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Performance of temperate perennial pastures in the Australian subtropics 2. Milk production

K. F. Lowe[AB], *T. M. Bowdler*[A], *N. D. Casey*[A] *and R. J. Moss*[A]

[A] Australian Tropical Dairy Institute, Department of Primary Industries, Mutdapilly Research Station, MS 825, Ipswich Qld 4306, Australia.
[B] Author for correspondence; e-mail: lowek@dpi.qld.gov.au

Summary. Milk production from irrigated, pure stands of perennial ryegrass (*Lolium* perenne cv. Yatsyn), prairie grass (*Bromus willdenodii* cv. Matua) and tall fescue (*Festuca arundinacea* cv. AU Triumph) were compared with that achieved from Italian ryegrass (*L. multiflorum* cv. Concord) over 3 lactations of multiparous Holstein–Friesian cows at Mutdapilly in south-east Queensland.

Pastures were fertilised with 50 kg nitrogen/ha.month as urea and annual dressings of 20 kg phosphorus/ha and 50 kg potassium/ha (as superphosphate and muriate of potash respectively). There were 4 pasture treatments grazed at 3 cows/ha in a 1-week-on, 3-weeks-off rotation with 2 replicates and 3 cows/treatment block. Cows grazed the pastures day and night from May to November. Over summer, cows grazed the pastures during the night and were fed supplements (silage in the first lactation, and lucerne hay in the second and third lactations) during the day because there was no shade available in the irrigation areas. In autumn, the animals were removed from the ryegrass and prairie grass pastures for 8 weeks to allow seedling re-establishment, either by oversowing (ryegrasses) or natural reseeding (prairie grass). Cows continued to graze the fescue pastures at night during autumn. All cows received a ration of 4 kg/cow of a grain–minerals mixture in the first lactation and 5 kg/cow in the second and third lactations.

Milk production from perennial ryegrass was higher than from fescue in the first lactation and Italian ryegrass in the second and third lactations. Prairie grass gave similar milk production to perennial ryegrass in all 3 years. In the third year, perennial ryegrass, prairie grass and fescue gave similar milk production. Milk quality from the 4 grasses was similar except in the third lactation when the lactose content of milk from perennial ryegrass pastures was lowest. There were also small and inconsistent differences in milk component yields between the 4 grasses. Liveweight changes were small except in the second lactation when the cows grazing fescue lost weight relative to the other treatments. Mean liveweight at calving increased over the 3 lactations.

It was concluded that all 3 temperate perennial grasses demonstrated useful traits for use in subtropical dairy pastures. Perennial ryegrass produced the most milk from the lowest amount of dry matter on offer. Prairie grass produced similar milk yields to perennial ryegrass, was well eaten by cattle and was self regenerating. Although fescue was slower to establish and needed more intensive management to control maturity, it was the most persistent and was the only grass to provide autumn grazing. In the second year this attribute resulted in a lower requirement for supplementary feeding. Fescue produced the highest gross margin in the second lactation and was only marginally less than prairie grass in the third. The performance of Italian ryegrass was as good as that of perennial ryegrass in the first lactation but fell substantially in the second and third lactations as the level of summer grass invasion increased.

Introduction

Fescue and prairie grass have shown higher yields and better persistence than other temperate perennial grasses in the subtropics (Lowe and Bowdler 1984, 1995) but this superiority must be converted into increased milk production if these perennial pasture grasses are to be successfully integrated into subtropical dairy forage systems. The better yield and persistence of fescue has been well established (Lowe and Bowdler 1984) but there have been concerns about its quality for

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dairy production (Lowe and Bowdler 1984; Easton *et al.* 1994; Stone 1994).

Matua prairie grass pastures can achieve high animal production if suitable management is imposed (McCallum *et al.* 1992). Smith *et al.* (1985) found that Kentucky 31 tall fescue produced more milk in autumn and spring than phalaris or annual ryegrass. While tall fescue produces more forage than perennial ryegrass, this advantage is not translated into increased milk yields (Thompson *et al.* 1988), due apparently to lower quality, particularly as the foliage matures. Collins and Casler (1990) demonstrated that the *in vitro* digestibility, and neutral detergent fibre (NDF) and acid detergent fibre (ADF) content of tall fescue cultivars changed more rapidly with maturity than *Dactylis*, *Bromus*, *Phalaris* and *Phleum* cultivars and that fescue would need to be grazed at an earlier stage to obtain forage of equal quality. Quality differences in the pasture in this experiment and the difficulty in managing fescue pastures have been described (Lowe *et al.* 1999).

