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AGRIBASE - A NATIONAL SPATIAL FARM DATABASE

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Le ministère de l'agriculture de la Nouvelle Zélande a développé un registre national de l'ensemble des propriétés et biens commerciaux d'origine agricole et horticole. La base de donnée comporte les informations sur le personnel, l'effectif des cheptels par espèce, les superficies, les productions, les liens avec le système d'information géographique (GIS). Ce système a été développé sur une base « client-serveur » avec plusieurs utilisateurs, et l'environnement GIS, de plus un accès en ligne garanti pour les utilisateurs par le biais du réseau (WAN) du ministère. Les enregistrements contiennent par exemple des informations géographiques et sanitaires, notamment sur les maladies exotiques, le contrôle des maladies endémiques, le programme assurance qualité, les désastres naturels. L'analyse statistique est donc possible depuis l'échelle d'élevage jusqu'au niveau national.

L'enregistrement des éleveurs est volontaire, la gestion des données est réalisée par un salarié. Le succès de ce système (particulièrement à frais réduits) a été conditionné par un retour d'informations aux éleveurs, et le développement d'une stratégie de partenariat avec les industries et autres organisations. Un des bénéfices, dans le cadre de l'organisation mondiale du commerce (OMC), est de fournir des garanties et des assurances sur les maladies, les résidus, et les indicateurs d'environnement liés au système de production. La Nouvelle Zélande serait capable de répondre à ces exigences.

INTRODUCTION

In 1988, the New Zealand Ministry of Agriculture (MAF) initiated the development of a decision support system (DSS) for foot-and-mouth disease (FMD). This system, later known as EpiMAN (Sanson et al. 1991) was designed to exploit a spatial database of farms, in order to enable more spatially-oriented, risk-based decision-making during an eradication campaign. Subsequently, this led to investigations into how such a database could be established at a national level, what pre-existing data sources could be utilised, and how best to combine spatial data with other (non-spatial) details about farms. In 1993, MAF conducted a comprehensive review of its database systems, the result of which was an Integrated Strategic Systems Project (ISSP), the key elements of which were:

- a move towards enterprise-wide client-server databases;
- adoption of a unified data model across the organisation (no duplication of data in different databases);
- establishment of a single national register of commercial farms.

This paper describes the resulting national spatial farms database in New Zealand, known as Agribase.

OVERVIEW OF SYSTEM

Agribase is a register of all commercial farms in New Zealand, including plants and livestock enterprises. It holds contact details for the key personnel involved with the premises, animal numbers by species, and land areas involved in various crops. Each farm can have multiple animal and crop sub-enterprises. Very importantly, the database contains the links to the land areas used by a farm, with the spatial co-ordinates stored in a geographic information system (GIS). Each farm has a unique FarmID, which is the primary key in Agribase, and the foreign key in all application-oriented databases that deal with farm-based data. Based on the unified data model concept, farm profile information required by these applications is stored in Agribase, but accessible and update-able by them. The use of client-server systems makes this possible, where the database servers are networked, centralised computers running multi-user relational database management systems (RDBMS).

To date, Agribase provides data for a number of MAF systems including EpiMAN, the National Livestock Database (NLDB) and the laboratory data management system (NuLAB). In addition, it is being used to support a range of external client applications, including a surveillance system for cystercosis in sheep meat, forest pest management, development of environmental indicators for atmospheric quality, resource management by regional councils, and air rescue services for quickly finding and dispatching helicopters to farms in emergency situations.

DEVELOPMENT OF THE SYSTEM

The steps in the creation of Agribase were as follows:

- Develop a workable definition of a farm.
- Select the essential data elements to be captured for each farm.
- Define the database schema for Agribase.
- Establish achievable targets for capturing data.
- Assign a unique FarmID to every farm in existing MAF databases, and transfer the required farm profile information to the new Agribase tables.

