
AUSTRALIAN INSTITUTE OF AGRICULTURAL SCIENCE/NSW AGRICULTURE

"FROM SATELLITE TO YOU" SEMINAR

NSW AGRICULTURE
161 KITE STREET, ORANGE

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Abstracts of Presentations

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JG Hamilton & KD Bryceson, Australian Plague Locust Commission, Canberra
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PKJ Flemons & GJ Tupper, Western Division Resource Monitor c/o NSW Agriculture
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John P Louis, Centre for Image Analysis, Charles Sturt University, Wagga
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JF Hindle, NSW Agriculture, Nowra
7. The Use of Landsat TM Data to Map Remnant Woodland in the Central Western Region NSW
David Goldney, Charles Sturt University, Bathurst and Dennis Hodgkins, UNE OAC
8. Woody Vegetation Monitoring in Western NSW
Sharon Weir^a & Maria Cofinas^b
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9. From SPOT to your Business
Alexis Vuillemin, Spot Imagery Services, Suite 502, 156 Pacific Highway, St Leonards 2065
10. Vertical Aerial Photography for Irrigation Management - Use of False Colour Infrared Prints
Barry D Swann, NSW Agriculture, PO Box 865, Dubbo
11. Remote Sensing for Property Planning
Karen Hall, Department of Conservation & Land Management, GPO Box 39, Sydney 2001
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Peter J Vickery, CSIRO Division of Animal Production, Pastoral Research Laboratory,
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Presentations

1. REMOTE SENSING IN AGRICULTURE: PAST, PRESENT, FUTURE

The application of remote sensing to agricultural resource management has come a long way in the past 50 years, from the days of a hand-held camera with the person standing on a fence post, to the high-tech days of the 90's.

A great leap forward occurred in 1972 with the launch of LANDSAT 1 (then known as ERTS-1 = Earth Resources Technology Satellite), and was followed up in the 80's with the rapid development of computer-based Geographic Information Systems, and further satellites from various nations.

In 1987, agriculturalists identified numerous present and potential applications of the technology in agriculture, including crop area, condition and yield prediction; pasture communities and conditions; accessible databases on land use, land cover, and agricultural suitability; drought mapping and monitoring; land degradation, salinity, waterlogging, soil acidity, erosion; irrigation extent, potential, management; tree cover extent, density, clearing, changes; vegetation cropping, degradation, fire; and so on.

In 1989, a study commissioned by the Rural Industries Research and Development Corporation came to various conclusions on the status of remote sensing in Agriculture; including that very few applications had been realised operationally; the majority of projects were research centred rather than operational; there was an absence of private sector involvement in operational projects; there was a frequent failure to extend completed research through the developmental stages; projects were often not needs - driven; successful remote sensing applications should be promoted; remote sensing is most effective when it is used with other types of data.

Where do we stand today, and what of the future? The other speakers today will help us to answer these questions.

As we look down the track we see technology developing at a continuing rapid rate. But are we harnessing the technology to serve agriculture's interests of sustainable land use, improved production and marketing, profitability, and increasing diversification, as well as we can?

2. NOAA AVHRR SATELLITE IMAGERY IN AGRICULTURE

The NOAA (National Oceanic and Atmospheric Administration of the USA) series of satellites were designed primarily for atmospheric and oceanic monitoring. Since the early 80s land monitoring applications for the AVHRR (advanced very high resolution radiometer) sensor on board the NOAA satellites have also been developed. The IGBP (International Geosphere-Biosphere Project) relies heavily on NOAA AVHRR data for monitoring global vegetation changes.

Most monitoring with AVHRR is based on the Normalised Difference Vegetation Index (NDVI) which, using the values of reflected red and near-infrared radiation captured by the AVHRR, provides a good measure of the density of actively photosynthetic (green) vegetation. Each of the two NOAA satellites captures data with the AVHRR sensor for any point on the earth's surface twice per day. By compositing a number of consecutive days' images a cloud free image can be produced for most times of the year. The compositing process also minimises other errors

which can occur in AVHRR data. Preprocessed 10 day composites are available from CSIRO marine laboratories in Hobart, and can be purchased at a cost which approximates one cent per square kilometre.

The data supplied by CSIRO in Hobart has been used by the Queensland Department of Primary Industries for 4 years for drought monitoring, and from October 1992 will be regularly acquired by NSW Agriculture for a number of monitoring tasks varying from assessing state wide seasonal conditions to monitoring individual cropping paddocks.

