Fodder for the Future

EXECUTIVE SUMMARY

Australian Government
Department of Climate Change, Energy, the Environment and Water

Murray DAIRY

Dairy Australia

Overview of Project

Background

Dairy farms in the Murray dairy region have historically relied on low input, intensively irrigated perennial pasture-based feed systems. Productivity and profitability of these systems were driven by access to abundant, cost effective and secure irrigation water and milder historical summer temperatures. Water policy reform, combined with volatility in climates as well as markets has significantly impacted the suitability of these feedbase systems. Dairy feedbase systems are increasingly complex both in terms of agronomic management and breadth of crop types and species grown. Due to the rapid pace of industry change, farmers are trialling new practices and innovating on the go. In the last 5 years 99% of dairy farmers have tried a new crop, 50% have grown winter cereals and 40% have grown sorghum[1]. The need to support on farm decision making with high quality, up to date and targeted extension information is critical in order to assist efficient transformation of these systems.

[1] Murray Dairy (2021), Murray Region Trends Report.

Project Objectives

The Fodder for the Future project is a cross-sectoral collaboration designed to support the development of complementary farming systems that optimise the use of both irrigated and dryland resources across the southern Murray-Darling Basin (MDB). Led by Murray Dairy, the project was delivered under a partnership model with Agriculture Victoria, Birchip Cropping Group, Irrigated Cropping Council, The University of Melbourne, Riverine Plains and Southern Growers. The program was funded by the Australian Government through the Murray–Darling Basin Economic Development Program.

Its aim was to assist communities in developing strategies to maintain and increase economic activity through a participatory approach. The project engaged 2,016 farmers, service providers & other stakeholders delivering communication and engagement activities, extension resources, workshops, and other initiatives to share information and support community adaptation to a water-limited future.

The Project Objectives were to:

1. Increase economic activity to support regional communities in a variable water future.

2. Increase collaboration, coordination and information sharing between communities and industries in the Southern MDB.

3. Enhance opportunities for broader community engagement through the development of locally generated meeting sites, information, knowledge, and support services for agricultural stakeholders.

4. Improve the quality and quantity of fodder produced in the MDB, including increasing water use efficiency, water productivity, and reducing reliance on irrigation.

5. Foster the development of a 'closed loop' fodder production system within the Southern MDB to retain the value of fodder production locally.

6. Enhance risk management, diversity and resilience of farm businesses by establishing long-term complementary relationships between fodder producers and end-users in the basin.

Project Activities

Project activities were multifaceted and were designed to both increase the technical knowledge available to farmers and service providers about how to improve quality and yield of key fodder products, but also encourage relationship building between different industries and partners.

Project activities involved:

1. Trial and demonstration sites to test the impact of different management strategies on key fodder species specifically to improve yield and quality. These sites were spread across geographical areas, soil types and irrigation and dryland systems to demonstrate the impact of seasonable variability but also to improve relevance to a wider range of farmers.

