Accurate Data Management for Precision Agriculture

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ABSTRACT

The advent of precision agriculture has highlighted the requirement for accurate data management. Furthermore the amount of both spatial and temporal information that is required to be updated on a continual basis is beyond the means of traditional data management practices. The Saturn HR guidance system provides a seamless path between the office and field machinery for planning, product application, and data archival of all seed, chemical and fertiliser applications. The data management system is embedded within the HR guidance system which can also be equipped with AutoSTEER and AutoSPRAY for a comprehensive precision agriculture management system.

INTRODUCTION

Precision agriculture is still very much in its infancy and today is still an emerging technology that is widely misconstrued. Earlier misconceptions were that precision agriculture was specifically the use of GPS with a yield monitor, or in more recent times the use of guidance or automated steering system. However these thoughts are merely some of the tools that are used within the precision agricultural solution. Hence it is first necessary to define what is meant by precision agriculture. Numerous organisations throughout educational and government institutions have defined precision agriculture, however for the purpose of this presentation the following definition from the US house of Representatives (US House of Representatives 1997) is considered.

PRECISION AGRICULTURE

> *"an integrated information- and production-based farming system that is designed to increase long term, site-specific and whole farm production efficiency, productivity and profitability while minimizing unintended impacts on wildlife and the environment".*

This definition recognises that site-specific product information is required across the whole farm, over a long term period. Hence traditional information recording techniques, such as a small notepad which may be transcribed to a computerised farm management package, is now being challenged. In order to adopt accurate data management for precision agriculture it is essential that the techniques for recording field data are improved. This field data will form the backbone of the spatial and temporal information in the farm management system.

The Saturn HR system (HR), from Rinex Technology, is an integrated GPS guidance and field data recording system designed specifically for accurate data collection for precision agriculture. Furthermore the HR allows the user to seamlessly transfer information between farm management systems and the vehicle as production based information is designed, applied and archived.

THE PLAN CENTRIC CONCEPT

The typical crop production cycle for any particular field commences at the completion of the harvest operation from the previous season. From this point in time forward, any activity or treatment that is performed in the field is recorded, the final activity being the seasonal harvest. This cycle has been

described as plan centric as the whole growing season is centred around a plan for the field. This plan will detail such activities as, the crop type and variety, seeding and fertiliser rate, insecticide and herbicide treatments throughout the growing season. The planning stage will commence in the farm office when a decision is made as to which crop is planted in the field. This decision will be made based upon historical records for the field. The plan centric concept is illustrated in Figure 1.

Figure 1. Plan Centric Concept

Once the plan has been devised in the office it is then necessary to implement this plan in the field. In the case of spraying a herbicide, the plan will detail such information as individual chemicals with any relevant attributes and their individual application rates, and the water delivery rate from the boom. However it is likely that from the time the treatment plan was conceived and when it is applied in the field, prevailing atmospheric conditions or crop growth stages may influence the final mix. Accordingly it is necessary to record the actual application information as opposed to the designed application. These actual records are those to be recorded for the particular field. This information is then transferred back to the farm management system in the office and will form the basis of management decisions in the future, hence the plan centric concept.

MAPS AND PLANS

In order to visualise the whole farm, with individual fields and their respective attributes, a scaled map provides the necessary detail in an intuitive format. However progressing forward from this point a geo-referenced map in a digital format is an integral component to record spatial data from field treatments. Furthermore digital maps may then also make use of remotely captured data such as aerial photographs or satellite images for underlays on the farm map for visual referencing.

Farm maps can be created using PlanIT, the back office management package from Rinex Technology. The farm map can be enhanced with mapping layers to show attributes such as arable areas, waterways, bush areas, roads or any necessary linear or area features. A fundamental feature which is recorded is the field boundary which defines the perimeter of individual fields. It is the field boundary which is used in the HR to automate the data collection when farm machinery is working within the respective field. A typical farm map derived from PlanIT is shown in Figure 2.

