Factors affecting the adoption of subtropical grasses in the Northern Agricultural region of WA

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Abstract
Perennial grass-based pastures grown on pale deep sands in the Northern Agricultural Region of WA have reduced erosion and provided out of season production. Over the past decade, about 50,000 ha of subtropical perennial pastures (mainly Gatton panic and Rhodes grass) have been sown in areas receiving at least 350 mm average annual rainfall. However, this is well below the 850,000 ha of suitable soils. This paper investigates the drivers and barriers to the adoption of perennial grasses and associated technologies: pasture cropping and companion legumes. Survey questions were developed for three target groups: farmers with no perennial grasses, farmers with some perennials (<200 ha), and farmers with large areas of their farm (>15% or >200 ha) under perennial grasses. Forty seven farm businesses completed the survey which was distributed at workshops or responded to an online survey. An interest in livestock was an important driver for adoption of perennial grasses. For the eight growers without perennial grasses the major constraint was the cost of establishment followed by the risk of establishment failure with the financial benefits not being clear. For the 39 farmers who had perennials the major reasons they adopted perennials was increased out-of-season feed, increased production, reduced erosion risk and increased profitability. For the 15 farmers that had large areas under perennials, the major weakness of their perennial based system was lack of or low companion legumes followed by difficulties with grazing management especially in dry seasons. The survey is complemented by two case studies, one farmer who has adopted subtropical grasses and one who has not.

Key words
EverCrop, pasture cropping, companion legume, practice change

Introduction
In the Northern Agricultural Region (NAR, which extends ~500 km north of Perth and ~100 km inland) an estimated 20% of the 2.0 million hectares of agricultural land are pale deep sands which have low fertility and low water holding capacity. Due to the low productivity of annual pastures on these soils and the high risk of wind erosion, farmers and researchers have evaluated alternative pasture species on these soils since the 1980s (Moore 2014). The fodder shrub tagasaste (*Chamaecytisus palmensis*) was successful on these poor sandy soils but it has some management limitations. Introduced subtropical perennial grasses have been tried in the area but with mixed success. As the technology improved particularly in relation to the establishment on non-wetting soils the area sown to subtropical grasses grew substantially and since 2000 more than 50,000 ha have been sown in the NAR. Adoption has been driven by increased pasture production in autumn–early winter, provision of out-of-season green feed, and their ability to reduce the risks of wind and water erosion by maintaining groundcover throughout the year (Moore 2014). The main subtropical species have been panic grass (*Megathyrsus maximus*) and Rhodes grass (*Chloris gayana*).

Pasture cropping over subtropical grasses is a more recent innovation in the NAR (Lawes 2014). Farmer interest was sparked initially by the NSW experience (Miller 2009) as it could provide additional income. 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 providing both grain and livestock income. Although perennial-based farming systems are continuing to increase in size there is a large gap between actual and potential adoption. This study as part of EverCrop and a Caring for our Country project examined the factors influencing the adoption of subtropical perennials and pasture cropping.

Method
Social science survey
The structure of the survey and questions were developed in a workshop with key stakeholders (consultants, local farming groups and the Department of Agriculture and Food, WA extension specialists). From the workshop 3 target groups were determined; farmers with no perennial grasses, farmers with some perennial

grasses (<15% of the farm or <200 ha) and farmers with large areas of perennial grasses (>15% of the farm or >200 ha). For each target group there were four to five sets of questions. One set had a list of responses for which the respondents could either rate as not applicable, or as low, moderate or high importance. For some questions the respondents were asked to select the three main reasons, constraints or weaknesses. For some questions the respondents were asked to give a rating from 1 to 5 in terms of either agreeing or disagreeing with a series of statements relating to the establishment and management of perennial grasses and related technologies like companion legumes and pasture cropping. The respondents completed the survey over the period from February to April 2012 either online using 'Survey Monkey' or a hard-copy at workshops which was subsequently entered into Survey Monkey. Some questions were similar between the group with some perennials and the group with large areas of perennials so the results were combined.

Case Studies
Two case studies are described which highlight differences in how farmers perceive and use perennial grasses. The information was collected between 2011 and 2014 from semi-structured interviews and informal discussion between at least one of the authors and the farmers involved.

Results
Social science survey
Forty seven farm businesses completed the survey. There were eight respondents who had no perennial grasses and on average their farms were larger (2725 ha, 52% crop) than the 24 respondents with some perennial grasses (1765 ha, 46% crop). There were 15 respondents who had larger areas of perennials and on average they had less crop area (17%) than the other two groups.

