

## Can emerging technologies improve the modelling of grass growth?

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**Abstract:** The challenge of a successful grazing management is to manage both in time and space animal grass intake and grass growth. Decision support tools for grazing have been developed since the 2000s (Murphy, 2005). These tools rely on average grass growth curves derived either from observations or from detailed model summary, and available from several soil types and weather conditions. From these curves, it is possible to simulate the future dry matter production of paddocks, thus the number of days animals can stay on the present paddock and which new paddock might receive them. These tools remain rarely used by farmers as they require an actualization of the present situation by regular grass height measurements, and as grass growth predictions by models are often distant from the reality (e.g. Hurtado-Uria et al., 2013). Grass growth is indeed difficult to model as it depends on several factors which are management (timing and intensity of grass utilization, fertilization), vegetation and soil and weather conditions. All these information are not always available to calibrate, assess and then feed mechanistic and detailed grassland models. As the development of emerging technologies facilitates the continuous acquisition of information about soil, weather and vegetation, it offers new perspectives for grassland modelling and management (e.g. Ali et al., 2016).

The objective of the study is to explore possible correlations between growth measurements and data from sensors, that could be used to build more accurate and user-friendly grass growth models. A randomized complete block design was used at the experimental farm at Le Rheu (Ille-et-Vilaine, France) to follow the growth of a sown ryegrass sward in case of a grass use frequency of 42 days. Grass growth above 4 cm was assessed every two weeks based on grass height and biomass measurements. Growth was followed from April to August 2016 i.e. during 3 cycles of regrowth. The effects of the 3 following factors were accounted for, each repeated 3 times: fertilization (60 kg N ha<sup>-1</sup> applied at each cycle end (Fert+) vs. no fertilization (Fert-)), date of first grass cut (3 dates with an offset of 14 days between each) and age of regrowth (14, 28 and 42 days of regrowth within each cycle). Species sorting allowed quantifying and following the proportion of grass, legume and other dicotyledons in sward. Soil sieve and chemical analysis was performed as several locations. Sensors developed by the Parrot industry (<https://www.parrot.com/>) recorded every 15 minutes soil (temperature, water content, pore water electrical conductivity) and climate (temperature, global radiation) information. Using a smartphone and a dedicated mobile application, sensors' data were collected *via* Bluetooth, sent and analyzed on Parrot's server *via* an internet connection then collected for analysis.

The pasture was established on a sandy clay loam soil and was on average dominated by grasses (79%) and dicotyledons (18%). Simple and interaction effects of agronomical factors on sward growth were found significant ( $p < 0.05$  to  $p < 0.001$ ). Observed responses of grass dry matter content, density, growth and botanical composition to fertilization were found consistent with literature (Delagarde et al., 2014; Peyraud and Astigarraga, 1998) : i) growth was increased of about 15 kg DM ha<sup>-1</sup> per additional kg N ha<sup>-1</sup> cycle<sup>-1</sup>, ii) due to N fertilization, sward density was decreased together with grass dry matter content of about 5 kg DM cm<sup>-1</sup> ha<sup>-1</sup> per percentage point of dry matter and iii) legumes were increased with fertilization. The comparison of sensors' information with weather data from a closed meteorological station showed also good agreement, ensuring the quality of part of sensors' data. Data-linkage between date-adjusted means of grass growth and sensor's information is promising (Figure 1). Pore water electrical conductivity responds to fertilization and could be used as an indicator of soil nutrients availability. More generally, sensors data reflect the suitability of weather and soil conditions for grass growth. Further analysis of data will allow proposing growth models directly fed with sensors' information.

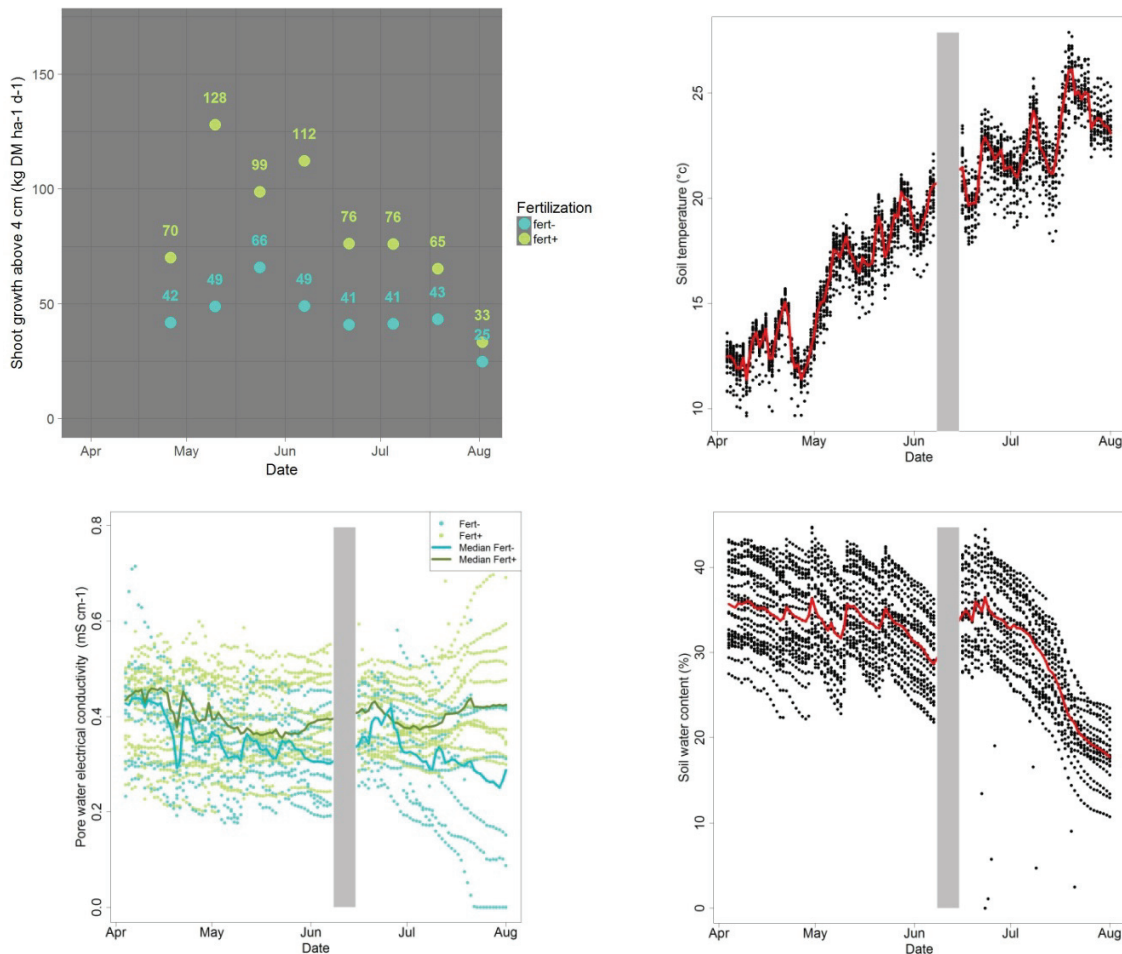


Figure 1. Date-adjusted means of grass growth above 4 cm for each level of fertilization (Fert-, Fert+); Soil temperature, soil water content and pore water electrical conductivity recorded by sensors (the red curve corresponds to daily median values, data from the 7<sup>th</sup> to the 16<sup>th</sup> of June were lost (grey rectangle)).

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