Effects of seasonal rest in aboveground biomass for a native grassland of the flood Pampa, Argentina

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Abstract

Changes in total biomass and botanical composition in a native pasture of the Flooding Pampa in the Salado River Basin (Province of Buenos Aires), under 3 grazing systems: spring-summer rest (November, December, and January); fall rest (April, May, and June), and continuous grazing were evaluated from October 1979 to August 1981. A variable stocking rate based on available forage was used. Total aboveground biomass was periodically sampled to ground level and separated into dead and green components. The green biomass was subdivided into individual species. Total aboveground biomass averaged 4,600 ± 445 kg • ha^{-1} and 3,750 ± 120 kg • ha^{-1} for the spring-summer rest treatment during the first and second years, respectively. In the same period, warm-season species increased, principally due to an increase in dallisgrass (*Paspalum dilatatum* Poir.) and bluestem (*Bothriochloa laguroides* Herter) biomass. Total aboveground biomass yield was 2,000 ± 170 kg • ha^{-1} during the fall rest treatment, and cool-season species such as *Poa* spp. and *Stipa* spp. increased. In general, continuous grazing at a moderate intensity resulted in total aboveground biomass of about 2,000 kg DM • ha^{-1} throughout the experimental period. Contributions of warm-season and cool-season species did not change. Only West Indies smutgrass (*Sporobolus indicus* (L.) R. Br.) increased under continuous grazing.

Key Words: botanical composition, *Paspalum dilatatum, Bothriochloa laguroides, Sporobolus indicus,* seasonal grazing

The Flooding Pampa in the province of Buenos Aires, Argentina, is a vast area of 100,000 km^2 (Fig. 1). It has a temperate-humid climate, a flat surface, and about 80% of the land area is covered with natural grasslands. Cow-calf operations predominate in this region. Meat production averages about 70 kg • ha^{-1}. Most of these natural pastures have low forage production and poor quality. The current reduced ecological condition is believed to be due to poor grazing management. Species that normally grow during the mild winters are more affected by heavy grazing pressures than those that grow during the early spring, although the summer growing species which are preferred by cattle have also declined (Deregibus and Cauhépé 1983). Seasonal rests have been suggested as a means of improving grasslands deteriorated under continuous grazing (Booysen and Tainton 1978). Seasonal rest during active growth was hypothesized as a means of promoting desirable species. Fall rest would favor cool-season species and spring-summer rest the warm-season species. The objective of this study was to evaluate changes in aboveground biomass as a result of fall and spring-summer rest periods in relation to continuous grazing management.

Methods

Study Area and Treatments

Research was conducted at the Balcarce Experimental Station of the Instituto Nacional de Tecnología Agropecuaria (INTA) which is located at latitude 37° 45′ S, longitude 58° 19′ W, approximately 73 km west of the Atlantic coast at an elevation of 130 m. Annual precipitation (average from 1930 to 1987) was 858 mm, with maximum rainfall in March and minimum in August. Monthly air temperatures during the experimental period were close to the average with a minimum in January of 19.6° C and a minimum in July of 7.6° C. The soil is a complex which includes Natraquoll and Natralboll soil series (Soil Survey Staff 1975). Natraquoll soils are imperfectly drained, with different degrees of alkalinity (the pH on the soil surface varies from 7 to 10) and the depth of the Al horizon varies from 9 to 15 cm, with a clay loam texture. The main limiting factors are: an excess of superficial and/or sub-superficial water and alkalinity. The Natralboll soils have a deeper Al horizon (0 to 25 cm), the B horizon is characterized by a columnar structure, the soil surface pH varies between 6 and 7, and the texture is loamy. The main limiting factor is an excess of superficial and/or sub-superficial water.