Farmers without perennial grasses. For the eight farmers with no perennial grasses the major constraint to adoption was the cost of establishment (7 rated this of high importance, 1 rated it as moderate), while second order constraints were risk of establishment failure (3 rated as high importance, 2 rated it as moderate) and that the financial benefits were unclear (3 rated as high importance, 3 rated it as moderate). A higher return from livestock was the most important factor (5 responses when asked to select the top 3 reasons) that would motivate them to trial perennial grasses, while more information on productivity (4 responses) and availability of incentive schemes (3 responses) were second order factors. Over half of the respondents believe that perennial grasses had a role on their farm in the future (rating of 4 or 5 with 1 = strongly disagree to this statement and 5 = strongly agree). All of the farmers were aware to some degree of pasture cropping (average rating of 4.0). However, they were neutral in terms as to whether it had a role on their farm (average rating 3.3).

Farmers with perennial grasses. For the 39 farmers who have perennial grasses there were a range of reasons for growing them or advantages to growing them with generally small differences in importance (rating 1 to 3, with 1 = low importance and 3 = high importance):
- increased production and reduced erosion on poor sandy soils (average rating 2.5, 64% rated it as high importance)
- increased out of season feed (average rating 2.3, 51% rated it as high importance)
- increased profitability (average rating 2.3, 51% rated it as high importance)
- improved soil health (average rating 1.9, 31% rated it as high importance)
- flexibility with pasture cropping (average rating 1.1, no one rated it as high importance, 5 indicated it was not applicable)

Nineteen of the 24 farmers that had some perennial grasses were planning to expand the area within 2-3 years. Of the 5 that were not expanding the area the major reasons were: out-of-season production is variable, risk of establishment failure and sub-optimal perennial plant density (poor persistence) (3 responses for each, when asked to pick the top three). Of lower importance (2 responses) were no suitable soils, cost of establishment and previous poor establishment.

The 15 farmers with large areas of perennial grasses identified the major weakness as lack of or low companion legumes (8 responses), while second order weaknesses were management in dry seasons (5 responses), grazing management (5 responses) and persistence (4 responses). Lower order weaknesses were; financial benefits are unclear, insufficient productivity of perennial grass-based pastures and risk of livestock disorders (all with 3 responses). There were 4 farmers who said that they had no major weaknesses with their perennial grass-based pastures.

For those farmers with large areas of perennial grasses to maximise the profitability of their perennial grass-based feed base the major needs were: more information on fertiliser requirements (8 responses) and more information on companion legumes (7 responses). Second order needs were a reliable package for summer sowing legumes (4 responses - Summer sowing is a technique to introduce hard seeded French serradella cultivars into pastures), more information on grazing systems and more information on reducing livestock disorders (both 3 responses). There were five farmers who said there were no major constraints.

In terms of pasture cropping the 39 farmers who have perennial grasses were more likely to disagree with statements that they have the information to pasture cropping (average rating of 2.5 with 1 = strongly disagreeing and 5 = strongly agreeing), the skills and experience to adopt pasture cropping (average rating 2.5) and plan to adopt within two years (average rating 2.6). They were neutral on the statements that pasture cropping has a role on their farm (average rating 3.1) and they have the confidence to adopt (average rating 2.8). In terms of annual legume content in their perennial pastures the farmers who more likely to disagree that they have a good content (average rating 2.5) and more likely to agree that they need to increase the content (average rating 3.9). They were also more likely to agree that they were aware of the summer sowing of annual legumes (average rating 3.2) and they need more information on the technique (average rating 3.4).

The main sources of information for perennial grasses and related technologies were field walks and field days (selected by 87% of the 39 respondents), while other important sources of information were other farmers (79%) and experienced growers (72%). Second order (36-51%) sources of information were a farming group (Evergreen Farming), the Department of Agriculture and Food, local natural resource management groups and the rural press.

Case studies

Farmer A is located near Geraldton and has 1200 arable hectares. The average annual rainfall is 465 mm of which 16% occurs outside the growing season. Cropping is a minor component of the enterprise. There are 900 ha of perennial grass based pastures, panic grasses are the dominant species sown with smaller amounts of Rhodes grass, kikuyu (for deep white sands) and Giant couch. The soil type consists of deep sand and sand over gravel with quality varying from poor sands to good yellow sand. On average the farm carries 800 head of cattle consisting of a mixture of 200 breeders their calves plus trade cattle. They buy in cattle around June and sell as many as they can between Christmas and February including their own calves. This cycle matches the availability of pasture on the property.

