Multipurpose Agricultural Machine for Smart Farming

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Abstract: *India's main industry, accounting for 70% of the workforce, is agriculture. Therefore, it is important to introduce new practices in agriculture for more productivity. The multi-purpose agricultural machine can perform five operations such as ploughing, digging, fertilizer pouring, seed sowing and grass cutting. All work was done with traditional machines in the past. Using the tool manually is tedious and difficult. The project offers multi-purpose smart agriculture with technologies such as Bluetooth, Arduino, ultrasonic sensors, servo motors, L293D and motors to create various agricultural machines. This innovation has many functions that are important for good agriculture. Integrating technology, innovation, freedom and connectivity, this smart agriculture aims to improve agriculture and contribute to stability and strength in food production.*

Keywords: *Smart Farming, Bluetooth, Arduino, Ultrasonic Sensors, Servo motors*

1. Introduction

Multi-Purpose Agricultural Machinery for smart agriculture is the most advanced, innovative, and versatile equipment designed to increase the efficiency and productivity of agriculture today. It affects the progress of developing countries, especially in agriculture. It is therefore time to automate the task in order to solve this issue [1]. Tractors are utilised in farms for tasks like seed planting and ploughing. However, it takes longer, and there is a persistent lack of manpower.

Using a dc motor, the process of planting seeds and ploughing is automated [2]. With Arduino, the distance between the two seeds may be adjusted and changed. The robot uses remote switches to shift course when it approaches the end of the field. A Bluetooth app is used to control the entire procedure.

While this equipment uses less energy than tractors or other agricultural instruments, pollution is still a major issue. Thus, now is the moment to automate the seed-sowing and ploughing processes. An additional requirement is to boost the operation's fast speed.

2. Literature Survey

Agriculture can achieve higher yields by using new technologies. Temperature, light and humidity are controlled according to the features of new electronic devices using microcontrollers and GSM phones.

A multifunctional autonomous agricultural robot vehicle that can be operated by Bluetooth for planting, farming, and irrigation is the goal of the work being done [2]. A multi-purpose agricultural machine is used to manage tasks of ploughing, planting, levelling the land, preventing mud, and spraying water, with little equipment change and lowest price.

The farm is driven with the help of DC motors and screws. When the cultivator rotates, the nuts welded to the cultivator slide on the auger screws. After that lower the cultivator to height and dig the soil to a depth of 1.5 inches. The direction of the tiller can be controlled using the Bluetooth app.

The research [3] aims to design, build and construct Agribot, a multipurpose robot that can perform all agricultural operations. Use a level, water crops, fertilize crops and use the camera to monitor farmers. Conventional farming practices need a great deal of manual effort. A portion of the task is completed manually, while a portion is completed with manual machinery. Therefore, there is no robot that can perform all these tasks autonomously. In addition, farmers need to inspect their fields for various reasons while performing important duties. This is done through various parameters such as water flow, fertilization, temperature control (for growing crops in greenhouses), removal of excess water (during floods) and tracking of crop growth through needle video will be controlled by the monitor.

Agriculture accounts for a large portion of India's GDP. These days, scarce water supplies and high labour prices are agriculture's two main issues. Precision agriculture may be pushed forward by using agricultural studies to find solutions to these issues [4]. This study examines the design and development of an Internet of Things (IoT)-based solar agricultural robot that can monitor remotely and carry out irrigation activities, taking into account India's solar system. Agribot was built using an Arduino microcontroller. It collects solar energy without water. It finds the humidity and temperature of fixed points by moving along a pre-planned path on a farm while doing water activities. Information is obtained from irrigation at each point and the farm is irrigated accordingly. Also farm robots.

A novel idea in farming is smart farming, wherein Internet of Things sensors offer data on the land. Utilising automation, the successful project [5] seeks to leverage cutting-edge technologies like the Internet of Things and smart agriculture. It's critical to keep an eye on environmental factors in order to produce successful goods. The purpose of this essay is to use CC3200 single-chip sensors to monitor the land's temperature and humidity. The CC3200 is connected to the camera in order to take pictures, which are then sent to the operator via MMS over Wi-Fi.

