our goals are to efficiently establish a high-value seed products business based on developing superior varieties of Camelina for the production of feedstock oils, nutritional oils, and PHA bioplastics, and to license our yield traits to major seed companies for commercialization in row crops, including corn, soybean, and **canola**.[11]	ja

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

11 https://www.yield10bio.com/company/corporate-overview

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja	Rapid Trait Development System (RTDS™), ODM	Verschiedene Traits in Planung: Krankheits-, Herbizid und Nematodenresistenz	***Cibus** (USA)*	"We are in final stages of completing our RTDS breeding platform for soybean. We expect to be developed by year end 2022"	nein
Soja	TALEN	Veränderte Fettsäurezusammen-setzung (*High oleic*) **Öl ist seit Anfang 2019 auf dem Markt in den USA, bald ev. auch in Kanada** (Fussnote 13) Verwendung als Lebensmittel und als Industrieschmierstoff	***Calyxt Inc.*** (USA)[12] Derzeit 6 Sorten im Verkauf. Weitere Sorten für 2021, 2022 geplant. Schwerpunkt des Anbaus: South Dakota, North Dakota, Minnesota, Iowa und Nebraska	APHIS-Bescheid 2015. Anbau 2020 etwa 72.000 Hektar. Health Canada has notified Calyxt Inc. that it has no objection to the food use of high oleic soybean.[13] Keine neuen Angaben: weder zur Soja, noch zum Öl. Webseite calyno.com funktioniert nicht mehr. Calyxt hat sich vollständig aus der Vermarktung von Pflanzen zurückgezogen (Schwerpunkt liegt jetzt auf synthetischer Biologie).[14] Das Unternehmen hatte 2022 zeitweise finanzielle Probleme.[15] Januar 2023: Cibus und Calyxt geben Fusion bekannt.[16]	ja

12 https://ir.calyxt.com/sec-filings/annual-reports/content/0001564590-21-010976/0001564590-21-010976.pdf, https://www.seedtoday.com/article/226010/calyxt-announces-high-oleic-soybean-seed-sales-agreement-with-perdue-agribusiness

13 https://www.canada.ca/en/health-canada/services/food-nutrition/genetically-modified-foods-other-novel-foods/approved-products/high-oleic-soybean/document.html

14 https://ir.calyxt.com/news-events/press-releases/detail/155/calyxt-reports-third-quarter-2022-financial-results-and

15 https://www.testbiotech.org/aktuelles/soja-aus-neuer-gentechnik-bringt-us-unternehmen-ins-straucheln

16 https://www.prnewswire.com/news-releases/calyxt-and-cibus-announce-definitive-merger-agreement-to-create-industry-leading-precision-gene-editing-and-trait-licensing-company-301722738.html

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja	CRISPR-Cas9	Herbizidresistenz	**Bioheuris** (ARG), **Santa Rosa Semillas** (ARG), **Grupo Don Mario** (ARG)	Kommerzialisierung geplant. Arbeit an 6 verschiedenen HR-Traits. Anfrage bei der APHIS 2021 (Secure).[17] Weitere Anfrage 2022 (ev. neuer Trait).[18] Nichtregulierungsbescheid erteilt.[19]	unklar
Soja	CRISPR/Cas9 (SDN2)	Drought tolerance[20]	**Corteva** (USA), Agricultural Research Corporation (EMBRAPA) (BRA)[21] EMBRAPA is intensifying partnerships with the private sector	2020 Corteva and EMBRAPA signed a partnership agreement that allows EMBRAPA to use CRISPR in plants for agricultural use. The first research project underway involves the development of drought tolerant and nematode resistant soybean varieties using CRISPR[22]	nein

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

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

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

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

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

22 https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Agricultural%20Biotechnology%20Annual_Brasilia_Brazil_10-20-2021.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja **NEU**	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.[23]	unklar
Soja	CRISPR	Veränderte Fettsäurezusammen-setzung (*High-oleic*)	**Corteva** (USA)	„Next product in pipeline“ (nach Wachsmais) “Corteva has new products and traits generated by CRISPR in its development pipeline, but none have been commercially released.”[24]	unklar

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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
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”.[25]	unklar
Soja	CRISPR-Cas9	Erhöhter Protein- und Ölgehalt	**Corteva** (USA)	APHIS-Bescheid 2020 Corteva has new products and traits generated by CRISPR in its development pipeline, but none have been commercially released.[26]	ja

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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja	CRISPR	Verschiedene Traits: Resistenz gegen Südliche Stinkwanze (*Nezara viridula),* Herbizidtoleranz, Trockentoleranz	**DonMario Semillas** (ARG, BRA)[27], gehört zur GDM Group (diese plant einen Ausbau der Geschäftstätigkeiten in China, USA, Europa)[28]	Kommerzialisierung geplant ab 2025	unklar
Soja	CRISPR	Nematodenresistenz	**Evogene** (ISR), **TMG – Tropical Melhoramento & Genética** (BRA)[29] Zusammenarbeit besteht seit 2018[30]	APHIS-Bescheid 2020 „Evogene plans to import and move Edited SCN-Resistant Soybean within the United States“	geplant (Brasilien)

27 https://publications.iadb.org/publications/english/document/Genome-Editing-in-Latin-America-Regional-Regulatory-Overview.pdf
28 https://www.gdmseeds.com/wp-content/uploads/2021/07/GDM-Special-EN.pdf
29 https://publications.iadb.org/publications/english/document/Genome-Editing-in-Latin-America-Regional-Regulatory-Overview.pdf
30 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 Fettsäurezusammen-setzung (*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. Approved by the USDA's Am I Regulated, this HO soybean can be sold like any non-GMO soybean, as it is not under the GMO regulation.	**ToolGen Inc.** (Süd-Korea)	APHIS-Bescheid 2020. Kommerzialisierung geplant. In Phase III (kurz vor Kommerzialisierung) "ToolGen is cultivating diverse sales channels and waging business activities, including producing high oleic soybean and trans-fat-free soybean oil." [31]	unklar
Soja **NEU**	CRISPR-Cas9	Herbizidresistenz	**ToolGen Inc.** (Süd-Korea)	Zwischen Phase I und II[32]	unklar

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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja **NEU**	CRISPR-Cas9	Essential amino acid enhanced soy	**ToolGen Inc.** (Süd-Korea)	Zwischen Phase I und II[33]	unklar
Soja	Vermutlich CRISPR	Keine Angabe (*Confidential Business Information*) Efficiency improvements: product pipeline includes fertilizer and water use Inari, a US agritech company set up in 2016, has been working on gene editing to increase yields on wheat, corn and soyabeans as well as reducing the necessary water and nitrogen fertiliser.[34]	**Inari Agriculture Inc.** (USA) 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.[35]	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.[36]	unklar

