Like many scientific findings, this one started out with an inkling and a passing conversation. To hear Henry Thompson tell it, a chance meeting on campus led to a decade-long project that would uncover health benefits, such as cancer prevention, of dry beans.

“The way I remember it, and Mark [Brick, past CSSA president] may tell it differently, I was walking to the building where my laboratory is, and Mark was walking in the opposite direction,” says Thompson, director of the Cancer Prevention Laboratory at Colorado State University. “He said, ‘Will you work with me on dry beans? I think they could have some great activity related to preventing diseases like cancer.’ So I said, ‘Sure, that’s why I’m here.’”

Thompson had recently moved his Cancer Prevention Laboratory from a cancer research center in Denver to the Department of Horticulture and Landscape Architecture—not an expected move. He took the risk in part because he had recently become very interested in how to get the best foods for human health into the marketplace. This meeting provided an opportunity to do just that.

With Thompson’s experience as a nutritional scientist and Brick’s expertise in crop breeding, their sidewalk conversation grew into a collaboration. Their work has shed light on the health benefits of dry, edible beans—a crop that is often forgotten in today’s modern diets though it can provide multiple benefits to consumers, growers, and the environment. The term “beans” is used for a number of crops, which can create confusion. The research of Thompson and Brick focuses on dry beans, which are part of a group of crops called pulses or grain legumes.

“These beans are often called edible, dry beans. That is a problem because when you say dry bean, are you supposed to eat them dry? No, dry beans need to be cooked before you eat them,” Thompson explains. “It’s not uncommon for people to misunderstand this.”

Dry beans, members of the species Phaseolus vulgaris, are also known as common beans. That’s not much better, says Thompson, but these names do help differentiate the parts of the plant that people eat. Dry or common beans are the mature seeds, while the immature forms of the bean, the fleshy pods, are often called snap or string beans.

Protecting against Cancer in Animal Studies

No matter what name is used, Brick and Thompson believe dry
beans should become a larger part of our diets—especially since they've found evidence that these beans protect against cancer in animals. Researchers have long used rat models to study cancer and possible treatments. Thompson and Brick took advantage of these models to look at the effects of beans in the diet. The rat model they used was one in which cancers were induced by injecting a compound that causes gene mutations.

“The compound mimics cancer because cancer is caused by gene mutations,” Brick explains. “Those mutations affect genes that regulate [at least] two things—cell division and cell adhesion. Cells divide uncontrollably, and that’s how we get tumors. And a subsequent step in the process is the cells metastasize—they slough off and spread to other parts of the body.”

While some people argue that rat cancer models are not relevant to human cancers, Thompson explains that this rat model has been used for years and has brought about important results. Findings from the model have been successfully transferred to the clinic and are still used today to treat people. “This model has been very useful for translating ideas to people,” Thompson adds.

With this oft-used model of rat cancer, Brick and Thompson, along with their teams, looked at how different amounts of bean in the rat diet affect tumors. They created rat diets that included 7.5, 15, 30, or 60% dry beans, while making sure all diets had the same amount of protein, carbohydrate, fiber, and other macronutrients. After the rats had been on the diets for 46 days, the researchers recorded how many rats got cancer (incidence), how many tumors each rat had (multiplicity), and how big the tumors were (burden). They also looked for common characteristics of “good” cells or “bad” cells. For instance, a good sign in cancer prevention are cells that are undergoing apoptosis—programmed cell death. Cells go through this program when they are defective. Cancer cells, however, often fail to undergo apoptosis, and they continue to divide, creating tumors.

The results of the study showed a dose-dependent response to beans in the diet. In other words, “the more beans the rats ate, the greater the protection against cancer,” Thompson says. Even in rats fed the lowest percentage of beans, cancer incidence and multiplicity were significantly lower than in rats fed the normal diet. And the protection provided by the 60% bean diet was impressive—incidence was reduced by 41%, multiplicity by 53%, and burden by 64%. Likewise,
The number of cells undergoing apoptosis increased with increasing levels of beans in the diet.

