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Economics of on-farm grain storage and drying

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Abstract. On-farm grain storage and drying is a risk-management strategy used by cropping enterprises to better manage adverse weather and market risks. However, decisions concerning grain handling and storage investment are difficult as there are many factors that need to be considered and most cannot be predicted with any certainty.

This paper outlines the methodology and proposed outcomes of a Grains Research and Development Corporation-funded project that is developing an economic decision-support model to assess the costs and benefits of on-farm grain storage. This decision aid uses quantitative risk-assessment methodology to describe and quantify the risks inherent in grain production, harvesting and marketing which may change with an investment in grain-handling facilities.

The decision-support model:

- calculates on-farm costs of storage and drying facilities
- calculates the net benefits derived from a storage and drying facility on a site-specific basis, dependent upon individual farm management, marketing strategy and seasonal conditions
- provides growers with a quantitative assessment that will give them the knowledge and confidence they need to make the financial and management commitment to on-farm storage.

Introduction

On-farm grain storage is a risk-management strategy used by cropping enterprises to minimise the impact of adverse weather events and variable market conditions. Grain growers in the northern cropping zone often incur serious financial losses due to weather damage and harvesting delays caused by seasonal summer storms. Grain storage and drying capacity potentially enables growers to reduce weather damage to crops at harvest. Storage of grain on-farm can also provide growers with greater marketing options. This is becoming increasingly important in a deregulated market for cereal and pulse grains. In a Grains Research and Development Corporation-funded project, an economic decision aid was developed to analyse the costs and benefits of on-farm grain storage and determine the viability of investment in grain storage, handling and drying facilities.

The capital costs required for a storage facility are determined by describing the type and size of the facility and then obtaining quotations for the construction and set-up. However, determining the benefits gained from an on-farm storage and drying facility can be quite difficult, especially when faced with variable seasons and markets. A storage facility may provide little benefit during dry seasonal conditions at harvest time, but can pay for itself quite quickly if wet harvest conditions are experienced in the years following construction.

The benefits derived from a storage facility are site-specific and dependent upon the individual grower's farm management and marketing strategy, together with the seasonal conditions encountered after the investment has been made. Assessment of these benefits requires an economic methodology that can be tailored to an individual farm and efficiently captures the full range of possible outcomes that a farmer may encounter.

The grain-storage economic-decision model determines the profitability of a storage investment and estimates the risk profile on an individual farm basis.

Determining the benefits

In the northern grains region, much of the crop quality losses are attributable to weather damage, as winter grain crops are being harvested when seasonal summer rainfall and storms are commencing.

On-farm storage and drying capacity provides benefits at harvest by:

- allowing the harvest of grain earlier in the season at higher moisture content
- allowing harvest to begin earlier and continue later on each available harvest day
- preventing a loss of grain quality due to weather damage
- avoiding losses from shedding and lodging

- allowing additional time to prepare for a subsequent crop—an opportunity that may have been lost without drying and storage capacity
- optimising grain yield.

The model determines these benefits by comparing the expected crop yields and prices of a farm 'with' and 'without' on-farm storage facilities.

On-farm grain storage and drying capacity can provide postharvest benefits in grain management and marketing by:

- enabling marketing into postharvest periods that may have price premiums
- allowing blending to reduce downgrading losses from high moisture, screenings and/or low protein levels
- allowing grain segregation to meet specific quality specifications
- providing the grower with much more control of grain marketing
- creating marketing opportunities by the ability to hold grain and sell in the future at higher prices, or forward contract and deliver at a designated time in the future.

The model accommodates the benefits that a farmer expects to gain from better grain management and marketing after harvest.

The benefits described above are possible to achieve with storage and drying facilities, but it is important to note that the management applied to the system is critical. The appropriate use of drying and storage will require a change in harvest management and marketing practices in order to achieve the benefits that will make storage a viable investment.

