Expo Melilla 2023

Supplementary irrigation in grazing: towards sustainable intensification in productive systems with grazing

Riego suplementario en forrajes: hacia la intensificación sostenible en sistemas productivos con pastoreo

Irrigação suplementar em forragens: rumo à intensificação sustentável em sistemas produtivos com pastejo

Puppo, Lucía; Hayashi, Raquel

Lucía Puppo
lpuppo@fagro.edu.uy
Universidad de la República, Uruguay
Raquel Hayashi
rhayashi@fagro.edu.uy
Universidad de la República, Uruguay

Agrociencia Uruguay
Universidad de la República, Uruguay
ISSN-e: 2730-5066
Periodicity: Bianual
vol. 27, Sup., e1205, 2023
agrociencia@fagro.edu.uy

Received: 19 April 2023
Accepted: 30 May 2023
Published: 29 June 2023

URL: http://portal.amelica.org/ameli/journal/506/5064244003/

DOI: https://doi.org/10.31285/AGRO.27.1205

Corresponding author: lpuppo@fagro.edu.uy

Climate change has increased the occurrence of extreme events, both droughts and floods, which have been intensifying in the world and the region. The spring 2022-summer 2023 period has been described as the most extreme in terms of water deficit in the last 50 years for Uruguay. Regardless of the above, summer rainfalls in Uruguay do not generally cover the crop water requirements. There is also great rainfall variability and soils have low available water capacity, which causes specific water deficits that reduce forage supply and frequently

Author notes

lpuppo@fagro.edu.uy

affect agricultural production. Considering the above and that water is the main environmental limitation in agricultural production, the Hydrology Unit of the Department of Soils and Water of the Agronomy College began, in 2020, the research line of Irrigation in Forages. The experimental activity "Evaluation of two irrigation thresholds in fescue and alfalfa with direct grazing" is presented below, aiming to define an irrigation strategy in forages that allows obtaining a differential dry matter yield in the double condition of irrigation and grazing, with a greater use of rainfall, evaluating the long-term persistence of forages and the physical soil properties.

In 2020, two independent experiments were established in the South Regional Center of the Agronomy College, Canelones (34° 36 # latitude S, 56° 13 # longitude W), for two forage species: fescue (cv. Aurora) and alfalfa (cv. Chaná). The evaluated treatments were: frequent irrigation (T1), which implies irrigation when 30% of the available water is depleted; spaced irrigation (T2), whenever 65% of the available water is depleted, and rainfed, which only receives rainwater. Each treatment had four replications, totaling twelve plots in each experiment, of 11×11 m each. The necessary paths to enable the entry and exit of animals were considered when planning the experiments. The irrigation treatments were applied with fixed sprinkler equipment, with four sprinklers per plot, sectorized at 90°, rising above ground level when the equipment is pressurized, with an application rate of 5.5 mmh^{-1}. The soil of the experiment site was a Typic Eutric Brunisol, corresponding to a Typic Argiudoll, according to USDA classification. Fescue was sown on August 2, 2020, with a density of 20 kg ha^{-1}, and fertilization at planting of 15 kg ha^{-1} of 18-46. After each grazing, a dose of urea of 70 kg ha^{-1} was applied. Alfalfa was sown on April 21, 2020, with a density of 20 kg ha^{-1}, and fertilization at planting of 15 kg ha^{-1} of 18-46. A soil analysis was carried out each autumn to verify the phosphorus level and rectify it, if necessary, to the critical level (10 ppm for fescue, and 20 ppm for alfalfa). The grazing time was defined phenologically at 2.5 leaves for fescue, and 8-9 knots (or 10% flowering in spring) for alfalfa. Both experiments had chicory meadow (*Cichorium intybus*) as predecessor crop. The irrigation timing was determined by independent water balances for each treatment. Frequent irrigation was applied whenever the accumulated deficit was 22 mm (30% depletion of available water in the effective root depth), and 48 mm in the spaced irrigation treatment (65% depletion of available water in the effective root depth), replenishing with irrigation up to a water content lower than field capacity, to prevent the soil from saturation conditions, before the possible occurrence of rainfall immediately after irrigation. The moisture content before irrigation was verified by FDR probe (Frequency Domain Reflectometry) in each evaluation plot. Penman-Monteith reference evapotranspiration data (ETo) from the climatic station at the National Institute of Agricultural Research (INIA) Las Brujas (located 15 km in a straight line from the experiment) were used for the balances, while precipitation data were measured with a rain gauge installed at the experiment site. The available dry matter (DM in $kgha^{-1}$) before each grazing was evaluated, visually defining three production levels depending on the volume of pasture. Each plot was evaluated by categorizing the production according to the three pre-established levels through the total route of the plot, presenting 15 times a square of 30×30 cm. Subsequently, three repetitions of each level were harvested using the same 30×30 cm square. Then, the animals entered (two cows per plot of 600-700 kg) and grazed until the forage reached a height of 5 cm or more. After each grazing, a homogenization cut was made at 5 cm height with a garden tractor. Finally, the yield per season was determined, considering the growth rates between grazing. The chemical quality of the forage is also determined seasonally, and the bulk density, organic matter and persistence in pastures are evaluated annually in the soil.

