Challenges and Prospects of Precision Agriculture in Iran

Hossein Bagherpour* and Hosna Mohamadi**
1Department of Biosystems Engineering, Bu-Ali Sina University, Hamedan, Iran

(Received 27 June 2014 Accepted 29 August 2014)

Abstract—Precision agriculture technology provides a way for adjusting production inputs based on the needs of individual areas within fields. Although precision farming (PF) infrastructures are acceptable in Iran, farmers’ knowledge about PF is the main challenge for applying this technology. Most of farms in Iran are small, so the benefits of hard PF in these farms are not sufficient to justify the costs. Utilizing some low-cost and low technology tools such as chlorophyll meter and leaf color chart might be the best choices for Iran's small farms. Most of farmers are uneducated and are not familiar with PF; therefore, education is the first step for applying this technology. Because of water crisis and low watering efficiency, Variable Rate Technology and Wireless Sensor Network can be used to optimize agricultural water consumption. Size of farmlands, farmers' knowledge, and low investment in agriculture sector are the main obstacles for PF adoption in Iran.

Keywords: precision farming, technology, adoption, Iran.

1. Introduction

Iran is the largest country in the Middle East and has a long history of agriculture. Collected stone tools and clay artifacts from a site in the Zagros Mountains indicates that humans were cultivating plants 12,000 years ago in Iran. In addition, the goat is believed to have been domesticated first in Persia around 10,000BC. The country also lays claim to the invention of the windmill. However, modern-day Iran faces a number of challenges to agricultural production, with the growing problems of water scarcity, soil salinity and decades of under-investment all taking their toll. Iranian agriculture needs more advanced research in terms of recent agricultural technologies and application of new methods of study, analysis and mechanization. Therefore, this paper studied the status of precision farming - which has emerged as a management practice with the potential of increasing the profits- opportunities and barriers of developing precision farming in Iran.

2. Precision farming

Yield monitors are a recent development in agricultural machinery that allow crop producers to assess the effects of soil properties, weather and management on crop production (Shearer et al., 1999). PA is conceptualized by a system approach to re-organize the total system of agriculture towards a low-input, high-efficiency, low environmental impact of chemical and sustainable agriculture. In precision farming, several technologies have been used, including the Geographic Information System (GIS), Global Positioning System (GPS), automatic control, computer components, remote sensing, mobile computing, advanced information processing, and telecommunications (Zhang et al., 2002). Precision farming technologies have dispersed widely around the world. In the United States 22% of soybean and 28% of corn areas were harvested in 2005 and 2002, respectively, with a yield monitor (Griffin and Bruce, 2009).

Several studies have examined precision agriculture adoption in the United States (Marvin et al., 2003; Daberkow et al., 2003). In the pilot project that was done about precision farming adoption in the U.S. Approximately 180 Alabama state farmers were participated. Results indicated that the precision farming technologies have been more readily adopted by farms with larger acreage rather than small-acre farms (Winstead et al., 2010). Before widespread adoption of these systems,
research are needed to simplify the technology, to improve decision rules for key inputs, and to develop new, lower-cost and more reliable sources of data to support PF decisions (Batte and Arnholt, 2003). Reichardt et al. (2009) reported that the reduction of the technological costs, assertion of the benefits of the precision farming and the development of the same standard for compatibility among the different resources are the main pre-needed factors for adoption of the precision farming in Germany.

In developed countries such as the United States, Germany, Canada and others, the Precision Farming (PF) has developed in the last decade. While the developing and third world countries have been relatively slow in accepting precision agricultural practices (bakhtiar et al., 2013).

The typical image of precision farming is of an intensive crop management system, served by high technology. This contrasts strongly with the image of developing agriculture as a low-or no-technology activity, undertaken by subsistence farmers with minimal resources. Iran is one of the developing countries that is faced with many challenges in terms of utilizing precision farming in agriculture.

