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Scientists across the globe are quite excited to employ gene editing technology for crop improvement and productivity increase. The technology offers a clear advantage of speed, accuracy, efficiency over the conventionally bred crops and advantage of reasonable regulatory burden compared to GM crops. This is clearly demonstrated by the number of gene edited crops already in the market and robust product pipelines within a decade of the technology being established. Despite the advantage, gene editing cannot be employed for all issues faced by the farmers and requires immense background information to select the targets for editing.

Even so, gene editing should be utilized for deep impact issues and critical traits. Some of them include climate resilient grains for higher productivity under unpredictable weather, oilseed crops with higher oil content and productivity and domestication of diverse crops for food, fuel and fibre so that consumer demands are met sustainably. Besides, climate change management, it can also be countered by developing crops and trees with increased photosynthetic efficiency for better carbon capture and reversing land conversion for increasing biodiversity. Biofuels are our first step towards reduction in fossil fuel use, carbon emissions and controlling temperature increase in the long term. The future of fuels is in farms as multiple bioresources are being identified as possible source of fuel. One such crops is camelina, a flowering seed oil plant from the Mediterranean region, it can serve as a source of plant-based sustainable airline fuels, feedstock for making bioplastics and nutritional oils. Camelina is being edited for higher productivity and to produce more oil for a variety of uses. Since it is used as a no-till cover crops, it can also provide additional income for farmers and encourage the restoration of complex root structures and biomes in the soil, offering new choices to farmers and consumers.

The diversity in plants, our knowledge around plant growth and uses and genome sequencing can pave the path for gene editing for sustainable agriculture.

In this edition of the newsletter, you will get a glimpse of success of biotechnology in agriculture for

near and long term benefits.

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A special interest group of Federation of Seed Industry of India

News from India and Around the World

Research in UG drought tolerant crops through genetic engineering

https://notus.com.mx/investigan-en-ug-cultivos-tolerantes-a-sequias-mediante-ingenieria-genetica/

Drought-tolerant crops, which with climate change are becoming more and more necessary, since they reduce food production around the world, is what Dr. Anareli Quintero Jiménez, researcher and professor at the Guanajuato University of Guanajuato (UG) at the Celaya-Salvatierra Campus. These works focus on the use of genes obtained from drought-resistant or resurrection plants. In the case of resurrection plants such as Selaginella *lepidophylla,* it was found that there are some genes that participate in the sugar biosynthesis pathway. That sugar, called trehalose, is what encapsulates the proteins and cell membranes and does not allow the proteins to denature or fuse the membranes when there is a lack of water.

Efficacy of drought-tolerant and insect-protected transgenic TELA® maize traits in Nigeria

https://pubmed.ncbi.nlm.nih.gov/37043164/

Assessment of efficacy of drought tolerance (DT) and insect protection (Bt) genes in maize genotypes is invaluable for commercialization and production of transgenic maize in Nigeria. Seven maize hybrids, known as TELA® maize, with stacked events of Bt insect protection (MON89034) and drought tolerance (MON87460; DroughtGard®) and their respective non-GM versions (isohybrids) developed through the TELA Maize Project were evaluated in confined field trial site at Zaria in 2020 and 2021.

Under optimum-moisture condition with pests controlled, the TELA® GM and their isogenic hybrids were similar, but both had 32% higher yield than the commercial checks. Adoption of TELA® GM technology by farmers as adaptation strategy to cope with climate change, will ensure sustainability of maize production and productivity in Nigeria.

Food Waste Prevention Week: How can gene-edited crops reduce food waste?

https://bio.news/agriculture/gene-edited-crops-and-waste-prevention-week/

Food Waste Prevention Week (FWPW) is being celebrated in US for the first time this year. Many foods are discarded before reaching the consumer. Estimates show that 7% of postharvest losses occur on the farm, meaning that imperfect foods are thrown away before ever reaching a grocery store. From those that do, more than double that number (17-18%) are wasted by consumer-facing businesses such as restaurants, cafeterias, and households. The biotech industry is seeking to rectify the food waste problem by editing the genes of produce to make them last longer and look better. Such improvements could significantly reduce food waste.

