

Im Auftrag des Bundesamtes für Umwelt (BAFU)

Tabellarische Übersichten

1. Welche Pflanzen, die mit Hilfe der neuen gentechnischen Verfahren entwickelt wurden:

befinden sich bereits im Anbau?

sind in der Entwicklungspipeline?

2. Lizenzvereinbarungen im Bereich der neuen gentechnischen Verfahren:

zwischen

Züchtungsunternehmen

Biotech-Unternehmen

Forschungseinrichtungen/Universitäten

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Hinweis: Dieser Bericht wurde im Auftrag des Bundesamtes für Umwelt (BAFU) verfasst. Für den Inhalt ist allein der Auftragnehmer verantwortlich.

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

(UPDATE Stand: November 2018, Neue Einträge sind unterstrichen)

Kultur	Pflanze (Sorte)	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c)}	Freisetzungsversuche	Quelle
Raps	Verschiedene Sorten	Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz	Cibus (USA)	Zulassung USA (seit 2004), Kanada (seit 2014) Anbau: USA seit 2015, Kanada seit 2018	USA, Kanada (2011), Schweden (vor 2014), UK	1a,2a, 41a, 47a, <u>61a</u>
Raps	Verschiedene Sorten, <i>Clearfield®-Production-System</i>	Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz	BASF (D, USA), Cibus (USA) Zusammenarbeit seit 2007. <u>Cibus CEO P. Beetham (2018, 62a): „we did some work with them [BASF] for their Clearfield brand on tolerance of a different herbicide.“</u>	Vermutlich im Anbau, USA	UK (2013)	17b, 60a, <u>62a</u>
Raps		TALEN	Veränderte Fettsäurezusammensetzung	Calyxt Inc. (USA)	Forschung & Entwicklung, Phase I der Entwicklung abgeschlossen	nein	29b, 57a, <u>63a</u>

Kultur	Pflanze (Sorte)	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c)}	Freisetzungsversuche	Quelle
Mais	Wachsmais	CRISPR	Veränderte Stärkezusammensetzung	DuPont Pioneer (USA), Caribou Biosciences (USA)	APHIS-Bescheid 2016, Kommerzialisierung geplant <u>ab 2021</u>	USA, ab 2016	3a,4a, 5a, 48a, <u>64a</u> , <u>65a</u>
Mais		CRISPR	Trockenheitstoleranz	DuPont Pioneer (USA), Caribou Biosciences (USA)	Kommerzialisierung geplant ab 2021	USA, ab 2016	7a,8a, 8b, 31a, <u>65a</u>
<u>Mais</u>		CRISPR	Resistenz gegen Blattfleckenkrankheit	DuPont Pioneer (USA), Caribou Biosciences (USA)	APHIS-Bescheid 2018, Kommerzialisierung geplant ab ca. 2025	unklar	65a, 90a, 91a, 92a
Mais		EXZACT™ precision technology, ZFN	Herbizidresistenz, Veränderte Phytat-Biosynthese	Dow AgroScience (USA), Sangamo (USA)	Kurz vor der Kommerzialisierung oder ev. bereits im Anbau , weitere Pflanzen (u. a. Raps) in Entwicklung → DOW: ZFN = „ <u>Key technology</u> “. Wird ev. <u>auch zum Trait-Stacking eingesetzt</u> (66a, S. 6, 98a).	unklar	1a, 19a, 20a, 21a, 40a, <u>66a</u> , <u>98a</u>

Kultur	Pflanze (Sorte)	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c)}	Freisetzungsversuche	Quelle
<u>Mais</u>		EXACT™ precision technology, ZFN	„The companies will jointly develop and commercialize agronomic yield traits, such as nutrient efficiency and water use efficiency, including several traits which have already completed advanced field trials in corn conducted by Dow AgroSciences.“ (98a)	Dow AgroScience (USA), Arcadia Bioscience (USA)	Forschung und Entwicklung, Freisetzungsversuche	This program is currently in field testing in multiple locations in the Midwest (99a, S. 4).	98a, 99a
<u>Mais</u>		CRISPR (SDN3 – CRISPR-Cpf1/Cms1)	Höherer Ertrag	Benson Hill Biosystems (USA)	Forschung & Entwicklung, APHIS-Bescheid 2018	unklar	85a, 86a, 87a
Lein		Rapid Trait Development System (RTDS™), ODM, TALEN, CRISPR	Herbizidresistenz (Glyphosat)	Cibus (USA)	Kommerzialisierung in den USA geplant ab 2020, in Kanada ab 2021	ab 2017 (ev. <u>Kanada</u>)	6a, 30a, 45a, 47a, 67a
Reis		Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz	Cibus (USA)	<u>Kommerzialisierung geplant ab 2020 - 2023</u>	unklar	6a, 67a

