



Future of Agriculture

Matthew N. O. Sadiku¹, Uwakwe C. Chukwu², Abayomi Ajayi-Majebi³, Sarhan M. Musa¹

¹Roy G. Perry College of Engineering, Prairie View A&M University, Prairie View, TX, USA

²Department of Engineering Technology, South Carolina State University, Orangeburg, SC, USA

³Department of Manufacturing Engineering, Central State University, P.O. Box 1004, Wilberforce, OH, USA
Email: sadiku@ieee.org; uchukwu@scsu.edu; ajayi-majebi@centralstate.edu; smmusa@pvamu.edu

Abstract The future of agriculture is significant if we are to provide quality food to the growing global population. It is an important question for the planners and all other stakeholders. Agriculture has become the focus of politicians, consumers, scientists, and environmentalists. For this reason, one is curious about how technology will direct the future of agriculture and, how we need to step up our efforts in order to reach zero hunger. It is well known that new technologies often expand output and reduce production costs. This paper addresses the future of technologies related to agriculture and food industry.

Keywords technology, agriculture, farming, future of agriculture, food industry

Introduction

With the advent of technology, every aspect man's activities experience advancement.

Man has experienced several technological advances that have had tremendous impact on his way of living. These advances are evident in several spheres including education, information and communication, transportation, healthcare, and agriculture. The agricultural sector has been vital for the economy and continuity of our life. Its importance will increase even more in the future.

As the world's population increases daily, there is a corresponding need to ensure food security. Right now, the planet's food systems, which are integral to the health of the people, are not capable of producing enough food to feed everyone. Given the limited scope for expanding agriculture's use of more land and water resources, the major challenge is to produce more with less. Therefore, there is an increasing pressure on decreasing available cultivable land to produce more quantity, variety, and quality of food.

The agriculture and food sector is one of the key sectors of national economy. The industry is facing a number of new challenge: climate disruptions to agriculture, soils are eroding, farm labor shortages, changing customer demand, shrinking fertile farmland, increased urbanization, global trade barriers, heavy ploughing machinery, and an aging farmer population. Farmers are facing increasing pressure to expand production and protect the environment. To counter these challenges, a gradual infusion of tech-based tools such as robotics, drones, big data, and Internet of things has taken place.

In many countries, agriculture is complex. Figure 1 illustrates the multifunctionality of agriculture [1]. It generates a rich diversity of food, fiber, feed, forage, and fuel for consumers around the globe. The chart in Figure 2 shows a breakdown of the monetary value of US agriculture products by category [2].



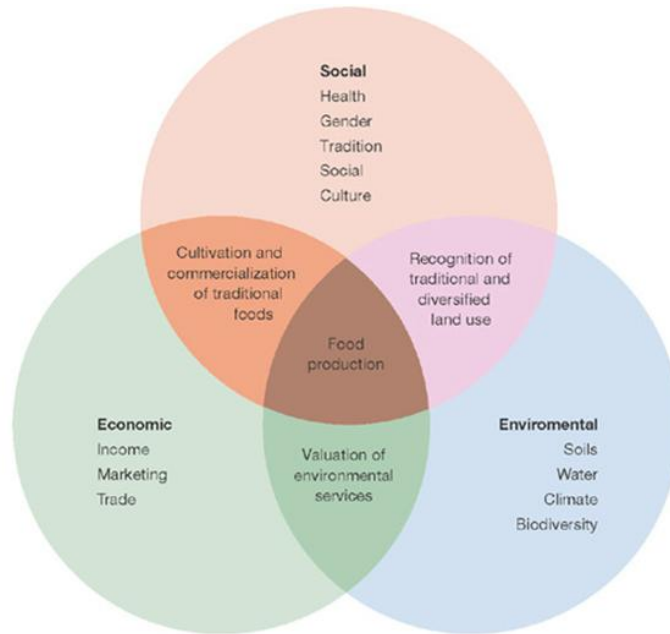


Figure 1: The multifunctionality of agriculture [1]

