The benefits of cover crops and their integration into the HRZ

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**Summary**

- Cover cropping is a beneficial and cost effective method of protecting soil, improving soil fertility, and increasing crop yields.
- Adoption in the Victorian high rainfall zone appears to be feasible.
- Prior research has suggested that cover crops can ameliorate subsoil constraints common to the HRZ.
- Future research conducted should focus on assessing and proving the benefits associated with cover crops do occur in the HRZ, and attempt to provide cost-benefit analyses of this addition to the system.

Cover cropping is a farming method which replaces fallow periods of the cropping cycle with plant cover, aiming to provide continuous soil cover throughout the season. Cover cropping was recognised as early as 44 BC as an effective method to protect and fertilise the soil with plant biomass, but due to the development of artificial fertilisers in the 1950s, the use of cover crops steadily declined.

However, recent efforts to increase the sustainability of farming systems have led to renewed interest in methods such as cover cropping. Countries in the northern hemisphere have readily integrated this method; while by comparison, Australian adoption remains limited. A key reason for this discrepancy is the climatic difference between the hemispheres, with adoption most often occurring in countries which replace a winter fallow with winter cover crops. In comparison, the fallow period of Australian cropping systems occurs over summer, when low water availability may inhibit cover crop productivity, and increased water use may negatively impact yields of the following winter crop. Although many Australian fallow periods have adverse rainfall and temperature conditions, the benefits of cover cropping are of particular importance to Australian farming systems. Our soils are inherently infertile and fragile, and the proposed benefits of cover cropping centre mainly on improvements in soil structure and fertility.

In the south-eastern high rainfall zones of Australia, there is an abundant annual rainfall (500-900 mm) and a relatively mild climate, compared to the majority of Australian regions. In addition, the yield potential of this area often exceeds actual yields, due to subsoil constraints associated with the duplex, sodic nature of the soil. The above factors provide a unique opportunity to assess the value of cover crops in the system- not only are they a niche strategy in the HRZ, but the method also has the potential to ameliorate subsoil constraints and improve yields and productivity.

This review provides a brief evaluation of the benefits and drawbacks associated with incorporating cover cropping into a farming system, including combating the unique constraints of the Victorian high rainfall zone, and therefore may provide justification and evidence as to the viability of the practice in the HRZ.

**Potential benefits of cover crops**

1. **Improvement of soil structure**

Productive cover crops species produce abundant levels of biomass, which protects the soil from wind, water and solar damage and also provides an important source of organic matter to the soil. Increases in organic matter from cover crop residues can alter the physical structure of the soil, by increasing porosity and aggregation and decreasing bulk density, which can improve nutrient and water storage. In addition, several studies have demonstrated the ability of cover crops to penetrate hostile subsoils and clay pans. Species such as buckwheat, sunn hemp and tillage radish have been used as ‘primer crops’ to open up the subsoil, and enable infiltration by water and other plant species. This ability is particularly important in the Victorian HRZ, due to the constraint imposed by subsoils.

2. **Improvement of soil fertility**

The retention of cover crop biomass can also improve the nutrient content of the soil, thereby enhancing soil fertility. Cover crops with tap roots, or extensive root biomass can ‘scavenge’ nutrients from deep in the profile, and store them in plant tissue. When the cover crop is terminated, this nutrient is then released to the soil. Cover crop decomposition can also increase soil carbon content, pH, soluble organic carbon, and water content. This improvement in soil physical and chemical fertility can also provide an improved, beneficial habitat for microorganisms, thereby increasing the biological fertility of soil. In turn, the microbial population of the soil can perform more efficiently, in turn enhancing nutrient cycling, nitrogen availability and plant productivity. The proposed changes to soil structure and fertility under a cover crop system centre around increases in nutrient and water holding capacity, greater porosity, and improved access of plant roots to soil. The improvements are crucial to areas such as the Victorian HRZ, due to the tendency for waterlogging in winter, and the restriction of yield.
3. Fixation of nitrogen by leguminous cover crops
Leguminous cover crops can scavenge residual nitrogen and other nutrients from the soil which would normally be lost below the root zone, fix atmospheric nitrogen into a form readily available for plant uptake, and increase the efficiency of nitrogen uptake by the following winter crop (Creamer and Baldwin 2000). This method of supplying nitrogen to the system is both cost effective, and sustainable when compared to artificial fertiliser application. These accumulated nutrients will be returned to the soil when the residues degrade, and if mineralization of these nutrients occurs, will be available for plant uptake.