Kultur	Pflanze (Sorte)	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c)}	Freisetzungsversuche	Quelle
Reis		Rapid Trait Development System (RTDS™), ODM	Krankheitsresistenz	Cibus (USA)	Kommerzialisierung nach 2023	unklar	67a
Reis		Cisgenese	Salztoleranz	Texas A&M University (USA), Nexgen Plants Pty Ltd (AUS)	APHIS-Bescheid 2018, „GE-rice cultivars are in the early phases of development“	geplant	88a, 89a
Soja		TALEN	Veränderte Fettsäurezusammensetzung (<i>High oleic</i>)	Calyxt Inc. (USA)	APHIS-Bescheid 2015. <u>Anbau in 3 US-Bundesstaaten auf 6500 ha</u> <u>Kommerzialisierung ab Ende 2018, Anf. 2019 als non-gm</u>	Seit 2014 in den USA, Argentinien	15a, 16a, 17a, 39a, 43a, 44a, 49a, 63a, 82a, 83a, 100a
Soja		TALEN	Veränderte Fettsäurezusammensetzung (<i>High oleic</i>) & niedrige Linolensäure	Calyxt Inc. (USA)	APHIS-Bescheid 2015, Phase II der Entwicklung abgeschlossen	USA	42a, 43a, 44a, 63a
Soja	Bert	CRISPR	Trocken- und Salztoleranz	USDA-ARS, Plant Science Research Unit (USA)	APHIS-Bescheid 2017, Kommerzialisierung unklar	Geplant: Sand Plain Research Farm, Becker, Minnesota	49a, 54a

Kultur	Pflanze (Sorte)	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c)}	Freisetzungsversuche	Quelle
Soja		EXACT™ precision technology, ZFN	Abiotic stress, Stacking verschiedener Traits incl. Herbizidtoleranz	Dow Agrosience, Arcadia Bioscience, Bioceres (USA)	Ankündigung der Zusammenarbeit erfolgte 2015	wahrscheinlich	97a
Soja		CRISPR?	Verschiedene Traits: Herbizidtoleranz, Trockentoleranz	DonMario Semillas (Argentinien)	Kommerzialisierung ab 2025	unklar	94a, 95a
Kartoffel	Innate™ 1 Generation & 2 Generation (Russet Burbank, Ranger Russet, Atlantic)	Intragenese Cisgenese RNAi	Resistenz gegen Kraut- und Knollenfäule Weniger anfällig für grau-schwarze Flecken (an Druckstellen), Weniger Acrylamide, Lagerung bei kühleren Temperaturen	J.R. Simplot (USA) <u>Auseinandersetzung zwischen Simplot und einem ehemaligen Mitarbeiter, der warnt, die Kartoffeln seien nicht ausreichend auf Risiken getestet worden (68a, 69a).</u>	1. Generation: Anbau 2015: 160 Hektar, 2016: 800 Hektar (USA), in Kanada zugelassen 2. Generation: Zulassung USA (USDA), Kanada (Juli 2017) Anbau 1. & 2. Generation: 2500 ha (USA), <u>sehr wenig</u> (Kanada)	1 Generation: mehrere Jahre auf Prince Edward Island (Kanada) 2 Generation: über 2 Jahre an 11 Standorten (USA)	1a, 13a, 29a, 32a, 33a, 34a, 68a, 69a, 70a
Kartoffel		TALEN	Bessere Lagereigenschaften bei kühlen Temperaturen	Calyxt Inc. (USA)	Kommerzialisierung ab 2019, APHIS-Bescheid 2014, <u>Phase II der Entwicklung abgeschlossen</u>	USA, ab 2015	22a, 23a, 24a, 36a, 63a
Kartoffel		TALEN	Weniger Acrylamid-Bildung beim Frittieren/ <i>non-browning</i>	Calyxt Inc. (USA)	APHIS-Bescheid 2016, <u>Phase I der Entwicklung abgeschlossen</u>	unklar	25a, 26a, 35a, 57a, 63a