3. Status of Iran’s agriculture

The wide range of temperature fluctuation in different parts of the country make it possible to cultivate a diverse variety of crops, including cereals, fruits, vegetables, cotton, sugar beets, sugarcane and pistachios. Now agricultural activities accounted for about 13% of Iran's gross domestic product (GDP) and employed a comparable proportion of the workforce (CBI, 2014). In terms of agriculture area, Iran is the 20th country in the world and its cultivated area is approximately 19 million ha. About one-third of Iran's total area is suitable for farmland but because of poor soil and lack of adequate water, most of them are not under cultivation. Less than one-third of the cultivated area is irrigated and the rest is devoted to dry farming and some 90 percent of agro products depend on water. Most farms are small (less than 5 hectares) and are not economically viable. In addition to water scarcity and areas of poor soil, seed are of low quality and farming techniques are not advanced (FAO, 2011). Despite the advent of new agricultural technologies, most Iranian farmers are currently applying antique and traditional methods for activities like sowing, weeding, irrigation and cultivation.

4. Infrastructures of Precision farming in Iran

Spatial and temporal variability of crop variables are at the heart of PA, while the temporal and spatial behaviors of that variability are key elements to defining amendment strategies. It is clear that the practice of precision farming was enabled by the development of GPS and GNSS technology (Whelan et al., 2003). DGPS is having a great impact in the precision farming; it gives farmers the ability to know a specific location and helps to use variable rate technology (VRT) at the farmland. Depending on the receiver used, this location can be found instantaneously. In 2009, Iran has developed Hoda system that could provide DGPS and RTK services with the accuracies of 20-50 and 2-5 cm, respectively. Recently, 73 stations of this system have been established across the country and National Cartographic Center of Iran has planned to increase these stations for covering all regions of the country (NCC, 2014).

Remote sensing can provide a significant technology for fast, accurate and dynamic acquisition of agricultural parameters. By using of this technology, a large number of studies on the acquisition of yield, drought and crop condition have been carried out and a lot of new models and methods were developed (Xiong et al., 2010; Bolten et al., 2010; Wu Bing fang et al., 2010). Remote sensing has increasingly become a significant management and decision-making tool in the development of precision farming in the developed countries. This technology requires satellites with high spatial and temporal
resolutions. Manufacturing, launching, and applying these satellites need high funding by the government. Despite the numerous works by Iranian scientists, they still could not have accessed this technology. Iran's government has planned some projects to achieve this technology in the near future and it is possible to obtain a native technology for applying a remote sensing in future. Considering Iran's space objectives and activities, it has a good potential for utilizing remote sensing in all aspects.

5. Obstacles and challenges for the future

Precision farming requires technologies and devices like GPS, GIS, remote sensing, computers, sensors, actuators, etc. However, people in rural areas do not have any familiarity with these issues. Also, there are no plans for encouraging people to utilize new technologies and there is few IT skilled people who can train farmers in these respects. Most of rural people are uneducated and conservative, have few innovations in their farming, and have been convinced to change their way of thinking about cultivation. In addition, profitability of precision farming has not been proved for them; thus, PF is rarely practiced in Iran. If only "hard PF" is considered, farmland size is an important issue that could affect PF application. In Iran, most farmlands are less than 5 ha. Therefore, farmers are not eager to apply mechanization in their fields (table 1).

If technologies meet a perceived need of farmers and there are sufficient incentives to encourage their adoption, they can take up quickly. Currently, as a result of targeted subsidies law, most of incentives have been cut to agricultural by the government. Accordingly, cultivation cost has been increased dramatically, which cannot be afforded by most of the framers. Because of low profitability in agriculture, farmers and private enterprises are hesitating in terms of investment in this sector. Therefore, to adopt new technologies, Iran's agriculture requires a high level of incentive and support by the government.

Adopting precision agriculture needs new and modern machines; but, there is considerable shortage of machinery usage in Iran's agriculture and most of the devices are old, which restricts the use of modern technologies in agriculture. In terms of software and hardware, precision farming components are not available in domestic market and they are very expensive too. In addition to technical and financial issues of adoption of PF, Iranian farmers are not also very much concerned about environmental and sustainability Issues. Furthermore, manufacturers are not familiar with precision farming and they are not fully aware of PF philosophy and its future.

