

# AGDAT: Spatial applications to improve harvest management, data recording and reporting, and data exchange between organisations †

Robert Crossley<sup>1\*</sup> and John Markley<sup>2</sup>

<sup>1</sup> Agtrix P/L, <sup>2</sup> Mackay Sugar, Australia.

\* Contact author: Email: robertc@agtrix.com

## abstract

**Geographic Information Systems (GIS) have been used in the Australian sugar industry for almost 20 years to map the crop, plan the harvest and record extension information. A number of customised applications have been supplied to the industry by Agtrix P/L to enable relatively untrained operators prepare maps for cropping, keep track of harvest progress through a mapping interface, and allow extension information to be recorded spatially. In 2007, a project was initiated to integrate this suite of products and enhance their operation. The resultant product, AgDat, provides an integrated suite of applications to perform the existing functionality of the current applications, but with added capabilities in terms of the technology used, the options available to the user to capture the data and the data exchange between organisations. This paper describes the development and the operation of the various components of AgDat and how and where these components can be used. They include (1) the desktop versions that allow operators to capture the base information on cropping and harvest progress as well as record various management data such as seed and plant records, inputs and surveys, (2) the AgDat Remote application that allows operations to be recorded in the field as they are being done, and (3) the web interface that allows on-line viewing and editing of the data. All of these applications are supported by the AgDat Interpolator application that interprets the areas affected by an operation from vehicle tracking using GPS, and data exchange systems that enable secure data exchange between organisations. The way that AgDat can be used by the industry to improve its harvest management and data recording, meet its regulatory reporting requirements, and share data between the various stakeholders is also described.**

Keywords: **data, GIS, mapping, spray diary, sugar**

## **AGDAT: Aplicaciones espaciales para mejorar la gestión de la cosecha, el registro e informe de datos y el intercambio de datos entre organizaciones**

Los sistemas de Información Geográfica se han usado por casi veinte años en la industria azucarera de Australia a fin de mapear el cultivo, planificar la cosecha y registrar la información de extensión. Agtrix P/L ha suministrado a la industria una cantidad de aplicaciones hechas a medida para permitir, a operadores relativamente poco entrenados, la confección de mapas para la cosecha, hacer el seguimiento del progreso de la cosecha a través de una interfaz de mapeo y permitir el registro espacial de la información de extensión. En 2007, se inició un proyecto para integrar este conjunto de productos y enriquecer su operación. El producto resultante, AgDat, provee un conjunto integrado de aplicaciones que mantiene la funcionalidad de las aplicaciones actuales pero con capacidades añadidas en lo que hace a la tecnología utilizada, las opciones de las que dispone el usuario para capturar datos, y el intercambio de datos entre organizaciones. Este trabajo describe el desarrollo y la operación de los diversos componentes de AgDat y cómo y dónde esos componentes pueden ser utilizados. Incluyen (1) las versiones de escritorio que permiten a los operadores capturar la información de base del progreso de la recolección y la cosecha así como registrar diversos datos de gestión, tales como registros, insumos y evaluaciones de semillas y de plantas, (2) la aplicación AgDat Remote que permite registrar operaciones en el terreno a medida que se efectúan y (3) una interfaz con la Web que permite ver y editar datos en línea. Todas estas aplicaciones están apoyadas por la aplicación AgDat Interpolator que interpreta las áreas sometidas a operaciones desde vehículos con rastreo utilizando GPS y por sistemas de intercambio de datos que permiten un intercambio seguro de información entre organizaciones. También se describe la manera en que el AgDat puede ser usado por la industria para mejorar su gestión de cosechas y manejo de datos, cumple con sus requerimientos regulatorios de informes y comparte datos entre los diversos interesados.

