

FARMING SYSTEMS – THE OPTIONS

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Cotton farmers have been adapting and changing their farming systems for as long as cotton has been grown. New machinery, new technology and streamlined management have all assisted in this process. But what of the future? Can we make further improvements? What factors and new information will drive to a more sustainable cotton farming system?

Some of the factors are as follows:

- Soil fertility decline
- Suitable crops for rotation
- Shortage of water
- Insect pest (heliiothis) management
- Disease (Fusarium, Verticillium and seedling disease) management
- Environmental issues (from pesticides in the environment through to greenhouse gas concerns)

All of these issues for the cotton industry can be tackled in a number of ways. I would like to cover some of the farming-systems approaches to solving these concerns.

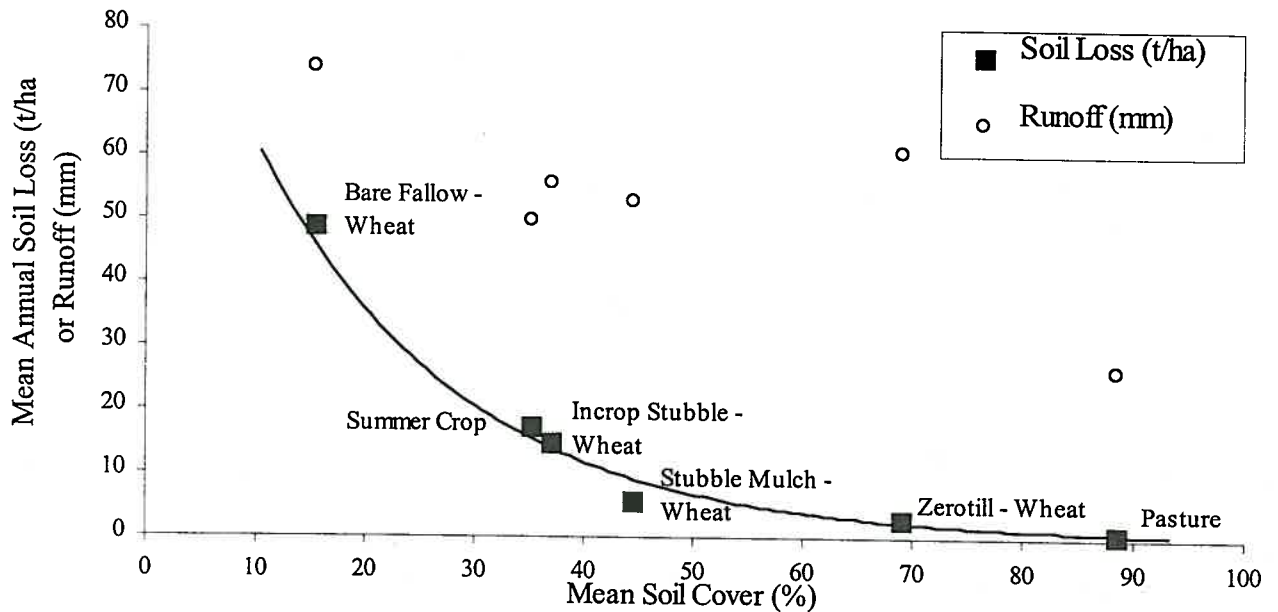
Options available

The options available to a grower in any particular situation are constrained by soil type, seasonal conditions and machinery available. In general, farmers can use cropping systems which range from monoculture cotton (rake and burn, full tillage with incorporated herbicides) through to complete zero tillage with crops in rotation (given heliothis pupae destruction following the cotton crop). Historically, all of these systems have, when well managed, produced profitable cotton yields. But are these systems sustainable?

Soil fertility effects

Considerable research has been conducted on the cracking clay soils of inland Queensland and New South Wales and in general terms, the overall conclusion has been that over time, soil organic matter levels decline and so does soil fertility. One classic study by Dalal *et al* is outlined in Figure 1.

Figure 3. Mean annual erosion and runoff as a function of total (stubble and crop) cover provided by a range of land uses on a cracking clay at Greenmount, Darling Downs. - from Loch and Silburn (1993).



So, clearly if we can maintain at least 40% cover in early summer we can minimise runoff and soil loss and also reduce the rate of decline of soil organic matter. Looking at this in another way, by maximising cropping frequency and minimising soil disturbance, we can maintain soil fertility and reduce soil erosion.