Kultur	Pflanze (Sorte)	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c)}	Freisetzungsversuche	Quelle
Kartoffel		Rapid Trait Development System (RTDS™), ODM	Resistenz gegen Kraut- und Knollenfäule	Cibus (USA)	<u>Kommerzialisierung ab 2023</u>	unklar	6a, 67a
<u>Kartoffel</u>		Rapid Trait Development System (RTDS™), ODM	Herbizidresistenz	Cibus (USA)	Kommerzialisierung ab 2023	unklar	67a
Weizen		CRISPR	Hybridweizen	DuPont Pioneer (USA), Caribou Biosciences (USA)	Kommerzialisierung geplant ab 2021	USA, ab 2016	7a, 8a, 72a
Weizen	MLO_KO Weizen	TALEN	Mehltauresistenz	Calyxt Inc. (USA)	APHIS-Bescheid 2016, Phase II der Entwicklung abgeschlossen	Ja	21b, 22b, 57a, 63a
Weizen		TALEN	Erhöhter Ballaststoffgehalt	Calyxt Inc. (USA)	Forschung & Entwicklung, Phase I der Entwicklung abgeschlossen, <u>APHIS-Bescheid 2018</u>	ja	50b, 63a, 79a, 80a, 81a, 93a
Weizen		TALEN	Herbizidresistenz	Calyxt Inc. (USA)	Forschung & Entwicklung, <u>Phase I der Entwicklung abgeschlossen</u>	nein	52b, 63a

Kultur	Pflanze (Sorte)	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c)}	Freisetzungsversuche	Quelle
Apfel	Arctic Apple „Arctic Granny“ „Arctic Golden“ „Arctic Fuji“	Intragenese RNAi	Keine braune Verfärbung nach Anschneiden	Okanagan Speciality Fruits (USA)	Anbau, Arctic Golden (vorgeschnitten) seit Ende 2017 in 400 Supermärkten im Mittleren Westen (USA). 2018: Getrocknete Apfelstücke, exklusiv über Amazon ⁱ	USA, Kanada	1a, 13a, zum Arctic Fuji s. 28a, 59a, 73a, 74a
Leindotter	Trait C3008a	CRISPR	Erhöhter Ölgehalt	Yield10 Bioscience, Metabolix Oilseeds, Inc. (USA, Kanada)	APHIS-Bescheid 2017	Ja, bislang im kleineren Masstab (USA)	49a, 50a, 51a, 75a, 78a, 96a
Leindotter	Traits: C3008a, C3008b, C3009	CRISPR (Multiplexing)	Erhöhter Ölgehalt	Yield10 Bioscience, Metabolix Oilseeds, Inc. (USA, Kanada)	APHIS-Bescheid 2018	geplant	75a, 76a, 77a, 78a, 96a
Alfalfa/Luzerne		TALEN	Verbesserte Nährstoffzusammen- setzung	Calyxt Inc. (USA), S&W Seed Company (USA)	APHIS-Bescheid 2017, Phase I der Entwicklung abgeschlossen	Unklar, eher nein (s. Quelle 52a)	49a, 52a, 53a, 63a, 84a

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 / **Meganuklease**

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

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

Das Unternehmen DuPont Pioneer (seit dem 1. September Teil von DowDuPont bzw. Teil der DowDuPont Agriculture Division, s. Quelle 46a) hat seit 2017 eine eigene CRISPR Webseite, um über die Nutzung des Verfahrens durch das Unternehmen zu informieren: <http://crisprcas.pioneer.com/>

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On September 23, 2016, APHIS announced the availability of the final Determination and Finding of No Significant Impact (FONSI) of Arctic® Fuji, developed by Okanagan Specialty Fruits, Inc.:

28a=https://www.aphis.usda.gov/aphis/ourfocus/biotechnology/sa_environmental_documents/sa_environmental_assessments/petition_extension_16-004-01p-osf-apple

The U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) extended deregulation to two lines of genetically engineered (GE) potatoes developed by **J.R. Simplot Company** for late blight resistance, low acrylamide potential, reduced black spot bruising, and lowered reducing sugars on October 28, 2016. APHIS previously reviewed and deregulated these GE traits in other GE potatoes:

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

(UPDATE Stand: November 2018, Neue Einträge sind unterstrichen)

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

Kultur	Pflanze	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungs- status ^{c), d)}	Freisetzungs- versuche	Quelle
Raps		TALEN	Herbizidresistenz	<i>Calyxt inc.</i> (USA)	Forschung & Entwicklung	nein	52b, <u>63a</u>
<u>Raps</u>	Trait C3007	CRISPR	Erhöhter Ölgehalt	Yield10Bioscience (USA)	Forschung & Entwicklung	nein	75a, 78a
<u>Raps</u>		ARCUS [®] genome-editing technology	Rapsöl mit einem geringeren Gehalt an gesättigten Fettsäuren	Cargill, Precision BioScience (USA)	Forschung & Entwicklung	nein	94b
Mais		CRISPR	Resistenz gegen <i>Maize Lethal Necrosis Disease</i>	DuPont Pioneer (USA), CIMMYT (MEX)	Forschung & Entwicklung Maissorten sollen für afrikanische Kleinbauern entwickelt werden	unklar	53b, <u>88b</u>
<u>Mais</u>		CRISPR	Forschung an Genfunktionen	Iowa State University (USA)	Forschung ^{d)} APHIS-Bescheid 2018	geplant	57b, 58b
<u>Mais</u>		CRISPR	SDN-1, Gen Knock Outs in Wee, ATM, ATR	Vlaams Instituut voor Biotechnologie (VIB) (BEL)	Forschung ^{d)} Freisetzungsversuche laufen seit 2017, erst seit 2018 im EU-GMO Register	Seit 2017-2018	72b, 73b

