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Research Article

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Determination of Precision Farming Applications in Turkey

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Abstract Precision farming is gradually new farm management for agricultural production in the World. The precision agriculture is not only electronically controlled agricultural machines, it is also to develop management strategies to decrease agricultural input and environmental effects for a country or region. Production processes of agricultural crops may differ from country to country. In addition; spatial variability of socio-economic structure affects agricultural production process. When determine precision farming strategies for a region, spatial variability of the farmers should takes into account. These characteristics are education level and age of farmers, dry or irrigated farming, parcel numbers and sizes, total size for farm and production method, mechanization level, variety, insects, herbs etc... for crops. There are big differences between farmers for these characteristics in Turkey. Small scale farming is also big problem for Turkey. All these factors create obstacles for applying of precision agriculture in Turkey. Solution is to develop selective precision agriculture strategies varied according to the region, farmer, farm and crop specifications. There should be different strategies for different farmers to use precision agriculture in Turkey. In this article, precision farming strategies will be discussed for production of wheat, rice, sunflower, dry onion, vineyard and olive in Turkey.

Keywords precision farming, adoption strategy, Turkey

Introduction

Precision farming is new farm management for agricultural production in the World. The precision agriculture is not only to use electronically controlled agricultural machine, sensors and software. It is also to develop management strategies to decrease agricultural input and environmental effects and to decrease production quality and yield for a country or a region.

Some companies produce agricultural machines with control systems for precision farming. However, quite a number of problems such as correct positioning, synchronisation of mapping and real-time systems, models of calculating the amount of applied factor must be solved before farmers start to apply precision farming techniques [1].Yield monitors were adopted by 36.5% of corn farmers and 28.7% of soybean farmers in the early 2000s in the USA[2] and [3]). Variable rate applicators (VRA) were adopted by 5% to 10% of these farmers in the same period. Questionnaire surveys by [4] revealed that 19% of cotton farms have GPS guidance.

Spatial variability of socio-economic structure in a country affects agricultural production and management strategies. Production process of crops may differ from country to country. If aim of precision agriculture is to decrease agricultural production inputs and to improve net income from agricultural production, socio-economic variability structure must be taken into account for adoption of precision farming. Its mean is site specific adoption strategies should be developed for each country or region in a country. Objective of this paper is to explain precision farming possibilities for Turkish agriculture and to discuss possible strategies for using precision farming applications in Turkey. In this article, an overview of Turkish agriculture, precision farming

in Turkey, and possible strategies investigated to achieve for this purpose. In addition, a survey carried out with Turkish companies to determine amount of the precision farming systems sold in Turkey.

Agricultural Structure of Turkey

Total area of Turkey is 778997 km^2. Only 15.2% of soils are deeper than 90 cm and the majority (72.1%) are shallow (20-50 cm) or very shallow (0-20 cm).Turkey has a semi-arid climate. Average precipitation is 646 mm per year. It is varied from 2,500 mm in the high mountains to 250-300 mm insome parts of Central Anatolia [5].Turkey is one of the biggest producers of, apricots, cherries,figs, lentils, olives, teaand tobacco in the world. Number of the agricultural farms is approximately 3 million in Turkey. Nearly two thirds of Turkish farms are less than 5.5 hectares. Although the share of agriculture in the economy has declined significantly, it is still important in both social and economic terms [6].One of the structural problem of Turkey is small size of farm holdings. Most of the small family farms are able to produce just for their own domestic consuming [7]. Even some disadvantages for soil precipitations, Turkey has a very good geographical posisiton for farming. A lot of field crops, vegetables, and fruits have been produced in Turkey. Turkish agriculture needs a sustanaible management to increase production, yield and quality.

Methodology

A survey was carried out with6companiesrepresantitiveof the precision farming systems in Turkey to determine total number of autosteering sytems, yield monitors, variable rate controllers, software and other related technologies and city/region of the farmers who buy these systems. Collected data was given as total for each group.

Information about research centres about precision farming and related topics such as geographical information systems (GIS) were given in this article. In addition, precision farming research projects were determined and summerized.

Results and Discussions

According to the results of the survey; number of the auto guidance systems is approximately 892. There are 356 yield monitoring system with combines in Turkey. In addition, a company sold a system that can control automatic guidance, variable rate controller etc. The number of this system was 22.

Mostly big farmers bought these systems. Big farmers started to use auto guidance systems because of its advantages. There is still big interest for auto guidance systems. Farmers has problem to create and evaluate yield map. Applying agricultural inputs such as fertilizer, seed, water and pesticide as variable rate is not easy for farmers. Automatic guidance and yield montiros have been mostly used in Thrace, Egean, Meditarrene and South-East Anaolia Region of Turkey in big private farms or State Farms.

When we look research centre related precision farming; there is a Center of Geographical Information Systems in the Ministry of Agriculture and Forestry. They analyse satellite pictures to determine yield, planted area, or distrubution of insects, or weeds etc. In addition, Istanbul Technical University - Center for Satellite Communications and Remote Sensing (ITU-CSCRS) is one of the forecoming institutions around the world with a highly capable ground receiving station unit [8]. IstanbulKulturUniversitycarried out a project to observe earth motion for estimating earthquake. They establish a GPS station network which is called COARS-TR (in Turkish: TUSAGA AKTİF) to get good accuracy for positioning[9].Some Turkish researcher cooperated with some farmers to apply precision farming in maize, wheat or determination of spatial variability in the fields[10], [11], [12], [13], [14]). In addition, a research group in Namik Kemal University, has been developing variable rate controllers for centrifugal fertiliser spreaders [15], variable rate controller for cereal sowing machine [16] and automatic steering system for tractors [17]. In addition, an Application Map software was also developed by [18]. An automatic soil sampling machine which can be used with tractor was developed [19] and a variable rate controllers for b travelling irrigators has been still developing. All these systems and software has been developing for agricultural machineries manufactured in Turkey. Because price of agricultural machineries with these systems are very high. After finishing all these projects, Turkish farmers don't need to change their

tractors and farm machineries to adopt variable rate controllers. Consewunetly there is a precision farming laboratory in Namik Kemal University, Biosystems Engineering Department.