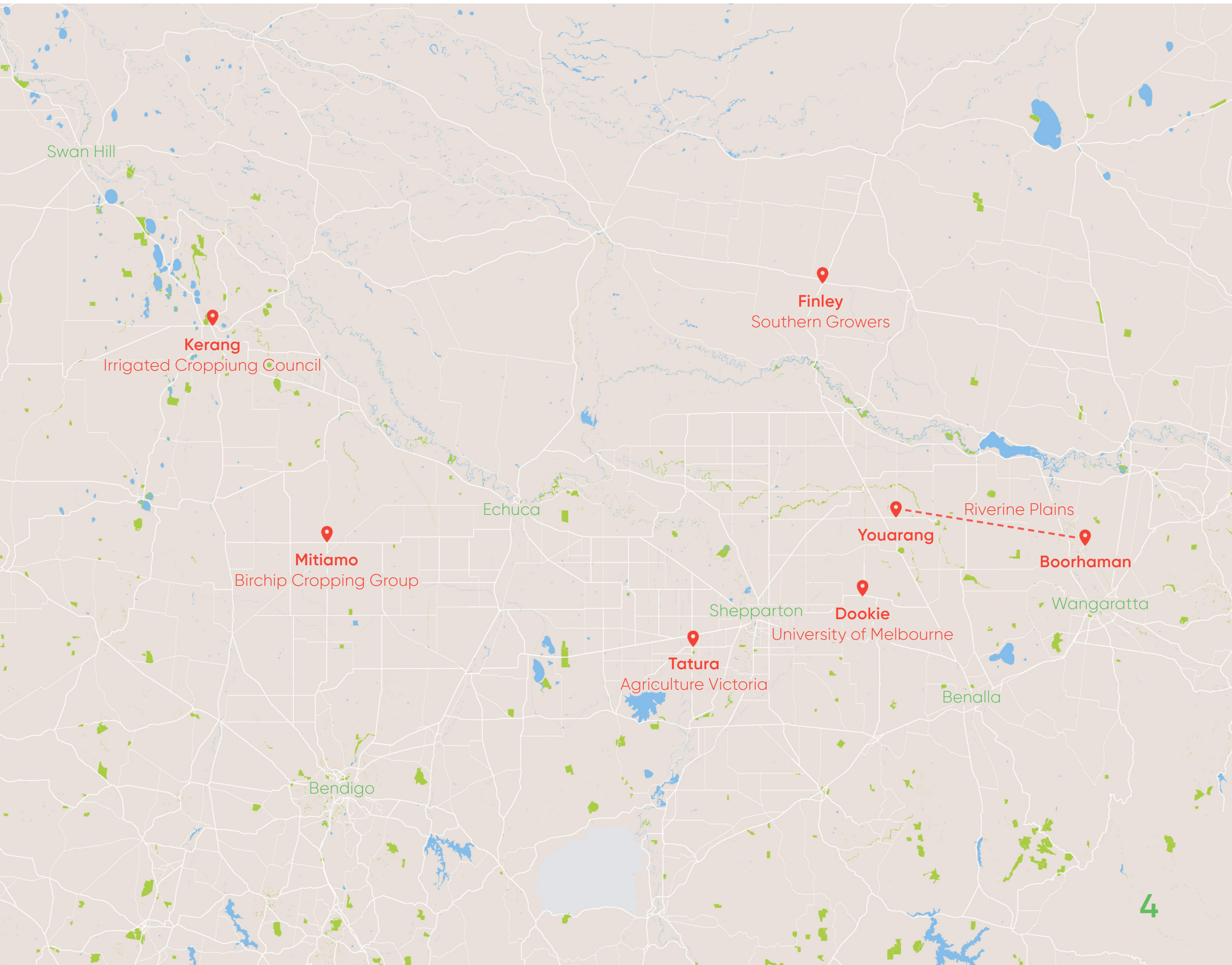
2. Extension and communication activities to engage stakeholders with project learnings and encourage cross sectoral collaboration and information sharing.

3. Development of information resources to support learning and provide legacy products for the project. This included technical reports from each site and a suite of videos showing the progress of each site across the seasons.

Summary

The project successfully delivered 2 years of cropping trials at 6 locations spread across the Murray Dairy region – 5 of these sites were winter only cropping activities and 1 trial site had both winter and summer activities. These sites were representative of climate and soil type as well as geographic spread of both dairy and livestock producers and grain farmers who also produce fodder for target markets. Each trial site delivered a set of field trials or demonstrations outlining management practices to improve yield and quality of key fodder species for dairy consumption.

The second year of trials built on learnings from the first year as well as feedback from researchers and growers. Collaboration between the Technical Committee and the partner organisations allowed trial protocols to be refined for Year 2. A key focus of each site was management practices that demonstrated optimal commercial relevance. Each Partner Organisation delivered a final report outlining their findings from Year 1 and Year 2.



The effect of crop growth stage on winter forages

One of the challenges of growing fodder for dairy cattle are the competing parameters of yield and quality – post-flowering the quality of most crops decline quite rapidly as yield increases. These relationships for crops grown during the project are presented Figure 1