Suitable crops in rotation

The jury still seems to be out on this issue. You will hear different points of view on this during the conference. Legumes fix nitrogen but are generally inefficient in terms of water use efficiency. They produce little surface cover and can have adverse effects on following crops (seedling diseases and allelopathic effects). Hulugalle *et al* found that chickpea and faba bean reduced cotton crop emergence, growth and lint yield when the legume crops were grown prior to cotton at a trial site at Wee Waa. Winter cereals have a distinct advantage in the type of cover produced and the durability of this cover.

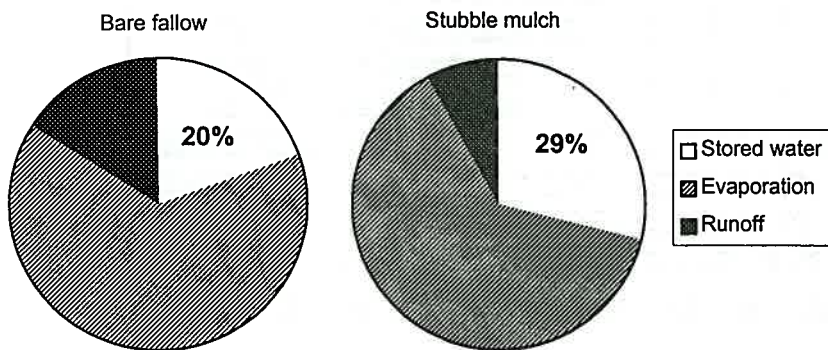
The issues associated with Mycorrhiza are yet to be elucidated but this may be the most important factor of all. Root Lesion Nematode effects may also be important, although at this stage, their impact on the cereals in rotation are likely to be greater than the cotton.

Reduced tillage and avoidance of long fallow seem to be the only “rules of thumb” at this stage.

Efficiency of water use

Water is now a valued (scarce) commodity in each of our cotton farming valleys. Irrigation water is the lifeblood of the Australian cotton industry, but can we make more use of rainfall? Again, I refer to some of the research conducted in dryland farming systems. Freebairn *et al* have clearly shown that by maximising surface cover and minimising runoff, an additional 25 to 50 mm can be stored during a fallow period. This extra storage is due to less runoff (and greater water infiltration). For irrigation farmers, this means an extra 0.25 to 0.5 ML per hectare. Roughly an extra .25 to .5 bale per hectare at little extra cost (if water use efficiency equates to 1 bale for every ML per hectare). For dryland farmers, this means the difference between covering costs and making a profit.

Figure 4. Increase in water infiltration (reduction in runoff) for contrasting tillage treatments. Freebairn and Wockner, 1983.



Can we make use of this in our cotton systems? In those regions and seasons where less than full water supply exists, by growing crops in rotation, by managing a fallow with full surface cover and maximising rainfall water infiltration during the growing season, we can improve the overall water use efficiency of our systems. With appropriate fallow management we may be able to add one megalitre per hectare to our total available water supply.