6. Precision farming experiences and studies in Iran

Although there are many challenges on utilizing PF in Iran, considering its many advantages and the future of agriculture, Iranian researchers have done numerous studies about this issue. In the study that was done about spatial variability of soil fertility properties in southern Iran, the degree of spatial variability of soil chemical properties and its textures were determined. The results demonstrate that within the same field, spatial pattern vary among several soil parameters (Yasrebi et al., 2008). Bordbar et al. (2009) did assessment of applying precision farming in Fars province of Iran. In this study, data were collected using questionnaire and 270 agricultural specialists participated. Results indicated that the priorities of precision farming technology were variable rate insecticides, weeds’ sensors, topography and depth of soil mapping, yield mapping, global positioning system and aerial picture, consequently.

Effective factors and barriers on the implementation of precision farming was investigated by Bahari et al. (2013). Participants of this study were experts of agriculture center of agricultural researches and center of agricultural training in Ardabil province (N=365) who had BA or MA degree in one of the branches of agricultural engineering. This
survey showed that, the "insight related" factor had a major role in description of the variables. After that, the "agricultural", "educational and promotional", and "financial and equipment related" factors were respectively ranked in the next classes. In the study that was done by Dinpanah and Omidi (2013), influencing factors on feasibility of precision agriculture about infrastructures in Iran was investigated. The results indicated that, attitude and policy-making factors had positive relationship with feasibility of precision agriculture. Concerning infrastructures, there were a negative and significant relationship between the complexity of the innovation and feasibility of precision agriculture. The results showed that 9, 62.8 and 28.2 percent of experts and researchers expressed that feasibility of the precision agriculture in regard to infrastructures were weak, moderate and good respectively.

Investigations on performance of a continuous mass flow rate measurement system for potato harvesting was conducted by Mostofi et al. (2007) in this study two weighing systems were evaluated: (a) cantilever transducers fitted to the conveyor belt mechanism and (b) a load cell system supporting the total weight of the conveyor and crop. This project was established to develop a process for the selection, design, installation, test and evaluation of mass-flow rate measurement systems for root crop harvesting.

In Iran, several yield monitoring systems have been fabricated and evaluated for crops such as sugarcane (Khorasani, 2009), sugar beet (Bagherpour, 2013), and potato (Mohammadzamani, 2014). Also, some studies have been done about spraying herbicides and pesticides using the VRT system (Mohammadzamani, 2009; Abdollahi, 2012). In spite of these academic studies, no practical PF experiences have been performed in Iran's agriculture.

Currently, in Fars province, the big project of precision farming is running, which is aimed to investigate soil property changes and modify agricultural inputs.

7. Reasons that Iran should pay attention to precision farming

Iran has an arid climate and in most of the country, yearly precipitation averages 250 millimeters or less. The geographic and climatic variation of the country is very extensive. For instance, annual average rainfall in the north is more than 1000 mm, while this figure is less than 100 mm for central and southeast of the country. Based on international standards, each country that consumes more than 40% of its total renewable fresh water resources is considered to suffer from water stress. Therefore, Iran is presently experiencing water stress (Larijani, 2005). In recent decades water demand has been increased very rapidly in agriculture, industry and urban services. The consumption rates in the three main sectors are as domestic urban consumer sector (5%), industrial sector (20%) and agricultural sector (93%) (Motiee, 2001). Crop production systems are entirely dependent on topography, seasonal rainfall and supply of water in irrigated area. In the agriculture, with the most water consumption, there are the highest losses. Increasing energy costs and decreasing water supplies point out using new methods such as VRI and Wireless Sensor Network (WSN) technologies for better water management in agriculture.

There has been a progression increase in population in Iran. In 1979, Iran's population was 30 million but now is about 77 million people and it is predicted that the population of Iran will pass 100 million in 2012. Therefore, the demand of food has being increased dramatically. In addition, Iranian economy has relied on the agricultural products and demand is growing every day. Although the genetic engineering plays an important role in dealing with these problems, but more innovative solutions using modern technologies is very important for having a sustainable agricultural.
Chemical fertilizers and Pesticides affect the environment. They can damage ecosystems, which may result in the extermination of species. Certain herbicides and fertilizers can leach into the water sources and cause pollution when used in high doses.