Figure 2. Sample Farm Map

Furthermore the use of the farm map provides a simple interface when developing an application plan for the farm. Recognition of individual fields displayed on a map is far easier than a tabular list of field names. Hence when selecting fields for inclusion in a plan the farm map is more instinctive to the human operator.

The design of any application plan for treatment of a field all have the same basic constituents, the product, its attributes and the application rate, and the field where it is to be applied. As previously indicated an application plan with chemicals will be more complex as there will most likely be several chemicals in the "cocktail mix". By using PlanIT a field and product matrix is generated where Chemicals are added in the columns and Fields are added in the rows. For each field in the application plan the intersecting cell for the applicable chemical will record the application rate. A typical application plan from PlanIT with the linked farm map is shown in Figure 3.

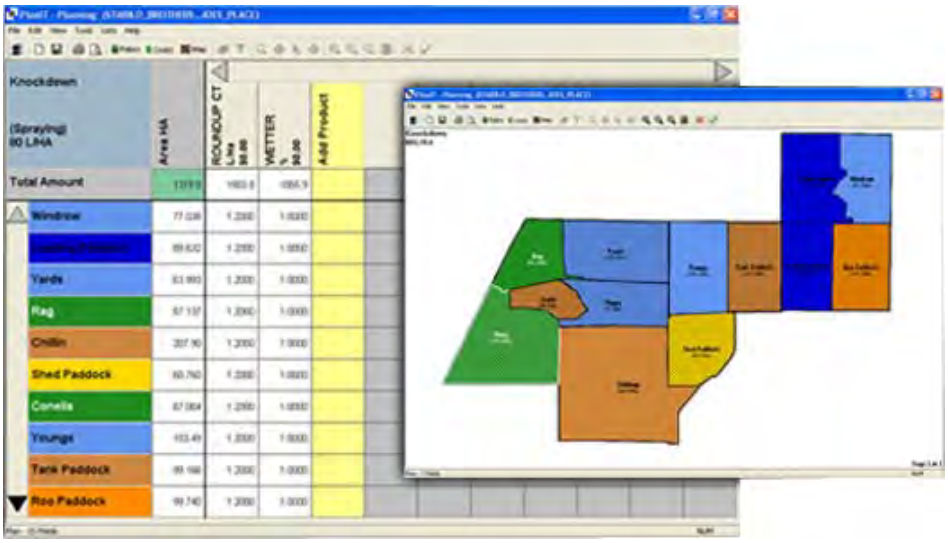

Figure 3. Application plan with linked farm map

THE SATURN HR

The Saturn HR is a combined GPS guidance and data management system produced by Rinex Technology. The user interface is a 22cm colour touch screen which allows the operator to control guidance and automated boom section functions, as well as import application plans from PlanIT and record relevant data on field treatments. The recorded data may be exported back to PlanIT. The Saturn HR touch screen is shown in Figure 4.

Figure 4. Saturn HR user interface

The HR will import plans designed in PlanIT, as well as other farm management systems such as PAM, for automated data management in the tractor. The application plan includes the necessary products and the fields where the products are to be applied. The overall integrity of the entire data management system is protected by the HR when using geo-referenced farm maps with individual field boundaries and the applications plans. As previously stated the application plan can be amended in the field prior to application to allow for prevailing conditions. Furthermore the HR can be interface to a number of flow controllers to record actual application rates. The overall functionality of the HR allows the applied products to be recorded with spatial and temporal attributes in an automated structure which can then be transferred the relevant farm management system.

TANK MANAGEMENT FOR PRODUCTS

The application plan which is imported to the HR details the products and fields which are to be treated using the respective plan. The operator of the tractor which will be applying the treatment is required to fill the tank with the appropriate products. For any product the HR tank is defined as a container which is used to hold seed (air seeder) chemicals (sprayers) or fertilisers (super spreaders). In the case of a chemical application the tank of a sprayer will be required to hold the applicable chemicals and water. The HR tank calculates the amount of product required to be placed in the tank to achieve the target rate in the application plan. This is shown in Figure 5.

