



Assessing precision agriculture applicability in agriculture sector in Egypt

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Abstract:

Precision Agriculture is a technological trend that has been introduced to serve agricultural sector in many countries. There are many solutions and applications of precision agriculture that depend on use of information technology as well as integration between sensors and systems. The PA solutions include use of remote sensing technologies, vision sensors, robots, Internet of Things (IOT), Machine Learning (ML), blockchain, and Artificial Intelligence (AI). This paper focused on assessing precision agriculture applicability in the agriculture sector in Egypt and challenges affecting the diffusion of these technologies with proposals of overcoming these challenges. The research objective was achieved through conduction of an online survey and a focus group discussion session. Through an online survey, 31 respondents were reached and provided their opinions on the current situation. This has been followed by a focus group discussion session that was attended by 39 experts in the field of agriculture and technology. Respondents to this research are agricultural and technological experts in the field of agriculture. Conducted focus group discussion session helped in identification of the current applications of PA, challenges affecting its implementations and ways to improve its applicability. Paper addressed some needs and appropriate technologies that might be adopted by agribusiness in Egypt. In addition, it is highlighted some main recommendations that are gathered from subject matter experts in both technological and agricultural fields. Finally, this research emphasized that the precision agriculture technologies can be implemented in Egypt and support in overcoming some of the challenges affecting the development of the agriculture sector.

Keywords: Precision Agriculture–Digital agriculture–Information and Communication Technologies – Sensors – Internet of Things and Robotics.

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Received: 4/9/ 2022

Accepted: .28/.9/ 2022

1- Introduction:

The digital transformation is currently serving the development of many sectors worldwide and receives attention of policy makers as well as businesses. One of the trends of digital transformation is the precision agriculture technologies. Precision agriculture depends on uses of data collection tools such as sensors that are connected to data collection hubs and analyzed to support the management decisions of farming activities. Precision agriculture can enhance the management of farms in response to climate change issues as well as optimization of water use and agrochemicals.

Litrature Review:

Precision agriculture as a new technological trend has been supported by image processing and vision machines as well as Machine Learning (ML), and Internet of Things (IOT). Precision Agriculture (PA) is a method for operating farm activities which depends on IT tools and services to obtain exact amounts of agriculture resources for applications. The objective of PA is to maximize profitability and returns on investments in a sustainable manner and be rational in using agricultural inputs to preserve the environment.

One of the used technologies in PA is the identification of plant pathogens/diseases using vision machines and image processing [1]. This gives a good scouting system to improve pest detection procedures and interventions. Artificial Intelligence (AI) is also one of the supporting technologies to precision agriculture applications in the last years [2]. The dependance on AI supports farm managers to use computer analytics in predicting incidents that might affect their crops in the field. AI enhance decisions based on correlating information that are gathered from different sources and this correlation helps in taking the right decision.

Data analytics and expert systems are main functions of the precision agriculture where the integration between devices and data analysis enhances the decision making of farm managers. This paper focusses on the current situation of applied precision agriculture technologies in Egypt and ways to enhance the agricultural sector through the Information and Communication technologies ICTs. Furthermore, this paper assessed the current obstacles affecting the adoption of PA in Egypt with some recommendations of improving its position.

The agricultural machines are also served by PA technologies in the last years as many companies have enhanced machinery with proximal/optical sensing [3]. PA can help in field surveys and yield estimation using moving tractors in the field. However, PA faces challenges in proofing the economic returns as it requires huge investments in installations and changing of the current management systems. Employing AI and Deep Learning DL technologies shall support agricultural sectors with decision improvement tools[4]. The agriculture sector consumes fresh water and this can be enhanced through adoption of PA technologies which are considered by many countries worldwide[5]. However, PA needs to be economically assessed to measure farmers' adoption and diffusion. This is one of the obstacles of promoting PA as it is hard to show economic returns of adopting such technologies specially at small scale farms level.

The Fourth Industrial Revolution (4IR) is supporting the PA concepts through the technological development in tools and services. Most of the technological tools and services are developing progressively so the impact of these developments shall improve offered services to businesses. 4IR enhances

the rational use of agricultural inputs, and provide solutions to weather related issues[6]. Internet of Things (IOT) has been frequently used in different industries and one of the served sectors is agriculture. PA integrated many IOT applications which are used to support the implementation of PA in many countries [7]. Still there are needs for more applied technologies to support agricultural sector that should be commercially available in the market.

The Precision Agriculture depends on many technologies, and it is expected to be developed in correlations with the progressive development of these technologies. This paper focuses on measuring the applicability of PA in Egypt with consideration of technology and economic assessments.