Precision farming provides a new solution using a systems approach for today's agricultural issues, namely the need for balancing productivity with environmental concerns. These issues provide enough incentives for changing the way of thinking about agriculture and using a new technology in it.

8. How to apply precision farming in Iran

Ostensibly, precision agriculture seems irrelevant to people in the developing world. But studies that were done by Cook et al and Subrata et al, indicated that the precision farming and especially spatial information have an important role in small scale agricultural land and can reduce uncertainty in these farms. They concluded that the value of information is in the improved decisions it enables. Most of agricultural land in Iran are small and it is necessary to utilize the precision farming experiences of country such as India, China, Indonesia, Philippines, Vietnam and Bangladesh etc. They utilize low cost and low technology tools for their small farms. The chlorophyll meter (SPAD) and leaf color chart (LCC) are simple, portable diagnostic tools that can be used for in situ measurement of the crop N status in rice fields to determine the timing of N top dressing, which is very useful for developing countries (Mandal et al., 2013). This technique can be used in Iran’s rice and wheat fields and makes optimal use of fertilizers. GIS is currently being adapted for use on small Asian farms, in Japan, the Republic of Korea and in the Taiwan Province of China, where government programs are developing the use of web-based GIS (Mondal and Basu, 2009). The purpose of applying this system is to encourage farmers to use the Internet and to obtain free information on the soil properties of their farms, including soil fertility and nutrient levels. In Indonesia, GIS is being used to re-evaluate appropriate agricultural land use. This system can be used to identify which areas are suitable for arable land, and it is used to identify the best crop for a particular region (Mandal et al., 2013). Most of Iranian farmers are not familiar with the Internet or IT. Holding training courses and workshops by IT experts are the first step toward adopting precision farming. The next step is to convince them by PF projects and studies that have been previously done and resulted in tangible profits by farmers.

Because of low rainfall and water resources, watering efficiency is a main agricultural problem. Therefore, application of new technologies such as VRI and WSN that can be used in both small- and large-scale farms could be appropriate methods for farm irrigation.

9. Conclusions and recommendations

Precision farming, as the best choice for managing inputs in agriculture, results environment-friendly sustainable agriculture. Although the concept of precision farming is considered for large-scale farms and developed countries, using some low-cost and low-technology tools may be proved to be useful for small farms of developing countries. In spite of the establishment of RTK and DGPS systems in Iran, Iranian farmers cannot use the new technology in their farms. Most farmers are uneducated and not familiar with new technology and GIS. For applying new methods and technologies in agriculture, the government should make enormous investments in education. Size of farmland is another issue for applying precision farming and mechanization in Iran. Iranian farmers and experts should use the PF experiences that have been practiced by countries such as India, the Philippines, Indonesia, Japan, etc. Most farms of these countries are like Iranian farms. Due to water shortage in Iran, using new methods...
such as VRI and wireless sensor network (WSN) technologies could be a suitable way for increasing watering efficiency in agriculture. In conclusion, integrating lands and supporting investment in agriculture are two important issues that could improve Iran’s agriculture.

References


11- Griffin, T., & Bruce, E. 2009. Adoption and Use of Yield Monitor Technology for US Crop Production. Site Specific Management Center Newsletter, Purdue University.


yield monitor installation and operation. *Dept. of Biosystems and Agr. Engineering, Univ. of Kentucky, PA-1*


<table>
<thead>
<tr>
<th>Size of Land Holding( ha)</th>
<th>Number of enjoyment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ha and less</td>
<td>1205032</td>
</tr>
<tr>
<td>1-5</td>
<td>1319962</td>
</tr>
<tr>
<td>5-20</td>
<td>786336</td>
</tr>
<tr>
<td>20-50</td>
<td>135649</td>
</tr>
<tr>
<td>50 and more</td>
<td>33750</td>
</tr>
</tbody>
</table>