The study was conducted in a B community (Leon 1975), one of the most conspicuous of the Flood Pampa. This community is associated with flat areas with hydromorphic soils and the grasslands are usually flooded during winter for 1 or 2 months. Warm-season species which contributed 11% to the green biomass were: saltgrass (*Distichlis spicata* (L.) Greene), *D. scoparia* (Kunth) Arech, dallisgrass (*Paspalum dilatatum* Poir.), West Indies smutgrass (*Sporobolus indicus* (L.) R. Br.), Saint Augustine grass (*Stenotaphrum secundatum* (Walt.) Kuntze), and bluestem (*Bothriochloa laguroides* Hert.). Cool-season species which contributed 88% to the green biomass were: Italian ryegrass (*Lolium multiflorum* Lamb.), *Poa lanigera* Nees., *Bromus mollis* L., *Stipa papposa* Nees, *S. neesiana* Trin. and Rupr., and *Carex phalaroides* Kunth. Other minor components which contributed 3% to the green bio-

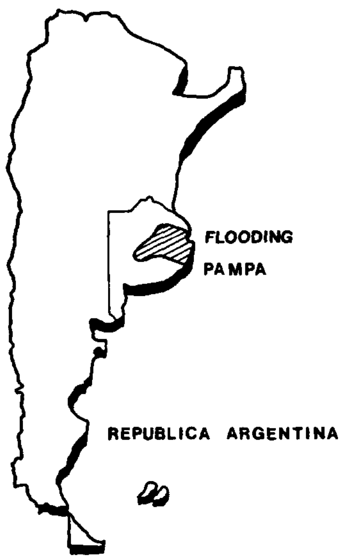

Fig. 1. The flooding Pampa in the Buenos Aires Province of Argentina.

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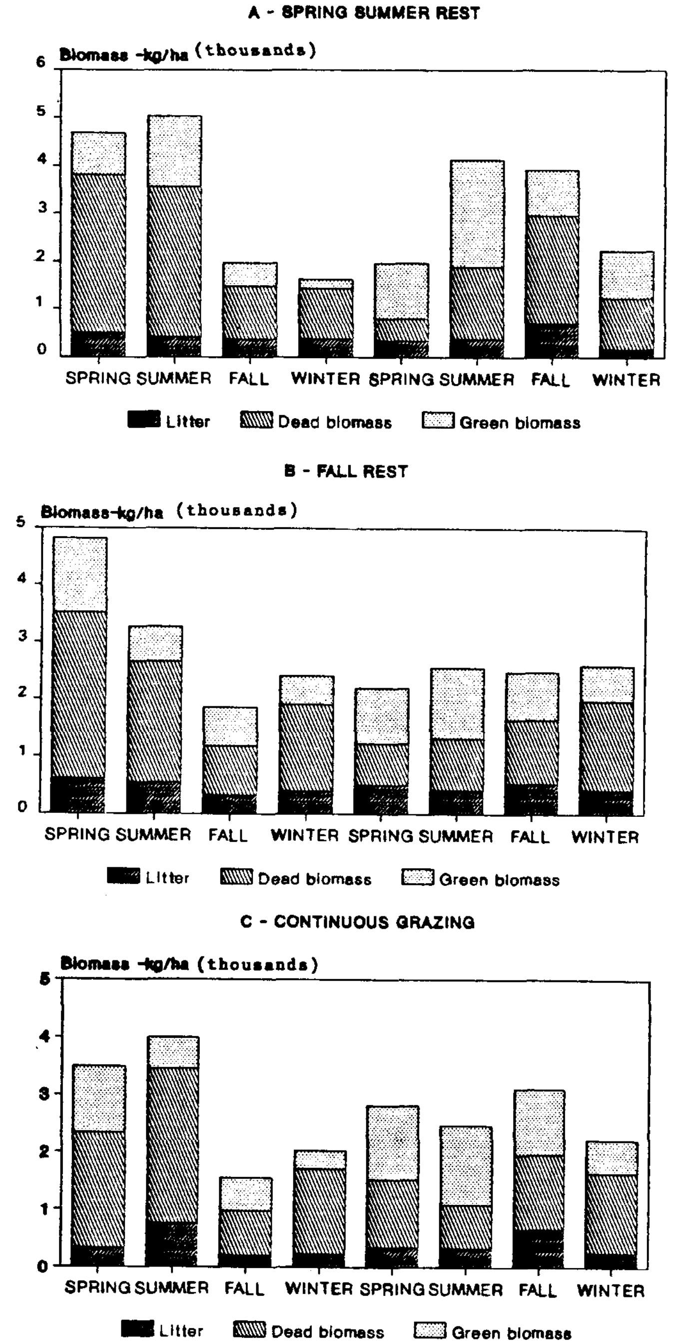

Fig. 2. Total biomass, green biomass, dead biomass, and litter under A) spring-summer rest (SSR), B) fall rest (FR), and C) continuous grazing (CG) treatments of a natural grassland.

