The advantages and disadvantages of pasture cropping in Western Australia

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Abstract
Pasture Cropping is a relatively new concept in Western Australia. It is increasingly being trialled by farmers on the low fertility sandy soils of the south coast and mid west. These sandy soils have historically been unprofitable to crop, due to poor yields and the need for high inputs. In more recent times, farmers have sown large areas of these sandy soils to subtropical perennial grasses (Kikuyu, Panic and Rhodes grass) as a way to improve pasture production and ground cover. A small number of innovative farmers, supported by researchers and agronomists, are trialling pasture cropping into these pastures. Using input from these growers, we have described the potential advantages and disadvantages of pasture cropping under WA conditions. This exercise has highlighted the need for further research to quantify the relativity of each advantage and disadvantage. Without this, it will be hard to determine if pasture cropping has a role to play on WA farms.

Key Words
Pasture cropping, perennials, low fertile soils

Introduction
Pasture cropping is a farming system where winter active crops are sown into established perennial pastures (Badgery and Millar 2009). This system combines species with complementary growth periods to improve overall productivity and environmental benefits. Growth of summer active (C4) perennial pasture occurs in late spring and summer while winter annual crops grow over winter and early spring. Pasture cropping systems exploit this dynamic and can be used to boost overall feed or grain production (Finlayson 2012). In Western Australia, pasture cropping is being trialled on introduced C4 perennials (Kikuyu, Panic and Rhodes grass). These C4 perennials have been sown on deep sandy soils which are generally unprofitable to crop, due to poor yields and the need for high inputs. In this paper we concentrate on pasture cropping in the Northern Agricultural region of WA which has a Mediterranean type climate. This is in contrast to the system developed in the Central West of NSW on native C4 perennial grasses and with a more even distribution of rainfall (Cluff 1998).

Methods
Farmer's perceptions
Farmer's perceptions of pasture cropping were obtained from semi structured interviews, informal discussions with farmers and views expressed at field days. This builds on the study by Ferris (2010). Collectively, the results represent the views of growers who have actually trialled and/or observed pasture cropping demonstrations. There was no attempt to rate the importance of the farmer's perceptions.

Demonstrations
Four pasture cropping demonstrations were established in 2011 by a local farming group, the Mingenew-Irwin Group (MIG) through a project funded by the Australian Government's Caring for our Country program. The perennial pastures were existing pastures and consisted of Gatton panic and Rhodes grass.

Results and Discussion
The advantages and disadvantages of pasture cropping over perennial pastures in WA are listed in Table 1 and expanded in the text below.

Reasons to pasture crop
To improve profitability. Pasture cropping can lift profitability when stocking rates are low or when the annual species component of the perennial pasture is low. This is probably more relevant for farmers with large areas of perennials and little or no cropping, as these operations often have a low stocking rate when measured on a winter grazed hectare basis and do not want the risk associated with high stocking rates. In addition, first year stands often have low productivity due to the slow development of the perennials and the

lack of annual plants therefore sowing a crop can increase productivity.

Table 1. Potential advantages and disadvantages of pasture cropping in WA

Potential Advantages	Potential Disadvantages
Improve profitability	Perennial density and productivity might decline
Rest perennials (improve persistence)	Crop unprofitable due to low yield potential of soil
Supply nutrients	Crop unprofitable in dry years due to competition
Control weeds	Specialist machinery is needed for sowing crops
Grow feed grain for on-farm use	Weed control is compromised
Improve business flexibility	Annual pasture productivity is reduced
Improve soil health	Soil health might be reduced
Stabilize erosion prone cropping paddocks	

To rest the perennials. Many perennial pasture paddocks are being overgrazed throughout the year but particularly in summer due to inadequate rest. Pasture cropping allows the perennials to be rested for 6 months, often enough time for the perennials to fully recover. The rest also allows opportunities for recruitment.

To supply nutrients. Nitrogen is the most limiting nutrient for perennial grasses. Pasture cropping can supply nitrogen to perennials in 2 ways – from N fixed by legume crops such as lupins, or from fertiliser nitrogen applied to cereal or canola crops. The majority of cereal crops grown on sandy soils have poor nitrogen use efficiency (due to leaching losses), so the perennials being deep rooted can use nitrogen which has leached below the crop root zone. Most farmers do not fertilise perennial pasture paddocks, potentially compromising future productivity. However, fertiliser is applied with the crop and therefore some of this fertiliser will be used by the perennials.

