Demonstrating Vetch Mix Options to Reduce Soil Erosion Whilst Maintaining Good Nitrogen Fixation

Written by Beth Humphris, Elders Jamestown

Vetch pastures are a great legume feed option for growers across the Upper North Farming region, however, can leave paddocks vulnerable to soil erosion once grazed. This was one of the concerns outlined by local growers and agronomists alike from initial surveys undertaken as part of this project. In this case study a vetch, barley (kraken) and a vetch, brassica (canola) mix is considered as an alternative option to a sole vetch, in an attempt to improve ground covering over the summer period. Parameters including soil cover, nitrogen fixation for the following crop and weed control are considered throughout the document.

What is Wind Erosion?

Wind erosion is a process where fertile soil particles from the soils surface are moved from one location to another via wind events. This can have a devastating impact on the productivity of a soil resource, while also causing issues where soil particles are deposited. The occurrence of wind erosion events has dramatically reduced since the shift from cultivation to no-till. However, modern rotations including a vetch pasture can still lead to wind erosion events. The likelihood of a wind erosion event is increased when the following factors are met;

- The occurrence of erosive wind events that persist for hours or days. Winds are considered erosive once they reach speeds above 28 km/hr.
- Prolonged dry periods, for example where the break of season is late following minimal summer rainfall events.
- **A soils surface is left exposed, making soil particles vulnerable to movement. Stubbles need to have a minimum of 50% ground cover, with at least a third of this still anchored to avoid soil losses via wind erosion. A soil with 30% or less ground cover is considered a very high hazard, with more than 70% ground cover being considered a negligible hazard. Typically, watering points, gate ways and wheel / sheep tracks are the most prone to soil erosion.**
- Lastly, for soil particles to be prone to movement via wind, they need to be 'disturbed' or 'loose'. This is commonly found where sheep have been walking over paddocks for an extended period. Paddocks with gravelly or rocky surfaces are considered at less risk of erosion.

Whilst not all of the above factors can be controlled (i.e. wind events or timing and amount of rainfall) growers of the Upper North can ensure paddocks have adequate ground cover to reduce or completely avoid the effect of top soil erosion.

Above information taken from Agriculture Food and Wine, Diagnosing Wind Erosion Risk, 2022.

UNFS Upper North Farming Systems

Australian Government

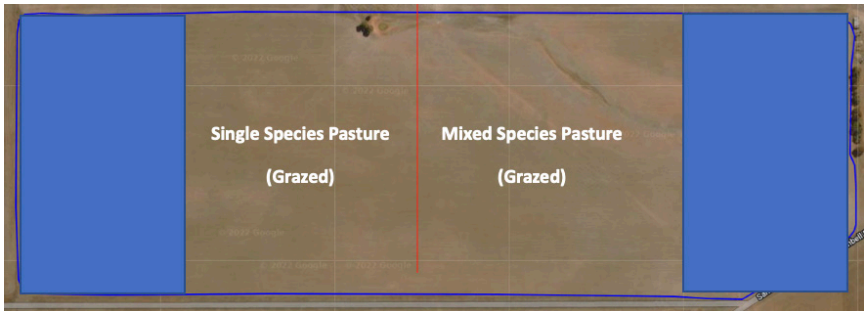
Elders

Vetch versus a vetch, barley mix demonstration

Grower: Alison Henderson, Henowie Poll Merinos

Location: Caltowie, SA
Rainfall: 370mm annually
History: 2022; Pasture
2021; Wheat
2020; Barley
2019; Wheat

This demonstration occurred throughout the 2022 season, sown on the 23rd of April, with opening rains falling closer to the 30th of May. One half of the paddock was sown to sole vetch (Rasina), with the other half of the paddock sown to a vetch, barley mix (Rasina, Kraken). The pastures were both grazed for a period of one month throughout winter and then green manured at the end of the season, before the pasture went reproductive.