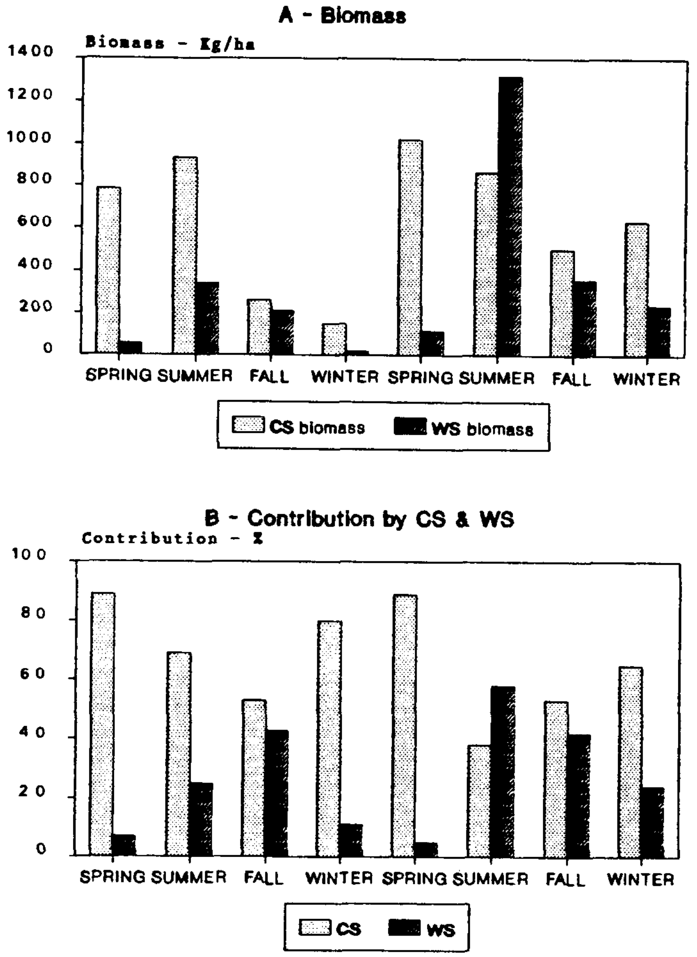

Fig. 3. A) Biomass and B) contributions of cool-season (CS) and warm-season (WS) species of a natural grassland under spring-summer rest (SSR) treatment.

mass were: sedges, forbs, and annual grasses. Minimum net dry matter productivity of 4 kg • ha^{-1} • d^{-1} in community B occurs in the fall and maximum of 30 kg • ha^{-1} • d^{-1} occurs in late spring (Sala et al. 1981).

In September 1979 the experimental site (9 ha) was divided into 3 paddocks of 3 ha for each treatment. Seasonal rest was allowed during the fall (fall rest-FR) from 2 April to 15 July or during spring and summer (spring-summer rest—SRR) from 30 October to 15 February. The control treatment was continuously grazed (CG). The experimental period was October 1979 to August 1981 (first period: 1979–80, and second period: 1980–81).

During the grazing season, when the desirable species had reached about one-half of their height in a nearby exclosure, the stocking rate was reduced. The objective was to obtain about 50% utilization (1,800 kg • ha^{-1}) of biomass by means of moderate grazing. In the spring-summer rest and fall rest treatments, after each rest period, the stocking rate was increased for a period no longer than 20 days to decrease biomass to a level similar to that of the CG treatment. The annual stocking rate of the control treatment averaged 2 heifers per ha.

Sampling Design

Total aboveground biomass of each treatment was periodically sampled in spring, summer, fall, and winter; and dates of sampling were coincident with the beginning and the end of rest periods. Plants were clipped to ground level within thirty 0.4-m^2 circular plots and litter was hand collected within each plot. Each sample was separated into live (green) and dead biomass components, and live biomass was then sub-divided by individual species. The samples were dried at 60° C for 48-h. The study was analyzed as a randomized complete block design with factorial arrangement of the treatments. The factors considered were grazing treatments and periods of sampling. Tukey's procedure was used to test differences ($P \leq 0.05$) among means that differed significantly in their F tests. Net aboveground productivity was calculated only in the rest treatments using the values obtained at the beginning and end of rest periods (Sala et al. 1981).

