IMPACT OF NEW AGRICULTURE TECHNOLOGY IN PREDICTION OF MODERN ROBOTIC SYSTEM

Dr. M. SATHEESH PANDIAN
Assistant Professor, Department of Economics and Centre for Research in Economics, Arumugam Pillai Seethai Ammal College, Tiruppattur

ABSTRACT

Innovation is most important in new agriculture than ever before. The industry as a whole is facing huge challenges, from rising costs of supplies, a shortage of labor, and changes in consumer willingness for transparency and sustainability. There is increasing recognition from agriculture corporations that solutions are needed for these challenges. In the last 10 years, agriculture technology has seen a little growth in investment. Major technology innovations within the space have focused around areas like indoor vertical farming, automation and robotics, livestock technology, modern greenhouse practices, precision agriculture and artificial intelligence, and blockchain. Most of the studies reviewed estimated economic implications assuming that technology design parameters were achieved and/or supported data from prototypes. Nowadays, in large part thanks to the tremendous recent improvements in growing technology, the industry is witnessing a blossoming like no time before. Greenhouses today are increasingly emerging that are large-scale, capital-infused, and urban-centered. Most predictions into the impact of latest ideas on the workforce are of a speculative nature in terms of both how the technologies will evolve, and the way the labour market will respond. Economic analysis of crop robotics could play an identical role within the research planning and adoption of the technology. Automation and robotics are changing the face of agriculture at an alarming pace. .From self-driving tractors to weeding robots and controlled environment agriculture, agriculture automation companies are kick starting the farming industry to a totally modern environment. Most predictions into the impact of latest technologies on the workforce are of a speculative nature in terms of both how the technologies will evolve, and the way the labor market will respond.

Keywords: *Transparency, Tremendous, blossoming, Predictions, Blockchain, Prototypes and Parameters.*

INTRODUCTION

Innovation is more important in modern agriculture than ever before. The industry as a whole is facing huge challenges, from rising costs of supplies, a shortage of labor, and changes in consumer preferences for transparency and sustainability. There is increasing recognition from agriculture corporations that solutions are needed for these challenges. In the last 10 years, agriculture technology has seen a huge growth in investment. Major technology innovations in the space have focused around areas such as indoor vertical farming, automation and robotics, livestock technology, modern greenhouse practices, precision agriculture and artificial intelligence, and blockchain. The working definition of a "field crop robot" for this study was: a mobile, autonomous, decision making, mechatronic device that accomplishes crop production tasks (e.g. soil preparation, seeding, transplanting, weeding, pest control and harvesting) under human supervision, but without direct human labour. Mobility is an essential part of the definition because field crops are typically geographically dispersed in the landscape. Autonomy is also essential because the field environment is not entirely controllable. Among the decisions that a field crop robot might make are distinguishing a crop plant from a weed, identifying an insect to choose the appropriate pesticide for micro dosing, choosing ripe fruits or vegetables, and stopping when it encounters an unknown obstacle.

AGRICULTURAL INVOLVEMENT TO INDOOR VERTICAL

Indoor vertical farming can increase crop yields, overcome limited land area, and even reduce farming's impact on the environment by cutting down distance traveled in the supply chain. Indoor vertical farming can be defined as the practice of growing produce stacked one above another in a closed and controlled environment. By using growing shelves mounted vertically, it significantly reduces the amount of land space needed to grow plants compared to traditional farming methods. This type of growing is often associated with city and urban farming because of its ability to thrive in limited space. Vertical farms are unique in that some setups don't require soil for plants to grow. Most are either hydroponic, where vegetables are grown in a nutrient-dense bowl of water, or aeroponic, where the plant roots are systematically sprayed with water and nutrients. In lieu of natural sunlight, artificial grow lights are used.

