

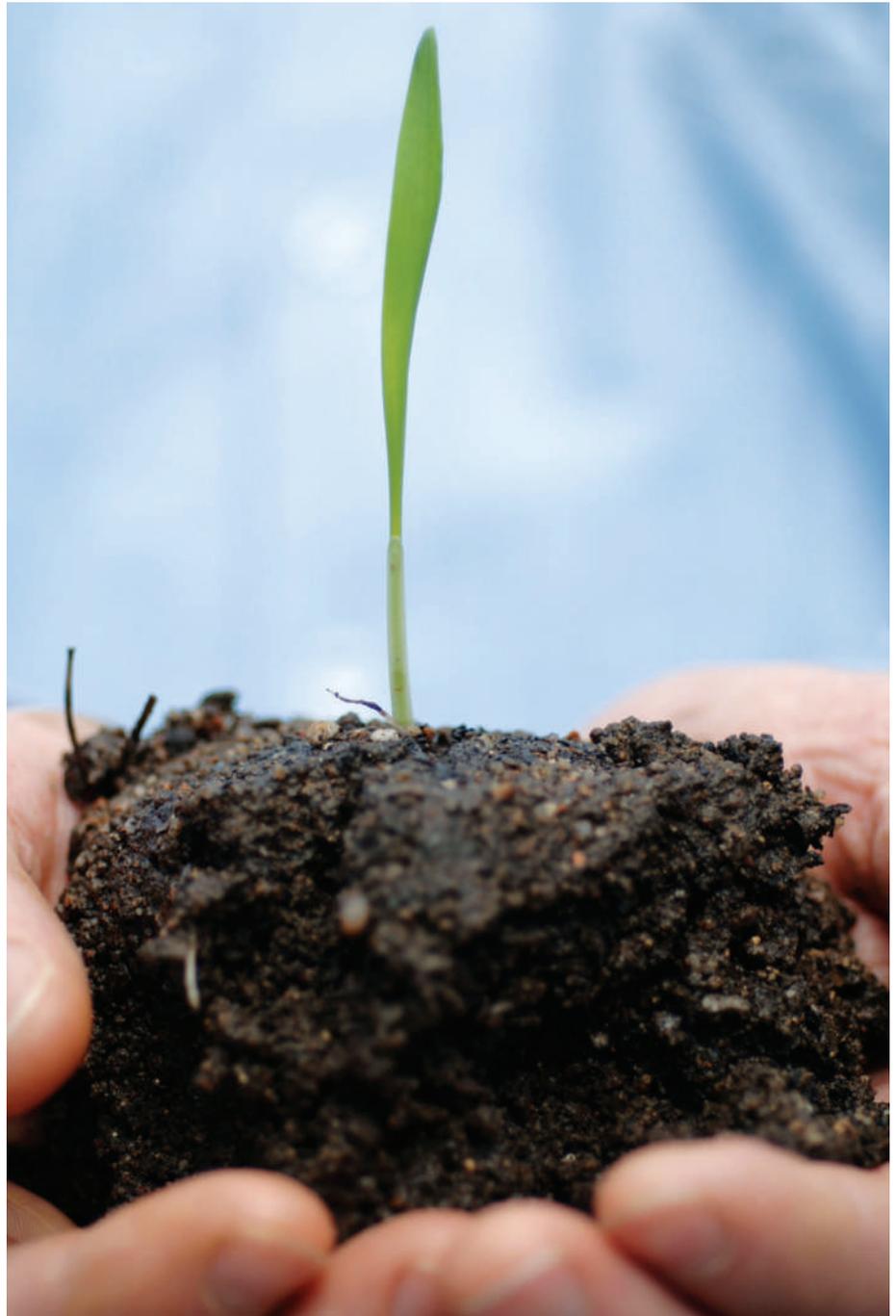
Cultivating new talent

Concerns about food shortages, land use, climate change and biodiversity have created a huge need for interdisciplinary researchers focused on agriculture. **Virginia Gewin** investigates the opportunities.