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

34 https://inari.com/seeddesign

35 https://inari.com/seeddesign

36 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	KEINE GENTECHNIK	Ultra-High Protein Soybeans The Ultra-High Protein varieties were developed through traditional breeding, allowing non-GMO certification and unrestricted use in U.S. and export markets, including Europe. Benson Hill will release the varieties through its Benson Hill Seeds division.	***Benson Hill*** (USA), **Schillinger Genetics/ eMerge Genetics** (USA), ADM (USA)[37] Benson Hill unterstützt das Framework for Responsible Use of Gene Editing in Agriculture[38]	Da kein APHIS-Bescheid vorliegt, wurde hier vermutlich **nicht mit CRISPR gearbeitet**.[39] Benson Hill measured the soy protein level, oil content, and **non-GMO status** across the UHP fields it contracted even before harvest was complete.[40] Soja wird angebaut. Marke für Öl etc.: https://truvailprotein.com/[41]	ja

37 https://bensonhill.com/2022/08/08/adm-and-benson-hill-partner-to-scale-innovative-ultra-high-protein-soy-for-north-american-food-ingredient-markets/

38 https://bensonhill.com/2022/11/30/benson-hill-endorses-framework-for-responsible-use-of-gene-editing-in-agriculture/

39 https://bensonhillwp.wpengine.com/2020/03/18/benson-hill-announces-first-commercially-available-ultra-high-protein-soy-varieties/?__hstc=129067539.5861aa557e0e17201f340e60e0cd2e6c.1615767855450.1615772214783.1615816502585.3&__hssc=129067539.1.1615816502585&__hsfp=226858690

40 https://bensonhill.com/2021/12/15/benson-hill-finalizes-first-commercial-harvest-of-ultra-high-protein-soybean-varieties-to-scale-production-of-its-innovative-soybean-ingredient-portfolio/, https://bensonhill.com/#real-results, https://www.foodmanufacturing.com/capital-investment/news/21427448/crop-genomics-developer-benson-hill-to-go-public-through-spac-merger

41 https://bensonhill.com/2022/07/27/two-st-louis-based-food-innovators-partner-to-introduce-heart-healthy-cooking-oil-into-foodservice-applications-forming-more-sustainable-seed-to-shopper-supply-chain/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Soja **NEU**	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.[42]	unklar
Mais	CRISPR	Resistenz gegen *Maize Lethal Necrosis Disease*	**Corteva** (USA), CIMMYT (MEX)[43]	Forschung & Entwicklung 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.”[44]	ja Gemäss Zeitplan soll das erste Maissaatgut bereits Mitte 2023 erhältlich sein.[45]

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

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

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

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

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[46]	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."[47] 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.[48]	unklar

46 https://inari.com/seeddesign

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

48 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	CRISPR-Cas9	Veränderte Stärkezusammen-setzung (waxy corn)	**Corteva** (USA)	APHIS-Bescheid 2016, Kommerzialisierung geplant ab „end of decade“.[49] “Corteva has new products and traits generated by CRISPR in its development pipeline, but none have been commercially released.”[50] Anbauzulassung in den USA, Kanada, Brasilien, Argentinien und Chile[51] Es ist nach wie vor unklar, ob der Mais bereits im Anbau ist. Die Dereregulierungsbescheide in den USA erschweren die weitere Recherche: ”The characteristics in CRISPR-produced Waxy Corn could occur in nature or be produced with conventional breeding. Waxy Corn is not a GMO and therefore does not require that labeling.”[52]	USA, ab 2016 Corteva is growing about 1,500 acres in research trials
Mais	CRISPR-Cas9	Trockenheitstoleranz und Ertragsstabilität	**Corteva** (USA)	APHIS-Bescheid 2020. Zeitpunkt der Kommerzialisierung unklar.	USA, ab 2016

49 https://de.slideshare.net/OECD_ENV/nextgeneration-waxy-corn-a-flagship-case-of-sdn1nhej-genome-editing-via-crisprcas9

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

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

52 https://www.corteva.com/our-impact/innovation/crispr/faqs.html

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Mais	CRISPR-Cas9	Höheres Ertragspotential (*enhanced yield potential*)	**Corteva** (USA)	APHIS-Bescheid 2020	unklar
Mais	CRISPR-Cas9	Höherer Kornertrag (*increased grain yield*)	**Corteva** (USA)	APHIS-Bescheid 2020	unklar
Mais	CRISPR	Pilzresistenz	**Evogene** (ISR),[53] Bayer Crop Science (DEU)	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."[54]	geplant

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

54 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/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Mais	Rapid Trait Development System (RTDS™), ODM	Verschiedene Traits in Planung: Krankheits-, Herbizid- und Nematodenresistenz	***Cibus** (USA)*	We expect to have our RTDS platform for corn developed by 2025[55] "Corn is expected to be our fifth major crop platform (~2025). Our development pipeline is planned to include traits for Weed Control, Disease Resistance, Insect Control and Nitrogen Use Efficiency. Corn is one of the major global crops primarily used for food, animal feed and biofuels. Corn is grown on more than 220 million acres in North America, South America and Europe and is an important crop in all regions."[56]	nein
Mais **NEU**	CRISPR-Cas9	Herbizidresistenz	**ToolGen Inc.** (Süd-Korea)	Zwischen Phase I und II[57]	unklar

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

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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Reis	CRISPR-Cas9	Resistant to bacterial blight disease	International Rice Research Institute (IRRI), International Center of Tropical Agriculture (CIAT)[58]	Zulassung in den USA und Kolumbien.[59] Anbau unklar. Wissenschaftliche Publikation (preprint) erschienen. “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.”[60]	unklar

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

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

60 https://www.biorxiv.org/content/biorxiv/early/2022/11/22/2022.11.20.517251.full.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Reis	Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz (1) Rice is our second major crop platform. Our development pipeline includes two Weed Control traits and have in development traits for Disease Resistance, Insect Control and Nitrogen Use Efficiency.	***Cibus** (USA)*	APHIS-Bescheid 2020 “We expect the first herbicide tolerance trait in rice to be ready for commercial development in North America by year end 2021”.[61] 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.[62]	ja
Reis	Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz (2)	***Cibus** (USA)*	APHIS-Bescheid 2020 Keine weiteren Quellen zum Stand der Entwicklung.	The second herbicide tolerance trait entering field trials 2022[63]
Reis	Rapid Trait Development System (RTDS™), ODM	Krankheitsresistenz	***Cibus** (USA)*	“Early discovery stage” Keine weiteren Quellen zum Stand der Entwicklung.	“We expect to have field trials by mid-2020s”[64]
Reis	Rapid Trait Development System (RTDS™), ODM	Effiziente Stickstoff-Verwertung	***Cibus** (USA)*	“Early discovery stage” Keine weiteren Quellen zum Stand der Entwicklung.	“We expect to have field trials by mid-2020s”[65]