Precision Agriculture can be defined as a modern technological approach that is currently introduced to the agricultural sector worldwide. The objective of the precision agriculture is to use sensors, devices, instruments, and equipment to support decisions on use of agricultural inputs such as fertilizers, pesticides, water, animal feed and veterinary products. Precision agriculture is not limited to crops or horticulture, but it is covering livestock and forests as well. The use of precision agriculture will allow farmers and professionals to better manage their agricultural projects and reduce operational costs of agricultural inputs or losses resulted from less control on agricultural pests.

The literature review assisted in identification of technological directions that were discussed in the focus group discussion. The objective of this research is to assess the applicability of PA in the agricultural sector in Egypt by identification of the current technological needs of the sector and addressing the suitable PA technologies to be introduced. In addition, addressing the available PA technologies in Egypt and sources of information and service

provision. Finally, the research aimed at addressing the challenges and obstacles affecting the adoption of PA technologies and ways to overcome these challenges.

2. Materials and Methods:

This paper depended on secondary and primary data collection approaches. Secondary data has been collected from recent studies in the field of technology management and precision agriculture. Previous studies in the field of precision agriculture showed a clear road map of technological categorization which included image sensors, internet of things and machine learning.

The followed research approach in primary data collection included two main sources which are an online survey followed by a focus group discussion. Both activities were announced through social media and reached most of the interested and relevant experts in the field of PA in Egypt and other countries where the selection process focused on Egyptian experts only.

Participants to the online survey and the focus group discussion session were professors at Egyptian universities, professors from the National Research Center, Desert Research Center, private sector, farmers, technical advisors, and technological firms in the field of irrigation and PA. The sample was randomly selected through an announcement that has been communicated over Facebook and WhatsApp groups, then 153 interested applicants showed interest to participate in the FGD. A selection process has been followed and identified 109 expert that received invitation links for the Zoom meeting and another link for the online survey which has been conducted three days before the FGD.

A. Online survey

The online survey has been designed to gather perception of respondents towards precision agriculture applicability in Egypt. It included

questions which gathered an overview of the current practices and available technologies in the field of precision agriculture. The tool included seven questions which collected opinions on the role of precision agriculture to support agribusiness sector in Egypt. Followed by identification of the respondents' relevant experience with PA. Then identification of service providers and technology firms offering PA solutions and packages. A question was given on the drivers that might lead to adopt PA in Egypt followed by questions on the challenges affecting the diffusion of PA in Egypt and how to overcome these challenges.

B. Focus Group Discussions

The second source of primary data collection has been implemented through conduction of a focus group discussion on PA applicability in Egypt. The session has been conducted virtually after identifying interested experts through social media. A selection process has been followed to exclude the irrelevant applicants and identify the most relevant expert to participate in the session.

The objectives of conducting Focus Group Discussions were to gather information about the current situation of agriculture sector and

3. Results and Discussion:

The online survey reached 31 respondents from the experts of the agricultural sector as well as

the applicability of precision agriculture technologies in Egypt. There were sub-objectives of conducting the focus group discussions which are listed below:

- Validation of the secondary data collected on precision agriculture applications from literature review.
- Identification of the current challenges affecting the agriculture sector in Egypt which can be solved through precision agriculture technologies and solutions.
- Identification of the current precision agriculture applications in Egypt.
- Identification of the potential precision agriculture solutions that might be accepted by Egyptian agriculture sector.
- Identification of the potential challenges that might be faced in introducing the precision agriculture to Egyptian agricultural sector.
- Identification of the potential supporters that might assist the implementation of precision agriculture in Egypt.

The participants of the focus group discussion included agricultural experts, researchers, inputs suppliers, agents of international firms, technology expert, and other experts.

technology experts. The following figures illustrate the key results of the survey.

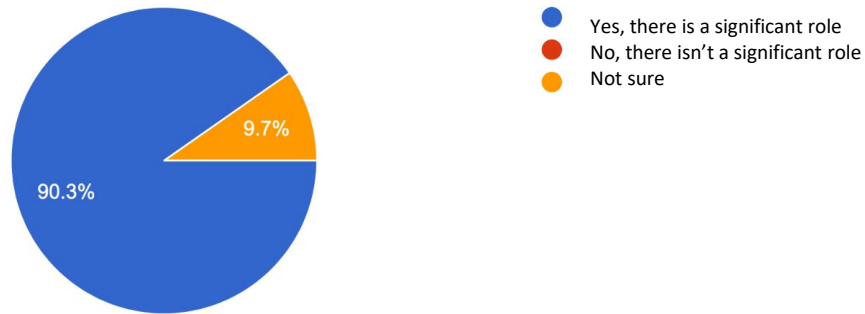


Fig .1 . Opinions on role of PA to develop agricultural sector in Egypt

As illustrated in figure 1, the majority of respondents agree that the PA can play a significant role in developing the agricultural sector in Egypt. twenty-eight respondents confirmed positively while only 3 respondents are not sure if PA can develop the agriculture sector or not. No one of the respondents confirmed negatively on the role that might be played by PA in developing the agriculture sector in Egypt.

