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ARTIFICIAL INTELLIGENCE AND AGRICULTURAL DEVELOPMENT IN NIGERIA

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Abstract

This paper discussed the application of artificial intelligence on agriculture. Secondary data were used in the paper. The data were collected from print and online publications. The paper concluded artificial intelligence (Al) can be applied to improve irrigation systems, for weeding of crops, to monitor livestock health, to sort and aid harvesting of produce, to detect leaks or damage to irrigation systems, to monitor crop and soil and to predict weather and price forecasting. On the area of Al benefits to farmers, the paper pointed out that artificial intelligence (Al) can aid decision making, cost saving and reduction in labor shortage. The paper recommended that government should increase investment in agricultural sectors and provide loans facilities for farmers to enable tem acquires modern artificial intelligence tools to boost agricultural production in Nigeria. Government should also ensure effective capacity building for farmers in rural communities with requisite knowledge and information necessary to promote utilization of Artificial Intelligence.

Keywords: Artificial Intelligence and Agricultural Development in Nigeria.

Introduction

Artificial intelligence is based on the principle that human intelligence can be defined in a way that a machine can easily mimic it and execute tasks, from the simplest to those that are even more complex. The goals of artificial intelligence include learning, reasoning, and perception (Naadzenga 2023). Alagbe (2023) viewed AI as the ability of a computer or machine to mimic the capabilities of the human mind – learning from examples and experience, recognising objects, understanding and responding to language, making decisions, solving problems – and combining these and other capabilities to perform functions a human might perform, such as greeting a hotel guest or driving a car. Artificial Intelligence refers to the development of computer systems and machines capable of performing tasks that typically require human intelligence (AFSA 2022; Ogunode & Gregory 2023). These tasks include learning, reasoning, problem solving, perception and natural language understanding. Artificial Intelligence technologies encompass various techniques and approaches, such as machine learning, deep learning, natural language processing, computer vision and robotics. These technologies enable computers to analyze vast amounts of data, recognize patterns, make predictions and automate complex processes. Artificial Intelligence has applications across numerous fields, including health care, finance, transportation, customer service and education. It has the potential to transform industries, improve efficiency and create new opportunities (AFSA 2022).

Ogunode (2023) defined Al as programs designed with human-like intelligence and structured in forms of computer, robot, or other machines to aid in provision of any kind of service or tasks to improve social economic and political development of the society. Artificial Intelligence is an application or program constructed to carry out tasks with human like intelligence. Ogunode also viewed Artificial Intelligence as collections system, packages and application designed into digital computer or computer-controlled robot to carry out assignments and tasks with human-like intelligence. Artificial Intelligence (AI) is the ability of a digital computer, computer-controlled machine or robot to perform tasks commonly associated with intelligent beings like humans (Amuge 2023). Artificial Intelligence (AI) is an emerging technology in the agricultural sector. AI is the science of making intelligent machines and programmes. It is rooted in the principle that machines can accurately describe and replicate human intelligence, allowing them to efficiently carry out tasks ranging from basic to the most complex (Deji, Alabi, Famakinwa and Faniyi 2023). Adilakshmi, Chaitany, Poojitha, and Ashok Naik (2021) noted that the basic idea of AI is to create technologies that mimic the functioning of the human brain. According to Research and Markets, the world's largest market research store, the global artificial intelligence in agriculture market was valued at $1.517 million in 2022 and is expected to reach $4.096.1 million in 2027, following a compound annual growth rate (CAGR) of 21.98 per cent during 2022-2027. Over the years, Artificial Intelligence has served as a relevant tool in optimizing and carrying out particular human activities such as planting and harvesting, increasing productivity, improving working conditions and using natural resources more efficiently. In addition, systems for crop and soil monitoring are leveraging machine learning, remote sensing, satellite imagery, drones, and precision technologies for informed production and management (Amuge 2023).

AI's role in the food industry is becoming increasingly important due to its ability to reduce waste, predict markets for products, enable round the clock efficient and effective monitoring, augment sanitation, manage cost and increase revenue (Amuge 2023)**.** Naadzenga (2023) noted that AI is making a huge impact in all domains of the industry. Every industry looking to automate certain jobs through the use of intelligent machinery. Agriculture and farming are one of the oldest and most important professions in the world. It plays an important role in the economic sector. Worldwide, agriculture is a $5 trillion industry. The global population is expected to reach more than nine billion by 2050 which will require an increase in agricultural production by 70% to fulfill the demand. As the world population is increasing land water and resources becoming insufficient to continue the demand-supply chain. So, we need a smarter approach and become more efficient about how we farm and can be the most productive.

