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Review Article

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Precision Agriculture Age

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Abstract

Precision agriculture is a management system based on information and technology for optimum profitability, sustainability, and environmental protection. There are three main elements considered the backbone of precision farming data and information, technology, and decision management. There are various technologies tools used in Precision agriculture such as Guidance Technology, Global Positioning System, Geographical Information Systems, Global Navigation Satellite System, hardware, software, grid sampling, and Remote Sensors.

There are different threats that attack the precision agriculture system due to its permanent internet connection and the potential threats include Information theft, stealing resources, losing reputation, and Destruction of machines, therefore, Precision agriculture required innovative people well qualified, and have the capacity to provide practical solutions through available information.

Keywords: Guidance technology; Precision agriculture; Profitability; Remote sensors; Variable rate technology

Abbreviation

GIS	:	Geographical Information Systems
PA	:	Precision Agriculture
GNSS	:	Global Navigation Satellite Systems
GPS	:	Global Positioning System
RT	:	Reacting Technology
VRA	:	Variable Rate Application

Introduction

The Precision Agriculture (PA) concept started to use in the early '90s in the last century and the main concept was the management of spatial variability in crop production, later, it includes study the role of other components of variability and different sectors of agricultural production related to the concept in a duly manner. According to The International Society of Precision Agriculture "Precision Agriculture is a management strategy that gathers, processes and analyzes temporal, spatial and individual data and combines it with other information to support management decisions according to estimated variability for improved resource use efficiency, productivity, quality, profitability and sustainability of agricultural production" [*1*].

The term precision agriculture or farming has emerged in the recent era, meaning the development of wireless networking and miniaturization of the sensors for monitoring, assessing, and controlling agricultural practices.

Precision agriculture is more related to the management of site-specific with a wide range of different aspects before cultivation until harvesting, and it's including all plant cultivars like field crops and horticultural crops [2]

Precision agriculture is a management system based on information and technology for optimum profitability, sustainability, and environmental protection. Precision Agriculture or precision farming include improved management technologies like soil sensing and mapping, yield monitoring and mapping, satellite-based positioning, remote sensing, field, and crop scouting, Geographical Information Systems (GIS), Variable Rate Application (VRA), and automatic steering [3]. This work aims to focusing the adoption of PA technologies and its role in improving agriculture production.

Materials and Methods

A systematic literature review was conducted, searching the platforms Web of Science, Google Scholar, AGRIS, Research Gate, Academia and Egyptian Knowledge Bank for a combination of the following keywords: "Precision agriculture", "Remote Sensors", "Guidance Technology", and "variable rate technology". The most recent papers dealing with precision agriculture were selected for this review.

Precision agriculture: The main purpose of precision agriculture is to support farmers by providing customized information and services that increase productivity, profitability, and protect environmentally [4]. Precision agriculture plays a direct role in developed country-specific intelligent platforms that provide farmers with context-relevant and personalized agricultural recommendations through their mobile phones, while the existing agricultural system improving through precision agriculture which helps render these advisory services more customizable and intelligent with time, by evaluates and enhances the current systems [5]. Precision agriculture is becoming an interesting scope for managing natural resources like water, soil, and seeds and applying modern sustainable agricultural development, it is bringing agriculture into the digital information era. Precision agricultural technology used to enhance crop yields and protect the environment, decrease nutrients leaching, in addition, to enhance nutrient's long-term incorporation by soil microorganisms [6]. Also, precision agriculture includes the livestock sector, it's used to improve meat and milk productivity [7].

What's the importance of precision agriculture?: There are different problems face the agricultural sector and affect crop productivity, like diseases, pests, lack of water management, chemicals management, shortage of storage management, and weed management, these problems can be solved by using a precision agriculture technology *[8]*. Today precision agricultural technologies have more interesting from farmers around the world particularly in developed countries, crop producers have more trust in technology in the agricultural sector, farmers are increasing their reliance on information age technologies and agricultural industries are making strategic investments to take advantage of new economic opportunities, also, currently many farmers are purchasing precision technologies but are challenged with fully implementing variable rate treatments, so, the increasing investments to get the new economic privilege, currently, there are more demands for precision technology to implement the agriculture production *[9]*.

Important of precision agriculture: There are important roles for precision agriculture in increase crop productivity and enhancing production quality [10] including:

- PA offers a significant contribution to producing more crops to enhance food security.
- Providing new solutions for enhancing food safety.
- PA support sustainable impact use of different resources in the agricultural sector.
- PA has influenced on work practices and living conditions on farmers' community, and increase new agribusiness models.