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

62 https://www.wsj.com/articles/calyxt-and-cibus-announce-definitive-merger-agreement-to-create-industry-leading-precision-gene-editing-and-trait-licensing-company-01673955319

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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Kartoffel	CRISPR-Cas9	Resistenz gegen Schwarzfleckigkeit („non-browning“)	**Simplot Plant Sciences** (USA)	APHIS-Bescheid 2020.[66] Kommerzialisierung geplant. Unklar, ob auch diese Kartoffel unter der Marke „Innate“ vertrieben werden soll. 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) **und** Resistenz gegen Schwarzfleckigkeit („non-browning“)	**Simplot Plant Sciences** (USA)	APHIS-Bescheid 2020.[67] 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.[68] Kommerzialisierung geplant Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.	unklar

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

66 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

67 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

68 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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Kartoffel	CRISPR-Cas9	Erzeugung von Selbstinkompatibilität	**Simplot Plant Sciences** (USA)	APHIS-Bescheid 2020.[69] Kommerzialisierung geplant Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.	unklar
Kartoffel	CRISPR-Cas9	Erhöhter Ertrag (Knollenbildung)	**Simplot Plant Sciences** (USA), **Yield10Bioscience** (USA) Extended Simplot research license[70]	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.[71]	unklar
Kartoffel	CRISPR-Cas9	Verbesserte Lagereigenschaften bei kühlen Temperaturen (reduzierte vakuoläre Invertasen)	**Simplot Plant Sciences** (USA)	APHIS-Bescheid 2020.[72] Kommerzialisierung geplant. Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.	unklar

69 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

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

71 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/

72 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	CRISPR-Cas9 GEiGS™ mediated silencing GEiGS® (Gene Editing induced Gene Silencing) technology utilizes established genome editing tools (e.g. CRISPR, TALEN) to make precise and specific changes to only a few nucleotides within non-coding genes of a host organism.	Non-browning	**Tropic Bioscience** (GBR)	APHIS-Bescheid 2021[73] “This is the first regulatory assessment of a product based on our proprietary GEiGS technology and the confirmation that this product is not regulated by USDA is an important step in bringing our crop products to market”, said Gilad Gershon, CEO of Tropic Biosciences. Unklar, ob Tropic Bioscience das Projekt noch weiterverfolgt. Gemäss ihrer Homepage arbeiten sie nur noch an Bananen, Kaffee, Reis.[74]	unklar

73 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

74 https://tropic.bio/banana/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Kartoffel **NEU**	CRISPR-Cas9	Enhanced functional potato 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.	**ToolGen Inc.** (Süd-Korea)	Zwischen Phase II und Phase III.[75]	unklar
Tomate	CRISPR (Cas-Enzym undeklariert, patentiert von Inari) Inari nutzt Genome Editing wohl für Multiplexing. Sie haben dazu 2022 ein White Paper veröffentlicht.[76]	Keine Angabe (*Confidential Business Information*)	**Inari Agriculture Inc.** (USA)	APHIS-Bescheid 2020. Kommerzialisierung geplant.[77] 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.[78]	unklar

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

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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Tomate **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.[79]	Erhöhter Gehalt an Gamma-Amino-Buttersäure (GABA)	**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.”[80]	ja
Paprika **NEU**	CRISPR-Cas9	Trockenheitstoleranz	**ToolGen Inc.** (Süd-Korea)	Zwischen Phase I und Phase II.[81]	unklar
Chinakohl	CRISPR-Cas9	Soft rot tolerant	**ToolGen Inc.** (Süd-Korea)	Zwischen Phase I und Phase II.[82]	unklar

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

79 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

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

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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Weizen	Rapid Trait Development System (RTDS™), ODM	Verschiedene Traits in Planung: Herbizidresistenz, Krankheitsresistenz, effiziente Stickstoff-Verwertung	***Cibus*** (USA)	Wheat is expected to be our fourth major crop platform (~2023). Our development pipeline is planned to include traits for Weed Control, Disease Resistance, Insect Control and Nitrogen Use Efficiency.[83]	nein
Weizen	CRISPR Unklar, ob Arcadia noch mit CRISPR arbeitet. GoodWheat hat inzwischen das Non-GMO-label erhalten.[84] Patent für GoodWheat deckt auch CRISPR ab. Das Unternehmen hat finanzielle Probleme und hat sein Portfolio umgestellt.[85]	Reduzierter Glutengehalt, weitere traits in Arbeit Unter GoodWheat™ sind 2 Produkte im Angebot: a) ballaststoffreicher Weizen, reduzierter Gluten- und Kaloriengehalt, b) ballaststoffreicher Weizen (auch als Hartweizen erhältlich). Diese wurden vermutlich mittels Tiling entwickelt.	**Arcadia Bioscience** (USA)	Forschung & Entwicklung. Unternehmen hat 2021 noch angegeben, dass sie mit Tilling, CRISPR und Transgenese arbeiten. 2022 keine Angaben mehr zur Technologie, die sie verwenden. Arcadia hat Zugang zu CRISPR über eine Lizenzvereinbarung mit dem Broad-Institute.[86]	ja

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

84 https://www.nongmoproject.org/find-non-gmo/

85 https://seekingalpha.com/article/4472414-arcadia-biosciences-an-update

86 https://ir.arcadiabio.com/news-releases/news-release-details/arcadia-biosciences-accelerate-agricultural-trait-development

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Avocado	Genome Editing – ohne weitere Angaben	Unklar („*Confidential Business Information*“)	**GreenVenus** (USA) Firmenausgründung von Intrexon, die den nicht-bräunenden GreenVenus™-Salat entwickelt haben[87]	APHIS-Bescheid 2020.[88] Kommerzialisierung geplant. Schwerpunkt von GreenVenus liegt aktuell wohl v. a. auf Salat (siehe unten).[89]	unklar
Avocado	CRISPR-Cas9	Non-browning	**J. R. Simplot** (USA)	APHIS-Bescheid 2020.[90] Kommerzialisierung geplant Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.	unklar
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.[91] Kommerzialisierung geplant Unklar, wie der Stand der Entwicklung ist. Letzte News auf der Seite von Simplot von 2021.	unklar

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

88 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

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

90 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

91 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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
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."[92] 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.[93]	nein
Apfel	CRISPR-Cas9	Feuerbrandtoleranz	**ToolGen Inc.** (Süd-Korea)	Zwischen Phase I und Phase II.[94]	unklar

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

93 https://plantsciences.com/

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Banane	CRISPR	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.[95] Anfrage nach Regulierungsstatus (Confirmation letter, SECURE) bei USDA[96]	The non-browning banana is already the subject of field trials in Honduras and the Philippines. If all goes well, the fruit could be available to buy in two to three years.[97]
Orange	CRISPR	Toleranz gegen Zitruskrebs (*Xanthonomas citri*)	**Soil Culture Solutions, LLC (Soilcea)** (USA)	APHIS-Bescheid 2020 2021: Neue Forschungsgelder erhalten[98] Soilcea is in the process of partnering with growers and nurseries to rapidly test and distribute the edited trees.[99]	geplant