The robot with four wheels is intended to plant seeds in fields that have been ploughed. In [6] shown that by employing user-specific parameters (length and width) and seed spacing as navigational parameters, the system may avoid effort and distribute seeds at equal rates. The seeds are released from the seed chamber by a flywheel mechanism. More seeds cannot fall into the wheel because of the tiny space between the bottom of the seed chamber and the wheel that collects the seed and drops it onto the slide. Because it lowers seed waste and drops the seeds precisely, the flywheel mechanism is used.

Autonomous robots [7], completely autonomous robots that can dig the soil, reduce products, spray water by covering the soil, and work with electrical equipment and machines are designed, developed, and produced. The gear and pinion mechanism gives the robot its steering capability. The power input to the motor is regulated by a relay switch. Infrared sensors are used to detect issues. Agriculture is the primary occupation of over 40% of the global population. Recently, interest in the widespread use of cars in agriculture has increased.

In [8], agricultural robots can send and receive information. Solar panels power the entire system. The system starts charging with solar energy when not in use. Sensors are placed in various parts of the field. IoT is used by agricultural robots to verify sensor boundaries and navigate to various areas of the field. Based on quality factors, the robot measures and chooses the necessary volume of water. Relying on the values, the robot performs measurements and determines if irrigation is necessary for the field.

In the project [9], a fully automatic water pump using ARM7 processor for control and monitoring was proposed. Sensors are used to monitor soil moisture content and automatically open or close system valves. Because soil pH influences nutrient availability, it is also a crucial factor to take into account. Farmers are given recommendations on how to manage the pH of their soil based on the results of soil pH measurements taken by sensors. Nitrogen is an important macronutrient in soil. It is an important nutritional compound for plant growth. The sensors are used to analyse the nitrogen level of the soil and give farmers recommendations to control the nitrogen level if needed based on the nitrogen level.

The equipment used for cultivation is quite complex and not easy to operate. As a result, instruments that can lessen farmers' labour must be developed [10]. The system demonstrates the control system that allows the seeds to be placed at a certain distance between two seeds and the line during planting, with the help of a crank mechanism using LabVIEW. Works that require a lot of workers and time, such as manual digging and planting, which are the disadvantages of existing seeds, will be done entirely with this automatic machine.

Robotic systems were used to create agricultural systems without the use of human labour. The purpose of [11] is to reduce staff and time and increase efficiency. The main automated work of robots is weeding, harvesting, etc. Such autonomous robots use designs that use microcontrollers for ploughing, planting seeds, watering or spraying fertilizer, and vehicle movement navigation. Depending on the robot's movement on the ground, ultrasonic sensors help detect problems, rotate the robot's position left, right or forward.

Creating a multi-purpose smart farmer [12] can improve operation speed and accuracy, as well as reduce the farmer's work. The system was designed to use a multipurpose agricultural robot vehicle that can be controlled via IoT, measures soil quality, sprays plant pesticides on leaves instead of empty space according to plant height, and plants seeds. It was needed. depth It also enables the necessary separation of seeds, detection of seed clogging and real-time video streaming of fields.

The objective of [13] is to develop a multifunctional agricultural vehicle that runs on solar energy obtained from a solar panel, which powers various components of the vehicle. Crystalline solar panels are used to charge 12-volt rechargeable batteries. The DC motor is powered by electrical energy that is transferred from the battery. By adjusting the control, the engine transforms electrical energy into mechanical energy that may be used for various operations including planting, ploughing, and irrigation. The car was designed mostly to increase the productivity of small farms. The car uses renewable energy and uses solar energy easily.

A mobile robot that can operate and spray fertiliser directly in an outdoor setting was created and tested in [14]. For mapping, localization, and navigation, these robots frequently use lidar sensors and wheel encoders. Software packages like Adaptive Monte Carlo Localization (AMCL), Mapping, and Simultaneous Localization and Mapping (SLAM) are used in this process. Three distinct product sections make up the environment in the simulations run with Gazebo and RViz. The primary focus of the tests is on the dynamic problem analysis and the suggested method's dependability.

The goal of the work [15] is to create a robot that uses solar energy to power itself, thereby cutting labour expenses and planting and digging times. This system uses a solar panel to collect solar energy and turn it into electricity. This electricity charges the 12V battery and supplies the necessary power to the parallel DC motor. The wheels are then driven by a DC motor using this power. Utilise infrared sensors to lower productivity. The region is defined in this instance by four column sensors, and the robot is aware of the length and distance needed to travel between columns. After shutting down, the seed and digging robot will move to different parts of the soil to perform digging, planting, watering, and other tasks.

