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Making better use of crop stubbles on mixed farms

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Abstract

This report was commissioned by Meat and Livestock Australia to examine the opportunities, challenges and risks associated with using crop stubbles as part of the feed base on mixed farms. Although there is a widely held belief that increased utilization of stubbles compromises optimum stubble management, which is seen as undesirable, increased opportunities were identified. These opportunities, however, often addressed cropping, farming systems or integration issues rather than the direct use of stubbles as a valuable feed source for livestock.

Executive summary

Falkiner Ag was contracted by Meat and Livestock Australia (MLA) to examine the opportunities, challenges and risks associated with using crop stubbles (and potentially dual purpose cereals) as part of the feedbase on mixed farms. The examination included contributions from farmers, advisors and researchers as well as the scientific literature. Insights were to inform the MLA and partners of reasons (if any) to invest in tools and technologies that would allow mixed farmers to make better use of crop stubbles on mixed farms.

Information gathering involved phone interviews, small group discussion and a facilitated workshop. A focussed conversation method was used for the phone interviews and face to face discussions. Sixty people contributed to the findings, including 40 farmers, 12 advisors and eight researchers. Interviews were conducted in October and November 2011 by FalkinerAg. The workshop was facilitated by Nicon Rural Services.

Three distinct farmer zones were evident from the interview. These were:

- The crop dominant wheat sheep zone including areas of Southern Western Australia, Southern and Western NSW and Northern Victoria and South Australia. This zone was characterised by crops with lighter stubble loads, long dry summers and soils that are potentially more prone to erosion. Livestock enterprises are generally a smaller proportion of the overall farming business.
- The southern high rainfall zone which includes Southern Victoria and East South Australia characterised by heavier textured soils, a cooler shorter summer and large residual stubble loads after harvest. Livestock has traditionally been the main enterprise.
- The northern summer/winter cropping zone of northern NSW, characterised by annual rainfall which is distributed about two-thirds over summer and one third over the winter. Summer rains are often intense, leading to a high likelihood of erosion. Livestock are present and are an important component of agriculture in the region, but sheep and cattle are often run on separate parts of the property where cropping is not practiced.

The most striking aspect of the interviews was the strongly entrenched belief by most farmers and advisors in the wheat sheep and northern summer/winter cropping zone that introducing livestock would compromise their stubble management. They believe grazing stubbles reduces the capture and conservation of soil moisture, makes stubble more difficult to manage in the next cropping phase and increases the risk of erosion through removal of groundcover and loosening of the topsoil. Significant research and farmer experience supports this position. The authors believe this attitude will limit the opportunities to develop, promote and practice stubble grazing in these zones. Greater opportunity exists in the southern high rainfall zone, where the shift to cropping has been more recent, moisture conservation and groundcover are lesser issues and livestock still play a major role in the enterprise mix.

Despite these previous comments some opportunities were identified, however these opportunities often address cropping, farming systems or integration issues rather than the direct use of stubbles as a valuable feed source for livestock. They are also only likely to have localized application.

The opportunities include:

1. The development of simple 'rules of thumb' for grazing stubbles that combine livestock performance, groundcover and stubble management objectives. These are applicable to all zones but are more likely to be taken up in the higher rainfall areas.
2. The creation of tools to enable short term economic comparisons between crop, fodder or livestock options, especially as the crop reaches maturity. Applicable to all zones.
3. Experimentation to understand the influence of weed growth and residual stubble mass over summer on soil moisture and nutrient levels and then the flow on effects on future crops in the southern high rainfall zone.
4. The scoping of novel livestock ownership - grazing models to provide pathways to enable farmers with stubble but no animals to utilise their stubbles with livestock. Applicable to all zones.
5. Experimentation into increased stubble utilisation by having high quality feed grown as a companion crop in the stubble. Limited to the higher rainfall zones where soil moisture is not a major limitation to crop production.
6. Investigating the benefits of grazing stubbles with livestock to achieve other crop outcomes such as pest control, reducing excess groundcover and managing herbicide resistant weeds. Applicable to all zones.
7. Investigating the expansion of novel or non traditional crops which have stubbles of much higher grazing value. This is likely to be limited to niche areas where the varieties, soils and environment are suitable.

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1. Background

Falkiner Ag was contracted by Meat and Livestock Australia (MLA) to conduct a knowledge and opportunity study. The objective of the study was to identify and prioritize prospective areas of research, development and/or extension that would maximize the benefits that mixed farmers can obtain from grazing stubble while minimizing any costs or risks to subsequent crops.

The study resulted from recommendations of the Feedbase R&D Plan (FR&DP), a component of the larger Feedbase Investment Plan (the FIP). The FR&DP recommended to *"explore how to most effectively utilise crop stubbles in mixed farming operations without damaging soils and the yield potential of future crops".* The study was required to take into account:

- Current and previous industry (grains, meat, wool) funded projects
- Farmer perceptions of the benefits and risks
- Published literature
- Insights from farm advisors and researchers
- Differences between agro ecological zones
- Current Government moves to price carbon and encourage farmers to increase carbon storage in soils

Outputs from the study were required to inform MLA and partners of reasons (if any) to invest in tools and technologies that would allow mixed farmers to make better use of crop stubbles on mixed farms.

2. Methodology

A stubble utilisation 'balance sheet' (appendix 1) combined with a focussed conversation method (Stanfield, 1997) formed the basis of the study process. The 'balance sheet' was created to map out the potential positives and negatives of grazing stubbles. It provided prompts or issue to explore during the interview process. The focussed conversation method is a semi structured questioning process that not only captures *what* people think and do, but enables participants to reflect on *why* they hold those views. In combination these methods enable a thorough examination of known issues and also provide an opportunity to examine other aspects relevant to the topic.

The stubble utilisation balance sheet and focussed conversation questions were prepared by FalkinerAg (Simon Falkiner) and Nicon Rural Services (Cam Nicholson). Interviews were conducted by FalkinerAg (Simon Falkiner) and Lisa McFadyen, Condobolin NSW. Sixty people were interviewed as part of the study. Approximately half the interviews were by phone, with 25 face to face discussions. Interviews were conducted in October and November 2011. The number of interviews was based on obtaining an adequate geographic spread and ceased when responses from interviewees were identifying issues and insights that had already been captured.

Once all interviews were completed, the key issues from the conversations were collated into a discussion paper. This discussion paper was used at a workshop of farmers, advisors and researchers who had not been interviewed previously. The workshop tested the initial findings in the discussion paper, enabled additional opinion to be examined and identified what potential investment opportunities may exist (including a ranking). The workshop provided a second filter of the data.