Nitrogen Fixation

The site was sampled throughout January 2023 to assess the level of nitrogen fixation from each of the treatments, with key results shown below. pH (CaCl2) across the site ranged from 7.5 to 6.3, organic carbon (W&B) between 1.5 to 1.1 and phosphorous (Cowell) between 52 and 14. The site with a Cowell P of 14 was removed from the dataset as the data was heavily affected by phosphorous deficiency.

There was no significant difference in nitrogen fixation between the two treatments, with 4.8 kg more nitrogen fixed per hectare by the sole vetch treatment. Therefore, it is reasonable to conclude from these results, that there was not a significant impact on final nitrogen content by incorporating a barley in a mix with the vetch rotation.

Treatment	Total N (kg/ha)	Fixed N supplied Wheat (t/ha)
	0-60cm	0-60cm
Vetch, Barley	94.6	3.8
Sole Vetch	99.4	4.0

Biomass

Biomass cuts were taken throughout spring. The paddock had been grazed once throughout early spring for a period of one month, the pasture was then left to regenerate for one month before collecting the above biomass data. Again, there was not a significant difference between the treatments. The vetch, barley mix had 0.19 t/ha more dry matter in comparison to the sole vetch.

Treatment	Biomass (t/ha)
Vetch, Barley	3.35
Sole Vetch	3.16

Ground Cover

The site was visited throughout early Autumn, following the vetch and vetch/barley phase to assess ground cover. The vetch, barley showed 90% ground cover, with 20% of that cover anchored into the soil resource, making the treatment at very low risk of soil erosion.

The sole vetch treatment had 60% ground cover with only 5% of that ground cover anchored, meaning the treatment was considered a moderate risk for soil erosion.