Agricultural biotechnology innovators making the world food secure and environmentally sustainable

https://timesofindia.indiatimes.com/blogs/not-categorized/agricultural-biotechnology-innovators-making-the-world-food-secure-and-environmentally-sustainable/

The agricultural biotechnology market has been estimated at USD 100 billion in 2020, with a projected compound annual growth rate (CAGR) of 8% over the next five years. The increasing adoption and advancements in new biotechnology tools will drive market growth by facilitating new breeding techniques. The global agricultural biotechnology market will be boosted by the penetration of biotechnology tools that create or modify traits of organisms, including plants, animals, and microbes, to enhance characteristics such as color, yield, or size.

CRISPR-Cas for accelerated domestication of wild plants

https://vigyanprasar.gov.in/isw/Crispr-cas-for-accelerated-domestication-of-wild-plants.html

Domestication can tame unruly wild plants into crop plants but may take thousands of years. A group of researchers from the ICAR-National Rice Research Institute, Cuttack, Odisha, and the National Academy of Agricultural Sciences, New Delhi, have suggested genome editing technologies to fasten the process of crop domestication for sustainable food production. It took around 9000 years to develop modern-day corn from a wild-grass, teosinte. The revolutionary gene editing technology can drastically reduce the time required for domestication.

Philippines Approves Tropic's Non-Browning Gene-Edited Banana

https://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=20135

Tropic, a pioneering agricultural biotechnology company in the United Kingdom using CRISPR gene

editing to improve traits in bananas and coffee, has announced that their non-browning gene-edited banana received a non-GMO exemption decision from the Philippines Department of Agriculture-Bureau of Plant Industry. This banana is the first gene-edited product to go through the Philippines' gene editing regulatory process.

Gene editing and food safety

https://www.fao.org/documents/card/en/c/cc5136en

This document explains the basic scientific principles underlying gene editing, providing information related to technical issues in the area of food safety in applying gene editing for food production. It offers some key considerations for developing and implementing policies and regulatory criteria for products derived from gene editing. It includes a summary of the current regulatory status of gene-edited foods in different countries as well as a review of the existing documents made available by Codex Alimentarius.

Artificial Intelligence (AI) tools to detect crops diseases are on the way

Plant breeders can use AI tools to predict which plants will grow quickly in a particular climate, which genes will help them thrive there, and which crosses between plant parents will likely yield better traits. The traits can relate to speed of growth, cooking properties, yield and resistance to pathogens. Crop breeders inoculate the offspring with a pathogen and see which ones resistant, and what genes are associated with resistance.

Necessary change. Pawar bats for GM crops and their trials in India

https://www.thehindubusinessline.com/economy/agri-business/pawar-bats-for-gm-crops-and-their-trials-in-india/article66772415.ece

Nationalist Congress Party (NCP) chief Sharad Pawar on Sunday said conducting trials of genetically modified (GM) crops was prohibited in India even as the import of such agricultural produce was allowed in the country. Since such trials are banned in India, the country could not go ahead with regard to GM crops, he said. Addressing an event organised by his party at Amravati in Maharashtra, Pawar said some decisions were taken by the Supreme Court on GM crops earlier and its ill-effects can be seen today.

Huge scope. Fisheries, experts call to bust myths on use of GM crops in India's aqua-feed sector

https://www.thehindubusinessline.com/economy/agri-business/fisheries-experts-call-to-bust-myths-on-use-of-gm-crops-in-indias-aqua-feed-sector/article66772550.ece

Fisheries and biotechnology experts have emphasised the need to bust the myths associated with the use of genetically modified (GM) crops as feed ingredients in India's aquaculture sector. They are of the view that GM crop-based products (mainly non-living genetically modified organisms) have huge

scope in enhancing the supply of feed ingredients in aquaculture, promoting growth, disease resistance and reduction of input costs in aquaculture production.

Biotechnology is important for more and sustainable food production

https://www.intrafish.no/kommentarer/bioteknologi-er-viktig-for-mer-og-barekraftig-matproduksjon/2-1-1439701

One of the aquaculture industry's major challenges is sufficient access to all the nutrients necessary for the fish. One of these is marine omega-3 fatty acids. Fish that receive a sufficient level of omega-3 in the feed have better health and quality, and the fillets are more nutritious. The Australian company Nuseed, has developed a plant-based oil enriched with omega-3, called Aquaterra. This has been done by adding genes from microalgae to rapeseed. Permission has now been applied for to use this rapeseed oil in fish feed in Norway, and the Science Committee for Food and Environment (VKM) concluded in a risk assessment that Aquaterra is safe and there is no health or environmental risk from to use the oil.

