Sowing decisions and soil water

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For the coming season in northern NSW's Nyngan district, the APSIM crop simulation computer model is used here to determine the long-term effects on financial returns of different soil water levels (SSW) at planting. APSIM – short for Agricultural Production Systems SIMulator – was developed to provide farmers, advisers and researchers with accurate predictions of crop production under variations in climate, genotype, soil and management strategies. In other words, to help manage risk.

Four rotations of four-year lengths were tested. A wheat/wheat/wheat rotation that is widely used in the district was simulated using a range of soil water 'trigger points'. In turn, the decision point for the range of trigger points is assumed to occur at the start of the second wheat crop when three alternative scenarios are created:

- Skip the second wheat and long fallow to sorghum then long fallow to wheat;
- Skip the second wheat and long fallow to sorghum then long fallow to chickpea; and,
- Skip the second wheat and go through an extended fallow to another wheat crop two years later then a short fallow to wheat.

Background to the simulations

- All the rotations end with a short fallow to wheat in the fourth year.
- For each rotation, the simulations ran for four years with the starting date progressing in one year steps for 113 starting dates. The average yields and gross margins were the averages of these 113 four-year runs with the tested soil water trigger set for each of those years. In other words, each possible season type after the decision point with its soil water trigger was included in the analysis.
- The hypothesis was that starting with low soil water could cause the second wheat crop to have low yield, using the available water then cause the next crop to also suffer a lowered yield. The alternative was long fallow to sorghum (then either wheat or chickpea) or an extended fallow

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APSIM crop modelling outputs for the Nyngan district indicates:

- Potential grain yield is increased with more stored soil water at planting;
- Waiting for a full profile may reduce crop frequency and returns;
- A wheat/wheat/wheat rotation works well if stored soil water is more than 50 mm;
- If soil water is less than 50 mm, consider an 'extended' (18-month) fallow to wheat; and,
- Long fallow to sorghum is not profitable in the long term.

TABLE 1: The rotations examined

Year 0	Year 1	Year 2	Year 3	Year 4
	Decision point			
Rotation 1: Wheat and chickpeas on short fallows				
Fallow wheat	Fallow wheat	Fallow wheat	Fallow wheat	Fallow wheat
Rotation 2: Introducing sorghum into the winter crop rotation				
Fallow wheat	Fallow fallow	Sorghum fallow	Fallow wheat	Fallow wheat
Used to test if there is a financial advantage of introducing long fallow sorghum. Long fallow wheat follows.				
Rotation 3: Includes wheat, sorghum and canola				
Fallow wheat	Fallow fallow	Sorghum fallow	Fallow chickpea	Fallow wheat
Used to test if there is a financial advantage of introducing long fallow sorghum. Long fallow chickpea follows.				
Rotation 4: Includes wheat and an 'extended' fallow				
Fallow wheat	Fallow fallow	Fallow wheat	Fallow wheat	Fallow wheat

to wheat.

After the decision points, the water was accumulated using ASPIM from the rainfall file. The subsequent crops were planted annually on set dates of:

- Wheat – May 1;
- Chickpea – June 15; aqnd,
- Sorghum – October 1. Other parameters are listed in Table 2.

Soil water trigger points

Soil water trigger points from 18 mm to 180 mm in 18 mm increments were tested. The soil water triggers referred to the total amount of water in the full 1.5 m depth of soil. The total soil water-holding capacity was 180 mm.

It needs to be remembered that no effects of weeds, diseases or frosts are taken into account in the modelling process.

An extended (18-month) fallow to wheat was created followed by a short fallow to wheat, then a short fallow to wheat.

SIMULATION RESULTS

If the soil water triggers are greater than approximately 50 mm, the standard winter-to-winter crop rotation (Rotation 1) gave the highest gross margin (Figure 1).

This was a result of the shorter fallows and the higher cropping frequency.

With soil water quantities of less than 50 mm at the decision point, the optimum rotation is the 18 month extended fallow to wheat (Rotation 4).

Rotations 2 and 3 which included a long fallow to sorghum, were less profitable than the winter-to-winter rotation (R1) and the extended fallow (R4).

