A Cost-Benefit Analysis of the Variable Rate Defoliation of Cotton in the Namoi Valley, NSW, March to May 2006.

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Abstract

The cost-benefit analysis of 43 fields of cotton defoliated using at least one pass with variable rate chemical application, showed significant benefits for the farmers involved. The average savings in chemicals when compared to what would otherwise have been applied was $11.82/ha. The farmer was able to save, on average, 25% of his chemical bill. In most situations this savings in chemicals more than covered the cost of the Belt-Wide Agriculture service ($10/ha) and left around $4.23/ha in the farmers pocket.

There were a number of non valued costs and benefits arising from the use of this technology. With the variable rate application of chemicals, an increased speed of defoliation was observed (5 days to a week quicker). Four fields were defoliated with one pass defoliation, with a variation in biomass that would have traditionally taken two or more passes. A significantly more uniform defoliation was also observed. An added benefit is the availability at the website of the *Vari-Scout* map for future prescription generations. Furthermore, typically, the variable rate application of chemicals results in less chemical being used, this is good for the environment.

An investment of time is required by the farmer, consultant and grower for the process to work smoothly. Geo-referenced field boundaries are required for the image acquisition. The consultant will need to invest time in learning how to effectively use the scout map. Printed scout maps may be used for ground truthing the image, however ideally a handheld personal digital assistant (pda), gps receiver and mapping software would be used. The cost of these items is generally around $1,600. Internet access is needed by the person who is to access the web site to download the scout map (a five minute task) and later, generate the variable rate prescription (a five minute task). Some time would also be required to set up the specifications on the website of the most likely variable rate applicators. The prescription report will save time for the applicator and grower by specifying for each field, the precise amount of each chemical to be used, the amount of water needed for the application, the number of spray loads, and the cost for each biomass class and each field.

With a relatively small investment of time and money, the farmer and consultant are able to access state of the art field biomass images and variable rate chemical application methods.

Introduction

Variable rate application technology allows chemicals to be applied to a crop at different rates across the paddock. There are a number of steps involved in getting to the point of the actual chemical application, and as time goes on, these steps are becoming simpler and cheaper for the farmer, consultant and applicators involved.

The service used by the 9 farmers involved in this study was provided by the Wee Waa based company Belt-Wide Agriculture, Pty. Ltd. The process initially required the farmers to provide a geo-referenced field boundary, and information on their likely applicators. Belt-Wide Agriculture acquired the images from their multispectral camera mounted in a plane flying at 12,000 feet. The camera has 2 meter resolution and collects data in the green, red and near infra red wavelengths.

These images were converted into *Vari-Scout* maps, (an accurate representation of the relative difference in the crop biomass across the paddock) and made available for downloading from the website within 24 hours of image acquisition. The scout map was used by the consultant to ground truth the image. This involved physically walking into each class of cotton biomass and establishing the precise rate and combination of chemicals for each class.

Prescription generation is done at the web site by identifying which application machinery will be used and entering the data on chemical rates for each class. A prescription is a combination of whatever chemical and rate the consultant specified for each class, linked to a longitude and latitude, and designed to be read by the computer attached to the variable rate machinery being used. The farmer, consultant or applicator can generate the prescription and copy it to a data storage card for insertion into the application machinery when it is time to apply the chemical.

This technology, is owned by the Mississippi (US) based company *InTime*, and has been used commercially for the last 6 years. A significant amount of research into the agronomic and economic value of this technology has been done. Much of this research involves the application of this technology to variable rate plant growth regulators, variable rate insecticides, nematicides and herbicides. A few papers refer directly to the use of variable rate defoliation of chemicals.

Kirkpatrick reported on a three year study on using aerial imagery for variable rate application of cotton defoliants in Mississippi. They found that the images very closely corresponded to the height and biomass of the cotton plants, and that after variable rate application of defoliants, the biggest change in biomass was at the high biomass class, and the smallest change at the low biomass class. This indicated the effectiveness of the variable rate applications (Kirkpatrick, M.T., et al. 2006).

The economic analysis reported from this project found that compared to traditional blanket defoliation chemical application methods, the variable rate application reduced chemical use by 17-18% and maintained the effectiveness of the defoliation (Fridgen, J.J., et al. 2003).

There has been a great deal of research showing the accuracy of correlating the crop canopy and crop biomass with aerial imagery data. Results of this type of research are presented by Holben et al. (1980); Wiegand et al. (1991) and Stewart et al., (1997). Bader (2001) showed that the "site-specific applications of chemical harvest aids compensated for the uneven distribution of plant biomass and unopened bolls that typically occur in a given field" (Kirkpatrick et al., 2003.) The practical use of aerial imagery for interpretation of crop biomass and health, for use in variable rate chemical and fertilizer applications as well as for assessing defoliation efficiency has now been well established.

Materials and Methods

The data for this research was gathered from the records held at Belt-Wide Agriculture for 46 fields in the Namoi Valley. This year 9 farmers used this service to variable rate apply their cotton defoliants to their 2005-6 cotton crop.