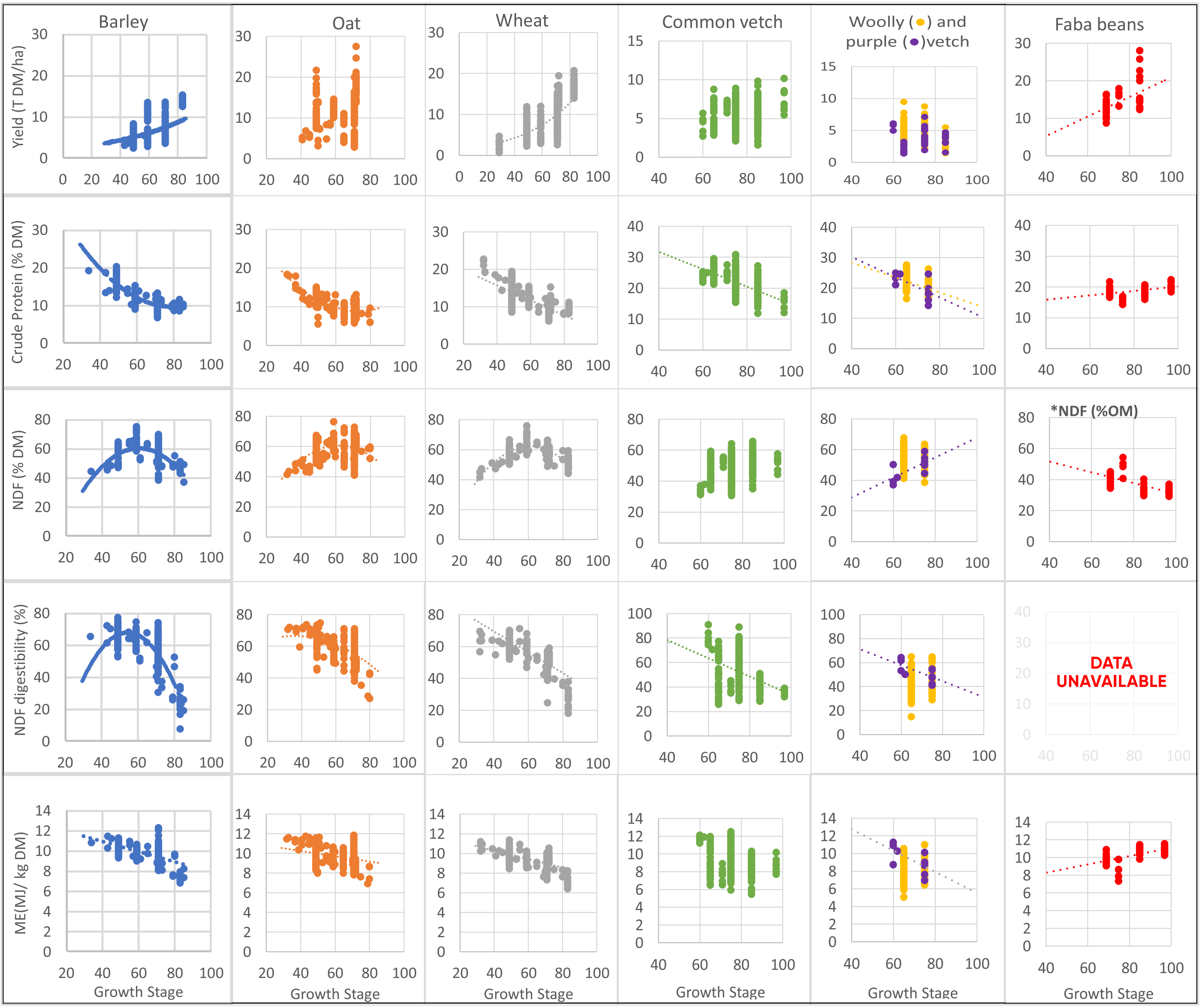


Figure 1. Effect of crop growth stage on yield and quality attributes of different winter forages. Decimal-based scales are used for growth stage: Zadoks scale for cereals and the BBCH scale for the legumes.

Yield and quality of cereal forages

Large variations in yield and quality were apparent across all sites demonstrating the impact of site seasonal conditions, time of sowing effects and crop type and variety (Figure 2).

The combination of strategies, crop selection and seasonal conditions all impacted yield and quality demonstrating that the practical implementation of managing crops to meet yield and quality targets can be extremely difficult. Complex interactions between all these factors led to hugely variable results in yield and quality across both years of trials and sites. This further emphasises the opportunity that exists to improve yield and quality of fodder produced based on current commercial practice that the trial sites reflected, but also the extent of the challenge to do so.