Jonathan Hickman never thought his scientific interests would lead him into agricultural research. Trained as an ecologist, he wanted his work to have a global impact. But Hickman soon saw that the work of such prominent ecologists as Pamela Matson of Stanford University, who documents how agricultural intensification in the tropics increases atmospheric concentrations of greenhouse gases, includes an oft-ignored ecological variable — human activity. Hickman realized that some of the most important questions in ecology — such as tracing human-caused changes to the carbon cycle — were best studied down on the farm. After all, agriculture represents a tremendous anthropogenic impact on land use, and affects biodiversity as well as climate.

When Hickman stumbled upon the postdoctoral fellowship programme at Columbia University's Earth Institute in New York, he found the perfect opportunity to conduct interdisciplinary work that would not only probe a key scientific question — how climate change might affect food production — but would also help alleviate food insecurity in developing nations. Now a postdoc at Columbia, Hickman models fertilizer-induced carbon and nitrogen emissions from agricultural lands in an attempt to help pinpoint sustainable, productive agricultural practices. His work is part of the Earth Institute's larger Millennium Villages project in Africa, an interdisciplinary research programme designed to help locals lift themselves out of poverty. "I couldn't have written a more perfect job description if I'd written it myself," he says.

Hickman is part of a growing trend. Historically, agricultural research has not been considered sexy science. Its lacklustre image is one reason that, over the past decade, agricultural professional societies have warned of a growing skills gap resulting from a long-term decline in student interest together with a wave of pending retirements. But the food shortage of 2008 — sparked by drought and a spike in oil prices — was a wake-up call for scientists and world leaders that the world's agricultural research infrastructure and workforce is woefully inadequate. Worries about how climate change might affect the food supply in the future have added to the sense of urgency, driving a recent increase in interest in agricultural research from both students and funding agencies.



BARLEYMAX

Delivering the dramatic increases in crop yields needed to feed 9 billion people by 2050 — without increasing greenhouse-gas emissions or encroaching on land that is needed to maintain biodiversity — is a daunting challenge with no simple solutions. It will probably require many different innovations in plant growth and food production, from exploiting plant genomics

to create crop strains resistant to changes in climate, to reducing greenhouse-gas emissions from agricultural practices, to boosting the efficiency of photosynthesis.

These challenges mean an array of new opportunities for budding researchers eager to address global problems and transcend individual disciplines such as genomics, nanotechnology and soil microbiology.

Already, government agencies and industry are actively recruiting top talent — and educating students about potential career opportunities — to help create more sustainable agricultural systems. “We can’t solve these challenges without a new model of scientific integration,” says Roger Beachy, director of the US National Institute of Food and Agriculture (NIFA), based in Washington DC.

Fertilizing the field

Congress created NIFA last year to tackle US national priorities such as climate change, nutrition and food safety. Beachy expects that NIFA’s focus on high-profile, high-impact research will lead to the creation of large multi-institutional, multi-state projects. Agricultural research funding has received a big boost under NIFA, although some wonder whether the new agency will promote genuine innovation or remain mired in ineffective and inefficient regional strategies, a criticism that legislators, agricultural researchers and others have levied against NIFA’s parent agency, the US Department of Agriculture (USDA — see *Nature* 461, 580; 2009). Beachy notes that NIFA’s Agricultural Food Research Initiative (AFRI), which used to be part of the USDA’s Cooperative Research Extension and Education Service, received a 25% increase in funding for competitive grants after NIFA’s creation. He says he will ensure that at least

one-third of future AFRI grants will require an extension or education component to help translate research findings to farmers and consumers. And although NIFA’s overall budget request from President Obama for fiscal year 2011 is essentially the same, it does include a doubling of funding for AFRI, up \$166.4 million from a fiscal year 2010 total of \$262.5 million.

AFRI’s resources will be dedicated to tackling five areas of social challenge — food safety, global food security, childhood obesity, climate change and sustainable bioenergy. To attract the scientific talent needed to meet these challenges, NIFA will offer larger grants over longer time periods. Rather than an average grant of \$500,000 per year over three years, funding levels of \$5 million per year for five years — or even longer — are now possible. NIFA also aims to create more training opportunities, says Beachy. The NIFA Fellows programme, to be officially announced in March, will offer at least 50 pre- and postdoctoral fellowships, funded from a dedicated pot of \$5 million for the first year. Beachy, the former director of the

Donald Danforth Plant Sciences Center in St Louis, Missouri (and the developer of the first virus-resistant tomato), says building interdisciplinary projects helps fulfil his mandate of attracting competitive research scientists to the field. “I want students to go to a programme or lab because of the excitement of the study,” he says.