95 https://www.geigs.com/

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

97 https://archive.ph/2022.11.05-083531/https:/www.thetimes.co.uk/article/dna-bid-to-banish-brown-bananas-nwmf7lpv6

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

99 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
Leindotter	CRISPR (Multiplexing)	Erhöhter Ölgehalt Trait C3007, C3010, C3012 "These oil-enhancing traits can produce an increase in oil content in individual seeds as well as an increase in seed oil content as a percentage of seed weight, as compared to control plants. We are also deploying C3007, licensed from the University of Missouri, in Camelina and studying the trait in field tests."[100]	**Yield10 Bioscience** (USA), University of Missouri (USA) Januar 2023: **Yield10 Bioscience** 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.[101]	APHIS-Bescheid 2020 "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."[102]	ja

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

101 https://www.seedquest.com/news.php?type=news&id_article=143683&id_region=&id_category=49&id_crop=

102 https://www.yield10bio.com/press/yield10-bioscience-begins-winter-2022-2023-field-test-and-seed-production-program

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Leindotter	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 Trait targets in this family are accessible using CRISPR genome editing. The Camelina line we have designated E3902 contains CRISPR edits of C3008a, C3008b, and C3009. This line has demonstrated increased oil content in field tests and is being scaled up to produce oil for customer sampling.[103]	**Yield10 Bioscience** (USA)	APHIS-Bescheid 2018 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.[104] Yield10 has contracted with growers to plant Camelina varieties E3902 (spring, high oil), WDH3 (winter, early maturing) and WDH2 (winter, cold tolerant) to produce commercial seed. This activity is intended to increase commercial inventory of Camelina seed available for growers' contracts for future planting of Camelina used to produce low-carbon intensity feedstock oil for the biofuel market and high-protein meal for the animal feed market.	ja 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.[105]

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

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

105 https://www.seedquest.com/news.php?type=news&id_article=135132&id_region=&id_category=&id_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).[106]	Ja.

106 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.[107]	Forschung & Entwicklung Neuer Freisetzungsantrag mit neuen Linien. Yield10Bioscience plant Markteinführung in Chile.[108]	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.

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

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

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.[109]	**Yield10Bioscience** (USA)	Forschung & Entwicklung “Yield10 designed traits C3014 and C3015 to produce PHA bioplastic as a third seed product in Camelina.”[110] “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”. We believe that crop-based production enables an advantaged cost structure that eliminates the barriers to the broad adoption of these materials for use potentially in animal feed, water treatment, and as a biobased, biodegradable plastics replacement.	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”.[111]

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

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

111 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 **NEU**	CRISPR	C4000 Trait Series These traits may be powerful regulators of plant growth and represent a potentially valuable resource for identifying genome editing traits for crops.	**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
Acker-Hellerkraut (*Thlaspi arvense)*	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) Drei Konzerne: Bayer, Bunge und Chevron planen 65% Mehrheitsbe-teiligung an CoverCress. 35% von CCI sollen weiter Bunge und Chevron gehören.[112]	APHIS-Bescheid 2020. Illinois State University has entered a licensing agreement with CoverCress, Inc. for use of the *fae1* germplasm.[113] CCI is preparing for a pre-commercial demonstration of our CoverCress™ crop in select geographies for planting during Fall 2023.[114]	Ja CoverCress Inc. will have its first pilot commercial planting in the fall of 2021 following a near decade of research and development.

112 https://www.agrarheute.com/pflanze/zwischenfruechte/fuer-biodiesel-konzerne-genveraendertem-ackerhellerkraut-planen-596344

113 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/

114 https://www.covercress.com/farmers.cfm

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Salat **Green Venus™ (Romana Salat)**	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.[115]	Verlängertes Shelf-life, verringerte enzymatische Bräunungsreaktion (an verletzten Blättern)	**Green Venus** (USA) Für die Sorte wurde US-Patentschutz angemeldet.[116]	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. Salat ist möglicherweise bereits auf dem Markt: 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.[117]	USA, ab 2019

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

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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Senf (Mustard Green) Conscious™ Greens	CRISPR-Cas12a Wissenschaftliche Publikation zum Verfahren[118]	Verbesserter Geschmack	**Pairwise Plants** (USA), Vertrieb u. a. durch Performance Foodservice[119]	APHIS-Bescheid 2020. The first product from Conscious Foods will be the new nutrient-dense, leafy salad greens called Conscious Greens, slated to hit grocery store shelves in the form of packaged salads in 2023[120] Eigene Webseite der neuen Marke.[121] 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. And because we are always thinking about new ways to grow our fruits and veggies responsibly, we are looking into growing in greenhouses or other indoor environments as well.[122]	ja Anfrage nach Regulierungs-status (Confirmation letter, SECURE) bei der USDA[123]

118 https://www.mdpi.com/2223-7747/11/19/2494/htm
119 https://performancefoodservice.com/Products-and-Services/Our-Family-of-Brands/Peak-Fresh-Produce/Veridi-Baby-Blend-by-Conscious-Greens
120 https://www.pairwise.com/about-us/news/introducing-conscious-foods
121 https://consciousfoods.net/conscious-greens
122 https://consciousfoods.net/process
123 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-213-02cr-request.pdf

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Alfalfa/ Luzerne **IQ™ Alfalfa**	TALEN	Verbesserte Nährstoffzusammen-setzung, bessere Verdaulichkeit, hohe Erträge	(***Calyxt Inc.*** (USA)), **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.[124]	APHIS-Bescheid 2017, Calyxt hat den Trait entwickelt, S&W wird das Saatgut auf den Markt bringen (137a). 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. Growers may have the flexibility to harvest later on without the typical rate of reduction in forage quality that occurs with conventional varieties, or they can cut on their normal schedule to potentially capture higher RFQ and lower lignin alfalfa. This can offer an extended harvest window with improved forage quality. Please consult with Alfalfa Partners for availability in your region and whether your specific growing environment may be sensitive to a gene-edited trait.[125]	ja

