The future of no-tillage systems in Western Australia

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Abstract

The adoption of no-till seeding in Western Australia (WA) appears to have reached a plateau and its sustainability has been questioned with increased occurrences of herbicide resistance in the dominant weed populations. Consequently, the WA No-Till Farmers Association (WANTFA) conducted a Situation Analysis of no-till systems in March 2005. Over 20 meetings and workshops were held with scientists, agronomists and growers at various locations across the wheatbelt to obtain an overview of important factors in the current no-tillage cropping system, such as ground cover levels, removal of stubble, rotations, seeding systems and weed control methods. The main conclusions from the analysis were that there was a lack of soil cover, inadequate crop diversity in the rotations and weed control difficulties with increasing herbicide resistance. Common practices such as over-grazing, burning and tillage were contributing to the problems. It was recommended that no-tillage systems in WA should be based on full stubble retention, diverse rotations with cover crops and a more holistic approach to weed management. In addition, seeding with disc openers was considered important to build up the required crop residue levels, as the full benefits of the system cannot be achieved with minimal soil cover. It is clear that if no-till is to advance, a systems approach must be used with all aspects of crop, and in some cases livestock, production being considered – no-till cannot be thought of as “just a seeding method”. In response, WANTFA has initiated a long term system study, involving scientists and farmers, to test and further develop these no-tillage recommendations as a sustainable farming system for the future. In addition, a program testing different cover crops has been initiated to provide options for adding diversity to the rotation.

Key Words

No-tillage, Situation Analysis, Derpsch, cover crops, herbicide resistance, full stubble retention

Introduction

No-tillage in WA has been defined as narrow/knife point seeding with less than full cut-out (Crabtree pers. Comm.). A knife point is a narrow seeding point (about 16 mm wide) attached to a tyne that creates a furrow into which the seed and fertilizer are placed. The benefits of using the no-tillage system include improved soil health, erosion control, moisture conservation, timeliness of operations and yield improvements. As a consequence of these benefits the adoption of no-tillage system by WA growers occurred rapidly during the 1990s (Crabtree, 2000). The practice is now widespread with approximately 86% of WA growers using no-tillage methods on a portion of their farm (D’Emden and Llewellyn 2004, 2006). Nonetheless, the adoption of this system appears to have reached a plateau with a number of challenges ahead. A survey of growers highlighted that herbicide resistance and weed control issues were the main reasons for reducing no-tillage use (D’Emden and Llewellyn 2004, 2006). With this in mind WANTFA approached Rolf Derpsch, an international no-tillage consultant based in Paraguay, to conduct a Situation Analysis of no-tillage systems in WA (Derpsch, 2005). The aim of this paper is to present the principle findings from the Situation Analysis and to discuss the implications and possible solutions that would form the basis of WANTFA’s future research and development activities.

Situation Analysis of no-tillage systems in WA

The Situation Analysis was conducted during February and March 2005. The Analysis involved a series of meetings with local scientists, agricultural industry representatives and growers, as well as presenting information and interacting with growers at WANTFA conferences and the 2005 Perth Agribusiness Crop

Updates. Meetings and interviews with small groups of up to 10 growers were conducted at 22 locations across the WA wheatbelt. At these gatherings leading-edge no-tillage systems from South America were discussed, after which local no-tillage practices and challenges were highlighted by growers in group discussions and interviews. The findings from the Situation Analysis were published in the "Derpsch Report" (WANTFA, 2005).

Constraints to crop production in WA

The Derpsch Report highlighted that WA has one of the most difficult environments for agricultural production in the world (Derpsch, 2005). The soils are infertile, generally sandy and often exhibit a range of physical and chemical constraints such as low pH, aluminium toxicity, subsoil compaction, salinity, boron toxicity and waterlogging. There are severe climatic limitations including low growing season rainfall and severe frosts that often lead to complete crop failure. Most wheat is produced in areas with less than 500 mm annual rainfall, with up to 84% of the rain falling in winter between May to October (Cramb, 2000). Consequently, there is little scope for utilising summer crops in an effort to double crop, except in the south-west of the wheatbelt. Another climatic phenomenon is the occurrence of strong winds that can lead to serious erosion problems where the soil surface is exposed.

Lack of cover on the soil

Derpsch contends that "almost all the benefits of the no-tillage system come from the permanent cover of the soil and only very few from not tilling the soil" (Derpsch, 2005). Wall (1999) found that no-till with crop residue retention had the highest yield and no-till with no residues the lowest. Conventional tillage had slightly lower yields than no-till with residue retention. Therefore, it was the presence of crop residues on the surface that resulted in a better performing no-tillage system. While doing the Situation Analysis and travelling through the wheatbelt in February and March 2005, it was observed that all too often paddocks had insufficient or no crop residues left on the soil. The main reasons for this were over-grazing of sheep, stubble burning, baling of cereal straw and low rainfall in the eastern wheatbelt.

