



Opinion

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The Sustainable Revolutions in Agriculture



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Abstract

Sustainable agriculture has seen several revolutions in the last half-century which can be broken into three main phases. Initial green agriculture ideas and practices are still in practice today but have been supplemented with improvements through genetic manipulation of seeds and integration of IT into the farming methods. These innovations have made major impacts and caused revolutionary changes in production yields of farmers, but with an exponentially growing world population it is still necessary to optimize and further develop sustainable agriculture.

Keywords: Sustainable agriculture; Green revolution; Gene revolution

Opinion

Sustainability in agriculture has had three phases in America: the early "Green Revolution", the "Gene Revolution", and the Information Technology (IT) phase revolution. The "Green Revolution" brought scientists and farmers together to change the world. It started in world agriculture around 1970 and crop yields greatly improved due to technology gains in hybrids, irrigation, terracing, and the use of industrialized farm equipment worldwide. It raised rice and wheat yields in Asia, and corn and soy yields in America. During this phase land produced higher yields to help feed a growing population, but more needed to be done about soil erosion and environmental impacts. Thus, a new greener and environmentally friendly phase evolved right out of this.

By the 1990's research and development introduced seed technology traits that would greatly increase yields, reduce pesticide and herbicide use, and allowing farmers to feed a rapidly growing world population. However, this revolution only occurred in the US, Canada, Argentina, and China due their genetically modified seed production in soybeans, corn, and cotton [1]. This transition from "Green" to a "Gene" Revolution offered a means to feed a growing world through biotechnology, with little increased need in land availability, and offered less impact on the environment [2]. GMO plants have traits that use less energy and water, and are made to resist specific pests and herbicides. After two decades, these GMO seeds now have the strength to produce grain in less favorable soils and have greatly increased yields to feed a growing world population.

Even Africa's very marginal soil can now grow corn in some regions. The AGCO Future Farm Project, that partners with Zambia's government and others in the private sector (seed, fertilizer, and chemical industry), records a four-fold increase in grain production since the use of mechanized machinery was introduced in conjunction with a strong seed package [3]. Africa needs GMO seeds that can produce grain on soils that are much less ideal than America's river valleys of the Midwest. In our opinion, this African agriculture revolution will reduce regional famine risks, create food and grain exchanges between nations, develop transportation routes for trade, and intensified farming will clearly contribute to many local economies. While many American farmers have farmed during all three phases of the sustainability revolution, African farmers are learning about them all at once during their Agriculture Revolution with the help of American agriculture industry investors and educators. Fortunately, they have the benefit of using other nations' developments and research to expedite their revolution progress. With support from the World Bank and private investors, many African nations hope to reduce the risk of famine and build their nation's economies pulling them out of poverty.

Though some nations are embracing GMO grain, others are not onboard with the idea of genetic plant modification, including most of Europe, and even China has skeptically changed their view [1]. Even though this Gene Revolution was greener toward environmental conservation and offered higher yields than the Green Revolution, it's a debate that has disrupted trade and

caused concern over human's health issues. In 2015, GMO seed was planted on 30% of the world's corn acres, 82% of its soybean acres, and 68% of all cotton lands; yet in the U.S., they are all well over 90% GMO produced [1]. This Gene Revolution has currently stalled out due to policies that restrict nations from importing certain traits or all GMO grains. Most issues of trade disruptions have been caused by seed companies selling seed to producers that has not been approved for export markets - only national use. November of 2013 thru mid-April of 2014, China rejected barges holding 1.45 million metric tons of co-mingled GMO corn, since some GMO traits were not approved [4]. When this massive amount of corn was rejected, it flooded the market with grain at clearance price rates. Much of this grain carried over into the next year effecting exports, and trade bans effected market prices for years. Since 2000, U.S. corn farmers have united against Syngenta for selling seed that was not approved for global marketing causing economic losses. It is hard to get countries to improve their opinions of importing GMOs, when we are sending nations co-mingling barges of approved and unapproved GMO grain. This "Gene Revolution" has not, and will not reach its full potential to feed the world's growing population until GMOs are accepted worldwide. Until then, trade barriers will limit major gains in yields and cause struggles with our leading exporters.

Overlapping the Gene Revolution, we have now entered a third phase of the Green Revolution, the computerized Information Technology (IT) Revolution. This phase is the greenest of all phases above, because it is all about efficiency, not yield. The benefit of reducing seed, chemical, and fertilizer waste has not only improved profitability, but improved America's rural ecosystem as well. These gains have been found through Precision® planting, GPS mapping, targeted application rates, and harvest data that is stored and imported into agriculture software. For example, data from grid soil sampling can be imported into programs that can apply variable rates of fertilizer, thus a higher rate can be applied where needed and less on nutrient rich ground. This doesn't raise the quantity or cost, but puts the money where it's needed to boost yields. The IT Revolution is responsible for reducing wastes by as much as 15%, but on average across all farm sizes between 12 and 15%

[5]. This has reduced chemical impacts on the environment, improved water quality, and consistently found ways to improve farm profitability [6].

In conclusion, the Sustainability Revolution gained momentum with each new phase; and all three phases have contributed to substantial gains in yield, soil sustainability, and environmental improvements. Note all agriculture revolutions benefit farmers, consumers, and governments worldwide. With America's agriculture industries leading the way in research and development many great innovations are on the horizon: crop irrigation technology, cover crop enhancements, gene technology, bio-fuel development, mechanical enhancements, and many more. American farmers are constantly learning how to farm better with less of a footprint on the environment. "I grew up on a farm in the 70's and now operate my own family farm; and have witnessed these three sustainable agriculture phases occur over my lifetime" (Schwenke , D., personal communication). We feed the world, and work long and hard to preserve our land and water for our children and all of America's next generation. There is no doubt we have not seen the last phase of the sustainable agriculture revolution, and with continued research and technology development we will see more integration of sustainable technologies and practices on the fields. These innovations are not a luxury but a necessity with a rapidly growing population that needs feeding.

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