This was caused by the lower cropping frequency and the relatively lower yields for sorghum and chickpea

Lower returns from Rotation 2 are evident at all soil water trigger values. The

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combination of the lower cropping frequency, lower yields from chickpea than canola and the higher costs from chickpea compared to canola, combined to reduce gross margins.

TABLE 2: Modelling set-up parameters

	Wheat	Sorghum	Canola	Chickpea
Sowing time	1 May	1 Oct	20 April	15 June
Maturity type	Sunvale	Buster	Hyola 50	Jimbour
Plant density (pl/m^2)	60	3.5	25	30
Typical soil N at sowing	250	250	250	250
Total variable costs (Longfallow/ Shortfallow)	175/150	235	211	290/256
Typical grain price ($/t)	224/212	200	495	500
Typical harvest moisture	11	12	6	12
Seed costs ($/kg)	0.6	9	14	1.6
Rainfall needed to sow/days	Always plant	Always plant	Always plant	Always plant

Crop	Price ($)	Variable cost ($/ha)
Long fallow wheat	224	175
Short fallow wheat	212	150
Long fallow chickpea	500	290
Short fallow chickpea	500	256
Long fallow sorghum	200	235
Long fallow canola	495	211

In-crop rainfall and stored moisture

Rainfall in most regions is widely variable and results in a wide range of yields. At Nyngan, the simulated yield of wheat varies from one tonne per hectare to four tonnes over the 100 years of weather records.

For a Nyngan district soil of a set plant available water holding capacity (PAWC) of 150 mm for example, refilling to different quantities affects the potential grain yields (Figure 2).

The range of subsequent yields is a result of the in-crop rainfall. So more stored soil water results in a higher yield potential for an equivalent amount of rain.

But in any particular year, high in-crop rain may override a poor start (low starting soil water) and vice versa.

Effect of PAWC – the 'bucket size'

A deeper soil with a higher PAWC when refilled to capacity, will obviously have a greater yield potential mainly because of the greater quantity of water available at planting.

But separate to this, a deeper soil can have an additional benefit in the ability to accumulate more water as rainfall occurs during crop growth.

A deeper soil also has a slightly greater yield potential in some years when rainfall can be accumulated that would otherwise run-off a shallower soil.

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GRDC RESEARCH UPDATES: NORTH

Howard Cox and other leading researchers and agronomists will be presenting to northern region growers their latest research advice and cropping strategies for 2010 at – Wellington: Feb 22; Nyngan: Feb 23; Gunnedah: Feb 25; Moonie: March 1; and, Mungindi: March 2. Contact John Cameron on 02 9482 4930 or E: updaten@tpg.com.au

FIGURE 1: Gross margins of the four rotations as a function of soil water at the decision point. Each point is the average annual gross margin in the four years following the decision and incorporates 113 four-year periods commencing 1890

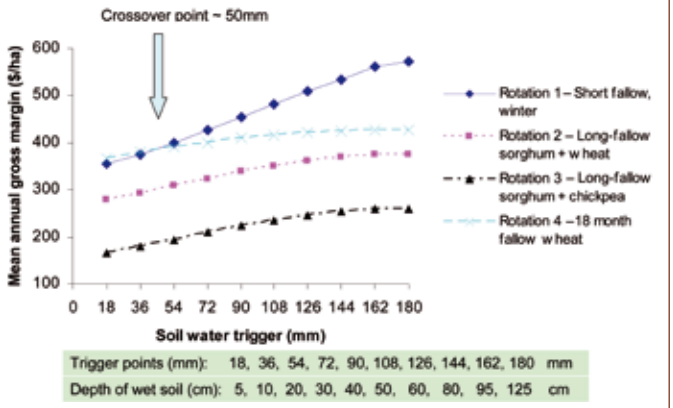

FIGURE 2: The effect of the quantity of stored soil water on the magnitude of the yield range for wheat at Nyngan planted May 15 every year. Assumptions are a 2/3 full soil water profile on a 150 mm PAWC soil, with non-limiting N supply