WATER USE EFFICIENCY IN CHILEAN AND ARGENTINE HUMID TEMPERATE GRASS-LEGUME PASTURES

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ABSTRACT
At two sites in Argentina and Chile five levels of water input were applied to four sown pastures of varying ages during spring and summer. The pastures consisted principally of C3 grasses and legumes, some of which were sown such as *Lolium perenne***,** *Trifolium repens*, *Dactylis glomerata*. Dry matter (DM) production was measured and related to the estimated total evapotranspiration (ET): responses were both highly linear. Both responses to ET and absolute yields were higher at the Argentinian than at the Chilean site: respectively 10.7 and 15.2 kg DM/mm water evapotranspired. Nevertheless the calculated indices of sensitivity (Ky) of Doorenbos and Kassam (1979) were similar for the two sites, indicating a similar priority for irrigation in terms of expected responses.

KEYWORDS
Evapotranspiration, pastures, production, water use

INTRODUCTION
Knowledge of the water use efficiency (WUE) of crops and pastures permits more effective programming of irrigation equipment and available water. In both Argentinian and Chilean temperate regions there is little information in this regard for multispecies pastures, even though there are considerable moisture deficits of varying intensity and duration in the summer and other months. Bolger and Matches (1990) among others have estimated the amount of biomass produced per mm of water evapotranspired in pastures, while earlier Stewart *et al.* (1977) and Doorenbos and Kassam (1979) used an index (Ky), which is the reduction in biomass production from the maximum caused by an estimated reduction in the evapotranspiration, as a result of soil moisture deficit, also compared to the maximum value. It is this index, the yield sensitivity value, which can be used to compare the expected responses of different crops and pastures in order to evaluate priorities for irrigation at different times in the year. The objective of this communication is to present estimates of the biomass production of pastures per mm of water evapotranspired, and of values of Ky for multispecies pastures in the SE of the Province of Buenos Aires, Argentina and in the Xth Region of Chile.

METHODS
The soils used in both regions were deep, well drained and open textured. In Argentina a typical Argiudol, "Mar del Plata" Series, at the Veterinary Faculty Dairy, Tandil (37.2° S, 59.3° W) and in Chile a typical haplumbreps, "Corte Alta" Series situated at the Oromo Experimental Farm of the University of Chile (40.9° S, 73.1° W). At both sites they were fertilized with P in autumn in order to ensure a minimum of 12 ppm and in Argentina with 60 kg/ha of urea at the initial cleaning cut in spring and at alternate harvests. The trials were carried out between 1992 and 1995 and in pastures in their first (P1) and second year (P2) in Argentina and fourth (PA) and twelfth year (PN) in Chile and composed principally of *Lolium perenne*, *Dactylis glomerata* and *Trifolium repens* (all pastures), *Festuca arundinacea* (P2), *Trifolium pratense* (P1 & 2) and *Bromus catharticus* (P2, PA and PN).

Previous defoliation management of all swards was by grazing dairy cows. Five levels of water input were applied on 4 replicates of 2 x 2 m plots by simulated rainfall and/or by plot covering during rainfall. Three treatments were defined from previous weather records for the area: normal year (NY) which received the monthly average for this period, dry year (DY) which received 50% of NY and very dry year (VDY) which was about 25% of NY. If, by the end of the week, natural rainfall was less than the required amount for the treatment, the deficit was supplied by sprinkler irrigation. When rainfall occurred during the week in excess of requirements, the plots were covered with polyethylene and wood frames. The other two treatments were: actual year (AY), receiving only natural rainfall in the experimental period and no water restriction (NWR): irrigation every week when the accumulated rainfall was less than the accumulated pan evaporation. Soil water contents at three depths were measured weekly by gravimetry (0-15 cm depth) and with a soil neutron probe (30 and 60 cm depths). An estimated soil water balance was used to calculate actual evapotranspiration (ET) as indicated by Doorenbos and Kassam (1979). Harvests were taken at approximately monthly intervals. Species composition was estimated by the point method of Daget and Poissonet (1971). The period analysed in Argentina was 135 days from the 8th of November and for Chile 105 days from the 4th of December.

RESULTS AND DISCUSSION
The range of deficits applied reduced herbage production by an average of 47 % in Chile and by 57 % in Argentina (Table 1). There was a tendency for the sown species, particularly *Lolium perenne* and *Trifolium repens*, at both sites to be sensitive to summer conditions, however in Argentina they were not immediately replaced by unsown species, in Chile they were.

The combined relations obtained between total forage production (Y kgDM/ha) and total evapotranpiration (ET mm) for each site were linear as is normally found (Ritchie, 1983; Bolger y Matches, 1990), but they were significantly different ($P<0.05$):

$Y_A = 387.1 (\pm 295.7) + 10.7 (\pm 1.01)$ ET ($r^2 = 0.97$; n = 10)
$Y_{Ch} = 1734.9 (\pm 671.6) + 15.2 (\pm 2.86)$ ET ($r^2 = 0.88$; n = 10)

Water use efficiency was thus greater at the Chilean site (15.2 kg DM/mm) than at the Argentinian (10.7 kg DM/mm). This was probably due to differences in soil and climatic conditions, for instance pan evaporation and maximum temperatures in Argentina were 160 and 200 mm and 27.3 and 28.0 °C in December and January respectively, while those for the Chilean site were 80 and 110 mm and 19.1 and 20.6 °C. Nevertheless when the yield sensitivity values (Ky) were calculated using the maximum yield and the corresponding maximum ET (Doorenbos and Kassam, 1979), it was found that they were similar at the two sites: 0.845 ($r^2 = 0.64$) and 0.802 ($r^2 = 0.78$). It is this value which can be used to compare with other crops in order to decide which will give the best response at a particular site.

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Table 1
Total dry matter production (DMP), total evapotranspiration (ET) in multi species temperate pastures at two sites with five levels of water input different water input.

Water input:	**NWY**	**NY**	**AY**	**DY**	**VDY**
Argentina: **P1**					
DMP (kg ha^{-1})	4657 a	3141 b	2514 bc	1547 c	1983 bc
ET (mm)	375	204	201	138	144
Argentina: **P2**					
DMP (kg ha^{-1})	4589 a	3609 ab	3093 bc	2375 bc	1999c
ET (mm)	427	295	252	194	173
Chile: **PA**					
DMP (kg ha^{-1})	7065 a	6582 a	4918 b	4463 b	3914b
ET (mm)	296	288	205	188	111
Chile: **PN**					
DMP (kg ha^{-1})	6564 a	6494 a	6259 a	4230 b	3330 b
ET (mm)	342	257	344	207	158

a,b,c: value on the same line with different letters are significantly different, $P < 0.05$.