The New Agricultural Research Revolution, Water, and the Future of Public Sector Research

Mark Giordano
Five (unprecedented) Changes

1. Speed of technology change
2. Rate of cost reduction
3. Sources of investment
4. Growth in investment volume
5. Nature of the science, the scientists and implementers
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Pest resistance by adding gene from bacteria
Implicit increase in water productivity from higher yield for same water
Possibility now to fundamentally change transpiration requirements

Corn with green photosynthesis proteins

Rice without

Rice with

Can rice be made to photosynthesize as efficiently as corn? If so, yields could rise 50 percent. In a magnified cross section of a corn leaf (left), photosynthesis proteins are stained fluorescent green. Ordinary rice (middle) makes none of the proteins—but rice that has been genetically manipulated by IRRI scientists (right) makes some. WILLIAM PAUL QUICK, IRRI
Deeper root systems

Increasing glaucousness

Quick closing stomates

Better early growth

Other water specific GMO efforts
Summary of potential mechanisms for biotech to impact agricultural water use

1. Implicit water implications of any yield improving biotech
2. Reduced runoff from less tillage means less sediment and more groundwater recharge/soil moisture
3. Fundamentally transform transpiration and/or more yield per unit of water transpired
4. Make crops better adapted to water stresses like drought, flood and salt
A programmable dual RNA-guided DNA endonuclease in adaptive bacterial immunity

Martin Jinek, #1,2 Krzysztof Chylinski, #3,4 Ines Fonfara, 4 Michael Hauer, 2,5 Jennifer A. Doudna, 1,2,6,7,* and Emmanuelle Charpentier 4,*
Insect Allies
Dr. Blake Bextine

The Insect Allies program is pursuing scalable, readily deployable, and generalizable countermeasures against potential natural and engineered threats to the food supply with the goals of preserving the U.S. crop system. National security can be quickly jeopardized by naturally occurring threats to the crop system, including pathogens, drought, flooding, and frost, but especially by threats introduced by state or non-state actors. Insect Allies seeks to mitigate the impact of these incursions by applying targeted therapies to mature plants with effects that are expressed at relevant timescales—namely, within a single growing season. Such an unprecedented capability would provide an urgently needed alternative to pesticides, selective breeding, slash-and-burn clearing, and quarantine, which are often ineffective against rapidly emerging threats and are not suited to securing mature plants.
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<tr>
<th>Crop</th>
<th>Gene/Transgene</th>
<th>Trait Description</th>
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<td>Maize</td>
<td>ZmNs</td>
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**Applications and potential of genome editing in crop improvement**

W. Zhang, Karen Maspel, Ian D. Godwin and Caiusa Gap III

*Genome Biology 2018: 19:310*

https://doi.org/10.1186/s13059-018-1686-z © The Author(s) 2018
Published: 30 November 2018
Technology Review

Biomedicine

With This Genetic Engineering Technology, There’s No Turning Back

Designers of a “selfish” gene able to spread among mosquitoes say it could wipe out malaria, but the scientific community is at odds over whether or not we should do it.

by Antonio Regalado November 23, 2015

MIT Technology Review

Biomedicine

We Have the Technology to Destroy All Zika Mosquitoes

Fear of the Zika virus could generate support for gene drives, a radical technology able to make species go extinct.

by Antonio Regalado February 8, 2016

MIT Technology Review

Biomedicine

Top U.S. Intelligence Official Calls Gene Editing a WMD Threat

Easy to use. Hard to control. The intelligence community now sees CRISPR as a threat to national safety.

by Antonio Regalado February 9, 2016
In China, Gene-Edited Babies Are the Latest in a String of Ethical Dilemmas

He Jiankui, who claimed to have created the world's first genetically edited babies, at a conference in Hong Kong this week. Other scientists have sharply denounced his work.  