Javatpoint.com (undated) noted that the challenges in agriculture by using traditional methods, include the following;

1. In farming, different weather factors such as Rainfall, temperature, and humidity play an important role. Due to pollution, sometimes climate varies abruptly, and hence it becomes difficult for farmers to make proper decisions for harvesting, sowing seeds, and soil preparing.
2. For a better crop, it is necessary that the soil should be productive and have the required nutrition, such as Nitrogen, Phosphorous, and Potassium. If these nutrients are not present in effective way in the soil, then it may lead to poor quality crops. But it is difficult to identify these soil-quality with traditional ways.
3. In the agriculture lifecycle, it is required that we save our crops from weeds. Else it may increase the production cost, and it also absorbs nutrients from the soil. But by traditional ways, identification and prevention of crop from weeds is not efficient.

Applications of Artificial Intelligence in Agriculture

Artificial Intelligence (Al) can be applied in in the following agricultural areas; optimizing automated irrigation systems, automatic weeding and harvesting, monitoring livestock health, sorting harvested produce, detecting leaks or damage to irrigation systems, crop and soil monitoring, detecting disease and pests and weather and price forecasting.

Optimizing Automated Irrigation Systems

Artificial Intelligence (Al) can be apply to improve irrigation farming system in Nigeria. Irrigation is the act of artificially providing water to soil through various systems of tubes, pumps, and sprays based on the requirement of the planted crops throughout the growing season to enhance the complete nourishment of the crop. *Irrigation* is the practice of applying controlled amounts of water to land to help grow crops, landscape plants, and lawns. Intellias (2023) submitted that AI algorithms enable autonomous crop management. When combined with Internet of Things (IoT) sensors that monitor soil moisture levels and weather conditions, algorithms can decide in real-time how much water to provide to crops. An autonomous crop irrigation system is designed to conserve water while promoting sustainable farming practices. The technology of smart irrigation is developed to increase the production without the involvement of large number of man power by detecting the level of water, temperature of the soil, nutrient content and weather forecasting. The actuation is performed according to the microcontroller by turning ON/OF the irrigator pump. The M2M that is, Machine to Machine technology is been developed to ease the communication and data sharing among each other and to the server or the cloud through the main network between all the nodes of the agricultural field (Shekhar et al., 2017).

Automatic Weeding and Harvesting

Another problem that is facing many farmers is the problem of weeding and to harvest the products. Harvesting according to Naadzenga (2023) is the process of gathering ripe crops from the fields. It requires a lot of laborers for this activity so this is a labor-intensive activity. This stage also includes post-harvest handling such as cleaning, sorting, packing, and cooling while weeds are unwanted plants that grow near crops or at the boundary of farms. Weed protection is an important factor as weed decreases yields, increases production cost, interfere with harvest, and lower crop quality (Naadzenga 2023). Artificial Intelligence (Al) can help farmers to weed and harvest produces from farms. Intellias (2023) noted that computer vision can detect pests and diseases, it can also be used to detect weeds and invasive plant species. When combined with machine learning, computer vision analyzes the size, shape, and color of leaves to distinguish weeds from crops. Such solutions can be used to program robots that carry out robotic process automation (RPA) tasks, such as automatic weeding. In fact, such a robot has already been used effectively. As these technologies become more accessible, both weeding and harvesting crops could be carried out entirely by smart bots. Rizzoli, (2021) noted that intelligent sprayers aren't the only AI getting into weeding. There are other computer vision robots taking an even more direct approach to eliminating unwanted plants. Now, spotting a weed in the same way that computer vision can spot an insect or oddly-behaving chicken doesn't actually eliminate very much work for the farmer. To be of even greater help the AI needs to both find and remove the weed. Being able to physically remove weeds not only saves the farmer quite a bit of work, but also reduces the need for herbicides and thus makes the whole farming operation much more environmentally friendly and sustainable

