The Second Green Revolution Will Bring Agri-Tech Breakthroughs to Growers

Donald R. Marvin

Concentric Ag Corporation, Denver, CO and Concentric Agriculture Inc., Montreal, Canada

Introduction

We are on the brink of the Second Green Revolution. The challenges at the start of the first Green Revolution in the mid-1940s remain, but today the population is massively larger and growing exponentially faster—to an expected 10 billion people by 2050.

We need to grow a lot of food quickly. But in this Second Green Revolution, we need to find a “greener” way to do it—a way that protects human health and the natural environment.

The good news is that the tools and the know-how already exist to usher in a new generation for agriculture that is focused on the critical role of healthy soils. The movement that’s just beginning is about getting these new tools deployed in farm fields and greenhouses.

First Green Revolution Used Chemicals

Agriculture’s well-known first green revolution is largely attributed to the pioneering work of the American biologist Norman Borlaug. Borlaug’s revolution combined the development of new and hearty plant breeds and crop varieties with a less-green element: the heavy use of manmade versions of the plant macronutrients nitrogen, phosphorus, and potassium. The faster growth and increased yields that resulted were impressive; yields of some crucial crops tripled, more food was produced on less land, vast expanses of woods and rainforests were spared from clear-cutting and cultivation, and better nutrition was available for millions worldwide.

These breakthroughs earned Borlaug a Nobel Peace Prize in 1970, along with a designation as “the man who saved a billion lives.” The Nobel Committee wrote of Borlaug, “More than any other single person of this age, he has helped to provide bread for a hungry world.”

Limits of Chemicals

Today, however, those same synthetic chemicals that were a boon to growers during the first Green Revolution are less effective at increasing crop yields. Plus, these synthetic crop inputs are expensive and require farmers to spend time at a desk—tracking and complying with environmental regulations—rather than in the field. Their overuse also causes problems for humans

who rely on fresh air and clean drinking water. As one recent article reports:

“The impact of this degradation isn’t just on farmers, but extends to Americans’ health. Dust blowing off degraded fields leads to respiratory illness in rural areas; thousands of people are exposed to drinking water with levels of pesticides at levels that the Environmental Protection Agency has deemed to be of concern. The drinking water of more than 210 million Americans is polluted with nitrate, a key fertilizer chemical that has been linked to developmental problems in children and poses cancer risks in adults. And thanks to some modern farming techniques, soil degradation is releasing carbon—which becomes carbon dioxide, a potent greenhouse gas—instead of holding on to it.”¹

Moving Toward a More Holistic Approach

Against this backdrop, our Second Green Revolution will require a more holistic approach that harnesses new scientific understandings about soil health and the plant microbiome. Major benefits will accrue for everyone—growers, crop input suppliers, and consumers—if we embrace this new paradigm.

The goals of this new generation of agriculture must include a sharp focus on soil health: how to restore soils to serve their original purpose of efficiently delivering nutrients to plants to improve yields, retain water for drought resistance, store carbon to reduce the effects of climate change, purify groundwater, and help crops naturally resist disease.

Re-Energizing the Plant Microbiome

An important focus of soil-enhancement innovation is happening in the plant microbiome—a miniature world where millions of microorganisms coexist, with a dizzying variety of shapes, sizes and functions. The plant microbiome—also called the phyto-microbiome—includes not just microorganisms found in soil, but also those that colonize the roots of the plant and enter plant tissues to form beneficial partnerships.

Healthy soils can contain up to 25,000 species of microorganisms per gram of soil. Depleted soils might contain only one-fifth as many. Soils need to contain a healthy mixture of microorganisms, including fungi and bacteria, if they’re to produce large crop yields with minimal disease loss.

Biological crop inputs, such as those now in commercial production by Concentric and others, actively increase microbial activity in the plant microbiome. They are being used alone, or in combination with traditional crop inputs, on farm fields and in greenhouses. Farmers can improve water quality and soil health through more efficient nutrient management. Products

that help improve nutrient use efficiency and nutrient uptake to increase crop yields will attract the attention of growers.

A Role for Scientific Initiatives

“Soil health” is getting a lot of buzz, but its definition is vague. What exactly is soil health? How can it be measured? The topic is being studied in both the private and public sectors. Important work at a number of institutions seeks to understand the complexities of nurturing and measuring healthy soils.

The Soil Health Initiative (SHI), established in 2013, by the Noble Research Institute and Farm Foundation (Ardmore, OK), is perhaps the leading initiative dedicated to advancing soil health science for both agriculture and land management. A September 2017 article by SHI President and CEO Wayne Honeycutt, *The Language of Soil Health*, impressively unravels the mysteries of soil health.² Based on three years of input and feedback from scientists, conservationists and growers, SHI has created a list of 19 “Tier 1” soil health measurements that can be used by growers to chart and map their soil-health progress. What can be defined can be measured and, therefore, improved.

Another organization, Organic Farming Research Foundation (OFRF; Santa Cruz, CA), devotes considerable resources to spreading scientific understanding about soil health to the agriculture community through regular conferences and symposiums.

