Four innovations that revolutionized Twentieth Century agriculture

Over a little more than a century, technological innovations have significantly changed agricultural practices and increased the yield per unit of ground and the level of production per unit of labor. Four key innovations—the internal combustion engine, the Haber-Bosch process of producing nitrogen fertilizer from the air, the introduction of hybrid corn and the focus on crop genetics, and the development and use of farm chemicals—transformed agricultural production in the 20th and early 21st centuries.

While steam engines were initially used by industry in the late 17th century and later adapted for use in nautical and railroad transportation, their use in agriculture was generally limited, due to their large size and need for a bulky supply of fuel. Those problems were overcome with the late 19th century development of the internal combustion engine powered by liquid fuel. These engines were soon adapted to power horseless carriages and from there it was only a small step to adapt them for farming purposes with the development of the gas tractor. While steam traction engines required several men to operate them efficiently, the gas tractor could be operated by a single person and was significantly lighter.

Tractors with liquid-fueled internal combustion engines were soon being adapted to a wide range of agricultural tasks from field preparation to planting to harvest. These tractors eliminated the need for draft animals, making land that had been used to grow draft animal feed available to produce food for human consumption, either directly or indirectly through grain fed to food animals. The introduction of tractors also reduced the level of human labor required by the agricultural sector.

The early 20th century development of the Haber-Bosch process which enabled the extraction of nitrogen from the air solved a significant limitation of agricultural production: the loss of soil fertility from continuous crop production on the same field. This loss of soil fertility could be partially overcome through the use of animal manure, the mining of thick deposits of bird guano, or crop rotations that included plants that could restore nitrogen to the soil with nitrogen fixing bacteria, but these supplies of nitrogen fertilizer either were not sufficient or did not provide the same revenue as the production of a cash crops like corn, wheat, and cotton. The use of nitrogen produced by the Haber-Bosch process along with phosphorus and potash restored soil fertility and allowed for the continuous production of cash crops in a two or three crop rotation.

The third transformative agricultural development of the last century was the development of hybrid corn beginning in the 1920s. Before that time, based on what they saw at corn judging contests, farmers selected the longest and most uniform ears to shell and use as their seed corn for next year's crop. In 1920, Henry A. Wallace along with "Iowa State agronomist H.D. Hughes…established the Iowa Corn Yield Test, a statewide contest to determine which farmer had corn with the highest yield rather than the prettiest ears" (Culver and Hyde, 2000, "American Dreamer," p. 69). That contest served as the death knell of corn judging contests and in 1924 Wallace's Coppers Cross hybrid corn won the contest and hybrid corn began to dominate the competition. Between 1900 and 1924 the average national corn yield was 26.6 bushels/acre. The projected yield for 2018 is 176.4 bushels/acre. In the intervening years, crop breeding based on improving understanding of the science of genetics has resulted in yield increases for all crops.

Crop diseases have been the bane of existence for farmers since they first began to deliberately put seeds in the ground to raise a crop. Over 4 millennia ago, farmers in the Fertile Crescent discovered that they could use sulphur dust as a pesticide. But the use of farm chemicals did not begin to accelerate until the 1920s with the development of a synthetic insecticide, Lethane 384, that could replace pyrethrum as an insecticide. From that point on there has been a steady parade of insecticides, fungicides, and herbicides to better control plant pests and diseases, and reduce the farm labor needed for weed control. In addition to crop genetics, farm pesticides have been a critical element in the steady increase in crop yields.

The result of these four technological innovations in agriculture has been increases in production that have outpaced the increase in utilization. Despite the analysis of Thomas Malthus that food production increases arithmetically while population increases geometrically, leading to increased hunger and death. To date production has outpaced population growth. From a humanitarian perspective this is a desirable outcome, but it has price consequences. Prices can easily fall below the cost of production for significant periods of time with little effect on production, itself.

The question then becomes "How do we meet the goal of providing a nutritious diet for all the citizens of the world while making sure that farmers can cover their cost of production?" This is a question that needs to be tackled at the national and international level in the coming years.

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