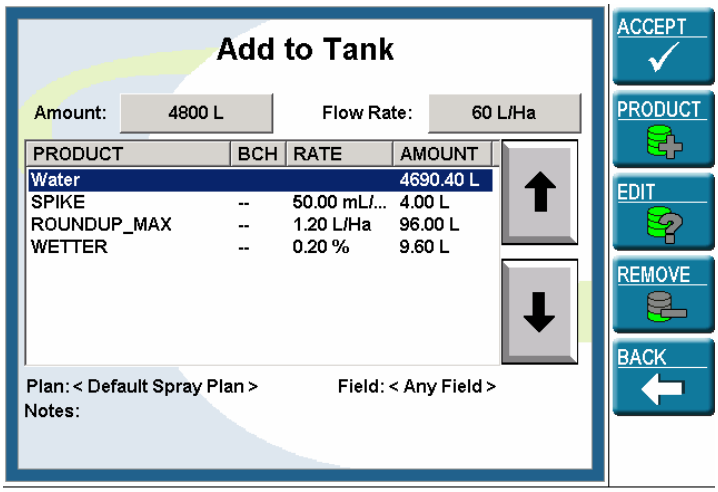

Figure 4. Saturn HR tank

The HR tank can calculate virtually any combination of rate, area or amount so that the operator is not required to do this task and minimises the errors from human operators. All products can be recorded with their respective attributes including the withholding period, chemical group and type, mixing configuration and batch numbers.

AUTOFIELD – AUTOMATED FIELD DATABASE RECOGNITION

An integral component of the HR is the automatic field recognition, AutoFIELD. As all data is spatially recorded it could be argued that it is not necessary to have defined fields with names. However with farm management the recognition of these fields is still an important aspect of day to day management. From the development phase of a plan to the treatment application in the field, it is the "field-name" that the owner and operator will refer to for the field in question.

Accordingly it is imperative that the treatment information is recorded within the correct field and this is the power of AutoFIELD function in the HR. This is intrinsically linked to the digital farm map in the farm management software which ensures that the treatment data is associated with the correct field.

Once an application plan has been loaded into the HR and the tractor commences work in the field the HR automatically checks the field is included for the applicable plan. The HR can not stop application of the treatment, however it does alarm the operator that they are working in the wrong field.

GUIDANCE FUNCTIONS ON THE HR

As previously stated the HR is a combined guidance and data management system. By incorporating the two functions it is possible to provide additional benefits to the operator for controlled traffic applications. The field database on the HR is also used to store and retrieve A-B points for each individual field, however when incorporating the AutoFIELD function it automatically selects the A-B points for the relevant field, minimising human error once again.

A relatively new guidance function offered on the HR is the RePLAY guidance. This allows a tractor to follow the same path from a previous treatment, hence if the field is not worked with parallel runs

for whatever reasons it is still possible to apply controlled traffic guidance in the field in which ever formation is required.

Finally the HR will interface with several automated steering systems for controlled traffic operations. The guidance functions available on the HR can all be used with AutoSTEER. Hence whether the system is used for straight parallel swaths using A-B guide points, or contour guidance around irregular shaped fields, the HR AutoSTEER can be invoked.

FIELDNET ON THE HR

Another new feature which has been released on the HR is for real time multiple vehicle guidance and data management. FieldNET distributes information pertaining to the vehicle between other vehicles in the same field using a wireless network. FieldNET allows guidance information to be transmitted between vehicles as well as farm data. The network synchronises data sets between the vehicles when the systems are connected for the same field.

CONCLUSION

The Saturn HR provides an easy to use interface for accurate data recording and vehicle guidance. The HR can be used extensively for controlled traffic and precision agriculture applications where meticulous data recording is required due to its unique functions including tank management and AutoFIELD. Furthermore the recorded information can be easily transferred to office management systems for further data management and archiving to improve whole farm production. The HR forms an integral component of automating the plan centric concept which is fundamental building block in precision agriculture.

REFERENCES

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