Frequently asked questions about soil water & fallow in the Liebe area

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Introduction:

In the northern wheatbelt of WA rainfall is our main limiting factor. Farmers are continually trying to conserve water and use it as efficiently as possible. In this document we have provided information to help farmers consider the risks and benefits of fallow, summer spraying and other soil water considerations.

We have tried to answer some of the frequently asked questions regarding soil water, fallow and summer spraying using on farm trial data and the APSIM computer modelling.

APSIM is a computer model which simulates crop growth based on historic climate data. The model uses soil type, water, nitrogen and temperature to determine how the crop grower and final yield. Numbers input into the model is based on previous field experiments and plant research. The model cannot take into account weeds or disease. Field trials in the Liebe area have shown the model is accurate when used appropriately.

The computer model uses real rainfall and temperate records from 1900 to 2010 in Dalwallinu and Perenjori to predict yield outcomes.

This study has focused on how soil moisture impacts grain yield after a fallow or summer spraying, it does not consider other agronomic or economic factors such as machinery costs, weed control or logistics.

This research has been conducted by Dr Yvette Oliver at CSIRO and Nadine Hollamby at the Liebe Group with funding from the Grains research and development corporation (GRDC) project LIE00006.

How much water can my soil hold?

The answer depends on your individual soil type but you can use Table 1 as a guide. Soil can actually hold more water than is available to the plant. Plant available water holding capacity is the term used to explain how much of the water within the soil is available to a crop. Table 1 is a general guide, individual soils will vary. Soil constraints such as an acidic layer or a compaction layer will reduce plant available water because the roots can't go as deep into the soil profile.

Table 1: Plant available water holding capacity of four representative soils from the Liebe area.

Soil type	Plant available water holding capacity (mm)
Poor sand (acidic or shallow)	40mm
Good sand	90mm
Loam	119mm
Clay	189mm

How important is summer rainfall to final yield?

Summer rainfall contributes to stored soil moisture. Having stored soil moisture prior to seeding gives a yield benefit in one out of three years. Having stored soil moisture at seeding helps in growing seasons when rainfall is less than 210mm and when the rainfall pattern does not meet crop water demand.

Figure 1: Rainstorm in December 2011, Wubin.

Is there an easy way to estimate stored soil moisture at seeding?

Below is a calculation based on rainfall that can be used and based on computer modelling is accurate for the Liebe area.

(January to April rainfall ÷2) -10mm = approximate soil water

For example if you had 30mm of rainfall between January and April, 5mm of that could potentially be stored for the plant to use.

E.g. (30÷2)-10 = 5mm

This number is the maximum potential water available to plants. However, keep in mind the maximum a soil can hold is determined by soil type and constraints like acidity. For example a poor acidic sand will never be able to store more then 40mm (Table1).

If I flatten my stubble will I save more water?

No, trial data from the Liebe area and computer modelling shows that flattening stubble will make less than 5mm of difference in stored water compared to standing stubble.

Figure 2: Trials were conducted at Wubin and Buntine on sands and clays, none of the sites showed a yield difference after flattening stubble.

On a hot summers day, how much of my soil moisture is evaporating?

5-10mm per day if surface is wet from recent rain. However, if the water is stored deep below the surface (below 20-30cm) it is protected from evaporation.

How much moisture are my summer weeds using?

If you don't manage summer weeds you could lose on average 10mm of your stored soil moisture over the whole summer. However this can range from 0-60mm depending on your weed burden, germination events, the time weeds remain alive and soil type.

Figure 3: Liebe Group R&D Coordinator Clare Johnston trialling summer weed control options at Goodlands, 2012.

Is spraying summer weeds to save water a good investment?

To answer this question you need to compare the cost of spraying to grain yield. The previous question outlines that not controlling summer weeds will result in the loss of 10mm of soil water. So what is that 10mm worth in grain yield? Start by working out your water use efficiency.