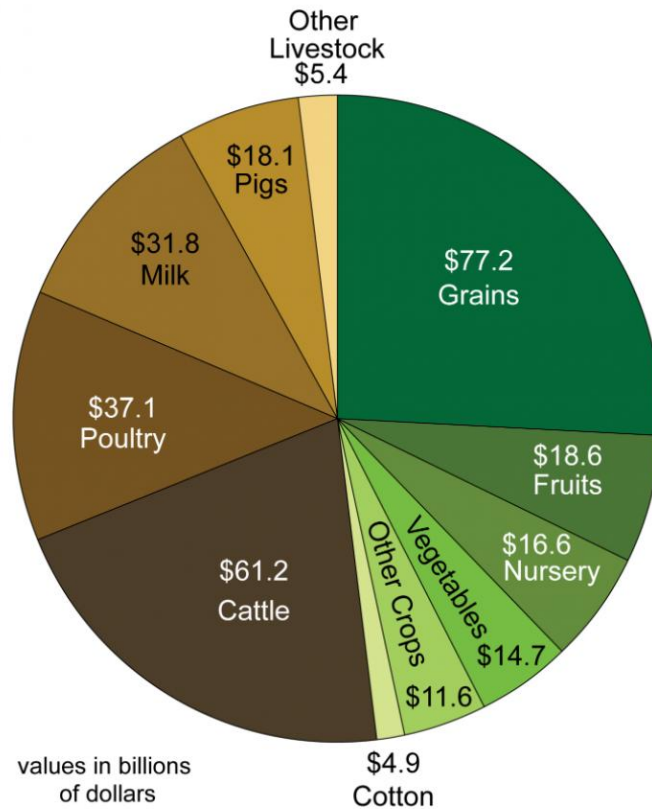


Figure 2: A breakdown of the monetary value of US agriculture products by category [2]

Trends in Agriculture

The reforms towards privatization, liberalization, and globalization significantly affected agricultural market. Technology is an integral component of agriculture and technological advances drive the shape of agriculture. Although future developments are hard to predict, the following ongoing trends in agriculture are noteworthy.

- The agricultural landscape will drastically change more than ever before.

- Emerging technologies will be harnessed to reduce costs and increase yields.
- Precision agriculture will spread from its North American heartland to Europe and those parts of South America, where large arable farms predominate.
- Urban agriculture has become a major trend.
- Robotics and sensing technologies can solve problems as old as farming itself.
- An unsustainable trend is the ever-increasing use of agricultural inputs (such as fertilizers) with diminishing increases in yield.
- Using nanotechnology to enhance food quality and safety will be expected in near future.

Future of Agriculture in Some Applications

Technology has taken a firm foothold in agricultural development in recent years. It is the solution to agriculture's problems. Technologies that will play a major role in tomorrow's agriculture are artificial intelligence, robotics, and big data. For future agriculture, we need new approaches aimed at increasing both productivity and environmental protection.

- *Artificial Intelligence:* AI and machine learning are the core technology shaping the future of agriculture. Artificial intelligence is one of the emerging technologies in the field of agriculture which tries to simulate human reasoning in intelligent systems. It is making a revolution in agriculture by replacing inefficient traditional methods with more efficient AI-based methods. AI is used in agriculture in various ways such as automation, robots, drones, soil and crop monitoring, spraying, harvesting, and predictive analytics AI will be key in solving one of the huge problem of feeding our growing population in the face of over-population and climate change. The application of artificial intelligence (AI) in agriculture has been widely considered as one of the most viable solutions to address food inadequacy.
- *Robotics:* A robot is a programmable machine that can carry out actions autonomously. The term "robotics" covers the system components, the perception, cognition, and actuation. The marriage of agriculture and robotics has a long history. The development of agricultural robotics began in the 20th century, with the goal of reducing the manual labor costs needed to produce food. Robotic systems offer the potential to reduce costs and increase efficiencies. Robots are used for harvesting. An agricultural robot is shown in Figure 3 [3].