From sustainable urban growth to maximizing crop yield with reduced labor costs, the advantages of indoor vertical farming are apparent. Vertical farming can control variables such as light, humidity, and water to precisely measure year-round, increasing food production with reliable harvests. The reduced water and energy usage optimizes energy conservation -- vertical farms use up to 70% less water than traditional farms. Labor is also greatly reduced by using robots to handle harvesting, planting, and logistics, solving the challenge farms face from the current labor shortage in the agriculture industry.

FARM AUTOMATION

Farm automation, often associated with "smart farming", is technology that makes farms more efficient and automates the crop or livestock production cycle.

An increasing number of companies are working on robotics innovation to develop drones, autonomous tractors, robotic harvesters, automatic watering, and seeding robots. Although these technologies are fairly new, the industry has seen an increasing number of traditional agriculture companies adopt farm automation into their processes.

New advancements in technologies ranging from robotics and drones to computer vision software have completely transformed modern agriculture. The primary goal of farm automation technology is to cover easier, mundane tasks. Some major technologies that are most commonly being utilized by farms include: harvest automation, autonomous tractors, seeding and weeding, and drones. Farm automation technology addresses major issues like a rising global population, farm labor shortages, and changing consumer preferences. The benefits of automating traditional farming processes are monumental by tackling issues from consumer preferences, labor shortages, and the environmental footprint of farming.

LIVESTOCK FARMING TECHNOLOGY

The traditional livestock industry is a sector that is widely overlooked and under-serviced, although it is arguably the most vital. Livestock provides much needed renewable, natural resources that we rely on every day. Livestock management has traditionally been known as running the business of poultry farms, dairy farms, cattle ranches, or other livestock-related agribusinesses. Livestock managers must keep accurate financial records, supervise workers, and ensure proper care and feeding of animals. However, recent trends have proven that technology is revolutionizing the world of livestock management. New developments in the past 8-10 years have made huge improvements to the industry that makes tracking and managing livestock much easier and data-driven. This technology can come in the form of nutritional technologies, genetics, digital technology, and more. Livestock technology can enhance or improve the productivity capacity, welfare, or management of animals and livestock.

Livestock technology can enhance or improve the productivity capacity, welfare, or management of animals and livestock. The concept of the 'connected cow' is a result of more and more dairy herds being fitted with sensors to monitor health and increase productivity. Putting individual wearable sensors on cattle can keep track of daily activity and health-related issues while providing data-driven insights for the entire herd. All this data generated is also being turned into meaningful, actionable insights where producers can look quickly and easily to make quick management decisions.

Animal genomics can be defined as the study of looking at the entire gene landscape of a living animal and how they interact with each other to influence the animal's growth and development. Genomics help livestock producers understand the genetic risk of their herds and determine the future profitability of their livestock. By being strategic with animal selection and breeding decisions, cattle genomics allows producers to optimize profitability and yields of livestock herds. Sensor and data technologies have huge benefits for the current livestock industry. It can improve the productivity and welfare of livestock by detecting sick animals and intelligently recognizing room for improvement.

Computer vision allows us to have all sorts of unbiased data that will get summarized into meaningful, actionable insights. Data-driven decision making leads to better, more efficient, and timely decisions that will advance the productivity of livestock herds.

SUPPORTIVE FOR MODERN GREENHOUSES

In recent decades, the Greenhouse industry has been transforming from small scale facilities used primarily for research and aesthetic purposes (i.e., botanic gardens) to significantly more large-scale facilities that compete directly with land-based conventional food production. Combined, the entire global greenhouse market currently produces nearly US $350 billion in vegetables annually, of which U.S. production comprises less than one percent.

Nowadays, in large part due to the tremendous recent improvements in growing technology, the industry is witnessing a blossoming like no time before. Greenhouses today are increasingly emerging that are large-scale, capital-infused, and urban-centered. As the market has grown dramatically, it has also experienced clear trends in recent years. Modern greenhouses are becoming increasingly tech-heavy, using LED lights and automated control systems to perfectly tailor the growing environment. Successful greenhouse companies are scaling significantly and located their growing facilities near urban hubs to capitalize on the ever-increasing demand for local food, no matter the season. To accomplish these feats, the greenhouse industry is also becoming increasingly capital-infused, using venture funding and other sources to build out the infrastructure necessary to compete in the current market.

