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A COMPUTER BASED DECISION AID FOR SUNFLOWER, SORGHUM AND WHEAT

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SUMMARY

Farmers need to manage production risk effectively. This requires quantification of climatic risk to production and needs to take account of major environmental variables such as rainfall and temperature. A computer based decision support system (DSS) is under development in Queensland (Australia) which provides the information necessary to make better informed decisions. The DSS is based on output from dynamic simulation models for sunflower (QSUN), sorghum (QSORG), and wheat. Using longterm, daily climatic data these simulation models are used to produce yield estimates and probability distributions for various locations, soil types and soil moisture conditions.

Users are required to supply their own, site specific information on location, soil type, depth of wet soil, growing and marketing costs and expected prices. Based on these inputs users are provided with probabilistic estimates of yields and gross margins.

The DSS can be used to examine yield and gross margin estimates for (a) a single crop at a particular time, (b) a crop planted now compared to the same or an alternative crop planted some time in the future and (c) two competing crops planted at the same time.

INTRODUCTION

In dryland cropping systems grain producers need to be well informed in order to manage their production risk effectively. In northern Australia, well-defined, crop specific planting windows exist. Within these planting windows likely yield outcomes are well quantified, based on long-term practical experience and extensive experimentation, providing a sound basis for the decision making process. However, outside these windows relatively little information is available, resulting in decisions being made without objective knowledge of the climatic risks involved. Frequently, growers are faced with planting rains outside conventional planting windows and/or sub-optimal soil moisture conditions. They must decide whether to take advantage of such planting opportunities and if so which crop might yield the higher returns. They must also consider whether greater returns could be achieved by waiting for another planting opportunity when an alternative crop could be planted.

For such circumstances, simulation analysis can provide a suitable tool to quantify production risk (e.g. Meinke and Stone, 1992; Meinke et al., 1992). However, extending the outcome of such simulation models to producers in a suitable manner is difficult and frequently unsuccessful.

The challenge is to present general but complex, scientific information in a form which is relevant to individual producers (i.e. location specific), appealing in its presentation but without unnecessary complexity. Field Crop Decision Aid (FCDA) is a computer based decision support system designed to provide the interface between research (in form of simulation analysis), extension and production.

PROGRAM DESCRIPTION

The program FCDA is currently under development in Central Queensland, Australia, to provide extension staff and producers with the information necessary to make well informed management decisions. It focuses mainly on the area of crop selection and exploitation of planting opportunities. The DSS is based on the output from crop simulation models for sunflower QSUN (Chapman et al. 1992), sorghum QSORG (Hammer et al. 1991), and wheat (Hammer et al. 1987). These models were run with long term, daily climatic data to produce yearly yield estimates for various soil types and starting soil water conditions. The yield estimates are processed to produce yield probability distributions which provide the database accessed by FCDA. Based on user supplied inputs, the program provides probabilities of exceeding given levels of yield and gross margin, thus allowing the user to objectively compare alternative management strategies.

Depending on user preferences, all information is presented in either interactive, graphic format, with explanatory notes on the graphs or as tables. Context sensitive help information is also available on request. Users are required to supply their own, site specific information on location, planting date, soil type, depth of wet soil, crops to be considered, growing and marketing costs and expected prices. This information is entered onto the Main Form (Table 1). The program then matches this user supplied information with the most appropriate dataset from the database and displays either yield or gross margin information in probabilistic form. This allows users to assess either a range of possible outcomes or the likelihood of a specific outcome (e.g. target yield).

Specifically, the system can be used to examine and compare likely yield and gross margin estimates for:

(a) a single crop at a particular planting opportunity,

(b) a crop planted now compared to the same or an alternative crop planted at a future planting opportunity and,

(c) two competing crops planted at the same time.

Once the farm specific parameters are set, the following information is available form the program:

(a) yield/gross margin outcomes and comparisons for given crops (sorghum, wheat or sunflower), locations, soil types and planting dates,

(b) yield/gross margin expectations for these crops for future planting dates.