3. USE OF ENHANCED GMS WEATHER SATELLITE DATA IN LOCUST FORECASTING

The APLC exists primarily to locate nascent locust outbreaks in the semi-arid interior, and to control these before they migrate to agricultural areas. We face the continuing challenge of improving our survey techniques and this season sees the first operational use of remotely sensed data to detect areas of likely locust breeding in inland Australia.

Rainfall is the key to understanding locust population dynamics. Areas where rain is likely to be falling are deduced from GMS satellite images that have been colour enhanced to display cloud top temperatures. These areas are then surveyed.

In far southwest Queensland rainfall in late November 1991 caused a widely dispersed population of adult locusts to aggregate and lay eggs. A visual analysis of the relevant GMS images aided the location of laying swarms and subsequent nymphal bands. In January 1992 adults of the second generation migrated and GMS images were used to help locate their destination.

4. A GEOGRAPHIC INFORMATION SYSTEM FOR CROPPING ACTIVITIES IN THE WESTERN DIVISION OF NSW

The Western Division Resource Monitor (WDRM) acts as a forum to foster collaboration between NSW State government departments and educational institutions interested in monitoring and managing the resources of the Western Division of NSW. The monitoring of cropping activities in the marginal areas in the east of the Division is a high priority for the WDRM. By using satellite imagery as an aid to monitoring cropping, and a Geographic Information System (GIS) to compile a spatial database on fallowing practices and the areal extent of cropping, the resource management activities of the WDRM members are assisted.

The framework for a spatial cropping database has been created in an image analysis system. Data is collected by combining satellite image interpretation information and field observations. A GIS is used for data storage, display and manipulation, and for producing hardcopy maps. Digital and hardcopy outputs are tailored to the needs of WDRM members.

5. APPLICATIONS OF LOW-COST AIRBORNE VIDEO TO AUSTRALIAN AGRICULTURE

A low-cost airborne video system is being developed as a qualitative instrument for agriculture and land management. A user-friendly software interface has been added to a commercially available multispectral video camera system to produce a robust and simple airborne data acquisition system. Acquisition is manually controlled via software in the aircraft while data

storage is onto hard disk and eventually onto DAT tape. Rapid and comprehensive interpretation of the multispectral imagery collected is carried out by an uncomplicated image processing package designed to complement the airborne system. In combination with a radiometric ground data collection program, the system is being trialed in a number of agricultural and environmental applications including cotton crop management, algal bloom monitoring and wheat assessment.

6. CARTOGRAPHIC 3-D FLY AROUND TERRAIN MODEL, MOUNT CANOBOLAS, NSW

The animation process provides the cartographer with a means of visually displaying and exploring real world phenomena, particularly where the data contains spatial and/or temporal interactions, and recognisable sequences of change and variability within environmental and natural resource systems.

In this study, Image analysis and spatial information systems (SIS) were used to create a cartographic 3-D fly around terrain model of Mount Canobolas, New South Wales. Stereo Spot HRV-7 multispectral colour positive transparencies were used to generate a digital elevation model in an analytical plotter (Wild Aviolyt BC2).

Spot HRV-7 multispectral digital data was used to create a land cover classification of ground cover features in a computer with image processing software.

SIS software combined the 3-D elevation model with the land cover classes to produce a 3-D terrain model of land cover features. A series of 3-D terrain models for each two degrees of compass direction were automatically created by the SIS (Arc Info @ aml file) and displayed on the computer screen for recording by a video camera (high frequency). Editing of the 180 3-D terrain model Images provided rotation of the 3-D model.

This research demonstrates the role and value of visualisation in analysis of relationships between landform and land cover displayed on the 3-D fly around terrain model of Mount Canobolas, New South Wales.

7. THE USE OF LANDSAT TM DATA TO MAP REMNANT WOODLAND IN THE CENTRAL WESTERN REGION OF NSW

The Central Western Region of NSW constitutes Australia's oldest inland agricultural lands. The area of around 65,000km² straddles Tablelands, Slopes and Plains and stretches from Lithgow in the east to Lake Cargelligo in the west. A decade ago, using MSS data, we were able to map the remnant woodlands and forests in the region. Approximately 75% of the area has been cleared and the remaining uncleared and/or regrowth areas are in a fragmented island landscape spread over more than 3,500 remnants. Over 90% of these remnants are less than 5km² in area and 30% of the absolute area is on private land. This remnant bushland, particularly on private land, is now a scarce resource both in terms of its conservation values and the implications over-clearing poses for sustainable agriculture in the MDB.

