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CRISPR in the Crop Field: Editing the Future of Food

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In fields starched by the sun all over the world, a silent revolution is blooming. Scientists armed with the gene editing toolbox called the 'CRP' is tinkering with the DNA of plants in order to breed better crops. Imagine tinkering with a plant's own instruction manual like an editor of a sentence: swapping out a word here, cutting out a typo there. This is not some fantasy, but something that is already occurring. The result? Crops more likely to sprout food, survive in less water or with less fertilizer and even pack in additional nutrients.

The CRISPR Toolbox: Cutting the Code

For example, CRISPR 'molecular scissors' cutting a strand of DNA. At the centre of this revolution is CRISPR-Cas9, which has been compared with a pair of tiny molecular scissors which are directed to a location in the genome. In essence, the DNA of a plant is a recipe book for growth and characteristics. CRISPR makes it possible to identify a single "sentence" in the book, and then cut it out with exact precision. Therefore, when the machine of the plant itself is repairing the cut, an undesirable gene can be disabled or modified into a different version. Because the changes to the plant are made from its own DNA (no foreign gene from another species is inserted), this process can increase change that may have taken place naturally, but in a fraction of a time.

Breeding Reboot: Faster, Sharper, Cheaper

Plant breeding is like a game of roulette: you cross plants and hope a lucky combination turns up after generations. CRISPR is like a search-and-replace on the DNA code, which is beneficial in large ways, like the following:

1) **Speed:** Rather than decades of back-and-forth breeding, a desired trait can be thrown in just a couple of lab and greenhouse cycles. What used to take many growing seasons is now an occurrence within months or a few years.
2) **Precision -** Breeders used to mix thousands of genes at a time CRISPR is able to target a single gene and leave the rest of the DNA of the plant unaffected. This means less surprises and less "weeding out" of side effects that are not desired.
3) **Cheaper:** A faster result translates to less overhead incurred on land, labor and trials. In essence, farmers and researchers can save money and time while still obtaining improved plants.
4) **Natural selection, not foreign genes:** Because CRISPR only edits existing DNA, it eliminates the need to insert DNA from unrelated organisms. This means that the edited plant will be more similar to the result of a natural breeding, and will pass the regulators and consumers more quickly.

Seeds of Change: CRISPR Crops in Action

The first seeds of this new generation of crops have already begun across the world. Here are just a couple examples of what of the impact of CRISPR on the Environment:

Tough season rice variety: There are edited varieties of rice, that can survive on less water. For example, scientists in Asia have employed the bioengineering technique called "CRP" to

manipulate genes to help rice plants use water more efficiently. The result is rice that is able to continue growing strong even during drought conditions. In another project, gene-edited rice was loaded with an extra source of iron to attempt to fight anaemia in communities that use rice as a staple food.

Armored wheat: Wheat crops throughout the world are plagued by diseases such as rust and mildew and others. Researchers used the technology known as CRISPR to knock out one wheat gene that usually allows the fungi to invade. The modified wheat plants became substantially more resistant to the diseases - and even grew bigger yields of grain than before. That is, a very slight alteration in the genetic system of wheat protected the grain from being consumed and produced more bread on the breakfast table.

Better tomatoes and more: Genetic makeover of tomatoes. Genes modified to resistant genes in lab trials, gene-edited tomato plants produced bigger tomatoes and shook off more pests. One Chinese team stapled a gene in tomatoes that reduced the pores of leaves (stomata), so that each plant lost less water during dry periods. The edited plants not only survived the lack of rain more easily, but also had heavier and juicier fruit. Also, other projects have increased the amount of vitamins or guided tomatoes to all ripen evenly, which means ripe fruit will come all at once and will taste even better.

Other growing stories: Biotech companies are testing the edited bananas that don't brown not rot as fast or apples if they last longer after picking. Even specialty crops such as coffee and cocoa are on the drawing board - Imagine coffee plants resistant to leaf disease or cacao trees which fend off fungus. These efforts show the promise of the gene editing technique goes beyond the big staples, reaching into the fruits and vegetables in our diets as well.

Each of the examples is at a different stage of development - some are still in the greenhouses or field trials, while others are close to approval for farmers to plant.

New Frontiers in Plant Editing

The speed at which progress is being made is breathtaking. Every year, there is a new headliner involving the topic of CRISPR in crops:

Best friend tools: Besides the erstwhile scissors (Cas9), scientists have found smaller and more efficient "scissors" (such as Cas12, etc.) that can cut a plant's DNA more easily. Some recent technologies can even adjust the DNA without even cutting it, to minimize the risks of unwanted alterations.

Tackling Tricky Genes With some traits crossing from networks of genes or so-called "master switches" in the genome. Scientists are now starting to attack these complex systems. For example, teams have employed the technique, called Crispr, to turn on helpful genes or shuffle fragments of the DNA which controls the amount of protein produced from a gene, squeezing out better growth, or tolerance to stress.

Countries are catching up: Worldwide deployments. China, for example, has been approving stocking of gene-edited varieties of crops (wheat, rice, soy and corn) for commercial planting since 2021 - dozens of varieties in all. Japan even cleared the first gene-edited tomato for sale in 2024. In the US and elsewhere, regulators are loosening their intended regulations on gene-edited crops, which consider some as safe as conventional plants if they aren't carrying foreign DNA. The CRISPR crops are thus getting a lot closer to your dinner plate.

Scientists are also targeting such moonshot goals: designing new crops across the saltier soil, or getting more power out of sunlight (some experiments are increasing photosynthesis itself). Each breakthrough in the lab is a tool in a toolbox that farmers and breeders will have to deal with the challenges yet to come.

A Harvest of Hope

How does all this translate to the food of our future? In one word: potential. Edited crops are set to play a major role in feeding a changing world, which is growing - and climate change will bring increasing uncertainty:

1) **Feeding a bigger population:** High yields and crop production on marginal land can help make more food from the same acre of land through CRISPR. This would stabilize prices and allow for feeding poor communities.
2) **Climate resilience:** Crops that are heat, drought and flood tolerant can adapt to erratic weather. A gene-edited maize that needs fewer litres of water or a salt-tolerant tomato plant mean farmers will be able to harvest crops despite new challenges brought on by climate change.
3) **Nutrition power up:** Staple foods can be vitamin and mineral "biofortified." Rice with more iron, wheat containing more protein or vitamin A or cassava with more zinc - all of these bioengineered crops could aid in combatting malnutrition in fragile areas without altering diets.
4) **Sustainability:** Tougher crops often require less in the way of chemical inputs. The fungicide-resistant wheat strain reduces pesticide use, which not only saves money but it also hurts the environment less. Fruits and vegetables that do not bruise easily or ripen quickly means less food waste - a massive advantage, as a third of all food available in the supermarkets ends up in the bin every year. In short, the use of the technology in so-called 'CRISPR crops' will allow farming to be made cleaner and more efficient.

These technology changes do not replace good farming practices, but are supportive. Imagine if the grower of a rice crop in lower India could still get an average crop even when the monsoon is weak; or if a wheat grower in Kansas could use fewer fungicide sprays - these are little bits of change, but the impact on world food security is tremendous.

As with any forceful power, the force must be directed. But the hope is obvious, that with care in editing plant genes, we might create a healthier, more reliable food system. From the golden kernels of the edited rice to the juicy red of video tomatoes, the seeds that we plant today could be used to feed and sustain generations of generations to come. Each bite of tomorrow's harvest may have a story to tell of science, innovation and a promise of a more secure table for all.