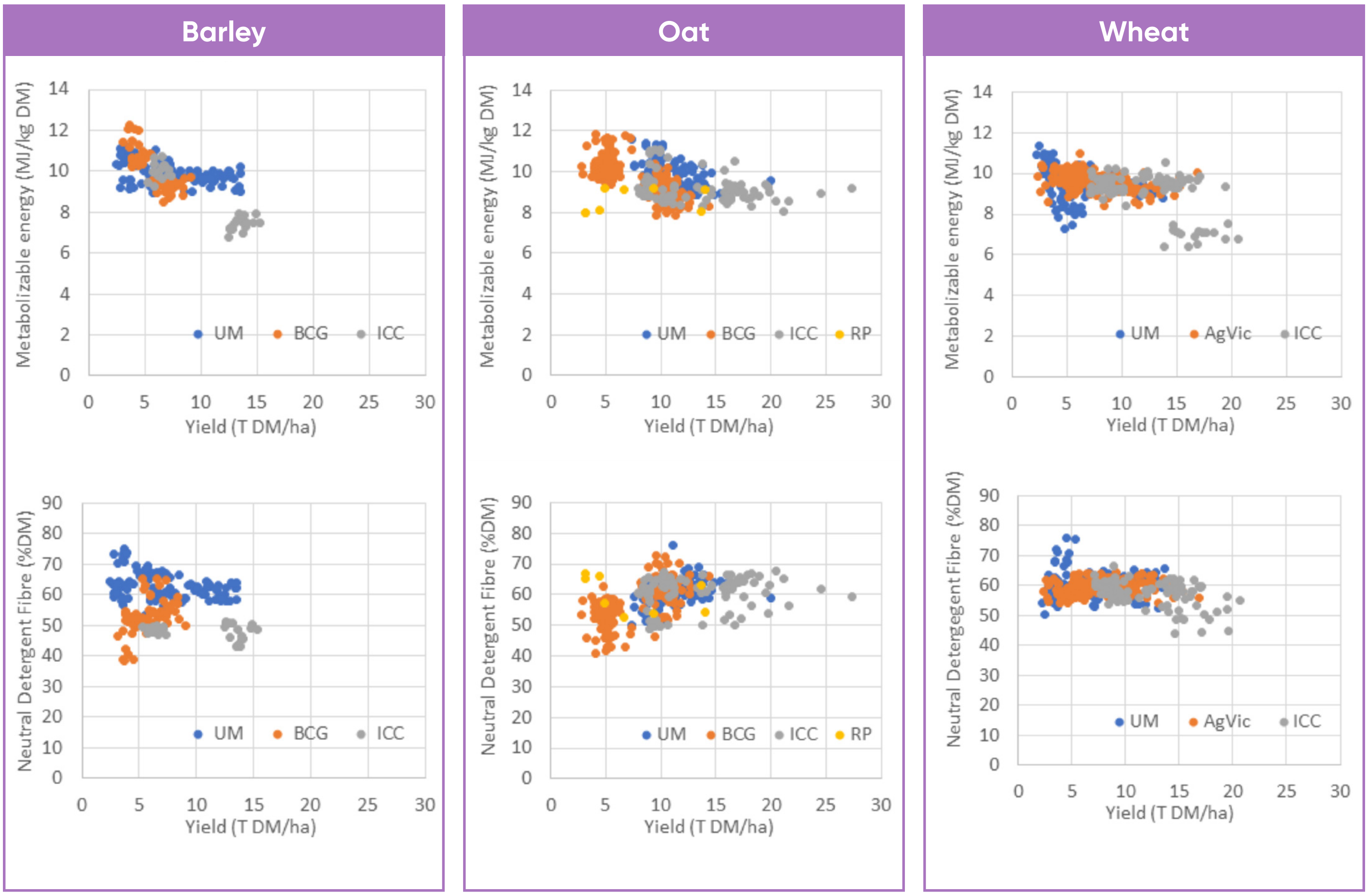


Figure 2. Relationship between yield and metabolizable energy and neutral detergent fibre concentrations in barley, oat and wheat forage crops grown by multiple research partners across the Murray Dairy region as part of the Fodder for the Future Project.
UM – University of Melbourne; **BCG** – Birchip Cropping group; **ICC** – Irrigated Cropping council; **RP** – Riverine Plains; **AgVic** – Agriculture Victoria.

Management strategies for impacting yield and quality of cereals for forage

1. Stage of cutting. Results confirmed that increasing growth stage at cutting time led to increased yield trends for barley and wheat crops however not for oats. There was also a general decline in ME and CP concentrations as growth stage increased however some observations were inconsistent.

2. Crop type and variety. Variability of crop type and variety on yield and quality was also apparent across all sites (Figure 1). Oat was usually higher yielding than wheat or barley—double or triple that of barley. This demonstrates the attractiveness of oats to fodder and grain producers who typically sell fodder based on tonnage. Varietal differences were influenced by cutting stage, time of sowing and seasonal conditions. Differences between wheat and barley yields were variable between sites and years. Quality parameters such as ME, CP and fibres were impacted by crop type, varieties, site seasonal conditions, harvest stage and time of sowing.

3. Time of sowing, sowing rate and nutrient input.
Time of sowing and sowing rate had variable effects on yield and nutritive characteristics and also varied between sites and with crop types and varieties and harvest stages. Yield increased with increasing nitrogen input but did plateau at the higher levels. There was no consistent effect of nitrogen applied on ME. CP was highest at highest nitrogen input levels and NDF was variable.