During the interview process it became clear that opinion divided on where the person lived and ran their business. This created three distinct farming zones, with respondents in each zone having common issues and consistent thoughts. It was decided to use the commonality *within* zones and differences *between* zones as the basis for analysis. The three zones are categorised as:

- The traditional wheat sheep zone including areas of Southern Western Australia, Southern and Western NSW and Northern Victoria and South Australia. This zone is characterised by crops with lighter stubble loads, long drier summers and soils that are potentially more prone to erosion. Livestock enterprises are generally a smaller proportion of the overall farming business and there has been a decline in livestock numbers over the past decades. Successful cropping outcomes drive their thinking.
- The southern high rainfall zone which includes Southern Victoria and East South Australia. This zone typically has heavier textured soils, a cooler shorter summer and large residual stubble loads after harvest. Livestock has traditionally been the main enterprise, with a very rapid shift towards cropping during the last decade. Livestock issues still drive much of their thinking. There is a need to utilize stubbles and maximise performance due to reduction in the pasture feed base. The other consideration is the need to maximize performance in the cropping operation due to high input costs.
- The northern summer/winter cropping zone encompasses Northern NSW. The zone is characterised by annual rainfall which is distributed about two-thirds over summer and one third over the winter. Summer rains are often intense, leading to a high likelihood of erosion. Livestock are present and are an important component of agriculture in the region, but sheep and cattle are often run on separate parts of the property where cropping is not practiced. Livestock infrastructure (internal fencing and water points) has generally been removed from cropping areas to maximise the efficiency of cropping

operations. Management decisions focus primarily on maximising the opportunities to dual (summer and winter) crop.

Interviews were conducted across the three zones (Table 1) and were a broad cross section of target audience (farmers, advisors and researchers) (Table 2).

Table 1: Participants interviewed by farming zone

Farming zone	Number
Traditional wheat - sheep zone	39
Southern high rainfall zone	15
Northern summer / winter cropping zone	6
TOTAL	60

Table 2: Participant type involved in interviews

Participant type	Number
Farmers	40
Advisors / consultants	12
Researchers	8
TOTAL	60

3. Discussion, key findings and conclusions

3.1. Dedicated croppers believe livestock compromise crop performance

The importance of crop success was the most consistent message gleaned from farmers and advisors in the traditional wheat-sheep zone. They would take actions or avoid certain practices to ensure the next crop had the maximum chance of establishing and reaching full potential. This is not surprising as they have 'put all their eggs in one basket' by pursuing a crop dominant business and don't wish to jeopardise potential success.

They believed the three most important components to achieving crop success were:

1. Capturing and conserving soil moisture (and nitrogen)
2. Keeping the stubble in a condition that is easy to manage in the next cropping phase[1]
3. Preventing erosion (groundcover management).

These three components are interlinked and in many cases farmers believe they are best achieved by not having livestock. Animals just complicate the management of these three components (as discussed below).

3.1.1. Capturing and conserving soil moisture (and nitrogen)

Soil moisture is king in the minds of farmers and advisors in the wheat sheep and northern cropping zones. They are aware of the key findings from the research e.g. Hunt *et al* (2011a), computer modelling e.g. *Yield Profit* and strongly believe there is a yield benefit from the retention of moisture and nitrogen. The cost benefit figures available confirm their intuition. They also believe an additional benefit is improved nitrogen mineralisation through the breakdown of organic matter due to better soil moisture levels.

Stubble retention is widely practiced, especially in the lower rainfall zones (GRDC, 2010), as a means of capturing rainfall and storing soil water. Those interviewed were convinced retaining stubbles increased infiltration of rainfall, especially after summer storm events. Many had also observed how effective stubble retention was at enhancing infiltration, because dams that would normally fill from surface runoff in conventionally farmed paddocks failed to fill under retained stubble systems.

Many also said they believed it helped prevent evaporation. Current literature supports the conclusion that even low levels of stubble (approx 2 t/ha) have a positive effect on infiltration (Hunt *et al* 2011b) but suggest much higher levels (>5 t/ha) are needed to influence evaporation (Hunt *et al* 2011a). The effect of high stubble levels reducing evaporation was confirmed by farmers in the southern high rainfall zone where excessive stubble loads often prevent soils from drying out over summer.

Investigations clearly show grazing will reduce the total stubble mass (Nicholson 2008, Scott *et al,* 2010) and therefore is counterproductive to retaining material to enhance infiltration in the two zones with the largest area of cropping.

Summer weed control was seen as the most appropriate action to conserve existing moisture and nitrogen levels. Even small populations of actively growing plants were seen as robbing the soil of valuable moisture. Herbicides were commonly applied during summer

[1] Ease of management includes avoiding blockages at sowing, enabling a quick and consistent burn if desired and optimising herbicide efficacy.

to control weeds because livestock 'can't be trusted' to do the job in a timely and effective manner.

Farmers and advisors in the southern high rainfall zone viewed summer weeds differently. Weed control in stubble was not seen as a priority, especially from a moisture conservation point of view and there is no experimental data to enlighten this position. Instead wet summers were seen as more of a problem, with farmers looking for ways of de-watering the soil profile to reduce the risk of water logging in the next winter crop. Many simply let the weeds grow (but controlled them before seed set while others grew low cost summer crops e.g. millet to deplete soil water over summer). The wetter than average summers over the past two years have probably elevated this issue in the minds of farmers and advisors.

3.1.2. Keeping stubble in a condition that is easy to manage in the next cropping phase

Creating stubbles that were easy to manage was a recurring justification for the decisions to exclude livestock. It was widely accepted that livestock tend to flatten standing stubble and often spread windrows. This creates potential crop establishment problems with blockages at sowing, reduced herbicide efficacy on weeds and inefficient burning of windrows and stubbles (if required).

Several interviewees said having livestock on stubbles tempted them to compromise on their crop preparation activities. These included delaying weed control, delaying burning or holding stock for extended periods on crop stubbles in an attempt to build a pasture feed wedge. If they didn't have livestock, there was no dilemma and crop preparation could proceed with less complication.

3.1.3. Preventing erosion (groundcover management)

It was clear the people interviewed in all areas, including some in the southern high rainfall zone had a genuine and consistent aim to avoid wind and to a lesser extent water erosion. Maintaining groundcover was the best means of preventing erosion (supported by ample experimental evidence) and this belief has become so strong that some farmers in Western Australia were convinced retained stubble would enable them to consider removing contour banks and tram lining up and down slopes.

As mentioned previously, grazing has been shown to reduce stubble mass and therefore groundcover. With a strong conviction to maintain groundcover, farmers in the lower rainfall zones in particular see livestock as working against this goal. In addition farmers feared grazing loosened the topsoil, which then made the soil more prone to potential erosion. There is limited data on the 'looseness' aspect of soil associated with grazing and the potential increase in erosion risk, to know if this is a legitimate concern or not.