PA system allows more precise application of crop and livestock management inputs such as fertilizer, seeds, and pesticides, resulting in lower costs and enhances outputs (crop yields and meat or milk production) [11].

There are three main factors considered the backbone of precision farming:

- Data and Information.
- Technology.
- Decision support.

Therefore, in the PA system the combining of the three factors to reduce inputs, increase crop production, improve product quality, and reduce risks of the environment.

There are various impacts of Precision agriculture like:

- Improve the operation system of the farms.
- Environmental protection.
- Social security to farm at risk.

Actually accurate information about soil fertility, crop productivity, water supply, climate change, and spreading diseases and pests is an important modeling input, which is helpful to farmers for decision making to establish the right policies [12].

PA techniques assist farmers in different agricultural operations from tillage to harvesting to reduce inputs, increase profits, and protect the environment [13], the farmers get various advantages through using PA-technologies including:

- Increase the accuracy of field works,
- Higher operation speeds,
- Easy operating,
- Working 24 h (day and night),
- Less affecting by unbalanced weather,
- Reduced operator fatigue,
- Less setup time,
- Decrease overlapping,
- Reduce skips,
- Working without foam markers,
- Reduced production costs (fuel, fertilizer, pesticides, seeds, etc).

In the next decade, auto guidance could be considered a standard feature for new high-powered farm tractors; also, in

current time driverless autonomous tractors are under-tested in some developed countries particularly in the USA.

However, the application of precision agriculture technologies in Sub-Sahara countries like Rwanda, Ethiopia, and Kenya is presently at the nascent stage due to various reasons [14]. The practice has efficiently extended into some developed countries like USA, Canada, Australia, and some EU countries like Germany, Finland, Denmark, and Sweden has some level of adoption for PA technologies, the basic principle of managing soil and crop variability within a field is certainly not new, reported that there are about 90% of the yield monitors worldwide were operated in the US due to there are many innovative technologies.

Precision agriculture technologies: Currently, there is an increasing trend in developed and some developing countries for increasing the adoption rate of precision agriculture technologies.

- The yield monitoring technology and variable rate technology were more dominant earlier in both developed and developing countries.
- While the auto-guidance systems had more popularity in the last decade.

New technology has offered new opportunities to provide proper information for the farmers to take the right decision at the right time to improve agricultural production [15], these technologies are assisting landowners to adapt to local conditions and reduce inputs, also, there are various objects for these technologies include measurement of specific parameters, Global Navigation Satellite Systems (GNSS), collecting information and analysis, advisory systems, robotics, and autonomous navigation [16]. Precision agriculture maximizing the crop yield by using the minimum inputs and increase net profit by decreasing operation costs, also, through mapping fields and use sensors, farmers could recognize their crops during various growth stages., preserve natural resources like (water, soil, and seeds), and protect the environment from various hazards [17].

The main steps required to promote precision agriculture at farmer's level:

- Identify the proper sites for the promotion of crop-specific precision farming
- Formation of working groups involving agricultural scientists in different fields, engineers, manufacturers and economists to study all objectives of precision agriculture.
- Start with a small pilot of precision agriculture and providing full technical support for the farmer
- The model or pilot must be in the field inside the community of farmers to show the positive effect of precision agriculture technologies.
- Increase farmers' awareness about the hazards of continuous applying different doses of various inputs like fertilizers, irrigation, and pesticides.

All these components are correlated and responsible for developing precision agriculture at the farmer's levels.

Precision agriculture tools: There are different technologies used in PA like Guidance Technology, Global Navigation Satellite System (GNSS), Geographical Information Systems (GIS), Global Positioning System (GPS), and Reacting Technology (RT). In addition to collecting accurate data about farms, and above components, precision agriculture uses a vast array of technologies tools including hardware, software, and various tools include:

- Global Positioning System (GPS)
- Geographic Information System (GIS)
- Grid Sampling
- Remote Sensors (Satellites & Drones)
- Variable Rate Technology (VRT)
- Mobile Devices
- Robotics
- Internet of Things (IOT)
- Weather Modeling
- Irrigation systems
- Nitrogen Modeling
- Yield Maps
- Standardization.

Nanotechnology and precision agriculture: There is a correlation between nanotechnology and precision agriculture, due to the direct applications of nanotechnology in precision agriculture, there is a different intended application like nanosensors, nano fertilizers, Nanopesicides, and nanotools which support precise management of the agricultural sector [18].