Monitoring Livestock Health

Farmer are always concern about the quality and health of their produces. Intellias (2023) observed that Al may seem easier to detect health problems in livestock than in crops, in fact, it's particularly challenging. Thankfully, AI can help with this. For example, a company called Cattle Eye has developed a solution that uses drones, cameras together with computer vision to monitor cattle health remotely. It detects atypical cattle behavior and identifies activities such as birthing. Cattle Eye uses AI and ML solutions to determine the impact of diet alongside environmental conditions on livestock and provide valuable insights. This knowledge can help farmers improve the well-being of cattle to increase milk production. Also, Naadzenga (2023) asserted that algorithms can be used to analyze, capture images and provide a detailed report containing the current health of the farm. It helps the farmer to identify pests and bacteria helping farmers to timely use pest control and other methods to take the required action. Precision Farming and Predictive Analytics: AI applications in agriculture have developed applications and tools which help farmers inaccurate and controlled farming by providing them proper guidance to

farmers about water management, crop rotation, timely harvesting, type of crop to be grown, optimum planting, pest attacks, nutrition management. Singh and Jain (2022), stated that artificial intelligence technologies help in achieving healthier crops, pest control, and soil monitoring and improve a wide range of agriculture-related tasks in the entire food supply chain including harvesting, processing, and marketing.

Sorting Harvested Produce

One of the tedious tasks of farmers to harvest crops from the farms. Farmers always looking for simple ways to harvest their products from the farms. Intellias (2023) asserted that AI is not only useful for identifying potential issues with crops while they're growing. It also has a role to play after produce has been harvested. Most sorting processes are traditionally carried out manually however AI can sort produce more accurately. Computer vision can detect pests as well as disease in harvested crops. What's more, it can grade produce based on its shape, size, and color. This enables farmers to quickly separate produce into categories — for example, to sell to different customers at different prices. In comparison, traditional manual sorting methods can be painstakingly labor-intensive. Rizzoli, (2021) observed that AI computer vision can continue to help farmers even once the crops have been harvested. Just as they are able to spot defects, disease, and pests as the plants are growing, imaging algorithms can also be used to sort "good" produce from the defective or just plain ugly. By inspecting fruit and vegetables for size, shape, color, and volume, computer vision can automate the sorting and grading process with accuracy rates and speed much higher than even a trained professional.

Detecting Leaks or Damage to Irrigation Systems

Intellias (2023) concluded that AI plays a crucial role in detecting leaks in irrigation systems. By analyzing data, algorithms can identify patterns and anomalies that indicate potential leaks. Machine learning (ML) models can be trained to recognize specific signatures of leaks, such as changes in water flow or pressure. Real-time monitoring and analysis enable early detection, preventing water waste together with potential crop damage. AI also incorporates weather data alongside crop water requirements to identify areas with excessive water usage. By automating leak detection and providing alerts, AI technology enhances water efficiency helping farmers conserve resources. Also, Naadzenga (2023) pointed out that Trace Genomics is another machine learning-based company that helps farmers to do a soil analysis to farmers. Such type of app helps farmers to monitor soil and crop health conditions and produce healthy crops with a higher level of productivity. Analyzing crop health by drones: Sky Squrrel Technologies has brought drone-based Ariel imaging solutions for monitoring crop health. In this technique, the drone captures data from fields and then data is transferred via a USB drive from the drone to a computer and analyzed by experts.

Crop and Soil Monitoring

Intellias (2023) maintained that the wrong combination of nutrients in soil can seriously affect the health and growth of crops. Identifying these nutrients and determining their effects on crop yield with AI allows farmers to easily make the necessary adjustments. While human observation is limited in its accuracy, computer vision models can monitor soil conditions to gather accurate data. This plant science data is then used to determine crop health, predict yields while flagging flag any particular issues. In practice, AI has been able to accurately track the stages of wheat growth and the ripeness of tomatoes with a degree of speed and accuracy no human can match. Also Rizzoli, (2021) noted that micro and macronutrients in the soil are critical factors for crop health and both the quantity and quality of yield. Then, once crops are in the soil, monitoring the stages of growth is also essential to optimizing production efficiency. It's vital to understand interactions between crop growth and the environment in order to make adjustments for improved crop health. Now, traditionally soil quality and crop health were determined by human observation and judgment. But this method is neither accurate nor timely. Instead, we can now use drones (UAVs) to capture aerial image data, and train computer vision model to use this for intelligent monitoring of crop and soil conditions. Visual sensing AI can analyze and interpret this data to; track crop health, make accurate yield predictions and detect crop malnutrition much faster than humans AI models can inform farmers of specific problem areas so that they can take

immediate action. Now let's look at some real examples of how computer vision is helping keep their crops healthy and productive. Rakhra, Sumaya, Quadri, Verma, Ray, and Asenso (2022), artificial intelligence-based technologies have aided in increasing productivity across all industries, including the agricultural sector, by addressing challenges in areas such as crop yield, irrigation, soil content sensing, crop monitoring, weeding, and crop establishment.