Promote crop diversification, use of digital tools in agriculture

Inaugurating the G20 meeting of agricultural chief scientists (MACS) in Varanasi, he asked G20 countries to work towards promotion of crop diversification, efficient use of inputs like fertilisers and post-harvest management and said the latest digital tools should be used in agriculture across the world. About 80 delegates from G20 member states -- Australia, Argentina, Brazil, Canada, China, France, Germany, Indonesia, Italy, Japan, Mexico, Republic of Korea, Russia, Saudi Arabia, South Africa, the United Kingdom, the USA and European Union -- are participating in the tree-day meeting.

Climate adviser sees GM trees as climate solution

https://www.news.at/a/tara-shirvani

In "Plastic Eaters and Turbo Trees" Dr. Tara Shirvani, who publishes at the University of Oxford on the subject of synthetic biology and climate change, makes it easy to understand how synthetic biology can contribute to saving the world. Trees that bind ten times more CO2 than those previously known, or bacteria that eat up plastic floating in the sea, are explained in detail in a way that laypeople can understand.

Scientists say East Africa's farmers need improved seeds to counter pests and effects of climate change

https://allianceforscience.org/blog/2023/04/scientists-say-east-africas-farmers-need-improved-seeds-to-counter-pests-and-effects-of-climate-change/

Like most regions in Africa, East Africa has not adopted gene-edited crops because of misinformation

and indecision. Only Kenya has made progress and is planting Bt cotton. Kiggundu said gene-edited crops will not leave farmers at the mercy of the global seed companies because the improved seeds are being developed by African scientists. It's also not true that improved seeds cannot germinate and will make soils infertile.

China approves safety of first gene-edited crop

https://www.indiatoday.in/amp/environment/story/china-approves-safety-of-first-gene-edited-crop-2368941-2023-05-05

China has approved the safety of a gene-edited soybean, its first approval of the technology in a crop, as the country increasingly looks to science to boost food production. The soybean, developed by privately owned Shandong Shunfeng Biotechnology Co., Ltd, has two modified genes, significantly raising the level of healthy fat oleic acid in the plant. The safety certificate has been approved for five years from April 21, according to a document published last week by the Ministry of Agriculture and Rural Affairs.

A Gene-edited Crop Coming to a Market Near You: When Gene-edited Crops Meet the Grain and Oilseed Supply Chain

https://research.rabobank.com/far/en/sectors/grains-oilseeds/a-gene-edited-crop-coming-to-a-market- near-you.html

The market demands that less inputs be used in agricultural production. This means a reduction in chemical pesticides and synthetic fertilizers, for example. Meanwhile, the continuous growth in food demand from a growing population requires more production, with fewer options for land expansion. Gene-editing (GE) technology has put the seed industry in the sweet spot amid this transition in production practices.

Experts Promote Genome Editing Regulations that Consider Societal Benefits

Genome editing provides a unique opportunity to create produce benefiting consumers, but success depends on risk-proportional regulation. Existing seedless fruit varieties such as watermelon, mandarin oranges and grape are strongly preferred by consumers and support healthy diets without pre-market regulatory approvals required for commercialization. Replicating the seedless trait in other fruits is a promising way to increase consumption. Here we compare the differential treatment by various regulatory systems of identical products made by inserting an ancient seedless allele into muscadine grape (*Vitis rotundifolia*) using traditional breeding or templated or non-templated genome editing tools.

Gene Editing Provides Promise to Grain and Oilseed Supply Chain

The current grain and oilseed market demands less inputs for agricultural production, while the need for more food is challenged with fewer options for land expansion. Gene editing provides options to

address these concerns. By applying direct modifications to a plant's genetics, gene editing can help design crops that meet the needs in reduced time compared to traditional breeding methods. Furthermore, there are countries that have exempted gene-edited crops from strict regulatory processes applied for genetically modified crops.