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- Purchase the Valuation Roll - a database of land valuations held by the Valuation Department. From this listing, every rural ratepayer occupying land over 5 ha with an agricultural use was sent a farm registration form, followed-up in some areas by telephone. In particular, farmers were asked to furnish their Valuation Roll numbers, which were necessary for linking to the spatial data (see below).
- Reconcile returned registration forms with existing farm records, and either enter new data or update existing records.
- Lease the national Digital Cadastral Database (DCDB) off the government land department. This was a digitised (electronic) register of all land parcel survey plans.
- Purchase a suitable in-house GIS for storing and manipulating the spatial data.
- Develop a methodology for linking Valuation Roll numbers to land parcel appellations (legal descriptions). Store links in Agribase.
- Market the growing system internally and externally!

Two major challenges facing the development of Agribase were that it had to be developed out of existing operational funds; and secondly, farm registration is voluntary. Therefore Agribase stands (or falls) on its usefulness both to the farmers themselves, and the end-user applications that link to it. This has led to a need for the Agribase team to become extremely market focused, and to seek external uses to help generate the revenue required to financially underwrite the system. Many of the applications to date have been right outside the usual domain of a State Veterinary Service.

STRUCTURE OF SYSTEM

All farm-related databases are held on centralised database servers running Microsoft SQL-Server. Desktop client applications (front-end systems) access this data across MAF's wide-area-network (WAN). The Agribase component is a set of related tables holding the core farm profile information, plus the links to the spatial data. Each land parcel in the GIS has a unique parcel identifier (UPI), and Agribase maintains a table that stores the one or many UPIs related to each FarmID. The actual land parcel co-ordinates are stored in the GIS. MAF currently uses two GIS software packages. The national data warehouse utilises Genamap, a full-featured topological vector GIS. District users have copies of the data for their districts in MapInfo format. To utilise the spatial data, links from the land parcels in the GIS are made back to the textual databases based on the FarmID-UPI relationships. In this way, any data linked to a FarmID in any of the related databases can be mapped and analysed.

ACHIEVEMENTS TO DATE

Since its launch some 3.5 years ago, over 80,000 farms have been entered into the textual database. In most areas of the country, this represents 100% of farms enumerated by the government's agricultural census. The spatial database comprises the co-ordinates of approximately 1 million land parcels, representing every rural land parcel in the country. An electronic method for linking these to the farms has been developed, and this achieves a match rate of between 70% and 90%, depending mainly on the standardisation of appellations used to describe the land parcels. This electronic match rate is then improved upon manually via a number of means. One such program, which also allows us to capture homestead point locations is a project on behalf of a number of rescue helicopter trusts, and funded out of donations by farmers. Each farm in a given trust area is mailed a map of the land parcels occupied by the farm generated by the GIS, and farmers validate the data and indicate their homestead by marking the location on the map. These annotated maps are then returned to MAF where the location is recorded digitally. These point locations are then made available to the trusts for use in responding to emergencies.

EPIDEMIOLOGICAL USE OF THE SYSTEM

The objective of the Agribase programme is to have every farm livestock, cropping and horticultural property in New Zealand recorded and maintained in the system. This system, due to its storage in an open computing environment, is available to a wide range of applications that require information on farming enterprises (subject to privacy constraints and the cost of maintenance - see below). Within the broad discipline of epidemiology, the scope of use is huge. Agribase essentially contains an animal census. Therefore true population parameters can be established. This means for instance, that at a farm level, there is a complete sampling frame for every major livestock category. This facilitates the planning of surveys, and allows the calculation of true incidence rates. As farms are also represented by areal co-ordinates and point locations, it makes possible sophisticated spatial analysis techniques, including geographical modelling of animal diseases. A large number of potential spatial determinants of disease required for mutivariable analyses can be measured directly out of or derived from data held in Agribase. Similarly, Agribase can furnish much of the data inputs for medium or macro-scale economic analyses.

What the Agribase system provides, is a facility whereby any variable (dependent or independent) can be placed in its geographical context with supporting demographic data. This facilitates the rapid deployment of passive or active surveillance programmes (including map-based reporting systems) and risk-based DSS; and allows disease control contingency planning (as well as exotic disease scenario generation for training purposes).