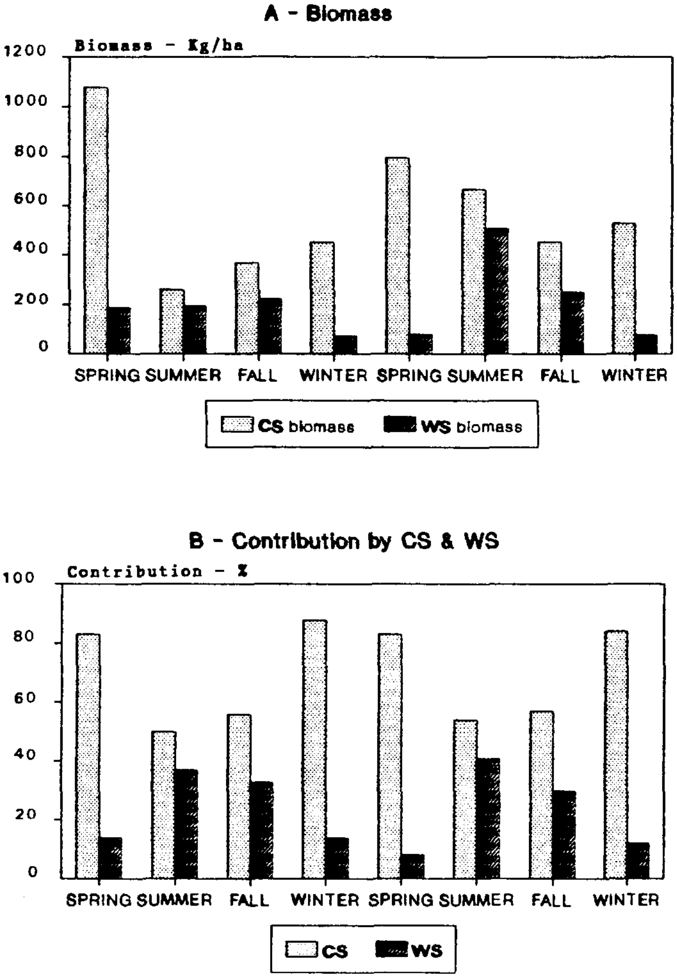

Fig. 4. A) Biomass and B) contributions of cool-season (CS) and warm-season (WS) species of a natural grassland under fall rest (FR) treatment.