Detecting Disease and Pests

As well as detecting soil quality and crop growth, Intellias (2023) pointed out that computer vision can detect the presence of pests or diseases. This works by using AI to scan images to find mold, rot, insects, or other threats to crop health. In conjunction with alert systems, this helps farmers to act quickly in order to exterminate pests or isolate crops to prevent the spread of disease. AI has been used to detect apple black rot with an accuracy of over 90%. It can also identify insects like flies, bees, moths, etc., with the same degree of accuracy. However, researchers first needed to collect images of these insects to have the necessary size of the training data set to train the algorithm with. Rizzoli, (2021) asserted that we've seen how AI computer vision can detect and analyze crop maturity and soil quality, but what about agricultural conditions that are less predictable? Using image recognition technology based on deep learning, we can now automate detection of plant diseases and pests. This works using image classification, detection, and image segmentation methods to build models that can "keep an eye" on plant health. Naadzenga (2023) observed that Nigerian -German-based tech start-up AgrocCo has envisioned developing an AI-based application that can identify the nutrient deficiencies in soil including plant pests and diseases by which farmers can also get an idea to use fertilizer which helps to improve harvest quality. This app uses image recognition-based technology. The farmer can capture images of plants using smartphones. We can also see soil restoration techniques with tips and other solutions through short videos on this application.

Weather and Price Forecasting

As we have discussed in challenges that it is difficult for the farmers to take the right decision for harvesting, sowing seeds, and soli preparing due to climate change. But with the help of AI weather forecasting, farmers can have information on weather analysis, and accordingly, they can plan for the type of crop to grow, seeds to sow, and harvesting the crop. With price forecasting, farmers can get a better idea about the price of crops for the next few weeks, which can help them to get maximum profit. Naadzenga (2023) noted that using the machine learning algorithms in connection with images captured by satellites and drones, AI-enabled technologies predict weather conditions, analyze crop sustainability and evaluate farms for the presence of diseases or pests and poor plant nutrition on farms with data like temperature, precipitation, wind speed, and solar radiation. Farmers without connectivity can get AI benefits right now, with tools as simple as an SMS-enabled phone and the Sowing App. Meanwhile, farmers with Wi-Fi access can use AI applications to get a continually AI-customized plan for their lands. With such IoT- and AI-driven solutions, farmers can meet the world's needs for increased food sustainably growing production and revenues without depleting precious natural resources.

Benefits of AI in agriculture

Javatpoint.com (undated) listed the following as benefits of using AI in agriculture as follows: decision making, cost saving and reduction in labor shortage.

AI Enables Better Decision-Making

Predictive analytics is really a boon for the agriculture industry. It helps the farmers solving the key challenges of farming, such as analysing the market demands, price forecasting, and finding optimal times for sowing and harvesting the crop. Moreover, AI-powered machines can also determine soil and crop health, provides fertilizer recommendations, monitor the weather, and can also determine the quality of crop. All such benefits of AI in agriculture enable the farmers to make better decisions and do efficient farming. Panpatte (2018) said that artificial intelligence makes it possible for farmers to assemble large amount of data from government as well as public websites, analyze all of it and provide farmers with solutions to many ambiguous issues as well as it provides us with a smarter way of

irrigation which results in higher yield to the farmers. Due to artificial intelligence, farming will be found to be a mix of technological as well as biological skills in the near future which will not only serve as a better outcome in the matter of quality for all the farmers but also minimize their losses and workloads