To control weeds. Most perennial pastures contain a range of annual grass and broad leaf weeds. In some cases these weeds can be toxic to livestock (e.g. Patterson's Curse, Blue Lupins) and producers are keen to remove them. In other cases they take over and shade out useful annual legumes such as serradella and subterranean clover (e.g. radish). Pasture cropping can reduce weed seed banks prior to the introduction of better annual pastures such as annual legumes and ryegrass. Perennial grasses are tolerant to a range of herbicides particularly broad leaf herbicides allowing weeds to be controlled (Borger and Ferris 2012).

To grow feed grain for on-farm use. Many farmers with perennial pastures don't grow much grain, or if they do, they focus on wheat and canola. Perennial pasture paddocks could be the area on the farm to focus on feed grain production due to the lower opportunity cost if yield penalties arise. Pasture cropped lupins provide multiple benefits; a valuable sheep feed, nitrogen fixation to benefit the perennials, annual grass weed control and a high quality stubble over summer for young sheep especially if there is summer rain.

To improve business flexibility. Pasture cropping can reduce business risk and provide flexibility as the crop : pasture ratio can easily be changed. It is likely that the majority of pasture cropped paddocks will be sown late in the program to maximize the grazing value from perennials in late autumn. As a result, in late break years they are more likely to be pulled out of cropping and kept as pasture. The benefit is they will probably be more productive than a standard annual paddock left out of crop. If the perennial is cropped then depending on seasonal conditions and commodity prices the paddock could be grazed or cut for hay.

To improve soil health and to *stabilize erosion prone cropping paddocks*. Inputs of carbon and nitrogen from cereal and lupin crops can increase soil microbe diversity and quantity. Increases in soil carbon may also occur. Planting perennials and pasture cropping is less likely to erode compared to annual crop and pasture without perennials. Pasture cropping may allow more crops to be grown because the soil is more stable.

Reasons not to pasture crop

The perennial pasture density and productivity might decline. By spraying out the weeds and sowing a crop into perennials, there is a good chance of causing some damage. Knife points can remove plants from the ground. Likewise, high rates of some herbicides can easily lead to damaged or dead perennials. A small decline in density each time the paddock is pasture cropped might soon lead to a sub-optimal density. On the other side, there is the potential for pasture density to actually improve from pasture cropping as new plants can recruit under the weed free crop.

The crop is unprofitable due to the low yield potential of the soil. Most perennials are sown on poor soils with inherently low crop yield potential. They usually have very low water and nutrient holding capacities, and need a wet year and plenty of fertiliser inputs to yield well. This means the risk of making a loss cropping these soils is fairly high. Lupins require less fertilizer inputs and for this reason they may be most suited to pasture cropping. The flipside being lupins typically have lower returns than other crops.

The crop is unprofitable in dry years due to competition. Perennial pastures actively grow over summer and autumn, meaning soil moisture levels can be very low at the break of the season. However, sandy soils do not store large amounts soil moisture. Therefore crop growth and yield on sands is mostly driven by growing season rainfall. However in late spring, when the crop is trying to fill grain, the perennials start growing due to warmer weather (Ward 2012). Competition as this time of year is likely to be the most detrimental to crop yield and grain quality. Using an early maturing crop variety may reduce this issue.

Specialist machinery is needed for sowing crops. 95% of farmers use knife points to sow their crops, but unless the perennials are widely spaced or everything set up on Auto-steer with 2cm accuracy or a good set of coulters, then a disc machine may be required. This could be a big limitation given the cost of owning a second machine and the small areas likely to be sown with it. Disc machines will be the best option to sow crops in to perennials without causing excessive damage to the perennials. However, a disc machine may not achieve satisfactory crop establishment on these mostly highly non-wetting sandy soils.

Weed control is compromised. Many perennials appear quite tolerant to a range of commonly used cropping herbicides, but there is always the risk of causing unacceptable damage to the perennials. This risk means producers might compromise effective in-crop weed control to guarantee the survival of their perennials, leading to weedy crops and weed problems in future years.

Annual pasture productivity is reduced. Even in dense perennial pastures, a good annual grass and legume (and weed) content improves carrying capacity. By spraying out the annuals to undertake pasture cropping a years' worth of annual pasture seed production has been removed. This will reduce the density and productivity of the paddock in the following year, if not longer. The cleaner the crop and the longer the paddock is pasture cropped, the more an issue this becomes. Ensuring pasture cropping paddocks contain a large seed bank of hard seeded annual legumes such as yellow serradella might minimise this downside.

