Changes in dairy farming systems and their forage base in northern Victoria over the last twenty years

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Abstract
There have been large changes in dairy farm systems and their forage base in northern Victoria over the last twenty years. These changes have occurred principally because of major water reforms leading to variations and reductions in water availability, and the increasingly hot summers that are being experienced in the region. Perennial ryegrass – historically the dominant species in perennial pastures –performs poorly under very hot and dry conditions and is now only a minor component of the dairy feed base. This paper documents the large changes in irrigation water usage in the region and describes how this has affected perennial ryegrass production and persistence as well as subsequent agricultural land use, including the increase in number and size of intensive dairies being established. New research is being undertaken to investigate a range of summer and winter crops and annual pastures that can be incorporated into the changing dairy farming systems of the region. These forage systems may be better suited to the climatic conditions and be capable of adapting to year to year variations in the supply and price of irrigation water.

Keywords
Perennial ryegrass, forage systems, irrigation, land use

Introduction
Major water reforms leading to overall reductions in water availability to the dairy industry in northern Victoria, along with increased variability in prices and availability, have been major drivers of changes in the forage base on dairy farms. In addition, the increasingly hotter summers are further affecting the composition of fodder used. Historically, the dairy industry in this area has been based on irrigated perennial pastures that have been dominated by perennial ryegrass (Doyle et al. 2000), because of its rapid establishment, strong seedling vigour, superior nutritive characteristics, and well-understood grazing management (Neal et al. 2009). However, the growth and performance of perennial ryegrass declines markedly over summer with high temperatures, particularly when they are not irrigated for several months, resulting in reduced dry matter (DM) production, plant density and persistence (Langworthy et al. 2018; Rogers et al. 2019; 2021a; 2021b). Recent figures suggest that the proportion of the irrigated area on dairy farms sown to perennial ryegrass in the northern Victorian dairy region has decreased from around 80% fifteen years ago to less than 15% in 2019/2020 (Murray Dairy 2019).

This paper documents the large changes in irrigation water usage in the region and how this has affected perennial ryegrass production and persistence and subsequently agricultural land use. Future forage options and new dairy management systems that are currently being investigated are discussed.

Land use changes
The extent of land use changes as well as changes in the amount of irrigation water used by the dairy industry have been mapped using satellite imagery and additional meteorological, irrigation water delivery and land use data (McAllister et al. 2020). Figure 1 illustrates the change in land use in Central Goulburn Water Service Area in northern Victoria (one of six regions in the Goulburn Murray Irrigation Region) from 2015/16 to 2018/19, showing a clear reduction in the land area used by dairying (blue).

Further analyses have demonstrated a continued move away from summer irrigation by the dairy industry as shown by the amount and seasonal timing of water use on dairy farms in a full (2017/18) and low (2019/20) water allocation year (McAllister et al. 2020, Figure 2).