## **AGDAT: aplicações espaciais para melhorar a gestão da colheita, a gravação de dados e relatórios, e a troca de dados entre as organizações**

Sistemas de Informação Geográfica (SIG) têm sido usados na indústria açucareira da Austrália há quase 20 anos para mapear a cultura, o planejar a safra e armazenar extensiva informação. Uma série de aplicações personalizadas foram fornecidos para a indústria por Agtrix P/L para permitir que operadores relativamente inexperientes prepararem mapeamentos de corte, acompanhem o progresso da colheita através de uma interface de mapeamento, e permitir que informações extensas sejam gravadas espacialmente. Em 2007, um projeto foi iniciado para integrar este conjunto de produtos e reforçar sua operação. O produto resultante, AgDat, fornece um conjunto integrado de aplicações para executar a funcionalidade existente das aplicações atuais, mas com recursos adicionais em termos de tecnologia utilizada, em relação as opções disponíveis para o usuário para capturar os dados e para troca de dados entre as organizações. Este artigo descreve o desenvolvimento e a operação dos vários componentes

da AgDat e como e onde esses componentes podem ser usados. Eles incluem (1) a versões desktop que permitem que os operadores capturarem as informações de base sobre o progresso do cultivo e da colheita, bem como os registros de gerenciamento de dados diversos, tais como registros de sementes e plantas, insumos e pesquisas, (2) a aplicação AgDat remota que permite que as operações sejam gravadas em campo enquanto estão sendo produzidas, e (3) a interface web que permite visualização on-line e edição dos dados. Todas estas aplicações são suportadas pela aplicação interpolador AgDat que interpreta as áreas afetadas por uma operação de rastreamento de veículos utilizando GPS, e o sistema de troca de dados que permite a troca segura de dados entre as organizações. A maneira que AgDat pode ser usada pela indústria para melhorar a sua gestão da colheita e gravação de dados, cumpre com os requisitos de regulamento de relatório, e compartilha dados entre os vários stakeholders também é descrito.

## Introduction

Geographic Information Systems (GIS) have been used in the Australian sugar industry since 1992 for mapping farms and estimating crop to process. Agtrix started supplying a customised GIS to the industry in 1995 to simplify the tasks involved in mapping farms and printing those maps for growers and field books. The software has been developed in close collaboration with the industry through annual workshops, and currently 85% of Australia's sugar crop is mapped with this software.

Other tools have also been provided to the industry by Agtrix, including applications to:

1. Manage harvest progress recording through a map interface (CHOMP - initially developed in 2002) (Crossley and Dines, 2004).
2. Deliver a mapping interface to growers over the web that growers can interact with the mill for information exchange (Mackay Web Mapping Portal - initially developed in 2001) (Crane and Fleming, 2003).
3. Interpret harvested areas from GPS tracking automatically on a daily basis, and report harvester performance (FRANK - initially developed in 2002) (Beattie and Crossley, 2006).
4. Allow extension services to record their data on a spatial basis (Prodbase Plus - initially developed in 2006) (Markley *et al.*, 2008).
5. Generate maps suitable for Land and Water Management plans (initially developed in 2003).

The suite of applications were developed on a GIS platform and limited by what could be done purely within a GIS. In 2007, a project to redevelop the current products into a more comprehensive, integrated application was initiated. The resultant product, called AgDat will provide all the existing functionality of the existing suite of products, but will include additional functionality that was not feasible to implement previously.

## AgDat development objectives

The development of AgDat provided the opportunity to review the features of the software suite that were well accepted and to identify areas that could be improved. AgDat was developed to progressively replace the existing range of applications that Agtrix provided to the sugar industry with a more integrated solution, which used the most appropriate technologies available and had a richer user interface than currently available.

The core functionality objectives identified for AgDat and the enhancements incorporated were:

1. **Base mapping** - tools to capture and maintain spatial data about farms, paddocks and crops, print field maps and maintain database integrity. Main enhancements were the use of a temporal (time-based) database and the use of agronomic events to change the underlying data (discussed subsequently).

2. **Harvest progress** - tools to track the harvest progress through the season, associate deliveries with the area that they were harvested from, improve estimates based on actual deliveries and areas harvested. Main enhancements were to improve the yield re-estimation through the season, improve the ability to audit product source, and incorporate in-paddock yield variation into the mapping system.

