Future Northland Pastures: 1. Introduction and temperate forages

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Abstract
The poor persistence of ryegrass–white clover pastures in Northland, New Zealand, has become a critical issue due to intensifying summer-autumn droughts, increased insect pressure, and competition from well-adapted C4 species such as Kikuyu. As climate change continues to challenge existing pastoral systems, Northland farmers are proactively seeking resilient forage alternatives. Historical evaluations of subtropical grasses and legumes in the region showed limited success due to poor cold tolerance and competition from weeds. However, changing climatic conditions warrant a re-evaluation of these and other species. Using the CLIMEX climate-matching tool, regions such as South-Eastern Australia, Uruguay, and parts of Southern Europe were identified as having climates analogous to Northland. A targeted literature and cultivar search revealed several summer-active tall fescue and cocksfoot cultivars with promising agronomic traits, including drought tolerance and pest resistance. In addition, species such as Phalaris and prairie grass were also considered. Introducing these forages requires careful management adaptation and risk assessment, particularly animal health and environmental impacts. Local trials, beginning under mowing regimes, are recommended to reduce risk and refine grazing protocols. This research informs future forage strategies not only for Northland but for the broader upper North Island as climatic challenges intensify.

Keywords: climate adaptation, future forages, resilient pastures

Introduction
The poor persistence of ryegrass (*Lolium perenne* L.)-white clover (*Trifolium repens* L.) pastures in Northland has been a significant challenge for local farmers (Jagger 2021; McCahon et al. 2021). The primary causes for pasture failure are multifactorial, including increased summer/autumn drought severity (Singh et al. 2021) and insect pest pressure (Dymock et al. 2009) with competition from well-adapted C4 grasses (Paton and Piggot 2009), especially Kikuyu (*Cenchrus clandestinus*). As climate change accelerates, Northland farmers recognise these challenges are likely to intensify, requiring practical solutions to maintain sustainable pastoral systems (McCahon et al. 2021). This trend is not isolated to Northland but is also becoming increasingly common in the northern Waikato region (Lee et al. 2017). Strategies to improve persistence of Northland pastures, are likely to be applicable to future farming over wide areas of the upper North Island.

In Northland early work by Lambert (1967) and Rumball and Lambert (1981) evaluated alternatives forages, particularly C4 grasses. This research by MAF and DSIR stopped in the 1990s and partial lists of the grasses evaluated are given in Crush and Rowarth (2007) and Teixeira et al. (2024). Subtropical forage legumes were also evaluated in the late 1970s/early 1980s (Goold 1978; Rumball and Lambert 1980; Goold and McMeikan 1980). Except for Kikuyu, none of the C4 grasses or subtropical legumes tested proved sufficiently productive or persistent to become part of Northland's forage base at that time. Key weaknesses were lack of cold tolerance and failure to compete effectively with weeds. However, the environment of Northland has changed significantly (Jagger 2009) – and will continue to change – so that plant species need to be reconsidered. Although the focus is on improving persistence and production under changing climate, other factors such as environmental mitigation from forages (e.g. reductions in nitrous oxide and methane emissions) could be additional benefits to be considered in the future.

In the early trials, subtropical grasses and legumes were often evaluated under a common defoliation/grazing system (Lambert 1967). A better approach may be to assess how the species are used successfully overseas and consider evaluating them here using similar management protocols to optimise expression of their potential. These protocols may not fit easily with current Northland farming systems and changes may be required (Jagger 2021). Optimisation of farm systems to realise benefits from Kikuyu grass have been done successfully for Northland dairy farms (Jagger 2009) and this is an excellent example of matching the system to the forage plant characteristics. Transitioning

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to new forages can be challenging for farmers where they have one or two paddocks of new species that require different management from the rest of the farm. Local support networks will be critical for successful transitions to new pasture.

Species such as cocksfoot (*Dactylis glomerata*) and tall fescue (*Festuca arundinacea*) have shown promise in recent field trials, and further cultivar evaluation is needed to identify the most suitable cultivars for the region, and to inform farmer decision making. Potential environmental benefits, such as reductions in greenhouse gas emissions from improved forage species, should also be considered.

Introducing new plant material carries risks, including potential negative impacts on animal health and product quality or the possibility of the plant becoming an invasive species. Weed risk assessments (Pheloung et al. 1999) should be done on any new species. Selecting species/cultivars for trials should consider their environmental impact and any effects on livestock. In this regard, initial agronomic evaluations may be better conducted under mowing regimes rather than grazing to minimize risk.

Northland farmers, informed by both recent observations and long-standing concerns, have recognised the need to act proactively. While Northland may serve as a future climate analogue for other regions (Garcia et al. 2021), the most appropriate forage solutions for this region remain less certain. Predictions of warming climates leading to more benign winters and increasing levels of cool-season productivity typically underestimate the significant issue of the late summer/early autumn feed deficit caused by the failure of perennial ryegrass/clover pastures (McCahon et al. 2021). Climate projections for Northland predict an increase in drought frequency and days above 25°C (NIWA 2016), compounding the challenges to current pastoral farming systems.

In 2021, Northland farmers, with the assistance of key advisors and scientists initiated a review to better understand the implications of a warming climate on their farming businesses. DairyNZ analysis has demonstrated there is a relationship of $300 profit per tonne of home-grown feed eaten, and that there is a declining trend in pasture and crop harvested across the entire upper North Island (Marmont et al. 2024). The cumulative effect across these regions has the potential to significantly impact not only the health and well-being of rural communities, but also Northland's GDP (Casey et al. 2022).