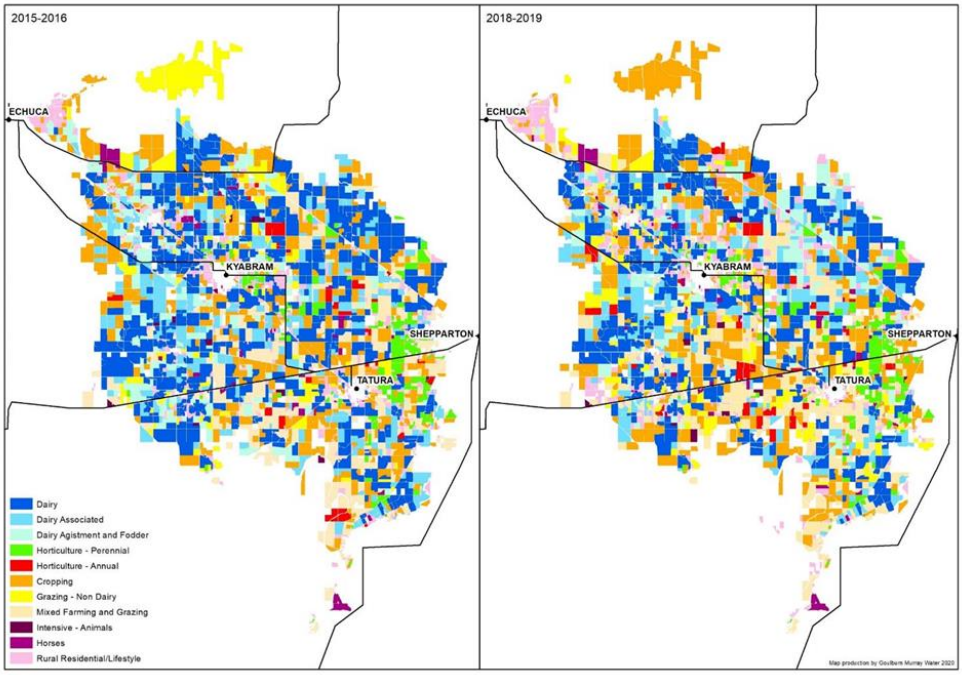

Figure 1. Changes in land use in the Central Goulburn region between 2015/16 and 2018/19 captured by water authority and local government (GB-CMA 2020)

For around 50% of the dairy farms, water use in a low water allocation year was reduced by 40% in spring and by around 60% in summer and autumn compared to in a high water allocation year (Fig 2a). In the other 50% of farms (referred to as low summer water use farms), water use in a low water allocation year was reduced to a much greater extent during summer (90%) than during either spring or autumn (60%) (Fig 2b), with the quantity of channel water used over summer only being sufficient to irrigate a maximum of 8 ha. These farms would have relied extensively on conserved fodder to feed their cows during this period. Normalised Difference Vegetation Index (NDVI) analyses of satellite images confirm that on many dairy farms, water is shut off to pastures during summer which impacts production (McAllister et al. 2020). These differences between farms in water use patterns reflect the wide diversity of the forage base of the dairy farms in the region.

Land use changes and the decline in dairy farm numbers have also been influenced by changes and uncertainties in milk price arrangements particularly in 2016, when many dairy farmers left the industry. There is also the drive to use alternative water sources, such as groundwater, for irrigation.

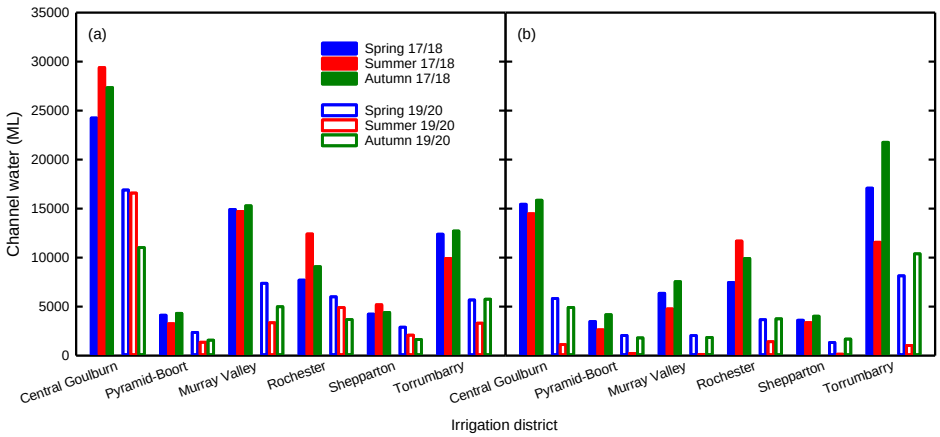

Figure 2. Seasonal channel irrigation water supply for (a) high and (b) low summer irrigation dairy farms in 2017/18 and 2019/20 for the 6 irrigation districts in the Goulburn Murray Irrigation Region (McAllister et al 2020).

Ryegrass in this environment

Extensive research on perennial ryegrass has been unable to identify any irrigation, grazing management or plant genotype effects that could consistently improve the persistence and performance of this species in northern Victoria when it is not irrigated for an extended period during summer (Rogers et al. 2019; 2021a; 2021b). In field research, it was demonstrated that by not irrigating for up to three months over summer, annual DM yield of perennial ryegrass decreased by around 4.3 t DM/ha per year (or by 33% on average) over a three year period (Rogers et al. 2019). The yield reduction was predominantly due to a 80-95% decrease in DM production over summer, but there was also a 10-50% reduction over the next three harvests (Figure 3), with all cultivars behaving similarly. These findings are also supported by Neal et al. (2009) who showed that DM production in perennial ryegrass swards decreased by more than 40% (from 21.1 t DM/ha to 12.2 t DM/ha) when irrigation was restricted to only 33% of what was considered optimal.