A Role for Growers and Their Fields

Growers provide the fields in which we learn application techniques and measure yield impacts. Those of us who have developed new biological products need real-world trials with growers to validate and improve the effectiveness of our products and to prove to growers that biological solutions provide bankable results in the field.

Growers themselves can contribute their expertise to the development of new farming practices. Increasingly college-educated and eager to explore new solutions, today’s most sophisticated growers are incited to embrace new solutions, especially ag biologicals, that increase microbial activity in the soil, which contributes to healthier root systems that improve the plant’s ability to absorb nutrients.

As an example, Concentric is pursuing product testing and grower education through more than 150 well-designed trials underway on two continents. In an increasingly globalized world, any Second Green Revolution must succeed in varying climates and soils and on all kinds of crops. Our trials include crops of strawberry, raspberry, Brussels sprouts, leafy greens, tomato, potato, almond, grape, apple, soybean, corn, cotton and wheat. Ultimately, it is only through trial and error that we can find the right combinations of biobased crop inputs, combined with reduced traditional fertilizers that consistently benefit particular plant groups.

Startups: Advantages and Challenges

It’s increasingly likely that any Second Green Revolution will depend heavily on discoveries by new and entrepreneurial agri-tech startups armed with leading-edge science and new ideas and pursuing new distribution models for their innovative products.

Instead of a former focus on multiyear R&D contracts between big ag companies and scientists, an innovation model is emerging that involves ongoing collaboration between agile scientific startups and the more aggressive agricultural producers, often with the active support of governmental entities. A collective effort will bring together top agronomists, microbiologists, statisticians and independent crop advisors, coupled with extension services, academic institutions, private industry and the growers themselves.

Scientists at entrepreneurial agri-tech startups have plenty of incentive to innovate. The financial community is responding, with significant investment dollars already being funneled into such startups. To garner investment dollars, those companies must show promise of offering a well-planned and integrated product pipeline, strong IP strategies and a clear path to profitability.

Those emerging startup companies that choose to partner their way into the world of Big Ag will need to offer solutions that can be seamlessly integrated into a Big Ag company’s manufacturing, marketing and distribution infrastructure and strategies. Others will find themselves working with second- and third-tier ag players hungry for promising innovative products that allow them to compete more effectively in the market. Various codevelopment relationships and alliances will develop as an alternative path to commercialization for these new technologies.

It is likely that today’s Big Ag consolidation and expansion will continue. These global firms will seek to acquire companies that have innovative products in the market and product pipelines that are complementary to those companies’ existing technology platforms and product suites. An overarching technology and product development strategy that can be extended into adjacent market areas will be of even greater value.

Traditional marketing channels will be disrupted as some innovators eschew partnering with, or being acquired by, Big Ag in favor of cozying up to those developing novel distribution strategies. In particular, some retailer cooperatives are growing more influential in the marketplace as hotbeds of tech-driven innovation. And tech-savvy players such as Amazon are eyeing opportunities in food retailing.

Just as Elon Musk’s Tesla has driven sweeping innovation in the auto industry, the rapid pace of agri-tech R&D coupled with a growing base of early adopters promises to keep accelerating agriculture’s pace of change.

Many agri-tech startups will fall by the wayside. Others will be so successful that their technologies will become part of standard farming practices. Large rewards will come to those who most rapidly get their solutions into the hands of growers.

Attracting Scientists

Young scientists are the future, and we need to find ways to attract them to agriculture. Our Second Green Revolution will stumble and stall if we do not make a career in agriculture hold as much appeal to scientists as working elsewhere in the Silicon Valley ecosystem.

A 2015 Purdue University/USDA study estimated that 58,000 skilled agriculture jobs would be posted online annually in fields

like management, technology, sustainability and biomaterials development, with only 35,000 graduating students qualified to fill them.³ As part of an overall tech-talent shortage, the recruiting of PhD-level scientific minds for ag-biotech positions has already become highly competitive, bordering on cutthroat. Many newly graduated experts in food, agriculture, renewable resources and environmental science are hard to snatch up.

Yet the rewards, intellectual and monetary, to those who choose to work in ag biotech are potentially great. Commercializing leading-edge science research while at the same time helping feed a hungry world is a pretty appealing career path.

A more scientifically based agricultural sector will help address the challenge of keeping young people involved in production agriculture. With the average American farmer now 58 years old, and with more Baby Boomer farmers retiring with each harvest, a movement that brings Silicon Valley-level scientific excellence to farming can and must occur.

Much of the original Green Revolution focused on adapting plant microbiology to existing soil conditions. In the Second Green Revolution, agriculture must continue to shift the cen-

ter of attention to innovations that nurture and enhance the soil itself.

Donald R. Marvin is President and CEO of Concentric Ag Corporation (Denver, CO) and Concentric Agriculture Inc. (Montreal, Canada). The company develops and produces biological crop inputs for farmers and greenhouse growers worldwide.

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