While milk production from annual temperate grasses and legumes growing in the subtropics is high (Chopping *et al.* 1982; Moss and Lowe 1993; Lowe *et al.* 1993), no definitive comparison of that from temperate perennial grasses has been made. It is important that the improved performance of the newer perennial ryegrass cultivars (Lowe and Bowdler 1995) can be translated into higher milk yields of cows grazing such pastures. In New Zealand, oversowing of short rotation ryegrasses achieved similar animal production to perennial ryegrasses where these persist for less than 5 years (Goold 1984). However, in the subtropics farmers have been forced to oversow both annual and perennial ryegrasses in each autumn to maintain productivity of irrigated pastures (Lowe and Hamilton 1986; Fulkerson *et al.* 1993*a*) and this reduces the feed potential in autumn, a time of the year when it is difficult to produce milk in the subtropics.

This project investigated the use of temperate perennial pastures in the subtropics by comparing the best available cultivar of each genus against current practice — the annual sowing of Italian ryegrass. The first paper in this series (Lowe *et al.* 1999) discussed pasture on offer, persistence characteristics and quality aspects of these grasses. In this paper, we describe yields and quality of milk from Holstein-Friesian cows grazing pure swards of fescue (*Festuca arundinacea* cv. AU Triumph), prairie grass (*Bromus willdenodii* cv. Grasslands Matua) and perennial ryegrass (*Lolium perenne* cv. Yatsyn) in comparison with Italian ryegrass (*L. multiflorum* cv. Concord). The economics of milk production from the forage system used to evaluate these grasses was also evaluated.

Materials and methods

Site, design and treatments

The experiment was located on Mutdapilly Research Station in south-east Queensland (26°46'S, 152°41'E) in a subtropical environment of predominantly summer rainfall. Details of rainfall, experimental site, establishment and management procedures are presented by Lowe *et al.* (1999). To summarise, the grazing experiment was a randomised block, with 4 pasture types, 2 replicates and 3 animals per treatment. Pure stands of Yatsyn perennial ryegrass, AU Triumph tall fescue, Grasslands Matua prairie grass and Concord Italian ryegrass were fertilised with 50 kg nitrogen (N)/ha.month and fully irrigated using a travelling irrigator. Grazing commenced in October 1992 and the experiment continued for 3 lactations until June 1995.

Animal and pasture management

Thirty-two multiparous Holstein-Friesian cows were allocated to the 8 treatment groups (4 treatments by 2 replicates) by stratified grouping on their production in the previous lactation. All animals had calved in spring 1992, the earliest calving in September and the latest in December. The initial stocking rate of 4 cows/ha was reduced to 3 cows/ha midway through the first lactation (Lowe *et al.* 1999). Cows were fed a daily supplement of 4 kg of a grain–minerals mixture in the first lactation and this was increased to 5 kg in the second and third lactations. Cows were dried off at 300 days after calving or if milk production dropped below 10 L/day for 2 consecutive weeks. Replacement cows were re-allocated to other treatments to achieve parity within the groups. Overall, 70% of animals remained in their original treatments.

The pastures were stocked for 24 h during winter and spring and during the night (from afternoon milking to morning milking) in summer. Cows were given a shaded area off the experimental area during the day. In the first summer (1992–93), animals were moved to a lounging area under trees and fed maize silage (945 kg wet weight per animal over 3 months). They also had access to a small area of naturalised grass in this area. In subsequent years, treatment groups were penned separately and fed lucerne hay. Hay supplement was supplied when feed on offer fell below 500 kg/ha. The amount of hay eaten was recorded. Because of the drought and impending irrigation restrictions in autumn 1995, differential feeding during daylight hours ceased from April onwards and animals were fed oats as green chop at the rate of 41 kg (wet weight)/cow.day over a 70-day period. This was a drought-related management option to utilise available forage rather than feeding purchased hay.