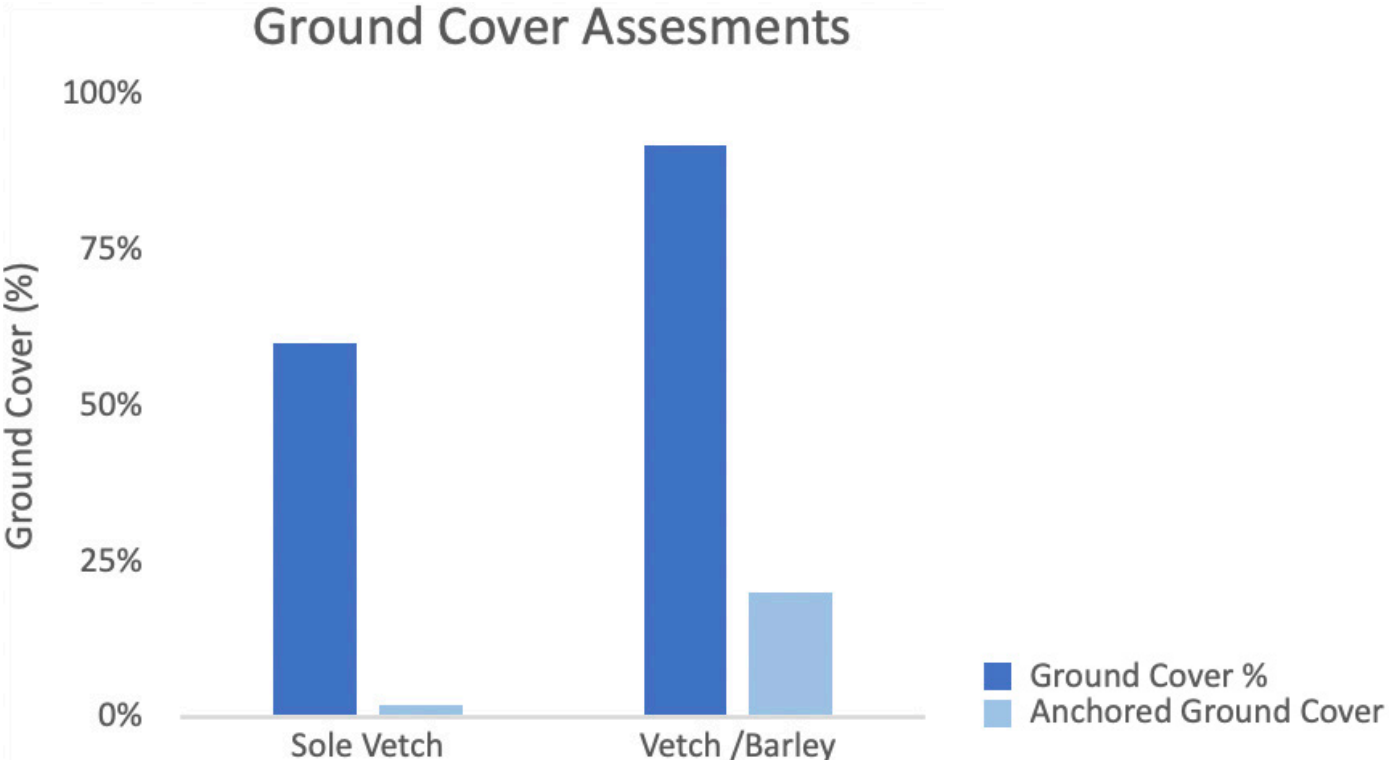


Figure 1.
Ground cover assessments taken throughout March, looking at overall ground cover and anchored ground cover.

Simulated Erosion

Soil erosion was simulated using a leaf blower, as shown in the below photos. A wind event was simulated using a leaf blower, with a wind speed of approximately 144 km/hr (determined using a kestrel). The leaf blower was held at a low angle, to simulate an erosion wind event. This was completed over a 30 second time frame.

The sole vetch treatment showed increased loss of ground cover resulting from the 'wind event'. This is likely a result of the low level of anchored biomass in this treatment, meaning biomass was free to move with winds. This in turn left the soil resource in a bare state, exposing topsoil to erosion for following wind events.

In contrast, there was minimal movement in the vetch, barley mix treatment. Therefore, with multiple erosive wind events the vetch, barley mix is less vulnerable to losses due to the higher percentage of anchored groundcover in contrast to the sole vetch treatment.

Another observation from the site was the consistency of ground cover across the trial site. The sole vetch treatment had patchy covering, with areas of accumulated vetch in some parts of the trial and other areas of bare, exposed soil. As a comparison, the vetch, barley treatment had consistent cover across the trial site, again linking back to the level of anchored biomass between treatments.

Sole Vetch

Vetch Barley Mix

VETCH VERSUS A VETCH, CANOLA MIX

Grower: Andrew Walter

Location: Melrose, SA
Rainfall: 280mm annually
History: 2022; Lentils
2021; Barley
2020; Barley
2019; Wheat

The replicated plot trial was sown at the beginning of 2022, looking at different mix options for vetch and canola. The vetch variety used at this trial site was Timok and the canola variety was Hi-Tec Trophy. The trial was sown with 40 kg N/ha. Below is a list of treatments considered in this case study;

Treatment Name	Description
Sole Vetch	Vetch alone, harvested for seed
Vetch, Canola - retained 1 graze	Canola and vetch sown together – Both mechanically grazed through-out winter once
Vetch, Canola - retained 2 graze	Canola and vetch sown together – mechanically grazed once in winter then again in spring
Vetch grazed	Vetch – mechanically grazed once in winter then again in spring
Vetch, Canola - retained	Canola and vetch sown together
Vetch, Canola - Early	Brown manured throughout early spring
Vetch, CAnola - Late	Brown manured throughout late spring

Nitrogen Fixation

The site was soil sampled throughout January 2023 to assess how much nitrogen each plot had fixed. Overall, the site had an organic carbon (W&B) of 0.7 to 0.6, a pH (CaCl2) of 7.1 to 6.2 and a phosphorous (Cowell) of 40 to 31 mg P/kg. Therefore, it is reasonable to conclude the site was unconstrained.