PRIVACY ISSUES

In New Zealand, privacy legislation outlines the principles under which data about individuals can be held and used. Essentially, these principles state that the intended use(s) of data should be clearly advertised at the time of capture; individuals have a right to access data about themselves, and every effort should be made to ensure the accuracy of the data. The latter two principles are in accordance with MAF's own objectives, and in the case of intended use, the statement was "to be used by MAF and allied organisations for responding to animal and plant pests and diseases, residue problems, rural emergencies, environmental concerns, and anything that could limit New Zealand's

productivity or ability to trade". This was carefully broad, and covers both existing and future perceived uses. Included for example, is the ability to respond to future market demands for product assurance, including disease, pest, residue, animal welfare and environmental indicators. Despite this breadth, there have been instances when access to data has been denied, e.g. a sales company requesting mailing lists of farmers. It is vitally important that we do not alienate the farmers about whom we wish to hold data.

MAINTENANCE

The maintenance aim for Agribase is to have the data on every farm updated annually. Achieving this is a major challenge, but is approached on multiple fronts. Firstly, every farm visit by a veterinary or para-veterinary officer in the course of routine work is an opportunity to verify and update the existing record for that farm. MAF Quality Management has some twenty-three District Offices throughout the country. The scope of interaction with the farming industry is broad, placing us in a unique position for achieving this nationally.

Secondly, maintenance is application-dependent. What this means is that if there are sufficient important uses for the data, maintenance will take care of itself. In relationship to this, there are two types of data users. One type consists purely of end-users, who have no direct contact with farms, and therefore no way of updating the data. In these cases, depending on the quality and completeness of the base data required, they should be willing to make a financial or resource contribution. The other type of user is in a position to provide updated data in return, via direct access to farmers in the course of the particular programme. In practice, this means that the level of maintenance for different industry sectors varies. For example, information on cattle and deer farms is far more up-to-date (due to the existing national TB control scheme) than information on orchards (due to less use of Agribase by this industry sector).

Thirdly, special projects to capture or update data for a particular type of farm, or for defined geographical areas can be implemented, where there are special funding arrangements. One such example, is the capture of homestead location on behalf of participating rescue helicopter trusts mentioned above.

Fourthly, strategic alliances with other bodies, such as local government authorities are being entered into, so that data sharing for defined purposes can take place, and to share the data capture and maintenance costs.

Spatial data is maintained by the relevant government land department, and supplied as regular updates. Similarly, ownership/occupancy changes are forwarded to MAF monthly by the Valuation Department.

FUTURE DIRECTIONS AND CHALLENGES

The New Zealand economy is still very dependent on primary exports. Due to our geographical isolation and therefore the cost of transport of products to our international markets, and the increasing competition from other countries, our strategy is to compete on quality. What this means is that our exporters recognise the need to be able to accredit our products to international standards demanded under a World Trading Organisation (WTO) environment. New Zealand is therefore developing standards-based quality accreditation systems that track products throughout their lifecycles, from paddock to the shelf (so called "plough-to-plate" quality systems). The key linkages from producers to processors are gradually being put in place.

A range of advanced DSS for specific disease problems are being developed to exploit the data in Agribase. These are based on (and extend) the techniques developed for EpiMAN (FMD), whereby veterinary epidemiological expertise is embedded into the information system itself. These systems include artificial intelligence techniques, simulation modelling, spatial analysis and risk-based decision making.

Meanwhile, there are some remaining deficiencies in Agribase. There are still a few industry sectors where its use is sub-optimal for maintaining the system. Encouraging the usage of the data in these areas is a priority. From a technical standpoint, storing historical data on farms (ownership, enterprise and spatial data) is a remaining challenge. Agribase in its current guise, attempts to represent the most current situation with respect to the data it carries. However, land occupancy and use by farmers changes over time. The ability to track these changes is something that current mainstream GIS packages do not cater for very well. However, there is a trend to move away from proprietary GIS data formats, and to store data in relational or object-extended database systems, where multiple spatial objects, each with a time-stamp can be stored. This development offers a potential solution to the problem.

Finally, ways of providing greater access to the data in Agribase using Internet tools such as Web-browsers are being explored.

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