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Training opportunities in food security are a focus of Britain’s Biotechnology and Biological Sciences Research Council (BBSRC). On 10 February, it allocated a £15-million (US\$23-million) boost in funding to increase the number of MSc and PhD training programmes in food-security research and development and to make them more relevant to the needs of the agricultural industry. Maurice Moloney, the new director of the independent, non-profit Rothamsted field station in Hertfordshire, UK, the longest-running agricultural research station in the world,

champions such opportunities. “My objective is to make Rothamsted so attractive that it’s the top choice for young scientists who are eager to make an impact on agriculture — both in terms of overall crop yield and in how

OPPORTUNITIES IN DEVELOPING NATIONS

Decades of neglect have weakened the agricultural research infrastructure in many developing countries, leaving them with far too few agricultural experts. But funding bodies elsewhere are helping to create schemes to train local researchers in these countries.

The US government backs the Borlaug Fellowship programme, which is overseen by the US Department of Agriculture (USDA) Foreign Agriculture Service. This programme offers six to eight weeks of training each year to around 50 scientists from developing countries. Borlaug Fellows — typically PhD students — receive air fare, health insurance, per diem pay and lodging while they develop a relationship with a US mentor scientist in a particular field of research.

The non-profit Gates Foundation, based in Seattle, Washington, also offers a Borlaug Fellowship that trains scientists from developing countries at Texas A&M University in Galveston. But the Gates Foundation concentrates most of



Participants in a Gates Foundation-funded programme in Uganda learn about the effects of different fertilizers used in an experimental rice field.

its effort in this field on building agricultural research training in the countries concerned. “We believe African problems have to be solved by Africans,” says Roy Steiner, a deputy director in the global development programme at the Gates Foundation.

The Nairobi-based Alliance for a Green Revolution in Africa, funded by the Gates Foundation and the

Rockefeller Foundation in New York, supports dozens of African PhD students and MSc candidates in their own countries. One of the Gates-funded programmes, called AWARD, is specifically aimed at increasing the number of female agricultural scientists, says Steiner, because women comprise the majority of farmers in developing nations and are most

often interested in the nutritional issues critical to development. The Gates Foundation also funds the \$12-million Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) to strengthen MSc programmes in agriculture at 25 African universities by attuning research methodologies to local conditions and providing access to the top agricultural journals.

Alerting people in developing nations to the opportunities that exist is a big challenge, says Noel Magor, training-centre head at the International Rice Research Institute (IRRI) in the Philippines. The IRRI offers several scholarships and short courses, aimed particularly at graduate students in the various Asian regions, which develop skills in plant breeding, entomology and targeted molecular research. In addition to funding graduate work, Magor says that the IRRI is developing a leadership programme for young postdoctoral scientists in the Philippines, as well as in Japan and China. **V.G.**

agriculture fits into global ecology," he says.

Both Beachy and Moloney are eager to demonstrate to young researchers that agricultural research has plenty of opportunities for scientists whose background is not in agriculture. Mathematicians are needed to model greenhouse-gas emissions, genomicists to work with traditional plant breeders to develop crops with desirable traits, and ecologists to apply their expertise to protecting biodiversity in intensely managed systems.

But simply luring non-agricultural scientists into agricultural research, without a concomitant increase in traditional plant breeders, agronomists, crop physiologists, plant pathologists and entomologists, could hamper progress towards agricultural productivity and sustainability. "We need more people who can think and act in a systems framework, putting all the good science together into practical solutions for farmers," says Achim Dobermann, deputy director-general of research at the International Rice Research Institute (IRRI), the Philippines-based branch of the Consultative Group on International Agricultural Research. Non-agricultural scientists interested in the field should obtain an understanding of agricultural practices. "Students need a practical knowledge of agricultural systems to ferret out opportunities for innovation," says Philippe Petithuguenin, a senior adviser on agricultural research development at the European Commission.