Following the trial. Soil was sampled to a depth of 60 cm's and split into 0-10, 10-30 and 30-60 cm increments. The below table displays the total nitrogen throughout the 0-60 cm core and finally, as the potential wheat yield using fixed soil nitrogen. Results are displayed in order of the treatment that fixed the greatest soil nitrogen to the treatment which fixed the least.

The two treatments that fixed the greatest amount of soil nitrogen was the vetch, canola treatments where the vetch was sprayed out in early spring and late spring respectively, leaving the canola to set seed. The next highest level of nitrogen fixation was the sole vetch treatment, where the vetch was left to go reproductive and harvested for seed. If vetch was sprayed off before going reproductive it is reasonable to assume more nitrogen would have been fixed in the sole vetch treatment.

When considering the vetch treatment that was grazed throughout the season, less nitrogen was fixed compared to the vetch, canola retained, vetch, canola mix and the vetch, canola grazed once treatments. This suggests that if a paddock is sown to a vetch, canola mix and either left un-grazed or only grazed once throughout the growing season, the paddock would be left with more nitrogen than a sole vetch paddock that is grazed throughout the growing season twice.

Analyte	Total N (kg N/ha)	Fixed N supplied Wheat yield (f/ha)
Treatment	0-60cm	0-60cm
Vetch, Canola - Early	320.0	12.8
Vetch, Canola - Late	253.8	10.2
Sole Vetch	125.3	5.0
Vetch, Canola - retained 1 graze	117.3	4.7
Vetch grazed	97.4	3.9
Vetch, Canola - retained	95.8	3.8
Vetch, Canola - Retained 2 graze	68.9	2.7

Biomass

Biomass measurements were collected throughout spring to identify if there is a trade off to moving from a sole vetch to a multi-species pasture option. There is no significant difference between vetch biomass cuts at this site (Figure 2). Therefore, when considering the additional biomass the canola provides, it is reasonable to conclude that by adding canola to the mix, you are in fact increasing your overall feed on offer, rather than reducing it.