This dose dependence—seeing more of the desired effect with increasing levels of beans—is promising. In the medical field, a dose-dependent response suggests that the effect is real. Additionally, by seeing a dose-dependent response to beans, it is possible to find the “sweet spot,” the point at which there is neither too little nor too much bean. Finding that spot, first for the rats in the model, and then for human consumption, can steer dietary recommendations and optimize the benefits.

“More and more evidence is coming out that too little or too much of something can do harm,” Thompson explains. “You’re looking for the sweet spot, the spot where you go from good to great, recognizing that at some point great turns to bad.”

Another question Brick and Thompson asked was whether different types of dry beans would have varying effects on tumors. To answer that, beans from different areas and of different colors were fed to the rats. Beans of multiple colors were important to test because darker beans have higher levels of antioxidants, which are of interest right now in cancer research circles.

With this in mind, rats were fed one of six kinds of beans—the researchers chose two white beans with low antioxidant activity and four colored beans. Interestingly, it was one of the white beans that seemed to be most beneficial. In fact, animals have varying effects on tumors. To answer that, beans from different areas and of different colors were fed to the rats. Beans of multiple colors were important to test because darker beans have higher levels of antioxidants, which are of interest right now in cancer research circles.

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Henry Thompson’s lab uses a variety of cellular and molecular techniques to determine how beans and other food crops impact the development of cancer (above, courtesy of Annie Cavanagh, Wellcome Images, images@wellcome.ac.uk).

fed white kidney beans (also called cannellini beans) had a 44% reduction in cancer multiplicity compared with rats fed navy beans, which were also beneficial.

“All beans are good, but the beans with even more than average activity were cannellini beans,” Thompson says. “Most people would expect a pigmented bean would be most effective, but it was a white bean.”

Because cannellini beans have lower levels of antioxidant compared with other beans in the experiment, this study suggests that something besides antioxidants protects against cancer. What is it?

Keeping the Benefits—and the Beans—Intact

Brick and Thompson recently received a grant from the National Cancer Institute to study and isolate the compounds responsible for protection against cancer. There is precedence for creating cancer treatments out of compounds in plants. Taxol, a common breast cancer treatment, was a compound found in a yew tree. It is now artificially synthesized.

For Brick, the development of treatments is an important pursuit, but his focus is elsewhere. Understanding how beans protect against cancer will allow breeders like him to improve the food supply and produce crops that provide even more benefits to human health.

“Clearly drug discovery is part of it … the pharmaceutical industry wants to know what the compound is that’s the magic bullet. But that’s not our goal,” Brick says. “We want to breed beans that are healthier. We want to breed crops that can help reduce major chronic diseases—and not just cancer.”

But Brick and Thompson are also hesitant to reduce the beans to a single compound. Instead, they hope their work will help find ways to breed many of the beneficial aspects of beans together in a single crop. There is precedence for conserving the food as a whole to provide multiple benefits. Many published studies have shown that the effects of separate ingredients in foods are not as good as the whole food.

It’s a sentiment that Thompson feels strongly about. “If you start to take apart what it is in beans that’s protective, people won’t want to eat the food anymore,” he says. “At the level of the consumer, we do a disservice to them if we get them to look beyond the food.”

One part of bean that likely has multiple health benefits is the fiber. Fiber has been shown to have an impact on cancer—especially colon cancer—and generally keeps the digestive system healthy and functioning efficiently. Yet, according to a recent study, only 3% of American children and 8% of adults eat the recommended amount of fiber. Additionally, beans are excellent sources of protein, especially when complemented with cereal crops, providing a calorically responsible food choice. By keeping a food like beans intact and bringing the complete crop to the market, consumers will receive all of the possible benefits.
Other reasons to keep bean crops intact go beyond health and disease prevention to economics and the environment. Beans are usually quite cost effective. “They’re affordable, so they work across all socioeconomic strata,” Thompson adds. By creating healthier bean crops, all sectors of society can cultivate or purchase these foods instead of worrying about the affordability of an isolated compound or supplement.

