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Precision Agriculture Technology: A Literature Review

C. A. Danbaki[1*], N. C. Onyemachi[1], D. S. M. Gado[2], G. S. Mohammed[2], D. Agbenu[3] and P. U. Ikegwuiro[4]

[1]Federal College of Forestry Mechanization, Afaka Kaduna, Nigeria.
[2]Kaduna Polythecnic, Kaduna, Nigeria.
[3]Forestry Research Institute of Nigeria, Ibadan, Nigeria.
[4]National Water Resources Institure, Kaduna, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Authors CAD and NCO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors DSMG and GSM managed the analyses of the study. Authors DA and PUI managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study is a survey on state-of-the-art methods based on artificial intelligence and image processing for precision agriculture on Crop Management, Pest and Disease Management, Soil and Irrigation Management, Livestock Farming and the challenges it presents. Precision agriculture (PA) described as applying current technologies into conventional farming methods. These methods have proved to be highly efficient, sustainable and profitable to the farmer hence boosting the economy. This study is a survey on the current state of the art methods applied to precision agriculture. The application of precision agriculture is expected to yield an increase in productivity which ultimately ends in profit to the farmer, to the society increase sustainability and also improve the economy.

Keywords: Precision agriculture; artificial intelligence; image processing; technology; remote sensing.

**Corresponding author: Email: cdanbaki2002@gmail.com;*

1. INTRODUCTION

With the growth of human population in geometric progression, there is a need for smart farming methods as just growing more crops and increasing cattle to feed the population will not solve the issue of feeding the fast-growing world population. This is where Precision Agriculture (PA) technology comes in. It is simply described as incorporating technologies to current farming methods with the goal of farming smarter [1]. The application of precision agriculture is expected to yield an increase in productivity which ultimately ends in profit to the farmer, to the society increase sustainability and also improve the economy [2]. It is one of the key approaches in the agricultural sector that links both environmental and economic interests [3]. Data Collection on Precision Farming, para. 1). The technologies integrated with precision agriculture includes Global Positioning System (GPS), Mobile devices, robotics, driverless tractor, Internet of Things, Sensors, Variable Rate Seeding, Weather modelling, Unmanned Aerial Vehicle (UAV) etc [4]. Incorporating these technologies has increased efficiency of farming methods, can control global food crisis, monitor crop and animal health thus increasing yield and brings about smarter ways to grow food thus regulate the use of land [4]. Ullah et al. [4], described the four main phases of precision agriculture: The data collection deals with the boundary of field remote sensing, weather data, cropcondition, and irrigation testing. The analysis phase determines the variability, determine possible causes of variability, howmuch do measure soil and crop characteristics, and howmuch do the variations affect crop yield and crop quality. The management and decisions phase we check either it is possible to change the variability, how to change increase yield and quality while decrease input, and how to implement these changes. The fourth phase which is the farming phase is where we apply the decisions. This paper is a survey on state-of-the-art methods based on artificial intelligence and image processing for precision agriculture on Crop Management, Pest and Disease Management, Soil and Irrigation Management, Livestock Farming and the challenges it presents.

2. CROP MANAGEMENT

Antonio da Silva Junior et al. [5], incorporated perceptron neural networks with remote sensing to differentiate and estimate areas of soya bean through a vegetative index thus improving the mapping results for Soya beans. Soheili-Fardand Salvatian [6], used artificial neural networks to determine the energy inputs in a tea farm thus enabling the ability to forecast the tea yield in that farm with the energy input. Agricultural field robots and manipulators have become an integral part in different aspects of smart farming [7]. The sweeper robot was built to harvest pepper fruit [8]. It sights the ripe fruits with its image sensor that has been trained with deep learning algorithms then moves to the location of the ripe fruit following the nearest trajectory to the location [8]. The Optoelectronic reflex sensor and microcontroller board is a device used to measure the continuous growth of the perimeter of a fruit or a stem of a plant [4].

3. PEST AND DISEASE MANAGEMENT

Pest infestation is one of the alarming problems in agriculture that can lead to heavy economic loss to the farmer [9]. Pests are inthe form of bacteria, fungi, insects, animals or even human activity that is contrary to the cultivation of the crop. They can be collectively called bio aggressors [10]. Sarma et al. [11], developed a rule-based expert system using the shell expert system for text animation for the diagnosis of common diseases of rice plants. Boissard et al [10], developed a cognitive vision system that combines image processing, learning and knowledge-based techniques for the automatic detection of whitefly with their numbers included on the plant in the greenhouse. Potatobacterial wilt can only be detected when extensive damage has been done to the crop [12]. The multifractal analysis applied to remote sensing can detect asymptomatic latent infection thus enabling control of the pest [12]. The Agribot is an agricultural robot used for spraying pesticides that could pose a health risk to a human applicator [13].