124 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

125 https://alfalfapartners.com/iqa/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c)]	Freisetzungs-versuche
Hanf	TALEN	Höhere Erträge Unklar, was aus diesem Projekt geworden ist. Calyxt hat sich aus der Züchtung von Pflanzen vollständig zurückgezogen, NRGene Ltd. Ist ein Forschungs-unternehmen.	***Calyxt Inc.*** (USA), Partnerschaft mit NRGene Ltd. (ISR)	Kommerzialisierung ab 2023. Phase 1: Gene-Editing und/oder Erzeugung von Zuchtmaterial, Saatgutproduktion für erste Tests, Beratung mit Regulierungsbehörden (derzeit freiwillig).[126]	unklar
Hanf	TALEN	Niedriger THC-Gehalt, breite Nutzungs-möglichkeiten (Fasern, Lebens-, Arzneimittel etc.) Unklar, was aus diesem Projekt geworden ist. Calyxt hat sich aus der Züchtung von Pflanzen vollständig zurückgezogen, NRGene Ltd. Ist ein Forschungs-unternehmen.	***Calyxt Inc.*** (USA), Partnerschaft mit NRGene Ltd. (ISR)	Kommerzialisierung ab 2024. Phase 1: Gene-Editing und/oder Erzeugung von Zuchtmaterial, Saatgutproduktion für erste Tests, Beratung mit Regulierungsbehörden (derzeit freiwillig).[127]	unklar

126 https://ir.calyxt.com/sec-filings/annual-reports/content/0001564590-21-010976/0001564590-21-010976.pdf

127 https://ir.calyxt.com/sec-filings/annual-reports/content/0001564590-21-010976/0001564590-21-010976.pdf

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
Raps	CRISPR-Cas9	Krankheitsresistenz, Ertrag/Ertragsstabilität & weitere „Output Traits“	**Corteva** (USA)	„Broad R & D Investigations“[128]	unklar
Raps Unklar, was Stand des Projekts ist. Gemäss Homepage arbeitet Elo Life Systems (Ex-Precision Bioscience) an Melonen, Bananen und Kichererbsen.[129]	ARCUS® genome-editing technology, Meganuklease	Raps(-öl) mit einem geringeren Gehalt an gesättigten Fettsäuren	**Cargill** (USA), Elo Life Systems (USA)	Forschung & Entwicklung Wird vermutlich in Zukunft unter der Marke ZeroCanola® durch Cargill vermarktet.[130]	unklar

128 https://de.slideshare.net/OECD_ENV/nextgeneration-waxy-corn-a-flagship-case-of-sdn1nhej-genome-editing-via-crisprcas9

129 https://elolife.com/pipeline/

130 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
Soja The research license with **Bayer** is scheduled to expire in December[131]	CRISPR	Yield gene C3004, C3003	**Yield10 Bioscience** (USA), **Bayer Crop Science** (DEU)	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."[132]	unklar
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** (USA)	Forschung & Entwicklung, 3-jährige Forschungs-zusammenarbeit (2020 - 2023)[133]	unklar

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

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

133 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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Soja	CRISPR	Herbizidresistenz	**Bioheuris** (ARG), Santa Rosa Semillas (ARG), Grupo Don Mario (ARG), ACA (ARG)[134]	Forschung & Entwicklung In partnerships with Santa Rosa Semillas, Grupo Don Mario and ACA, we started collaboration agreements to develop management systems for high-yield soybean varieties.	unklar
Soja **NEU**	CRISPR	Altered Seed Morphology and Composition	**Benson Hill** (USA)	Anfrage nach Regulierungsstatus (Confirmation letter, SECURE) bei der USDA (3 Briefe und Antworten vorhanden)[135]	unklar
Soja **NEU**	CRISPR	Veränderter Geschmack	**Benson Hill** (USA)	Anfrage nach Regulierungsstatus (Confirmation letter, SECURE) bei der USDA[136]	unklar

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

135 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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
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[137]	unklar
Reis	CRISPR	Krankheitsresistenz, Ertrag/Ertragsstabilität & Trockentoleranz	**Corteva** (USA)	„Broad R & D Investigations“[138]	unklar
Reis **NEU**	CRISPR	Herbizidresistenz Anfrage nach Regulierungsstatus (Confirmation letter, SECURE) bei der USDA[139]	**Bioheuris** (USA), Itá Caabo (Group Adecocagro)	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.	nein

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

138 https://de.slideshare.net/OECD_ENV/nextgeneration-waxy-corn-a-flagship-case-of-sdn1nhej-genome-editing-via-crisprcas9

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
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)[140]	Forschung & Entwicklung	unklar
Reis **NEU**	CRISPR	Altered Reproductive Function	**Syngenta** (USA, China)	Anfrage nach Regulierungsstatus (Confirmation letter, SECURE) bei der USDA[141]	nein
Weizen	CRISPR	Reduzierter Acrylamid-Gehalt	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.[142] Preliminary results from Europe's first field trials of gene-edited (GE) wheat have indicated there's no yield or other agronomic penalty from the precision-breeding technique.[143]	1 September 2021 bis 31 Dezember 2026 The year 2 CRISPR wheat field trial was drilled 14 November 2022.[144]

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

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

142 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-

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[145] 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[146]	unklar
Weizen	CRISPR	Krankheitsresistenz, Ertrag/Ertragsstabilität	**Corteva** (USA)	„Broad R & D Investigations"[147]	unklar

research-21-R08-01-consent.pdf

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

144 https://twitter.com/Halford1Nigel/status/1592505154510594048?cxt=HHwWgICp2YTA25ksAAAA

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

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

147 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)	Zeitpunkt der Kommerzialisierung unklar. Keine aktuellen Informationen verfügbar[148]	USA, ab 2016
Weizen	CRISPR, RNAi	Gluten“freier“ Weizen	Institute for Sustainable Agriculture in Cordoba (ESP), PBL Technologies (UK)[149]	Forschung & Entwicklung Neue wiss. Publikation[150] The CSIC gliadin-reduction technology is the subject of pending patent applications filed by CSIC and is available for licensing from PBL.[151]	“The GM wheat is currently being tested in 30 celiac patients from Mexico and Spain and so far the results are very encouraging.”

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

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

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

151 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	CRISPR	Pilztoleranz. Im Rahmen des 2020 gestarteten Forschungsvorhabens PILTON sollen Weizenpflanzen mit verbesserter, multipler und dauerhafter Pilztoleranz durch neue Züchtungsmethoden entwickelt werden.	Träger: Gemeinschaft zur Förderung von Pflanzen-innovation e. V. (GFPi)	Forschung & Entwicklung, Gewächshaus-versuche laufen[152] 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.[153]
Hartweizen	CRISPR	Gluten“freier“ Hartweizen	Institute for Sustainable Agriculture in Cordoba (ES)	Forschung & Entwicklung “A number of companies have expressed interest in the technology and in using the material as it is or incorporating it into their breeding programs.”[154]	unklar

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

153 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/

154 https://www.globalrust.org/blog/francisco-barro-developer-gluten-free-wheat-deliver-keynote-address-bgri-technical-workshop

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Leindotter **NEU**	CRISPR	Erhöhte Omega-3-Fettsäure	Rothamsted Research (GBR)	Forschung & Entwicklung 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
Leindotter	CRISPR-Cas9	Herbizidresistenz	**Yield10Bio-science** (USA)	Evaluating non-GMO lines (CRISPR) GMO lines in development. Intensive effort evaluating herbicide tolerance and downy mildew resistance traits. Elite herbicide tolerant spring Camelina lines met performance criteria and lead lines are progressing in contra-season testing and seed scale-up.[155]	2022: First field tests of herbicide tolerant E3902 Camelina lines