Defining optimum groundcover levels was interesting. Nobody interviewed managed to a generic groundcover target. Instead they created their own 'benchmark' because they believed the optimum groundcover was highly specific to the paddock conditions, residual crop and the soil type. The groundcover targets they work towards were formulated by balancing the fragility of their soils (which they know better than anyone else), actual groundcover remaining after harvest (which changes on an annual basis), with the capability of their machinery to cope with the remaining groundcover and potentially realising some animal production from the resource. It was evident the intuitive benchmarks they use are paddock specific and change annually. Therefore it is not surprising that the majority of farmers surveyed in the 2007-2008 Agricultural Resource Management Survey (ABS 2009) indicated that they did not manage to a numeric groundcover target.

This finding brings into question the value in using generic groundcover targets as promoted by Catchment Management Authorities, Research and Development Agencies and funding partners like Caring for our Country as a measure of success. They are not specific enough and clearly farmers do not use numbers to determine the groundcover levels they manage for.

Several people interviewed admitted they did not always achieve their optimum groundcover levels, but their intent was clear. Sometimes the actual groundcover was below what they considered to be adequate or what they aspired to, but as one farmer said 'if that is all you have got, that's all you've got'. They then manage the stubble accordingly. If groundcover was at or below their intuitive minimum groundcover target, then it is highly unlikely these stubbles would be grazed.

The second deviation from the ideal groundcover level occurred when there were 'excessive' amounts of groundcover. This applied to all zones. The definition of excessive was unique to each farmer and was shaped by the sowing equipment used, weeds to be dealt with, herbicide options available and the pest and disease history. In all instances, excessive groundcover created a problem because it had the potential to compromise future crop establishment. In particular farmers in the southern high rainfall zone believed excessive groundcover (high stubble loads) prevented evaporation which resulted in a wetter soil profile at sowing and potentially increased water logging later in the season. Increases in pest and diseases were also mentioned.

The risk of excessive stubble compromising future crop performance led farmers to 'break their own rules'. For example, a crop stubble that may have the ideal minimum groundcover level may also cause a slug problem. Groundcover can enable slugs to survive summer if untreated threatening the next crop, despite the use of baits. Grazing and/or burning are two options that could be used. Burning removes the shelter, leaving the slugs vulnerable to desiccation and predation. The hoof impact from grazing destroys their habitat and physically crushes the slugs. However both actions may well lead to groundcover below the desired target of the farmer, but is seen as necessary to protect the future crop. The farmer is trading (increasing) erosion risk to reduce risk of establishment problems, but doing this in a calculated way.

Considerable discussion has been given to why farmers and advisors believe livestock should not graze stubbles, especially in the lower rainfall zones. This may appear counter to the purpose of this study which is to identify opportunities to effectively utilise crop stubbles in mixed farming operations. However the authors believe these strong (entrenched) beliefs, may well over-ride any attempts to 'paint the positives' of stubble grazing. This has important implications for not overstating positive outcomes that may be achieved if MLA invested resources in stubble management.

Conclusion:

There is limited short term opportunity to increase the grazing of crop stubbles with dedicated croppers because they currently believe livestock can compromise their management system too much. These farmers manage most of the crop stubbles in the country.

3.2. Farmers in higher rainfall zones have more interest and see greater benefits in trying to graze livestock on stubbles.

Farmers with a higher proportion of livestock were more likely to seek grazing opportunities in stubbles if it delivered an overall net benefit to the farming system. These farmers generally came from the higher rainfall parts of the wheat-sheep zone and the southern high rainfall zone where livestock is or was a higher proportion of their farming business. They exhibit the characteristics and flexibility described by Ewing and Flugge (2004) where the enterprise mix changes, sometimes rapidly, to capitalise on emerging opportunities.

Retaining livestock was a critical part of their risk management. They see livestock as a valuable hedge against the greater volatility of the cropping enterprise. Because of this mind-set, they seek opportunities to integrate livestock into the cropping system. These included

- Using the feed value in stubbles
- Grazing crops in winter
- Trading stock when feed was in abundance
- Choosing the class of livestock to graze on crops that matched the feed quality available and performance targets required
- Achieving animal health (internal parasite) objectives
- Utilising cropping land when the crop establishment 'window' was missed because of failed, late or no sowing.

This group were more interested in maximising the return per hectare, making best use of the rainfall and soil moisture, irrespective of the enterprise. A crop that was sown, but was deemed marginal nearing harvest, may well be grazed rather than taken through for grain. They were less set in their approach and flexed between enterprises based on potential returns that could be achieved.

Farmers and advisors in this group also recognise the importance of managing soil moisture and groundcover, especially those who currently have a higher proportion of cropping. However they would be prepared to compromise on these aspects if the net benefit to their system is large enough.

From the interviews and workshop several issues have been identified. They are discussed with consideration of the potential audience and likely practice change that could be achieved.

3.2.1. Promoting stubbles as a feed source

Most interviewees believed stubbles did have some value for a livestock operation because of the presence of residual grain and weeds but the value was highly variable and paddock specific. This observation is supported by quantity and quality surveys of paddocks in Western Australia (Butler & Croker, 2006) and Southern Victoria (Nicholson, 2007) and suggests that more could be made to utilise this resource with farmers in the southern high rainfall zone (appendix A2).

However we found the desire of farmers to extract *100 % of* the feed value from all stubbles in this zone is diminishing especially with the more progressive farmers. Traditionally animals were set stocked in stubbles for lengthy periods, resulting in a rapid gain in weight followed by a rapid loss in weight (the yo-yo effect). While this type of grazing approach can still be seen, there is growing acceptance that 'a hit and run approach' to grazing stubble is

better. It appears this is partly a result of a spin-off from applying the principles of rotational grazing and condition scoring of stock on pasture (e.g. from programs like lifetime wool), in combination with the groundcover and easy stubble management goals mention previously.

Most interviewed said stubbles 'only having a week or two's value'. While the research data would suggest this is only true some of the time (Butler & Croker, 2006, DPI, 2005, Nicholson, 2007), the apparent rudimentary approach to grazing is understandable. The stocking rate chosen was determined by getting animals through in a tough year rather than stocking to optimise the better years. Their thoughts usually focused on winter stocking rates as this was seen as the limiting parameter[2]. This means most farmers have more stubbles than they have stock, so even if they became more sophisticated in their grazing of a single paddock, there would be ungrazed stubbles by the time next year's crop was due to be prepared and sown. Many saw supplementary feeding as an easier (but maybe not more cost effective) option than trying to determine when all the feed value had been removed from the stubble.