Keeping sheep

Of the growers interviewed in the study about 75 to 80% had an integrated livestock (typically sheep) production/cropping system. Sheep production is for many farmers an important source of income and a way of diversification and risk management. However, sheep production on good cropping paddocks can have a number of detrimental consequences. These include reduced soil cover leading to an increased erosion potential. The movement of sheep across paddocks "tickles" the soil surface and leads to the burial of weed seeds which enhances the germination of the dominant weed species annual ryegrass (*Lolium rigidum*). The movement of sheep across a paddock also results in soil compaction occurring just below the soil surface.

Seeders with tynes and knife points

More than 80% of growers in WA use tyned seeders fitted with knife points for no-tillage seeding (WANTFA, 2003). Most of these throw soil from the seed row into the inter-row region, burying significant amounts of crop residue and creating a furrow. This tillage and subsequent soil throw enhances the germination of annual ryegrass seed that prior to seeding was exposed on the soil surface. Many farmers have indicated that their seeders could not cope with heavy crop residues and they often burn paddocks to prevent the blocking of seeding equipment. However, this leads to the complete removal of surface residues and any associated benefits. There are some growers who have adapted their tyne seeders to handle relatively heavy residues of about 3 t/ha. The main perceived benefits of tyne seeders are in furrow moisture harvesting, deep cultivation beneath the seed and incorporation of the pre-emergence herbicide, trifluarlin, for grass weed control.

Burning

The most common reasons for burning are for weed control (especially herbicide resistant weeds) and removal of residue to facilitate seeding with tyned seeders. In some instances farmers burn narrow windrows in order to keep some residue; however, this still results in most of the stubble residue being burnt in these windrows. Additionally, these windrow fires can be difficult to control and often result in large areas being burnt. Because of the negative attributes of residue removal and erosion potential associated with burning the report concluded that burning of crop residues always has a negative impact on the system.

Lack of diversity in the crop rotation

Cereals are dominating no-tillage farming systems in WA leading to difficulties in controlling grass weeds such as annual ryegrass where limited herbicide options have resulted in the widespread evolution of herbicide resistant populations. This is because the lack of diversity in the rotation results in overuse of cereal herbicides, particularly trifluralin in wheat. Rotational diversity incorporating non-cereal crops is a key strategy for a sustainable no-tillage system that also allows a wider range of herbicide options. Farmers interviewed as part of the Situation Analysis were aware of the need for using crop rotations and would very much like to have more options. However, farmers indicated that rotational options were limited, largely due to poor economic returns from other crops when grown under dry conditions or on unsuitable soils. As a consequence, the area sown to alternative crops such as canola, lupins and other grain legumes has declined in recent years.

Herbicide resistance in Ryegrass and other weeds

Annual ryegrass is the most problematic weed of dryland crop production systems of southern Australia (Alemseged *et al.* 2001). In WA cropping paddocks there are now very high frequencies of annual ryegrass populations with resistance across multiple modes of action (Owen *et al*., 2005). The widespread evolution of resistance has lead to the control of this weed being focussed on the use of glyphosate and trifluralin in no-till wheat cropping systems. However, resistance has evolved to these herbicides already in WA with 25% of randomly collected ryegrass populations containing trifluarlin resistant plants. Because of the reliance on herbicidal weed control in no-tillage systems the continuing evolution of herbicide resistance is one of the greatest threats to no-tillage cropping.

Different qualities of no-tillage

Derpsch (2005) argued that the main difference between a high and low quality no-tillage system is the amount of soil cover on the surface after seeding where a higher quality of no-tillage production is achieved with full stubble retention. From the Situation Analysis it was evident that there are different qualities of no-till production in WA. At one extreme, paddocks are bare when they are sown and seeders with tynes and knife points throw a substantial amount of soil into the inter-row. On the other hand, there is some high quality no-tillage being practiced where growers are seeding into heavy crop residues with disc seeders that can cope with high levels of residue. Most of this high quality no-tillage has developed in the southern areas where higher rainfall allows for greater crop diversity in the rotation and more robust weed control strategies - it is recommended that researchers and farmers develop these systems in the drier areas. However, two key questions arise that are especially relevant to high quality no-till in the more marginal areas: how much soil cover is enough; and can we use cover crops to add useful levels of diversity to the rotation?