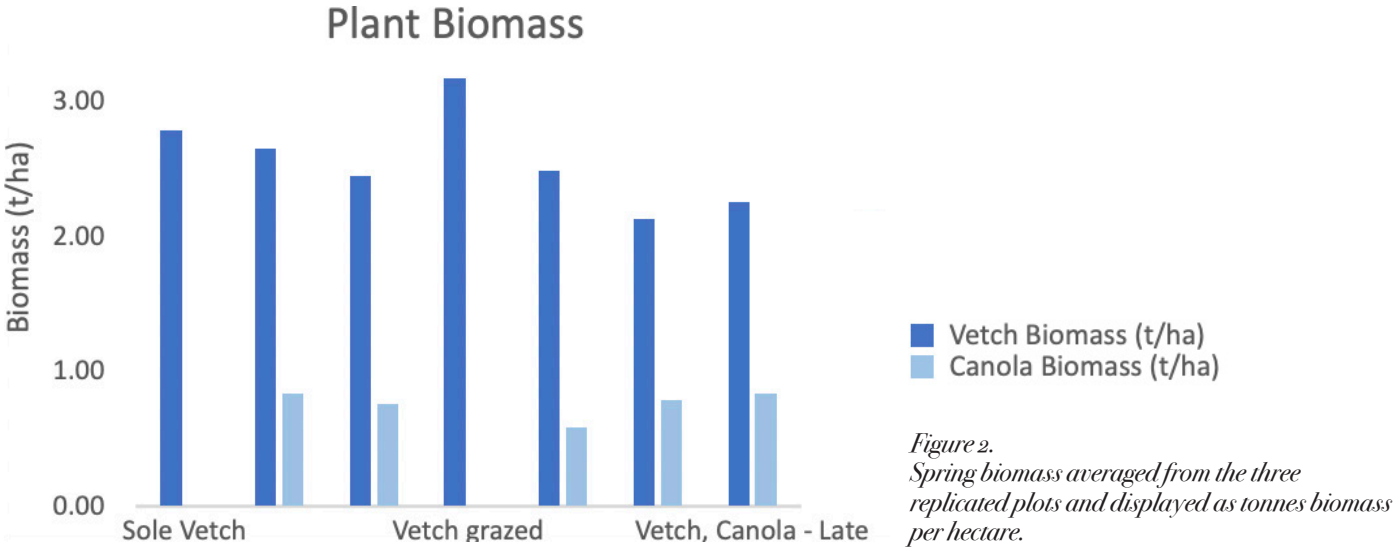


Figure 2.
Spring biomass averaged from the three replicated plots and displayed as tonnes biomass per hectare.

Ground Cover Assessments

Ground cover assessments were taken throughout early autumn 2023, following the trial phase in 2022, to assess how well plant biomass could persist over the dry period. Total biomass and anchored biomass was recorded in three locations of each treatment, with the below figure showing the averaged results (Figure 3). When looking at the mixed plots, the data indicates there are higher levels of anchored biomass and the ground cover is more consistent spatially across treatments, as shown by the error bars. Typically, treatments that were grazed throughout the season showed lower levels of ground cover in comparison to treatments that were not grazed or were grazed fewer times throughout the season. Overall, the vetch, canola treatment that was grazed twice showed the least amount of ground cover, followed by the vetch which was grazed twice, then the vetch, canola retained treatment. The treatments that resulted in the best ground cover was the vetch, canola treatments where the vetch was sprayed out early and late, then the vetch, canola grazed once, followed by the sole vetch treatment.