Earth911 Podcast: Yield10's Oliver Peoples on Genetic Engineering's Role in Regenerative Agriculture for Biofuels

Yield10 has announced agreements with Mitsubishi Corporation and American Airlines to develop biofuels and progress on developing camelina strains that are more efficient and herbicide-resistant. During the Fall of 2022, farmers in the US and Canada planted Yield10-engineered camelina as a winter crop for the first time. No-till cover crops like camelina can provide additional income for farmers and encourage the restoration of complex root structures and biomes in the soil, offering new choices to farmers and consumers.

Biotech can help make our food healthier, safer and more sustainable

https://www.scienceforsustainableagriculture.com/johnathannapier3

Continued growth of the global aquaculture sector, allied to concerns over the sustainability of marine fish stocks traditionally used as feed, are driving increased interest in health-giving Omega-3 enriched oilseed crops as a renewable feedstock. Recent food scares over 'forever chemicals' found in eggs, linked to the use of fishmeal as feed, suggest biotech crops may not only be more sustainable, but also safer, writes Professor Johnathan Napier.

New Research

Study Reveals Mechanism to Regulate Rice Root Hair Length

Root hairs are tube-like structures formed from root epidermal cells. They function as extensions of the roots to maximize contact with the soil for water and nutrient absorption. The researchers used CRISPR-Cas9 technology to knockout *OsUGE1* in rice. This led to longer root hairs than wild type rice plants. In contrast, overexpression of *OsUGE1* formed shorter root hairs. Further analysis revealed that *OsGRF6* could bind to the promoter of *OsUGE1*. When *OsGRF6* was knocked out, the mutants exhibited shorter root hair than the wild type rice plants.

Risk assessment of additional information on maize MIR162

https://www.efsa.europa.eu/en/efsajournal/pub/7935

The European Commission requested the Panel on Genetically Modified Organisms of the European Food Safety Authority (EFSA GMO Panel) to assess new scientific information on maize MIR162, and to indicate whether the previous conclusions on the safety of maize MIR162 as a single event and as a

part of stacked events remain valid. The new information is included in a European patent that reports a decrease in male fertility in some MIR162 inbred lines, pointing to a potential link between such decrease and the Vip3 protein expressed by maize MIR162. The EFSA GMO Panel concluded that a decrease in male fertility would have no impact on the previous conclusions on maize MIR162 and stacked events containing MIR162.

Accelerating crop domestication through genome editing for sustainable agriculture

https://link.springer.com/article/10.1007/s13562-023-00837-1

Today's improved crop plants are the result of years of artificial selection for a few of those mutations, many times coupled with deliberate selection for desirable recombinants that originated in nature or developed through targeted breeding. Artificial phenotypic selection leaves footprints in the genome of crop species. Over the last three decades, researchers have identified numerous genes and causal mutations associated with domestication events, leading to a better understanding of how our forefathers and foremothers tinkered with plant development to meet their food and fodder needs.

Breakthrough in fight against devastating potato disease

https://www.wur.nl/en/research-results/research-institutes/plant-research/show-wpr/breakthrough-in-fight-against-devastating-potato-disease.htm

Potato is the third most important food crop in the world after rice and wheat in terms of human consumption. But potato world production is threatened by potato late blight, one of the most devastating potato diseases which causes globally 3-10 billion euros in yield loss and management costs annually. With his PhD study, WUR researcher Daniel Moñino-López made a breakthrough in fighting the disease. With the gene editing technology CRISPR/Cas, he made potato plants resistant to late blight disease caused by Phytophthora infestans.

Eggs that can be eaten by people with egg allergies

https://newsdig.tbs.co.jp/articles/rcc/441374?display=1

Research that has the potential to change the "future of food" is underway in Hiroshima. Today's theme is "Eliminating food allergies, eliminating food crises, changing the diet of the future, Hiroshima University 'genome research' at the forefront!"

Video: World's first climate-resistant strawberries developed in steamy Singapore

While the fruit usually grows in cooler temperatures of 5 to 15 degrees Celsius, Singrow strawberries can thrive at around 20 to 28 degrees Celsius, said Singrow CEO and co-founder Bao Shengjie.

Moth sex pheromones: Tweaking plants with gene editing can replace some pesticides

By using precision gene engineering techniques, researchers at the Earlham Institute in Norwich have been able to turn tobacco plants into solar-powered factories for moth sex pheromones. Critically,

they've shown how the production of these molecules can be efficiently managed so as not to hamper normal plant growth.