Kultur	Pflanze	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c), d)}	Freisetzungsversuche	Quelle
Mais		CRISPR (CRISPR-Cpf1/Cms1)	Photosynthetic efficiency trait, Ertragssteigerung	Benson Hill Biosystems, Beck's (USA)	Forschung & Entwicklung, anticipate filing a regulatory dossier with the USDA by 2021	Nein (Elitelinien: ja)	95b
Mais		Meganuklease	Veränderte Stärkezusammensetzung	Agrivida Inc. (USA)	APHIS-Bescheid 2015	unklar	23b, 24b
Kartoffel in NL: Freisetzung BEENDET		Cisgenese	Kraut- und Knollenfäuleresistenz	Universität Wageningen (NL)	Forschung ^{d)} , DuRPh-Projekt 2006 - 2016	Vor 2018: NL, Irland (89b), Belgien In CH seit 2015 - 2019	1b, 32b, <u>89b</u>
Kartoffel in UK: Freisetzung BEENDET		Cisgenese	Kraut- und Knollenfäuleresistenz	Biotechnology and Biological Sciences Research Council (BBSRC) (UK)	Forschung ^{d)}	Freisetzungsversuche (UK), 2010 - 2012	1b
Kartoffel Forschungsprojekt vermutlich BEENDET	Bintje	Cisgenese	Resistenz gegen Kraut- und Knollenfäule	Ghent University, Vlaams Instituut voor Biotechnologie (VIB), Institute for Agricultural and Fisheries Research (ILVO) (BEL)	Kommerzialisierung unklar	nein	37a, 58a

Kultur	Pflanze	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c), d)}	Freisetzungsversuche	Quelle
Kartoffel	Maris Piper, Agria	Cisgenese ev. RNAi	Resistenz gegen Kraut- und Knollenfäule, Kartoffelzysten-nematoden, geringere Anfälligkeit gegen Druckstellen	TSL Potato Partnership Project (The Sainsbury Laboratory), University of Leeds, J. R. Simplot, BioPotatoes UK Ltd (USA, UK)	ev. Kommerzialisierung ab 2025	Freisetzungsversuche 2016 – 2019 (UK)	38a, <u>71a</u> , <u>90b</u>
Kartoffel		TALEN	Kraut- und Knollenfäule-Resistenz	Calyxt Inc. (USA)	Forschung & Entwicklung	nein	52b, <u>63a</u>
Kartoffel		TALEN	Verbesserte Lagerfähigkeit bei kühlen Temperaturen, <i>non-browning</i>	Calyxt Inc. (USA)	Forschung & Entwicklung	nein	52b, <u>63a</u>
Soja		TALEN	Verbesserte Protein-Zusammensetzung	Calyxt Inc. (USA)	Forschung & Entwicklung	nein	52b, <u>63a</u>
Soja		TALEN	Trockentoleranz	Calyxt Inc. (USA)	Forschung & Entwicklung	nein	52b, <u>63a</u>
Soja		TALEN	Erhöhter Ertrag	Calyxt Inc. (USA)	Forschung & Entwicklung	nein	52b, <u>63a</u>
Soja		TALEN	Herbizidresistenz	Calyxt Inc. (USA)	Forschung & Entwicklung	nein	52b, <u>63a</u>
Soja, Sorghum, Weizen		CRISPR	Herbizidresistenz	Benson Hill Biosystems (USA), Bioheuris (USA)	Forschung & Entwicklung	geplant	64b

Kultur	Pflanze	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungs- status ^{c), d)}	Freisetzungs- versuche	Quelle
Weizen		CRISPR	Verschiedene Eigenschaften in Planung	DuPont Pioneer (USA), CIMMYT (MEX)	Forschung & Entwicklung Weizensorten sollen für afrikanische Kleinbauern entwickelt werden	nein	88b
Weizen		TALEN	Reduzierter Glutengehalt	<i>Calyxt Inc.</i> (USA)	Forschung & Entwicklung	nein	30b, 52b, 63a
Weizen		TALEN	Erhöhter Ballaststoffgehalt	<i>Calyxt Inc.</i> (USA)	Forschung & Entwicklung	nein	52b, 63a
Weizen		CRISPR	Gluten“freier“ Weizen	Institute for Sustainable Agriculture in Cordoba (ES)	Forschung & Entwicklung	<u>Ja, Ort unklar</u> <u>“The GM wheat</u> <u>is currently</u> <u>being tested in</u> <u>30 celiac</u> <u>patients from</u> <u>Mexico and</u> <u>Spain and so</u> <u>far the results</u> <u>are very</u> <u>encouraging.”</u> (82b)	54b, 81b, 82b