The Grain and Graze stubble assessment tool was created in Southern Victoria to assist farmers in determining if a stubble contained enough feed value for animals to gain weight. This simple approach enabled farmers to (i) decide if the stubble had grazing value and (ii) if used routinely could indicate when feed capable of increase liveweights in a stubble had been passed. While the tool was distributed to farmers and advisors and has been incorporated into training programs e.g. Lifetime wool, the application has been limited because of the more simple 'a week or two' rule of thumb.

There were specific issues raised about grazing stubbles including casting of sheep on raised beds, toxic weeds and lupinosis, but none were seen as broad scale or insurmountable issues.

The benefits from grazing stubbles were not described or calculated in dollar terms. Instead they identified positives to the livestock and/or cropping enterprises without quantifying the values. The positives included:

- a reduction in supplementary feeding
- somewhere to place animals over summer
- providing a burst of high quality feed to enhance ovulation at joining
- improved worm control strategy, especially in the southern high rainfall zone
- an opportunity to spell perennial pastures and take the pressure of annual pastures so groundcover was maintained. This was especially true for summer active perennials such as lucerne that could be spelled if there was rain over summer.
- to achieve pest control in the subsequent crop eg slugs and snails

Modelling work by Thomas et al (2010) suggests the benefits are modest at best ($16 to $20/ha), but given several of the benefits are difficult to quantify and farmers have more stubble than stock, preparing more accurate figures is unlikely to change attitudes or influence the simple management approach. Farmers were not prepared to complicate a simple system for the sake of chasing marginal additional value from the stubble.

[2] In the traditional wheat-sheep zone, the lack of an adequate and reliable feed base during winter greatly influences their view that stubbles had no grazing value (DPI, 2005). It was concluded that if a more satisfactory feed winter feed base could be created, then farmers may graze stubbles.

Conclusion:

Most farmers recognise some feed value in stubbles but want to adopt a simple grazing approach. This means tools that aim to maximise the grazing value from a stubble or calculate a financial value on the stubble may have limited application beyond simple rules of thumb (which would be valuable).

3.2.2. Enhanced evaluation of crop or livestock option to inform tactical decisions

Several farmers with a mix of crop and livestock were interested in achieving the best return per hectare given the short term circumstances they were confronted with. They suggested their capacity to calculate what might be the best tactical decision (harvest grain, graze standing, oversowing etc) was currently approached with 'back of the envelope' analysis and poorly informed rules of thumb. A more comprehensive comparison was seen as valuable in informing tactical decisions (appendix A3).

Understanding the implications of manipulating or preserving different moisture levels in the high rainfall zone was identified as important. Unlike the lower rainfall zones, where moisture conservation is not in dispute, a 'grey' area exists in the higher rainfall zones. This 'grey' area relates to moisture levels below the wet summer scenario discussed in section 1.1. It is unclear what impact relying on grazing stubbles to control weeds or oversowing a stubble to use (assumed) excess soil moisture is having on future crop performance. Work could be carried out to help clarify this situation (appendix A4).

Conclusion:

There may be opportunity to develop tools that would enable short term comparisons between crop or livestock options and soil moisture manipulation for the Southern high rainfall zone, but application is thought to be limited to the more business savvy farmers and advisors.

3.2.3. Novel ways of accessing livestock to graze stubbles

Gaining access to adequate stock to graze crops effectively was an issue for many farmers whose enterprise was crop dominant. While there is a perception that these crop dominant farmers 'hate livestock', we did not encounter this sentiment from the people interviewed. Most had some affinity towards livestock, had past experience with them and believed they could have a place in their farming system in the future, even with aging infrastructure[3]. Their move out of livestock was more to do with returns, their recent investments in large scale cropping equipment and a failure to have a reliable grazing base at other times of the year to support the livestock enterprise. With recent large scale investment in equipment, it has become more difficult for them to scale back the cropping investment and move into livestock. Also with increased size of cropping machinery affecting labour efficiency, people have left district depleting the human resources needed to manage livestock.

We identified four major impediments to crop dominant operations having more livestock in the mixed farming system. The first is the cost of buying livestock. Inevitably with better returns the cost of buying stock also rises. Many said they simply could not afford to buy stock given cash flow constraints created by the cropping enterprise over the past few years.

Secondly and probably more importantly they did not want to be responsible for livestock for 12 months of the year. The timing of operations often conflicted with the cropping program,

[3] The loss of fencing making the ability to effectively graze large paddocks more difficult and unreliable water supplies were the two most common infrastructure issues identified.

so they would prefer to have someone else take responsibility for their annual wellbeing and just have access to them when opportunities arose e.g. on stubble or grazing in the middle of winter. Animal welfare was also raised as an issue. As long as someone accepts the annual ownership issues such as shearing, lambing, marking, animal health and access to water when grazing, they would be willing to entertain livestock in their system and use them on stubbles. Trading livestock was discussed but not favoured because of the logistics e.g. water, infrastructure, animal health, disease and financial outlay.

The third impediment is the relevant skills to operate livestock successfully. The shift to cropping has resulted in a reduction in skilled graziers and also a lack of knowledge by advisors of the potential benefits of livestock in a cropping system. Potential benefits may be missed as a result. These issues have been well researched and practical solutions presented (Ag Excellence Alliance, 2009).

Finally in the lower rainfall areas, the few farmers who would contemplate livestock in their operation suffered from a reliable and productive pasture base and limited stock water at other times of the year. This prevented regular use of stubbles even if they wanted to. Feeding livestock at other times of the year was a greater impediment than the grazing of stubbles. This issue is well documented (DPI 2005; Latta and Weston 2006) and suggests increased stubble grazing may occur for some lower rainfall farmers if other parts of the feed base are successfully addressed.

It was suggested the impediments described above may be overcome by creating relationships between crop dominant businesses with an empathy for livestock and livestock dominant businesses to achieve mutual benefits (appendix A5). The crop dominant farmer would have the feed in their stubbles and would not have to own the livestock and the livestock farmer would have the animals and skills to eat the feed. While there are numerous issues to work through eg managing feed in a timely manner, transport, disease, cost share arrangements, a successful outcome could lead to greater utilisation of stubbles. This concept is currently being explored in the Southern Victorian Grain and Graze program (Falkiner *pers comm*).

Conclusion:

There are serious impediments to increasing livestock on 'animal friendly' traditional wheat sheep farms using the historic ownership and management models. However a novel livestock ownership - grazing model which achieves mutual benefit may provide a pathway to increase utilisation of stubbles in areas where livestock are currently not present.