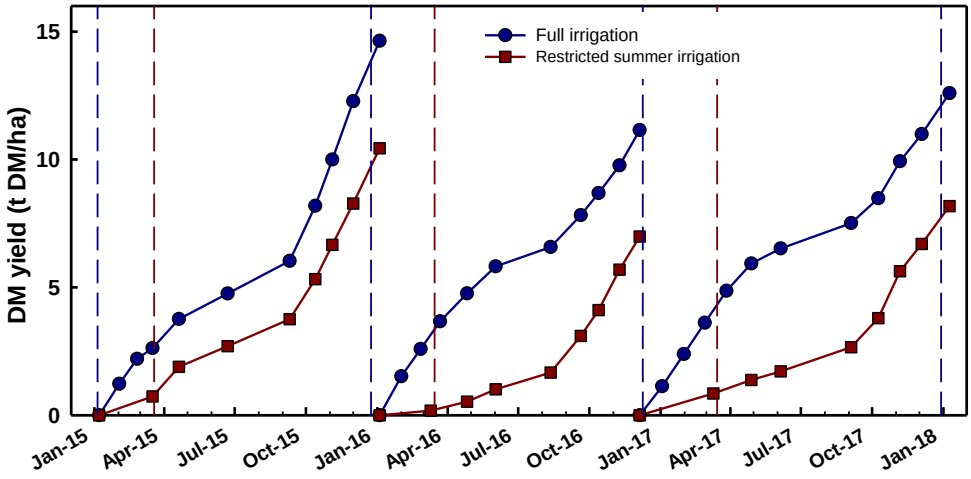

Figure 3. Mean cumulative annual dry matter yields (t DM/ha) in perennial ryegrass under full (circles) or restricted (squares) summer irrigation. Dashed vertical lines indicate when irrigation ceased each summer (blue) and then recommenced in the autumn (red) (Rogers et al 2019).

Alternative species to perennial ryegrass

Dairy farmers are investigating other forages such as summer or winter crops as replacements for perennial pastures as they adapt to a changing climate and a volatile water market. Research on the agronomy of irrigated winter cereals has been conducted previously in the region however, this work has predominantly focused on cereals for grain production (North et al. 2017) rather than forage production for animals. Consequently, there are many agronomic and management issues on the use of irrigated cereal crops for forage production that need to be addressed, with an emphasis on optimal combinations of forage DM yield and forage nutritive characteristics. Research is currently being conducted at Agriculture Victoria, Tatura, to identify how sowing rates, nitrogen application rates and defoliation during the vegetative stage can affect the tiller density, dry matter yield and nutritive characteristics of winter cereals grown for fodder conservation for the dairy industry.

Dairy system changes

Linked to the observed land use changes, many farmers have moved to more intensive dairy production systems, based around partial, or total mixed rations where cows do not graze for some, or all, of the year (Williams et al. 2020). Since 2015, Agriculture Victoria has assisted more than 70 farmers with farm developments for feeding and/or containing cows off pasture (e.g. feed pads, loafing areas) and enquiries are continuing (Scott McDonald pers comm.). An unknown number of farmers have undergone a similar process without the assistance of Agriculture Victoria.

Key drivers for farmers to transition to more permanent and intensive feeding systems vary and may not all be a direct result of water reforms or the declining performance of ryegrass. Some of the rationales outlined by clients to Agriculture Victoria can be broadly categorised as:

1. More effective feeding and reduced wastage of various supplementary feeds,
2. Providing an environment more suitable for high production cows,
3. Adjusting production systems to achieve a consistent daily milk production throughout the year to meet milk factory requirements,
4. Providing a safe and manageable place during weather extremities such as heat waves and very wet conditions,
5. More efficient utilization of high cost irrigation water by growing high yielding crops instead of perennial grass,
6. More opportunities for technology, labour, and funding grants.

Regardless of the rationale, these changes generally shift dairy land use away from irrigated pastures for grazing and towards cropping to supply feedstuffs for rations, thereby reducing the use of ryegrass. Thus, in the region, there is a diversity of dairy systems in operation ranging from grazing throughout the entire year to no grazing at any time.

Conclusions

Extensive research on perennial ryegrass has been unable to identify any factors (irrigation, grazing or genetic) that could consistently improve its performance during hot, dry summers. Water availability and climate in this region continue to be highly variable from season to season and, consequently, there have been large changes in water and land use by dairy farmers who are rapidly changing their fodder systems, with a large range in types of dairy systems currently being utilised. Future research is continuing to investigate alternative forage sources and their integration into new farming systems.

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