Autumn grazing was affected by the need to re-establish both ryegrass components each year. For 7 weeks after oversowing, the ryegrass pastures were ungrazed and cows were held in pens and fed supplements. For the remaining 4 weeks of autumn, cows grazed the pastures day and night. Prairie grass was not resown each year as it re-established from self-sown seed; however, a similar spelling regime to the ryegrass area was employed to allow seedlings to establish. Fescue was grazed through autumn without spelling and the summer management regime was continued though the first 8 weeks of autumn.

Measurements

Milk yield and a composite sample of milk which was analysed for milk fat, protein and lactose (Fossomatic Milkoscan 203) were recorded once a week at morning and evening milkings. Animals were weighed every 2 weeks after morning milking.

Gross margins

Gross margins were calculated using the Department of Primary Industries' Dairy Farm Accounting Scheme (Busby and Lake 1996). Experiment costs were based on the costs associated with maintaining the full herd at Mutdapilly Research Station. Only feed costs were affected by treatments. A number of assumptions were made in utilising this general data. All costs and returns for the 3 lactations were calculated at 1994–95 prices. This underestimated the profitability of the pasture systems because 1994–95 was the third year of a major drought in the region which inflated costs, particularly that of purchased feeds. This was partly offset by a 4 cents/L premium paid for milk as a result of drought.

Statistical analyses

Milk yields and milk composition were analysed by analysis of variance. Analyses were conducted as a 4 x 2 randomised block design and as a split-plot using the 'animals within treatment' interaction as the error term. As the latter design contributed little to the analyses, results are presented from the randomised block analysis. Years were analysed separately.

Results

Average daily and 300-day milk production

In 1992–93, average daily milk production from cows grazing perennial ryegrass was significantly higher (P<0.05) than for those grazing fescue (Table 1) with yields from the other grasses not being significantly different to perennial ryegrass. In 1993–94 there were no significant differences in milk production between the grasses, though milk production from Italian ryegrass was almost 2 L/cow.day lower than that from perennial ryegrass. In 1994–95, milk production from prairie grass was significantly higher (P<0.05) than from Italian ryegrass while prairie grass, fescue and perennial ryegrass were similar.

There were no significant differences in 300-day milk production from cows grazing the 4 grasses in 1992–93 or 1993–94 (Table 1). Highest production was recorded in the second lactation, averaging over 6200 L/cow. Grasses had no effect on lactation length.

Seasonal milk production

Differences in seasonal milk production between the 4 grass swards were demonstrated in winter 1993, summer 1993–94 and 1994–95, and autumn 1995 (Fig. 1). Winter milk production from fescue was less (P<0.05) in 1993 than perennial ryegrass but there was no difference between perennial ryegrass, prairie grass or Italian ryegrass. Cows grazing perennial ryegrass produced significantly more milk in summer 1993–94 than Italian ryegrass or prairie grass. In summer 1994–95, prairie grass and fescue produced significantly (P<0.05) higher milk yields than Italian ryegrass, while in autumn 1995, all 3 were higher (P<0.05) yielding than Italian ryegrass. The data for the final winter period were incomplete because of drought effects and have not been presented.

Table 1. Milk production and milk quality for cows grazing three perennial grasses and Concord Italian ryegrass in subtropical south-east Queensland

Means within columns followed by the same letter are not significantly different at P = 0.05

Pasture	Av. milk yield (kg/cow. day)	300-day milk yield (kg/cow)	Milk fat (%)	Protein (%)	Lactose (%)
		1992–93			
Concord	15.9ab	3767a	3.82	3.15	4.92
Yatsyn	16.7a	3817a	3.85	3.14	4.83
Matua	16.2ab	3669a	3.88	3.15	4.91
AU Triumph	15.2b	3386a	3.73	3.10	4.96
		1993–94			
Concord	20.7a	5900a	3.70	3.15	4.73
Yatsyn	23.7a	6879a	3.76	3.33	4.73
Matua	21.6a	6240a	3.87	3.22	4.78
AU Triumph	21.3a	5929a	3.59	3.09	4.76
		1994–95			
Concord	21.0b	4629b	4.14	2.95	4.76
Yatsyn	22.4ab	5001ab	3.77	2.87	4.63
Matua	22.6a	5332a	4.14	2.93	4.80
AU Triumph	22.4ab	5117ab	3.84	2.87	4.71

