Model for determining the proportion of preservation area to total forage area

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ABSTRACT

In order to determine the working-time requirement for forage conservation over the course of the year, two parameters must be given: the mass of forage available at specified cutting dates and the corresponding crop area. Agroscope has developed a model for calculating these parameter by using forage-growth curves provided in regression models. After deducting the necessary feed mass for fresh forage, the present model calculates the feed mass and crop area for each conservation cut, taking altitude, frequency of use and fresh-forage requirement into account. Weekly calculation not only considers varying forage growth over the course of the year, but also allows the working-time requirements for harvesting jobs to be allocated to the appropriate work period, thus enabling peak workloads to be identified in a more differentiated manner.

Keywords: Working time requirement, forage harvest, forage mass, forage growth, forage conservation.

1. INTRODUCTION

Among other features, the ART Work Budget software (Schick, 2006; Stark and Schick, 2009) enables the calculation of working-time requirements for the conservation of meadow forage. In order to determine the working-time requirements for forage conservation over the course of year, both the mass of forage to be conserved and the corresponding crop area must be known.

On most Swiss cattle farms, the animals are fed with fresh grass during the vegetation period. The feeding takes place in the pasture, the barn, or in a combination of both. The meadow areas of a farm are therefore harvested several times a year, both for fresh grass and for forage conservation.

Contrary to a linear requirement of fresh forage for a steady livestock population, plant growth is non-linear. The consequence of this is that repeated use of the same area over the year yields varying masses of forage. The growth rate of most forage plants rises sharply in spring after the onset of the growing season and levels off after reaching a peak in early summer. Thus, substantially more forage is left over for conservation in early summer than in late summer and autumn.

The fresh-grass mass is calculated from the requirements of the number of animals, that will be fed. A calculation model was developed to determine the mass of forage available and the area required at a given point in time. Hence the key figures calculated enable us to determine the working-time requirements for pasture management, or alternatively grass harvesting for indoor feeding.

2. MATERIAL AND METHODS

Approx. 100 growth curves from 42 Swiss sites in different regions and at different altitudes were used to calculate daily forage growth (Mosimann, 2004). The growth curves were based on weekly measurements of forage growth. In addition to altitude, both the frequency of precipitation and the suitability of the measuring sites climates were known.

The available data were analysed according to the known site influences. Hereby, altitude and the course of the growth curve were proven to be linked. Although further site factors such as frequency of precipitation and suitability of climate were found to exert an influence, the size of the sample did not permit any further differentiation. The data were therefore grouped into altitude zones and depicted in a number of non-linear regression models as a function of altitude and calendar week. Seven altitude zones (<450, 450-600, 600-750, 750-900, 900-1050, 1050-1200 and >1200 metres above sea level), which have already been employed in other areas of the ART Work Budget (e.g. for the allocation of the cutting dates), were used.

The mean growth curve for a given altitude was compared with the corresponding curve of the regression model (Figure 1). Figure 2 shows the growth curves of the regression model for the seven altitude zones.