Kultur	Pflanze	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c), d)}	Freisetzungsversuche	Quelle
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.” (81b)	unklar	81b
<u>Weizen</u>	Traits C4001, C4003	CRISPR	Verbesserte Photosyntheseleistung mehr Pflanzenbiomasse	Yield10Bioscience (USA)	Forschung & Entwicklung	Nein	75a, 78a
Gerste in DK: Freisetzung BEENDET		Cisgenese	Verbesserte Phytase-Aktivität	Aarhus Universität (DK)	Forschung ^{d)}	Dänemark, 2012 - 2016	1b
Reis		TALEN	Resistenz gegen eine bakterielle Krankheit	State University of Iowa, Prof. Bing Yang (USA)	APHIS-Bescheid 2015, Forschung	Sommer 2014, Universitäts-gelände, Iowa	25b, 26b
<u>Reis</u>	Traits C4001, C4003	CRISPR	Verbesserte Photosyntheseleistung erhöhte Pflanzenbiomasse	Yield10Bioscience (USA)	Forschung & Entwicklung	Nein	75a
<u>Reis</u>		CRISPR	Ertragssteigerung	Purdue University (USA), Chinese Academy of Sciences (China) ⁱⁱ	Forschung ^{d)}	Ja, Shanghai, Hainan Island	77b, 78b

Kultur	Pflanze	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c), d)}	Freisetzungsversuche	Quelle
Tomate		CRISPR	Früchte lösen sich ohne Stielansatz beim Pflücken	University of Florida, Horticultural Sciences (USA)	Forschung ^{d)} APHIS-Bescheid 2018	unklar	59b, 60b
Tomate		CRISPR	Performing a proof-of-concept of a new method of rapid and efficient gene editing in a tomato plant	UC Davis Plant Biology Department, TechAccel (USA)	Forschung und Entwicklung	geplant	74b
Kassava		CRISPR	Krankheitsresistenz	Donald Danforth Plant Science Center (USA), Virus Resistant Cassava for Africa (VIRCA)	Forschung & Entwicklung	Wahrscheinlich (Kenia, Uganda)	67b, 68b
Alfalfa/Luzerne		Intragenese	Niedriger Ligningehalt	J. R. Simplot (USA)	Forschung & Entwicklung	unklar	1b, <u>91b</u>
Alfalfa/Luzerne		TALEN	Herbizidresistenz	Calyxt inc. (USA)	Forschung & Entwicklung	nein	52b, <u>63a</u>
Leindotter	Trait C3007	CRISPR	Erhöhter Ölgehalt	Yield10Bioscience (USA)	Forschung & Entwicklung	nein	75a, 78a

Kultur	Pflanze	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c), d)}	Freisetzungsversuche	Quelle
<u>Leindotter</u>		CRISPR	Erhöhter Ölgehalt (Omega-3-Fettsäure)	Rothamsted Reserach (UK)	Forschung ^{d)} 2 mittels CRISPR veränderte Kontrolllinien. Sollen entfernt werden. Angaben im EU-GMO Register zu konv. GVO-Linien. Wenn erneut mit CRISPR-Pflanzen gearbeitet wird, wird neuer Antrag fällig (DEFRA an GM Freeze. Brief nicht öffentlich).	Ja, UK seit 2018 (- 2020)	69b, 70b, 71b
<u>Tabak</u>		Meganuklease	Geringerer Nikotingehalt	North Carolina State University (USA), Precision Bioscience (USA)	APHIS-Bescheid 2018, Forschung (unklar ob Entwicklung)	unklar	61b, 62b, 63b
Apfel, Birne		Pfropfen auf GV-Unterlage	Veränderte Wurzeleigenschaften, Einfluss der GV-Unterlage auf Wachstum, Blüte etc.	Swedish University of Agricultural Sciences (SWE)	Forschung ^{d)} (unklar ob Entwicklung)	Schweden, 2015 - 2019	1b, 15b, 34b