The model calculates all the benefits, the operational costs and the capital costs associated with the storage facility in a discounted cash flow analysis to determine the viability of an investment in on-farm grain storage. Discounted cash flow analysis is a method of financial analysis used throughout the financial world to measure the net benefit of projects that have large initial capital outlays followed by a stream of variable costs and benefits extending over a number of years. The assessment criterion used for viability is net present value (NPV), which is the sum of the negative and positive cash flows, discounted at a nominated discount rate, over the life of the investment.

A positive NPV means that an investment is viable at the prescribed discount rate and over the period of time determined as the life of the investment.

Risk analysis

The model uses risk analysis methodology to capture and describe the possible, but unpredictable, variation that exists in yields and prices due to seasonal conditions and market fluctuations. This is achieved by incorporating the expected range of possible outcomes for each of the variables used in the analysis and applying probabilities of likely occurrence. For each of the variables in the 'with' and 'without' storage cases, a cumulative distribution is used (see Table 1).

In the example in Table 1, the cumulative distribution of the crop yield is described as follows:

- the minimum possible yield is 0 t/ha (note: the model identifies and takes into account non-economic yields, i.e. yields that have a value less than the cost of harvesting)
- a poor yield is 1 t/ha and the probability of getting 1 t/ha or less is 20%
- the most likely yield is 2.5 t/ha and the probability of getting 2.5 t/ha or less is 60%, thus the probability of getting over 1 t/ha and less than 2.5 t/ha is 40%
- a good yield is 3 t/ha and the probability of getting 3 t/ha or less is 80%, thus the probability of getting over 2.5 t/ha and less than 3 t/ha is 20%
- the maximum yield is 3.5 t/ha, thus the probability of getting over 3 t/ha and less than 3.5 t/ha is 20%
- the expected value is the mean value of the distribution.

Table 1. An example of input data for crop yield.

Yield	Tonnes/ha	Cumulative probability (%)
Minimum tonnage	0	0
Poor tonnage	1	20
Most likely tonnage	2.5	60
Good tonnage	3	80
Maximum tonnage	3.5	100
Expected yield	2.0	

The yield amounts and the probabilities used to define the distributions can be varied according to the perceptions of the model user. Figure 1 provides the distribution of the example yield as described in Table 1.

The model uses random sampling techniques to define the distribution from each of the variables where a cumulative distribution has been used as illustrated in Figure 1. The distributions of variables can also be correlated either positively or negatively, depending on the relationship between the variables. For example, if the price of wheat is high, it is expected that a positively correlated product would also have a high price at the same time. If one variable is high while another is low, then a negative correlation exists.

The model does two analyses simultaneously. Firstly, it calculates the mean NPV based on the expected values (or mean values) of each of the variables used throughout the model. The example illustrated in Figure 2 shows that the mean or expected NPV is $42,500, which suggests a viable investment. Secondly, the model provides a distribution of the combined NPV as illustrated in Figure 2. The combined NPV is derived by randomly sampling each of the variables according to their cumulative distribution in a simulation that re-calculates the spreadsheet a

designated number of times (usually 2000). Each recalculation represents a different possible outcome for the investment scenario. All of the outcomes are sorted from largest to smallest and graphed to indicate the final combined NPV distribution. The risk analysis methodology uses values from the cumulative distributions for each of the variables to evaluate the overall riskiness of the investment.

The data generated by the simulation allow the estimation of a range of statistical data, such as the mean ($42,500), standard deviation, maximum and minimum NPVs as well as an estimate of the probability of obtaining a negative NPV. These are key considerations when assessing the viability of an investment.

Figure 2 provides an example distribution of the NPV for a storage investment. It shows the mean NPV but it also shows the possible minimum (–$248,000) and maximum ($550,000) NPVs and the probability of achieving any NPV between these extremes. The critical NPV value for an investment decision is the probability of achieving a negative NPV, as a negative NPV means that the investment is not viable. From the example in Figure 2, it can be seen that the probability of achieving a negative NPV is 44.5%, which demonstrates the degree of riskiness that this investment entails.