The main reason they are growing perennials is because they are livestock producers, the bulk of the property is not suited to cropping and the shallower soils don't seem to be suited to annual species.
Perennial pastures have increased the carrying capacity. Farmer A believes that the carrying capacity has doubled and now considers rain at any time of the year as valuable. Since establishing the perennial pastures summer rain has been infrequent. The perennial grasses have also improved the ground cover reducing the risk of wind erosion.

Farmer A has been pasture cropping since 2009. They were interested initially in pasture cropping as a way to spell the perennial pastures because under a crop they are not grazed for 6 months. Subsequently they saw a place for it in second year stands of perennial pastures. This is because when establishing perennial grasses in late winter-early spring the annual pasture are sprayed out, so there is no seed-set in the year of establishment. Therefore crop adds to the density and if it is a cereal and depending on the season they can either graze or harvest the grain. Barley and lupin have been tried and yields have been sufficient to justify the expense of cropping.

Farmer B is located near Moora and farms 1450 arable hectares with 500 mm average annual rainfall of which 20% occurs outside the growing season. Average cropping area is 55% and livestock enterprise involves buying and selling sheep. They buy sheep in spring when the prices are lower and run them over summer on the stubbles and they are generally sold before the break of season. The dominant soil type on the property is yellow sandplain (75%) and 25% gravelly soils, with 140 ha of tagasaste on infertile deep sands. The rest of the non-crop area is volunteer annual pastures.

Tagasaste is used for sheep grazing, to control salinity/waterlogging, to provide flexibility in responding to variable seasonal conditions including out-of-season rainfall and to reduce wind erosion. Farmer B does not intend to grow perennial grasses and said that reduced trafficability was a key factor. A second issue is the risk of establishment failure and wind erosion at establishment. In addition crop yields are increasing on the soil they were considering for growing perennial grasses, because of the adoption of new technologies such as spading. This has overcome water repellence by bringing up subsoil clay. Also subterranean clover suits their system. It can be grazed heavily and it sets seed, it handles herbicides and it always comes back after cropping. If there was no issue with trafficability and they were slightly more committed in terms of livestock then they would consider perennial grasses.

Farmer B hosted a long-term pasture cropping trial and therefore observed the results first hand (Lawes 2014). The farmer's thoughts on pasture cropping were that you get both crop and pasture with the opportunity of the pasture to respond to out-of-season rain. The trial found that overall the productivity is increased (crop and pasture) which he finds promising in this climate. The trial showed no yield loss but his thoughts were that if you went north then the situation changes and trials are showing there is a yield loss. The farmer's belief is that if there is a hint of yield loss many farmers would not adopt the technology. For Farmer B even though there was increased productivity he would not consider pasture cropping because good yields are achieved without perennial grasses especially with techniques like spading to reduce water repellence and if you had perennial grasses there may be issues with trafficability. Farmer B believes that pasture cropping will not be widely adopted.

Discussion and conclusions

The survey of farmers with large areas of perennials (>15% of the farm or >200 ha) and the example of Farmer A show that perennial grasses give a clear relative advantage to their livestock system. The major reasons for adoption of perennials by these farmers are that livestock is their main focus, they have higher percentage of low quality soils which are less suited to cropping and perennial grasses are more productive and they reduce wind erosion compared to annual pastures.

For those farmers who have a greater percentage of crops, less livestock and a lower proportion of poor quality soils the relative advantage of growing perennials is lower. Farmer B is one example of this group with tagasaste replacing the need for perennial grasses. For these farmers the disadvantages like cost of establishment and risk of establishment failure are more prominent, the advantages are not as clear and possibly there is less motivation to make the system work. Adoption or expansion (or dis-adoption) of perennial grass-based farming systems will depend on how much focus the farmer have on livestock, the area of lower quality soils on their farm, the degree of productivity increase by the perennials, the amount of out-of-season rain, the cost-benefits of other technologies (such as spading) and the relative profitability of livestock compared to crop. Those farmers who have no perennial grasses probably have an even greater focus on crop and may try alternative technologies to improve the productivity of their soils rather than growing perennial grasses.

Pasture cropping is generally viewed favourably by those who have perennial grasses. However, most farmers do not see the technology as a reason for adopting perennial grasses rather it adds to the advantages of growing perennials. Perennial systems are a way to reduce the risk associated with farming in this environment (Robertson 2014) and are valued by mixed crop-livestock farmers who responded to the survey. Additional research and development is required to continue to improve the profitability of perennials in cropping systems. Technologies like pasture cropping and increasing the legume content using summer sowing are examples of such research.

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