4. SOIL AND IRRIGATION MANAGEMENT

Improper irrigation and soil management could lead to low crop yield and degraded quality [9]. This makes this an important factor for crop productivity. Massaro et al. [14], develop a decision support system (DSS) based on sensor threshold for irrigation management. The system reads field and weather values via the sensor and irrigation decision is done after analysis of the predicted weather data [14]. PA can increase the efficiency of fertilizer applied in the soil for crop yield by measuring the crop nutrient status and applying the rate accordingly Frits et al. [2], used a Takagi Sugeno Kang fuzzy inference system to estimate the stem water potential of a plant-based on meteorological and soil water content data with 86% accuracy [9].

5. LIVESTOCK FARMING

Precision livestock farming is the management of livestock by continuous automated real-time monitoring of production, welfare and health of livestock and its impact on the environment [15]. Over the years technologies have been incorporated that have the potential to revolutionise the livestock farming industry [16]. In dairy farming, robots coupled with sensors take the role of milking while the farmers, on the other hand, manage the information given on the computer by the robots [17]. Sensors have been developed to get the exact measurement of behavioural parameters in the animals as well as incorporating identification of milk composition, quality, hormones and ketones into milking robots [17]. The dynamic monitoring system, developed for broiler chicken is used to automatically monitor the housed birds' behaviour and raise alarm when an anomaly is detected [18]. Online cough recognition algorithm was developed for pigs to detect respiratory issues as this is very common for them [15].

6. CHALLENGES OF PRECISION AGRICULTURE TECHNOLOGY

Fakhruddin [19], states 15 challenges and issues of precision agriculture: The first is Interoperability of different standards. Various technologies and tools do not follow the same operational standards. The second the steep learning curve it presents for the average farmer. The third is the unavailability of a strong internet connection in rural areas. The fourth is making sense of big data as it is impossible to monitor and manage every data point daily and weekly over all the growing seasons. The fifth is non-awareness of varying farming functions. For the fact you apply a certain amount of fertilizer on a particular soil, it does mean another soil with the same plant needs the same amount of fertilizer as the nutrient amount in the soil may differ. The sixth is the size of management zones. There is not much reference to use when dividing the management zones concerning soil sampling requirement. The seventh is barriers for entry for new firms. Precision agriculture is still new, so there are not a lot of companies in the market with this technology. This low competition can prevent new firms from entering the market. The eight is lack of scalability and configuration problem. The same used for commercial sizes should also be used for small farms. However, this is not the case. The ninth is energy depletion risk. PA should be about conserving energy but when using all these technologies, in the long run it consumes a lot of energy using data hubs/ data centres, sensors and other gadgets. The tenth is that it poses a challenge for indoor farming. Most of the PA methods are optimized for outdoor farming. The eleventh is a technical failure and resultant damages. If there is a breakdown in the gadgets, it could lead to low crop yield or even crop failure. The twelfth is mounting e-waste. Regular updates of gadgets are making the older ones obsolete dumping them causes a landfill hence land pollution in the long run. The thirteenth is the loss of manual employment. With the introduction of PA which reduces the need for much of the manual labour, those that were required for that job will not be needed since they have been replaced by technology. The fourteenth is the security factor. As long as a system is connected to the internet, security concerns will be an issue as it is in the conventional world. The last is benefits are not imminent. Like every good thing takes time, the benefits of PA are not immediate thus making the farmer not wanting to risk it financially in the beginning.In the aspect of livestock farming, the use of robots could reduce the human to animal interaction thus disallowing the farmers to familiarize themselves with the animals as in the conventional manner [17]. The usage of technology increases the mental workload of the average farmer (Houstiou et al, 2017). Lack of national infrastructure such as power in outskirts where the farm is located could pose as a challenge for the enablement of precision agriculture [20].