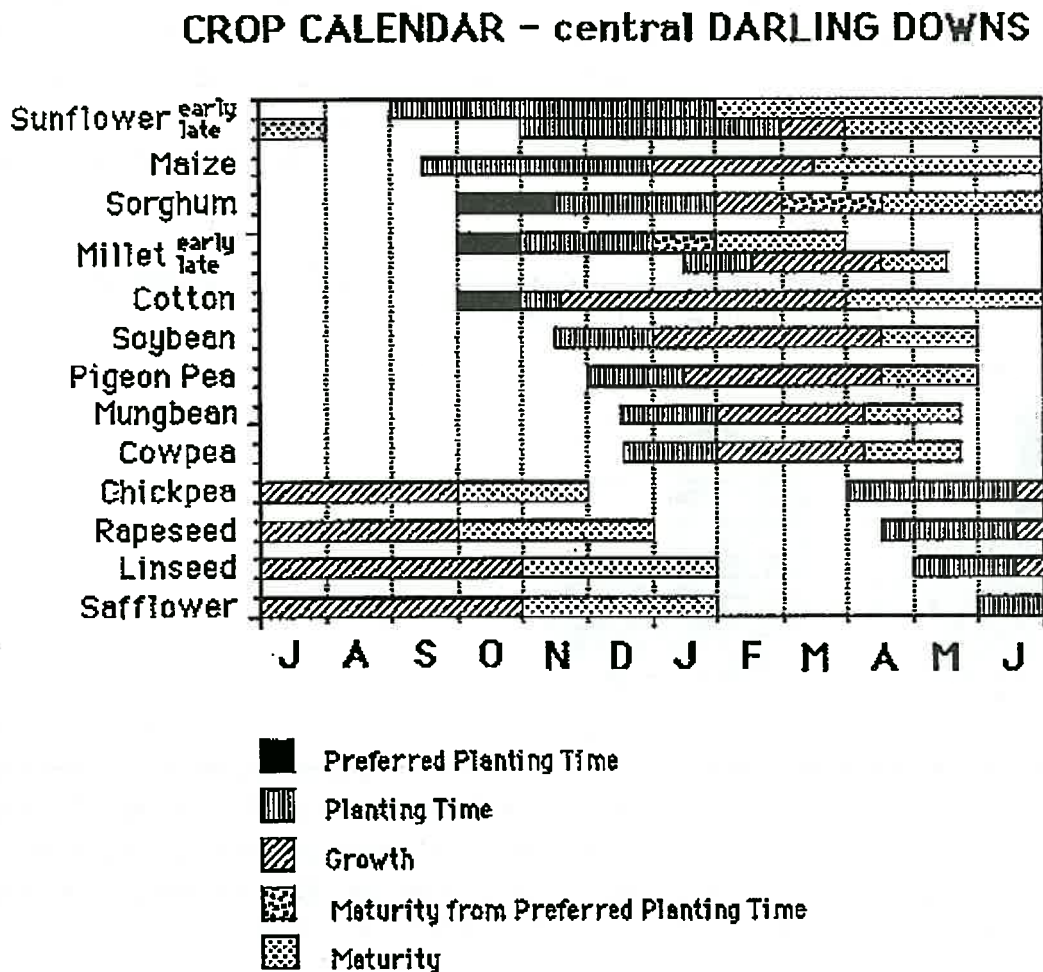
Insect (heliethis) management

This subject will receive a lot of attention during the conference, but two ideas come clearly to mind.

Firstly, our cropping systems may be responsible for generating large numbers of heliothis. By growing a sequence of crops and a multitude of crops, we may be generating locally bred heliothis. Titmarsh (1992) has described a cropping almanac which outlines the problem. Pulse crops prior to cotton (flowering in spring) pose a particular risk to cotton and cotton

poses a risk to pulse crops grown in autumn. Can we manage this on a region-wide basis? Can we use trap crops and other techniques of maximising the impact of beneficial insects generated in one crop for an adjacent cotton crop? We should know more by this time next year, but I suspect we have a lot of room for improvement.

Figure 5. Cropping almanac for the open downs country of the Darling Downs. (Titmarsh, 1992).



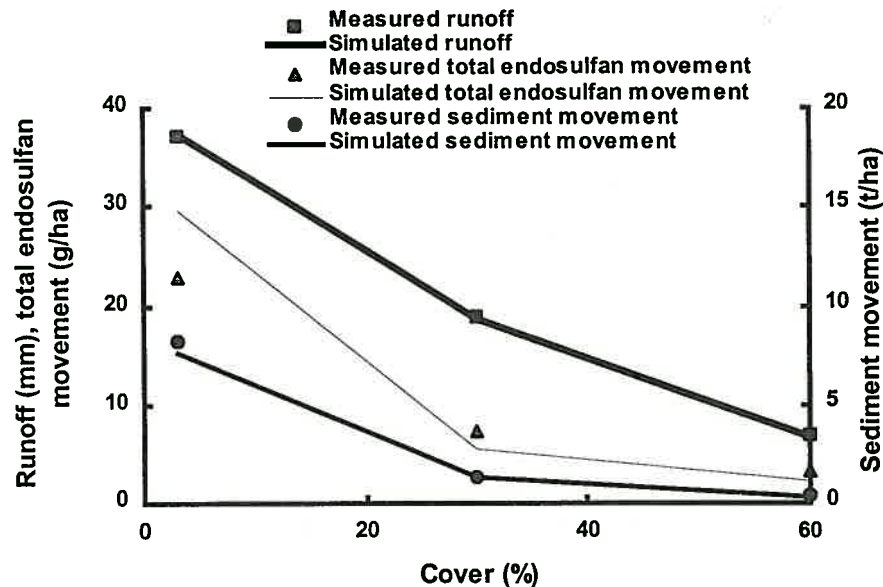
Diseases

Other papers during the conference will cover the disease issue in some depth. As a summary it seems that summer crop rotations are unlikely to solve the Fusarium problem, but winter crop rotations and growing resistant varieties (already good evidence of variation among available varieties) will reduce levels of carryover inoculum. Likewise, crop rotations are beneficial for Verticillium Wilt control.

