A nitrogen fertiliser calculator emphasising climate risk management

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Abstract

Nitrogen fertiliser rate decisions remain an important part of crop management. Potential yield outcomes in northern Australian environments are a function, almost equally, of stored soil water and in-crop rainfall. Most existing nitrogen fertiliser calculators are based on a single target yield to calculate crop nitrogen demand. This de-emphasises the widely-varying yield outcomes that can occur. In a variable rainfall environment such as Central Queensland, the full range of potential yield outcomes needs to be appreciated. This nitrogen fertiliser calculator has been developed by the Central Queensland Sustainable Farming Systems Project and incorporates several existing modelling technologies. Novel features of this calculator are:

• Appreciation of the wide range of potential yield outcomes using WhopperCropper thus allowing the user to evaluate their attitude to risk

• The option to use Howwet to calculate soil water at sowing

• Accounting for nitrogen mineralisation in the time gap between soil sampling and sowing

• Using soil organic carbon as an indicator to avoid unnecessary application of N fertiliser when dry fallow precedes sowing

• Ability to account for co-location of water and nitrogen in calculating soil nitrogen supply

The extension package incorporates a Spreadsheet Calculator, a Workbook containing information for paper-based calculations and a detailed Reference Book containing detailed soil nutrition information and risk management strategies.

Key Words

Nitrogen, fertiliser, calculator, WhopperCropper

Introduction

Nitrogen fertilizer budgeting techniques have been promoted successfully in southern and central Queensland (Lawrence *et al.* 1996). These were paper-based processes that gave users, principally farmers the ability to use soil test data to create an approximate nutrient balance. The workshops were well received because of their simplicity and empowerment to the participants. However, there were some technical deficiencies in the process that are addressed in this model.