PRECISION AGRICULTURE

Agriculture is undergoing an evolution - technology is becoming an indispensable part of every commercial farm. New precision agriculture companies are developing technologies that allow farmers to maximize yields by controlling every variable of crop farming such as moisture levels, pest stress, soil conditions, and micro-climates. By providing more accurate techniques for planting and growing crops, precision agriculture enables farmers to increase efficiency and manage costs.

Precision agriculture companies have found a huge opportunity to grow. A recent report by Grand View Research, Inc. predicts the precision agriculture market to reach $43.4 billion by 2025. The emerging new generations of farmers are attracted to faster, more flexible startups that systematically maximize crop yields.

BLOCKCHAIN

Blockchain's capability of tracking ownership records and tamper-resistance can be used to solve urgent issues such as food fraud, safety recalls, supply chain inefficiency and food traceability in the current food system. Blockchain's unique decentralized structure ensures verified products and practices to create a market for premium products with transparency.

Food traceability has been at the center of recent food safety discussions, particularly with new advancements in blockchain applications. Due to the nature of perishable food, the food industry at whole is extremely vulnerable to making mistakes that would ultimately affect human lives. When foodborne diseases threaten public health, the first step to root-cause analysis is to track down the source of contamination and there is no tolerance for uncertainty. Blockchain can be used to solve urgent issues such as food fraud, safety recalls, supply chain inefficiency and food traceability in the current food system.

Consequently, traceability is critical for the food supply chain. The current communication framework within the food ecosystem makes traceability a time-consuming task since some involved parties are still tracking information on paper. The structure of blockchain ensures that each player along the food value chain would generate and securely share data points to create an accountable and traceable system. Vast data points with labels that clarify ownership can be recorded promptly without any alteration. As a result, the record of a food item's journey, from farm to table, is available to monitor in real-time.

The use cases of blockchain in food go beyond ensuring food safety. It also adds value to the current market by establishing a ledger in the network and balancing market pricing. The traditional price mechanism for buying and selling relies on judgments of the involved players, rather than the information provided by the entire value chain. Giving access to data would create a holistic picture of the supply and demand. The blockchain application for trades might revolutionize traditional commodity trading and hedging as well. Blockchain enables verified transactions to be securely shared with every player in the food supply chain, creating a marketplace with immense transparency.

ARTIFICIAL INTELLIGENCE TO ADAPTED

The rise of digital agriculture and its related technologies has opened a wealth of new data opportunities. Remote sensors, satellites, and UAVs can gather information 24 hours per day over an entire field. These can monitor plant health, soil condition, temperature, humidity, etc. The amount of data these sensors can generate is overwhelming, and the significance of the numbers is hidden in the avalanche of that data.

The idea is to allow farmers to gain a better understanding of the situation on the ground through advanced technology (such as remote sensing) that can tell them more about their situation than they can see with the naked eye and not just more accurately but also more quickly than seeing it walking or driving through the fields.

Remote sensors enable algorithms to interpret a field's environment as statistical data that can be understood and useful to farmers for decision-making. Algorithms process the data, adapting and learning based on the data received. The more inputs and statistical information collected, the better the algorithm will be at predicting a range of outcomes. And the aim is that farmers can use this artificial intelligence to achieve their goal of a better harvest through making better decisions in the field.

INVOLVEMENT FOR AGRICULTURAL DEVELOPMENT

An **agricultural robot** is a robot deployed for agricultural purposes. The main area of application of robots in agriculture today is at the harvesting stage. Emerging applications of robots or drones in agriculture include weed control, cloud seeding, planting seeds, harvesting, environmental monitoring and soil analysis. According to Verified Market Research, the agricultural robots market is expected to reach $11.58 billion by 2025 for the reason labour shortage, climatic condition, market demanded so for the purpose to increase high production.

