Using a cropping systems simulator to investigate the impact of subsoil constraints on a wheat crop in the southern Mallee in 2001.

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The aim of this investigation was to use the cropping systems simulator APSIM to assess the impact of high levels of sodicity chlorine, electrical conductivity and boron on the growth and yield of a wheat crop (cv. Yitpi) grown in the BCG Systems Trial.

Background

The recent discovery, through soil testing, that many soils in the southern Mallee have extremely hostile subsoils has prompted much interest in what the impact is on crop yields. There is a keen interest by farmers and researchers to investigate what might be done either to overcome or to learn to live with these limitations.

Methods

APSIM uses daily weather inputs together with information about the soil's characteristics and crop management to calculate crop and soil processes through one or many seasons. Our experience in applying APSIM in other regions in Australia and overseas shows the importance of an accurate description of soil water holding characteristics, of good data on soil moisture and nitrogen to planting a crop, and of reliable weather data. In 2001 researchers from CSIRO Sustainable Ecosystems cooperated with the BCG to obtain such data for simulating crops in the Farming Systems Trial.

Once the data were available, the next step was to use APSIM to conduct virtual experiments to investigate the impact on wheat yield of two contrasting levels of water holding capacity with two contrasting assumptions about root growth restrictions in the subsoil.

All simulations reported here used the same information as gathered during the 2001-cropping season in paddock 25 and the same weather data as measured at the site (rainfall) or at the nearest weather station. Simulations differed only as follows:

1. Available water holding capacity as measured in the field; Root development was not restricted (default parameters used for Vertosols with "normal" subsoils).
2. Available water holding capacity as measured in the field; Root development parameter was restricted to reflect observed rooting depth and water extraction during the season.
3. Available water holding capacity as previously estimated from various sources prior to measurement in the field; Root development was not restricted.
4. Available water holding capacity as previously estimated from various sources prior to measurement in the field; Root development was restricted as per 2 above.

Results

The finding that available water holding capacity for wheat in these soils is as high as 190mm to an effective rooting depth of 100 cm that can be accessed by wheat is discussed elsewhere in this manual. The results of the simulations are summarised in Table 1.

Table 1. A comparison of filed observations with 4 simulated scenarios for Yitpi wheat in 2001.

	Actual	**Simulation type**			
		1	**2**	**3**	**4**
Yield (t/ha)	3.12	3.37	3.46	1.39	1.38
Root depth on 6th Sept. (cm)	70	115	57	55	50
Root depth at harvest (cm)	100	115	107	69	64

Given the uncertainties of field measurements, and that APSIM does not attempt to account for loss of yield due to weeds or diseases, simulation 2 has come close to describing the observed field data. The comparison of the four scenarios shows that yield is dramatically modified by the available water capacity. However, for either water capacities, simulating the impact of subsoil constraints on root depth had minimal impact on final yields.

Conclusion

This study has demonstrated the use of simulation to investigate competing ideas about what is constraining crop production. The simulation study suggests that the rate of root extension into the subsoil was dramatically slower in the presence of subsoil constraints. However, in the 2001 season, wheat yield was not limited by this factor, which reduced the use of soil moisture early in the season and thus delayed the onset of water stress during the dry grain-filling period. Different results may be observed in different seasons and this will be further investigated with simulation and by continuing field measurements.