AAAID Adopting Precision Farming Technology to Improve Farm Management at the Rain-fed Sector in Sudan

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Summary

Precision farming (PF) is a product of a variety of technical and economical aspects of agriculture. It is an approach that allows more efficient use of inputs and outputs. It improves management system, diagnoses crop problems, and increases equipment efficiency, optimizes profit, and minimizes environmental impact. Application of PF is becoming of increasing importance and its availability increased by recent technological development in positioning, sensing and control systems such as Global Positioning Systems (GPS) and Geographical Information Systems (GIS).

Arab Authority for Agricultural Investment and Development (AAAID) has a growing reputation as a leader in adopting and promoting modern agricultural technologies into the Arab countries.

AAAID has introduced a full package of zero-tillage system as a substitute for the traditional farming system at Agadi (one of AAAID's activities in the rainfed sector in Sudan). The system was implemented in 2000 at a large experimental trial followed by a pilot farm in year 2001 and 2002. A considerable improvement in yield of cotton, sunflower and sorghum was achieved. Along with such system, AAAID is intending to adopt PF in 2003 at Agadi. This is based on a demonstration trial where a yield base map was generated with the Global Positioning Systems at harvesting time for a sorghum field at Agadi.

This article addresses a brief background about the PF, its rational at Agadi and the AAAID's master plan of its adoption.

Kewords: Precision Farming; Control Traffic; Base Map; Yield Map.

Introduction

The main objective of the Arab Authority for Agricultural Investment and Development (AAAID) is developing agricultural resources for investment in the Arab World. It is well recognized that improvement in any kind of agricultural investment can not be achieved without sensible management.

Recently Precision farming (PF), as a knowledge-based technical management approach is becoming of increasing importance. Its availability increased by the fast technological development in positioning, sensing and control systems. Such as the Global Positioning Systems (GPS) and the Geographical Information Systems (GIS). Its application should optimize profit, minimize environmental impact, reduce risk and assist agricultural sustainability.

On the contrary, to traditional agriculture, precision farming does not consider a field as a homogenous unit. Land heterogeneity and yield variability are major inherited problems in agriculture worldwide. The ideal management of such problems needs accurate identification, analyses and correction. The PF technology could be the tool.

AAAID is considered to be a leader in introducing modern agricultural technologies in the Arab World. AAAID introduced a full package of Zero-tillage farming system at Agadi, its largest farming project in the rain-fed sector in Sudan.

A full package of zero-tillage farming system applied at Agadi as a substitute for the traditional farming system in 2000. The introduction of such system led to a considerable improvement in the yield of cotton, sunflower, and sorghum in 2001, at a pilot project. AAAID intents to implement the PF for the benefit of the Agadi project in year 2003. The objective of this article is to give a brief background about the PF technology, its rational for Agadi project, and the AAAID's master plan for PF adoption.

AAAID was established on the first of November 1976 with 16 shareholder of the Arab countries. The main office of the AAAID is located in the city of Khartoum, Republic of Sudan and has a regional office in Dubai, United Arab Emirates.

Its activities include investment in all forms of agricultural production and related activities and its objectives include :

* Development of agricultural resources, and supplying the maximum possible amount of food materials.
* Increased exchange of agricultural products and inputs.
* Promotion, financing and implementation of projects and other complementary activities, including the essential infrastructure projects.

Agadi Project

Its one of the AAAID agricultural investment activities. It is about 80,000 ha of heavy clay Vertisols soil type that of severe fractures and deep cracks during seasons. The objective of the project is to farm field crops (Cotton, Sorghum, Sunflower and sesame) in the rain-fed area.

The project is located at Agadi, 35km west of Damazine, the Blue Nile state about 570km south east of Khartoum. It is within the central semi-arid zone of eastern Sudan located between longitude 35 E° and 36E° and latitude 10 ^{0}N and 12 ^{0}N. Agadi is of a seasonal rainfall (varies between 450-700 mm through July up to the end of October), high average temperature and 8.6 hours daily average sunshine.

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In general, the main reason that keeps low quantity and quality crop production in the rainfed sub-sector in Sudan, is sticking to the traditional farming practices. Therefore, a full package of zero-tillage farming system has been introduced by AAAID at Agadi project for maximizing yield production. The implementation of the system is supported by a private management organization; follow-up committee and a complete research program.