ROBOTICS DEVELOPMENT

The first development of robotics in agriculture can be dated as early as the 1920s, with research to incorporate automatic vehicle guidance into agriculture beginning to take shape. This research led to the advancements between the 1950s and 60s of autonomous agricultural vehicles. The concept was not perfect however, with the vehicles still needing a cable system to guide their path. Robots in agriculture continued to develop as technologies in other sectors began to develop as well. It was not until the 1980s; following the development of the computer that machine vision guidance became possible.

Other developments over the years included the harvesting of oranges using a robot both in France and the US. While robots have been incorporated in indoor industrial settings for decades, outdoor robots for the use of agriculture are considered more complex and difficult to develop. This is due to concerns over safety, but also over the complexity of picking crops subject to different environmental factors and unpredictability.

DEMAND IN THE AGRICULTURAL MARKET

There are concerns over the amount of labor the agricultural sector needs. With an aging population, Japan is unable to meet the demands of the agricultural labor market. Similarly, the United States currently depends on a large number of immigrant workers, but between the decrease in seasonal farm workers and increased efforts to stop immigration by the government, they too are unable to meet the demand. Businesses are often forced to let crops rot due to an inability to pick them all by the end of the season. Additionally, there are concerns over the growing population that will need to be fed over the next years. Because of this, there is a large desire to improve agricultural machinery to make it more cost efficient and viable for continued use.

CURRENT APPLICATIONS AND TRENDS

Much of the current research continues to work towards autonomous agricultural vehicles. This research is based on the advancements made in driver-assist systems and self-driving cars. While robots have already been incorporated in many areas of agricultural farm work, they are still largely missing in the harvest of various crops. This has started to change as companies begin to develop robots that complete more specific tasks on the farm. The biggest concern over robots harvesting crops comes from harvesting soft crops such as strawberries which can easily be damaged or missed entirely.

Despite these concerns, progress in this area is being made. According to Gary Wishnatzki, the co-founder of Harvest Croo Robotics, one of their strawberry pickers currently being tested in Florida can "pick a 25-acre field in just three days and replace a crew of about 30 farm workers". Similar progress is being made in harvesting apples, grapes, and other crops.

Another goal being set by agricultural companies involves the collection of data. There are rising concerns over the growing population and the decreasing labor available to feed them. Data collection is being developed as a way to increase productivity on farms. Agri Data is currently developing new technology to do just this and help farmers better determine the best time to harvest their crops by scanning fruit trees.

APPLICATIONS

Robots have many fields of application in agriculture. Some examples and prototypes of robots include the Merlin Robot Milker, Rosphere, Harvest Automation, Orange Harvester, lettuce bot, and weeder. One case of a large scale use of robots in farming is the milk bot. It is widespread among British dairy farms because of its efficiency and non requirement to move. According to David Gardner (chief executive of the Royal Agricultural Society of England), a robot can complete a complicated task if it's repetitive and the robot is allowed to sit in a single place. Furthermore, robots that work on repetitive tasks (e.g. milking) fulfill their role to a consistent and particular standard.

Another field of application is horticulture. One horticultural application is the development of RV100 by Harvest Automation Inc. RV 100 is designed to transport potted plants in a greenhouse or outdoor setting. The functions of RV100 in handling and organizing potted plants include spacing capabilities, collection, and consolidation. The benefits of using RV100 for this task include high placement accuracy, autonomous outdoor and indoor function, and reduced production costs.