Irrigation treatments in fescue and alfalfa began their applications in November 2020, so the preliminary results of two years of evaluation are presented, completed on November 30, 2022. In addition, the results of summer 2023, a record year in water deficit, are presented. Compared to the preliminary results referred to fescue, the average annual productivity with irrigation was 21239 kg DM ha^{-1} in the first year and 19157 kg $DMha^{-1}$ in the second year (41% and 56% higher than rainfed). The highest dry matter productivity per

season was recorded in spring. In the last summer (2023) the seasonal productivity with irrigation was 3349 kg DMha^{-1}, while the rainfed had no production, given the installed drought. The irrigation management in T2 (spaced irrigation) allowed saving 38% of pumped water, compared to the management with frequent irrigation (T1). In two years and one summer, the irrigated treatments had six more grazing periods than the rainfed. As a particularity of summer 2023, the average amount of irrigation applied in the season was 271 mm, while the amount of annual irrigation of previous years was 214 mm on average. Since the summer 2023 rainfall was minimal, the amount of mm applied was similar for both irrigation management alternatives. Each mm of water received by fescue increased production by 43 kg DMha^{-1}. Water accounted for 83% of the variation in DM ha^{-1} productivity, and from 565 mm there would be no increase in productivity, with a maximum of 19 tha^{-1}.

Regarding the preliminary results referring to alfalfa, there was a difference in favor of irrigation in the summer. The average productivity of the irrigated treatments for the three evaluated summers was 9184 kg DM ha^{-1}, 51% higher than the productivity of rainfed. In the last summer (2023) the seasonal productivity with irrigation was 6700 kg DM ha^{-1}, while the rainfed had a productivity of 1523 kg DMha^{-1}, four times lower than the productivity of irrigated treatments. There was no difference in summer productivity between the two evaluated irrigation managements; however, the management of spaced irrigation (T2) meant saving 33%, 29% and 14% of mm of irrigation compared to management with frequent irrigation (T1), for summers 2021, 2022 and 2023, respectively. The average annual productivity was 25223 kg DM ha^{-1} in the first year, and 22592 kg DM ha^{-1} in the second year. There was no difference between the annual productivity of irrigated and rainfed treatments. As a particularity of summer 2023, the average amount of irrigation applied in the season was 269 mm, while the annual irrigation of the previous years was 220 mm on average. Each mm of water received by alfalfa increased production by 48 kg DMha^{-1}. Water accounted for 88% of the variation in DMha^{-1}productivity and from 515 mm there would be no increase in productivity, with a maximum of 24.5 tha^{-1}.

Within the same line of research, other activities aiming to generate complementary information to the experimental activity presented in this study are being evaluated. Together with INIA Las Brujas the following activity is being carried out: Determination of crop evapotranspiration (ETc) by lysimetry in alfalfa and fescue in the facilities of INIA Las Brujas, which objective is to adjust the crop coefficients (Kc) and stress coefficients (Ks), which will be used to manage irrigation more accurately and define design flows. Likewise, in the South Regional Center of the Agronomy College, the following experimental activity is being carried out: Melgas irrigation technology for the edaphotopographic conditions predominant in Uruguay and optimization with the WinSRFR Model, which aims to determine the performance indicators of melgas irrigation for the soils of southern Uruguay, and propose optimization scenarios to identify melgas irrigation management strategies in conditions other than the evaluated in the field.

Alternative link

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