Environment issues

Two main issues are of concern here. Firstly, we can reduce the movement of pesticides out of cotton paddocks by reducing runoff and soil loss. Surface cover again plays a major role.

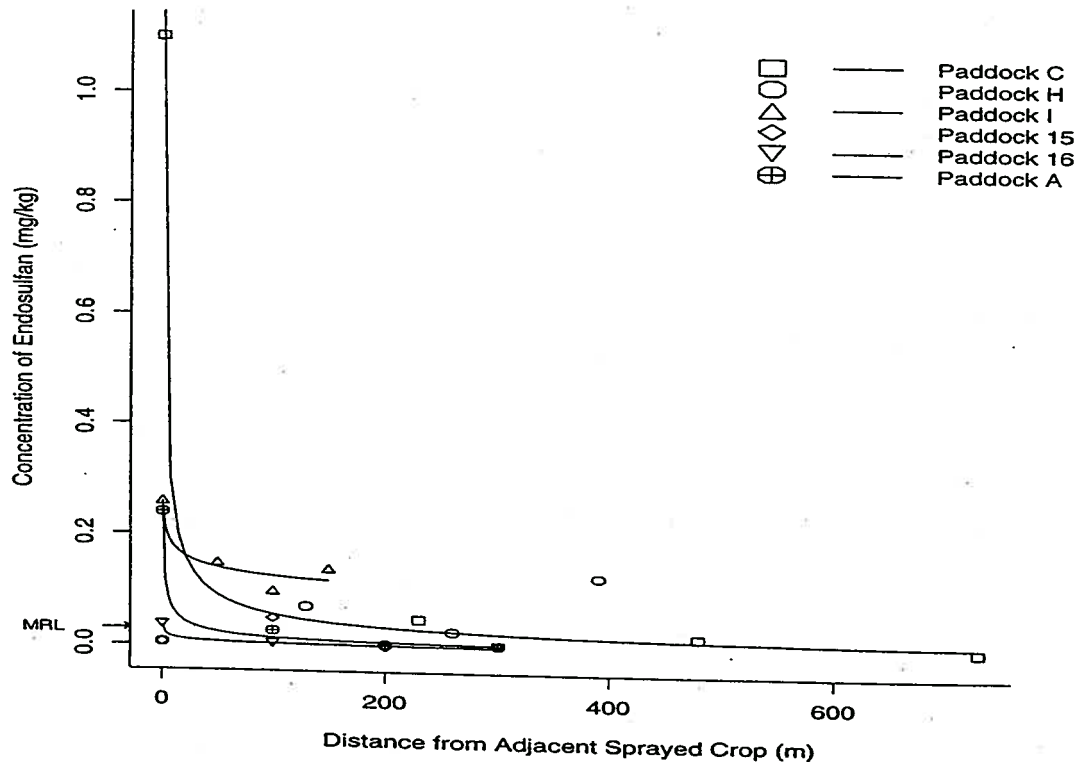
Figure 6. Measured and predicted runoff, sediment and total endosulfan movement from rainfall simulator plots at Auscott Warren. (Connolly, 1997).



Connolly (Figure 6) has shown that runoff, sediment and total endosulfan movement from rainfall simulator plots at Auscott Warren have all been reduced with increased surface cover. Furthermore, Silburn *et al* conclude that crop residues on the surface intercept pesticides that would otherwise reach the soil and, in the case of endosulfan at least, dissipated them rapidly. My conclusion from this is that by maintaining surface cover (again, greater than 40%) we can reduce the transport of pesticides from cotton fields and we can also enhance the rate of dissipation of certain pesticides such as endosulfan.

