While common beans are a versatile and healthy staple crop for millions of people in Africa and the Americas, they can be difficult to grow, store and digest.

In the future, gene editing could help scientists develop varieties that are drought-tolerant, have a longer shelf life, and are more digestible — traits that could benefit farmers and consumers alike.
The Benefits of Beans

There are close to 40,000 different varieties of common beans and more than 400 million people worldwide include beans as part of their daily diet. This is because common beans are a good source of vitamins and are highly nutritious. Common beans contain complex carbohydrates, dietary fiber, and important vitamins and minerals, such as thiamine, vitamin B6, iron, zinc, potassium and folate. Regular consumption of common beans has even been linked to a reduced risk of cardiovascular disease and diabetes. They offer 2-4 times more protein than cereals and are more affordable than meat and dairy. In fact, in many emerging markets, a third of the protein needs of humans come from legumes, including beans.

Beans have many positive qualities and farmers and consumers continue to search for beans that are easier to grow and eat. While breeders have successfully developed bean varieties with disease resistance and higher levels of nutrients, traditional breeding programs can be time-consuming and labor intensive, which means other traits, such as yield increases, resistance to pests and other diseases, improved storage and shelf life, and nutritional qualities remain elusive.

Using Soybean Genetics to Guide Better Common Beans

The genome of common beans is similar to that of soybean, which has been widely studied, sequenced, and mapped across the world. Soybeans have benefited enormously from innovation and research for more than two decades and plant biotechnology has increased yield, resistance to pests and diseases, and has improved the nutritional quality of soybeans. Organizations like the Brazilian Agricultural Research Corporation (EMBRAPA) and the International Center for Tropical Agriculture (CIAT) are using their understanding of soybeans to guide their research on common beans.

Gene Editing as a Recipe for Hardier Beans

Even though common beans are relatively easy to grow, drought can decimate the majority of the crop, leaving farmers with only about 20 or 30% of the potential yield. These prolonged dry episodes can have devastating impacts on bean crops in places like Brazil, the world’s largest producer of beans. EMBRAPA has targeted drought genes previously identified in soybean for gene editing in common beans. The projects under development work with the genes already present in the bean genome for the development of more drought-resistant varieties.

An additional issue farmers face with beans is post-harvest storage. Once harvested and dried, beans are often kept for long periods of time in order to provide a reliable staple food that can be consumed year-round. Unfortunately, quality deteriorates over time, making beans less desirable to consumers. For example, in Brazil, where annual per-capita bean consumption is 17kg or 27 pounds, Carioca is the most commonly consumed bean. As months pass in storage, the beans darken and harden. Darker beans take more time and energy to cook, and that longer cooking time reduces the nutritional benefits of beans. EMBRAPA is using gene editing to improve post-harvest quality and develop varieties of beans that can be stored for longer periods and marketed at better prices with longer shelf life.

Using Gene Editing to Solve the Issue of Digestibility

In many parts of the world, consumption of common beans as a main source of protein remains relatively low and the health benefits they provide that may help ward off chronic disease go untapped. One reason that common
beans are not more popular may have to do with their digestibility. Common beans contain some naturally occurring compounds that can’t be broken down in the human digestive tract.

Steve Beebe, leader of the Bean Program at the International Center for Tropical Agriculture (CIAT) says “Discomfort caused by gases that beans generate as they move through the gut might be a reason people don’t eat more of them. That’s an issue whether you’re a European looking to change your diet to avoid Type 2 diabetes or a mother in Africa choosing what to feed your young children to keep them healthy and active. Too many of us hesitate to eat beans.”

Scientists at CIAT have recently adapted a protocol for editing genes in soybean that they can use to develop common beans that don’t produce the indigestible polysaccharides. They are using CRISPR/Cas9 to adjust three different genes in the Chaucha-Chuga, Ica Quimbaya and Calima varieties.

CIAT’s work is ongoing but reducing the expression levels of these genes in the common bean or ‘knocking out’ their function all together could result in varieties that are easier for people to digest, while maintaining all of the other excellent nutritional qualities. If better digestion makes common beans more popular, then more people could benefit from their rich nutritional profile, ultimately making a positive contribution to public health across populations.

**Gene Editing for Better, More Nutritious Crops**

With further improvements to applications of gene editing tools for common bean, researchers can take better advantage of information gleaned from the recently-sequenced genome. Not only can they identify genes within the common bean that are involved in critical traits such as size, flavor, disease resistance and drought tolerance, but they can use them to develop better beans for all of us.

Innovative tools such as gene editing and other advances in plant breeding are integral to producing food that meets diverse dietary preferences and nutrition needs around the world, naturally and sustainably. Gene editing is a safe, precise and important way to meet urgent health demands of a growing world population, and helps farmers cultivate better crops for their families and communities.

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**Key references:**

Personal Communications from Joe Tohme and Steve Beebe, CIAT.

Personal communication with Rosana Pereira Vianello Brondani - Embrapa Arroz e Feijão - CNPACF <rosana.vianello@embrapa.br>