There are different applications of nanotechnology in precision agriculture include:

- Nanobiosensors to watch soil fertility.
- Slow-release fertilizers and pesticides.
- Discovery of the pollution of soil and water.
- Management plant disease.
- Improvement of shelf-life of the agricultural commodities.
- Use nanomaterials as growth regulators like silver nanoparticles.
- Produce nano Zeolites for increase soil holding capacity.
- Nutrient/water delivery system via selective localization.
- Increase the quality of crops by nano nutrients.

Advantages of precision agriculture:

- It will enhance agricultural productivity and prevent soil degradation in cultivable land resulting in sustained agricultural development.
- Reducing excessive chemical usage in crop production.
- Increase water resources use efficiency; will be utilized efficiently under the precision farming
- GPS allows agricultural fields to be survived with ease. Moreover, the yield and soil characteristics can also be mapped
- Non-uniform fields can be subdivided into small plots based on their unique requirements

Disadvantages

There are some disadvantages for PA system for different reasons [19], includes:

- High capital costs may discourage farmers to not adopt this method of farming [20]
- Precision agriculture techniques are still under development and require expert advice before actual implementation.
- It may take several years to collect sufficient data to fully implement the system particularly in Developing countries [21]
- It is an extremely difficult task particularly the collection and analysis the data [22]

Challenges for precision agriculture

The lack of a creative, workforce represent the main challenge of the precision agriculture which required innovative people well qualified, adapted with technology literate, able to utilize and interpret data and information gained from information-age technologies to make smart management decisions, and have the capacity to provide practical solutions through available collected information [23].

There are different factors affecting precision agriculture includes:

- Awareness,
- Characteristics of the farms,
- Personality and family structure of the farmer,
- Features of the equipment,
- Characteristics of the technology,
- Legal affairs,
- Social interaction [24].

One of the most important factors in favor of the adoption of the PA technologies is farm size, therefore, the countries with wide farms like the US, Australia, Canada, Brazil, and Argentina tend to adopt these technologies in bigger areas.

In developing countries, the main challenges for precision agriculture are the majority of farms are small size and difficulty of collecting adequate data to extract required knowledge, therefore, under developing countries conditions with small farm size, farmers must form large entities to be able to take advantage of the precision farming applications [25]. From another side, different developing countries like India, China, Kenya, Egypt, Ethiopia, and Bangladesh, are starting from the last decade preparing to follow the experience of the developed world in precision agriculture and are starting to investigate the new technology [26]. Currently, smallholder farmers in developing countries who represent more than two billion people worldwide could be using precision agriculture partially by providing customized information and services that increase productivity, profitability, and environmental sustainability, also, in developing countries it is preferable to introduce precision agriculture to high-value crops to encourage farmers to use this technology.

The threats for precision agriculture

In precision agriculture system there are different threats attack the agricultural sector [27], due to:

- PA connected online permanently
- PA considered a mechanical intensive industry,

Until now there is no fully understand potential threats to precision agriculture, or maybe not treated seriously [28].

Potential threats to PA include

- Information theft.
- Stealing resources.
- Losing reputation
- Destruction of machines.

USB thumb drives, spear-phishing, considered weak points allowing to malicious cyber-attacks, therefore more attention required to avoid the threat and stopped any attack quickly, also, the threats for PA include any element that has negative effects on productivity like natural disasters that affect crop and livestock productivity, terrorist attacks, equipment breakdown.

Conclusion

Precision agriculture is a management system planned to reduce input and maximize production, enhancing product quality, increase the efficiency of energy, sustain various resources, and protect the environment.

There are various techniques used in precision agriculture like Remote Sensors, variable rate control, yield mapping, while, data and information, technology, and decision management considered the backbone of precision agriculture system. from another side, there are various threats that attack the PA system because the permanent connection to the internet offers a chance to attack the PA system by various threats like Information theft, stealing resources, losing reputation, and Destruction of machines, in addition, the natural disasters, terrorist attacks, machines breakdown that considered a threats affect negatively on PA system.

