

# THIS WEEK

## EDITORIALS

**TASTE** Savour the flavour of a gene-edited tomato **p.8**

**WORLD VIEW** How farmers transformed climate-science project **p.9**



**YELLOWSTONE** More endangered than your average bear **p.13**

## Power to the people

*Everyone gains when researchers partner with the public and policymakers. The knowledge generated is more likely to be useful to society and should be encouraged.*

Few sign up to science for a glamorous lifestyle, colossal salary or generous dental plan. They do it to gain insights and knowledge and, they hope, to make the world a better place. Too often, that last objective proves hard to achieve — not because of uncaring researchers living in ivory towers, but because the way in which some types of study are done and rewarded does not set the correct priorities. That needs to change.

Enter co-production: full involvement in research by people who hope to benefit from the work, in partnership with communities, policymakers and other members of the public. Popular since the 1970s among sociologists as a way to help set inclusive policy, the term — and the principle — is spreading throughout academic science. As we highlight in a special issue this week, a growing number of projects are adopting the approach and working with such groups to jointly carry out research. And ‘jointly’ applies at all stages, from the project’s initial framing through to publication and follow-up.

Co-production can take many forms. Climate scientists, for example, are partnering with farmers to tailor projects to focus on their specific circumstances, such as the changes in precipitation that are likely in a warming world. A World View on page 9 explores how researchers worked with farmers in northeast Argentina to produce forecast systems for local needs, on the basis of emerging climate models and local knowledge of crop losses.

Clinicians, environmental researchers and many others are coming to appreciate that there are crucial kinds of lived expertise that can improve their studies.

Co-production is less suited to some scientific pursuits, but it can be a powerful way to make results more relevant and practicable across a spread of disciplines. Some call it science that is actionable. At present, too much research done in the name of society is not used by society. Instead it is paid for, produced and dutifully recorded, and then left waiting for someone to come along and use it.

Co-production demands a different approach — from funders, who need to find flexible ways to include and pay for people who work outside academia, to institutions, some of which appoint dedicated staff to negotiate and champion the sometimes-sensitive partnerships required. It needs better incentives: ones that recognize that this work often takes time and doesn’t necessarily lead to high-profile papers and other conventional types of academic success, but can produce outcomes that make a difference in the lives of the people at the heart of the research. Also needed are better ways to analyse and measure the success of co-produced research (see Comment, page 32). Publishers and journals can play a part; in one small step, for instance, *Nature’s* authorship guidelines state that anyone who had a sufficient role in the

work can be included as an author (see [go.nature.com/2pocpux](http://go.nature.com/2pocpux)). Most of all, co-production requires individual scientists to see the opportunities and to want to take advantage of them.

The growth in political populism and rising public dissatisfaction with policies some people see as excluding their interests have made it more important for researchers to produce — and to be seen to produce — research that is both beneficial and relevant to society. Efforts to do so are overdue. The onus is on researchers and those who support them to put systems in place to encourage more collaborations.

If ivory-tower scientists did cut themselves off from the problems of the world in the past (and multiple lines of evidence over decades across medicine, engineering, technology, agriculture and dozens of other fields suggest that many did not), then few can get away with such an attitude now. Grant applications and project assessments ask for explanations of the work’s probable societal impact, and commercial funding frequently comes with a desired application as a goal.

Co-production is better for society. It also leads to better research — both technically, because it accounts for more factors, and ethically, because it’s more equitable. That means it increases the chances of genuinely making the world a better place, because what emerges will be more suitable for take-up. That’s something that everyone who cares about research can sign up to. ■

## Forgotten crime

*The United States should not execute a murderer who no longer remembers his offence.*

In 1985, Vernon Madison shot a police officer in the back of the head while the officer sat in his car. It was a heinous crime for which Madison has spent the past 33 years on death row, much of it in solitary confinement.

But Madison now doesn’t remember the Alabama shooting or the name of the officer — he can remember very little at all. Multiple strokes in the past few years have wiped out parts of his brain involved in memory and left him with vascular dementia. Madison’s lawyers have appealed against his death sentence, and presented his case before the US Supreme Court earlier this week.

The case raises complex philosophical, legal and ethical questions about the purpose of the death penalty and what it means to truly understand one’s own guilt. In taking the case, the court accepted the task of deciding whether it is cruel and unusual to execute a violent murderer



**CO-PRODUCTION OF RESEARCH**  
A *Nature* special issue  
[nature.com/collections/coproduction](http://nature.com/collections/coproduction)

who doesn't understand his fate, even if he understood the possible consequences at the time the crime occurred.

The evidence of Madison's cognitive disability is convincing. In neuropsychological tests administered by multiple specialists, he can't interpret the meaning of stories or logically draw conclusions. His lawyers say that, in terms of his intellectual function, there is no difference between his current condition and that of a person born with an intellectual disability. The latter group is protected from execution, thanks to a 2002 Supreme Court decision.

Madison's case differs because he did not have a severe cognitive impairment at the time he committed the murder, and presumably knew it was wrong. The state of Alabama argues that once the situation is explained to him, Madison also understands that he was tried and will be executed. Alabama says it doesn't matter whether he remembers it, because he can still rationally conceptualize it.

But psychologists and psychiatrists say that this is very different from a deep understanding of one's own guilt. Ultimately, the court will have to determine what level of 'understanding' is sufficient to conclude that Madison can rationally process his punishment.