The goal of the work being presented is to construct a low-cost, battery-operated smart agricultural device that can do multiple tasks on farms while requiring less effort from farmers. Furthermore, it facilitates the acceleration and precision of agricultural tasks, hence enhancing output, effectiveness, and sustainability of farming.

3. Methodology

The device has a digging or ploughing attachment and DC motors. The Arduino directs the machine to dig or plough by controlling the motors based on user input or pre-programmed settings. The machine's construction is linked to a system for spraying or pouring fertilizer. When fertilizer is needed, the Arduino senses input and triggers the mechanism to spray or pour the fertilizer. The device has a mechanism for sowing seeds and a seed container. At predetermined times or places, a mechanism to release seeds is activated by the Arduino. A DC motor powers an attachment for cutting grass. The motor is driven by the Arduino to mow the grass in the chosen regions or heights. With the help of a smartphone app, users may operate the machine electronically thanks to the Bluetooth module. The Arduino receives commands from the app and performs the necessary tasks. The device has sensors—possibly ultrasonic ones—to identify boundaries and obstructions. The Arduino stops the machine to avoid crashes when it detects an obstruction by turning on the automatic brake.
This versatile agricultural device integrates multiple functions managed by an Arduino via Bluetooth and sensor inputs, rendering it effective and intuitive for intelligent farming uses. The block diagram for multipurpose smart agriculture machine is presented in figure 1.

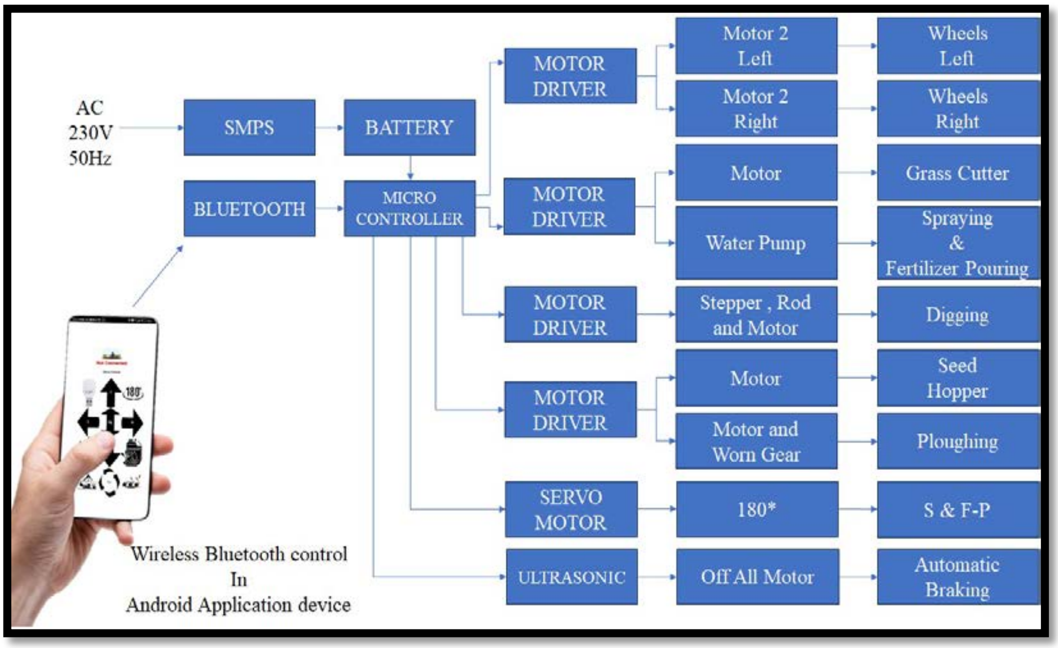

Figure 1: Block Diagram of Multipurpose Agricultural Machine

The presented agricultural machine has different working module (see figure 2) as following in conjunction with Bluetooth app:-

1. Ploughing: - This module is responsible for ploughing the field, preparing it for planting. It uses a servo motor and can be controlled remotely via the Bluetooth app

2. Digging: - The digging module is designed to excavate soil for various farming tasks. It also uses a servo motor and can be controlled via the Bluetooth app.

3. Spraying: - This module helps the distribution of liquids, such as pesticides or water, onto the crops. It can be controlled remotely through the Bluetooth app.