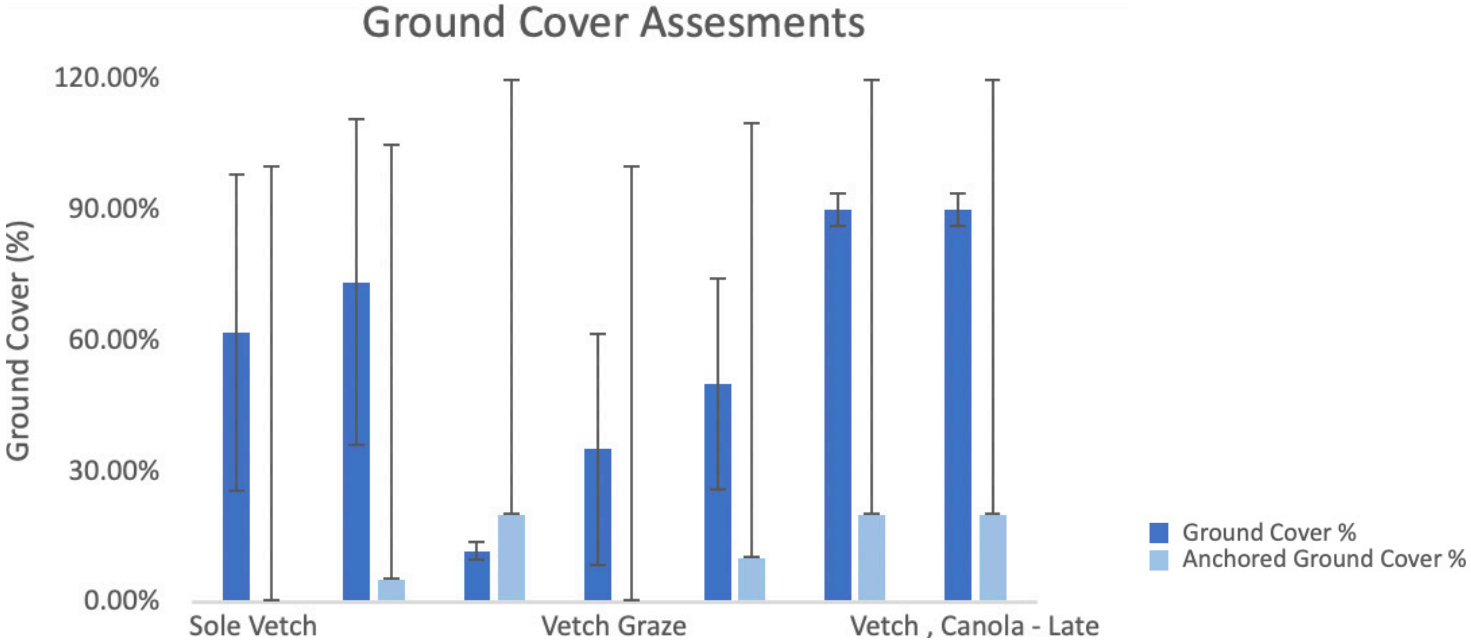


Figure 3..
Ground cover assessments taken throughout March 2023, looking at overall ground cover and anchored ground cover. These are averaged results using three measurements.

Simulated Erosion

In addition to the ground cover assessments, soil wind erosion was simulated using a leaf blower. Wind speed in this simulation was equivalent to 144~ km/hr winds (determined using a kestrel) and the results are shown in the below photos. Results highlight that numerous factors feed into the degree of soil loss during a wind event. Firstly, anchored biomass dictates how much ground cover is lost in initial wind events, with higher levels of anchored biomass inimising ground cover losses and leading to more consistent ground cover across plot areas. Lower levels of anchored biomass results in patchy ground cover and hence patches of exposed soil. Another big factor is if soil particles are dislodged and vulnerable to movement. This trial has not had sheep across it and so much of the soils surface had set hard, reducing the risk of erosion on a bare surface.

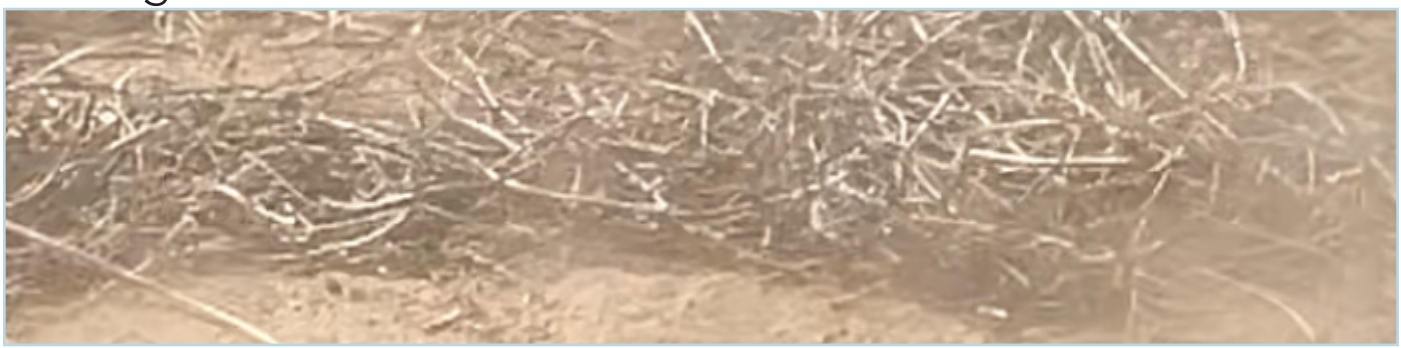
Overall, the sole vetch, grazed treatment showed the worst soil erosion, followed by the vetch, canola treatment that was grazed once. The best treatments were the vetch, canola, retained, early and late. In these treatments no movement of soil particles were observed.

Sole vetch

Vetch, Canola - 1 graze

Vetch, Canola - 2 graze

Vetch grazed



Vetch, Canola - retained, early, late

TRADE-OFFS TO A MIXED PASTURE

While the above demonstration sites attempted to consider a lot of the key factors for moving from a sole vetch pasture toward a mixed option, there are still a few considerations that could not be investigated throughout the lifespan of this project. These are listed below.