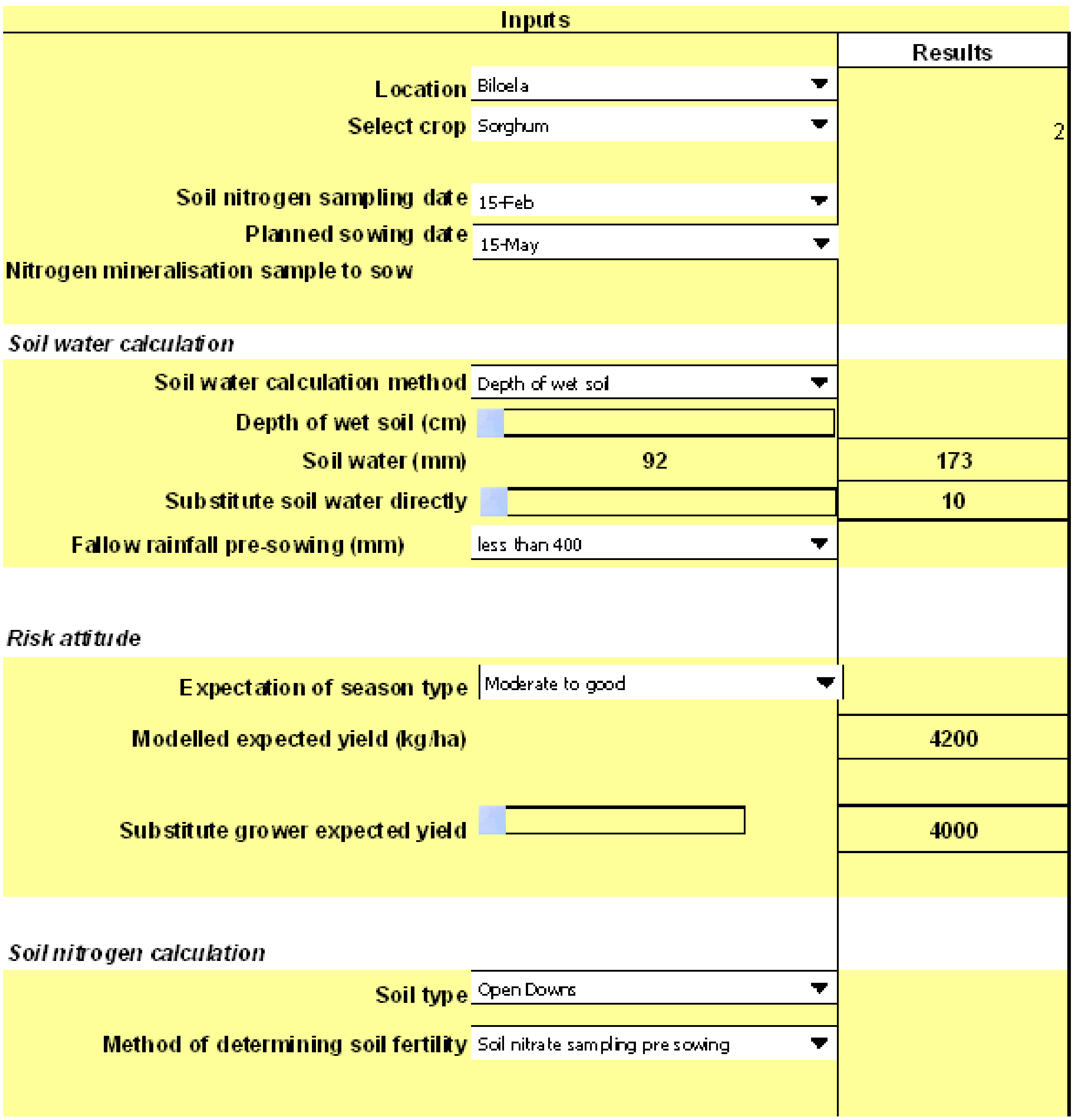
Methods

A three-part kit

This full nitrogen fertiliser calculator contains three parts. The spreadsheet calculator accompanies a 54 page workbook that contains detail of the science together with a paper-based calculation process. The third part of the kit is a reference manual that more fully explains the science of soil nitrogen and climate processes.

Incorporating climate risk management

The written material and the Excel? spreadsheet utilises output from the WhopperCropper (Cox *et al* 2003, Nelson *et al* 2002) and Howwet (Freebairn et al 1994) programs. This was done because WhopperCropper explicitly demonstrates yield distributions as driven by variable in-crop rainfall and a number of other important input variables. This encourages the user to think about their attitude to risk and hence better target a nitrogen input level. Similarly, Howwet can be used to calculate the soil water at sowing which in the northern region, is a major factor in the management of yield risk and is also a major input into the WhopperCropper analysis.