Precision Farming Technology

Definition Concept

Precision farming is an approach to manage crops and land selectively according to their need. It is sometimes referred to as site-specific management or variable application rate technology. It integrates the latest information technology tools and techniques, convert them into usable knowledge. This knowledge will enable farm managers to get better understanding and control their fields, by making the right decision particularly when there is a great variability within the field. PF utilizes information technology such as GPS and GIS, aerial photography and satellites images (Fig.1). Positioning determination, georeferencing and guidance play a critical role in precision farming. GPS and deferential GPS aerial photography and satellite images are fast becoming a necessary condition for successful site specific management.

Components

Global Positioning Systems (GPS)

The GPS was introduced by the department of defense in 1970s to provide continuous worldwide positioning and navigation data to US military force around the globe. Nowadays the GPS has broader civilian and commercial application. The system consist of 24 satellites orbiting the earth and 5 ground stations to monitor these satellites provide 24-hours a day coverage for two and three dimensions positioning anywhere on the earth. The satellites that orbit the earth twice a day transmit precise time and position (latitude, longitude and altitude) informations. The user can determine his location by the GPS with a GPS receiver any where on the earth.

GPS Receiver

This device receives signals form three or more satellites at once to determine user position under normal conditions. The best a accurate signals can be obtained by the GPS is up to 15 meters. Therefore, for precision farming these signals need to be corrected by other component Differential Global Positioning System.

Differential Global Positioning System (DGPS)

The precision farming greatly depends upon the accuracy of the attainable signals. The GPS signals, however has several errors resources. The complication of such errors can be overcomed with a ground base with DGPS. The correction of the signal with DGPS is done by a second GPS receiver at known fixed location (ground base). The signal is then transmitted to the farm equipments that correct their proper location through differential processing. Differential processing can be carried in real time or during post processing. The differential post processing involves down loading GPS information from the recievers and from the base station into software program. Either forms of DGPS can be used for boundary correction and mapping soil spraying, but farm equipments guidance fertilizer application or chemical spraying the real time differential should only be used. The DGPS can increase the accuracy of GPS from 15 meters to 1-3 meter.