Science cannot offer all the answers in this specific case. Still, decades of research on neuropsychology — much of it done to better understand mental-health conditions — have honed the ability of specialists to understand brain function. In a joint amicus brief filed to the Supreme

Court, the American Psychiatric Association and the American Psychological Association say that neuropsychological tests and advances in neuroimaging can accurately assess cognitive capacity, precluding any concerns that in the future, courts might see a flood of appeals from people who falsely claim to have no memory of their crime.

The court could issue a narrow decision that applies only to Madison, or it could rule broadly on people who cannot understand the reason for punishment. Although there are probably very few people on death row with vascular dementia, conditions such as traumatic brain injury or tumours could cause a person to forget a crime.

**“The case highlights the illogic of capital punishment.”** The case highlights the illogic of capital punishment. Death-penalty proponents argue that it is necessary for justice to be served, as well as to deter others from crime. Yet neither of these conditions applies here. Madison cannot see his execution as justice because he cannot recall his crime. And executing a person with an intellectual disability hardly serves as an example or deterrent.

Regardless of the decision, Madison is not going unpunished. If he escapes execution, he will spend the rest of his life in prison alone, disabled and confused by the world around him. He is no longer a threat. The court should set an example and grant mercy. ■

## I say tomato

*A new super-tomato highlights Europe's outdated approach to gene editing.*

**T**he world produces some 800 billion tomatoes each year — but how many of them are worth eating? Thousands of years of breeding have produced a fruit that often suits farmers and sellers more than consumers. Vines now grow in an orderly fashion, and produce lots of tomatoes that stay in place until they are harvested and are firm enough to be shipped long distances. But, in too many cases, studies have confirmed that flavour and nutrition have got lost somewhere along the way.

Plant scientists are on the case. This week, three papers from research groups around the world detail attempts to make a new type of super-tomato: one that does not sacrifice taste for convenience. To do this, the researchers used CRISPR–Cas9 gene editing, which allowed them to modify specific genes in wild relatives of tomatoes. The result — according to a scientist who has tasted one of the fruits — is an “aromatic” tomato that could re-energize taste buds.

The studies are a demonstration of the fruits of decades of painstaking plant-genetics research: a cupboard full of genes with known effects, that can each be adjusted to turn an unruly wild plant into a valuable domesticated one. The work serves as a reminder of the value of basic research into plant growth and development. And it shows how other useful traits could be introduced in other crops.

One group edited a wild relative of the tomato called *Physalis peruviana*, which is grown in Central and South America (Z. H. Lemmon *et al. Nature Plants* 4, 766–770; 2018). Its berries are tasty and slightly sweet, but its sprawling growth pattern and tendency to drop its fruit onto the ground make it ill-suited for large-scale agriculture. The edited plant was more compact, and produced larger fruits.

The other two groups tinkered with a relative called *Solanum pimpinellifolium*. This species is stress tolerant and resistant to the commercially devastating disease bacterial spot, but the researchers sought to boost the size and attractiveness of its fruits, while making plant growth easier to control (A. Zsögön *et al. Nature Biotechnol.* <http://doi.org/cvf2>; 2018; T. Li *et al. Nature*

*Biotechnol.* <http://doi.org/cvfz>; 2018). They aimed to combine the benefits of *S. pimpinellifolium* with the features of modern tomatoes that appeal to farmers and consumers. The researchers also laboured to increase the nutritional value of their new tomatoes: first, by boosting the levels of lycopene, a carotenoid linked to health benefits; and second, by focusing on a greater vitamin C content.

To achieve the same product through conventional breeding would have taken decades, says Jörg Kudla at the University of Münster in Germany, a lead author on one of the papers. Instead, it took his team three years. It's an example of science serving a need of society — and one that highlights the flawed steps the European Union is taking that will threaten such work in the future. In July, the European Court of Justice ruled that foods produced by CRISPR–Cas9 gene editing must be bound by the same onerous regulations as genetically modified crops. The resulting mandatory tests and trials will massively increase the cost of developing a commercial product, which in turn makes funding for research on such products less viable.

The expense is one reason why genetically modified crops have so far yielded little benefit for consumers: because it has cost so much to produce such plants, companies focus on developing commodity crops and traits that appeal to farmers. Kudla has grant applications for up to €2 million (US\$2.3 million) now under review to fund research related to his gene-editing work. But funders have a responsibility to spend their cash in ways that might benefit taxpayers, he notes, and if such crops have no commercial future in Europe, it might be a struggle to justify paying for the crops' development.

The long-awaited European court decision puzzled many researchers, because the technique involves gene edits that merely disable a gene, rather than rewriting it with a specific sequence. Scientifically, advocates see this as being similar to using a chemical or radiation to generate mutations and then screening the plants for a desired trait — which is not classed as genetic modification. But with CRISPR–Cas9, researchers can generate the mutations in specific genes, without having to screen thousands of plants for each trait they want to introduce.

The ruling came as a blow, particularly because, in January, an advocate-general to the European court argued that such crops do not need the same scrutiny as conventional genetically modified crops. And it highlights the degree to which researchers are at odds with officials on genetic modification in Europe. Scientists and supporters must keep up their efforts to advocate for cutting-edge research. Meanwhile, perhaps a better-tasting tomato could help to bring more policymakers on side. ■