3. **Data recording and analysis** - tools to enable agronomy advisors and extension organisations to record a wide variety of data about farms, paddocks and crops on a spatial database. Enhancements included better data structures to allow better analysis and reporting capabilities, multiple interfaces to data (desktop/ laptop, web and remote).

4. **Data exchange and security** - system to allow organisations to protect their own information, but share portions of that data with other organisations if they choose.

5. **Web access** - a web mapping interface to allow growers to view data recorded on their farm by others, and to record data about their farm that will be included into a database use by the advisors. Main enhancements were to improve the coupling between the databases used for the web with those used by the rest of the system.

The development of AgDat was implemented using Agile development methodologies (Anon., 2001; Boehm and Turner, 2003) to involve users in the early phases of development and ensure that the system developed met user requirements. As a consequence, objectives and delivery schedules changed over the course of the development to focus more on the data recording and reporting requirements associated with Great Barrier Reef Regulations, rather than the initially planned objectives of base mapping, data recording and harvest progress monitoring. Further, new interfaces to record data using a web mapping interface and in-field data collection were developed.

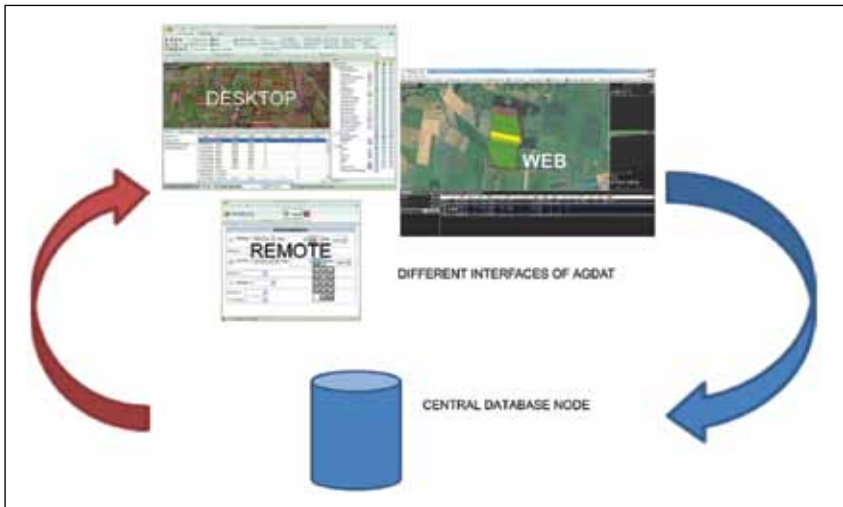
## Technology

AgDat was developed in C#.NET using Framework 3.5. The data is stored in SQL Server 2008 (any version including the free Express version). The mapping functionality is provided by Pitney Bowes MapXtreme for the desktop/ laptop application, but uses open-source software for web applications.

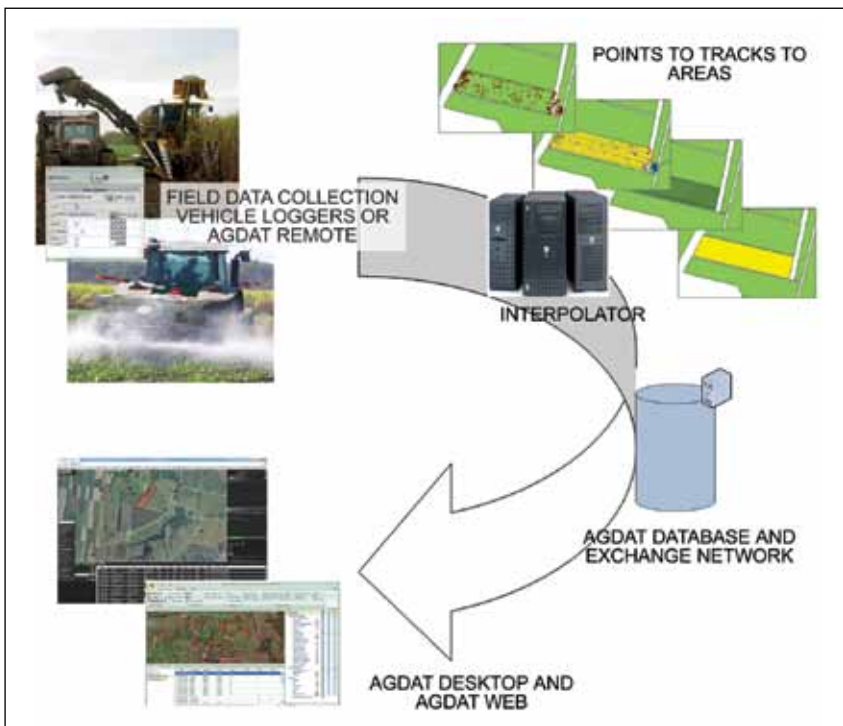
The use of an industry standard database to store all spatial data allows integration with various GIS platforms that may be used in the industry (MapInfo, ArcInfo, Manifold).