AI Brings Cost Savings

Precision farming using AI-enabled equipment helps the farmers to grow more crops with lesser resources and cost. AI provides the real-time insights to farmers that enables them to take proper decision at each stage of farming. With this correct decision, there is less loss of products and chemicals and efficient use of time and money. Moreover, it also allows the farmers to identify the particular areas that need irrigation, fertilization, and pesticide treatment, which saves excessive use of chemicals on the crop. All these things sum up and result in reduced use of herbicides, better crop quality and high profit with fewer resource. Intellias (2023) concluded that improving farm yields is a constant goal for farmers. Combined with AI, precision agriculture can help farmers grow more crops with fewer resources. AI in farming combines the best soil management practices, variable rate technology, and the most effective data management practices to maximize yields while minimizing spending. Application of AI in agriculture provides farmers with real-time crop insights, helping them to identify which areas need irrigation, fertilization, or pesticide treatment. Innovative farming practices such as vertical agriculture can also increase food production while minimizing resource usage. Resulting in reduced use of herbicides, better harvest quality, higher profits alongside significant cost savings.

AI Reduces Labour Shortage

There has always been an issue of labour shortage in the agriculture industry. AI can solve this issue with automation in farming. With AI and automation, farmers can get work done without having more people, and some examples are Driverless tractors, smart irrigation and fertilizing systems, smart spraying, vertical farming software, and AI-based robots for harvesting. AI-driven machines and equipment are much faster and accurate compared to human farmhands. The main purpose of coming up with this technology is to replace human labor and produce effective benefits on small as well as large scale productions (Manivannan and Priyadharshini, 2016). In this sector, the room for robotic technologies has amplified productivity immensely (Pedersen et al., 2008). The robots are performing various agricultural operations autonomously such as weeding, irrigation, guarding the farms for delivering effective reports, ensuring that the adverse environmental conditions do not affect the production, increase precision, and manage individual plants in various unfamiliar ways.

Key Steps for Nigerian Farmers to leverage the impact of Artificial Intelligence in Nigeria's according to Isreal (2023) includes;

1. Embrace AI-enabled technologies designed specifically for agriculture.
2. Utilize predictive analytics to make informed decisions regarding planting schedules, fertilization, and pest control.
3. Implement precision farming techniques for optimal resource allocation and waste reduction.
4. Seek market opportunities for their products to mitigate food losses and waste.
5. Collaborate with agricultural research institutions to stay updated on the latest advancements in AI and its applications in farming.
6. Participate in AI-focused training programs to enhance skills and knowledge in utilizing AI tools effectively.
7. Share experiences and best practices through knowledge-sharing platforms, both offline and online, to accelerate the adoption of AI in the agricultural sector.

Conclusion and Recommendations

This paper discussed the application of artificial intelligence on agriculture. The paper concluded artificial intelligence (Al) can be applied to improve irrigation systems, for weeding and harvesting of crops, to monitor livestock health, to sort and aid harvesting of produce, to detect leaks or damage to irrigation systems, to monitor crop and soil, to detect disease and pests and to predict weather and price forecasting. On the area of Al benefits to farmers, the paper pointed out that artificial intelligence (Al) can aid decision making, cost saving and reduction in labor shortage.

Amuge noted that Artificial Intelligence investments is needed to boost production, storage, processing and marketing infrastructure is essential to boost agriculture productivity and set the country on the path to future farming techniques. Amuge noted cited Reagan Robinson, a research analyst and lecturer, Rivers State University of Education, in a research article on AI adoption for improved agriculture productivity, highlighted the following recommendations to enhance its development. These include:

a) Innovative research and policy making on the use of AI technology in workplace management, monitoring and hiring of personnel.

b) Development of standards to track the provenance of different AI development, and use of training data sets throughout its life cycle.

c) Proper processes to AI mitigation and unbiased strategies beyond a narrowly technical approach.

d) Hiring experts from disciplines beyond computer science and engineering and ensure they have good managers to AI development and usage.

e) Collaborations between the government agritech firms, universities, conferences and other stakeholders to foster the development of AI technology through investments in AI research and development. However, the paper recommended that government should increase investment in agricultural sectors and provide loans facilities for farmers to enable tem acquires modern artificial intelligence tools to boost agricultural production in Nigeria. Government should also ensure effective capacity building to strengthen the most vulnerable group in agricultural production with requisite knowledge and information necessary to promote utilization of Artificial Intelligence.