3.2.4. Enhancing the utilisation of stubbles by companion or complementary feed sources within the stubble.

In higher rainfall areas where excess summer moisture is an issue, an opportunity was identified to potentially increase the utilisation of the *lower* feed value components of the stubble by including a high feed value companion or complementary crop (rather than traditional supplementation). The concept (appendix A6) is an extension of the pasture cropping type approach used in summer rainfall environments and now being experimented through Evergraze and more recently in some Grain and Graze 2 regions[4]. However the focus of this opportunity is on increasing the consumption of the lower quality feed by having higher quality feed in the same area. This is not being widely measured in most of the Evergraze and Grain and Graze 2 work, where the interest is on optimising the *returns per hectare* through a combination of cropping and grazing and not to utilise the stubble.

[4] Companion cropping work is being trials in:
Southern Victoria - winter dormant lucerne, row spacing's and herbicide manipulation
Southern NSW -

Conclusion:

There would be merit in investigating the stubble utilisation effect of having high quality feed in a stubble (although we suspect the extra grazing value and stubble benefits would be minor). We recommend the stubble dimension should build on existing work being conducted. If a stand-alone project is contemplated, then stubble utilisation should be a measurement of a wider concept of optimising returns per hectare through integrated crops and livestock.

3.2.5. Using livestock to control excess groundcover

Livestock could be seen as an obvious means of managing excessive groundcover. As mentioned previously, evidence suggests grazing will reduce the stubble mass through direct consumption and trampling will break up the dry residue so it blows away, however many farmers and advisors, even in the more animal sympathetic farmers, believed livestock often complicated the ability to successfully establish a future crop and therefore resulted in more harm than good. The major issues were:

- pushing the stubble over, creating sowing problems (mainly blockages and dragging) and preventing the soil from drying out (southern high rainfall zone)
- uneven weed germination caused by pushing seeds into the ground and covering seeds with residual stubble
- Reduced herbicide efficacy because stubbles shield weeds from chemical contact or prevent adequate incorporation of residual chemicals in the soil
- Sheep tracks and spreading windrows that makes burning less effective

Two obvious strategies to reduce stubble loads is at harvest, with lower harvest heights and wider spreading of trash and to graze crops in winter when they are vegetative. Harvesting stubbles to a height of 300 mm or below reduced the 'pushing over' effect of grazing but had to be traded off against slower harvesting rates (Davey, 2011). Works from the Grain and Graze program (Nicholson, 2008b) clearly shows it is possible to reduce final stubble mass and not compromise grain yield by grazing in winter.

Conclusion:

Livestock can reduce excessive groundcover but this reduction may complicate future crop establishment unless low harvest heights are also used, so will be adopted cautiously and strategically by farmers. It will not eliminate the need to adopt other practices at times e.g. burning, mulching, cultivation and may be better approached by grazing the crop in winter.

3.2.6. Using livestock to control crop weeds

Farmers and advisors in the wheat sheep zone don't believe livestock are the most effective, efficient or timely way of controlling weeds in a stubble. They are not prepared to let animals control a potential weed problem over a long period e.g. a month, when they have the potential to control moisture loss in a day with herbicides.

The southern high rainfall zone was different because conserving soil moisture and managing to groundcover was less of an issue. More farmers were prepared to leave stock in a paddock to control the weeds, the paddocks were smaller and they were looking to gain other benefits such as soil moisture depletion, parasite control and the spelling of pastures. It was suggested that spray/grazing of hard to kill summer broadleaf weeds in crop stubbles was a valuable management tool.

The role of livestock may be further enhanced if the 'elephant in the room', namely herbicide weed resistance continues to increase (appendix A7). Even farmers and advisors across all the zones who don't advocate livestock in the system said they need to find a bigger suite of

control options and (reluctantly) admitted that livestock may end up being one of these alternatives (or other fodder options). The opportunity to use the trampling effect from grazing to stimulate more even germination of weed seeds was seen by some as another possible management tool.

Interestingly many farmers were concerned about increasing ryegrass populations as a result of the grazing of winter crops during their *vegetative* stage. It was felt the winter grazing opened the crop canopy and stimulated a late season germination at a time when early applied residual herbicides had worn off. This meant increased ryegrass populations were encouraged due to winter grazing that had to then be dealt with in the stubble phase.

Conclusion:

Livestock are viewed as inefficient and ineffective for weed control in the traditional wheat-sheep zone but may make a (reluctant) comeback if herbicide resistance becomes unmanageable. In the higher rainfall southern zone, grazing plays a useful role in weed control and can be used in conjunction with herbicides to improve control efficiencies e.g. spray/grazing. However alternative fodder options (rotations) are likely to be more widely adopted as part of a weed control strategy than stubble grazing.

3.2.7. Growing less common crops that have increased stubble feed value

The stubble of wheat, barley and canola provide limited direct grazing value. However less common crops such as lupins, peas and beans are recognised as having much higher grazing value that cereals and canola stubble because stock can use the residual dry material as well as any spilt grain and weeds. While they provide greater potential for livestock, and are highly valued by those who grow them, these crops tend to provide less natural groundcover and therefore grazing is often limited to short periods or in areas where the soil are less prone to erosion e.g. grazing bean stubbles in South East South Australia. Nevertheless there appears to be potential to develop and promote non traditional crops that have enhanced grazing value in the cropping rotation.

Conclusion:

Grazing novel or non-traditional crop stubbles provides an opportunity to increase stubble grazing, but is limited because of groundcover issues and the lack of suitable choices over the cropping zones.

3.3. Observations on other issues

3.3.1. Soil compaction

Potential soil compaction through grazing stubbles in summer did not rate as a major concern to farmers or advisors. More comments were made about potential compaction of 'wet soils' over winter when grazing crops in the vegetative stage or grazing stubble after a big rainfall event in the north.

The review of soil compaction (Bell *et al*, 2011) plus other work emerging from Grain and Graze 2 (Simon Falkiner *pers comm*) would support the view of farmers and advisors that summer compaction is not a concern and at times when compaction does occur, the effect is short term and is repaired by natural biological processes.

Conclusion

Loose topsoil not compaction is the concern with farmers and advisors from summer grazing.

3.3.2. Stubble grazing and soil carbon

No farmer or advisor mentioned soil carbon in the context of stubble management. It simply was not on the radar. Work by DPI Victoria (Robertson, 2008) suggests that accumulation of soil carbon in cropping systems is highly unlikely even with stubble retention. Instead a decline in soil carbon because of other practices such as cultivation and burning are more likely and a pasture phase would be required to lift soil carbon levels. While the specific issue of stubble grazing and the impact of soil carbon was not addressed in the study, it is thought removing small amounts of organic material through grazing stubble would have little or no impact on soil carbon levels (Fiona Robertson, *pers comm*).

Analogous to the soil carbon issue is greenhouse gas emission from grazing stubbles (methane and nitrous oxide). While this was not part of the scope of the study, the conclusion is that because it is not part of any accounting scheme, now or in the future, that it does not need to be considered.