Kim Cheung/Associated Press
Best Drones For Agriculture 2019: The Ultimate Buyer’s Guide

POSTED ON JUNE 11, 2019 BY ANDREW NIXON
VEGAN IMPOSSIBLE BURGER HEADS TO AFRICA TO SOLVE THE WORLD’S ‘BIGGEST ENVIRONMENTAL ISSUE’
New tech and lower research costs should make it possible to target farmers, regions and crops missed by the GR and GMOs.

But if this possibility is not realized, those farmers may be made worse off by negative price effects.
Edit-R tracrRNA

Chemically synthesized trans-activating CRISPR RNA required for use with synthetic crRNA for fast and easy gene editing.

The synthetic crRNA:tracrRNA approach to CRISPR-Cas9 includes transfection-ready RNA components and enables fast assessment of multiple target sites per gene, for multiple genes.

Edit-R CRISPR-Cas9 Synthetic tracrRNA

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<th>Catalog #</th>
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Find a Biohacking Makerspace Near You
Five (unprecedented) Changes

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A FOOD REVOLUTION HAS BEGUN
S2G IS INVESTING IN IT

S2G Ventures (Seed 2 Growth) is a multi-stage food and agriculture venture fund investing in entrepreneurs whose products and services meet the shifting demands for healthy and sustainable food.

WE INVEST FROM “SOIL TO SHELF”
We help build next-generation food and agriculture technology companies.

The food and agriculture sector is undergoing unprecedented change, driven by demographics, globalization, sustainability pressures, new energy sources and concerns about food safety and security.
Taranjeet Singh of AgNext is disrupting the agribusiness industry by using sensing solutions and big data to embed intelligence across growing, procurement, and processing
Funding the future of food
Invest with us in the bold and exceptional founders transforming our food and agriculture system.

#SOILHEALTH #MICROBIOME #BIOTECH
Some venture funds in traditional ventures

Tyson Ventures
Monsanto Growth Ventures
Danone Manifesto Ventures
Syngenta Ventures
Mars Ventures
Rabobank Food and Ag Fund
WE INVEST IN COMPANIES THAT ARE TRANSFORMING THE SAFETY, SECURITY AND SUSTAINABILITY OF GLOBAL FOOD
BIG IDEA VENTURES

Cohort Close Date: August 1
APPLY NOW

Apply to BIV: Food Accelerator

Investing in Entrepreneurs to Deliver Big Ideas
We help ambitious founders transform food and agriculture

Since 2006, we've provided growth capital to partner with the best and boldest companies that are helping feed the world sustainably. Learn more about us.
We back Food Tech Entrepreneurs for a healthier, more sustainable and efficient food system.

Learn how we work
Some accelerators investing in food/ag

Ycombinator
SOSV
Hatch
TechStars
Food-X
<table>
<thead>
<tr>
<th>Category</th>
<th>Investment</th>
<th>Deals</th>
<th>Investment with BAT Involvement</th>
<th>BAT Investors</th>
<th>Largest Deal</th>
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<td><strong>China AgriFood Startup Funding Breakdown 2017</strong></td>
<td>$1.8bn</td>
<td>177</td>
<td>$741m</td>
<td>79%</td>
<td>$330m</td>
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<td><strong>Upstream</strong></td>
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<td>Ag Biotech</td>
<td>$106m</td>
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<td>$30.3m</td>
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<td>Bioenergy &amp; Biomaterials</td>
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<td>Novel Farming</td>
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<td>Agribusiness Marketplaces</td>
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<td>Midstream</td>
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<td><strong>Downstream</strong></td>
<td>$1.7bn</td>
<td>149</td>
<td>$741m</td>
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<td>In-store Restaurant &amp; Retail</td>
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<td>Online Restaurants</td>
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<td>eGrocery</td>
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<td>Restaurant Marketplaces</td>
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<td>Home &amp; Cooking</td>
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*BAT refers to China's three largest internet companies Alibaba, Tencent and Baidu*
Most Active Venture Funds

- The most prolific was ZhenFund, China's largest seed fund set up by two founders of China's educational group New Oriental School, with 11 agrifood investments, mostly in In-Store Retail & Restaurant Tech.