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Leindotter	CRISPR-Cas9	Mehltauresistenz	**Yield10Bio-science** (USA)	Forschung & Entwicklung Intensive effort evaluating herbicide tolerance and downy mildew resistance traits. Elite herbicide tolerant spring Camelina lines met performance criteria and lead lines are progressing in contra-season testing and seed scale-up.[156]	wahrscheinlich

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Leindotter **NEU**	CRISPR-Cas9	Sustainable Oils has the ability to use the technology to create targeted changes to camelina DNA and incorporate desirable new traits such as high oil yield, quick maturity, herbicide tolerance, drought tolerance, and other desirable traits.	**Sustainable Oils** (USA), Kooperationen mit World Energy und ExxonMobil	August 2022: 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, 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.[157]	nein
Mais **NEU**	CRISPR	Herbizidresistenz	**Bioheuris** (USA)	In our maize program we are creating novel traits to manage weeds.	nein

157 https://susoils.com/news/crispr-cas9-license-agreement

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Mais	CRISPR	Verkürzte Stängellänge. Other areas of focus include disease resistance, stress tolerance and plant growth and development. Wird als "klimaangepasste" Pflanze beworben: "It's going to be a contributor to better nutrient access, better water access and the potential for more carbon sequestration," Reiter told Reuters in an interview.	**Bayer CropScience** (GER)	3 Projekte: 1. Advanced breeding used to introgress naturally occurring short stature characteristic into elite germplasm (Vitalia – Testanbau in Mexiko, 2020). 2. In collaboration with BASF, uses transgene to shorten internodes; enables applicability across wide-array of germplasm. 3. Genome editing: Multiple, elegant approaches to generate short-stature corn, creating potential for opportunities in multiple markets.[158]	Unklar. Kommerz. ab 2028 Extraseite bewirbt den Mais bereits.[159] Bayer said initial plantings (2023) will be from traditionally bred seeds. Biotech traits and gene edited varieties will be rolled out in 2027 or later in North America and other geographies including Latin America, Asia and possibly Europe, with global sales expected to peak in the 2030s.[160]

158 https://www.cropscience.bayer.com/de/innovationen/saatgut-und-pflanzeneigenschaften/genom-editierung

159 https://www.bayer.com/en/news-stories/short-corn-is-smart-corn

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Mais	CROP OS™ platform combines machine learning and big data with genome editing (CRISPR) and plant biology	Ethanolgehalt (E+™)	***Benson Hill*** (USA)**, Brownseed hybrids** (USA) Auf der Seite von Benson Hill gibt es keine Informationen zur Kooperation	Forschung & Entwicklung. Brownseed Genetics, a developer of non-GMO and organic hybrid seed corn. Brownseed had developed a Purity Plus program to prevent non-GMO corn seed from being contaminated by genetically modified corn. Daher ist unklar, ob in diesem Projekt CRISPR zur Anwendung gekommen ist.[161]	After four encouraging trial runs of E+™ corn in research and commercial-scale ethanol plants, Brownseed hybrids plans a major planting in 2020

160 https://www.reuters.com/business/cop/bayer-rolls-out-short-corn-variety-tolerant-weather-extremes-2022-02-17/

161 https://bensonhill.com/#real-results, https://www.foodmanufacturing.com/capital-investment/news/21427448/crop-genomics-developer-benson-hill-to-go-public-through-spac-merger, https://non-gmoreport.com/articles/gene-editing-companies-infiltrating-non-gmo-and-organic-seed-industries-making-non-gmo-claims/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Mais	CRISPR	Verschiedene Traits, Ertragssteigerung, Trockentoleranz etc. The company has initiated an early development program in corn to evaluate novel seed yield and drought tolerance traits. The Company's corn program began in early 2019, centered around the successful deployment of novel traits discovered by Yield10 into corn by a major third-party agriculture company partner.	**Yield10 Bioscience** (USA), in Kooperation mit einem Saatgut-Unternehmen	The company has initiated an early development program in corn to evaluate novel seed yield and drought tolerance traits.[162] Unklar, was der Stand dieses Projekts ist.	ja Yield10 recently contracted an additional third-party agriculture company to create homozygous and hybrid corn lines, bulk-up seed, and conduct field testing of the novel traits in corn to evaluate the impact on seed yield.

162 https://www.globenewswire.com/en/news-release/2020/03/10/1997979/34378/en/Yield10-Bioscience-Achieves-Key-Milestones-in-Early-Development-Program-in-Corn-to-Evaluate-Novel-Traits.html

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Mais, Soja, Weizen, Baumwolle, Raps	CRISPR	Verschiedene Traits Bayer and Pairwise have formed a strategic alliance… Under our partnership, Pairwise works in corn, soybeans, wheat, cotton and canola crops exclusively with Bayer. [163]	**Pairwise Plants** (USA), **Bayer Crop Science** (DEU)	Pairwise is researching how to use the technology to alter crops, like corn, soy, wheat, cotton and canola, exclusively for Bayer. If Pairwise is successful, Bayer will get the chance to commercialize the products, likely in about five to 10 years.[164]	ja (Mais) Pairwise successfully created a new corn phenotype with increased kernel-row numbers, and it is already in field trials across the Midwest (Iowa, Illinois and Minnesota).[165]
Mais	CRISPR	Resistenz gegen Blattfleckenkrankheit	**Corteva** (USA)	APHIS-Bescheid 2018, Zeitpunkt der Kommerzialisierung unklar[166]	unklar

163 https://www.pairwise.com/food-systems/

164 https://www.pairwise.com/products/

165 https://www.farmprogress.com/corn/pairwise-bayer-team-increase-kernel-rows-corn-ears

166 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
Mais	CRISPR (SDN3 – CRISPR-Cpf1/Cms1) CropOS™ platform: combines machine learning & big data with genome editing and plant biology	Höherer Ertrag	***Benson Hill*** (USA)	Forschung & Entwicklung, APHIS-Bescheid 2018.[167] Unklar, ob dieses Projekt noch aktuell ist. Gemäss Homepage konzentriert sich Benson Hill Biosystems auf Soja und gelbe Erbsen.[168]	unklar
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.[169] Unklar, ob dieses Projekt noch aktuell ist. Gemäss Homepage konzentriert sich Benson Hill Biosystems auf Soja und gelbe Erbsen.	Nein (Elitelinien: ja)

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

168 https://bensonhill.com/

169 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[170] Kein Update verfügbar.	2017-2019 Noch kein Final Report verfügbar.
Mais **NEU**	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.[171]	Proposed period of release: 15/04/2022 to 31/10/2023