Step 1: Water Use Efficiency
Yield (kg/ha) ÷ GSR rainfall = Water Use Effciency kg/ha/mm
Example: 2000 kg/ha ÷ 180mm = 11 kg/ha/mm
You can use water use efficiency for a specific paddock or farm averages. Average for wheat in the Liebe area ranges from 10-15 kg/ha per mm of rainfall.

Step 2: Work out what 10 mm is worth in terms of grain yield.
Multiply 10mm by water use efficiency.
Example: 10mm x 11 kg/ha/mm= 110 kg/ha
So 10mm may give an extra 110 kg/ha of grain in a third of years.
Why only a third of years? Our research suggests that stored soil water only increases yield in 1 out of 3 years.(See page 3)

Step 3: Work out the value of 110 kg/ha of grain
If wheat is worth $270/t and you can now produce a 2 t/ha crop rather than 1.89 t/ha crop, that is an extra $29/ha. If your summer weed control costs less than $29/ha it could be considered a good investment for that year. However, the water loss from weeds depends on factors such as weed density and germination events over summer, so that the loss of stored soil water can vary from 0-60mm. Stored soil moisture only increases yield when growing season rainfall is low and poorly distributed (about a third of years) and you can't predict how much rain will fall in the upcoming season.

It is also worth noting that this equation does not take into account other reasons for spraying summer weeds such as ensuring melons don't get tangled in the bar during seeding.

Why can't I do a long fallow (18 months with no crop) on my sandplain?

If weed or disease control is the aim fallow is an option but if you are trying to get a yield benefit by storing more water, a sand is not as responsive as a clay. On sandplain the opportunity cost of not growing may be greater than the yield benefit of fallow.

Sands have a low ability to store moisture (in our modelling we used sands with PAWC of 90mm) compared to a clay (which in our modelling has a PAWC of 189mm). Figure 4 shows that on average clay will have an extra 62mm stored after a fallow, whereas a sand will have an extra 39mm. The clay can store more water over the fallow and therefore has a greater potential to produce more yield in the following wheat crop, particularly if growing season rainfall in the year after fallow is low (<210mm) and summer rainfall is low (<100mm).