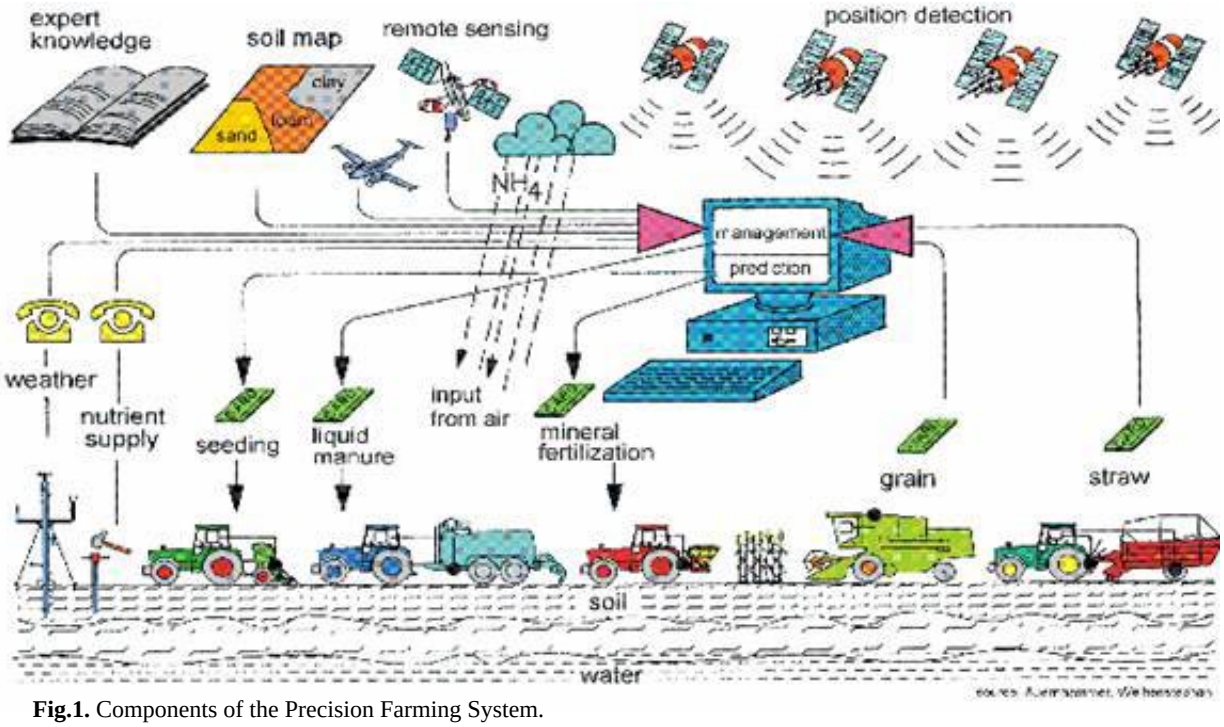

Fig.1. Components of the Precision Farming System.

Yield monitors

PF is commonly associated with Combine Yield Monitor, the most commonly used components of this technology are electronic sensors, microprocessor and control system enable certain precision operation. Combine sensors measure yield. Microprocessors collect and store information from GPS-receivers and the yield flow rate sensors and compare that data with computer map of the recommended fertilizers is reasonably well developed variable rate of spraying is another. Site specific technology where infestation of insects in the field is mapped to create spray need map.

Geographical Information s System (GIS)

It is an organized collections of computer hardware, software and geographic data. The system must be operated by professional people for efficiently display all forms of geographically references, informations end up into a collective computer based maps. These maps may be of soil type, topography, level of nutrients, moisture, pH, alkalinity, crop growth and yield monitoring .. etc.

Thermal Infrared Photographic technology

IR photographs can be taken by aircraft or satellite images to monitor crop condition such as: emergence percentages, growth vigor, stresses (diseased area, pest attack, drought, nutrient deficiencies, weed infestation) and yield prediction through the growing season and yield monitoring at harvesting.

The out-comes of the PF are :

* Construct base maps.
* Design farm layout and measure lands.
* Implement variable rate application technology.
* Set-up standardized reporting system.
* Facilate out-farming technology.

Advantages of the Precision Farming :

* Provides accurate farm records (inputs and out puts).
* Reduce soil compaction.
* Assesses input variable rate application.
* Increases productivity and profitability.

Prerequisites of the PF

PF is a high technology way of farming management that includes rather expensive equipments the following prerequisite therefore must be checked in order to justify its implementation:

1. Utilization of a proper and high advanced farming system (full package machines, instruments, seeds, fertilizers, pest management, .etc) for the PF to be valid.
2. Usage of big enough farm area> 100 ha for the PF to be profitable.
3. Management with most possibly level for the PF to be enhancer.
4. Clear land heterogeneity and big yield variability for the PF to be justifiable.

Rational for Precision Farming at Agadi

The present condition at Agadi suggest and justify implementation and adoption and PF, where Agadi project is characteralized by the following :

* Farming a large area about 80,000 ha.
* Farming under variable rainfall seasons.
* Land of un-even topography and high heterogeneity.
* Farming with zero-tillage system of heavy machinery movement.
* Soil of Vertisols type.
* Using shielded sprayers through the growing season.

AAAID s Master Plan

The AAAID is intending to adopt PF technology to help overcoming the previous mentioned properities of Agadi. The PF will serve the project, once the system is adopted it will serve other AAAID activities around the Arab countries. A unit for PF with full technological package will be initialed through technology transfer program. The PF unit should create and establish a farm management system that enables timely informed decision regarding farming practices, create opportunities for training, jobs, and exchange knowledge within the Arab countries.

1. The objectives of the PFU:

The PFU will be designed to utilize all possible information technology of PF to fulfill the following objectives:

1.1.Construction of base map: The PF will start by constructing a base map for the field, drawing the boundaries and field layout, marking the contour intervals and control traffic lines, roads, buildings .ect. This base map is very important because it will determine from the beginning the topography that enables to eliminate the high and low areas from farming plan.

1.2.Controlled traffic: Lines for controlled traffic can be designed and laid out with GPS technology through the base maps, where the wheels of heavy machinery are matched, allowing the tires to run on the same permanent wheel tracks. This helps to eliminate soil compaction.