Yield and quality of vetch forages

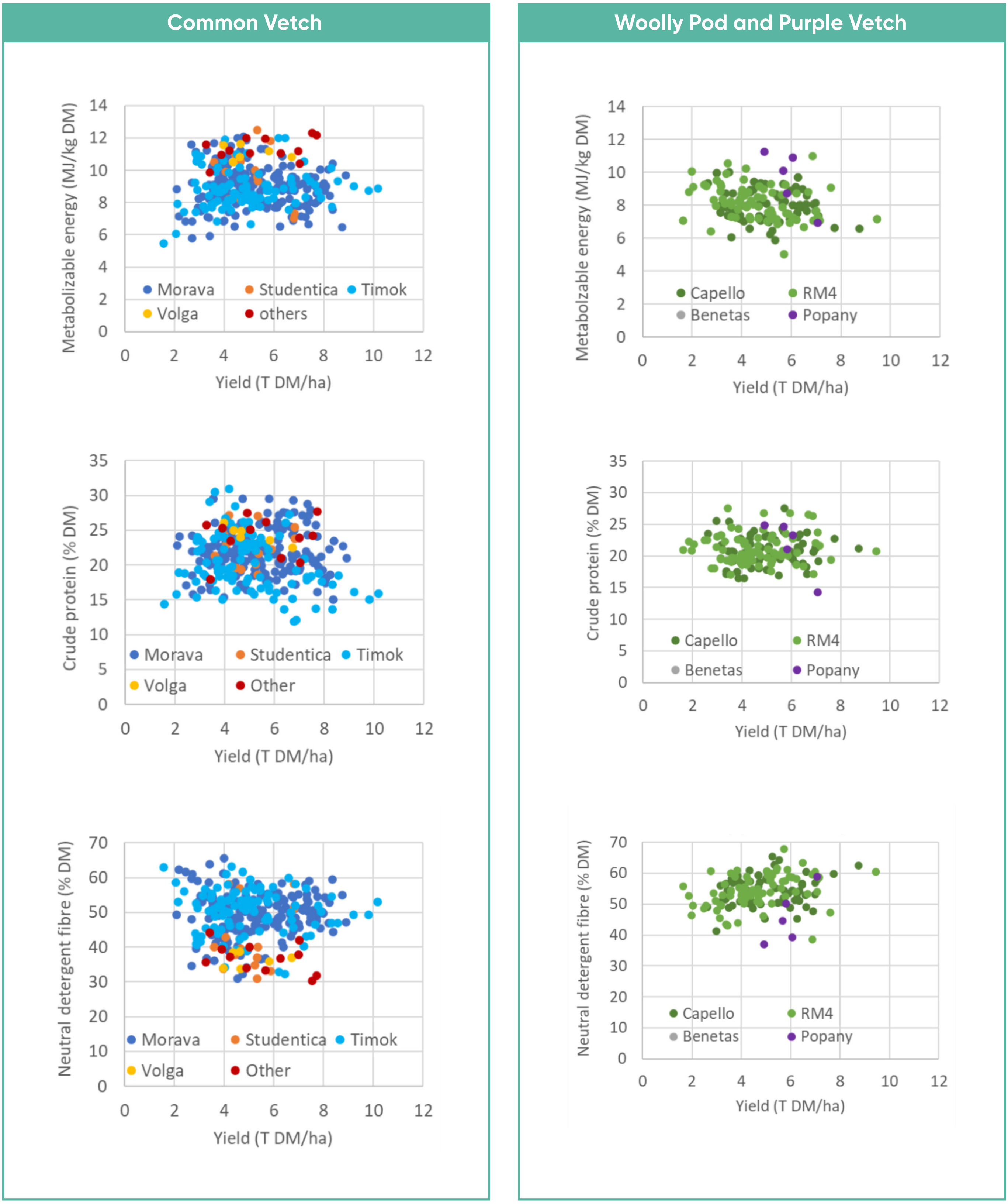


Figure 3. Relationship between yield and metabolizable energy, crude protein and neutral detergent fibre concentrations in different varieties of common, woolly pod and purple vetch crops grown across the Murray Dairy region. Crops were harvested at varying growth stages and the sample proportions were - Common vetch: 50% R4, 25% R6, 13% R2; Wooly vetch: 50% R2, 50% R4. Vetch fodder crops are usually targetting hay as an end-product.

Large variations in yields and quality between the two growing years meant there were no obvious relationships between yield and quality in the vetch crops (Figure 3).

Management strategies for impacting yield and quality of vetch for forage:

1. Stage of cutting. While the overall data shows no strong relationships between cutting stage and hay yield or quality, a strong relationship between time of cutting and quality was found in BCG's year 2 trials which also showed that the maturity type of the plant also interacts with hay quality e.g. early maturing types can be cut at a more mature stage than late maturing types while still maintaining forage quality. Southern Growers trials in year 2 also found quality parameters were higher at earlier growth stages, but in their year 1 work there was no strong relationship between cutting stage and yield or quality.

2. Vetch type and variety. Common vetches did tend to have better quality parameters than the woolly pod or purple vetches. Impact of variety on yield varied across the two growing sites with BCG recording more variety impact than Southern Growers.

3. Time of sowing and sowing rate. These variables were not tested at both sites so overall data is limited. Southern Growers saw no or minimal impact of sowing rate on yield and quality parameters in year 1 and BCG found that earlier sowing increased yield with some varieties but didn't affect quality parameters.

4. Irrigation timing. Irrigations treatments had minimal to no effects on outcomes due to the timings and volumes of rainfall across the two years.

Commercial forage quality specifications

Cereal and vetch hays that meet the specifications for the export cereal hay market[2], or the Grade A1 or Good to Excellent specifications of the AFIA[3] and Feed Central[4] rankings respectively would generally be suitable for milk production. A third of the project's cereal samples and a quarter of the vetch samples met the AFIA Grade A1 specifications, but only 1-3% of the samples met the more stringent quality specifications of the Feed Central - Excellent grade (Table 1).