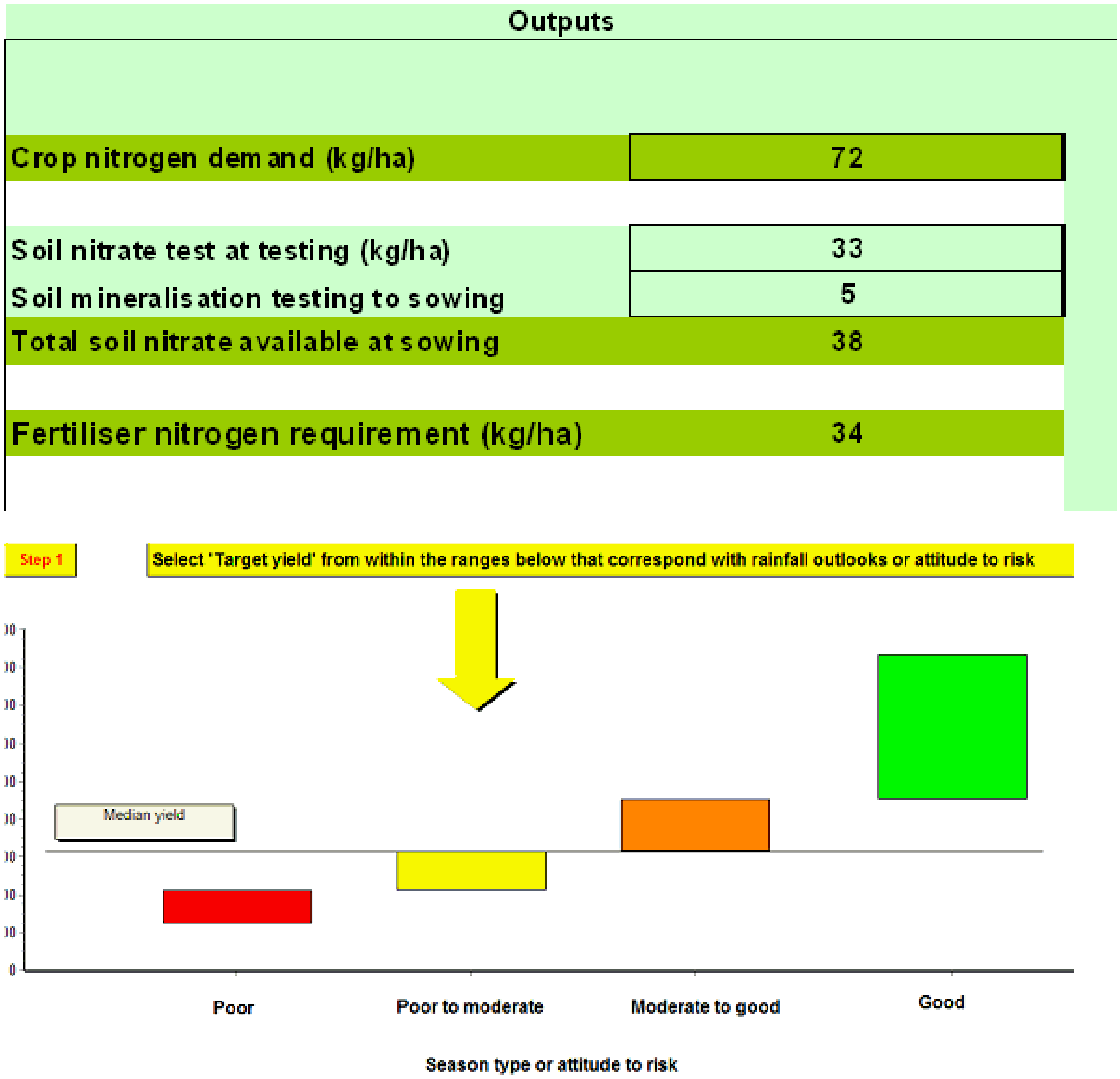


Figure 1. Screens for selecting inputs, rainfall risk profile and subsequent output

Soil mineralisation

Time between sampling and sowing can be lengthy and significant amounts of nitrogen may mineralise from organic matter. Modelled N mineralisation values can be accessed to account for this period and better estimate the nitrogen fertiliser requirement. Users can select a range of antecedent fallow moisture conditions that may have influenced the N mineralisation rate. Nitrogen mineralisation during crop growth is accounted for in two ways: a default nitrogen uptake efficiency value (0.6) accounts for the in-crop mineralisation required to achieve? default grain protein percentages of 11.5% for wheat, 9.5% for sorghum and 10.5% for barley. Because the protein target is closer to the optimum economic level, the accompanying NUE value results in a lower N fertiliser requirement than previous calculation methods that used a factor of 0.5. The spreadsheet calculator does not allow targeting higher values for grain protein and the paper-based process discourages it. This is because in the northern environment, higher grain protein is usually a consequence of low in-crop rainfall, an undesirable and unpredictable outcome.

Soil organic carbon

The soil organic carbon level is used to give a broad indication of the potential of the soil to mineralise significant quantities of nitrogen and the frequency that responses to N fertiliser may occur. In the northern region, low and variable winter rainfall limits N mineralisation to small quantities and the difference between low and high organic carbon soils is quite small. However, annual mineralisation values can differ by 100% (40kg/ha) between high and low OC soils and this difference is used in this calculator. Field trials also demonstrated this difference (Routley et al 2006).

References

Cox HW, Chapman V J, and McLean G B (2003). WhopperCropper – supporting risk management discussion. Proceedings First Australian Farming Systems Conference, Toowoomba, Queensland September 2003

Freebairn DM, Hamilton AH, Cox PG, and Holzworth D. (1994). HOWWET? Estimating the storage of water in your soil using rainfall records. A computer program. Agricultural Production Systems Research Unit, DPI-CSIRO, Toowoomba, Queensland.

Lawrence DN, Cawley ST, Cahill M.J, Douglas N, and Doughton, JA. (1996). Soil nitrogen decision aid puts farmers in the picture. Proceedings. 8th Australian Agronomy Conference Toowoomba. pp 369-372.

Nelson RA, Holzworth DP, Hammer GL, and Hayman PT. (2002) Infusing the use of seasonal climate forecasting into crop management practice in North East Australia using discussion support software. Agricultural Systems 74 393-414.

Routley R, Sullivan A, Braunack M, Spackman G, and Conway M. (2006). Components of long-term nitrogen balance in central Qld grain cropping systems. Proceedings 13th Agronomy Conference (In press).