- Bits x Bites was the only food tech-focused fund in China backing eight projects covering indoor farming, blockchain for food supply chain, insect protein, and other food tech sectors.

- Big VCs with diversified portfolios such as Matrix Partners China, IDG and Tiantu Capital were active in mid-to-later stages. In 2017, they chose startups in In-Store Retail & Restaurant Tech, Premium Branded Foods and Restaurants, and eGrocery.

Projects invested by BAT's controlled subsidiaries or venture arms are counted as BAT's projects.
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Pakistan's GNP 2017 = $305 Billion

India's GNP growth 2016-2017 = $323 Billion
2017-18 GROWTH in upstream ag VC is 2.5X CGIAR total budget

Investment to startups operating closer to the farmer grew over 44% year-over-year, the fastest annual growth rate on record, and in-line with downstream funding growth for the first time.
Note: Dotted line is extrapolated. Source: USDA
Figure 3. CGIAR revenue by funding channel in 2017, compared to the CRP Portfolio 2011-16
A basic shift

Federal agencies provided less than half of U.S. basic science funding in 2015, a result of stagnant budgets and rising investment by industry, universities, and philanthropies.

- Federal
- Corporate
- University
- Philanthropy

Data check: U.S. government share of basic research funding falls below 50%

Graphic: D. Malakoff/Science
Data: National Science Foundation
Global Investment World Map
Five (unprecedented) Changes

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Data Analyst
- Data Analyst
- Data Engineer
- Data Scientist - Deep Learning
- Operations Lead, Data Analytics
- Senior Software Engineer, Backend (Data Analytics)
- Software Engineering Manager, Backend (Data Analytics)
- Sr. Engineering Manager, Data Analytics

Design
- Principal UX Designer
- UX Researcher

Engineering
- Engineering Director, Data Infrastructure
- Enterprise Data Architect
- Head of Application and Platform Engineering
- Lead Web Engineer
- Master Data Management Lead (MDM)
- Senior Technical Program Manager
- Senior Technical Program Manager, Capabilities
- Software Engineer, Backend (Multiple levels)
- Software Engineering Manager, Data Translation
- Sr. Software Engineer, Cloud Engineering
- Sr. Staff Software Engineer, Backend (Multiple levels)
- Sr. Staff Software Engineer, Cloud Engineering
- Staff Software Engineer, Backend (Remote Sensing / Raster Pipelines)

Science
- Atmospheric Scientist
- Data Scientist - Machine Learning
- Data Scientist - Soy Crop
- Data Scientist - Spatial Statistics
- Data Scientist - Cereals/Other Crops
- Designed Field Research Scientist
- Scientific Analytics Technical Project Manager
- Scientific Software Engineer
- Senior Data Scientist - Machine Learning

Security
- Product Security Manager

Check on an application you've submitted.
Seattle and San Francisco, not Pullman and Davis
Millennials ‘Make Farming Sexy’ in Africa, Where Tilling the Soil Once Meant Shame
Welcome to WWOOF

**WWOOF organisations** connect people who want to live and learn on organic farms and smallholdings with people who want to share their lifestyles, teach new skills and welcome volunteer help. There are places in Africa, Americas, Asia, Europe, Middle East and Oceania.

**WWOOF hosts** offer food, accommodation and opportunities to stay and learn about organic/biological growing and farming.

**WWOOF Volunteers** give hands on help and have an interest in learning about organic farming and gaining skills in sustainable...
• **The Good** - rapidly changing technology and rapidly falling costs will make it possible to target the water problems of neglected farmers.

• **The Bad** - The changing nature of investment suggests that the neglected may well be neglected again—with greater negative impacts, since markets are now more integrated.

• **The (potentially) Ugly** - It is not clear that the public sector research community will adapt quickly enough to the changing environment to impact its direction.
• Recognize and acknowledge the changes
• Think like Pakistan
• At a minimum:
  – New engagement strategies to deliver the equity messages we have already learned
  – Rethink the public sector/CGIAR niche
  – New and different partnerships