This highlights the variation in quality that is achieved when growing fodder under relatively controlled trial plot conditions, the challenges that are amplified at commercial paddock scale and the opportunity that exists to improve quality of fodder products on the market.

Table 1. Classification specifications for high quality cereal or legume hays and silages used by different companies or organisations and the proportion of project cereal and vetch forage samples that met these specifications.

COMPANY AND CLASSIFICATION	SPECIFICATIONS—CEREALS					SAMPLES MEETING SPECIFICATIONS (%)
	ME (MJ/kg DM)	CP (%DM)	ADF (%DM)	NDF (%DM)	WSC (%DM)	
AFIA – Grade A1	>9.5	>10				34
Gilmac - Export (2016)	>9.5	4-10	<32	<57	>18	19
Feed Central - Good	≥9.5	≥10	≤45	≤54	≥18	12
Feed Central - Excellent	>10.5	>12	<40	<50	>25	3

COMPANY AND CLASSIFICATION	SPECIFICATIONS—LEGUMES					SAMPLES MEETING SPECIFICATIONS (%)
	ME (MJ/kg DM)	CP (%DM)	ADF (%DM)	NDF (%DM)	WSC (%DM)	
AFIA – Grade A1	>9.5	>19				26
Feed Central - Good	≥9.5	≥19.5	≤32	≤41	≥11	3
Feed Central - Excellent	>10.5	>22	<29	<38	>15	1

[2] Gilmac (2016), referenced within AEXCO (2016) 'Producing quality oat hay', p15.

[3] AFIA & GTA (2015) 'Section 5 Fodders trading standards' In Guide to the GTA grain trading standards 2022/23 season. (Grain Trade Australia: Royal Exchange, NSW).

[4] Feed Central (2023) Quality certificate explanation notes, p13. (Feed Central: Toowoomba, QLD).

Yield and quality of maize and sorghum forages

The project demonstrated that forage harvested from the selected grain and forage sorghum varieties could achieve quality characteristics comparable to maize, in the context of seasonal conditions experienced during the project (Table 2). However, maize was still a higher yielding crop than the grain sorghums and also had better water use efficiency (WUE; kg DM/mm applied), even under mild to moderate deficit irrigation strategies (Figure 4). Forage sorghum had comparable yield and WUE to the maize. Starch concentration in the maize crops was lower than expected.

Table 2. Nutrient characteristics of maize and sorghum crops grown for ensiling at Kerang.

	SENTINAL RED GRAIN SORGHUM	LIBERTY WHITE GRAIN SORGHUM	MEGASWEET FORAGE SORGHUM	PAC440 MAIZE	PAC606IT MAIZE
DM% at harvest	34.4	34.7	30.0	41.0	43.3
Starch (%DM)	33.2	31.1	20.0	24.3	23.7
NFC (%DM)	46.2	38.6	41.7	40.5	43.7
NDF (%OM)	33.1	42.3	40.3	42.2	40.2
ADF (%DM)	22.5	26.0	24.8	26.7	24.2
CP (%DM)	9.3	8.2	8.2	7.3	6.9
ME (MJ/kg DM)	10.1	9.6	9.6	9.2	9.1

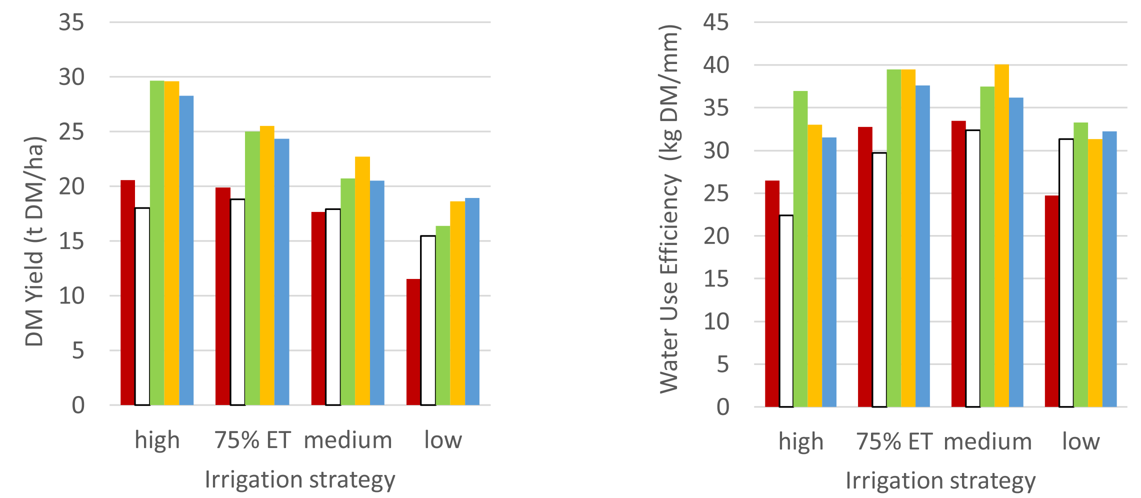


Figure 4. Yield and water use efficiency of maize and sorghum forage crops grown under different irrigation strategies at Kerang.