In addition to their benefits to consumers, beans are environmentally friendly. They generally demand less water compared with other crops, such as corn, making them a good choice in areas where water is limited. Also beans, like other legumes, associate with nitrogen-fixing bacteria, bringing often-needed nitrogen back to the soil. This can be extremely useful in areas where other crops deplete the soil of nitrogen and producers are required to apply fertilizers.

“When I’m pushing beans, one of the things I talk about is that they’re very friendly in terms of the environment,” Thompson says. “So they’re sustainable, water friendly, and cost friendly.”

**Bringing Beans Back into Favor**

Thompson finds himself pushing—and defending—beans often. In his studies of the crop, he has fully realized the benefits of beans to growers, consumers, and the environment. But many people still see beans as a less desirable food option. In fact, on average, people currently eat only 1/20 of the daily recommendation of a half cup of beans per day. And Thompson would like to see people eat even more than that recommended amount—up to one and a half cups each day.

“I really do see that [beans] could solve multiple problems,” he says. “That’s why I’m getting on the bandwagon to refocus attention on these neglected crops.”

One of the reasons beans may have fallen out of favor is misinformation that’s out there about the crop. One of the most widely circulated myths is that beans should not be eaten because they are toxic. While beans do contain lectins, which can be harmful to humans, the harm is removed through cooking. Another reason that beans seem to have been neglected in recent years is that people don’t know how to prepare them or get them into their diets anymore. To address the lack of know-how, Thompson and Brick have a number of bean recipes on their website, “Crops for Health” at www.cropsforhealth.colostate.edu/ (see box). The recipes, called “Beani-ficial Recipes,” help people work the crop into more meals more often.

Ultimately, Thompson wants to make beans “sexy” again—to bring them back into the forefront and out of the shadows. Introducing people to new ways of cooking and consuming beans is one way. Also, drawing upon many people’s interest in environmentally friendly foods could convince some that redirecting diets toward more beans and pulse crops is a sustainable choice. Any of the many benefits of beans could be used to draw the public back to the crop and to get them eating, growing, and—importantly—talking about beans.

“We want to breed beans that are healthier,” says Mark Brick (left). “We want to breed crops that can help reduce major chronic diseases—and not just cancer.” Photo courtesy of Colorado State University. Photo below by Stephanie Malyon (CIAT).
“I learned that people need to hear a message 70 times before it comes routinized,” Thompson explains. “That means you’ve got to work on multiple levels to get people to really embrace your message. If consumers get hooked and create a trend, a lot of good could be done. It ultimately will come from consumers.”

If beans do come back into favor among consumers and they start including more of the crop in their diet, it won’t be a new phenomenon. Instead, it will be a return to an older diet, a return to staple crops. Staple foods have largely been forgotten today, but they are the foods people eat in large quantities and that provide most of their nutrients and energy.

Two common groups of stable foods are the cereals and the pulses. The Food and Agriculture Organization (FAO) of the United Nations recommends that consumers eat cereals and pulses in a ratio of 2:1—two servings of cereals to one of pulses. Today, however, that ratio is more often around 8:1.

“Since the green revolution, that ratio has drastically changed,” Thompson says. “As a global community, we’re really under-eating something that for 10,000 years was a staple part of the diet in most regions of the world. I think that’s a problem.”

For that reason, Thompson likes to tell people that we can seek an ancient solution to a 21st century problem. We need to realize the potential of less “attractive” crops, such as beans, to return to a time when pulses were a regular part of the diet. Only then will the full benefits of these crops—from disease protection to environmental sustainability—be available to consumers and farmers.

“Beans and other pulses make important contributions, and they’re a global food,” Thompson says. “We’re missing something because we’re not eating them.”

C. Schneider, Science Communications Coordinator for ASA, CSSA, and SSSA

Crops for Health is a transdisciplinary research program based at Colorado State University. The aim of the program is to breed food crops that better aid in disease prevention. The program website (www.cropsforhealth.colostate.edu/) provides a number of resources including information about plant-based foods, press releases about research in the field, health calculators, and bean recipes.