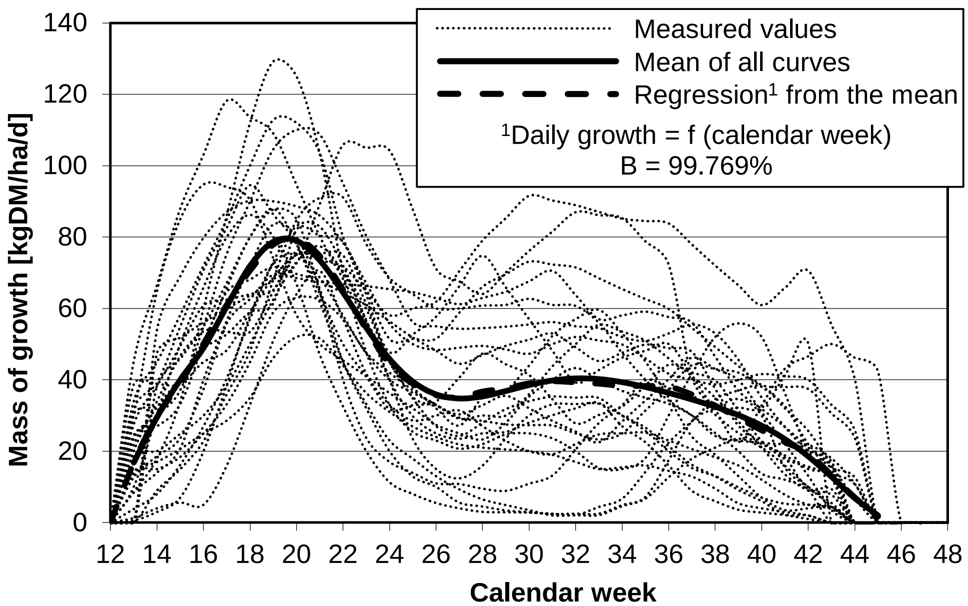

Figure 1: 25 forage growth curves of the altitude zone 400-650 m.a.s.l. (measured values), mean of measured values and depiction of the means in the regression model

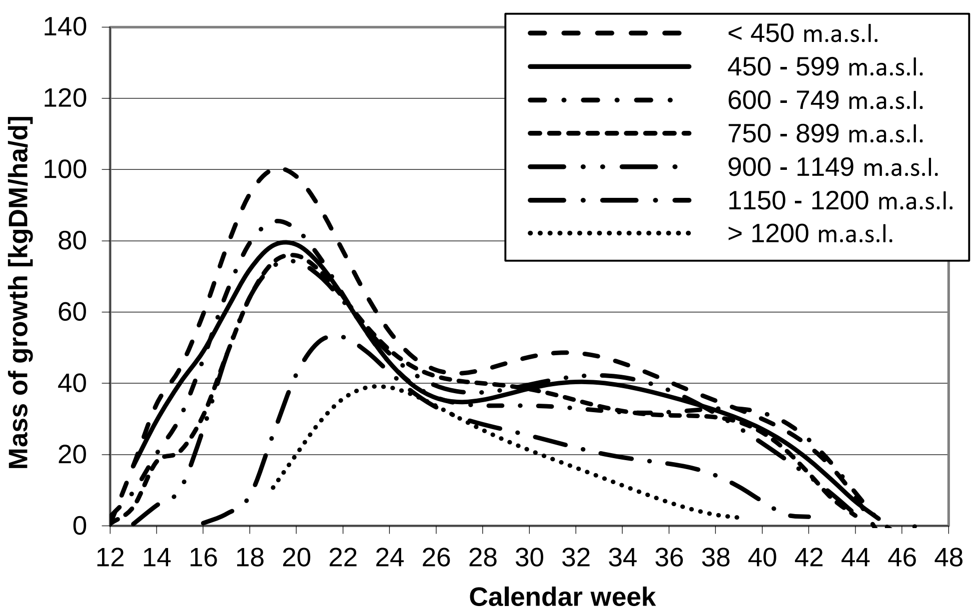

Figure 2: Forage growth curves from regression models for 7 altitude zones

To determine the resulting forage mass, the forage-growth curve corresponding to the altitude were selected in the model. This curve was used to calculate the forage growth for the entire forage area of the farm for each calendar week. The sum of the weekly forage mass, gives the annual yield of these areas. If the calculated annual yields differed from the effective annual yields, the curve was linearly adjusted.

The mass of fresh grass for pasture and indoor feeding was determined by the number of animals to be fed and the forage ration. The requirement for fresh grass was deducted from the weekly forage growth in each case. The remaining forage mass of the weeks until the next harvest date were cumulated. This forage mass corresponded to the amount available for conservation.

The harvest dates were appointed depending on the altitude and the frequency of use (number conservation cuts per year). The corresponding growth period (number of weeks before the first and between the different harvest dates) and the corresponding forage mass were assigned to the harvest dates. With the average fodder yield per hectare for each growth period (calculated from the growth curve) and the remaining forage mass the corresponding harvest area were determined.