Sentinal red grain sorghum ◯ Liberty white grain sorghum Megasweet forage sorghum PAC440 maize PAC606IT maize.

Outcomes-Extension

In addition to the specific technical messages generated by each trial site, the project also identified several additional extension messages to support farmers to adopt practices on farm to improve the quality and yield of their fodder. These messages focused on the practical application of technical outcomes and took into consideration current and future seasonal and market conditions. They included:

1. Relationship building

The project emphasized the importance of building relationships between the dairy and grains industries. By understanding each other's needs, both industries can work together to create mutually beneficial outcomes, promote collaboration, and enhance long-term sustainability. An example of this was the role of oaten hay. Grain industry stakeholders involved in the project had a high emphasis on oaten hay given its high yield and potential high value market for export. It was assumed that the dairy industry saw it as an equally valuable product. By bringing the two industries together through the Technical Committee and at project events, dairy farmers were able to share their preference for wheat and barley hay and the quality benefits which helped grain growers understand what species suited different uses in the dairy industry. Having a clear target end product in mind enables fodder growers & dairy farmers to select the correct species, varieties and managements strategies including cutting time in advance in order to optimise the chances of growing a high quality, high value and cost-effective fodder product.

2. Diversification and income generation:

The project delivered trials in extremely challenging and diverse seasonal conditions. Year 1 was largely dry across the region apart from the east, and Year 2 was extraordinary wet with flooding impacting the majority of trial sites. Results from the trials show that seasonal conditions had the biggest impact on quality and yield, which was to be expected in such extreme growing conditions. In order to manage this on farm, farmers need to take a risk management approach to selecting the type, volume and desired end market for their fodder. The project demonstrated a wide variety of fodder options and the relative pros and cons of each one in different seasonal conditions. For example growing vetch in cereal rotations was identified as a beneficial practice for diversifying income streams for farmers as well as having significant agronomic benefits as a break crop. However it was also the most difficult to grow, particularly in wet conditions. Not one fodder species emerged as the highest performing, however the results across sites and years demonstrated that different species performed differently in different conditions. This highlights the need to diversify species and products in order to optimise success in a given year.

3. Yield and quality trade-off

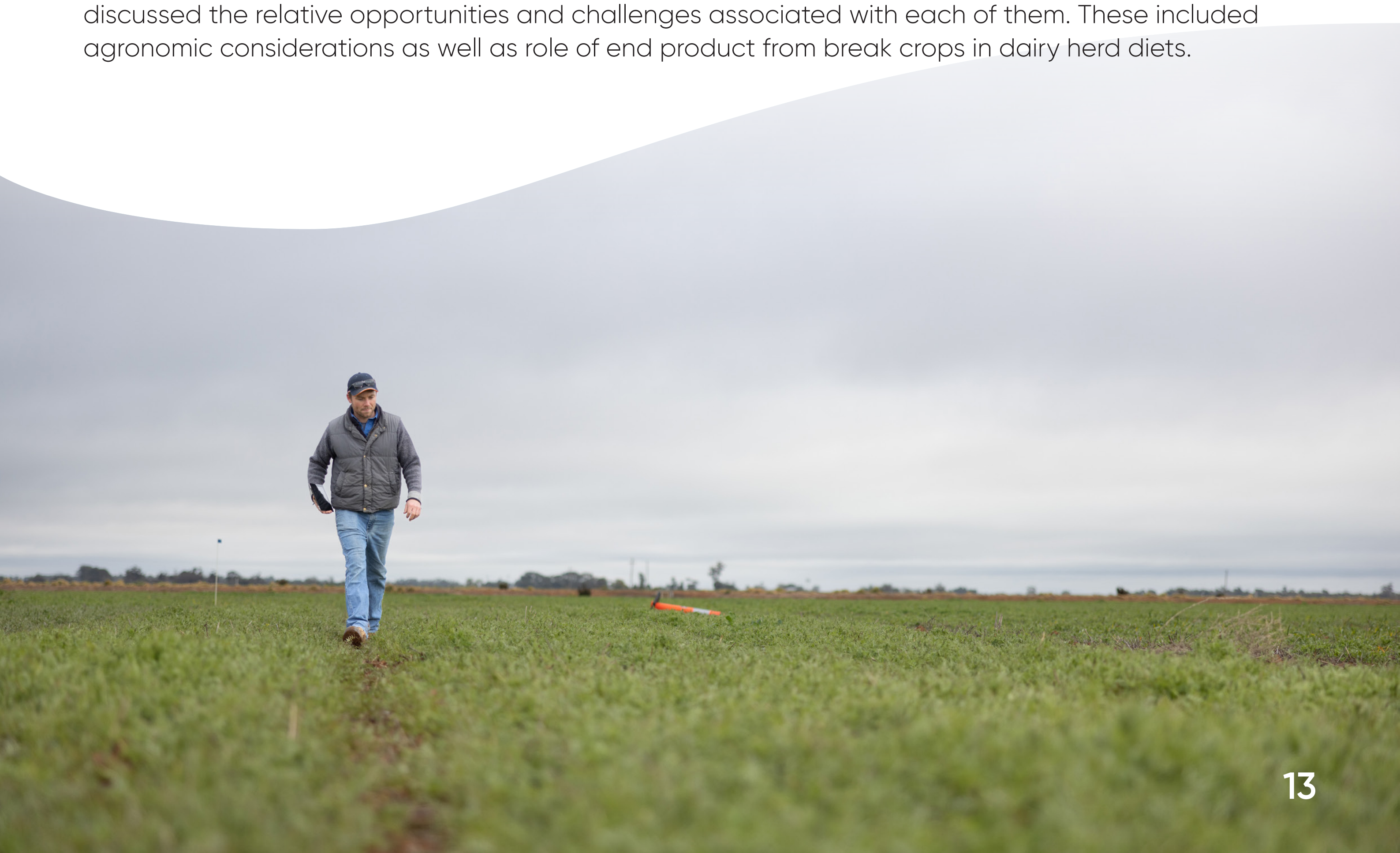
It is well known there is a direct trade-off between quality and yield in most fodder species. The project demonstrated that within that there are often complex decisions to be made in practice to balance seasonal conditions and harvestability with target yield and quality. The project reiterated the importance of having a clear end product with target yield and quality in mind from the beginning, in order to plan ahead for in crop management, particularly target cutting times. The project also demonstrated the importance of problem solving and being flexible with decision making in order to be realistic about what is possible to achieve depending on seasonal conditions. A number of times target yields and quality had to be abandoned as they were not possible to be achieved due to seasonal conditions or harvestability.