4. Fertilizer Pouring: - The fertilizer pouring module dispenses fertilizers accurately across the field. It uses a servo motor and can be operated remotely using a Bluetooth app.

5. Seed Sowing: - This module is responsible for precisely planting seeds in the soil. It can be controlled via the Bluetooth app for accurate seed distribution.

6. Grass Cutter: - The grass cutter module is designed to trim or mow grass in the field, keeping it neat and well maintained. It can be controlled remotely through the Bluetooth app.

7. Wireless Control: - This feature allows farmers to operate and control the various functions of the machine wirelessly via the Bluetooth app, enhancing convenience and efficiency.

8. Automatic Brake: - It ensures safety during machine operation. It automatically activates to stop machine movement when necessary.

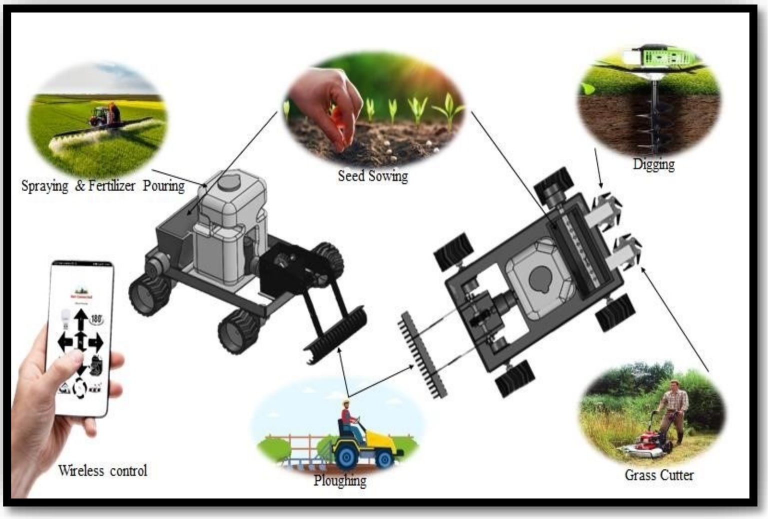

Figure 2: System Design of Multipurpose Agricultural Machine

4. Simulation

1. Computer Modelling: Use proteus software to simulate the machine's functions and ensure they work as intended.

2. Performance Testing: Simulate different scenarios to evaluate the machine's performance under various conditions, including app control.