1.3. Yield monitoring: This can be achieved by fitting a GPS-receiver and a yield monitor to the harvester to track and record yield throughout the harvesting process. In this manner PF application enables to determine specific yield per square meter. Minimize harvest loss and compare the yield of the same area at different successive seasons so problematic areas can be identified and deficiencies can be corrected.

1.4. Monitoring of soil nutrients level: Soil nutrients level can be monitored directly from the yield maps and from soil sampling and analysis. Automated grid samplers guided with GPS can be used for soil sampling. A common approach uses hectare grid (100x 100 m). Soil analysis together with yield map observations will help in developing a main

fertilizer map. Accordingly a variable rate application of fertilizers can be programmed.

1.5. Variable rate spraying: Variable rate spraying of herbicides and pesticides technology can be utilized, where infrared photograph GPS image of insects diseases and weeds infestation can be developed. This will enable ground or aerial spraying.

2. Cost and benefit of PFU:

PFU is expected to cover expenditure cost and achieve profit because it is a site specific data base which improves management skill diagnose crop problems, eliminates problematic area, increase equipment use efficiency. This should at least cut about 15% off the inputs cost besides investing the PFU to serve other projects.

3. Plan for 2001:

The study for establishing this unit was started in season 2001 as a result of a demonstration trial of monitoring the yield of sorghum field at harvesting in Agadi project. A yield map was generated using a GPS receiver and a yield monitor and a sensor mounted on a harvester. The map revealed a considerable variation in yield ranged from 0.4-5.0 ton/ha ton/ ha (Fig 2). The study of implementing the PFU is now under the final evaluation. In the season 2004 the PFU will serve other agricultural projects.

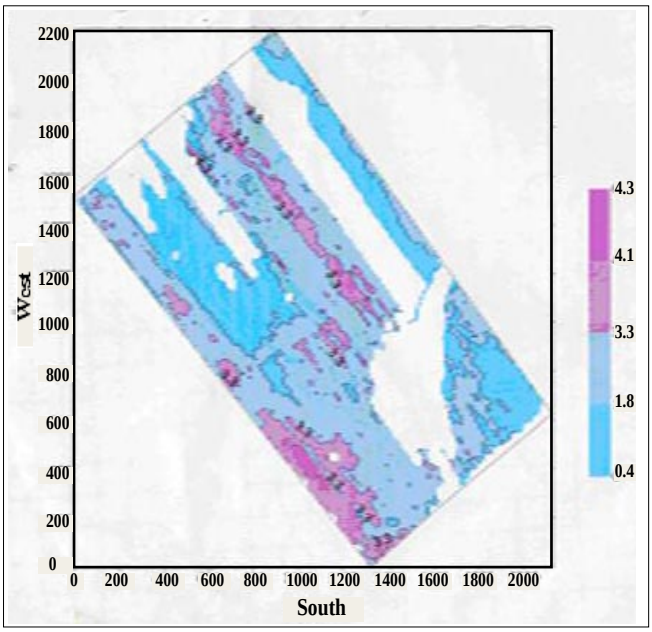

Fig.2. Yield Map (ton/ha) for a sorghum block in Agadi-Sudan.

4. Phases of implementation the PFU:

The PFU will be implemented in three different phases.

4.1. The field layout: In this phase the unit will concentrate on making a very accurate and precise base-map including boundaries, contour intervals, control traffic lines, road, blocks layout, drainages .ect.

4.2. Controlled traffic farming (CTF): Lines for controlled traffic will be designed and laid out as a permanent wheel tracks.

4.3. Crops and Yield monitoring: In this phase the unit will concentrate to fallow up performance and growth of the crops at all stages, using infrared and aerial photography. At harvest mounting a yield monitor and sensors on the harvester will monitor yield. All these information will be setup to establish variable rate application on each project.

5. Plan for 2004 Management information system:

In this phase PFU will introduce GIS based management information system that integrates PF technologies together into a fully integrated daily management tool.

The following equipments are required:

* Auto steering GPS and software.
* GPS base station as a reference point.
* Communication devices (telephones, radios,ect).
* An office very well equipped with powerful computers, plotters, printers, and other
* Computer accessories.
* Transportation (vehicles, motor cycles).
* Very well trained staff.
* For infrared and aerial photography small plane and a digital camera with infrared lenses are required.