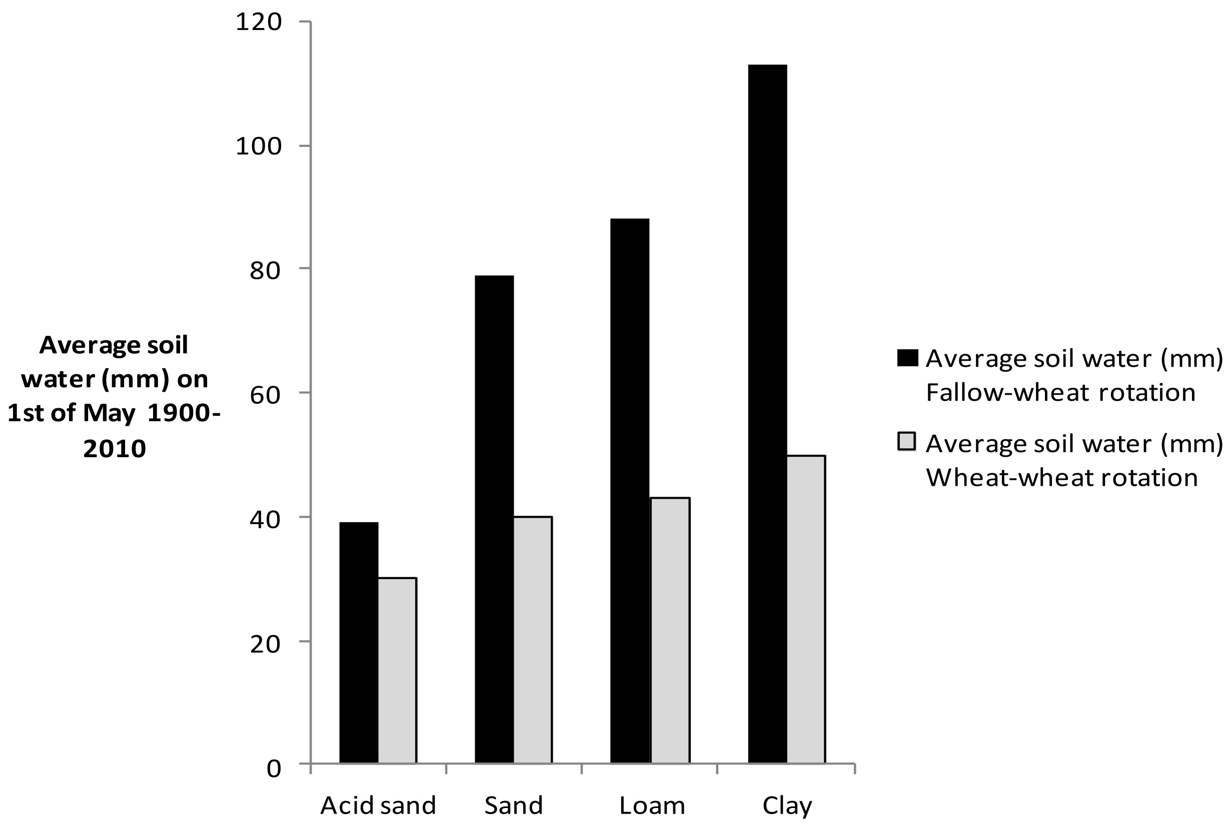


Figure 4: Average soil moisture (mm) for fallow/wheat and wheat/wheat rotations as of 1st of May according to computer simulation using Dalwallinu's rainfall from 1900-2010 on four local soil types.

Would a fallow have helped me through the dry years like 2006?

Using climate data for Dalwallinu and modelling crop growth using APSIM, if you fallowed in 2005 and planted wheat in 2006 you would have got a yield benefit of 0.8 t/ha on sand and 1.6 t/ha benefit on clay compared to not fallowing.

On sand, fallow has benefited wheat yield (in terms of soil water) in 3 out of the last 10 years. A clay soil, because of its higher water holding capacity, shows a benefit in 7 out of 10 years. These estimates do not take into account other benefits of fallow such as reducing weeds or disease.

As a general rule we say yield benefits that are the result of increased stored moisture after the fallow occur in years:

- with low summer rainfall after the fallow (<100mm)
- Low growing season rainfall <210mm

Unfortunately we don't know what the weather will do in advance.

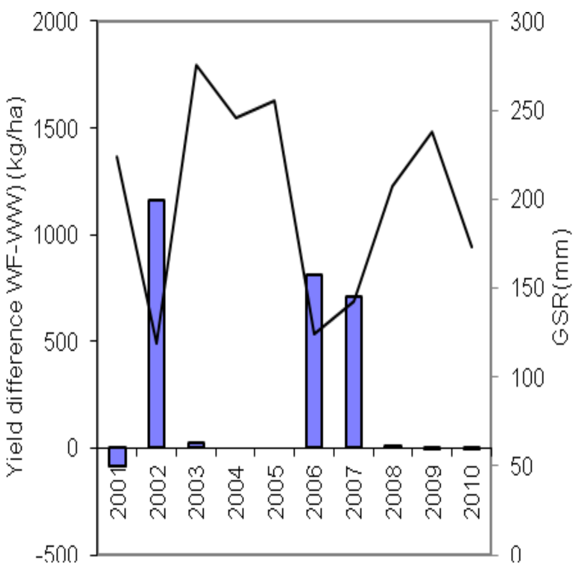
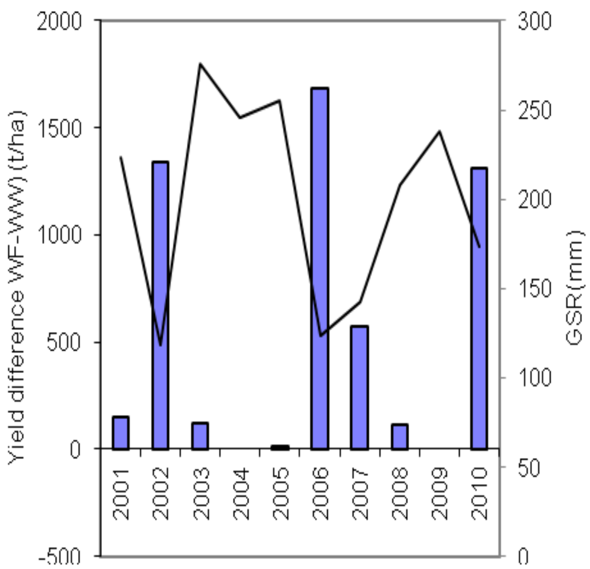
Sand	Clay
	