References

1. The international Society of Precision Agriculture ISPA (2019).
2. Pierce FJ and Nowak P (1999) Aspects of precision agriculture. Advances in Agronomy 67: 1-85.
3. Das U, Pathak P, Meena MK, Mallikarjun N (2018) Precision Farming a Promising Technology in Horticulture: A Review, Int. J. Pure App. Biosci. 6: 1596-1606.
4. Borghi E, Avanzi JC, Bortolon L, Luchiari A, Bortolon ESO (2016) Adoption and use of precision agriculture in Brazil: Perception of growers and service dealership. Journal of Agricultural Science 8: 89-104.
5. Fountas S, Van der Wal T, Eory V, Gómez-Barbero M (2019) The contribution of precision agriculture technologies to farm productivity and the mitigation of greenhouse gas emissions in the EU. Publications Office of the European Union.
6. Abobatta WF (2018) Nanotechnology Application in Agriculture. Acta Scientific Agriculture 2: 99-102.
7. Kutter T, Tiemann S, Siebert R, Fountas S (2011) The role of communication and cooperation in the adoption of precision farming. Precision Agriculture 12: 2-17.
8. Paustian M and Theuvsen L (2017) Adoption of precision agriculture technologies by German crop farmers. Precision Agriculture 18: 701-716.
9. Stanciu S (2019) Precision agriculture in Romania. Facts and statistics. 34th International Business Information Management Association Conference: Vision 2025: Education Excellence and Management of Innovations through Sustainable Economic Competitive Advantage. Pp: 7366-7375.
10. Takács-György K (2009) Importance of precision farming in improving the environment. ŽEMĖS ŪKIO MOKSLAI 16: 217-223.
11. Balafoutis A, Beck B, Fountas S, Vangeyte J, Van der Wal T, et al. (2017) Precision Agriculture Technologies Positively Contributing to GHG Emissions Mitigation, Farm Productivity and Economics. Sustainability 9: 1339.
12. Bobby R, M Alley, W Thompson, D Holshouser (2011) Precision Farming tools: Variable rate application. Virginia Cooperative Extension. Pp: 442-505.
13. Maheswari R, Ashok KR and Prahadeeswaran M (2008) Precision Farming Technology, Adoption Decisions and Productivity of Vegetables in Resource-Poor Environments. Agricultural Economics Research Review 21: 415-424.
14. Ehsani R (2011) Precision Agriculture for Small Growers. Resource Magazine 18: 11-12.
15. Ess DR (2002) Precision and Profits. Resource Magazine 9: 11-12.
16. Pierpaoli E, Carlia G, Pignattia E, Canavaria M (2013) Drivers of Precision Agriculture Technologies Adoption: A Literature Review. Procedia Technology 8: 61-69.
17. Abdulwaheed A (2019) Benefits 0f Precision Agriculture in Nigeria. London Journals Press 19: 29-34.
18. Duhan JS, Kumar R, Kumar N, Kaur P, Nehra K, et al. (2017) Nanotechnology: The new perspective in precision agriculture. Biotechnology Reports 15: 11-23.
19. Duarte-Galvan C, Torres-Pacheco I, Guevara-Gonzalez RG, Romero-Troncoso RJ, Contreras-Medina LM, et al. (2012) Review. Advantages and disadvantages of control theories applied in greenhouse climate control systems. Spanish Journal of Agricultural Research 10: 926-938.
20. Demirbaş N (2018) Precision Agriculture in Terms of Food Security: Needs for The Future. X. IBANESS Congress Series-Ohrid / Macedonia.
21. Yirga C and RM Hassan (2010) Social costs and incentives for optimal control of soil nutrient depletion in the central highlands of Ethiopia. Agricultural Systems 103: 153-160.
22. Wiseman L and Sanderson J (2018) Realising the Full Potential of Precision Agriculture: Encouraging Farmer 'buy-in' by Building Trust in data Sharing, In Proceedings of the 14th International Conference on Precision Agriculture, June 24-June 27, Montreal, Quebec, Canada.
23. McBratney A, Whelan B, Ancev T (2005) Future Directions of Precision Agriculture. Precision Agriculture 6: 7-23.
24. Jensen H G, Jacobsen L B, Pedersen S M, Tavella E (2012) Socioeconomic impact of widespread adoption of precision farming and controlled traffic systems in Denmark. Precision Agriculture 13: 661-677.
25. Katke K (2019) Precision Agriculture Adoption: Challenges of Indian Agriculture. International Journal of Research and Analytical Reviews 6: 863-869.
26. Getinet A and Getachew A (2019) Precision Agriculture and the Need to Introduce in Ethiopia. Ethiop. J. Agric. Sci. 29: 139-158.
27. Chae CJ and Cho HJ (2018) Enhanced secure device authentication algorithm in P2P-based smart farm system. Peer--Peer Netw. Appl 11: 1230-1239.
28. Bergmann KP and Denzinger J (2013) Testing of precision agricultural networks for adversary-induced problems, in: Proceeding of The 15th Annual Conference on Genetic and Evolutionary Computation (GECCO '13). ACM, Amsterdam, The Netherlands. Pp: 1421-1428.