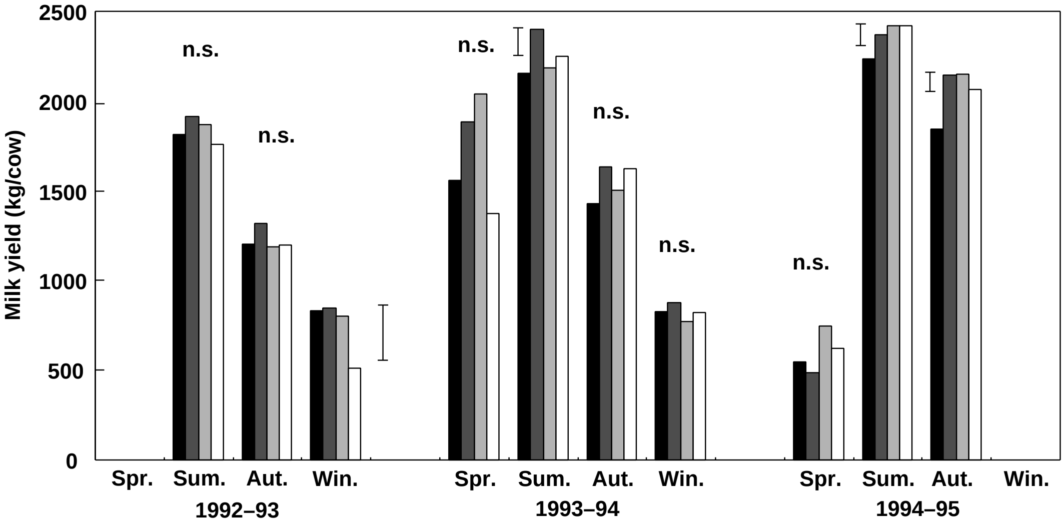

Figure 1. Seasonal milk production from cows grazing 4 temperate grasses (Concord, solid bars; Yatsyn, heavily shaded bars; Matua, lightly shaded bars; AU Triumph, open bars) over 3 lactations at Mutdapilly, south-east Queensland.

Milk quality

There were no significant differences between the 4 grasses in milk fat or protein content in any of the 3 lactations. In 1994–95 the lactose content of milk from Yatsyn was significantly (P<0.05) lower than that from the other 3 grasses (Table 1). Lactose content of milk from prairie grass was also higher (P<0.05) than that from fescue.

Protein yield was significantly (P<0.05) higher from cows grazing perennial ryegrass in 1993–94 and again in 1994–95. In 1994–95, cows grazing prairie grass produced more milk fat than those grazing the other 3 grasses and higher lactose yields than those grazing perennial ryegrass.

Liveweight changes

Cows grazing Italian ryegrass in 1992–93 were heavier than those grazing the other 3 grasses while those grazing perennial ryegrass were generally the lightest (Fig. 2). Cows grazing perennial ryegrass, prairie grass and fescue increased liveweight by up to 100 kg, compared with that at the beginning of the experiment but those grazing Italian ryegrass only just regained their initial weight by the end of the lactation. Cows grazing perennial ryegrass commenced the second (1993–94) lactation as the heaviest group and this was maintained throughout the lactation. The fescue cows lost weight throughout the lactation and by autumn clearly weighed less than the other groups. In the third lactation (1994–95), cows grazing Italian ryegrass were the heaviest, and those grazing prairie grass, the lightest. This relative difference was maintained throughout the lactation. In the third lactation, animals were maintained on high quality pasture for an extra month in spring before calving and therefore gained more weight. There was a substantial increase in the liveweight at calving over the 3 years. While the animals were not in poor condition at the beginning of the 1992–93 season (averaging 527 kg), their preparation was not ideal. In 1993–94, they averaged 620 kg and in 1994–95, 660 kg.