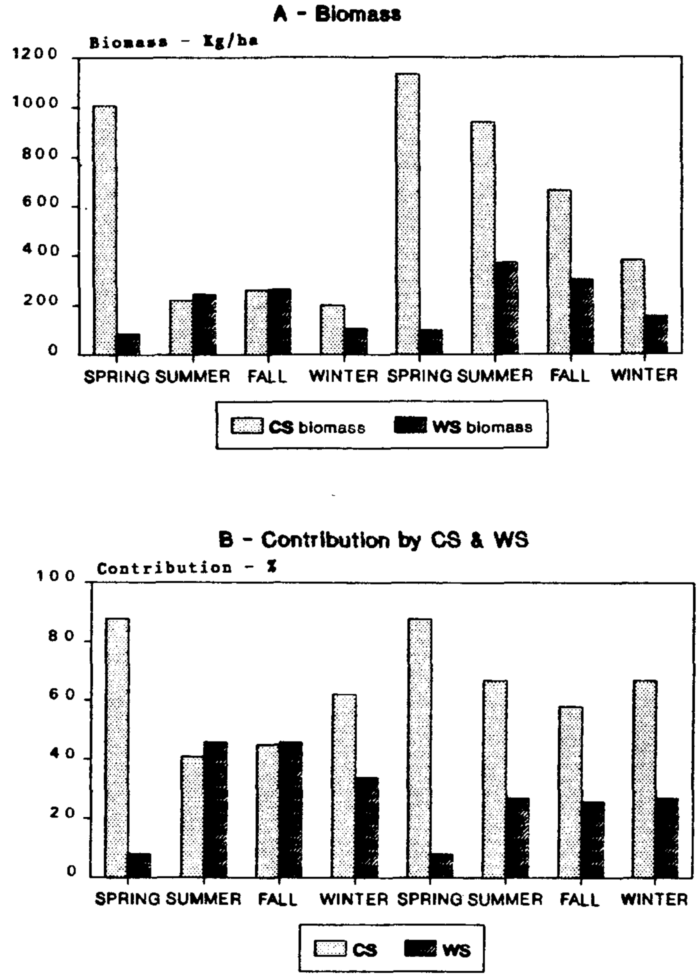

Fig. 5. A) Biomass and B) contributions of cool-season (CS) and warm-season (WS) species of a natural grassland under continuous grazing (CG) treatment.

Results and Discussion

Initial total aboveground biomass, dead biomass and green biomass of the experimental site were 3,750 ± 455, 2,715 ±315, and 1,035 ±120 kg • ha^{-1}, respectively. Cool-season species were the most abundant and contributed 88% to green biomass. Major species were *Bromus brevis Linné*, *B. auleticus* Trin, *Stipa neesiana, S. formicarum* Delile, *Poa lanigera, Carex phalaroides,* and *Italian ryegrass.* Representative species of the warm-season group were saltgrass, West Indies smutgrass, Saint Augustine grass, and bluestem, which contributed 10% of the green biomass. Other minor components, less than 3%, were sedges, forbs, and legumes. Significant variations in the litter component occurred only among periods.

Spring-Summer Rest

The total aboveground biomass increased significantly with the accumulation of 480 kg • ha^{-1} in 1979–80, the first period, and 2,050 kgkg • ha^{-1} in 1980–81, the second period of spring-summer rest (Fig. 2a) as a result of net aboveground productivity of 10 and 23 kg • ha^{-1} • d^{-1} during the first and second periods of the spring-summer rest, respectively. In 1980 the contribution of dead biomass to the total aboveground biomass was 79%. This high amount of dead biomass could have limited the increase of green biomass as has been found by Maceira and Verona (1982) in this community. The canopy structure of the native grassland in the first spring-summer rest period could have affected the growth of new tillers. This possibly limited light at the base of the plants (Deregibus et al. 1983, 1985). During the spring of 1980 and summer of 1981, 1,080 kg • ha^{-1} of green biomass accumulated, which was the highest amount accumulated in the experiment. Dead biomass contributed 40% to the total aboveground biomass. Favorable climatic conditions occurred during the rest period. The spring-summer rest treatment had the highest green: dead biomass ratio of the study in the spring of 1981. During the second year, the accumulated biomass was 3,500 kg • ha^{-1}. The green: dead biomass ratio during the first period was 0.5: 1.0 and in the second period was 1.5: 1.0.

Warm-season species biomass accumulated 280 and 1,200 kg • ha^{-1} in 1980 and 1981, respectively (Fig. 3a). Martin (1973), Owensby et al. (1973), Reardon and Merrill (1976), and Trlica et al. (1977) have found that spring-summer rest promoted growth of major season species, as occurred in this study. Important relative biomass changes (after/before rest) were found in Saint Augustine grass (10/20), bluestem (30/75), and dallisgrass (7/450). These values are for the first and second periods of the rest, respectively. Bluestem and dallisgrass have maximum growth potential during spring and early summer (Sala et al. 1981) and high preference by beef cattle (Cauhépé and Fernandez Grecco 1981, Brizuela et al. 1983). Warm-season species contributed 29% to the green biomass for the first period of spring-summer rest and 58% for the second period (Fig. 3b). Dallisgrass contributed 38% to the green biomass. Early spring regrowth of dallisgrass is a possible consequence of a high carbohydrate concentration during the winter (Ito et al. 1985).

Therefore spring-summer rest would strongly benefit this species. These results of warm-season species were expected as a consequence of protection from grazing during the maximum growth period.

Spring-summer rest also promoted growth of Italian ryegrass that increased in relative biomass at the end of the experiment. Sala (1985) found that Italian ryegrass seeds do not have a dormant period, therefore future seedlings will depend on establishment from seeds of the previous year. It should be noted that the period and duration of the spring-summer rest should affect (a) the development of vegetative growth of warm-season species and (b) the reproduction rate of the cool-season species. The litter biomass averaged 400 ±70 kg • ha^{-1}, with its highest value 700 ±80 kg • ha^{-1} in April 1981, and was influenced by the accumulation of aboveground biomass.