ROBOTIC SUPPORTIVE FOR GENERAL AGRICULTURAL WORK

Fruit picking robots, driverless tractor / sprayers, and sheep shearing robots are designed to replace human labor. In most cases, a lot of factors have to be considered (e.g., the size and color of the fruit to be picked) before the commencement of a task. Robots can be used for other horticultural tasks such as pruning, weeding, spraying and monitoring. Robots can also be used in livestock applications (livestock robotics) such as automatic milking, washing and castrating. Robots like these have many benefits for the agricultural industry, including a higher quality of fresh produce, lower production costs, and a decreased need for manual labor. They can also be used to automate manual tasks, such as weed or bracken spraying, where the use of tractors and other manned vehicles is too dangerous for the operators.

Labour economics seeks to understand the functioning and dynamics of the markets for wage labour. Labour is a commodity that supplied by laborers in exchange for a wage paid by demanding firms.

Labour markets or **job markets** function through the interaction of workers and employers. Labour economics looks at the suppliers of labour services (workers) and the demanders of labour services (employers), and attempts to understand the resulting pattern of wages, employment, and income.

Labour is a measure of the work done by human beings. It is conventionally contrasted with such other factors of production as land and capital. Some theories focus on human capital (referring to the skills that workers possess, not necessarily their actual work). Labour is unique to study because it is a special type of good that cannot be separated from the owner (i.e. the work cannot be separated from the person who does it). A labour market is also different from other markets in that workers are the suppliers and firms are the demanders.

CONCLUSIONS

This study showed that while research on crop robotics is relatively abundant, studies on the economics of that technology are scarce. The review identified only 18 studies since 1990 which estimated the profitability or cost-effectiveness of crop robotics. Of those 18 studies, eight consider autonomous equipment and ten focuses on automated equipment with human operators. Seventeen of the eighteen studies use budgeting to estimate the cost effectiveness of robotics for specific crop operations. Only one study used farm level linear programming to examine the systemic impacts of crop robotics. All the studies focused on private monetary benefits of crop robotics; none of them estimated the economic impacts beyond the farm gate or the potential environmental and social impacts. The results of this review reinforce the need for economic research on crop robotics. Research needs include:

- Impacts on different crops—Most existing crop robotics studies focus on horticultural or industrial crops, but grains and oilseeds may be the “low handing fruit” for robotics entrepreneurs because most grain and oilseed production is already mechanized. Robotics would only need to make that equipment autonomous.
- System analysis—switching from conventional mechanization to crop robots may have systemic effects that ripple through the whole farm.
- Farm level robotics testing—Farmer experience with new technologies is often different from the use intended by researchers and manufacturers.
- Robot size—with conventional mechanization, the economic rule of thumb is “bigger is better”. That may change when human operators are no longer needed.
- Structure of farm equipment market—traditionally, farmers have owned most farm equipment. With robotics leasing or a service provide model may have advantages for both farmers and equipment providers.
- Market size estimates—the types of crop robots commercialized will depend in part on market size. Highly specialized robots would be commercialized only for relatively large markets and/or high value crops. A general purpose robot with specialized attachments would probably be best for a mosaic of niche markets.
- Co-robotics or cobots—what is the optimal combination of human operated equipment and autonomous equipment for a given farm? While robotic technology is being developed, it is almost inevitable that humans and robots will work together.
- National, regional and sector level impacts and externalities—Crop robotics will impact labour markets, farm structure and agricultural policy.
- Cost-effectiveness of using robotics to achieve environmental and social goals—crop robotics is a potentially win–win strategy that uses profitable technology with environmental and social benefits.
- Cost/benefit of robotic safety regulations—initial crop robot safety regulations in some countries focus on human supervision. Fencing to limit human–robot interaction, and better sensors and software to detect humans, might be more cost effective.
- Value of data collected by robotic operations—some researchers have argued that the value of data collected by crop robots may exceed the labour savings.
- Potential for crop robotics in the developing world—the shortage of farm labour and the need to manage agricultural inputs more precisely is worldwide, but automation technology may differ by farm structure and local needs.

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