4. Importance of proactive weed control

In traditional dairy feedbase systems based on perennial ryegrass, targeted weed control is less critical to feedbase performance given the natural weed suppression from intensive grazing and continuous ground cover that perennial ryegrass provides. In contrast, dryland fodder and grain areas surrounding irrigated dairy farms generally have a sophisticated integrated weed management approach to reduce impact of weeds on target crop emergence and conserve soil moisture and nutrients over the summer fallow periods. Through cross collaboration, the project identified a number of critical improvements that dairy farmers should implement to reduce impact of weeds on fodder crop performance including the importance of rotations that break up continuous cereal and grass species with broadleaves (e.g., brassicas or legumes), pre-emergence and post-emergence chemical options and summer fallow spraying. The current uptake of these best practice options varies significantly between individual businesses.

5. Importance of break crops in dairy rotations

In addition to assisting in long term weed control, particularly the avoidance of herbicide resistance in grass weeds, the project demonstrated the role of break crops in intensive fodder and grain systems. This is already an established practice on dryland grain and fodder systems in the region, but implementation on intensive fodder rotations on dryland and irrigated dairy feedbase systems is mixed. The project demonstrated various break crop options from legume and broadleaf species, and discussed the relative opportunities and challenges associated with each of them. These included agronomic considerations as well as role of end product from break crops in dairy herd diets.



Recommendations & areas for future work

The project delivered a comprehensive set of activities to engage stakeholders with a range of information in order to improve yield and quality of fodder produced by cereal species. A number of areas for future work were identified in order to build on the outcomes of this investment. These include:

1. Support to continue the Fodder for the Future Network as a key mechanism for sharing technical knowledge around how to improve fodder yield and quality, as well as engage large numbers of farmers and service providers effectively.

2. Future research into the role of break crops in intensive cropping rotations to support dairy feedbase systems. This includes how to achieve the natural resource benefits of break crops such as weed and pest control whilst balancing the need to produce high quality fodder for lactating cows cost effectively.

3. Integration of best management practices relating to site preparation, weed control and nutrient management into standard dairy extension programs relating to feedbase. Their remains significant potential to adapt common best management practice principals from the cropping industry into dairy extension packages as winter & summer cereals are continued to be adapted for dairy feedbase systems.

4. Sharing of information on fodder storage and handling developed by dairy industry to grain, fodder and other livestock producers particularly in the context of dry conditions. Similarly, grain and livestock stakeholders identified the opportunity to integrate common best management practice principals from the dairy industry around fodder quality testing, storage & handling into their extension delivery.

5. Updating current and future research projects, particularly those focusing on physical and economic modelling, with yield and quality results from this project to ensure realistic assumptions are being made around yield and quality targets. The variability of performance across years and species demonstrated by this project shows the importance of using current up to date data to inform modelling and economic analysis. This information could also benefit other regions when looking into future climate models and the impact on dairy feedbase performance.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