DEVELOPMENT OF CLIMATE-BASED COMPUTER MODEL TO REDUCE CROP HARVEST LOSSES IN AUSTRALIA

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INTRODUCTION

Nowadays, Australia is the fourth leading wheat exporting in the world wheat market. In 2005-6, Australia exported 16 million tonnes of wheat to the world which earned around $A 3.54 billion of foreign exchanges for the nation [1]. Most grain in Australia is harvested at lower moisture content than safe storage moisture. As grain dries in the field, losses due to natural shedding and lodging increase. Furthermore, a summer rainfall pattern prevails and causes weather damage when the crop is ripe but not yet harvested.

For instance, the losses of sprouting due to rainfall are at least $30-40 million per year across Australia [2]. Therefore wheat harvest represents a period of high risk and is also a bottleneck in wheat production in Australia. This study aims to develop and apply a Grain Harvest Simulation Model as a potential tool to quantify and test the various management options to effectively manage the risks associated with weather damage at harvesting time. The overall aim of the study is to maximize the economic returns to growers, through maximizing the quality and quantity of delivered grain whilst minimizing annual and long-term financial risks associated with weather damage.

METHOD

A Grain Harvest Simulation Model has been developed in the MATLAB software. The main simulation model is based on a series of sub-models associated with the grain moisture content, the yield losses, the quality losses, the fixed costs and the variable costs in harvesting process (Fig1). A mathematical model in each sub-model was developed. The model has been run and evaluated for a number of case studies, in order to assess the feasibility of various harvesting management options, in particular the economic return of harvesting at high moisture content and drying using aeration. This study is extended to three important grain growing regions in Australia, represented by Goondiwindi (QLD), Tamworth (NSW), and Albany (WA). The weather data for these regions were obtained from Bureau of Meteorology in Brisbane.

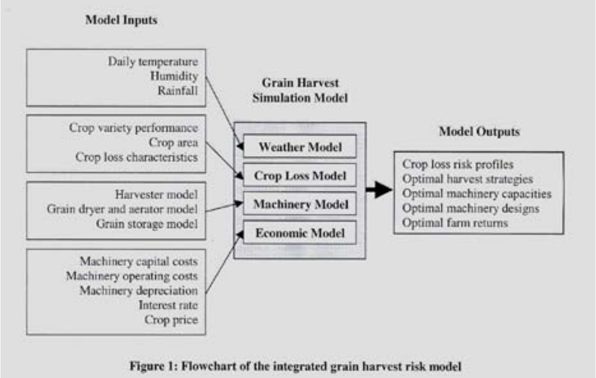

Figure 1: Flowchart of the integrated grain harvest risk model

In the study, available harvesting time for mentioned locations was determined based on recent ten-year historical weather data (1996-2005). This is followed by model sensitivity runs and comparisons for different crop yield losses, quality losses, initial harvest moisture contents, dryers, aerators, and harvester capacities.

Results and discussion

Fig.2 shows the average cumulative frequency analysis for the rainfalls in Goondiwindi (QLD), Tamworrth (NSW) and Albany (WA) between 1996 and 2005.

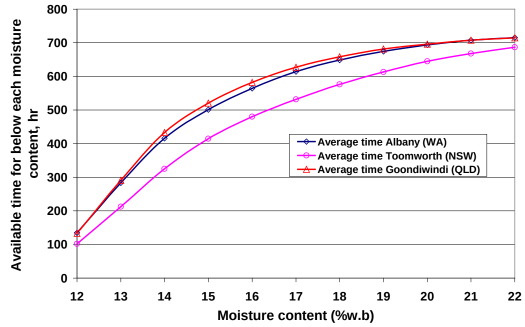

Figure 2. Available operating hours at a given grain moisture content for 3 different places in Australia

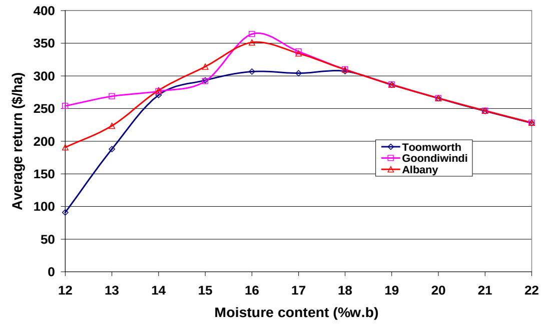

Figure 3. The effect of 3 different locations on average return

It can be seen that the available operating hours for Albany and Goondiwindi is broadly similar but they differ significantly from Tamworth. In fact, based on 10 recent year weather data, the total available time of harvesting in Tamworth is considerably less than the other two locations. This result in the returns for farmers in Tamworth is considerably lower than the other two locations, particularly at the low range of moisture contents. It is also predicted that harvesting at 16% moisture content would produce very good returns for all three locations (Fig.3). However, return is flat between 16 to 18% of moisture contents for Tamworth.

From the simulation model some other results has been found:

1. Local weather conditions/rain pattern and the harvest moisture contents can have a very significant influence on the calculated returns. A drier weather in the harvest season will generally produce better returns for farmers, particularly at the low range of moisture contents.
2. Larger crop area will produce higher returns ($/ha) at any given moisture content. The optimum harvest moisture content also increase as the dryer capacity increases. At lower crop area, the grain can be harvested at higher moisture content (17%) to make better uses of the available dryer capacity.
3. For a large farm, aerators will have a positive impact when the harvest grain moisture content exceeds 16%.
4. For the large farm simulated, the return for batch dryer is much lower, particularly at high grain moisture contents. This highlights the need to have a high capacity continuous dryer to match the capacity of harvester for the assumed farm.
5. Crop yield loss has a very significant impact on farmer’s return, particularly at the lower range of moisture content. In comparison, the impact of crop quality loss is relatively small because the small difference in grain prices received for lower grades in Australia in 2006. It is therefore suggested that if possible, crop yield loss should be measured as accurately as possible.

CONCLUSION

The management of climate risk and climate variability is fundamentally important for Australia. With the aid of computer model, it is hoped that we would be able to determine the best schedule of grain harvesting, increase the efficiency of machinery and energy use, and significantly reduce the grain harvest losses.

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