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

171 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 **NEU**	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.[172]	Proposed period of release: 15/04/2022 to 31/10/2024
Mais **NEU**	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.[173]	Proposed period of release: 15/04/2022 to 31/10/2024
Gerste **NEU**	CRISPR	Altered Germination	Hartwick College, Center for Craft Food & Beverage (USA)	Anfrage nach Regulierungsstatus (Confirmation letter, SECURE) bei USDA[174]	nein

172 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/BE/22/V3&Cat=gmp

173 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/BE/22/V1&Cat=gmp

174 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.	Swedish University of Agricultural Sciences SLU, Department of Plant Protection Biology (SWE)	Freisetzungsversuch The experiment is only for research purposes.[175]	2021 to 2025 We will also identify any morphological abnormalities, produce field-grown material for laboratory testing, and produce seed for next year's field trials.
Kartoffel	CRISPR	Vorhandene Abwehrebenen der Kartoffel verstärken, neue Abwehrmechanismen gegen diverse Schaderreger etablieren.	Verbundprojekt ADLATUS (gefördert vom BMEL)	Forschung & Entwicklung[176] Kein Update verfügbar	geplant

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

176 https://www.bmel.de/SharedDocs/Pressemitteilungen/DE/2020/236-widerstandsfaehige-kulturpflanzen.html

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Kartoffel	CRISPR-Cas9	Non-browning	u. a. Consejo Nacional de Investigaciones Científicas y Técnicas/CONICET, Buenos Aires (ARG), Department of Plant Breeding, Swedish University of Agricultural Sciences, Alnarp (SWE)	Forschung[177]	Seit 2020 in Argentinien
Kartoffel	CRISPR	Veränderter Stärkegehalt	Lyckeby Starch AB (SWE)	Forschung & Entwicklung Long-term goals are variety testing and marketing.[178]	2019 bis 2023
Kartoffel	CRISPR RNAi	Potato with altered resistance to pathogens	Swedish University of Agricultural Sciences SLU, Department of Plant Protection Biology (SWE)	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.[179]	2020 bis 2024

177 https://geneticliteracyproject.org/2020/02/04/field-trials-of-non-browning-crispr-edited-potatoes-begin-in-argentina/, https://www.frontiersin.org/articles/10.3389/fpls.2019.01649/full?utm_source=F-NTF&utm_medium=EMLX&utm_campaign=PRD_FEOPS_20170000_ARTICLE

178 https://webgate.ec.europa.eu/fip/GMO_Registers/GMO_Summary.php?NotificationNum=B/SE/19/5614&Cat=gmp

179 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	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.[180]	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)	„We have now identified multiple lines that carry blight resistance genes and also genes for tuber quality (the nematode resistance constructs did not work well enough). We have submitted a proposal for follow on funding to continue the work for another 2 years (→ 2022), to identify a commercialisable transgenic line.” Professor Jonathan Jones’ group at The Sainsbury Laboratory, Norwich, has successfully developed a late blight resistant Maris Piper potato, PiperPlus 1.0, which is ready to be commercialized when the UK puts in place workable regulation for crops improved with the genetic modification (GM) method.[181]	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.”

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Erbse, gelb	Genome Editing – ohne weitere Angaben CropOS™ platform: combines machine learning & big data with genome editing and plant biology	Verbesserter Geschmack Dakota Ingredients offers an elite grower program and closed-loop production capabilities that can now test premium yellow pea varieties and supply ingredients that are traceable and meet food-grade, kosher and non-GMO certification standards.	**Benson Hill** (USA) To enable us to better serve the pet and human food plant-based markets, we've expanded and upgraded Dakota Ingredients, an upper Midwest-based yellow pea processor that is part of our Ingredients business segment.	APHIS-Bescheid 2020 "We're currently engaged with pet and human food ingredient customers interested in the next generation of yellow pea protein ingredients and working to establish sustainability best practices across our supply chain."[182]	unklar

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

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

182 https://bensonhill.com/#real-results

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Tomate **NEU**	CRISPR	Erhöhter Vitamin D-Gehalt	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.[183]	unklar
Tomate	CRISPR	Früchte lösen sich ohne Stielansatz beim Pflücken	University of Florida, Horticultural Sciences (USA)	APHIS-Bescheid 2018. Weiterer APHIS-Bescheid 2020 für neue Tomaten-Zuchtlinien (mit dem gleichen Trait)[184]	Ja Ergebnisse der Freisetzungs-versuche wurden veröffentlicht[185]

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

184 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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Tomate	CRISPR	Performing a proof-of-concept of a new method of rapid and efficient gene editing in a tomato plant[186]	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[187]	geplant
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) "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][188]	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.[189]	Gewächshaus

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

187 https://techaccel.net/portfolio/

188 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

189 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
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)	Forschung & Entwicklung. Es sind 3 verschiedene HR-Traits in Arbeit.[190] Currently, the focus of our alfalfa innovation program is the generation of integrated weed management systems in high-productivity cultivars.[191]	unklar Anfrage nach Regulierungs-status (Confirmation letter, SECURE) bei der USDA[192]

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

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

192 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 “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.”[193]	**Bioheuris** (ARG), **Gensus** (ARG)	Forschung & Entwicklung Anfrage nach Regulierungsstatus (Confirmation letter, SECURE) bei der USDA[194]	unklar
Sorghum	CRISPR	Improved disease resistance, nutritional value and enhanced resilience to biotic stresses[195]	**Corteva** (USA), Donald Danforth Plant Science Center (USA)	Forschung & Entwicklung	unklar
Sorghum, Hirse	CRISPR	Productivity and quality improvements	**Corteva** (USA), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) (IND)[196]	Forschung & Entwicklung	unklar

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

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

195https://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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Sorghum	CRISPR	Herbizidresistenz In partnership with Tobin, a leader in sorghum breeding and seed production, we are editing elite lines to bring new hybrids to international markets more rapidly and efficiently.[197]	**Bioheuris** (ARG), **Tobin** (ARG)	Forschung & Entwicklung. Es sind 5 verschiedene HR-Traits in Arbeit.	unklar Anfrage nach Regulierungs-status (Confirmation letter, SECURE) bei der USDA[198]
Sorghum	CRISPR	Multiple Traits, non-exclusive research license to evaluate five novel yield traits in forage sorghum[199]	**Yield10 Bioscience** (USA), **Forage Genetics** (USA)	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.[200]	unklar

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

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

199 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

200 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)[201]	Forschung & Entwicklung Forscher:innen (u. a. der ETH Zürich) weisen auf Schwierigkeiten bei Resistenzzüchtung mit CRISPR in Cassava hin.[202]	wahrscheinlich (Kenia, Uganda)

201 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/

202 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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Straucherbse (*Cajanus cajan)* **NEU**	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.[203]	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”.	nein