Table 1: The FIELD CROP DECISION AID Main Form

```
CQ Field Crop Decision Aid
--> 1. Location                          :  Emerald
    2. Planting Date                     :  15/02

    3. Soil type                         :  Deep open downs
       Effective rooting Depth           :  1000
    4. Depth of wet soil                 :  1000mm
       Available Soil Water                 150
    5. Crop                              :  Sorghum
       > Yield Crop
       > Mean Yield over time
       > Residual soil water
    6. Costs and Returns                 :  updated 15/2
       > Cost and Return probabilities
       > Cost and Return Over Time
    7. Alternate Crop                    :  Sunflower
    8. Alternate Planting Date           :  15/02
       > Yield comparison
       > Mean Yield over time comparison
       > Residual soil water comparison
    9. Alternate Crop Costs and Returns:    updated 15/2
       > Cost & Return Comparison
       > GM comparison over time
                                                        The End

                     Select the nearest location
F1 Help                                                    Esc Exit
```

The program FCDA is designed so that all parameters are accessible from the Main Form. With the exception of date entries, options are entered onto the Main Form by selecting items from "pop-up" menus. Output is provided in form of interactive probability graphs or textual tables that are displayed in a window over the Main Form. In this paper, reproductions of the text based tables are used to display program output.

A CASE STUDY

For this case study, a grain grower in Emerald, Central Queensland, Australia, compares sorghum and sunflower, both planted on 15 February. It is assumed that a planting opportunity has occurred on this date and that the soil profile is a "deep open downs" soil (a profile typical for the area) with a plant extractable soil moisture content of 150mm. Table 2 shows the yield probabilities for a sorghum crop grown under these specified conditions. In 50% of years a sorghum yield in excess of 1.3 t ha^{-1} can be expected. There is at least a 90% chance of exceeding 0.9 t ha^{-1} and a 10% chance of exceeding 3.2 t ha^{-1} (Table 2). The next option then provides information about the yield expectations for future planting times (Table 3).

Table 2: Yield estimates for sorghum grown at Emerald on 15 February on a soil with 150mm plant extractable soil moisture

Crop Yield

Probability of Exceedance (%)	Yield (tonnes/hectare)
90%	0.9
80%	1.0
70%	1.1
60%	1.2
50%	1.3
40%	1.5
30%	1.7
20%	2.4
10%	3.2

Press [G] to view graph, [F2] to print, [Esc] to exit

Table 3: Yield expectations for sorghum for future planting times

Yield over time

Day of Planting	Yield (tonnes/hectare) Probability of exceeding 70%	50%	30%
01-January	1.2	1.9	2.7
15-January	1.1	1.5	2.2
01-February	1.1	1.4	2.0
15-February	1.1	1.3	1.7
01-March	1.1	1.3	2.1
15-March	0.0	1.3	2.1
01-April	0.0	0.0	0.0
15-April	0.0	0.0	0.0
01-May	0.0	0.0	0.0
15-May	0.0	0.0	0.0
01-June	0.0	0.0	0.0
15-June	0.0	0.0	0.0
01-July	0.0	0.0	1.0
15-July	0.0	0.0	1.1
01-August	0.0	0.9	1.3
15-August	0.9	1.3	1.6
01-September	1.0	1.2	1.6
15-September	1.0	1.3	1.6
01-October	1.0	1.2	1.6
15-October	1.1	1.4	2.0
01-November	1.2	1.5	2.1
15-November	1.4	1.9	2.5
01-December	1.4	1.9	2.5
15-December	1.3	1.9	2.7

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Table 3 shows that yield potential for sorghum has already peaked in December and is now declining. This indicates that the optimum planting time for sorghum has passed. The grower now faces the question of whether there is a more profitable alternative to growing sorghum. A yield comparison with sorghum and the alternative crop, sunflower, then shows that in 50% of years sunflower is expected to yield slightly less than half of the expected sorghum yield (Table 4).