Conclusion:

Soil carbon, in a stubble grazing context, is not on farmer's radar. Even if it was it may not be worth worrying about in the current environment.

3.3.3. Using crops as a pasture improvement tool

The comments and focus from most interviewees was based on a stable and permanent cropping enterprise and asking 'how livestock fit into this system'. An alternative view was put, where cropping could be considered as part of a pasture renovation phase. Under these circumstances, the cropping phase is a tool that enables weed and soil fertility issues to be addressed with the likelihood of potentially higher returns to offset the renovation costs of the pasture improvement program. Grazing both over summer and in winter would be integral to this system. Short phase cropping, while not new, is not practiced very widely but may have a role given the increasing cost of resowing pasture.

Conclusion:

Short phase cropping could be integrated into the promotion of a pasture renovation program to help offset the cost of pasture sowing.

4. Potential areas for investment

Opportunities to invest in the greater use of stubbles as a valuable contribution to the feedbase are limited. Farmers with the largest potential source of stubble, the traditional wheat sheep zone and the northern cropping zones, do not want animals on their stubbles because they firmly believe grazing would compromise their future crop production and lead to environmental degradation. This attitude is strongly entrenched and supported by research on soil moisture and stubble retention. Trying to convince them otherwise would be futile. Large areas of the wheat-sheep zone also have unproductive and unreliable winter pastures which means utilizing a summer feed source is not a consideration when they cannot reliably support animals for the rest of the year.

The southern higher rainfall zone provides greater opportunity for a number of reasons. Large scale cropping is a more recent change to the farming business and many still have significant livestock enterprises that they retain for diversity and risk management. Soil

moisture and groundcover are not considered major issues and residual stubble loads are generally higher. Pastures have greater perenniality, are more productive and farmers actively manage the feedbase. They are more receptive to trying to see stubbles as a feed source. Having said this many are wary of the potential negative effects of grazing heavy stubbles including the laying over of stubble and creating sowing problems, preventing the soil from drying out, encouraging weeds and compromising herbicide efficacy. Even in this zone there is some reluctance to graze stubbles.

Opportunity 1: The development of simple 'rules of thumb' for grazing stubbles that combine livestock performance, groundcover and stubble management objectives. These are applicable to all zones but are more likely to be taken up in the higher rainfall areas. Work has already been undertaken for Southern Victoria.

All other opportunities identified involve stubble manipulation to enhance the next crop, farming systems or integration issues rather than the direct use of stubbles as an integral part of the feedbase. These include:

Opportunity 2: The creation of tools to enable short term economic comparisons between crop, fodder or livestock options, especially as the crop reaches maturity. This would enable farmers to make a more informed decision about harvesting, turning the crop into fodder or grazing it standing (rather than harvesting and then feeding it back out to the animals at a later date). It is applicable to all zones.

Opportunity 3: Experimentation designed to understand the influence of weed growth and residual stubble mass over summer on soil moisture and then the flow on effects to future crops in the southern high rainfall zone. The focus is on the next crop and the effect of grazing to 'set this crop up'. Questions revolve around:

> What effect does leaving weeds and grazing them rather than spraying have on soil moisture and does this matter anyway?
>
> What effect does stubble reduction have on soil moisture evaporation and capture?

Opportunity 4: Create pathways for farmers who are receptive to grazing their stubbles but don't have or want the responsibility of livestock for 12 months of the year to link up with farmers with excess stock but limited summer feed. This concept goes beyond the traditional agistment model, to create longer term partnerships that benefit both businesses. It requires facilitation support to develop the 'rules'. The potential is to enable expansion of livestock dominant businesses through better utilisation of winter and spring feed with a secure summer feed source from crop stubbles. It could be used for livestock finishing or enhancing reproductive performance e.g. joining on stubbles. The reward to the cropping farmer would have to be worthwhile and not compromise the cropping business. This is currently being explored in the Grain and Graze 2 program.

Opportunity 5: Experimentation into increased stubble utilisation by having high quality feed grown as a companion crop in the stubble. It is based on the pasture cropping or companion cropping concepts, but in areas without summer dominant rainfall and native grasses. The focus is on increasing annual productivity by having two potential crops, a traditional winter crop that is harvested but then a high quality grazing option. The stubble is simply a roughage source to balance the higher quality feed. It is limited to the higher rainfall zones where soil moisture is not a major limitation to subsequent crop production.

Opportunity 6: Investigating the benefits of grazing stubbles with livestock to achieve other crop outcomes. This is applicable to all zones and would be applied when farmers have to 'break their stubble management rules' because other issues have become so great that

future crop production is at risk. This includes issues such as pest control and managing herbicide resistant weeds. Winter grazing would be part of this consideration

Opportunity 7: Investigating the expansion of novel or non traditional crops which have stubbles that have much higher grazing value. These crops currently exist but have limited geographic and rotation application. They could be promoted in other areas but the varieties, crop agronomy and groundcover issues are still likely to limit their application to niche areas around the country.