Figure 2 illustrated the three segments of respondents who are users of PA technologies in their business, potential users of PA technologies or non-users of PA technologies. Results showed that



Fig .2. Percentage of respondents depending on PA technologies

15 respondents are depending on PA technologies. While 10 respondents are

It's foreseen that there is an interest from governmental bodies, research centers, universities, and agribusinesses companies on the precision agriculture concepts with some attempts of introducing it. The second figure showed that the respondents of this survey are representing different groups such as adopters, non-adopters, and potential adopters.

potentially considering the PA technologies at their businesses. Six participants of this survey are not accepting the PA technologies and not considering it for current interventions at their businesses.

The respondents of the online survey stated that there are international firms in the field of

PA which offer services to agribusiness. Most of their focus is on precision irrigation and controlled systems which depend on sensors

and devices to calculate the amount of water to be discharged in the irrigation system. Rain-Bird and Hunter are the key international players in the field of irrigation technologies and they are providing partial precision tools based on the demand of agribusinesses in Egypt. An agent of Rijk Zwaan is active in Egypt and offers precision irrigation packages as well as hydroponics and vertical farming technologies. Shira company is an Egyptian firm offers controllers and systems for irrigation. Agrimatco is an Egyptian company

specialized in agricultural production and inputs trade, they are providing technical support activities for precision irrigation and horticulture production. There are other companies offering services in the field of Robotics but still their work is under research and development with limited presence in the market.

The focus group discussions session was attended by 39 experts out of 109 invited candidates which have been selected from 153 interested respondents. The selection has been made using the following criteria: relevance to the topic, institutions, and experience. Based on both the online survey and the focus group discussions there are many drivers that increase the demand on PA as a serving technology which are listed below:

- Needs for having accurate data on the crop requirements that can be assigned to large scale farms. This shall decrease the quantities of used agrochemicals and by default achieve cost reductions.
- Small scale farmers need to have accurate information on their crop management practices to overcome the challenges resulted from climate change. Farmers are affected by climate change, and they are lacking support in that field.

- There are some quality requirements that might increase the demand on PA specially for the exported vegetables. PA can serve this segment through decreasing their dependance on agrochemicals.
 - Technology development and availability of services are potential reasons for the adoption of PA in Egypt. There are many international and national firms that are offering solutions in that field in Egypt and providing technical support activities.
 - Another driver for adopting the PA in Egypt is the need to have a tool to analyze and support management decisions. In most of the cases the agricultural companies are depending on insights rather than analytics and PA can provide services to improve businesses.
 - Serving the mega projects that are established by the government such as the 1.5 million acer project and the modernization of irrigation systems which are two governmental initiatives targeting agricultural sector in Egypt.
 - Pest control procedures that can be enhanced by adopting PA are also driving its presence and adoption by the agribusiness companies in Egypt. PA can provide accurate identification of pests in the field and assists farmers to intervene in the meantime with biological control or chemical control measures.
- For the obstacles affecting the diffusion of PA in Egypt, the experts shared their feedback in the focus group discussions and the following points summarize the key challenges faced in introducing PA:
- Absence of strategic planning towards the introduction of PA in Egypt and most of the activities are considered attempts that are taken by private sector or research institutions.
 - Security issues that cause limited availability of some PA technologies such as agricultural drones which are not allowed for imports. In addition, there are some security concerns on

satellite-based devices and sensors that require certain approvals to be imported.

- Lack of awareness on the PA technologies and applications that can serve the agricultural sector in Egypt.
- Lack of access to finance for PA technologies and absence of banking products that focus on PA solutions. However, there are some products focusing on irrigation modernization but without introduction of precision irrigation technologies.
- Limited presence of international firms or national companies specialized in the field of PA.
- Limited promotional activities of PA technologies in Egypt. The available solutions are associated to landscape or gardens irrigation management but not to agricultural projects.

The focus group discussions resulted in the identification of the following tracks to overcome the diffusion challenges of PA technologies in Egypt:

- Develop a national strategy for promoting PA technologies. This shall enhance the role of research centers as well as academia to provide solutions that are based on scientific approach.
- Increase the awareness on PA technologies and its important role in supporting the decisions of agribusinesses based on accurate analytics of agricultural activities.
- Support startups through business incubators to get the needed authorizations to manufacture sensors and devices locally that are linked to PA technologies.
- Assist financial institutions to design banking products that are focusing on PA technologies.
- Assist machinery providers to get the needed approvals for importing materials and sensors that can increase the accuracy of these machines in the field.