Kultur	Pflanze	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c), d)}	Freisetzungsversuche	Quelle
Apfel		Cisgenese	Erhöhter Anthocyan-Gehalt	Stichting Dienst Land-bouwkundig Onderzoek (DLO), Stichting Dienst Landbouwkundig Onderzoek (DLO) in particular Praktijk-onderzoek Plant, Om-geving / Plant Research International (PPO/PRI)(NL)	Forschung ^{d)}	NL, 2016 - 2026	1b, 11b, 33b
Apfel		Cisgenese	Feuerbrandresistenz	ETH Zürich (CH), Agroscope (CH)	Forschung ^{d)}	Mit Auflagen in CH bewilligt 2016 - 2019	1b, 12b
Apfel		Cisgenese	Schorfresistenz	ETH Zürich (CH), Universität Wageningen (NL)	Forschung ^{d)} , teilweise Regulierung, APHIS 2012 (siehe Quelle 47b)	NL, 2011 - 2021	1b, 47b, <u>92b</u>
Apfel, Birne		unbekannt	Feuerbrandresistenz	Okanagan Speciality Fruits (USA)	Forschung & Entwicklung	unklar	27b, <u>75b</u>
Apfel		unbekannt	Schorfresistenz	Okanagan Speciality Fruits (USA)	Forschung & Entwicklung	unklar	27b, <u>75b</u>
Pflaume, Aprikose		Pfropfen auf GV-Unterlage	u. a. Trockenheits-toleranz	Centro de Edafología y Biología del Segura (ES)	Forschung ^{d)}	Spanien, 2015 - 2018	1b, 16b, 35b

Kultur	Pflanze	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c), d)}	Freisetzungsversuche	Quelle
Pfirsich		unbekannt	Resistenz gegen <i>Plum pox virus</i>	Okanagan Speciality Fruits (USA)	Forschung & Entwicklung	unklar	27b, <u>75b</u>
<u>Physalis</u>		CRISPR	Verschiedene: Fruchtgrösse, Vorerntefruchtfall, Invasivität	Physalis Improvement Project, Boyce Thompson Institute (USA)	Forschung & Entwicklung	unklar	65b, 66b
Walnuss		Pfropfen auf GV-Unterlage	Resistenz gegen <i>Crown Gall disease</i>	Department of Pomology, University of California (USA)	Forschung und Entwicklung, gemäss OECD-Workshop (2b): „Close to commercialization“ <u>Bislang keine APHIS-Anfrage</u>	unklar	43b, 2b, <u>93b</u>
Erdbeere		Cisgenese, TALEN	Ertragssteigerung, verbessertes <i>Shelf life</i> , erhöhter Zuckergehalt, Krankheitsresistenz	J. R. Simplot (USA)	Forschung & Entwicklung <u>Patentanmeldung (USA), 2018</u>	Ja, ab 2015	38b, 39b, <u>76b</u>
<u>Weinrebe</u>	<i>Vitis rotundifolia</i> <i>Muscadinia</i>	Cisgenese	Pilzresistenz, Kernlosigkeit	University of Florida (USA)	USDA-gefördertes Projekt, Kommerzialisierung geplant	Seit 2016	86b, 87b
Weinrebe		Intragenese	Erhöhter Anthocyan-Gehalt	University of Florida (USA)	APHIS-Bescheid 2012	wahrscheinlich	1b, 44b, 46b

Kultur	Pflanze	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c), d)}	Freisetzungsversuche	Quelle
Weinrebe		Pfropfen auf GV-Unterlage	Resistenz gegen die bakterielle <i>Pierce disease</i>	Department of Viticulture and Enology, University of California (USA)	Forschung & Entwicklung, gemäss OECD-Workshop (2b): „Product development for commercialization“	<u>Quelle 85b nennt gentechnisch veränderte Trauben, keine GV-Unterlagen</u>	2b, 45b, <u>85b</u>
Weinrebe In FRA: Forschungsprojekt BEENDET		Pfropfen auf GV-Unterlage	Resistenz gegen Reisigkrankheit	French National Institute for Agricultural Research (INRA) (FRA)	Forschung ^{d)}	ab 2010, Dauer unbekannt. <u>Keine Versuche mehr. Zwei Versuche in Colmar wurden zerstört.</u>	44b, <u>83b, 84b</u>
Pappel WURDE NIE BEGONNEN?		CRISPR Transgenese	Grundlagenforschung	Umeå University, Department of Plant Physiology (SWE)	Forschung ^{d)} Keine Angaben zu CRISPR-Bäumen im EU-GMO Register.	Geplant war: 2016 – 2021, Schweden Unklar ob Versuch je begonnen wurde	31b
Pilze	Weisser Champignon	CRISPR	Keine braune Verfärbung nach Anschneiden, verbessertes <i>Shelf-life</i>	Prof. Yinong Yang, Pennsylvania State University (USA)	Forschung & Entwicklung, Keine Kommerzialisierung (s. Quelle 18a)	nein	9a,10a 18a
	Grüne Borstenhirse (<i>Setaria viridis</i>)	CRISPR	Blühverfrühung	Donald Danforth Plant Science Center (USA)	APHIS-Bescheid 2017, Forschung ^{d)}	unklar	48b, 49b

