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Prospects and scope of precision engineering, protected agriculture and vertical farming in Pakistan- A review

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Abstract

Precision agriculture is designed to improve agricultural production system through generating and converging multiple information based systems to boost income and reduce environmental hazards. These techniques have shown advantages for farmers as well as reduced environmental pressures in advanced world. This article offers overview of agricultural accuracy and observes potential, opportunities, consequences, problems and significance of agricultural precision apps in Pakistan's agricultural system. Farmer and government establishments should look forward to implementing fresh and supportable technologies in this view to improve effectiveness of accessible resources and decrease involvement expenses. Before this, it is necessary to realize the efficiency of precision techniques in Pakistan through field studies and procedures in land management. Before this, it is necessary to realize the efficiency of precision techniques in Pakistan. Precision farming (PA) idea was launched as a mixture of positioning system technology, adaptable rate technology, remote sensing, yield mapping, etc. for site-specific crop management to enhance productivity, Sustainability with decreased environmental impact. Recent study has concentrated considerably on different characteristics of protective structures for protected agriculture. For vertical farming, study has often identified technological differences depending on outdoor / indoor structures, ways to enhance the access of crops to light (natural or artificial), increasing media and nutrient/ water supply, sophisticated structures such as generating electricity and integrating manufacturing room into an office / residential room, and water treatment.

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Introduction

Pakistan is emerging country and South Asia's agrarian country. Agricultural sector adds 21% to the (GDP) of Pakistan (GOP, 2012). Pakistani farming can be defined through tiny farms with less production and unproductive use of crop inputs, although there are two categories of farmers: tiny to medium-size medium-sized farmers and big property managers. Agricultural sector has faced severe issues in latest years, such as decreased crop yields, higher input prices, energy shortages, water shortages, and decreased recognition of agricultural products on global markets (Amjad, 2012). Moreover, the absence of sponsorships on agricultural commodities, uncontrolled food prices, unavailability of agricultural inputs, absence of data from consulting organizations, bad state agricultural policies, reduced returns for farmers and unavailability of irrigation are some of the main variables that have a negative impact on the agricultural sector and therefore on the farming society (Amjad, 2012).

Indian farms have been witnessing some kind of soft precision farming technology from decades. But the difficulties of a free and globalized economy and an ever-increasing population with enormous demand for food grain generate the scope for the implementation of hard-precision farming technology on Indian farms. It is therefore essential to learn the latest agricultural technology invented in developed countries and to adapt and apply it properly to the national situation. Nearly hundred study papers produced over the past three decades have therefore been critically evaluated to determine the status of the primary six PA parts, i.e., Positioning System, Remote Sensing, Variable Rate Technology, Crop & Soil Sensing & Analysis, Yield Mapping and Information Transmission Protocol. In addition, PA adoption policies are discussed in Indian agriculture (GOP, 2012).

Predictable farm administration schemes are based on use of widespread suggestions across the field or across all areas within a farm (Bakhsh, 2011). This improves original costs because of unproductive chemical use and increases environmental fears such as the value of ground water (Corwin *et al.*, 2003). Farmers used to change treatments by creating small-scale farms before the revolution of agricultural mechanization in the globe. The areas in the developed world have been expanded with extensive mechanization and it has been hard to take into consideration in field variability without revolutionary technological growth (Stafford, 2000).

Precision farming is a farm management scheme based on data and technology. This seeks to apply techniques and principles to recognize, analyze and handle spatial and temporal variability connected with all elements of agricultural manufacturing in areas of near-optimal profitability, sustainability, improved crop efficiency, soil resource protection and environmental protection (McBartney *et al.*, 2003). It is evident from the definition that precision agriculture is a multidisciplinary method covering a wide range of subjects such as characterizing soil resource variability, Soil tillage, irrigation, crop rotation, equipment efficiency, plant genetics, and crop physical, chemical, and biological efforts (Zhang *et al.*, 2002).

To a large extent engineering discipline owes the creation of new sensors, actuators, applicators, agricultural machinery and other equipment. Precision farming also plays a role in determining soil and crop-related engineering parameters, such as anticipating soil tillage and workability, prominent irrigation requirements, soil strength, and compaction, and measuring drawn force. Now brief, the idea of precision farming is to fine-tune the system of agricultural manufacturing through the creation and conservation of several techniques to boost profit and reduce environmental hazards (Whelan, 2007).

Precision farming implementation is recognized as a fresh revolution in agricultural sector, particularly in America, Australia and Europe while implementation is slow. Precision techniques were limited to a few developed countries only a few years ago. Report from United States, Canada, Europe and Australia have presented that agricultural accuracy applications can lead to reduced input application rate without without forgoing crop produces (Gebbers and Adamchuk, 2010). Strict environmental legislation, government concern about excessive use of agrochemicals and financial benefit from decreased agricultural inputs and enhanced farm management effectiveness may result in extensive implementation of agricultural precision techniques (McBratney *et al.*, 2003; Zhang *et al.*, 2002).