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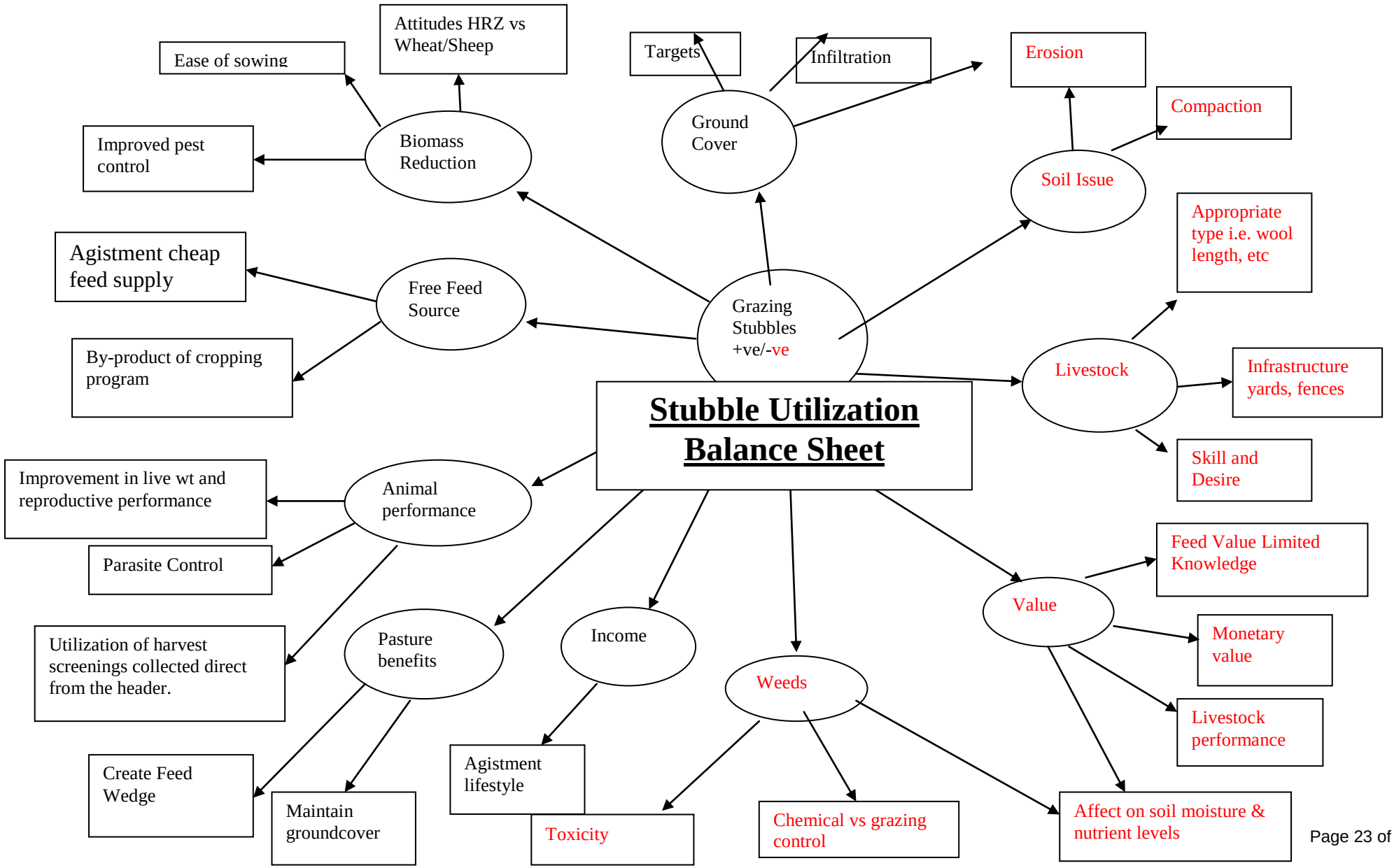
Appendix 1: Stubble utilisation balance sheet



Appendix 2: Areas of potential investment

Nine opportunities were identified through the interview and workshop process. Some of these opportunities were brainstormed at the workshop conducted in Geelong on November 16. The participants at this workshop were mainly from the higher rainfall zones.

The ideas from this brainstorming session are listed in appendices A2 to A7. The wording has not been refined and should be used to gain an additional sense of what may be included in the opportunity. It is possible there is work that has been completed or is underway that workshop participants were not aware of. Therefore answers may already exist to the questions raised.

The rating score was determined by the participants giving a 3, 2 and 1 score to the concepts in order of importance.

Appendix A2: Matching animal performance with stubble value

Applicable area: All

Workshop rating: 8

Concept: This idea relates to farmers being able to match animal performance with what is available in the stubble. It was felt that farmers could better utilize the "value" that presented in stubbles if they better understood the demands of the livestock they intended grazing in the stubble. It was felt that most farmers understood that value in stubbles was limited to a short period but **the gap was in how to maximise the performance from that limited resource**.

Areas of discussion:

- Identifying what is the value in the stubble. It was thought that the nutritional value of some weeds was not known well enough. This may well need to be investigated on a regional basis. The data could be added to the Grain & Graze high rainfall stubble assessment tool.
- Utilise programs such as Lifetime ewe to discuss how to make best use of stubbles. These programs match resource availability to animal demands whilst maximizing performance.
- The targeting of specific production goals (increase in joining performance, condition score etc) and an evaluation of the financial benefit to the producer is needed.
- It was thought a tool to determine whether a crop should be taken through to harvest or cut for hay or grazed was needed. The tool should determine the best dollar and NRM outcome on a paddock by paddock basis.
- It was thought that a way of measuring what contribution stubbles made to maintaining annual stocking rates was needed. Is the downside to using stubbles offset by an increase in animal production? At what stage do confinement areas become a better option?
- It was felt that improved extension could solve many of the challenges. Case studies showing a comparison between good and bad outcomes would be useful. As would a matrix showing the different outcomes resulting from matching different livestock classes and stubbles.
- Current niche crop are highly regarded for stubble grazing value, but what is the potential for expanding their application?
- Where do fodder crops fit in?
- What are the factors that determine the feed value of stubbles?
    - Do we know enough about the nutrient value of actual stubble (is a wheat stubble a wheat stubble), the spilt grain and the weeds that make up the Feed on Offer?
    - Are there any microbes that can be added to the stubble to help improve digestion?

- What affect does in crop nutrition have on stubble value? If yes, is it a cost effective way of improving animal performance.
- Do events such as water logging or in crop grazing effect the nutritional value of stubbles?
- Does a late hay freeze (after seed maturity) have any effect on the nutritional value of stubble? Does it allow it to break down more readily?
- Is there a way of accessing the pith of a canola stem and does it have any value?

Appendix A3: Rules of thumb for soil moisture management

Applicable area: High rainfall zone and higher rainfall areas of the wheat sheep zone

Workshop rating: 9

Concept: It was suggested that some rules of thumb needed to be developed so farmers knew what the appropriate management decision was associated with certain soil moisture levels. Before rules of thumb could be developed, an understanding of soil moisture levels needs to be commonly understood. Presently it was felt that in most regions (except the summer/winter cropping zone) farmer's understanding of moisture levels was limited therefore opportunities to harvest moisture through appropriate management were less than optimal. These rules of thumbs would help make decision making easier and would focus on decision such as:

- Topsoil moisture levels which affect germination levels. The rule would look at how you manage stubble to achieve the optimum level. May need to graze heavily to remove groundcover to help dry out the surface in HRZ, it may be the opposite in more arid zones, but what is the rule of thumb that determines what happens ?
- Topsoil moisture levels which affect compaction and pugging levels.
- Topsoil moisture levels which affect run off levels. Tactical grazing of stubble to create run-off to ensure the replenishment of stock water reserves without causing erosion.
- Subsoil moisture. At what level should farmers subdue Lucerne so it doesn't limit crop production?
- At what soil moisture level should I turn a crop into stock feed when moisture is limiting.
- What is the link between the network of moisture probes in a region and what happens on farm?
- Do farmers understand the different moisture requirements of particular crops? Are all crops well characterised when it comes to moisture usage.
- Marry soil moisture levels with weather forecast. E.g. MLA Tool

There appear to be a number of moisture probes networks across the regions which it was thought weren't being utilized fully. Increased use it this data could be made and some of the existing tools like the MLA's Rainfall to Pasture Growth Outlook Tool could be built into the concept.