3. Testing: Thoroughly test each function to ensure it works correctly, including testing the app.

4. Refinement: Make any necessary adjustments to improve the machine’s performance and app functionality.

5. Safety Measures: Implement safety features such as the automatic brake system to ensure safe operation.

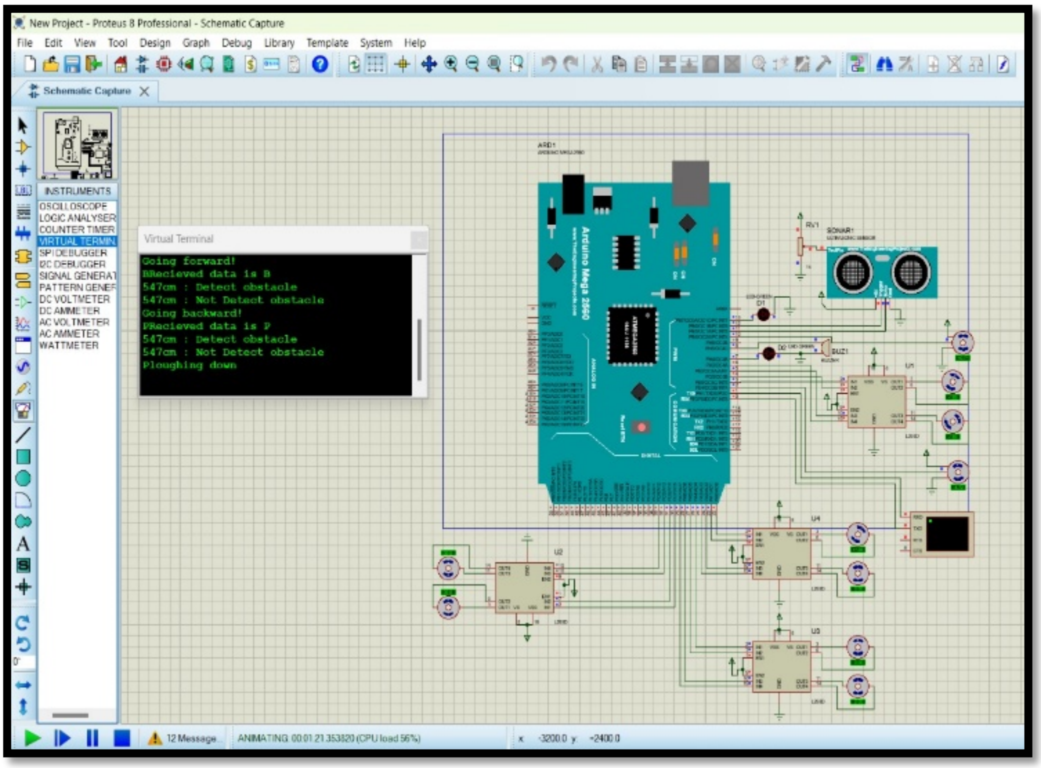

Figure 3: System Simulation using Proteus

The created Bluetooth app serves as a user-friendly interface (figure 4) to control and monitor these functional modules, making the Multipurpose Agricultural Machine a versatile and efficient tool for modern farming.

1. Needs Assessment: Understand the specific farming practices and requirements for ploughing, digging, spraying, etc.

2. Conceptual Design: Create an initial plan for the machine's structure and its intended functions.

3. Bluetooth App Design: Design the user-friendly app interface for controlling the machine via Bluetooth.

4. Detailed Design: Develop a comprehensive design specifying the components and how they will work together.

5. Prototyping: Build a prototype to test and refine the design.

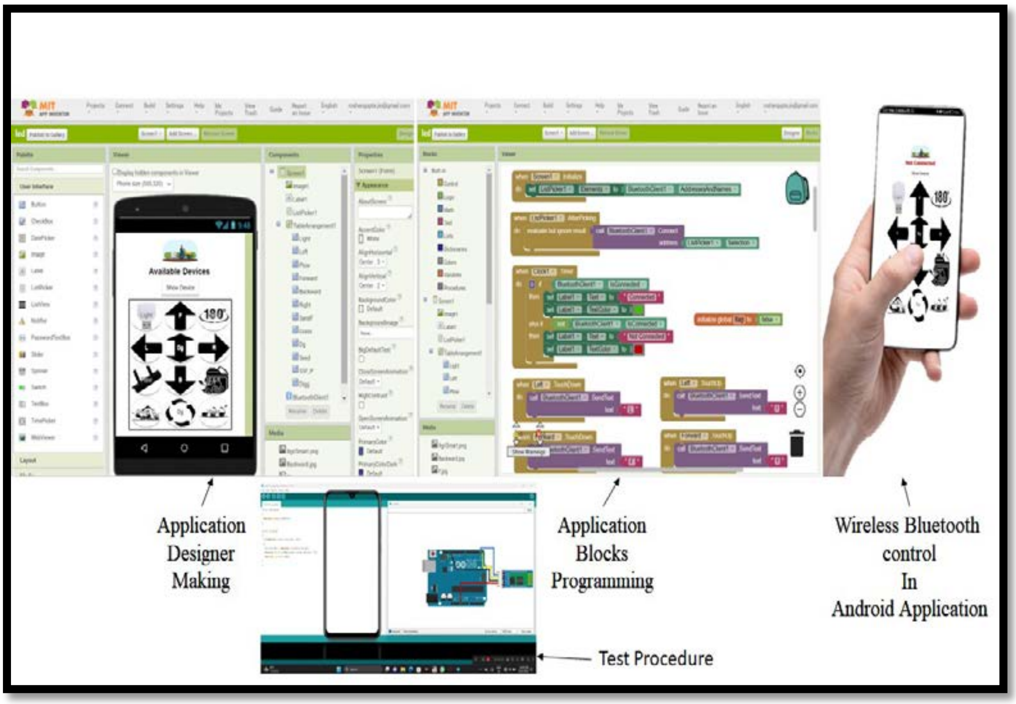

Figure 4: Detailed user interface app

By following this methodology, the Multipurpose Agricultural Machine for Smart Farming can be designed, simulated, constructed, and integrated with a Bluetooth app to meet the project's goals effectively.