Kultur	Pflanze	Verfahren ^{a)}	Eigenschaften	Unternehmen ^{b)}	Entwicklungsstatus ^{c), d)}	Freisetzungsversuche	Quelle
	Acker-Schmalwand (<i>Arabidopsis thaliana</i>)	CRISPR	Protein PsbS („Sicherheitsventil“ in der Photosynthese) wurde ausgeschaltet	Umeå Plant Science Centre and Umeå University (SWE)	Forschung ^{d)} Unklar, ob Freisetzungsversuch noch läuft. Keine Angaben im EU-GMO Register	Ab Sommer 2016, Schweden	19b, 20b
	Acker-Hellerkraut (<i>Thlaspi arvense</i>)	CRISPR	Veränderter/erhöhter Ölgehalt im Samen	Illinois State University, Department of Biological Sciences (USA)	Forschung ^{d)} APHIS-Bescheid 2018	geplant	55b, 56b

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

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

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i Anfang Oktober 2018 führte Okanagan Specialty Fruits (OSF) 10 ausgewählte Medienvertreter, Blogger und Ernährungswissenschaftler durch die Apfelanlagen, um sie über die weiteren Pläne des Unternehmens zu informieren (siehe auch Quelle: 73a).

Zu diesen Plänen gehört:

- Adding fresh-cut Arctic Grannys to retail availability, and releasing golden and granny smith ApBits to retailers (whole apples in both varieties will be in 2-pound bags);
- Expanding production — OSF is harvesting on 60 acres this season and plans to have 180 acres in production next year and 560 in 2020;
- Expanding planted acreage — there are about 600 acres of Arctic variety trees, with another 800 planned for next year;
- Opening the first phase of a massive facility in Royal City by the end of 2019. The 100,000-square-foot initial phase will grow to about 1 million square feet by the mid-2020s, with pre-grading lines, slicing lines, dehydration equipment for ApBitz and lines for packing whole, fresh Arctics;
- More varieties — The company has received approval to grow non-browning fujis from the U.S. Department of Agriculture (waiting on Food and Drug Administration's OK) and is working on gala approval; and
- Licensing growers in other areas, including the Southern Hemisphere. OSF is working with authorities and a potential growing partner in Argentina.

ii Die Situation in China ist, insbesondere was Freisetzungsversuche angeht, unklar.

Der USDA-Gain-Report zu China (GAIN Report Number: CH 17054, 12/29/2017, p. 8) schreibt: "China allows field trials of biotech crops for the purpose of import approval and research, but does not provide data on the number of field trials or types of crops / traits being tested."

Zu Forschung im Bereich Genome Editing (p. 8, siehe auch Quellen: 79b, 80b):

"Chinese scientists associated with the China Academy of Sciences and the China Academy of Agricultural Sciences are making impressive progress in innovative biotechnology and have published dozens of papers about CRISPR technology."

Lizenzvereinbarungen und Kooperationen

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

im Bereich der neuen gentechnischen Verfahren – landwirtschaftliche Anwendungen (2005 – 2018)

(UPDATE Stand: November 2018, 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
<i>Two Blades Foundation</i> (<i>2Blades</i>) (USA)	<i>Epicrop Technologies Inc.</i> (USA)	TAL code technology	<u>2018-11</u>	Non-exclusive licence agreement. “We are pleased to be able to utilize this technology in our research to 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	61

Lizenzgeber	Lizenznehmer	Verfahren	Jahr-Monat	Verwendungszweck	Quelle
				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."	
<i>Broad Institute (USA)</i>	<i>BASF</i>	CRISPR-Cpf1	<u>2018-10</u>	"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 to improve products in agricultural and industrial microbiology applications. "	57
<i>Corteva Agriscience™, Agriculture Division of DowDuPont™, Broad Institute (USA)</i>	<i>J. R. Simplot</i>	CRISPR-Cas9 and related gene editing tools	<u>2018-08</u>	"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
<i>Corteva Agriscience™, Agriculture Division of DowDuPont™, Broad Institute (USA)</i>	<i>Yield10Bioscience (USA)</i>	CRISPR-Cas9	<u>2018-08</u>	"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

Lizenzgeber	Lizenznehmer	Verfahren	Jahr-Monat	Verwendungszweck	Quelle
<i>Precision BioScience (USA)</i>	<i>Cargill (USA)</i>	ARCUS® genome-editing technology	<u>2018-02</u>	“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
<i>Broad Institute (USA)</i>	<i>Syngenta (China, CH)</i>	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
<p><i>Broad Institute (USA)</i></p> <p style="text-align: center;">+</p> <p><i>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</i></p>	<p><i>DuPont Pioneer (USA)</i></p>	<p>CRISPR-Cas9</p>	<p>2017-10</p>	<p>“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. (...)”</p>	<p>55</p>
<p><i>Broad Institute (USA)</i></p>	<p><i>Arcadia Bioscience Inc. (USA)</i></p>	<p>CRISPR-Cas9</p>	<p>2017-09</p>	<p>“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.”</p>	<p>51</p>

