USE OF WILLOWS (SALIX SPP) AS DROUGHT FODDER FOR SHEEP

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ABSTRACT
The effects of cutting height and harvesting times on the forage yield, yield components and quality of Tangoio hybrid willow and Kinuyanagi willow were examined, to evaluate these willows as drought fodder for sheep. Tangoio (3.8 tDM/ha) outyielded Kinuyanagi (3 tDM/ha) in edible forage production and provided reasonable quality fodder (nitrogen content of 2.0 % and digestibility of 65 -69 %). The high edible forage yield of the willows relative to pasture (0.8 tDM/ha) during January and April showed that they provided potentially valuable supplements to pasture production. The willows, especially Tangoio, are recommended for use as maintenance fodder for summer droughts.

KEYWORDS
Cutting height, drought fodder, *Salix matsudana* x *alba*, *Salix kinuyanagi*, supplement, browse

INTRODUCTION
The leaves and twigs of woody plants (browse) contribute to ruminant nutrition throughout the world. In New Zealand, browse use dates to the 19th century, when British and Irish settlers introduced gorse (*Ulex europaeus* L.) as stock fodder (Radcliffe, 1986). Recently there has been renewed interest in the use of browse to offset the shortage of quality feed during summer droughts. The existing temperate pastures of perennial ryegrass and white clover succumb to water deficits, leading to low yields and poor quality forage during summer and early autumn, especially in areas prone to drought.

Traditionally, willows were used on farms for soil conservation and rehabilitation (van Kraayenoord and Hathaway, 1986) but their potential use as fodder for deer, sheep and cattle especially during summer drought has been recognized (Hathaway, 1986). The potential of willows as drought fodder demands a critical look at their management for increased edible forage production to enhance their multipurpose status. This study therefore examined the effects of cutting height and harvesting times on edible dry matter yield and quality of two species of willow for use as drought fodder for sheep.

METHODS
Experimental plants. The species used were Tangoio hybrid willow (*Salix matsudana* Koidz. x *alba* L.) and Kinuyanagi willow (*Salix kinuyanagi*). These species are described in detail by Douglas *et al*. (1996).

Experimental site. The experiment was conducted on a cool moist, lowland site at the Horticultural Research Institute's field station at Aokautere near Palmerston North. The annual rainfall is 991 mm. The soil is a Manawatu silt loam, with medium fertility, for example Olsen P of 17 mg/kg soil, freely drained but subject to surface compaction.

Experimental procedures and analyses. The willows were aged four years and received similar treatment the previous year (Oppong *et al*., 1996). The treatments were three cutting heights (30cm, 80cm, and 120cm above ground) and two harvesting times (summer, 18 January 1996 and summer plus autumn, January plus 11 April 1996). On 18/21 August 1995, all trees were cut and trimmed to the above heights. The experiment was arranged as a split plot design with cutting heights allocated to main plots and species x harvesting times to sub-plots in three randomised complete blocks. There were six trees per plot.

Two randomly selected trees per plot were harvested. The material was subsampled and dissected into leaf, edible stem (soft stems < 5mm in diameter) and woody stem (stems > 5mm). Subsamples of leaf and edible stem from each species for summer and autumn were also prepared for nutrient analysis (Oppong *et al*., 1996).

PROC GLM in the Statistical Analysis System programme (SAS, 1988) was used for all statistical analyses.

RESULTS AND DISCUSSION
Dry matter yield. Cutting height and harvesting times did not significantly affect forage yield or its components. Stur *et al*. (1994) also found that the yield of a range of browse species was unaffected by cutting height. Thus, the willows can be harvested at a height which keeps current growth within reach of browsing animals (Oppong *et al*., 1996).

Tangoio hybrid willow had higher total dry matter (p=0.01), edible forage (p=0.02), edible stem (p=0.0001) and woody stem (p=0.02) yields than Kinuyanagi willow (Table 1). The trend in data were consistent with those reported by Oppong *et al*. (1996), with the exception of woody stem yield. Tangoio yield (5 tDM/ha) was greater than Kinuyanagi (4 tDM/ha), whereas the reverse occured in the previous year (Oppong *et al*., 1996). However, the edible forage yield of Tangoio hybrid willow (3.8 tDM/ha) in our study lies within the range 3.2 -5.7 tDM/ha found by Hathaway (1986) for 5-year old trees. The present study showed increased edible forage yield over the previous year suggesting that yield increased as trees aged (Oppong *et al*. (1996).