Fall Rest

During the first (2 April to 15 July 1980) and second (2 April to 15 July 1981) periods of fall rest treatment, the green biomass decreased from 660 ± 70 to 510 ± 75 kg • ha^{-1} and from 840 ± 120 to 630 ± 65 kg • ha^{-1}, respectively (Fig. 2b). Dead biomass increased from 865 ± 140 to 1,500 ± 210 kg • ha^{-1} during the first rest and from 1,110 ± 170 to 1,155 ± 260 kg • ha^{-1} during the second rest. The rate of senescence was 2.6 and 1.5 kg • ha^{-1} for each period, respectively. Warm-season species accounted for 96 and 80% of the senescence that occurred during 1980 and 1981, respectively, and were the main contributors to the dead component. Although total aboveground biomass increase was not significant, the biomass accumulated was 500 kg • ha^{-1} in both years. Primary productivity was 4.5 and 4.1 kg • ha^{-1} • d^{-1} for the fall rest of 1980 and 1981, respectively. These values are similar to those obtained by Sala et al. (1981) for the same community. Low growth rates of the vegetation coupled with the high rates of senescence (Lemcoff et al. 1981) during this season resulted in reduced productivity. Similar increments in biomass for the cool-season species were found in both years (Fig. 4a). The biomass accumulated was 85 and 76 kg • ha^{-1} for the first and second rest period, respectively. The cool-season group contributed 88% to the green biomass during the winter period (Fig. 4b). This small variation in biomass came from 2 species: *Poa lanigera* and *Stipa* spp. Larger proportions of *Poa lanigera* and *Stipa* spp. were found in cattle diets in the fall (Cauhépé and Fernandez Grecco 1981). Consequently, grazing exclusion during this period should promote the development of these species.

The observed response was expected since both species have a high rate of growth during the fall and winter (Sala et al. 1981).

Continuous Grazing

Continuous grazing resulted in moderate utilization of the grassland. Total aboveground biomass averaged 2,000 kg • ha^{-1} (Fig. 2c) during the experimental period, except in April 1980 (1,350 ± 160 kg • ha^{-1}). The high rates of senescence in the winter resulting from freezing of WS species, probably resulted in the increases of dead biomass. After July, high levels of green biomass accounted for the total aboveground biomass accumulated. This was possible because the grazing management allowed a high proportion of active photosynthetic biomass to accumulate in late winter. During the active period of growth, no dead biomass accumulated and the cool-season and warm-season species could express high yields of biomass.

Peak biomass was found in spring (1,200 kg • ha^{-1}) and summer (375 kg • ha^{-1}) for the cool-season and warm-season, respectively (Fig. 5a and 5b). Similar responses were obtained among the other species. For Italian ryegrass the biomass accumulated in winter would account for 31% of green biomass produced in spring (1,300 ± 160 kg • ha^{-1}), due to high reproduction of this species. *Bromus* spp. and *Poa lanigera* showed a general pattern of growth for the cool-season species, with peak biomass in the spring.

The warm-season species, bluestem and dallisgrass, contributed to green biomass in summer with 2 and 10%, respectively, and their contribution remained constant throughout the study, whereas, West Indies smutgrass increased in this treatment and contributed 8% of the total aboveground biomass at the end of the experiment. In winter, dallisgrass decreased in biomass and bluestem stopped aboveground growth; on the other hand, West Indies smutgrass was more productive. These data suggest that the warm-season species have different responses to grazing, similar to results of tiller density that were obtained for these species by Gaspari (1985).

The litter biomass was about 300 kg • ha^{-1} except in February and April of 1980 when it was 750 and 670 kg • ha^{-1}, respectively.

Conclusions

All periods of rest from grazing resulted in significant changes in total aboveground biomass. The patterns of distribution for green and dead biomass during the experiment were similar for fall rest treatment and continuous grazing, but different for spring-summer rest treatment. This was a consequence of the greater biomass accumulated by plants in the spring-summer rest treatment.

The warm-season species: dallisgrass and bluestem were favored by the spring-summer rest, and the cool-season species: *Poa* spp and *Stipa* spp. with fall rest.

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