<i>Lizenzgeber</i>	<i>Lizenznehmer</i>	<i>Verfahren</i>	<i>Jahr-Monat</i>	<i>Verwendungszweck</i>	<i>Quelle</i>
<i>ToolGen (USA)</i>	<i>Monsanto (USA)</i>	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
<i>DuPont Pioneer (USA)</i>	<i>ERS Genomics</i>	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
<i>Broad Institute (USA)</i>	<i>BASF (Germany)</i>	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
<i>Broad Institute (USA)</i>	<i>Monsanto (USA)</i>	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
<i>Two Blades Foundation (2Blades) (USA)</i>	<i>International Rice Research Institute (IRRI) (Philippines)</i>	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
<i>Caribou Bioscience</i> (USA)	<i>Genus</i> (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
<i>Institute of Genetics and Developmental Biology</i> (IGDB), <i>Chinese Academy of Sciences</i> (China) via <i>Plant Bioscience Limited</i> (PBL) (UK)	<i>Calyxt, Inc.</i> (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. <i>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.</i> ”	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 to 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 <i>for all commercial uses, including in agriculture.</i> ”	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 Victoria, 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)	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
	⇔ Kreuzlizenzierung				

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	<p>“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.”</p>	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 Editor™ (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 Editor™ (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 to 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
Cellestis plant sciences (FRA) ⇔	Precision BioSciences (USA) Kreuzlizenzierung	Meganuclease technology	2014-01	“Precision BioSciences, Inc. and Cellestis 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
<i>Collectis plant sciences</i> (FRA)	<i>Bayer CropScience</i> (D)	Gene editing	2014-01	“Collectis 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 Collectis 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
<i>Two Blades Foundation</i> (2Blades) (USA)	<i>DuPont Pioneer</i> (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 for uses in certain crops. Improvements to the technology will be granted back for 2Blades’ humanitarian projects benefiting subsistence farming.”	22
<i>Iowa State University</i> (USA)	<i>Collectis plant sciences, Inc.</i> (FRA)	Inventions related to TAL effector- nucleases (TALENs™) and monomeric TALENs™	2012-10	“Collectis (...), the genome engineering specialist, announces that it has signed two exclusive license agreements with the Iowa State University that grant Collectis the worldwide right to use inventions related to TAL effector-nucleases (TALENs™) and monomeric TALENs™. These two exclusive licenses granted to Collectis cover all uses of the TAL technologies in any field. ”	26

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<i>Two Blades Foundation (2Blades) (USA)</i>	<i>Monsanto Company (USA)</i>	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
<i>Two Blades Foundation (2Blades) (USA)</i>	<i>KWS SAAT AG (D)</i>	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
<i>Two Blades Foundation (2Blades) (USA)</i>	<i>Bayer CropScience (D)</i>	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
<i>Two Blades Foundation (2Blades) (USA)</i>	<i>Monsanto Company (USA)</i>	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	Collectis (FRA)	Inventions related to TAL effector-mediated DNA recognition and cleavage (TALEN)	2011-01	“Collectis (...), the French genome engineering specialist, has announced today that it has signed an exclusive license agreement with the University of Minnesota that grants Collectis 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 Collectis 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
Collectis (FRA)	Monsanto Company (USA)	Meganuclease technology	2009-09	“Monsanto Company (...) today announced a non-exclusive research and commercial license agreement with Collectis S.A. (...) for broad use of its meganuclease technology in plants . (...) Under the agreement, Monsanto will have access to Collectis’ intellectual property on meganucleases and its custom meganuclease production platform. Collectis will receive an upfront payment of €3 million, and subject to the approval of the Extraordinary General Meeting of Collectis’ shareholders, Monsanto will make an equity investment of €1 million to allow Collectis to scale the technology for agriculture. Collectis 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

→ Zur Diskussion der komplizierten IP- und Lizenzsituation rund um CRISPR-Cas, siehe:

CRISPR, surrogate licensing, and scientific discovery

Jorge L. Contreras and Jacob S. Sherkow (February 16, 2017) *Science* **355** (6326), 698-700. [doi: 10.1126/science.aal4222]. Download: <http://science.sciencemag.org/content/355/6326/698/tab-pdf>

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Zu den **breiten Ansprüchen rund um CRISPR-Cas9:**

[CRISPR–Cas9 claim sets and the potential to stifle innovation](#)

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