Leaves constituted 79% of edible forage for Tangoio and 82% for Kinuyanagi. The percentage of dry matter that was edible forage above cutting height was 42% and 44% for Tangoio hybrid willow and Kinuyanagi willow, respectively. Douglas *et al*. (1996) found a similar trend, but the percentage of edible forage was lower (28 % vs 36 %).

Forage quality. Tangoio hybrid willow had higher total nitrogen content (p=0.005) and organic matter digestibility (OMD) (p=0.008) than Kinuyanagi willow in both summer and autumn (Table 2). However, the OMD of Kinuyanagi was unaffected by harvesting time. The mean nitrogen contents of the two willows were more than adequate for a lactating ewe with a single lamb (NRC, 1975).

The total condensed tannin (CT) content in Kinuyanagi was four times higher than in Tangoio, but this was not significant within species for summer and autumn (Table 2).

The leaves and edible stem of Tangoio and Kinuyanagi were significantly different for total nitrogen content, organic matter digestibility, and total CT content (p=0.0001). The leaves and edible stem of Tangoio have relatively low CT content. Nevertheless, sheep have

been observed browsing leaves and soft stems of Kinuyanagi willow despite its much higher CT content (unpublished data). McCabe and Barry (1988) demonstrated that willow leaves were a nutritionally good supplement to pasture for livestock during dry summers. Further, Hathaway (1986) also showed that willows may provide greater than a maintenance diet requirement for sheep.

The high edible forage yield obtained from Tangoio (3.8 tDM/ha) and Kinuyanagi (3 tDM/ha) relative to pasture (0.4 tDM/ha in both January and April) was as expected at that time of the year (Douglas *et al*., 1996). This browse fodder would supplement the pasture and supports the inclusion of browse plants in some pastoral farming systems (Lambert *et al*., 1989).

In conclusion, Tangoio hybrid willow, especially the leaves, could be used as a maintenance feed for sheep during summer drought due to its satisfactory quality and edible forage yield during dry summers and early autumn. However the potential role of Kinuyanagi willow as a supplementary drought fodder should not be discounted, despite its high condensed tannin level, because of its relatively high edible forage yield (Oppong *et al*., 1996). Tangoio and Kinuyanagi have potential as drought fodder in addition to their traditional roles in soil conservation and rehabilitation.

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Table 1
Forage yield and yield components of 4-year old willows (*Salix* spp) under cutting at Aokautere. (SEM, standard error of means).

Species	DRY MATTER YIELD (kgDM/tree) Total dry matter	Edible forage	Leaf	Edible stem	Woody stem
Tangoio hybrid willow	3.3	1.4	1.1	0.3	1.9
Kinuyanagi willow	2.5	1.1	0.9	0.2	1.5
SEM	0.15	0.07	0.06	0.01	0.09
Significance	0.01	0.02	0.15	0.0001	0.02

Table 2
Quality of willows (*Salix* spp) under cutting at Aokautere.(OMD, Organic matter digestibility; CT, Condensed tannin; SEM, standard error of mean).

Species/Interactions		NUTRITIVE VALUE (g/kgDM) Total nitrogen (Auto-macro kjedahl)	OMD (Cellulase technique)	Total CT (Modified butanol-hcl)
Species x Harvesting times				
Tangoio hybrid willow	Summer	18.8	690	65
	Autumn	21.5	650	53
Kinuyanagi willow	Summer	14.8	610	275
	Autumn	19.7	615	230
	SEM	0.3	6.1	8.9
	Significance	0.005	0.008	0.19
Species x plant part				
Tangoio hybrid willow	Leaf	31.6	910	45
	Edible stem	8.6	430	73
Kinuyanagi willow	Leaf	25.3	715	290
	Edible stem	9.1	510	220
	SEM	0.3	7.4	5.0
	Significance	0.0001	0.0001	0.0001

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