The remnant bushland is now being remapped using TM data in conjunction with the LIC in an attempt to identify the smaller components and the linear features such as are found on waterways, in TSRs and on farm land. Concurrently all remnants in 3 x 1:100,000 sheets (Bathurst, Molong and Bogan Gate) are being 'ground-truthed' to determine conservation values,

map dominant vegetation types and to assess the long-term sustainability of the remnant cover. The project is part of a socio-ecology-extension program in the CWR funded by the WWF.

8. WOODY VEGETATION MONITORING IN WESTERN NSW

Pastoralists and NSW Agriculture advisory staff in the Western Division of NSW have identified woody weed infestations as their major management problem, but the exact extent of the problem had not been adequately quantified.

The project operationally implemented a method developed by McCloy and Hall (1991), to map the distribution and density of woody canopy cover in the Cobar and Bourke districts for two dates, and to monitor changes between those dates using Landsat MSS imagery.

Imagery from 1979 and 1987 for Cobar, and 1980 and 1990 for Bourke, were classified and woody cover change images produced. The change images were divided into classes which highlighted the increases and decreases in woody cover that have occurred in the ten year period for both scene areas. The classified image data were incorporated into EPPI 7, a PC-based Geographic Information System (GIS), along with operational property boundaries, so that for each district, and for individual properties, statistics could be obtained on the amount of land affected by a particular cover class.

Results have been achieved for the Cobar and Bourke districts which will allow advisory staff and pastoralists to gain a regional perspective of the problem. Also the information can be used to improve knowledge of the problem and aid advisory programs, such as identifying properties and paddocks that have conditions of woody weeds requiring the application of various control measures.

9. FROM SPOT TO YOUR BUSINESS

Spot satellite images are available since 1986 and the next generations are already planned for launch. Spot satellite worldwide success is mainly due to its high resolution – 20 meters for multispectral images and 10 meters for panchromatic images – and its ability to provide steady updated data within short deadlines: thanks to its oblique viewing, the same place can be shot every two and a half days on the average.

As an information source, Spot imagery is a useful tool for agricultural management projects. Application fields range from land use assessments, crop monitoring, setting irrigation systems, to the mapping of agricultural potentialities. All of them contribute to supply key information for decisions which have to be taken. As a result, Spot helps you for increasing your productivity, improving your efficiency in managing and, therefore, makes you save a lot of money.

10. VERTICAL AERIAL PHOTOGRAPHY FOR IRRIGATION MANAGEMENT

Project aims

To demonstrate the variation that exists in typically developed irrigation fields.

To combine existing technologies in the areas of aerial photography (false colour infrared, colour and monochrome) image scanning and image analysis into a cost effective management tool for irrigation managers.

To promote this concept throughout the irrigation industry.

Significance

Currently a number of programs are underway across Australia aimed at investigating and improving the productivity of irrigated agriculture. Most of these projects involve work on detailed, specific components of the production equation, for example plant agronomy, soil water relations, weed/insect/disease control etc.

The problem facing the irrigation manager is:-

once we apply these improved technologies to farm scale operations they often do not reflect a very large increase in average yields, but the technology has a cash cost. Many irrigated fields are so variable in themselves; either from soil type, engineering layout or human irrigation operation, there is little chance of achieving great improvements by applying individual improved technologies.

The aim of this aerial photography project was to develop a technique that would allow irrigation managers to evaluate the variability of existing fields. Once the variability map of a field is recognised then a quantitative assessment can be made of the (see attached) limiting factors in the poor areas, leading to increased average yields.

The value of using vertical aerial photography, particularly the false colour infra-red process, has been recognised for a number of years as a technique to identify the variability in agricultural fields. Techniques have been developed for predicting diseases, analysing the performance of centre pivot irrigators, surface irrigation run-off, etc.

Aerial photography in the past has either been a specialised task involving expensive cameras and aircraft, or, amateurs have used 35mm cameras taking shots at various angles out the window. The first method is too expensive for use in agriculture as a routine task and the second method has provided interesting shots but is basically unusable for objective analysis, as there is no control over the scale and angle of the shots.