The comparisons with the variable rate fields depended upon what would have been the most likely scenario if variable rate application had not been available.

In some cases the class 7 cotton (highest biomass) received what normally would have been applied on the entire field, the lower biomass classes received less than this amount. In these cases the class 7 rates were then used as the comparison for what would normally have been applied.

In other cases the consultant chose to apply very heavy quantities of defoliation on the high biomass areas and very light quantities on the low biomass areas. Because of this, a one pass defoliation was achieved in some situations where it would have been uneconomic to apply the class 7 rate to the entire field. Thus these fields were compared by identifying what the consultant would have normally applied if he had not had the variable application option and comparing it to what was actually applied with variable rates. See table 1 and 2 for the economic assumptions used in this paper.

An *Excel* spreadsheet was used to collate and calculate the cost of the defoliation methods used for each of the fields.

When comparing the costs and benefits of new technology there are often factors which are hard to value, but are important aspects that the farmers and consultants should consider about the technology. The non valued benefits in this study include included: timeliness; increased speed of defoliation; the environmental benefit from decreased chemical use and the option of using the Scout map for future variable rate applications. The non valued costs were primarily associated with the time to become proficient with the system; need for internet access; and if desired, a PDA with a GPS and mapping software. Downloading of the scout map and generation of the prescription would normally take around 10 minutes or less, each.

At the moment there are 5 planes set up for variable rate application of chemicals in the Namoi-Gwydir Valley of NSW, and two ground rigs. The aerial and ground application contract charges remained the same for variable rate application as they are traditionally for ground rate application, therefore the standard contract rates were used for these operations.

Results and Discussion

The results showed an average net benefit for the 45 cotton fields, which had at least one pass of variable rate chemical application. The approximate savings in chemicals when compared to using a blanket rate of the class 7 (or some other traditional uniform chemical application) was $11.82/ha The approximate net savings after the Belt-Wide Agriculture scout map image and service was paid for was $4.23/ha (see Table 3). Overall, the key benefits for the farmer were a savings in chemicals.

The benefit of increased defoliation speed was particularly obvious in the fields which were able to be defoliated in one pass, as opposed to the traditional two pass applications they would otherwise have received. The ability to variable rate chemicals lends itself to applying much heavier rates than would otherwise be applied to the entire field. At defoliation time there are normally areas of the field which are significantly more or significantly less ready than others. By applying much heavier defoliation and boll opener chemicals to less ready, and much lower amounts to the areas more ready, one is able to achieve a very uniform defoliation. The defoliants and boll openers are put to a much more efficient use. By applying less defoliants to the lower biomass areas you are getting less leaf dessication and may reduce the leaf in the picked cotton resulting in a better quality cotton once it has been picked.

Another of the non valued benefits, is the existence of the Scout Map which is permanently available for future prescription generations at no further charges. This map can also be used to make other managerial decisions related to drainage, soil type, fertility and any other factors which may cause biomass variations with the field.

Conclusions

The chemical rate by application area data was collated for each of the 7 classes specified in the variable rate defoliation applications on 45 farms in the Namoi Valley this year. Contract rates for variable rate aerial ($13/ha) and ground application ($10/ha) were used, along with the Belt-Wide Agriculture service charges ($10/ha). Comparisons were made between the costs of the variable rate applications and either the class 7 application rate used across the entire field; or, if more likely, with traditional chemical rates and passes. Overall, the farmers saved an average 25% (or $11.82/ha) on their chemical bills. The net situation, after paying for the Belt-Wide Agriculture service, averaged out at a savings of $4.23/ha.

The non valued costs included the investment of time by the consultant to learn to scout the cotton using the biomass maps, to learn to use the website for scout map download and prescription generation, and the option to invest in a handheld pda with gps receiver and mapping software ($1600). The farmer may also need to invest some time in learning how to use the website. If the wants to use his own machinery, instead of the variable rate aerial or ground rig contractors, then the investment in the tractor gps linked flow controller system needs to be calculated.

The non valued benefits include a quicker and more even defoliation, and the availability of the scout map for future prescription generations. The environmental benefit is linked to the fact that variable rate chemical applications usually result in less chemicals being used on the crop in total.

Generally speaking, it would appear that for a relatively small investment in time and money, the farmer and consultant are able to defoliate the cotton field with speed, simplicity and accuracy. The use of this technology can be extended to any crop where differential application of chemicals would save money and improve the crop husbandry.

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Table 1. Chemical prices assumed

Chemical	Price
Dropp SC	$ 110.00 /L
Dimethoate (Rogor)	$ 5.00 /L
Finish	$ 15.00 /L
Prep	$ 10.00 /L
DC Tron	$ 2.00 /L

Table 2. Contract rates and Aerial imagery and prescription costs

Aerial application cost (contract)	$ 13.00 /Ha
Ground rig application cost (contract)	$ 10.00 /Ha
Belt-Wide Ag cost	$ 10.00 /Ha