Video: From scorpion-venom cabbage to human breast milk from cows, here are 9 of the most unique genetically-engineered products likely to come to market

From square watermelons to bananas that have the vaccination for hepatitis B, these products are purely man-made. But time will only tell whether or not these genetically modified products are for the betterment of society or the downfall of it or it could actually save the world from starvation and disease. Only time will give us the answer.

Indian farmers face threats from pest infestations, erratic weather, droughts, floods, salinity, and soil degradation. Gene-edited crops could help

Indian farmers have contributed significantly to the global agricultural industry with a wide range of crops. Agriculture employs nearly 60% of the Indian population and contributes approximately 18% to the country's GDP. Despite significant progress in agriculture, Indian farmers continue to face several challenges such as pest infestations, erratic weather, droughts, floods, salinity, and soil degradation. The latest in the list is climate change which is bound to worsen these situations.

The air-cleaning qualities of plants get a genetically modified boost

https://www.technologyreview.com/2023/04/26/1071407/plants-air-cleaning-neoplants-genetically-modified-air-quality/

In the late 1980s, NASA conducted a study to determine how well indoor plants like aloe vera, Chinese ivy, and potted chrysanthemums abate air pollution. A tropical vine native to the Solomon Islands, also known as "Devil's Ivy"—is indistinguishable from the real thing. It's photogenic, fast-growing, and hard to kill. But unlike typical nursery stock, it also metabolizes indoor air pollutants missed by traditional air purifiers, which filter particulate matter: the volatile organic compounds (VOCs) produced by paint, gas stoves, and building materials.

Chinese rice breeding tech boosts agricultural development in Asia, Africa

https://www.shine.cn/news/nation/2305021542/

In a laboratory at the Chinese Academy of Agricultural Sciences (CAAS) in northern Beijing, researchers are busy tagging and editing genes in rice, a key component of the complex breeding process of green super rice (GSR). As its name suggests, this variety of rice boasts high yields while remaining environmentally friendly. "We apply the method of genetic screening to put the quality or the traits that we need in the rice," said Xu Jianlong, a professor at the Laboratory for Molecular Rice Breeding under the Institute of Crop Sciences, CAAS.

Full Genome Sequence of Lablab Bean Now Available

The genome of a climate-resilient bean has been fully sequenced by an international team of researchers. The full sequence of the hyacinth bean or 'lablab bean' paves the way for wider cultivation of the crop, bringing nutritional and economic benefits, and bolstering food security in drought-prone regions of the world.

[Scientists Find New Mechanisms Controling Plant's Temperature Response]

Experts from Danforth Plant Science Center discovered a plant protein complex that controls temperature response by the circadian clock. With the impact of climate change in daily and seasonal temperature trends, it is vital to comprehend how plants read and respond to varying temperature signals. The findings are published in the journal *Plant Physiology*.

[Scientists Discover Puzzling Nature of RNA Editing in Plants]

RNA (ribonucleic acid) editing is a vital process in sustaining the important roles of encoded proteins at the RNA level. Previous studies have shown that RNA editing commonly occurs in different land plants, but there were only a few studies that compare chloroplast RNA editing within and between groups except for ferns. This led the researchers to pick out plant species representing the three distant evolutionary clades and pinpoint editing sites.

[Bacterium Transfers Own Genes into Plants to Give Them Superpowers]

Researchers at the University of Copenhagen have discovered plants that contain *root oncogenic loci (rol)* genes that originate from *Rhizobium rhizogenes* bacteria introduced to a wide variety of plants millions of years ago through a natural process. The bacterium *R. rhizogenes* has the special ability to transfer its genes to host plants and transform them in the process.

Tweaking Vegetables' Genes Could Make Them Tastier—And You'll Get to Try Them Soon

https://www.scientificamerican.com/article/tweaking-vegetables-genes-could-make-them-tastier-and-youll-get-to-try-them-soon/

Some companies are beginning to use those tools to tackle the challenge of developing tastier veggies. One company, Pairwise, is fighting the same compounds that plagued Brussels sprouts: glucosinolates. But this time researchers are modifying salad greens—and they're armed with the science of gene editing.