The application will run on all modern Windows operating systems that support .NET framework. In a corporate environment where multiple users will want to share the data, a network is required. A centrally hosted model was also trialled for smaller groups that were not directly associated with an organisation that could provide centralised data management.

**Figure 1.** The various interfaces to AgDat data recording module - desktop/ laptop, web and remote



**Figure 2.** Data processing by AgDat interpolator. Data collected from paddock are processed by the interpolator and inserted into the AgDat database. This is then made available to users through either AgDat Desktop or AgDat Web



## System description

AgDat has been developed as three main modules: The base mapping module, the harvest management module, and the data recording module.

### Base mapping module

The base mapping module is an application that allows users to record information about large numbers of farms, paddocks and crops through a map interface. This module provides managed

data editing (including data integrity checking), cartographic labelling and batch printing of farm maps. The data that is generated forms the basis for most other functionality.

### Harvest management module

The harvest management module allows users to track the progress of the harvest and associate delivered product with the area of land from which it was harvested. Data is managed through a map interface. This process is greatly streamlined by using vehicle tracking on the harvesters to interpret the areas cut each day (refer to the following section on AgDat Interpolator, to Crossley and Dines (2004) and to Markley *et al.* (2003)).

Recording where delivered product originated from on a map allows:

1. Verification of consignment data visually. Users and growers relate to maps as a way of conveying information, and a map showing the areas harvested or with remaining crop allows users to very quickly verify if the data in the system is correct. Displaying yield calculated from delivered product over the actual area harvested as a thematic map was noted to assist users recognise obvious consignment areas (Crossley and Dines, 2004).
2. Trending analysis of original estimate against actual production, allowing re-estimating of the crop left to harvest.
3. Productivity analysis by analysing production against mapped land attributes and spatially recorded inputs.
4. Rapid access to all information that may be relevant to an enquiry of inputs that may be used in the production of product (an auditable system that can prove the location that product was sourced from).

### Data recording module

The data recording module allows organisations to configure data 'contexts', which can then be used to provide a data entry form for users. These contexts configured have included:

1. farm inputs like nutrient or chemical applications
2. surveys such as disease or pest survey
3. tests such as soil, leaf or water analyses
4. farmer advice or recommendations.

All of these data are recorded spatially (against the land that it refers to) so that it can be accessed through time regardless of what the paddock layout or name is in the future.

Further, all data can be retrieved for any area through spatial queries using the spatial representation of the land of interest.

The AgDat data recording has three different interfaces (Figure 1), all of which are simply different ways of entering the same data as they are driven by the common configuration of the data contexts. All data ends up in a common database regardless of

how it is entered. The interfaces are:

**1. AgDat Desktop** - a fully functional .NET application that provides a rich user experience and all the functionality that is expected from a desktop/ laptop application.

**2. AgDat Web** - a web mapping interface that allows users to view and edit data that have been recorded previously, as well as record new data. This interface and functionality is much simpler than the desktop version, but allows a wider audience to access the data securely without installing any local applications.

**3. AgDat Remote** - a very simple interface that allows operators to record various farming activities as they occur. The farming activities being undertaken are recorded by the operator in the paddock, with GPS locations and sensor data collected automatically. These data are then sent to the AgDat interpolator. The interpolator then calculates the area that has been affected, and then sends both the contextual and spatial data to AgDat through AgDat's exchange network.