5. Result

In this implemented multipurpose agricultural machine (side view figure 5 and front view figure 6), the SMPS circuit converts unregulated DC power to regulated DC power to provide power to the various mechanism of the machine to perform multiple operations.

A plant cutter is mounted on the front of the machine, if the machine does not detect any obstacles, then it will move forward and plant cutter will rotate and cut useless crops.

A sprayer is mounted on the top of the machine, which uses a nozzle to spray pesticides.

The plough is mounted on the back of the machine. The plough moves forward and takes away the sand and ploughing will perform.

To sow the seed, we use a mechanism that consists of a seed pipe that will turn the engine and seeding is done.

A tank in which the fertilizers are stored is available for spraying fertilizers. The engine will pump water to the main pipe that will spray the area. The range of spraying to be done can be extended or shortened as needed. This is how the process of spraying will be carried out.

Attached to the rear of the chassis structure would be a lever. Every time the digging operation is necessary, the lever must be lowered. Following its descent, the machine continues to dig while moving forward.

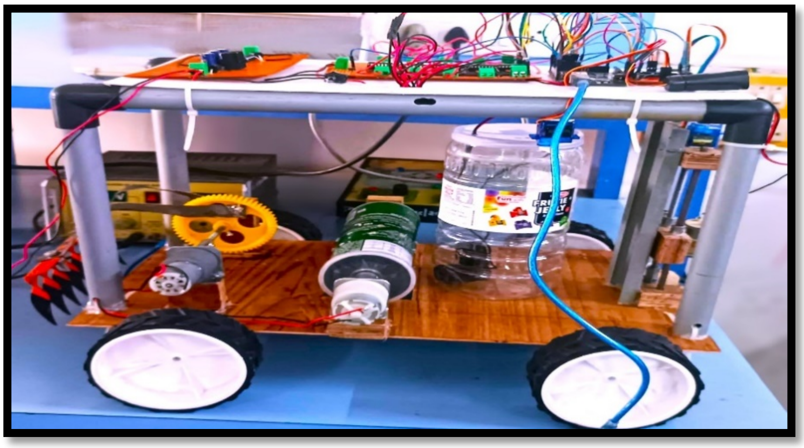

Figure 5: Side View of Implemented Multipurpose Farming Machine

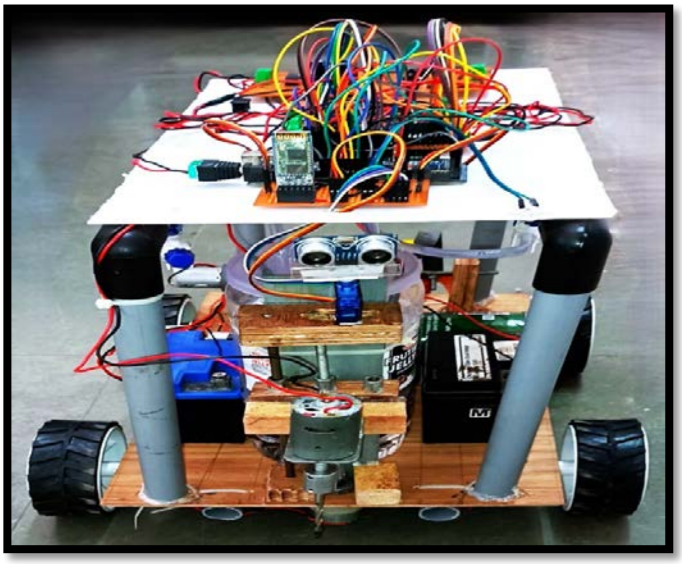

Figure 6: Front View Implemented Multipurpose Farming Machine

6. Conclusion

Modern technology can make smart farming more effective and less harmful to the environment. Smart agriculture also provides many benefits to consumers, such as new products, fewer pesticides, increased taste and nutrition of food, reduced food waste and longer shelf life. Looking at all the advantages of the machine, the presented low-cost multipurpose agricultural machine meet the needs of small farmers as they cannot invest in expensive products for agricultural use.

The machine requires less energy and time compared to conventional use, so if built on a large scale, its cost will come down considerably and this can be done as part of the breakthrough of Indian agriculture. Thus, this may provide an answer to the issue of the labour force required for agriculture in India today.