Soil health might be reduced. One of the claimed benefits of perennial pastures is an improvement in soil health, particularly soil carbon. Pasture cropping could compromise this due to the increased use of tillage and chemicals that are harmful to soil biology. However it is well known that a soil with good soil organic matter can better buffer the effects of tillage and chemicals, so this might be a zero sum game.

Demonstrations

Details and yields of the demonstrations are summarised in Table 2, additional information is given in the text. Farmer A sowed two crops into separate areas of an overgrazed and thin perennial grass stand using a No-kill system. Weed competition was minimal. Nitrogen deficiency reduced the growth of the oat crop but the yellow lupins grew well. The crops were not harvested but grazed over summer. The farmer is confident that summer livestock carrying capacity has increased and plans to trial another paddock in 2012. The farmer believes that a low input cropping system has a better fit because of the higher risk associated with cash cropping on poor soils.

Farmer B sowed two crops into different paddocks both with good stands of perennials. The paddock with the oats was sown to lupins the previous year and was relatively weed free. The lupin crop was profitable returning $300/ha of income compared to $155/ha of costs and a large number of perennials seedlings emerged in spring. The oats was nitrogen deficient and was left as a standing fodder crop, the costs were $228/ha. The grazing value over summer would have been higher in this paddock due to the oats but the benefit is unlikely to have covered costs. However, the serradella will improve the quality of the pasture.

Farmer C sowed three crops into different parts of an overgrazed and thin perennial grass stand. Nitrogen was applied post seeding and a broadleaf herbicide was applied to control radish and Patterson's curse. Grass weeds were a problem due to the early sowing and lack of previous weed control. It was therefore decided to

graze the paddock during winter. The paddocks did not give any additional grazing compared to adjacent perennial paddocks. The paddock was destocked in spring to create a standing fodder crop for summer grazing. The crop cost $110/ha but the extra return from grazing over summer is unlikely to cover these costs. The farmer will try a lower cost pasture cropping system in the future to increase winter and spring grazing.

Farmer D sowed two crops in separate locations into a dense 2009 sown stand of subtropical perennial grasses. At sowing the seeder was causing damage to the perennials and therefore it was decided to shallow seed. This resulted in reduced crop germination but because of the high seeding rate plant density was okay. Although the knock down herbicide was effective broadleaf weeds were evident later in the season. In addition the perennials were actively growing in spring and would have competed with the crop. The crops were not harvested as sheep broke into the paddock in summer. The input costs were $203/ha for wheat and $165/ha for lupins. The farmer thought that it was not profitable and therefore will not look to grow a cash crop again. However, he sees a fit for pasture cropping to grow a standing fodder crop.

Table 2. Summary of pasture cropping demonstrations

Farmer (locations)	Crop	Date sown	Inputs [A]	Yield (t/ha)
A (Kojarena)	Oats	26 May	None	0.6-0.9
A (Kojarena)	Yellow lupins	26 May	None	1.1-2.3
B (Dongara)	Oats & French serradella	3 July	Standard	<1
B (Dongara)	Lupins	3 July	Standard	1.45
C (Irwin)	Oats	8 May	Standard	0.6-1.0
C (Irwin)	Wheat	8 May	Standard	0.3-0.7
C (Irwin)	Triticale	8 May	Standard	0.3-0.7
D (Three Springs)	Wheat	10-11 June	Standard	1.5
D (Three Springs)	Lupin	10-11 June	Standard	1.0

[A] Standard refers to a knockdown herbicide and fertiliser at seeding

Conclusion

Pasture cropping has captured the imagination of farmers with existing stands of perennials in the Northern Agricultural Region because it can provide a dual income (crop and livestock products), it allows the perennials to be rested, nutrients are supplied to the perennials, it allows the control of weeds, it can improve flexibility and it can provide NRM benefits. Farmers in association with MIG have established paddock scale demonstrations to test the advantages and disadvantages of pasture cropping. The results from these demonstrations were mixed with some successes but others produced a cash loss. Until the fertility of these soils can be increased lupins appear to be the best fit as it supplies nitrogen and is a lower cost option. Although using cereals with minimal input may also have a place especially if paddocks with low weed burdens are selected. Using the crop as a standing fodder crop is one way to reduce costs. To improve our understanding of pasture cropping in this environment MIG will conduct an additional five on-farm demonstrations in 2012 and a trial has been established in 2011 to be sown to wheat and lupins in 2012.

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