Implementation of precise agriculture technologies in developing world has established a true task for emerging nations to contain some appropriate contemporary techniques in their farming system to satisfy their increasing population's food demands. In tolerant this trial, some evolving countries, such as Argentina, Brazil, China, India and Malaysia, have started adopting certain elements of precision farming, particularly on study farms, but implementation is still very restricted (Aimrun *et al.*, 2009).

Agricultural mechanization is currently in its development stage in Pakistan, which has now been actively launched for two decades. Farm energy was based on humans and livestock prior to the advent of agricultural mechanization. Although agricultural mechanization has significantly enhanced output, it has had no impact on soil and crop characteristics such as soil texture, humidity content, soil nitrogen and other minerals, plant stress analysis and chlorophyll concentration within the field variation (USAID, 2009).

In field variability that can be used for site specific variable implementation of soil and inputs, precision techniques can be predicted. Because 93 percent of the country's landowners are tiny and marginal landowners (Ghafoor *et al.*, 2010), farmers ' desire was hence to manage field variability to maximize yield and income. A wide gap exists between Pakistan's prospective and real yield level (Bakhsh, 2011).

To accomplish the expected advantages, this requires promoting precision farming. It was assumed that, regardless of tiny landholdings and less revenue ranks, accuracy techniques can make important variance in machinery workers and farmers livelihoods (Mondal and Basu, 2009; Srinivasan 2001). Subsequently exactness farming is slightly new country's agriculture society, this article defines the overview of precision farming and examines the potential, opportunities, consequences, problems and significance of precision farming apps in Pakistan.

Precision Agriculture Mechanism

Agriculture precision has the ability and wisdom to make efficient use of natural resources and protect the natural environment. Four steps are taken to implement precision farming: (a) characterizing the extent and scale of variability in soil and crop attributes; (b) interpreting the significance and causes of variability; (c) managing spatial and temporal variability; and (d) monitoring the results of variability management practices (Shanwad *et al.*, 2004).

Variability in yield

To determine crop yield variability. In addition, proximal soil sensors are supplementary precise as compare to distant sensors and measuring depth can be controlled as well. The measurement depth can not be regulated using remote sensors. Crop variability in various crop elements, like to crop density, height, plant nutrient level, water stress, leaf zone index and biomass quantity (Wood *et al.*, 2003).

Variability of tillage

It is decided, to site-specific operations, where tillage should be performed on the basis of soil strength and tillage-related characteristics, (Vrindts *et al.*, 2005) System of Geographic Information (GIS). This scheme integrates hardware, software and data for all types of geographically referenced information to be collected, managed, analyzed and displayed (ESRI, 2012). A GIS is capable of accepting, organizing, analyzing statistically and displaying various kinds of spatial data to numerically denoted to dominant organize scheme (Adamchuk *et al.*, 2004a).

Current status and scope of precision agriculture in Pakistan

Several specialists have long stressed initiating precision farming in the nation and driven farmers to use precision husbandry, such as tillage, water, agrochemicals to increase the advantages of the farming society. A single study on the use of precision technology is not yet available. The only accuracy technology effectively used for a couple of years in Pakistan is laser land leveling (Bakhsh, 2011).

It is a topographical improvement, gradation and smoothing of soil to level with slight or no slop, to recover the effectiveness of irrigation implementation and rises water application consistency with less possibility of over and under irrigation. Approximately 50% of the complete water available is wasted during transportation in the irrigation scheme at tertiary level and at the farm during crop implementation (Gill, 1994). Due to undulated areas and field ditches, a substantial quantity of irrigation water is wasted (Kahiown *et al*., 2002).

Hitherto, there are no other instances of precision techniques in the nation. India has produced important progress over the past two decades in implementing agricultural accuracy techniques such as micro-irrigation and protected farming (Tiwari and Jaga, 2012). It is recognized to Indian government policy assistance, which inspires farmers to implement precise techniques. In Pakistan, there is also a need for government agencies to promote this information-based farming, and scientists should undertake studies on the areas of farmers to focus their attention on this form of fresh farming. Unfortunately, in encouraging this technology, Pakistan lags far behind as this should be launched with extensive strategy to increase production. This is the fact that, owing to expenses and unknown advantages, the original adoption of fresh techniques is always slower. It is also true that the implementation of precision farming throughout the nation is not feasible because not every farmer will be willing to embrace these advanced techniques (Mondal and Basu, 2009)