This versatile machine is suitable for many types of farming, so it is also suitable for small and large farms. It can be incorporated into traditional and modern agriculture to improve quality and productivity. Bluetooth applications allow farmers to control and monitor machines remotely, reducing the need for manual labour.

7. References

[1] Abdullah Tanveer , Abhishek Choudhary , Divya Pal , Rajani Gupta , Farooq Husain, *"Automated Farming Using Microcontroller and Sensors"*, International Journal of Scientific Research & Management Studies(IJSRMS), vol 2, issue 1 **(2015),** pp 21-30.

[2] S. A. Amrita, E. Abirami, A. Ankita, R. Praveena and R. Srimeena, "*Agricultural Robot for automatic ploughing and seeding*," 2015 IEEE Technological Innovation in ICT for Agriculture and Rural Development (TIAR), Chennai, India **(2015)**, pp. 17-23, doi: 10.1109/TIAR.2015.7358525.

[3] Sowjanya, K., Sindhu, R., Parijatham, M., Srikanth, K., & Bhargav, P.S., "Multipurpose autonomous agricultural robot", *2017 International conference of Electronics, Communication and Aerospace Technology (ICECA), 2*, **(2017)**, pp 696-699.

[4] Ranjitha, B., M. N. Nikhitha, K. Aruna, and BT Venkatesh Murthy. "*Solar powered autonomous multipurpose agricultural robot using Bluetooth/android app*." In 2019 3rd International conference on Electronics, Communication and Aerospace Technology (ICECA), **(2019)**, pp. 872-877.

[5] Nikesh Gondchawar, Prof. Dr. R. S. Kawitkar , "*IOT Based Smart Agriculture*", International Journal of Advanced Research in Computer and Communication Engineering, vol 5, issue 6, **(2016)**, pp 838-842.

[6] P. V. S. Jayakrishna, M. S. Reddy, et al, "*Autonomous Seed Sowing Agricultural Robot*", IEEE International Conference on Advances in Computing, Communications, and Informatics. (ICACCI), **(2018)**, pp2332-2336.

[7] Nithin P V, Shivaprakash S, *"Multipurpose agricultural robot"*, International Journal of Engineering Research, ISSN: 2319-6890) (online),2347-5013(print) Volume No.5 Issue: Special 6, **(2016)**, pp: 1129 – 1254.

[8] Meeradevi and H. Salpekar, *"Design and Implementation of Mobile Application for Crop Yield Prediction using Machine Learning",* Global Conference for Advancement in Technology (GCAT),**(2019)**, pp.1-6, doi:10.1109/GCAT47503.2019.8978315.

[9] Gayatri Londhe, Prof. S. G. Galande, *"Automated Irrigation System by Using ARM Processor"*, International Journal of Scientific Research Engineering & Technology, vol 3, no. 2, (**2014**).

[10] Prashant G. Salunkhe, Sahil Y. Shaikh, Mayur S. Dhable, Danis I. Sayyad , *"Automatic Seed Plantation Robot"*, International Journal of Engineering Science and Computing, vol 6, issue 4 (**2016)**, pp 4661-4663.

[11] P. Usha, V. Maheshwari, Dr. V. Nandagopal , *"Design and Implementation of Seeding Agricultural Robot"*, Journal of innovative research and Solutions, vol 1, issue 1 **(2015)**, pp 138-143.

[12] N. T. V and H. M Kalpana, "Smart Multipurpose Agricultural Robot," *2021 IEEE International Conference on Electronics, Computing and Communication Technologies (CONECCT)*, Bangalore, India, **(2021)**, pp. 1-6, doi: 10.1109/CONECCT52877.2021.9622632.

[13] P. V. Prasad Reddy , M. Yadi Reddy, "*Development of Multi-Purpose Agricultural Vehicle by using Solar Power*", International Journal Of Engineering Research & Technology (IJERT) Volume 10, Issue 04 **(2021)**, pp 48-51.

[14] Abhiram R, Rajesh Kannan Megalingam , *"Autonomous Fertilizer Spraying Mobile Robot"*, India Council International Conference (INDICON), **(2022)**, pp 1-6.

[15] Shwetha S. and Shreeharsha G. H , "*Solar Operated Automatic Seed Sowing Machine"*, International Advanced Research Journal of Advanced Agricultural Sciences and Technology, vol 4, no.1, **(2015)**, pp 67-71 .