People/organizations thought to be working in the soil moisture field include:

- James Hunt & Co. CSIRO
- Penny Riffkin DPI Hamilton
- Members of the EH Graham centre
- Daniel Parkes
- Chris Guppy, UNE
- Trent Potter, SARDI
- Malcolm McCaskell, DPI
- SFS, CHAF, Farmlink

Appendix A4: Systems understanding of stubbles in mixed farming

Applicable area: All

Workshop rating: 4

Concept: This idea focused on the need to develop a systems approach to stubble utilization. From general discussion many of the ideas stem from trying to making component improvements to the system. What was not well understood was the flow on effects of a management decision over time. It is thought to be regionally specific. Burning is an example. For some farmers regular burning is necessary in their cropping enterprise because there are no other management options. For others burning is practiced only in unusual circumstances.

Areas of discussion

- What is the $ value to the system of grazing compared to the benefits of not or a modifying a grazing regime?
- What is the impact on subsequent crops (weeds, infiltration, compaction) from grazing?
- What $ value can we put on the animal benefits of utilizing stubbles. i.e. worm control, pasture ground cover, stocking rates etc?
- When do you make the decision to use a confinement area rather than graze stubbles and what are the long term consequences of that decision?
- What are the economics of baling straw or collecting chaff and utilizing those resources in a confinement area?
- How do you change your enterprise priority emphasis? It is difficult to justify winding back a cropping enterprise investment of let us say $800,000. It needs to be demonstrated that foregoing maximum machinery utilization to increase the livestock operation has a benefit.
- It is easier to “gear up or down” a livestock enterprise. e.g. Increase or decrease the % of ewes, buy or sell more livestock, take on agistment than to do the same with cropping.

Appendix A5: Livestock resource sharing

Applicable area: High rainfall zone and higher rainfall areas of the wheat sheep zone

Workshop rating: 7

Concept: This idea is being driven by need and desire.

> *The need***.** There are livestock producers that need more feed to fulfil the potential of their livestock systems.
>
> *The desire*. There are farmers who would like to utilize a resource (stubble) which they largely waste now because they don't have or want ownership of animals.

There is common ground to be found in both systems and it was felt that if a structured arrangement could be put together both parties could benefit. The successful driver of this system could be an equitable distribution of 'value' to both participants. It was thought that there was more value to be had by combining both operations than running them in isolation. The extra value could then be distributed as the 'cream' to all participants. The strict development and adherence to ground rules would be critical to the success of any business model. The moment a cropping outcome was compromised the system would fail. Likewise if animal production levels didn't meet targets the system would collapse.

Areas of discussion

- Add value/expand "my business" by using a resource some-one else has.
- Capitalise on a resource that is currently being underutilised.
- Provide expertise and access to skills and equipment that may no longer be available.
- Provide expertise in and management of animal welfare issues. Enhances best practise in overall mixed farming. The croppers are looking after the soil and environmental issues.
- **The development of core outcomes (both sides) that can't be compromised and the identification of the overlap, the area of mutual benefit.**
- The development of the financial analysis so informed decisions can be made.
- The identification of the more intangible benefits that can be achieved. E.g. Better paddock hygiene leading to less mouse pressure.
- The development of a structured logistics plan so costs don't blow out and enough feed is on hand to achieve the desired outcome.
- The identification of what infrastructure is available and what state it is in.
- The identification of specialist livestock producers who can achieve top end returns. Can afford to finance the system whilst improving their margin. E.g. improved economies of scale, earlier and heavier turnoff weights etc.
- The need for a pilot business case that sets out the system.

Farming systems groups, consultants and other networks would be essential in providing access to the right producers

Appendix A6: Dual / double crop and fodder

Applicable area: High rainfall zone and higher rainfall areas of the wheat sheep zone

Workshop rating: 26

Concept: Utilisation of available moisture late in the growing season and into the summer which could potentially increase animal production levels through grazing extra summer fodder. It was felt to better utilize stubbles, **more green should be grown but not in the form of weeds**.

There were two ideas discussed:

1. Establishment of a long lived high quality forage in the cropping phase. This idea revolved primarily around the growing lucerne under the traditional winter crop although hard seeded legumes where also suggested due to their ability to germinate over time. In crop it was thought that the growth of the lucerne could be chemically retarded (much work needs to be done in this area) before the lucerne could take over after harvest, using summer soil moisture and providing excellent forage which would encourage the better utilization of the stubble.
2. Establishment of an opportunity crop in a stubble. This focuses on a low cost opportunity fodder crop being established either at windrowing or after harvest through the mulching of the stubble.

Both ideas promote the use of available moisture (in more arid zones this would be seen as inappropriate as moisture conservation is of great importance) but more importantly provide high quality feed (protein) which would allow the turn off of prime animals out of season.
A skip cropping system was also discussed. The concept uses lucerne in crop followed by a year of stubble/lucerne followed by a return to crop/lucerne. The process helps utilize soil moisture (helps dry out the profile for the second cropping year) and deals with the cropping stubble load by using animals and time to break it down. A variation on this theme is the use of a fodder crop (break crop) instead of Canola in the system. The value of both variations to the mixed farm system is:

- The benefits to long term weed control by not cropping continually.
- The access to land so livestock number can be maintained.
- A productive natural way of incorporating stubble
- Provides a water logging mitigation tool whilst encouraging good animal production.

<u>Areas of discussion:</u>

- Chemical manipulation
- Row spacing, sowing tramlines, sowing buffers etc.
- Sowing time and variety choice.
- Polymer coatings to delay germination
- Stubble quality “improvers”.
- Understanding how to match animal performance to increased feed availability. An extension issue.

Appendix A7: Non chemical weed control strategies

Applicable area: All zones

Workshop rating: 5

Concept: This idea stems from the concern generated from our reliance of chemical solutions to weed challenges, in particular ryegrass and radish. The increased use of herbicides, often the same chemistry, during summer to control weeds (considered a best practise option) exacerbates the problem. It was suggested that livestock could be used as a tool in this battle but the consequences of leaving herbicide resistant weed control to livestock were not fully known.

Areas of discussion:

- The impact grazing has on the germination of seed. One camp suggests that livestock can be used to promote germination another camp suggests that by burying the seed germination is staggered. The time of germination has a big effect on the efficacy of chemicals and how they should be used.
- What opportunities are there to use a spray/graze technique to improve weed control and maybe animal performance?
- Is there a roll in the HRZ to cultivate/mulch stubbles promoting weed germination which in turn can provide a useful feed source and mop up excess moisture prior to the next crop?
- Do we know the long term implications of excluding livestock?
- Do we need to collate data from established no livestock systems to determine trends?
- Are farmers fully aware of withholding period requirements? NB. In crop fungicides can be an issue which are not always picked up.

Other thoughts

- Nitrous oxide emissions. What do we know? Who cares?