The data collected through each of these interfaces are accessible from either AgDat Desktop or AgDat Web.

## Data exchange

Data collected by individuals or organisations need to be kept in the control of that organisation. However, other users may want to view that data to provide supporting services. AgDat has a system of data exchange that allows each organisation to keep control of its own data, but exchange all or some of it with other users through electronic contracts. These contracts are entered into through mutual agreement between both parties with the primary party maintaining the controlling function. The system is quite analogous to the existing systems of data exchange that exist for digital or printed data currently.

## AgDat interpolator

The Interpolator is a centralised service that takes GPS positions and sensor data from vehicles and interprets what the vehicle is doing and the area in which the operation was performed (Figure 2).

This system was used for harvesters to produce daily harvested areas for almost 220 sugar harvesters from Cairns to Harwood in 2009, as well as activity reports of how effectively the vehicles were operating. This same technology was used for 20 AgDat remote devices and 19 mud and ash trucks to interpret areas associated with other activities (Markley *et al.*, 2010).

Data on time spent operating and not operating is interpreted from vehicle activity and can be passed onto AgDat so that resources used in any particular operation can be accurately recorded. Daily reports are provided on operational performance parameters such as cutting to running ratios, turning ratios, or where yield data are available, pour rates for paddocks on a daily or season basis (Crossley and Dines, 2004; Beattie and Crossley, 2006).

## Innovations

There were some significant innovations incorporated into AgDat to meet design goals and user requirements/ wishes. The major shifts from the traditional method that data are collected and stored were:

**1. Spatial database** - The underlying data structures of AgDat

are spatially enabled. All data in AgDat are associated to the piece of land it relates to, and relationships are based on where they are, meaning that no matter what a paddock may be called or how it may be reshaped, operations and productivity associated with the location can be accessed.

**2. Temporal database** - All underlying data in the database is time stamped *viz.* related to a period of time, and not segregated into a separate dataset that is seasonally based. This means that all crops and actions done on a piece of land can be stored in a single repository of data, allowing access to historical information through spatial queries of what data are present for a particular area of land. The traditional seasonally based databases currently used by the sugar industry are restrictive if trying to incorporate break crops or mixed enterprises that are not synchronised to the sugar season.

**3. Event based data management** - Most traditional databases used in the sugar industry are records of the crop that was harvested each season. They are analogous to a series of snap shots of what was present at the start of the harvest season. While spatial systems allow analysis of the history of a crop, there is no direct reference to the events that caused the changes; for example if there is a different crop over half the paddock than last year - when did it get planted? AgDat incorporates these changes made by events in time, allows ties to agronomy, multiple crops and break crops, analysis of inputs to crop, defined individual.

**4. Field data recording** - Use of AgDat remote to record activities in the field from data inputted in the field. AgDat remote combines data recorded in the tractor using a touch screen with the capability to interpret the spatial area for the activity from GPS data, to create data recording events that are passed to the central database.

**5. 'Intelligent' data structures** - Data structures are designed to allow users to configure data collection contexts via a purpose built interface in an ad-hoc manner, yet allows the system to be able to recognise and process properties that can be used in reporting. An example is that fertilisers can have constituent property (% nutrient concentration) that can be used to calculate the total quantity of the nutrient that has been applied, yet users do not have to specify explicitly how this calculation needs to be made when configuring a fertiliser recording context.

**6. Automated, secure data exchange between organisations** - AgDat is designed to allow automated syncing of data between organisations data nodes to allow extension services and milling organisations to work cooperatively..

## Conclusion

The use of Agile approach (Anon., 2001) for the development of AgDat meant that the functionality that was released was led by the users. As a consequence, the release schedule of the functionality focused on the data recording aspects, including a desktop/ laptop application, AgDat Remote and AgDat Web.

A number of innovations have been introduced into AgDat to make it more powerful than the previous applications it was to replace, including the spatial, temporal database to enable better analysis, the use of agronomic events to cause changes in the data and allow a better connection between mill data and extension services, and the development of AgDat Remote to allow data recording in the field.