Reference

1. Adilakshmi, G, Chaitany, A, Poojitha, K. & Ashok Naik, M. (2021). Application of artificial intelligence in agriculture, Just Agriculture 1(10):1-3
2. Alagbe, J, Awodele, O & Ayorinde, I. (2021). Is Nigeria ready for Artificial Intelligence in schools? https://punchng.com/is-nigeria-ready-for-artificial-intelligence-in-schools/
3. AFSA (2022) Artificial Intelligence and Education https://www.theschoolleader.org/news/artificial-intelligence-and-education
4. Amuge, O. (2023). Protecting-the-future-of-nigerias-agriculture-with-artificial-intelligence https://www.businessamlive.com/protecting-the-future-of-nigerias-agriculture-with- artificial-intelligence/
5. Deji O.F., Alabi D.L., Famakinwa M. & Faniyi E.O (2023). Utilisation of artificial intelligence-based technology for agricultural extension services among extension professionals in Nigeria. Journal of Agricultural Extension 27 (3) 80-92
6. Farinde, A. J., Ojo, T. F. & Famakinwa, M. (2022). Virtual and Artificial Intelligence Tools for Extension Practices in Nigeria in Agricultural Extension in Nigeria. 3rd edition, Agricultural Extension Society of Nigeria, Pg.165-180
7. Isreal, G. (2023). The impact of AI on Nigeria's Agricultural sector https://hastomnigeria.com/the-impact-of-ai-on-nigerias-agricultural-sector/

8. Intellias (2023) .AI in Agriculture — The Future of Farming. https://intellias.com/artificial-intelligence-in-agriculture/#:~:text=Application%20of%20AI%20in%20agriculture,production%20while%20minimizing%20resource%20usage.
9. Javatpoint.com (2022).Artificial Intelligence in Agriculture https://www.javatpoint.com/artificial-intelligence-in-agriculturev
10. Manivannan, L, & Priyadharshini, M.S. (2016) Agricultural robot International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (2016), 153-156
11. Naadzenga, D (2023). Using Ai to solve traditional farming challenges in Nigeria. Artificial Intelligence (AI) has continued to revolutionize every aspect of human existence. https://www.nairapen.com/posts/using-ai-to-solve-traditional-farming-challenges-in- Nigeria
12. Ogunode, N. J. & Ukozor C,. U. (2023). Curriculum Revolution in Higher Education: The Mighty Role of Artificial Intelligence. https://ijins.umsida.ac.id/index.php/ijins/article/view/971/1183
13. Ogunode, N. J., Agbade, O. P., & Bassey, U. O. (2023). Barriers to Effective Usage of Artificial Intelligence in Tertiary Institution in North-Central, Nigeria. Web of Semantics: Journal of Interdisciplinary Science, 1(1), 38–43. Retrieved from http://web.semanticjournals.org/index.php/wos/article/view/13
14. Ogunode, N,. J. & Gregory, D. M. (2023). Artificial Intelligence (AI) in Educational Administration. International Journal on Orange Technologies, 5(10), 7-16. Retrieved from https://journals.researchparks.org/index.php/IJOT/article/view/483
15. Singh, S., & Jain, P. (2022). Applications of Artificial Intelligence for the Development of Sustainable Agriculture. In: Kumar, P., Tomar, R.S., Bhat, J.A., Dobriyal, M., Rani, M. (eds) Agro-biodiversity and Agri-ecosystem Management. Springer, Singapore. https://doi.org/10.1007/978-981-19-0928-3_16
16. Rakhra, M., Sumaya, S., Quadri,N. N.,Verma, N., Ray, S., & Asenso, E (2022).Implementing Machine Learning for Smart Farming to Forecast Farmers' Interest in Hiring Equipment. Hindawi Journal of Food Quality, Volume 2022, Article ID 4721547, 17 pages Accessed on 21 February 2022 from https://doi.org/10.1155/2022/4721547
17. Rizzoli, A (2021). Practical Applications of AI in Agriculture. https://www.v7labs.com/blog/ai-in-agriculture
18. Shekhar, Y. Dagur, E. Mishra, S. Tom, R.J. Veeramanikandan, M. & Sankaranarayanan, S (2017).Intelligent IoT based automated irrigation systemInt. J. Appl. Eng. Res., 12 (18) (2017), 7306-7320
19. Pedersen, S,.M, Fountas, S. & Blackmore, S. (2008). Agricultural robots – applications and economic perspectives Service Robot Applications. (2008), pp. 369-382