7. CONCLUSION

In this survey, different technologies based on artificial intelligence and image processing was presented as well as the challenges of precision agriculture. Precision Agriculture has shown that it can proffer solutions such as increasing efficiency, productivity thus boosting the economy of the nation in effect to the teeming ever-growing population.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mcconnell M, Burger WL. Precision agriculture technology: Quail Forever; 2017.
   Available:https://www.quailforever.org/
2. European Environment Agency. Data collection on precision farming; 2018.
   Retrieved January 20 2019.
   Available:https://www.eea.europa.eu/themes/agriculture/background-note-data-collection-on/download
3. Ullah A, Ahmad J, Muhammad K, Young Lee M, Kang B, Beom Soo O, Baik SW. A Survey on precision agriculture: technologiesand challenges. 3rd International Conference on Next Generation Computing (ICNGC2017b); 2017.
4. Antonio da Silva JuniorC.NanniMR, Teodoro PE, Guilherme FCS, Guerreiro de Lima M, EriM. Comparison of mapping soybean areas in Brazil through perceptron neural networks and vegetationindices. African Journal of Agricultural Research. 2016;11(43):4413-4424.
5. Soheili-Fard F, Salvatian SB. Forecasting of tea yield based on energy inputs using artificialneural networks (A case study: Guilan province of Iran). Biological Forum. 2015;7(1):1432-1438.
6. Shamshiri RR, Weltzien C, Hameed IA, Yule IJ, Grift TE, Balasundram SK, Lenka P, Ahmad D, Chowdhary G. Research and development in agricultural robotics: A perspective of digital farming. International Journal Agriculture & Biological Engineering. 2018;11(4):1-4.
7. Sweeper – Sweet Pepper harvesting robot.
   Retrieved January 20, 2019.
   Available:http://www.sweeper-robot.eu/.. 2018
8. Bannerjee G, Sarkar U, Das S, Ghosh I.Artificial in telligence in agriculture: A literature survey. International Journal of Scientific Research in Computer Science Applications and Management Studies. 2018;17(3).
9. Boissard P, Martin V, Moisan S. A cognitive vision approach to early pest detectionin greenhouse crops. Computers and Electronics in Agriculture, Elsevier. 2010;6(2):81-93.
10. Sarma SK, Singh KR, Singh A. An expert system for diagnosis of diseases in rice plant. International Journal of Artificial Intelligence. 2010;1(1):26-31.
11. Cha´vez P, Yarleque C, Loayza H, Mares V, Hancco P, Priou S, Marı´a del Pilar M, Posadas A, Zorogastu´a P, Flexas J, Quiroz R. Detection of bacterial wilt infection caused by Ralstonia solanacearum in potato (*Solanum tuberosum* L.) through multifractal analysis applied to remotely sensed data. Springer: Precision Agric. 2011;13:236–255.
12. Gowrishankar V, Venkatachalam K. ICT based precision agriculture using Agribot. Global Research and Development Journal for Engineering. 2018;3(5):2455-5703.
13. Massaro A, Meuli G, Savino N, Galiano N. A precision agriculture DSS based onsensor threshold management forirrigation field. Signal & Image Processing: An International Journal (SIPIJ). 2018;9(6):40-58.
14. Frits KV, Gaitan-Cremaschi D, Fountas S, Kempernaar C. Can precision agriculture increase the profitabilityand sustainability of the production of potatoes and olives? Sustainability. 2017;9(10):1863.
15. Norton T. Precision livestock farming: Use of technologies to optimize animal production; 2017.
    Retrieved January 21 2019.
    Available:http://www.livestockforum.com/documents/5645614/c57271f2-a91a-42c0-989a-661e483d4ae9.
16. Banhazi T, Lehr H, Black J, Crabtree H, Schofield P, Tscharke M, Berckmans D. Precision livestock farming: An international review of scientific and commercial aspects. International Journal Agriculture & Biological Engineering. 2012;(3):1-10.
17. Hostiou N, Fagonn J, Chauvat S, Turlot A., Kling-Eveillard F, Boivin X, Allain C. Impact of precision livestock farming on work and human-animal interactions on dairy farms. A review. Biotechnology. Agron. Soc. Environ. 2017;21(4):268-275.
18. Berckmans D. Precision livestock farming technologies for welfare management in intensive livestock systems. Rev. Sci. Tech. off. Int. Epiz. 2014;33(1):189-196.
19. Fakhruddin H. Precision agriculture: Top 15 challenges and issues; 2017.
    Retrieved Feb 1, 2019.

Available:<https://teks.co.in/site/blog/precision-agriculture-top-15-challenges-and-issues/
20. Eastwood C, Klerkx L, Ayre M, Rue B. Managing socio-ethical challenges in the development of smart farming: From a fragmented to a comprehensive approach for responsible research and innovation. Journal of Agricultural & Environmental Ethics. 2017;1:28.

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