This paper is the first in a series of Northland papers and introduces the problem of poor pasture persistence and identifies some C3 grasses that should be evaluated in the region. Paper two covers potentially useful C4 forage gasses and subtropical legumes while Paper 3 discusses the potential of woody forages. Paper 4 discusses the arthropod pests and 'Sleeper' pests that may be more active in future Northland pastures while the final paper examines 'Sleeper' weeds.

Methods

The climate matching tool CLIMEX (Philips et al. 2018; Roigé and Phillips 2021) was used to identify regions with similar climatic conditions to Northland. A composite match index (CMI) of 0.9 was applied to ensure a high level of climate commonality. This identified the regions of South-Eastern Australia, Tasmania, Uruguay, Argentina, and parts of Southern Europe as having climates that closely matched Northland's. Based on this, a literature review and internet searches were conducted to identify temperate forage species and cultivars successfully used in these regions, focusing on summer-active cultivars capable of responding to summer rainfall and recovering quickly after drought.

The following selection criteria were used:

- summer activity of cultivars
- endophyte presence (important for managing pest pressures like black beetle)
- reports of good agronomic performance in trials conducted in similar climatic locations
- commercial availability of seed
- other agronomic characteristics such as growth habit, palatability, and flowering patterns.

Results and Discussion

A strong dominance of tall fescue and cocksfoot was found in regions similar to Northland's climate, while perennial ryegrass cultivars were notably absent. This supports the idea that perennial ryegrass is not well-suited to many Northland locations under current and future climate conditions. This list is not exhaustive, but the focus was to short-list six tall fescue and six cocksfoot cultivars not currently available or trialled in New Zealand. Prairie grass (*Bromus catharticus*) and Phalaris (*Phalaris arundinacea*) cultivars were also being used in some regions with similar climate to Northland.

Tall fescue cultivars

1. **Jesup MaxP** (Pennington Seed, USA): Good summer activity and high persistence, Jesup MaxP performs well in New South Wales, Australia, with higher productivity compared to other fescue cultivars (Harris 2008).
2. **Fortune** (Barenbrug, Australia): A drought-resistant cultivar with medium-width leaves and no endophyte, Fortune is promoted for its drought resilience.

3. **Crimp (Rizar)** (PGG Wrightson, Uruguay): A summer-active, rhizomatous cultivar with MaxQ® endophyte, showing good persistence and production in trials.
4. **INIA Fortuna** (PGG Wrightson, Uruguay): A high-quality, late-flowering cultivar with excellent tillering and good drought resistance.
5. **INIA Aurora** (PGG Wrightson, Uruguay): An early-flowering cultivar with good year-round production, including during the summer.
6. **BarOptima®** (Barenbrug, South Africa, USA): A highly palatable cultivar with a soft leaf and good drought resistance, performing well in South African trials.

Cocksfoot cultivars

1. **SF Lazuly** (Seedforce, Australia): A soft-leaved, summer-active cultivar that has shown good performance in Australian trials.
2. **INIA Perseo** (Procampo, Uruguay): A summer-active, early flowering cultivar with good summer and autumn production.
3. **Pizza** (DLF Seeds, South Africa): A late-flowering, summer-active cultivar suited for production in South Africa's Western and Eastern Capes.
4. **PINGO** (Biscayart Semillas, Argentina): A late-flowering cultivar from France with good trial performance.
5. **Oberon** (Capstone Seeds, South America): A semi-erect, late-flowering cultivar with good establishment and performance in South American trials.
6. **Yarck** (Vic Seeds, Australia): An intermediate, summer-active cultivar that responds well to summer rainfall.

Other C3 grasses

Most commercially available Phalaris cultivars grown in climate-matched regions were winter-active types, some with low to moderate summer dormancy. The selection focused on two summer-active cultivars to leverage summer rainfall and mitigate summer/autumn feed deficits.

1. **Holdfast GT** (Barenbrug): A semi-erect, grazing-tolerant cultivar with low alkaloid levels and limited summer dormancy, widely marketed in Australia.
2. **Confederate** (PGG Wrightson Seeds Australia): A semi-erect cultivar with low summer dormancy, with consistent performance in trials.

Prairie grass was apparently little used in the overseas climate matched regions. Matua prairie grass, sown into kikuyu pastures on dairy farms near Kaikohe increased annual dry matter yield through better autumn, winter and spring growth (Betteridge and Haynes 1986) but the trial only ran for two years. Prairie grass had not persisted well in Waikato pastures (Thom et al. 1990) with susceptibility to Hessian fly (*Mayetiola destructor*) being a major issue. It is also more susceptible than ryegrass to waterlogged soils (Eccles et al. 1990). Remnant prairie grass plants have persisted for decades in some Northland pastures (AD McCahon pers. comm.) indicating possible adaptation and warranting further investigation. The cultivar Jeronimo from Seed Force could be used as a control for assessing the agronomic traits of the persistent Northland plants.

Practical Applications

Using climate-matching and international cultivar evaluation, the study identified summer-active tall fescue, cocksfoot, and selected Phalaris cultivars as promising alternatives to traditional perennial ryegrass–clover pastures in Northland. Trialling these species under locally adapted management systems—starting with mowing trials and progressing to grazing trials—could confirm their potential utility in the region. New and regionally focused trials of cocksfoot, tall fescue, and Phalaris cultivars in Northland are urgently needed to produce data showing their suitability to local conditions and evolving climate realities. Only then can farmers and industry make informed decisions about their applicability to farming systems across the upper North Island, contributing to a roadmap for building more resilient and sustainable pasture systems.

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