The full distribution of the NPV with the accompanying probabilities provides more information for the decision-maker than calculating an average or expected return for the investment. From this sample analysis, it can be seen that this investment has a 44.5% chance of achieving a negative NPV, which means it has a 44.5% chance of not being viable, based on the figures and probabilities fed into the model.

The example described here is not a representative outcome of the viability of storage investments. It is an example to demonstrate the use of risk analysis in storage investments. The model is designed to be used on an individual-property basis, and as such could have completely differing outcomes of each farm's investment analysis and risk profile.

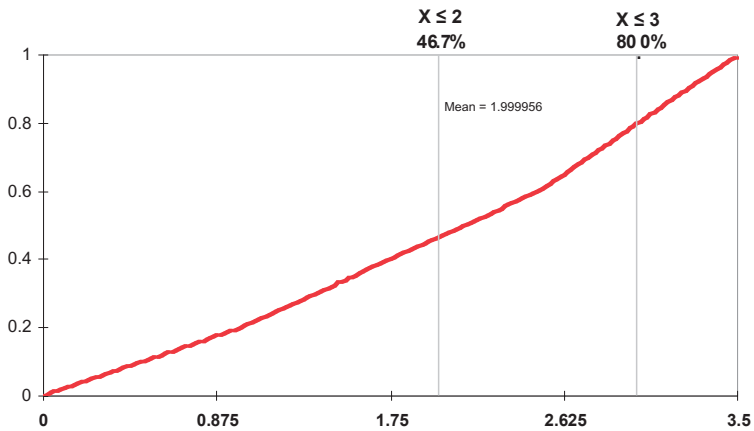

Figure 1. Distribution of the yield variable as described in Table 1.

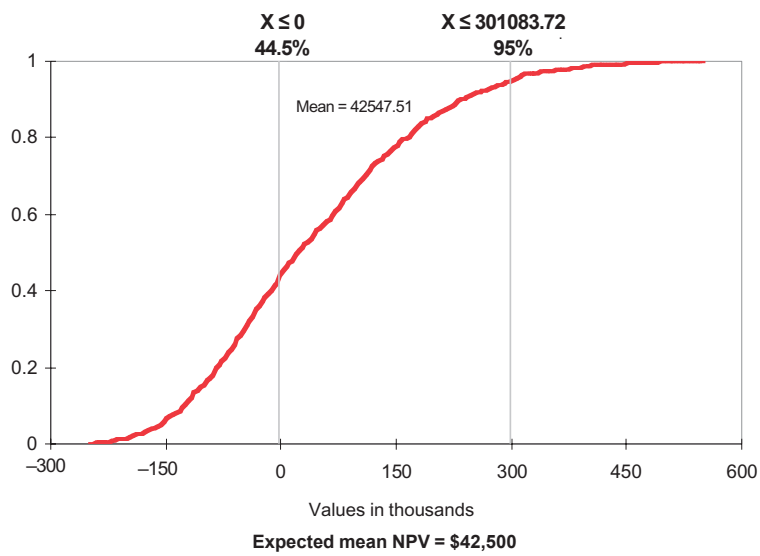

Figure 2. Distribution for the combined net present value (NPV).

Conclusion

The methodology used in this model gives a better feel for the overall viability of grain storage and drying investment, as it provides an understanding of the full range of possible outcomes as well as a quantitative assessment of the risks involved. It also offers a succinct summary of viability in its estimate of mean, maximum and minimum NPV as well as an estimate of the probability of the project being unviable. This is vital information for decision-makers seeking the best information they can obtain to help them make difficult management and investment decisions, especially in a business sector that is characterised by seasonal and market variation.

However, the key to the success of investing in on-farm storage capacity is the management applied to the system. It is pointless investing in on-farm storage capacity if the benefits are not achieved. Storage and drying of grain requires appropriate and diligent management. If poorly managed, substantial losses may be incurred from overheating grain, and mould or insect infestation.