Skills shortage

The IRRI's staffing needs, like those of other agricultural research centres, are acute. It recruited more than 200 employees in 2009 and expects that level of hiring to continue through mid-2010. The food shortage of 2008 prompted agricultural research organizations, such as the IRRI and the USDA, to address a skills gap resulting from retirements and a decade of low recruitment. The USDA estimates that 17,000 of its 100,000 staff will retire in the next five years.

And the demand for scientific talent in agricultural research is expected to grow. Young agricultural scientists will soon have their pick of research positions, according to Molly Jahn, acting under secretary for research, education and economics at the USDA in Washington DC. "Many agricultural research operations will face large waves of retirement in the next five to seven years, so we are really emphasizing

graduate training opportunities," she says.

Industry also expects to add staff, and some companies are setting up in-house training programmes. Monsanto, based in St Louis, Missouri, has its 'Emerging Leaders of Science' initiative, a three-year programme designed to provide both newly minted PhDs and those with postdoctoral experience with an opportunity to develop new skills — for example, adding traditional crop breeding to a background in quantitative genetics. For fellows who successfully complete the programme, a high-level position at Monsanto awaits. "Our goal is to develop a pipeline of hybrid individuals who are able to marry skills across the genetic and molecular technologies, regulatory and chemistry processes," says David Feldman, Monsanto's senior recruiter for technology.

The seed company Pioneer Hi-Bred International, owned by DuPont and headquartered in Johnston, Iowa, hired more than 700 scientists and support staff last year globally — a recruitment trend the company expects to continue in the near term. Although it currently hires for specific skills — particularly molecular biologists, biochemists and statisticians — Bill Neibur, vice-president of crop-genetics research for DuPont, says the company is searching for people who can combine molecular technology, simulation technology and agronomic understanding to find new ways to extend the limits of a plant's productivity.

Breaking down silos

One way in which research institutes are trying to attract top talent is by crafting positions that defy traditional discipline boundaries. INRA, the French national agency for agricultural research, based in Paris, is Europe's largest such body. Its labs recruit around 70 scientists each year and six positions to be advertised later this year will be free of any disciplinary label and designed specifically to attract new scientists to agricultural research. "We want to see top economists competing with top plant breeders or biologists for these fully open positions," says François Houllier, INRA's deputy director-general.

Other research organizations are breaking down disciplinary barriers in

pursuit of specific goals. Like NIFA with its challenge-based approach, Australia's Commonwealth Scientific Industry and Research Organization (CSIRO) has created flagship goal-oriented programmes. One of these is involved in breeding crops with greater nutritional value, which requires the skills of both plant breeders and nutritionists.

A recent success is BarleyMax, a high-fibre grain developed to improve bowel health that's been made into a top-selling breakfast cereal. "We feel that if we do things in a single discipline, we don't tap into the innovation that lies at the interfaces between disciplines," says Bruce Lee, director of the CSIRO's Food Futures Flagship.

The interdisciplinary study of the impact of climate change is likely to play a big part in many research agendas. Following the Copenhagen Climate Conference in December 2009, the USDA created the \$90-million Global Research Alliance (GRA) on Agricultural Greenhouse

Gases. Through partnerships with 20 other countries, researchers will expand climate-change mitigation research. The US money will be split between USDA in-house research projects and NIFA-funded extramural grants focusing on topics such as carbon sequestration and reducing agriculture's carbon footprint. In addition to training opportunities for MSc and PhD candidates that will result, the GRA will also increase the scientific capacity in developed countries by supporting developing scientists through the Borlaug Fellowship scheme (see 'Opportunities in developing nations').

Hickman hopes his climate-change work will benefit the wider world. But he also expects it to pave the way towards a viable academic career; he is encouraged that so many institutions are placing increased emphasis on interdisciplinary research. "The kind of interdisciplinary research structure at the Earth Institute is rare," he admits. But given the global need, and the fact that agriculture is at the heart of so many colossal ecological, biological and societal challenges, many more universities are likely to follow suit.

Virginia Gewin is a science writer based in Portland, Oregon.



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Correction

The story 'Big Apple biotech' (*Nature* **463**, 836–837; 2010) incorrectly stated the role of Tom Cirrito at Stemline Therapeutics. He is the director of operations at the company. In addition, contrary to what the article implied, the company employs more than four people.