Supplementary feeding

A small amount of hay, amounting to 1.1 bales/cow for the 2 ryegrass groups (Table 2), was fed in the paddocks during February and March 1993. In the second year, cows grazing fescue required significantly

Table 2. The amount of hay (bales/cow) fed as supplements to cows grazing four temperate grass pastures at Mutdapilly over three lactations (a bale of lucerne hay is estimated to weigh around 25 kg)

Means within columns followed by the same letter are not significantly different at P = 0.05

Grass	1992–93	1993–94	1994–95
Concord	1.1a	55.8a	20.2a
Yatsyn	1.1a	55.4a	20.4a
Matua	0b	53.6a	20.2a
AU Triumph	0b	38.2b	20.1a

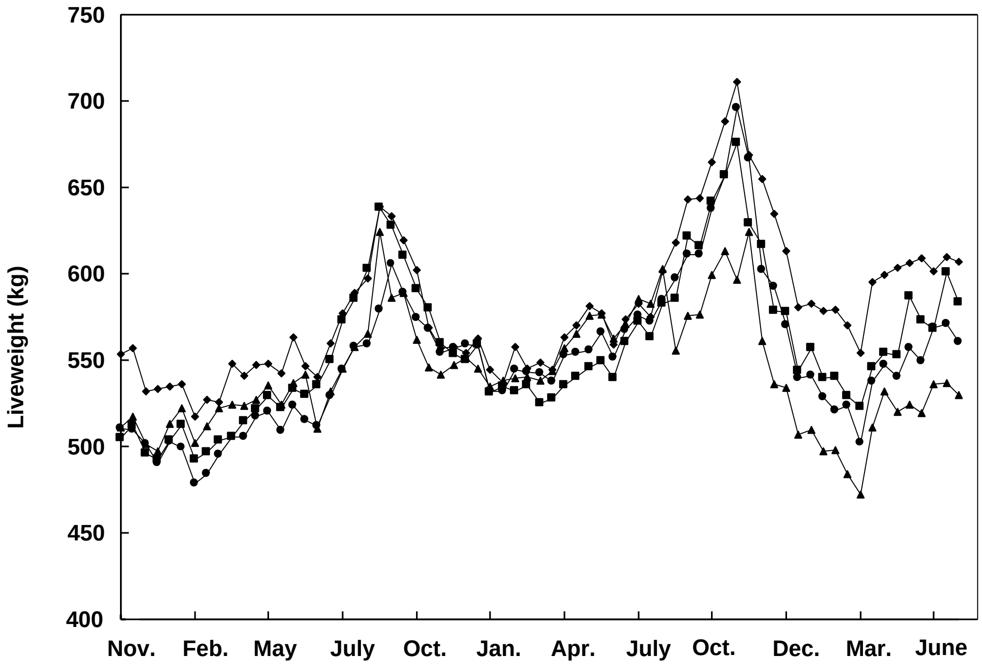

Figure 2. Liveweight changes of cows grazing 4 temperate grasses (● Yatsyn, ◆ Concord, ■ AU Triumph, ▲ Matua) over 3 lactations at Mutdapilly, south-east Queensland.

less hay than the other 3 groups. Most of this difference occurred in autumn (data not shown). There were no significant (P>0.05) differences between treatments in the amount of supplements fed in the third year.

Gross margins

The major differences in components used to calculate gross margin between the grasses occurred in the areas of milk income and purchased feed costs; small differences also occurred in seed and other feed costs. Perennial ryegrass had the highest income and the highest gross margin over the 3 lactations. Italian ryegrass had the highest purchased feed and total production costs (Table 3). The differences between grasses in terms of gross margin per cow were greatest in 1993–94; perennial ryegrass and fescue were twice as profitable as Italian ryegrass. Purchased feed cost differences were also greatest in 1993–94 when that required for fescue was 32% lower than that for Italian ryegrass.

In 1992–93 the gross margin was highest ($A682) for perennial ryegrass; that for fescue ($555) was substantially lower than the other 3 grasses. In 1993–94, perennial ryegrass again produced the highest gross margin ($882) and Italian ryegrass produced the lowest ($409). Prairie grass was highest in 1994–95 ($908) and Italian ryegrass again the lowest at $641.