Reduced weed control options

This is particularly true for the vetch / cereal options. Group A herbicides that are typically used to control grass weeds in the pasture rotation are either taken off the table completely, or only used late in the season once the cereal has pushed out a head and the grower is happy to kill of the cereal. At this stage it can be difficult to get a good knock on grass weeds such as ryegrass, barley grass or wild oats. There are group A tolerant cereal options coming through breeding lines currently, which would make it possible to control grass weeds, while keeping the vetch, cereal mix for grazing. Alternatively, green manuring is an option, killing all plant species throughout late spring, before anything has set seed. This also has benefits for organic carbon levels within the soil resource. Alternatively, a mix of vetch and a forage brassica still allows the option of in season grass control using conventional herbicides in a timely fashion. Green manuring in this scenario also helps to control any grass weeds that may have germinated after the in-season control or escaped the in-season herbicide application. Chemical applications in season comes with the requirement of grazing with holding periods, as per label requirements.

Reduced root disease break

Typically, a legume rotation is used as a root disease break for other crop types within the rotation, for example cereals and brassicas. By incorporating these crop types into the legume phase, this reduces the ability for paddocks to have a good root disease break before re-planting crop types. For example, in a wheat, wheat, barley, legume rotation, if you were to add a cereal into the legume phase there would consistently be a cereal root in the soil resource increasing risk of root disease on cereals long term. Under this scenario a vetch, brassica option would be much better suited. Alternatively, a rotation following wheat, wheat, barley, vetch, canola, the vetch, brassica would present issues for the following canola. Seed treatments, appropriate nutrition and testing will help to manage this issue.

Other key methods to control erosion

- Managing other soil health aspects such as soil acidity, sodicity and compaction as unhealthy soil resources are unlikely to support good ground cover, therefore reducing organic carbon input and increasing wind erosion.
- Rotational grazing and good grazing management can minimises erosion and reduces compaction. Do not over graze paddocks as this can lead to poor ground cover and dislodged topsoil particles, leaving the resource highly prone to erosion.

CONCLUSIONS

Findings from this work have given confidence that moving from a sole vetch pasture rotation towards a mixed option such as vetch, barley or vetch, canola will benefit the overall system. Soil sampling work has highlighted little difference, in some cases benefits, to nitrogen fixation by incorporating a cereal or canola to a vetch pasture. Additionally, by using the inter-species method the paddock is left with a greater percentage of ground cover, particularly when considering anchored ground cover. Whilst there is concern around root disease breaks and weed control methods, there are options to combat these issues should growers across the upper north region choose to move toward an inter-species pasture phase.

ACKNOWLEDGEMENTS

This fact sheet is part of the 'Building soil knowledge and capacity to implement change in the farmers of the Upper North Agricultural zone of South Australia' project funded by the National Landcare Program: Smart Farms Small Grants Round 4.
The Vetch, Barley Mix Options soil sampling, wind erosion scoring and data analysis was completed by Beth Humphris, Elders Jamestown. Other data collection including spring plant biomass was collected by Morgan McCallum, Upper North Farming Systems. This Demonstration was as part of the project 'Improved Pasture Management Systems' made possible with the funding of SA Drought Hub.
The Vetch, Canola Mix Options project management and biomass data collection was completed by SARDI Clare, with soil sampling, wind erosion scoring and data analysis completed by Beth Humphris, Elders Jamestown. This project was as part of the 'Intercropping in Break Crops in the Upper North' funding by the SA Drought Hub.
A big thankyou to the landholders, Alison Henderson and Andrew Walter for facilitating the projects and being generous with data sharing.

References

1. Agriculture Food and Wine, Diagnosing Wind Erosion Risk, 2022

Report prepared for Upper North Farming Systems group by Beth Humphris, Elders Jamestown in 2023.