Chapter Nine

General Conclusions and Future Research

Australian agricultural soils are generally low in soil physical and chemical fertility and have traditionally relied on inorganic inputs to sustain production. The role of soil organic matter in maintenance of soil quality is well known and using organic amendments is one of the management techniques whereby SOM content can be increased. This project was designed to evaluate the effect of different organic amendments on soil quality of Vertosol used for cotton production systems and also the economic feasibility of using these organic materials. The outcomes of the research should provide cotton farmers with some quantitative information on those organic amendments which may be economically feasible and the appropriate rates at which they can be applied in cotton production systems. The information will also help farmers to understand whether organic amendments can be used to ameliorate sodicity, prevalent in most of the Australian Vertosols. This chapter highlights some of the major findings presented in Chapters 4-8. A number of future research directions have also been outlined.

Cotton gin trash

- Cotton gin trash did not have any effect on the soil microbial properties when applied at lower rates (Chapter 4, 5). It was able to increase the microbial biomass only at higher rates (Chapter 6).
- A 68% higher nitrate-N was observed in soil during cotton picking in the 1st year of the field experiment.
- There was a trend of increasing N levels in soil with the increase in application rates (Chapter 6).
- Cotton gin trash can potentially improve short-term nutrient availability in Vertosols.
- The optimal rate for this amendment was 30 t/ha (Chapter 6).
- It also improved soil physical properties by decreasing the dispersion index of sodic Vertosol (Chapter 7).

- However, benefits would only be achieved using this amendment if it is available within 100 km distance (Chapter 8).

Cattle manure

- Cattle manure is very high in nutrient content (Chapter 4, 5).
- Soil microbial properties were not affected by application of low rates of cattle manure (Chapter 4, 5). However, at higher rates, it could stimulate the microbial activity and biomass (Chapter 6).
- It improved the nutrient status of Vertosol even at lower rates (Chapter 4, 5). The exchangeable K content of soil was significantly increased by applying this amendment (Chapter 4, 5, 6, 7).
- The optimal rate for this amendment was 30 t/ha (Chapter 6).
- A concurrent increase in exchangeable Na needs further investigation for any adverse effects on soil quality.
- If cattle manure is available within 100 km, the farmer could benefit by applying the amendment at higher rates (Chapter 8).

Chicken manure

- Chicken manure contains high N and P (Chapter 5) resulting in significant increases of these nutrients into the soil even at lower application rates (Chapter 5).
- The microbial biomass was increased with increasing application rates of chicken manure (Chapter 6).
- The optimal application rate (9-18 t/ha) was lower than for the other amendments (Chapter 6).
- It had the potential for improving physical properties of sodic Vertosol by lowering the dispersion index (Chapter 8).
- Chicken manure could prove beneficial for the farmers even if it is supplied from distances beyond 100 km (Chapter 8).

Biosolids

- Biosolids contributed high amounts of P into the soil (Chapter 5, 6).
- They increased biological activity in the soil with increased microbial respiration (Chapter 5).
- Biosolids could affect the soil physical condition by reducing the size of dry-sieved aggregates, but did not affect the dispersion index (Chapter 5).
- An increasing trend of N levels was observed in soil with the increase in application rates (Chapter 6).
- The optimal rate of application of biosolids is 60 t/ha.
- Due to its low cost, it could be applied at higher rates even if available from suppliers beyond 100 km (Chapter 8).

Vermicompost

- The nutrient concentration of vermicompost was quite low as compared with other organic amendments (Chapter 4, 5, 6).
- Vermicompost did not have any short-term effect on soil microbial properties (Chapter 4, 5), but at higher rates, it did enhance soil microbial activity and soil N levels (Chapter 6).
- Even though vermicompost contributed very small amounts of N, but it increased the soil N status. The microorganisms present in the amendment may have stimulated the mineralization of the native SOM and the mineralization also resulted in increased available P of the soil.
- However, adverse effects were associated with the use of vermicompost as it caused a deterioration of soil physical properties by enhancing soil dispersion (Chapter 5).
- As there is very low transport cost involved, this amendment could be applied at higher rates (Chapter 8).

In summary, organic amendments were useful in improving short-term soil quality when used at higher levels. For example, higher labile C fractions and higher levels of N and P in soil were associated with increased microbial activity. An additional

advantage of using organic amendments was the increased nutrient availability at high sodicity levels. However, we observed low levels of soil P in these soils even after the addition of organic matter, compared with levels found in previous field and pot experiments. This might be due to changes in chemical composition of the soils with sodification (Section 7.2.1.2). Sodicity and high alkalinity of the soils might have reduced P availability with precipitation of P as calcium phosphates. Field assessment of these organic amendments is needed over a longer time span at the rates found to be effective in improving soil quality in this study.

Limitations and Future Scope

The major limitations of this project were the evaluation of organic amendments on a short-term basis in the field (2 years) and many experiments were conducted in a controlled environment in the temperature-controlled growth chamber.

Increased Na concentration and its associated adverse effect on increased ESP due to application of the organic amendments is one of the issues which also needs to be explored. If vermicompost application hastens the mineralization of organic matter, then the soil would soon be depleted in organic matter which would have an adverse effect on soil quality. Therefore, future work is needed to evaluate the effect of vermicompost on Vertosol quality. Soil moisture level also affects the decomposition rate of organic matter by influencing the microbial properties. It is also important to investigate the effect of organic amendments on varying moisture regimes and their effects on other physical properties.

Future work should also focus on the potential of these organic amendments in the longer term under field conditions.

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