Figure 5: The yield difference (kg/ha) of having a fallow-wheat rotation compared to a wheat-wheat rotation over the last 10 years as modelled by APSIM on a sand and a clay at Dalwallinu. Growing season rainfall shown as black line.

How often is a fallow going to be able to store large amounts of water?

To work this out we used historic rainfall figures from 1900-2010 for Dalwallinu and Perenjori. Using the computer model we are able to see how much extra water a fallow would have stored compared to a wheat-wheat rotation. In Dalwallinu fallowing a sandy soil would store an extra 30-50mm compared to wheat-wheat in 25% of years.

Table 2: The percentage of years where the difference in stored water between a wheat-wheat rotation and a fallow-wheat rotation fits into the ranges below on a sand and clay at Dalwallinu and Perenjori.

	% of years a fallow will store more water than a wheat-wheat rotation			
Extra stored moisture	**Less than 30mm**	**30-50mm**	**50-75mm**	**> 75mm**
Dalwallinu				
Sand	30%	25%	45%	0%
Clay	17%	18%	28%	38%
Perenjori				
Sand	35%	18%	47%	0%
Clay	24%	9%	28%	40%

Figure 6: Fallow trial at Wubin, 2011. Computer modelling is used to generate information because although the Liebe Group are conducting field trials on fallowing the response is highly dependent on the season. By using historical rainfall and computer modelling 100 ''rials' can be conducted at once.

If I fallow what are the odds of getting a yield benefit over 1 t/ha?

In Perenjori on a clay, a fallow-wheat rotation will give a yield increase of greater then 1t/ha compared to wheat-wheat rotation in 25% of years. In Dalwallinu a yield benefit of over 1 t/ha only occurs in 11% of years. The Perenjori area sees a greater yield benefit because growing season rainfall is less. It is worth noting that this study only looks at soil water, so it cannot work out yield benefits which might occur from weed and disease benefits associated with fallow.

Table 3: Average yield difference between a fallow/wheat and wheat-wheat rotation in Perenjori and Dalwallinu based on climate data from 1900-2010 and APSIM modelling, and the frequency at which yield benefit from fallow-wheat is over 1 t/ha.

Soil	Average yield difference (t/ha) between a fallow-wheat and wheat-wheat rotation.	% of years when yield benefit is greater than 1 t/ha
Perenjori		
Acid sand	-0.05	0%
Sand	0.25	8%
Loam	0.28	7%
Clay	0.55	25%
Dalwallinu		
Acid sand	-0.09	0%
Sand	0.12	4%
Loam	0.14	6%
Clay	0.24	11%

Where has the information in this document come from?

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In this document we have used climate records from 1900 to 2010 in Dalwallinu and Perenjori. Two soil types were used in the model, a yellow sand at Buntine and a clay at Mingenew. A Mingenew soil was used because it is representative for clay soils in the Liebe area.

Information is general in nature and should be used in conjunction with other information sources when making farm decisions. No responsibility is accepted for its accuracy and no liability is accepted for any statement, error or omission.

Figure 7: Liebe farmers and researchers sharing information at a field walk at Buntine, 2012.