Drift on to adjacent crops has also been a concern in cropping systems where feed grain crops are grown in the vicinity of cotton crops treated with insecticide. A survey conducted on the Darling Downs by Lambourne *et al* (1996) (Figure 7) shows that drift onto grain sorghum from adjacent cotton crops sprayed with endosulfan can be of concern if the sorghum crops are senescing.

Figure 7. Concentration of endosulfan in samples (of grain sorghum) against distance from treated crop.



This shows, that with appropriate management, (no endosulfan on cotton to adjacent sorghum after the sorghum has flowered, or sorghum at least 100 metres away from the cotton crop and appropriate drift reduction practices), it will be unlikely that sorghum crops will have residues which exceed MRL.

Conclusion

The evidence seems to be overwhelming. Reduced tillage, cereal crops in rotation with cotton and maintenance of surface cover will help maintain soil fertility, improve water infiltration, reduce soil and pesticide runoff and improve system water use efficiency. A total systems approach to heliothis management also offers promise.

However, several questions remain. How can we effectively zero till cotton into wheat stubble? This is difficult enough without the question of incorporation of herbicides and maintenance of beds and furrows. The role of soil organisms, including beneficial ones such as Mycorrhiza deserves further attention. Controlled traffic, selective herbicides (herbicide resistant cotton varieties) and even ley pastures may all provide part of the solution. In essence, by continually striving towards Best Management Practice, we will develop productive, sustainable cotton production systems.

References

- Connolly, R.D. (1997). Application of models to estimate transport of pesticides from cotton production systems. Final Report for LWRRDC Project AP122.
- Dalal, R.C., Strong, W.M., Weston, E.J. and Gaffney, J. (1991). Sustaining multiple production systems. 2. Soil fertility decline and restoration of cropping lands in sub-tropical Queensland. *Tropical Grasslands*. **25**:173-180.
- Freebairn, D.M., Hulugalle, N., Tullberg, J.N. and Connelly, R.D. (1998). Greenhouse Gas Emission from Cropping – The Role of the Alternative Tillage Systems on Clay Soils. Proceedings of the Symposium on Conservation Tillage -- Can it Assist in Mitigating the Greenhouse Gas Problem? University of Queensland. In Press.
- Freebairn D.M. and Wockner, G.H. (1983). Soil erosion control research provides management answers. *Qld. Ag. J* **109**: 227-234
- Hulugalle, N.R., Entwistle, P.C., Roberts, G., and Finlay, L.A. (1998). Allelopathic behaviour of grain legumes in cotton-based farming systems. Proc. 9th Australian Agronomy Conference, 20-24 July 1998, Wagga Wagga, NSW, In Press.
- Hulugalle, N.R., Entwistle, P.C., Scott, F., and Kahl, J. (1998). Sustainable cropping systems for irrigated cotton: sowing wheat or grain legumes as rotation crops. Proc. 9th Australian Cotton Conference, 12-14 August 1998, Broadbeach, Qld., In Press.
- Kochman, J., Allen, S. and Davis, B. Fusarium Wilt of Cotton. Co-operative Research Centre for Sustainable Cotton Production. Grower Information Bulletin.
- Lambourne, R., Butler, D. and Hamilton, D. (1996). Endosulfan Residues in Grain Sorghum – Field study to determine extent of residues in south Queensland crops 1996. DPI Information Series No. Q196094.
- Loch, R.J. and Silburn, D.M. (1993). "Erosion processes and contaminant transport". In: Environmental Soil Science (Eds. I.F. Fergus and K.J. Coughlan). Australian Society of Soil Science Incorporated, Queensland Branch: Brisbane, Australia. pp 77-106.
- Silburn, M. (1997). "Rainulator Studies of Pesticide Movement from Cotton Production Systems". Final Report, LWRRDC/CRDC/MDBC "Minimising the Impact of Pesticides on the Riverine Environment using the Cotton Industry as a Model", 23 May 1997.
- Silburn, M., Simpson, B., Kennedy, I. and Connolly, R. (1997). Soil Erosion in the Australian Cotton Industry. Cotton Farming Systems Forum, Narrabri, 4 December 1997.
- Titmarsh, I.J. (1992). Mortality of Immature Lepidoptera: a case study with *Heliothis* species (Lepidoptera: Noctuidae) in agricultural crops on the Darling Downs. University of Queensland PhD thesis.