Table 4: Yield comparison between the sorghum and the sunflower option

Yield Comparison

Probability of Exceedance (%)	Yield (tonnes/hectare)	
	Sorghum	Sunflower
90%	0.9	0.5
80%	1.0	0.5
70%	1.1	0.6
60%	1.2	0.6
50%	1.3	0.6
40%	1.5	0.7
30%	1.7	0.8
20%	2.4	0.9
10%	3.2	1.7

Press [G] to view graph, [F2] to print, [Esc] to exit

An economic analysis is needed to thoroughly evaluate the two options. The "Cost and Return" options from the Main Form provide a detailed spreadsheet for each crop (spreadsheet forms not presented). Expected on farm commodity prices and all variable costs associated with the particular cropping option are entered and a gross margin ($ ha^{-1}) is calculated. Gross margins at each probability level are then compared for the two alternative cropping strategies (Table 5).

Table 5: Gross margin comparison between sorghum and sunflower at a range of probability levels

Gross Margin Comparison

Probability of Exceedance (%)	Gross Margin ($/Ha)	
	Sorghum	Sunflower
90%	-12.73	-2.62
80%	0.64	10.52
70%	12.94	17.72
60%	19.90	29.87
50%	34.34	40.04
40%	*53.60*	*56.40*
30%	81.96	75.75
20%	149.37	112.95
10%	239.25	308.62

Press [G] to view graph, [F2] to print, [Esc] to exit

This allows an assessment of the level of risk involved with each alternative strategy. Producers are now able to assess the impact of the effect of both, better than average outcomes and worse than average outcomes, on their business. Table 5 shows that with the assumed price and cost structure of the enterprises, sunflower could achieve a higher monetary return up to the 40% probability level (i.e. in 60% of years), but in some years sorghum would provide a slightly better return. This advantage over sunflower can, however, only be expected in 20% of all years. In this case study, it appears that sunflower is the safer and more profitable option.

DISCUSSION

The program FCDA provides a tool to objectively compare alternative farming strategies and thus aid producers to make decisions prior to planting a crop. Specifically, FCDA can assist in:

(1) the comparison of yield and gross margin outcomes for a given crop (sorghum, wheat, sunflower), location, soil type and planting date,

(2) quantifying yield expectations over time which allows an assessment of the risks involved with opting to wait for a subsequent planting event,

(3) comparing alternative crops "competing" for the same planting opportunity,

(4) deciding whether to plant now or wait and plant the same crop or an alternative crop at a later planting opportunity.

This study shows how simulation modelling can provide information for situations for which little other information exists and would be difficult to obtain in any other way. This can provide valuable support to decision makers faced with risky choices. Generated yield probabilities combined with a gross margin analysis allows financial assessment of likely outcomes and the risks involved with particular strategies. The appropriate risk level depends largely on the financial situation of the farming business (e.g. cash flow) and the personal preferences of the farm manager (e.g. level of risk aversion). The information provided by FCDA will allow better informed farming decisions than could otherwise be made. Potential improvements would be the incorporation of varietal and nutritional options as well as long-range climatic forecasts.

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REFERENCES

Chapman, S.C., Hammer, G.L. and Meinke H. 1992. A crop simulation model for sunflower. I. Model development. *Agronomy J.*, in press.

Hammer, G.L. and Muchow, R.C. 1991. Quantifying climatic risk to sorghum in Australia's semiarid tropics and subtropics: model development and simulation. In: Climatic risk in crop production: models and management for the semiarid tropics and subtropics. R.C. Muchow and J.A. Bellamy (ed.), Wallingford, UK, 1991. p.205-232.

Hammer, G.L., Woodruff, D.R. and Robinson J.B. 1987. Effects of climatic variability and possible climatic change on reliability of wheat cropping - a modelling approach. Agricultural and Forestry Meteorology, 41:123-142.

Meinke, H. and Stone, R. 1992. Impact of skill in climate forecasting on tactical management of dryland sunflower - a simulation study. These proceedings.

Meinke, H., Hammer, G.L. and Chapman, S.C. 1992. A crop simulation model for sunflower. II. Simulation analysis of production risk in a variable sub-tropical environment. *Agronomy J.*, in press.