Project report

The funds supplied by the National Irrigation Research Fund have enabled the development of a viable commercial enterprise that is now able to produce cost effective photographs of individual or groups of irrigated fields. It has been demonstrated from the range of photographs produced so far that there is a huge variability in most irrigated fields. In a large proportion of fields that have been photographed there are areas where productivity is severely reduced, thus reducing average yields significantly.

A system has been developed whereby one person is able to fly an aircraft, take photographs and produce the final enlargement of irrigated fields up to a coverage of approximately 2kms by 2kms. The quality and resolution of these photographs is of a very high standard. Variation in the density of crops can be depicted down to at least a one metre resolution.

Investigation in the international scene indicates that we have technology, and a system, that is not being used anywhere else in the world for this purpose. The significant breakthrough is the ability to produce false colour infrared prints with the normal photographic laboratory equipment

available in country cities.

Previously, infrared photographs have only been available in a positive transparency (slide) form which requires viewing with a projector. The prints produced in this project can be mounted on the wall of the farm office as a continual, visual reminder of the problems to be addressed.

The project has developed into a fully commercial service and is now being provided to the industry to produce photographs of selected fields or sections of farms at a scale requested by the client. The service is also available to provide simultaneous colour and false colour infrared photographs of identical areas.

Images have been scanned and loaded into image processing software. Once a scale reference is included on the photograph, calculating the areas of the various colours is a simple procedure.

An opportunity was taken to hand harvest some sections of a cotton field that had been photographed. As can be seen on the displayed photograph there are bluish areas, khaki areas, small red areas (next to the khaki), and a large section of bright red. The hand harvested areas were taken on a number of one metre row lengths of these different coloured areas and the results in lint/ha and gross margin/ha were calculated. The gross margins were minus \$1,400, minus \$700, plus \$700 and plus \$1,400 per hectare respectively.

One manager has assessed the cost of lost production due to an inefficient tractor operator in one days cultivation work, as several hundreds of dollars.

The manager of a centre pivot irrigation unit found that one of his pivots had been operating with a section of incorrect sprinklers since installation many years ago. The fault was picked up on a false colour infrared print taken when the irrigator was operating on bare soil.

12. SATELLITES FOR FERTILISER MANAGEMENT OF PASTURES: WHERE TO NOW?

Fertilisers represent some 20% of the variable costs for most graziers in temperate Australia, but often they fertilise pastures with little knowledge of how responsive individual paddocks will be. Within farm differences in pasture productivity are a major challenge to managers of improved pastures. Satellite remote sensing and geographic information system (GIS) methods can be used to provide improved fertiliser management. In the context of an annual expenditure of \$200m per year in good seasons, the direct benefits to the industry of a method to map a pasture's responsiveness to plant nutrients, and hence need for fertiliser, would be substantial. There are also national benefits in the areas of reduced land degradation and savings in the import costs of raw materials for the manufacture of superphosphate and from a wiser more tactical use of fertiliser.

The Division of Animal Production has developed ways of using the data from Landsat and SPOT to define which areas of improved pastures are most in need of additional fertiliser. By relating the satellite radiance data to the reflectance characteristics of pastures with known histories of fertiliser treatment it has been possible to develop methods to classify and calibrate data from the satellites. This allows use of the data to map the likely responsiveness of particular areas of improved pastures to additional fertiliser. The research has involved the development of a database system containing farm and paddock boundaries together with local data on roads. The road and boundary data are used as an overlay on the map to allow display and printing of

the processed data for individual properties; fence lines are included to show the fertiliser responsiveness of particular paddocks and to allow reporting on the composition of each paddock to be tabulated on an area basis. The data, presented as colour coded maps, are provided through a personal computer based GIS. Maps produced by this system are being field tested at a number of sites in eastern Australia.

Work to identify a suitable commercial partner for provision of the technology to graziers has focused on developing an appropriate delivery mechanism as none currently exists. After discussions with business and agricultural extension specialists, it appears that the preferred mechanism would be one involving a value adding specialist company to make the maps available to consultants, farm extension groups and individuals. Interest in the pasture growth maps from potential commercial partners and from consultants to the farming and grazing community has been significant and a number of consultants have asked to trial the technology as soon as it is available. Arrangements have been made to provide experimental samples of the maps for individual graziers, to selected farm management and planning groups and to clients of consultants. Several potential companies who might act as value adding companies in the map production process have been identified and negotiations with them have commenced. Work to add more properties to the experimental database is continuing as it is essential that there be a strong potential client base available to offer a potential value adding company if a successful commercialisation is to be achieved.