Figure 3: Agricultural robot [9]

- *Precision Agriculture:* This may be regarded as the next wave of agricultural innovation. It is based on electronic information and communications technology. PA basically uses knowledge and technology to better distribute available resources. Its core principle is to apply the right input at the right place at



the right time. It implements two key concepts: increasing yield and reducing costs. PA technology offers more sustainable and effective alternatives. In PA, drones are used in detailed tracking, which facilitates steps such as irrigation and maintenance by allowing aerial view of agricultural land. However, the percentage of farmers adopting PA is quite low. This is due to the fact that these sensors are both expensive and complex. Sensors watch everything: temperature, humidity, illumination, etc. Farmers often do not believe the benefits of these sensors have been shown sufficiently in real farms [4]. PA technology does not require specialized knowledge by the user and is being adopted by farmers around in the world.

- *Smart Farming*: Agriculture is one of the biggest users of smart technology since technology is a significant factor in increasing our ability to grow more food. The smart farming is a subset of precision agriculture, which is designed to control the suitable environments for crops inside a greenhouse. It constitutes the key feature to the future of agriculture. It involves using of modern technology to improve and increase the efficiency, quality, and quantity of farm products. The major technological tools that facilitate smart farming include artificial intelligence, drones and rovers, and Internet of things (IoT), and sensors [5]. A smart greenhouse is designed with the help of IoT intelligently monitors, eliminating the need for manual intervention.

Challenges

Agriculture will face many challenges in the future and the growing population will require a drastic increase in food supply. Labor availability for agriculture is under threat.

Agriculture is a risky business due its dependence on the weather. The risks are real, and the public can help farmers to mitigate them. Governments, the private sector and farmers themselves need to build robust and overlapping risk-management systems that provide farmers with more than one avenue for protection. The impact of producing food is under increasing scrutiny. Agriculture in the United States has been systematically corporatized such that a few corporations control up to 80 per cent of the business. American farmers are losing income, piling up debt and nobody listens to them. Some are even committing suicide out of deep distress [6]. The needs of the agricultural workforce, both farm managers and hired workers, must be addressed to ensure that our food system meets the needs of our population. Innovation using digital tools and data science is key to tackling agriculture's challenges. To handle increasing demand successfully in the future, the industry will need to overcome these challenges.

Conclusion

There is nothing inevitable about the future direction of the agricultural and food systems. What happens is a political choice. Numerous national government and international development programs in the past have sought to improve agriculture.

Women play a major role in the productivity of the agriculture ecosystem. They should be granted the same rights as men and supported by governmental and economic foundations [7]. Farmers everywhere must have clear rights over the land they cultivate before they can be expected to improve their productivity.

Beginning farmers are in every area of agricultural production. The agriculture graduates of tomorrow should be familiar with emerging technologies in agriculture and understand best-practice regional farming systems. For example, they will need manage big data sets to make informed decisions and optimize farm production [8]. More information about the future of agriculture can be found in the books in [9-14] and the related journals: *Journal of Agricultural Education*.

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About Authors

Matthew N. O. Sadiku is a professor emeritus in the Department of Electrical and Computer Engineering at Prairie View A&M University, Prairie View, Texas. He is the author of several books and papers. His areas of research interest include computational electromagnetics and computer networks. He is a fellow of IEEE.

Uwakwe C. Chukwu is an associate professor in the Department of Industrial & Electrical Engineering Technology of South Carolina State University. He has published several books and papers. His research interests are power systems, smart grid, V2G, energy scavenging, renewable energies, and microgrids.

Abayomi Ajayi-Majebi is a professor in the Department of Manufacturing Engineering at Central State University in Wilberforce, Ohio. In 2015 he was honored by the White House as a Champion of Change for his significant contributions to the engineering education of minority students. He is a senior member of both the Society of Manufacturing Engineers and the American Society for Quality.

Sarhan M. Musa is a professor in the Department Electrical and Computer Engineering at Prairie View A&M University, Texas. He has been the director of Prairie View Networking Academy, Texas, since 2004. He is an LTD Sprint and Boeing Welliver Fellow. His areas of research interest include computational electromagnetics and computer networks.