4. Suppression of weeds and diseases
The germination and growth of weeds can be reduced by cover crop smothering ability, production of allelopathic compounds or competition for nutrients and water (Creamer and Baldwin 2000). Some studies have suggested that weed burdens of 2 t/ha can be reduced by 80% by cover crop growth.

5. Feed source over summer
Over 80% of Western District farmers have livestock, and in a mixed farming system, the value of the green fodder produced over summer in the ‘feed gap’ will be of substantial benefit.

6. Improved diversity in the farming system
Due to the continuous cropping method popular in Australian farming systems, and the monocultures this imposes on the farming system, a lack of diversity is common. Therefore, the opportunity to improve diversity by integrating diverse species mixes into the system will of benefit in improving resilience, and promoting soil health.

7. Water use by the summer cover crop
Although cover crops have been shown to increase infiltration and water storage through residue retention and improved soil structure, in many parts of Australia the water use by the cover crop is still highlighted as an issue. However, in the HRZ of Victoria, our rainfall is winter dominant, with hostile subsoils causing waterlogging in winter. There is no necessity to conserve summer moisture in this region, with a dry profile at the beginning of the season now seen as a beneficial strategy. For example, Price & Castor (2007) grew French millet for 30-90 days in Goondiwindi, with no detrimental effect on the amount of soil water at planting of the following wheat crop. When comparing climatic data, summer rainfall in the HRZ was less on average, but 95 mm more fell at Winchelsea in the growing season than at Goondiwindi (April to November). This comparison suggests that in an average year, summer cover cropping in the Victorian high rainfall zone appears to be a viable alternative to the summer fallow, due to our ability to replenish soil water during the growing season.

Potential drawbacks
1. Expense
While there is no doubt cover cropping is beneficial, the establishment and maintenance of productive species requires additional costs related to seed purchase, machinery and labour. The termination of the cover crop may also become costly and difficult, depending upon the tenacity of the species, and the termination method. American studies have reported a 95%-100% termination of leguminous species using undercutting and mowing, while mowing terminated 75% of grass species. However, these methods have to be validated when these species are utilised in the climatic conditions of the HRZ. While there are costs related to cover cropping, an Australian trial, evaluating French millet as a spring crop in the Goondiwindi region, determined total direct costs to be $42/ha, while the yield increase of the following crop when compared to fallow was 0.33 t/ha, or $59/ha (Price and Castor 2007). This resulted in a net gain of $17/ha, showing that cover crops grown in Australian conditions may be costly, but can still be economically viable due to their beneficial effects.

2. Potential increase in pest and disease pressure
Although cover crops provide fodder for livestock, the presence of living biomass over summer may provide a ‘green bridge’ for disease, and a refuge and feed source for major pests such as slugs.

Cover cropping: the Victorian perspective
Paddock scale demonstrations of cover cropping in the HRZ
During 2014, there was increasing interest regarding cover cropping in the HRZ, with several growers taking the initiative and sowing paddock scale trials, while other growers received funding from the Australian Government through Corangamite Catchment Management Authority and Glenelg Hopkins Catchment Management Authority.

Case study: Inverleigh “deep rip” cover crop mix
Aim: the main aim of the mix was to have the rape, radish and sunflowers extend their tap roots into the clay subsoil, thereby providing easier access via channels for the following wheat crop. In addition, the plants will provide protection over the summer, and keep the microbial population active.

Species: forage rape, tillage radish and millet at 3 kg/ha each, sunflowers at 0.75 kg/ha.
Composition of the cover crop mix: the composition will depend on the desired outcome for the paddock/overall system. The addition of legumes provides nitrogen, and also alters the C/N ratio to allow faster decomposition of stubble to humus. In comparison, grass species provide larger amounts of carbon in their residues, and also provide valuable biomass for fodder, and longer lasting soil protection after termination. A mix of species will also stimulate soil productivity, with differing species having differing root properties. The shorter and more fibrous grass species can co-exist favourably with the longer tap roots of the leguminous species, providing beneficial relationships without direct competition.

Preliminary findings: Seasonal conditions for summer plant growth have been excellent, with crucial rains providing well timed sowing opportunities. Cover crops have germinated and emerged successfully as shown in Figure 1. Test paddocks are scattered from Inverleigh to Hamilton, in a range of farming systems, allowing assessment of cover crop performance in varying conditions. The paddocks sown in the 2014-2015 summer will provide preliminary information regarding the suitability of species versus their economic cost. The paddocks will also be monitored for any benefits or deficits caused by the cover crop in terms of soil conditions or yield of the following crop.

Figure 1. Participants of the Western District February cover crop walk examine a trial paddock.