The combination of using events to change data and the

use of a temporal database will enable the system to integrate management and production data better than has been possible in the past.

Future development will focus on:

1. on-going user requests
2. base mapping and harvest management modules
3. improved reporting and analysis functionality, particularly with regards to future reporting requirements
4. improvements to AgDat Remote to enable advisors to pass data to the units in the field about planning events
5. inclusion of yield variation mapping is contained in the AgDat database.

The release schedule will be largely dependent on user demands. AgDat will ultimately be made available to the rest of the Australian sugar industry as an upgrade to Agtrix's current product range.

## Acknowledgments

The authors would like to thank the stakeholders throughout the sugar industry who have supported the development of AgDat,- specifically Agtrix, Mackay Sugar Ltd, BSES Limited, Mackay Area Productivity Services (MAPS), Burdekin Productivity Services (BPS) and Mackay Canegrowers, the Reef Rescue Program and Catalyst. We also wish to acknowledge MAPS and BPS staff, in particular Kevin Moore, Burn Ashburner and Peter McDonnell, as well as Neil Young, Robert Fenwick and Tony Crowley for their input into the functionality of AgDat during its development.

*\* This paper was presented at the 2010 Australian Society of Sugar Cane Technologists annual conference and is published here with the agreement of the Society.*

## References

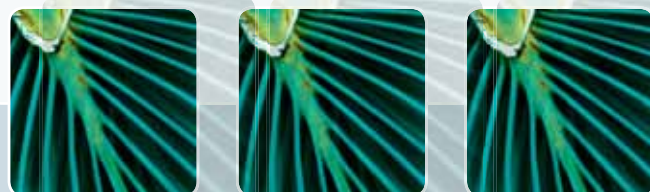
- Anon. (2001) Principles behind the Agile Manifesto, [www.agilemanifesto.org/principles.html](http://www.agilemanifesto.org/principles.html) (accessed December 2009).
- Beattie, R. and Crossley, R. (2006) Achieving world's best practice harvesting and transport costs for the NSW sugar industry. *SRDC Final Report Project NSC006*. Sugar Research and Development Corporation, Brisbane.
- Boehm, B. and Turner, R. (2003) *Balancing agility and discipline - A guide for the perplexed* (Addison Wesley: Boston).
- Crane, J. and Fleming, G. (2003) Improving information flows in the sugar industry supply chain: The Mackay Sugar Web Portal. *Proceedings of the Australian Society of Sugar Cane Technologists 25*: (CD-ROM) 8 pp.
- Crossley, R. and Dines, G. (2004) Integrating harvester GPS tracking data with spatial harvest recording system. *Proceedings of the Australian Society of Sugar Cane Technologists 26*: (CD-ROM) 11 pp.
- Markley, J., Raines, A. and Crossley, R. (2003) The development and integration of remote sensing, GIS and data processing tools for effective harvest management. *Proceedings of the Australian Society of Sugar Cane Technologists 25*: (CD ROM). 12 pp.
- Markley, J., Ashburner, B. and Beech, M. (2008) The development of a spatial recording and reporting system for productivity service providers. *Proceedings of the Australian Society of Sugar Cane Technologists 30*: 10-16.
- Markley, J., Raines, A., Everitt, P. and Crossley, R. (2010) The implementation of a mud and ash delivery strategy in Mackay. *Proceedings of the Australian Society of Sugar Cane Technologists 32* (These Proceedings).

## November Issue 2011

MATERIALS DEADLINE

**November** > World Ethanol & Biofuels 2011 and World Biofuels Outlook **25/10/11**

**Bonus distribution at:**  
F.O. Licht's World Ethanol & Biofuels 2011, Spain  
ISO, United Kingdom



## December Issue 2011

MATERIALS DEADLINE

**December** > Centrifugals and Crystallisation **23/11/11**



Call **Stuart Velden** on

Direct: **+44 (0)20 7017 7559**

Phone: **+44 (0)20 7017 7493**

Fax: **+44 (0)20 7017 7593**

Email: **stuart.velden@informa.com**