The Advantages of the PF

The most likely advantages of the PF at Agadi project are:

1. Highlighting differences in crop condition during growing season and yield monitoring. This will declare the magnitude of the land heterogeneity for future correction.
2. Measuring the size of field wetland, potholes or bluffs. This will help for contour farming.
3. Planning next years seed, fertilizer and herbicides needs. This will help input reduction by applying variable application rate technology.
4. Predicting yield potential, using a vegetation index (vigor idex). This will justify additional fertilizer or pesticides inputs through the season.
5. Implementing controlled traffic. This will avoid soil compaction.
6. Increasing productivity and profitability. This will be reached by overcome land heterogeneity and better crop management.

Conclusion

The availability of the precision farming (PF) is increased by the fast development in the Global positioning systems (GPS) and the Geographical information Systems (GIS). Its application should optimize profit, minimize environmental impact, reduce risk and assist agricultural sustainability. Precision Farming assists in solving land heterogeneity and yield variability. Certain conditions of Agadi need to be managed by the PF. The PF will be adopted to serve Agadi project at the beginning, once the system is adopted the technology will be utilized to serve other AAAID activities around the Arab World.

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الهيئة العربية للإستثمار والإنماء الزراعي تطبق نظام الإحكام الزراعي في القطاع المطرى بالسودان (اقدى)

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الخلاصة

نظام الإحكام الزراعي هو نظامٌ برز حديثاً نتيجة للتطوُّر السريع في النواحى التقنية والجوانب الاقتصادية. إذ يُمكّن تطبيق هذا النظام في الإنتاج الزراعي من التحكُّم الدقيق في استعمال المُدخلات الزراعية المختلفة كالأسمدة والتقاوى والمبيدات العشبية ومبيدات الآفات، والسيطرة التامة على استعمال المعدات والالآت الزراعية ورفع كفاءتها والتحكُّم في مساراتها تفادياً لانضغاط التربة، ومُراقبة أداء المحاصيل خلال تطوُّرها ونموها في المراحل المختلفة، وتقدير الإنتاجية في كل نقطة داخل المساحات المزروعة بدقةٍ مُتناهية مما يُقلّل الفاقد في الإنتاج. كما يُساعد تطبيق هذا النظام على تطوير الإدارة الفنّية وكشف المخاطر في وقتٍ مُبكّر وتخطّيها أو تفاديها، بالإضافة إلى تقليل الفاقد من الأسمدة والمُساهمة في إيجاد بيئة زراعية سليمة.

أصبح تطبيق هذا النظام في السنوات الاخيرة ذو أهمّية قصوى بعد توفُّر العديد من التقنيات المتطورة من نظم المواقع الجُغرافية (GPS) ونظم المعلومات الجُغرافية (GIS) واجهزة التحسُّس (Sensors) والتحكُّم (Control) المختلفة.

وفي إطار توجُّهاتها الرامية إلى تبنّي التقنيات الحديثة في القطاع الزراعي وترقيته وتطويره، والمُساهمة في تحقيق الأمن الغذائي في الدول العربية، فقد تبنّت الهيئة العربية للاستثمار والإنماء الزراعي إدخال نظام الزراعة بدون حرث في عام 2001 في أحد مشاريعها الكبرى في القطاع المطرى بمنطقة اقدي بالسودان كحزمةٍ تقنيةٍ مُتكاملة. حيث أدّى تطبيق هذه التقنية إلى زيادة معنوية في إنتاجية محاصيل القطن وزهرة الشمس والذرة الرفيعة وإمكانية زيادة الرقعة الزراعية لتصل إلى 80,000 هكتار خلال السبع سنوات القادمة.

ومُواصلةً لجهودها في هذا المجال، تعكف الهيئة العربية على دراسة نظام الإحكام الزراعي تمهيداً لتطبيقه في الموسم القادم 2003 تأسيساً على تجربة تطبيقية تم فيها استخراج الخريطة الإنتاجية لمواقع زراعة الذرة الرفيعة وقت الحصاد باستخدام تقنية نظم المواقع الجُغرافية (GPS) ونظم المعلومات الجُغرافية (GIS).

وتهدف هذه المقالة إلى إعطاء نبذة تعريفية مختصرة عن نظام الإحكام الزراعي ومُبرّرات تطبيقه في مشروع اقدي وخطة الهيئة العربية المستقبلية لتطبيق هذا النظام.

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