Table 3. Mean gross margins of the four grasses within an irrigated forage system over three lactations in south-east Queensland

	Concord	Yatsyn	Matua	AU Triumph
(a) Income	1817.50	1995.61	1937.64	1834.78
(b) Purchased feed costs	674.06	639.64	625.17	532.04
(c) Other feed costs	330.69	335.76	320.91	320.99
(d) Total feed costs (b + c)	1004.82	975.40	946.08	853.04
(e) Total non-feed costs	238.79	238.79	238.79	238.79
(f) Total production costs (d + e)	1243.61	1214.19	1184.87	1091.83
Gross margin per cow (a – f)	573.88	781.42	752.77	742.96

Discussion

Production systems based on the 4 grasses achieved high milk yields compared with district averages (Busby 1995). Matua prairie grass was the most consistent performer, achieving high milk and pasture production levels and excellent gross margin figures. It regenerated naturally each year. However, to achieve this, prairie grass required spelling during autumn to allow establishment of new plants and the provision of an alternate source. Prairie grass was always well utilised by the cattle and consistently produced the most forage on offer to the animals, particularly in mid–late spring and this is reflected in better spring milk yields from this grass. This result is in contrast to the New Zealand experience which showed that the stands did not reliably self-regenerate causing its performance over time to decline (G. Milne pers. comm.). Perennial ryegrass produced the most milk in the first and second lactations. However, it required oversowing to replace the population lost during summer and therefore also needed spelling and the provision of an alternative autumn feed source. This agrees with milk production studies in temperate climates (Cunningham *et al*. 1994).

Fescue produced lower milk yields due in part to its lower pasture quality (Lowe *et al*. 1999) and it needed special management to maintain this relatively modest milk production. However, it was the only grass capable of sustaining autumn grazing, required less outside supplementation and achieved good gross margins in the second and third years. Poor performance of fescue in the establishment year is well documented (Easton *et al*. 1994) and this was one of the reasons why the experimental grazing did not commence until the middle of spring in 1992. Its performance improved each year and, over the 3 lactations, its milk production was better than expected from the results achieved in temperate areas (Thompson *et al*. 1988). Its summer and autumn milk production was as good as perennial ryegrass and prairie grass and improved throughout the 3-year period. It was also the only grass to persist for the duration of the experiment.

All 3 perennial grasses were superior to the annual ryegrass system. Concord performed well in the first year and confirms it as a most useful ryegrass cultivar for annual sowings in the subtropics. Its lack of consistency in subsequent years has also been demonstrated under commercial conditions when dairy farmers have attempted to maintain it for longer than 1 year; this problem is related to summer grass invasion (Fulkerson *et al*. 1993*b*).

Milk quality was high from cows grazing all 4 grasses. There appeared to be no consistent effect of species on milk quality with the exception of lactose in the final year which was lower from the 2 ryegrasses. There is no evidence that this result is different from the performance of the grasses in temperate climates.

In practical forage systems, the supplementary forage that was supplied in times of deficiency would have been provided by other pasture options such as lucerne, tropical grass or silage. Our experimental design, and area restrictions, did not allow for the provision of paddock-grown feed. However, the results strongly suggest that the requirement for such options would have been considerably less for fescue than for the other grasses. This is an important consideration when choosing temperate species for perennial pastures in the subtropics and is another reason to base such pastures on fescue, particularly as autumn is still the period of greatest feed shortage.

A comparison of the grasses using gross margin analysis has demonstrated the value of perennial temperate pastures in comparison to an annually oversown Italian ryegrass system. Comparing milk production alone does not show such a large difference between the grasses and emphasises the value of economic assessment in comparing feeding systems. The performance of fescue improved relative to the other 3 systems over 3 lactations mainly as a result of the lower supplementary feed requirement. The gross margins achieved by the pasture treatments in this experiment compare favourably with the average figures achieved by farmers in south-east Queensland from 1990–91 to 1994–95 (Busby 1995). The average gross margin for the 138 south-east Queensland farms included in the Queensland Dairy Accounting Scheme in 1994–95 was $A698. Average feed-related costs ($/cow) in south-east Queensland have shown a large increase since 1990–91, ranging from $523 for 1990–91 to $918 in 1994–95.

In conclusion, the performance of prairie grass and fescue in the second and third years indicates that perennial pastures based on these 2 grasses can play a role in providing economically viable forage systems for the subtropical dairy industry. Italian ryegrass performed as well or better than the perennial grasses in the first year but subsequently its performance deteriorated as summer-growing grasses became dominant. To maintain its performance in subsequent years, more drastic suppression of these invading species (either by mechanical cultivation or spraying with herbicide) is required. The results confirm that perennial ryegrass is the most efficient producer of milk even in the subtropics and therefore must be a component of any perennial irrigated pasture. There is a need to investigate practical ways of achieving this.

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