Possible Strategies for Precision Farming in Turkey

Successful implementation of precision agriculture depends on numerous factors, spatial variability of field, amount of application rate, and controller to apply agricultural inputs. Computers, Global Positioning System (GPS), Geographic Information System (GIS), Remote Sensing (RS) and Application controls enable to apply precision farming applications in the field [20].

Agricultural high-tech trial farms are emerging very quickly in many developing countries. The renovation of traditional farming technology through precision farming techniques is a good strategic objective. It integrates a multidisciplinary approach involving agronomists in various fields, engineers, manufacturers, and economists to achieve sustainable development [21].

A research was carried out for analyzing the adoption patterns among cotton farmers for precision agriculture Technologies. The propensity to adopt technology bundles was greater for producers managing relatively larger operations who used a variety of information sources to learn about precision farming, irrigated cotton, practiced crop rotation, and participated in working land conservation programs [22].

A study was conducted with 164 participants that were agricultural engineers, farm equipment dealers and farmers in Turkey. 90.2% of participants followed new trends in agriculture, 51.8% of all participants did not hear the term 'PA' before and 29.3% of the participants who heard the term 'PA' knew its concept. Most three well-known technologies were GPS (81.7%), GIS (69.5%) and remote sensing (61.0%). The least known were variable rate application (33.5%) and soil sampling and mapping (34.8%). 97.6% of the participants expressed that these technologies would be some how beneficial for Turkey. 88.4% of the participants wanted to get more detailed training on these Technologies [23].

The level of adoption is variable in different countries as well as in different regions in a particular country. Also, PA technologies are introduced in some developing countries including Turkey in recent years. In both developed and developing countries, auto guidance is more adopted in the last decade while yield monitoring and variable rate application was more dominant earlier [24].

Production of agricultural crops may differ from country to country. In addition; spatial variability of socio-economic structure affects agricultural production process. When determine precision farming strategies for a region, spatial variability of the farmers should takes into account. These characteristics are education level and age of farmers, dry or irrigated farming, parcel numbers and sizes, total size for farm and production method, mechanization level, variety, insects, herbs for crops. There are big differences between farmers for these characteristics in Turkey. Small scale farming is also big problem for Turkey. All these factors create obstacles for applying of precision agriculture in Turkey. Solution is to develop selective precision agriculture strategies varied according to the region, farmer, farm and crop specifications.

Turkey agricultural extension policy does not focus on sustainable agricultural production practices. The conventional farming practices are based on intensive agro-chemical use. There is a growing need for reducing the environmental pollution of farming practices [25].

Possible strategies are also summerized below for government, non-governmental organizations, and farmers.

Government: Ministry of Agriculture and Forestry (MFAL) should prepare a strategic plan to support the farmers for precision agriculture. Actually, MFAL supports precision farming research projects listed in the research priorities. MFAL has for research and education institutions. These institutions should prepare a programme to teach farmers on sustainable agriculture. In addition, they should develop policy to support farmers who start to use sustainable agriculture practices to protect environment.

Non-Governemental Organısatıon (NGOs): There are many civil societies about agriculture, organic farming, sustainable agriculture and environment such as farmer's organizations, agricultural engineering chambers, environmental organisations etc. in Turkey, These Institutions may focus on precision agriculture and inform the farmers for increasing awareness, understanding and using precision agriculture in their fields

Farmers: Farmers always worried about cost and profitability. Precision farming applications start from determining of spatial variability of soils, and crops. Farmers may apply some precision farming practices to

decrease amount of the agricultural inputs by determining of the spatial variability. Actually, farmers know spatial variability in their fields. When they look their fields they can easily see spatial weed distribution or high yield areas. Some farmers in Turkey use workers to apply pesticides only required areas. They can create yield variability data sheet based on geographical or local field positions for a field. They don't need to create yield map. The farmers may focus on the low yield are evaluate results of soil analyses for determined high, medium and low yield areas. They cooperate soil analyses with yield variability data sheet. Farmers should take into account economical grid size, not so small grid sizes.

Precision farming applications require investment such as buying gps, yield monitors, variable rate controllers, software, and automatic steering systems. Farm size is approximately 5.5 ha. in Turkey. This is so small to make a precision investment. Solution of this problem should be fine for not only precision agriculture but also for other agriculture inputs investment such as tractor, agricultural machineries.

Authorities should develop strategies according to their region farmer's condition. As an example they may put an obligation for using yield monitoring systems with combine because most of the farmers doesn't have combine. Combines generally rented by farmers for harvesting their crops. a hand GPS can be used for determining soil sampling positions. These two applications may help to start understand spatial variability and precision agriculture. If a farmer have 50 ha. Field size and financial ability to buy precision farming systems, he/she may start by using automatic guidance system, yield monitoring to determine yield variability and georeferenced soil sampling to understand spatial variability in the field.

Turkey has different mechanization levels for field and horticultural crops. Soil tillage, spraying, fertilisation, planting etc. have been doing by agricultural machines for field crops. Some processes of agricultural production such as hoeing, harvesting, fertilisation, pruning etc. have been doing by hand in vineyard, apple, olive, tea, dry onion production.. In that fields, precision farming applications can also be used to create yield map and determine spatial variability. Farmer's should be educated for sustainable agriculture and they can learn what does it means precision farming. They can start create their specific precision farming solutions.

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