Sward surface height estimation with a rising plate meter and the C-Dax Pasturemeter

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Abstract

Pasture-based production systems are economically interesting, but only if grown herbage is efficiently used. The sward surface height (SSH) and the herbage mass (HM) are appropriate indicators to use in checking pasture management and thereby improving the output of milk and meat per hectare (ha). Because farms are becoming larger, the periodic measurement of SSH with a rising plate meter takes more and more time. Devices towed by small vehicles, such as the C-DAX Pasturemeter (PM), could reduce the workload significantly if the measurements are carried out correctly. To verify the estimation accuracy of the PM as compared to an electronic rising plate meter, the SSH of 252 strips (each approximately 8 m^2) and 187 paddock diagonals on multi-species pastures of two farms were measured. Subsequently, the strips were cut, and the harvested biomass was weighed. The dry matter (DM) of a subsample of the biomass was determined to calculate the HM in kg DM ha^{-1} over 49 mm. Because the measuring principles of the two devices are different, equations were created for the conversion of SSH. Furthermore, regressions were developed to estimate the HM based on the SSH. With the two devices, HM estimations of similar quality were obtained.

Keywords: pasture, sward surface height, herbage mass, rising plate meter, pasturemeter

Introduction

Pasture-based production systems are economically interesting (Dillon *et al.*, 2005), but only if grown herbage is efficiently used (Shalloo, 2009). The sward surface height (SSH) and the herbage mass (HM) are appropriate indicators to use in checking pasture management (O'Donovan, 2000) and thereby improving the output of milk and meat per ha. According to Hannson (2011), a variety of methods and devices are used to estimate SSH or HM: visual methods, pasture rulers, sward sticks, plate and disc meters, and devices mounted on vehicles or towed equipment. Because farms are becoming larger, the periodic measurement of SSH with a rising plate meter takes more and more time. Devices towed by small vehicles, such as the C-Dax Pasturemeter (PM), could reduce the workload significantly if the measurements are carried out correctly. Experience has shown that using the PM, the measuring time can be reduced to approximately 1/6 as compared to using the rising plate meter (RPM). On the other hand, the initial cost is about ten times higher. The aim of this study was to verify the estimation accuracy of the PM as compared to the RPM on multi-species pastures in Switzerland.

Materials and methods

The PM (C-DAX Ltd., Palmerston, North, NZ, unit: mm) is an electronic device mounted on a sled. It is trailed behind a small vehicle and operates at speeds of up to 20 km h^{-1}. With 18 light beams spaced at 20 mm, the PM takes 200 height-measures s^{-1} (C-DAX, 2014).

From 2011 to 2013, comparative measurements were made of the pasture of the organic farm 'Ferme École de Sorens' (820 m.a.s.l., Switzerland), and 2014 of the pastures at Agroscope ILS in Posieux (640 m.a.s.l., Switzerland), run according to the proof of ecological performances. In 2011, every week, the SSH of the diagonals of all used pasture paddocks, 187 in total during the vegetation period, were simultaneously measured with the RPM (Jenquip, Feilding, NZ, 1 unit corresponds to 0.5 cm) and the PM. In 2012 and 2014, four herbage strips averaging 8 m^2 large and covering the SSH range between 50

to 160 mm were cut weekly. During 2013, four herbage strips were cut every two weeks. Thus, there were a total of 92 strips in 2012, 52 strips in 2013 and 108 strips in 2014. Before and after cutting the strips, the SSH was measured with the RPM and the PM. The harvested biomass was weighed, and the DM of a subsample was determined to calculate the HM ha^{-1} over an average cut height of 49 mm. According to the technical notes of the Swiss Grassland Society (AGFF, 2007), three-quarters of the herbage strips were visually associated with specific types of plant communities. A regression analysis was performed with Systat 13 (Systat Software Inc., San Jose, CA, USA).

Results and discussion

Because the measurement principles of the devices used are different, compressed (RPM) versus non-compressed SSH (PM), contrasting results for the same swards were obtained. The average of the 439 SSH measures was lower ($P<0.001$) when measured with the RPM (12.4±4.3 units or 62±21 mm, respectively) as compared to the PM (94±35 mm). As the measurements of the two devices correlate well, a function based on a linear regression was created to convert the results. To increase validity, a merged data set with an arithmetic mean of SSH = 94 mm (38 to 216 mm) or 12.4 units (5 to 35), respectively, was used to calculate the following regression:

$$y = 7.2 x + 5.3 \; (n=439, R^2=0.79, SEE=15.9)$$

where y = SSH in mm measured with PM, x = SSH in units measured with RPM, and SEE = standard error of the estimate.

For Sorens and Posieux, site-specific regressions exhibited differences in relation to the y-intercept (0.7 vs 19, $P<0.001$) and the slope (7.45 vs 6.4, $P=0.003$), which may indicate the need for regionally adapted regressions. Because the measurements on both sites were not performed during the same year, the effects of year and site could not be separated.

The following regressions estimate the HM per ha over measured cut heights of 49±9 mm and 7.4±1.4 units, respectively:

RPM: $y = 118 x – 728 \; (n=252, R^2=0.81, SEE=285)$

PM: $y = 15.2 x –742 \; (n=252, R^2=0.77, SEE=311)$

where y = HM kg ha^{-1}, x = SSH measured with PM (mm) or RPM (units), SEE = standard error of the estimate.

Hannson (2011), in Denmark, found similar coefficients of determination (0.63 to 0.89) for the HM estimated with the PM SSH. In the present study, the y-intercepts did not differ in relation to the measuring devices, but the slopes did due to the contrasting measuring principles and differences in relation to the units. For pre-grazing HM targets of 1,200 to 1,500 kg ha^{-1}, the SEEs are high, so prior sward density measures would probably improve the precision of the HM estimation per ha. The coefficients of correlation for HM estimation based on SSH measured with the RPM or the PM are equal ($r_{RPM}=0.90$, $r_{PM}=0.88$, $P=0.26$). Consequently, both regressions explain a similar percentage of the total variation of HM per ha – approximately 80%. Discrepancies exist regarding the HM estimation relative to the sites. Both slopes of the regressions for the HM estimation on the Posieux site are higher (RPM: 111 vs 131, $P=0.001$ and PM: 13.9 vs 17.8, $P<0.001$) than those for Sorens, which may be due to denser swards in Posieux or an effect of the year because the measurements were not performed the same year. Differences in the botanical composition of the swards may contribute to the contrasting regressions as

well. In Sorens, 55% of the visually determined strips were grass-rich (>70% grasses), 22% were balanced (50 to 70% grasses), and 17 were diverse (>50% forbs). Ryegrasses were not the dominant grasses (<50% of the grasses) in Sorens. In addition to ryegrass and *Poa* species, *Phleum pratense* and *Dactylis glomerata* were present, among others. Although mineral N-fertilizer was used in Posieux, 55% were balanced, 19% were grass-rich, 17% were balanced with ryegrass domination (>50% of the grasses) and 9% were grass-rich with ryegrass-dominated plant community types. To adjust the regressions to the types of plant communities, to the site or to other factors, a much larger dataset would be required.

Conclusions

The SSH measured with the RPM or the PM provided similar estimations of HM per ha and explained about 80% of the variation. The standard error of the estimate is too high to provide an accurate estimate of the HM, so prior sward density measures would probably improve the precision of the HM estimation per ha. To create individual regressions for specific plant communities or for specific sites, a much larger dataset must be analysed.

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