To meet the enormous food grain requirement of 480 million tonnes (Mt) by 2050, implementing and implementing modern technology in Indian agriculture is inevitable with increasing difficulties faced by crops with biotic and abiotic stresses. Like other industries, agriculture has joined the age of knowledge, abandoning its former resource-based nature. Future agriculture will be extremely competitive, market-driven and knowledge-intensive. The WTO Agreement and agricultural trade liberalization have developed not only fresh scope, but also new threats to Indian agriculture (Mondal and Basu, 2009). Removal of quantitative import constraints for April 1st-2001, made quality and price competitiveness two of the most significant variables to maintain in the globalized industry. Unlike India's' Green Revolution,' which was driven by supply, demand will be motivated by future agriculture. Even though we generate big quantities of output, the high price of manufacturing and low productivity will drive Indian farmers out of the free market arena of financial competition (Kalkat, 2000). Once again, knowledge poverty, owing to the absence of timely beginning of sophisticated technology studies, is one of developing countries ' primary problems. In order to face all these new difficulties, it is essential to raise the level of productivity of pollution-free product by applying sophisticated, environmentally friendly technology that can effectively manage and allocate all resources for sustainable agricultural growth (Mahapatra, 2011). Precision farming is such a fresh emerging, extremely promising technology that is quickly spreading in developed countries. Precision agriculture is a science effort to enhance agricultural management through the use of information technology (IT) and satellite-based technology (e.g. worldwide positioning system, remote sensing, etc.) to recognize, evaluate and handle the spatial and temporal variability of agronomic parameters (e.g. soil, disease, nutrient, water, etc.) in the field through the timely implementation of only requested agricultural parameters (Bhadoria and Basu, 2011).

Over the past decade, agriculture has been created thanks to improvements in scientific research and technology developments. "Precision Agriculture" is the day that farmers required to make excellent decisions in order to optimize input yields while preserving resources and the environment. Precision agriculture seeks at optimizing crop science field management, protecting the environment and enhancing the grower's economy.

Farming, however, faces complicated problems such as global warming, climate change, natural resource deterioration, economic change, etc. There is therefore a need to concentrate research and research on precision farming. In the field of agriculture, therefore, smart technologies will enable this objective to be achieved. The First International Conference on Smart Information and Communication Technologies (Saidia and Morocco, 2019) will include the International Workshop on Precision Agriculture (Prec Agri'19). The workshop will cover the management of intelligent farming for plant production. This will be a chance to meet with scientists, practitioners and those interested in this sector. Furthermore, Prec Agri'19 will be an opportunity to exchange expertise, identify fresh study subjects in the field of precision farming, and begin fresh study collaborations. Springer Scope and Topics will include the largest chosen and reviewed documents submitted in the International Workshop on Precision Agriculture. The workshop will focus on intelligent crop management farming and will cover the following topics: Smart strategies for controlling irrigation systems and water management Crop health indicator and implementation of pest control. Smart fertilizers. Detection of plant reactions to modifications in the environment. Plant manufacturing and quality perfection. Controlled plant growth and crop manufacturing environment. Remote sensing tools for managing crops. Smart plant, cultivar and variety type selections. Technology of engineering, airborne and satellite remote sensing Adoption and economy of agricultural accuracy management (Saidia and Morocco, 2019).

Mobile apps and software. Agricultural precision for sustainability. Soil mapping factors Precision crop protection. Soil and crop maximum and remote sensing. Intelligent weather and microclimate for plants. Precision for variability in natural resources. Coverage of the environment including sediments, leaching, flooding and drainage. Presentation Guidelines and Publications In any of the fields of concern, prospective authors are encouraged to send documents to the workshop. It is necessary to write submitted documents in English (Saidia and Morocco, 2019).

Study of protected agriculture also concentrations on kinds of regulated climate parameters and, among others, energy structure. Recent study has concentrated on the three-dimensional variability of manufacturing settings, the improvement of effective and appropriate data management system, the effectiveness of different kinds of image analysis and optical sensing, the effectiveness of sensors and associated techniques, precision farming machinery designs.

Just during winter season (Padilla *et al.*, 2015) greenhouse beans were generated in regions with warm, humid summers, such as Sinaloa in Mexico. Some big exporters in these areas, however, have also begun experimenting with more advanced control features in more contemporary greenhouses (Bernal *et al.*, 2010). Mexico's tomato exports have grown substantially, to the extent that the U.S. has recently seen a deterioration in fields under protected farming (de Anda and Shear 2017).

The heights of the tunnels were also an significant aspect. As mentioned above, as employees can walk in, tunnels height make it simpler to work on soil or perform multiple crop management operations. Given the simplicity of technology, small tunnels incline to be implement first and the elevated tunnels followed. This was a case in China, where in the 1990s small tunnel greenhouses spread more rapidly, whereas high tunnel greenhouses spread more rapidly since the early 1990s (Jiang 2009).