A systems approach to cropping with high levels of residue

According to Derpsch (2005), there is enough scientific evidence to show that no-tillage without soil cover results in poor crop yields (Ashburner, 1984; Wall, 1999). Consequently, soil cover is seen as one of the most important factors in the establishment of successful no-tillage systems in WA. Therefore, it is essential that farming methods to promote the retention of crop residues be pursued. Although soil cover is of vital importance, high levels of crop residue on their own will not provide the solution. In order to be successful no-till must be considered as a cropping system and not just a method of seeding through residues. For example, moving to disc seeders to allow for sowing into heavy crop residues without

consideration of rotations, no-till history, soil type, compaction, livestock, weed burden etc. could lead to failure. The main components of high quality no-tillage systems are permanent residue cover, minimal soil disturbance with disc seeders, controlled or no grazing, diverse cropping rotations with cover crops and integrated weed management.

Many of the benefits of no-tillage and full stubble retention become evident only in the long term. S? (2004) proposed that it took 10 to 20 years, in the consolidation phase of no-tillage, for organic soil carbon to accrue and greater nutrient cycling occur. Long term no-tillage research was recommended to test and further develop high quality no-tillage systems that include full stubble retention, the use of disc seeders, IWM and rotations with cover crops. The situation analysis Report (Derpsch 2005) has been used as the basis for the initiation of two new research projects by WANTFA. The first is a long term project titled “Improving the quality of no-till systems”. The aim is to develop and test no-till systems that have high levels of residue, disc seeders, diverse rotations with cover crops and integrated weed management. The treatments are designed to give different levels of soil cover and these will be compared with current district practice no-till that has relatively low levels of residue and crop diversity and uses tyne seeders. Sheep grazing may be included in the district practice treatment after the first three years, when the trial has been well established. Ground cover levels, weed and disease assessments, crop water use and soil chemical, physical and biological parameters will be measured. This will provide important information on required levels of residue and diversity. The trial has two sites, sandplain soil at Mingenew and heavy soil at Cunderdin, and each of the no-till systems is championed by a team consisting of three local farmers and an agronomist or scientist and the project manager – the “champion” approach to farming systems research was used by the Birchip Cropping Group (2003). The second project is for three years and is titled “Cover crops for no-till farming systems”. The aim is to identify some suitable cover crops, develop methods for managing the cover crops in the rotation and determine their benefits for subsequent cash crops. Interaction and involvement with farmers is a key component of these projects as many growers have experimented with different no-tillage systems and have tried cover cropping – they provide the experience and innovation.

Disc seeders

Disc seeders are the most effective implements for seeding through stubble residues and should, therefore, be promoted as an integral component of the no-tillage system – disc seeders allow seeding into high levels of residue. Derpsch (2005) observed that despite the great variety of disc seeder designs available in Australia, only a few met the requirement of seeding into high levels of residue. Derpsch (2005) recommended that more work should be done to develop disc seeders that were suitable for local conditions and WANTFA strongly endorses this view – hence their inclusion in the long term trials. If the benefits from high residue to-till systems are positive, this might encourage further uptake of disc seeders.

Sheep feeding

Sheep should be kept off no-tillage paddocks in the cropping phase or their grazing managed to avoid bare soil. Confinement feeding systems allow sheep and cropping systems to coexist and create more profitable and sustainable farming systems (Milton 2003), and this method should be encouraged. Alternatively, the use of a separate pasture phase with grazing to control ryegrass is a good option for mixed cropping enterprises. The inclusion of livestock in farming system trials makes them more complicated and requires greater resources. Nonetheless, they are an important component of the WA wheatbelt farming system and we will endeavour to include sheep grazing in the long term no-till trial after it has been running for a few years.

Cover cropping

Crop rotation is a key component of a sustainable no-tillage system. However, the climate and soils in WA limit the options for cash crops. Cover crops, plants grown for soil cover and not for harvest, are a good alternative to increase diversity in the system and to achieve the objectives of crop rotations. The cover crops can be killed with a knife roller or by herbicides and left on the surface and never incorporated. As

well as soil cover, other benefits of cover crops include root exploration at different soil depths, providing additional soil nitrogen and weed control options. As a result the new project on management of cover crops was started in 2006.

Weed control

Weeds provide one of the biggest challenges to no-till systems and there is no one solution. The Situation Analysis emphasised the need for a more holistic approach to weed and nutrient management using crop rotation, cover crops and suitable agronomic practices (IWM - integrated weed management). Agronomic practices that reduce ryegrass germination and growth include: not tickling the soil; using narrow row spacing and higher seed rates; shading the soil with crop residues; and using more competitive cereal varieties. Other practices that should be encouraged occasionally to reduce weed pressure are: windrowing early barley varieties before weed seed set; cutting hay; growing canola that would allow use of other effective herbicides; and growing a cover crop such as saia oats (black oats, *Avena strigosa*) that could be knife rolled before seed set. Many of these IWM components are tested in the new long term no-till systems trial.

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