203 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
Sonnenblume **NEU**	CRISPR	Herbizidresistenz	**Bioheuris** (USA), Argenetics (ARG)	With the seed company Argenetics, we recently started a project to improve the integrated management of weeds in this crop.	nein
Sonnenblume	CRISPR	Krankheitsresistenz, weitere „Output Traits“	**Corteva** (USA)[204]	„Broad R & D Investigations“	unklar
Erdnuss **NEU**	CRISPR	Herbizidresistenz	**Bioheuris** (ARG)	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[205]	**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.[206]	nein

204 https://de.slideshare.net/OECD_ENV/nextgeneration-waxy-corn-a-flagship-case-of-sdn1nhej-genome-editing-via-crisprcas9

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

206 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
Banane	CRISPR We use gene editing to increase yield, extend shelf-life and improve natural disease resistance. Meaning a whole lot more bananas, using a lot less agricultural land, less chemicals, less food waste, less carbon emissions and less costs for growers.[207]	Krankheitsresistenz gegen die Panama Krankheit (TR4)	**Tropic Bioscience** (GBR)	We are now developing commercial banana lines that are resistant to TR4[208]	geplant, u. a. in Costa Rica
Kaffee	CRISPR	Koffeinfreier Kaffee Video verfügbar[209]	**Tropic Bioscience** (GBR)	With the new round of funding, the company, which was founded in 2016, will begin testing its new varieties globally.[210]	geplant

207 https://tropic.bio/

208 https://www.geigs.com/

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

210 https://www.geigs.com/

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Kichererbse	ARCUS® genome-editing technology	Kichererbsenprotein als Fleischersatz, Kichererbse als «klimaangepasste» Pflanze	**Elo Life Sciences** (AUS), Queensland University of Technology (AUS)[211]	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.[212]	nein

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

212 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
Hanf	CRISPR (CRISPR Cms1) CropOS™ platform: combines machine learning & big data with genome editing and plant biology Unklar, ob dieses Projekt noch aktuell ist. Lone Wolf bietet Hanf zum Rauchen an: http://www.lonewolfhemp.com/[213]	Research agreement: is designed to breed improved cultivars of *Cannabis sativa* – u. a. Ölgehalt	California Hemp Corporation (USA), ***Benson Hill*** (USA), University of California, Davis (UC Davis) (USA)	Da Benson Hill sein Geschäftsmodell geändert hat, geht das Hanf-Projekt möglicherweise zu einem neuen Start-Up, das derzeit vom Benson-Hill-CEO gegründet wird: Lone Wolf Genetics. “We’re applying some of the same technologies and approaches—genome analysis, predictive breeding, gene editing, high-throughput phenotyping - all driven or enabled by AI - to cannabis, including industrial hemp.”[214]	geplant

213 https://www.linkedin.com/in/brianfox73?original_referer=https%3A%2F%2Fwww.startpage.com%2F

214 https://www.danforthcenter.org/news/danforth-center-spinout-benson-hill-goes-public-valued-at-1-35b-only-the-second-unicorn-in-st-louis/

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.[215]	Instituto de Biología Molecular y Celular de Plantas, Agencia Estatal Consejo Superior de Investigaciones Científicas (ESP)	Forschung. Finaler Bericht liegt vor.[216]	01.03.2021 bis 31.10.2021. CTAEX Experimental field, Villafranco del Guadiana, Badajoz (950m^2)
Orange **NEU**	CRISPR	Krankheitsresistenz	University of Florida, Institute of Food and Agricultural Sciences Citrus Research and Education Center (USA)	Anfrage nach Regulierungsstatus (Confirmation letter, SECURE) bei USDA[217]	nein

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

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

217 https://www.aphis.usda.gov/biotechnology/downloads/confirmation-response/22-311-01cr-request.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	**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.”[218]	geplant
Apfel	Cisgenese	Erhöhter Anthocyan-Gehalt	Stichting Dienst Land-bouwkundig Onderzoek (DLO) et al. (NLD)	Forschung[219]	NL, 2016 - 2026

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

219 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[220] Keine Updates auf der Webseite. Über Twitter erfährt man, dass auch 2022 Pflanzungen stattgefunden haben.[221]	ja

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

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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Brombeere	CRISPR	Kernlose Brombeeren, ev. zweiter Trait in Arbeit	**Pairwise Plants** (USA), Plant Sciences Inc. (USA)	Pairwise has entered a partnership with the USDA, N.C. State University and some other universities to study the genetics of caneberries (i.e. blackberries and raspberries)[222] We plan to make consistently sweet, juicy blackberries available in grocery stores within the next few years.[223] Plant Sciences Inc.: Through our collaboration with Pairwise we are implementing gene editing accross our caneberry breeding programs to bring to market fruit with traits that would otherwise take a lifetime to achieve through traditional breeding methods.[224]	unklar Zwei Anfragen nach Regulierungs-status (Confirmation letter, SECURE) bei der USDA[225]

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

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![226]	unklar
Erdbeere	Cisgenese, TALEN	Ertragssteigerung, verbessertes *Shelf life*, erhöhter Zuckergehalt, Krankheitsresistenz	**J. R. Simplot** (USA)	Forschung & Entwicklung Patentanmeldung (USA), 2018[227]	Ja, ab 2015
Rutenhirse, Switchgras (*Panicum virgatum* L.)	CRISPR	Nutzung als Bioenergiepflanze Projekt-beschreibung[228]	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)[229]	geplant

223 https://consciousfoods.net/process

224 https://plantsciences.com/

225 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

226 https://consciousfoods.net/process

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

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

229 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

Kultur	Verfahren [a)]	Eigenschaften	Unternehmen [b)]	Entwicklungs-status [c), d)]	Freisetzungs-versuche
Eukalyptus **Neu**	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.[230]	nein

230 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 **NEU**	CRISPR	Changes in lignin with directed mutagenesis	SweTree Technologies AB (SWE)	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. This to provide a substantially increased fermentable sugar yield from wood biomass, which can lead to environmental benefits in the transition from a fossil-based to bio-based economy.[231]	Proposed period of release: 01/05/2022 to 31/12/2026

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.

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

Lizenzvereinbarungen und Kooperationen

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

im Bereich der neuen gentechnischen Verfahren – landwirtschaftliche Anwendungen (2005 – 2022)

(UPDATE Stand: Dezember 2022, 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***
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

Lizenzgeber	*Lizenznehmer*	*Verfahren*	*Jahr-Monat*	*Verwendungszweck*	*Quelle*
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

Lizenzgeber	*Lizenznehmer*	*Verfahren*	*Jahr-Monat*	*Verwendungszweck*	*Quelle*
				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

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
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

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
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

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
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

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
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

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
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

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
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

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
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

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
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

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
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

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
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

Lizenzgeber	***Lizenznehmer***	***Verfahren***	***Jahr-Monat***	***Verwendungszweck***	***Quelle***
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

Quellen

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