When used, stabilized plastic movie ultraviolet (UV) impacts the effectiveness of temperature control. Nearly 90% of the fresh greenhouses were built worldwide by 2011 using UV-stabilized polythene sheet as coating material. The day temperature is greater in Maharashtra, India, covered in UV stabilized plastic film, tube framed polyhouse, while the night temperature is smaller than the outside (Sopan 2011).

Glass, fiberglass use has often been connected with increased of temperature control. For example, in Qatar during 2010, fiberglass greenhouses used pad and fan cooling systems while plastic tunnels cooled only 4 percent (Moustafa 2010).

Controlled climate type. In Kuwait in the late 1990s, 85% of greenhouses were made of plastic instead of glasses. Some 2/3 green buildings were uncooled, although 1/3 greenhouses were cooled (Moustafa *et al.*, 1998). Further methods of temperature control, including in developing nations, have been progressively researched in the literature. A split-roof scheme is being researched for enhanced temperature control, which helps to obtain warm air at the top of the structure (Birch 2017).

Typical frames used in greenhouses in Bahrain in the late 1990s were produced of 22mm diameter galvanized steel tubes, aluminum or covered steel tubes. Similarly, metal had become the most frequently used form of frames in Jamaica by 2015, exceeding wood (Moulton 2015).

Structure of energy. There is still restricted use of renewable energy for protected crops. In latest years, however, research on photovoltaic (PV) greenhouses has advanced in China. PV greenhouses are becoming progressively expensive at multiple places in China due to the decreasing expenses of PV-related technologies, classically demanding a payback period of less than 9 years (Wang *et al.*, 2017).

Also frequently used was drip irrigation. For instance, drip irrigation in all greenhouses had been used in Qatar by 1995, except for a few where sprinklers or flood structures were used (Moustafa 2010).

There are also potential for improved varieties to complement protected farming. For instance, by changing the bandwidth of LED [light-emitting diode] lighting, "big yield rises (20% in tobacco) were connected with genetically altered crops, which were intended to use light more effectively" (Devlin 2016 quoted in Pinstrup-Andersen 2018).

Precision agriculture

Precision agriculture is a second instance of border production system. Precision farming relates to a set of techniques that can decrease input expenses by offering comprehensive spatial data for farm operators can be used to enhance field management procedures (Schimmelpfennig 2016).

Adoption trends around the world

Precision-farm technology adoptions have, to date, been mostly restricted to areas of developed countries. In Australia, 90% of farmers used some kind of precision farming by 2013, and 20% of farmers used production mapping and fluctuating fertilizer implementation (Bramley and Trengove 2013). In Germany, some type of precision agriculture was used by about 10~30 percent of farmers during 2016 (Paustian and Theuvsen 2017-quoted in Taylor 2018). In some other developed countries, Keskin & Sekerli (2016) offers associated stats.

In China, yam in *et al.* (2016) are looking at the enhanced farming data collection scheme they are proposing to detect and collect the relative chlorophyll satisfied, temperature, humidity, light intensity, and geographic place (using Cloud). Using the case of mushroom manufacturing in Indonesia, Mahmud *et al.* (2018) is investigating a suggested scheme that links heat moisture sensor and others to the Wifi module, which becomes lot sensors that send a large quantity of information to the web for surveillance and evaluation. They discover the system appears to be efficient, automatically on and off the irrigation scheme to optimize the temperature.

Vertical farming

It is often referred to crop production system that maximizes land use by having a vertical layout whereby crops, livestock, fungi and other types of life are grown for food, fuel and fiber by assembling them vertically above each other artificially (Kalantari *et al.*, 2017). Growing vertical farming methods take benefit of many breakthroughs accomplished in latest decades in construction equipment, materials, renewable energy systems (Heath, Zhu, and Shao 2012).

Trend in the world-vertical farming

Worldwide implementation of vertical farming is quiet restricted to a few pockets. The amount has progressively increased, though. A number of low-rise vertical farming projects in towns around the globe have been constructed and high-rise projects are being suggested (Al-Kodmany 2018).

Operations facility Often through activities on current office spaces or shipping containers, these vertical farms arose. Grönska in Sweden, for instance, which is the first to grow crops vertically and sell them on the Swedish market, has constructed its increasing scheme in the cellar of an current office room (Bustamante 2018). Exposed system with little control over the climate. Some of the remarkable examples for exposed structures are green walls and green roofs (rooftop farms) (Clarkin 2016).

Conclusion

In Pakistan agriculture production system facing problems of decreasing fertile land, water shortage and climate change. To provide food for increasing population it is necessary to adopt innovative agricultural precision engineering technologies, protected agriculture and vertical farming etc. There is a good scope of many precision technologies to be implemented in the country. In this perspective, farmers and government authorities should look forward to adopt new and sustainable technologies to increase the efficiency of available source and reducing inputs costs.

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