- Promote models of PA through research centers and private farms to increase the awareness of farmers about these technologies.

The focus group discussions resulted also in the identification of the key PA technologies that can be easily adopted by agribusiness sector in Egypt which are:

- Precision irrigation that depends on use of sensors and devices to detect the water quantities and correlate between field requirements and assigned irrigation protocols.
- Use of image processing technologies to facilitate the implementation of pest control activities and detect pest in the meantime.
- Use of vision machines in crop identification, maturity detection as well as identification of pests. However, this needs to be developed commercially and be user friendly.
- Use of agricultural robotics in cultivation of seeds, weeding, sorting, and harvesting. This needs to be also developed in a commercial manner.
- Support the commercial use of Satellite information.
- Support the commercial use of IOT technologies which shall include irrigation sensors, robotics, and autonomous agricultural vehicles.

The experts participated in the focus group discussions showed great interest to support any initiatives related to PA technologies. They also see many opportunities that can be achieved through introducing these technologies to support the agriculture sector in Egypt.

Recommendations:

This paper captures an emerging technology in the Egyptian context and addresses some of the key functions to support the agricultural sector with technological solutions. These recommendations are addressed to the Government of Egypt, governmental and nongovernmental universities, research centers

and private sector. The key recommendations out of this paper are:

- Increase the attention on PA technologies and direct research to be conducted for supporting this important sector.
- Increase the local manufacturing of PA tools and sensors which shall decrease the initial cost of establishing PA solutions and lead to diffusion of these technologies.
- Assess the applicability of PA using financial models and economic assessment.
- Assess the results of PA technologies on the social aspects related to the workforce and decrease of human presence in the developed activities.

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- Support initiatives in the field of digital transformation with specific focus on PA technologies.

Acknowledgment:

This research work has been conducted under the supervision of Management of Technology School – Nile University (Egypt) and the authors appreciated support of the experts participated in the focus group discussions. The authors appreciate the time and valuable inputs from participants of the online survey as well as the participants of the focus group discussion which are from Egyptian universities, Ministry of Agriculture, private companies, and farms.

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الملخص العربي

تقييم قابلية الزراعة الدقيقة في القطاع الزراعي بمصر

الزراعة الدقيقة هي اتجاه تكنولوجي تم إدخاله لخدمة وتطوير القطاع الزراعي في الكثير من البلدان. هناك العديد من الحلول والتطبيقات لتكنولوجيات الزراعة الدقيقة التي تعتمد على استخدام تكنولوجيا الاتصالات والمعلومات وتتكامل مع أجهزة الاستشعار والأنظمة والمجسات. تشمل حلول الزراعة الدقيقة استخدام وتوظيف بعض التكنولوجيات مثل تكنولوجيا الاستشعار عن بعد، أجهزة الاستشعار البصرية، الروبوتات، انترنت الأشياء، تعلم الآلة، تقنيات التعاملات الرقمية (البلوك تشين) والذكاء الاصطناعي. يركز البحث على تقييم قابلية تطبيق الزراعة الدقيقة في جمهورية مصر العربية وتوضيح التحديات التي تؤثر على انتشار وتبني هذه التكنولوجيات المستحدثة مع مقترحات للتغلب على تلك التحديات. تم تحقيق الهدف من البحث من خلال إجراء مسح عبر الانترنت وجلسة نقاش جماعي مركزة حيث تم الوصول الي ٣١ مشاركا ساهموا بمشاركة آرائهم حول موضوع الدراسة. وبعد إجراء المسح عبر الانترنت تم عقد جلسة نقاش جماعي مركزة حضرها ٣٩ خبير في مجالي الزراعة والتكنولوجيا. وساعدت الجلسة في تحديد التطبيقات الحالية للزراعة الدقيقة في مصر والتحديات التي تؤثر على انتشارها وتطبيقها وطرق التحسين لنشرها وتطبيقها بشكل أفضل. تم تحديد بعض الاحتياجات، التقنيات المناسبة التي يمكن ان يتم تبنيها عن طريق الشركات الزراعية والجهات ذات الصلة. بالإضافة الي ذلك، تسلط الورقة الضوء على بعض التوصيات الرئيسية التي تم جمعها من الخبراء المتخصصين في المجالين التكنولوجي والزراعي. وأكد البحث انه يمكن تنفيذ تكنولوجيات الزراعة الدقيقة في مصر والتغلب على بعض التحديات التي تؤثر على تنمية القطاع الزراعي.