The available forage mass as well as the corresponding harvest area were therefore available as parameters for calculating the working-time requirement of the ‘forage conservation’ procedure.

3. RESULTS AND DISCUSSION

The results are illustrated using the example of a farm with 30 dairy cows and 15 ha of meadow. The assumed forage yield is 115 dt DM per hectare and year. The cows consume 60 kg of grass in calendar weeks 15 to 40 (8.5 kg DM) and 40 kg in calendar weeks 41 to 45 (5.5 kg DM) per animal and day on the meadow. In calendar weeks 19 to 43, additionally 40 kg (5.5 kg DM) grass is fed indoors per animal and day.
The forage supply comes to 1.725 dt DM per annum. Figure 3 illustrates how this amount is distributed over the vegetation period (calendar weeks 12 to 47). After deducting the 930 dt DM of fresh grass fed from this supply, 795 dt DM remains for conservation.

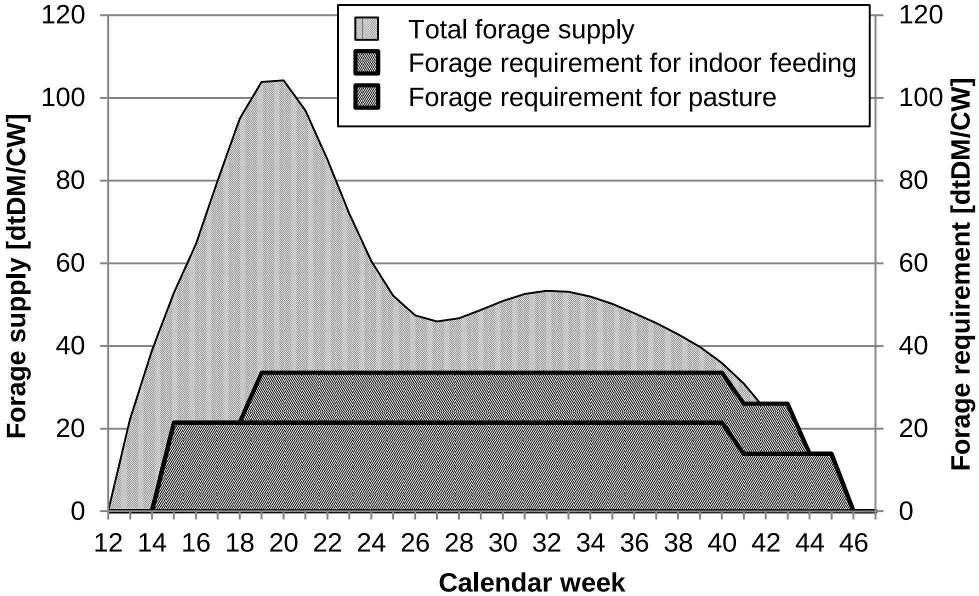

Figure 3: Forage supply over the course of the year (15 ha meadow, 115 dt DM per ha and year) and forage requirement for 30 dairy cows (indoor feeding 5.5 kg DM, pasture 8.5kg / 5.5 kg DM per animal and day)

In calendar weeks 21, 26, 32 and 37, conservation forage is harvested. Table 1 lists the calculated forage mass as well as the area to be harvested on the cutting date in question.

Table 1: Forage conservation dates with corresponding area and mass available to be harvested in each case.

	Cut number				
	1	2	3	4	Total
Calendar week	21	26	32	37	
Forage mass [dt DM]	409	213	77	89	788
Area [ha]	11.0	7.7	4.7	5.2	28.6
ø Yield [dt DM/ha]	37	28	16	17	

At the time of the first cut, 409 dt DM are available on 10.9 ha. At the second cut, this figure is 213 dt DM on 7.7 ha; at the third cut 77 dt DM on 4.7 ha, and at the fourth cut, 89 dt DM on 5.2 ha. Figure 4 shows the cumulated forage mass after deduction of the fresh grass fed, as well as the cutting dates.

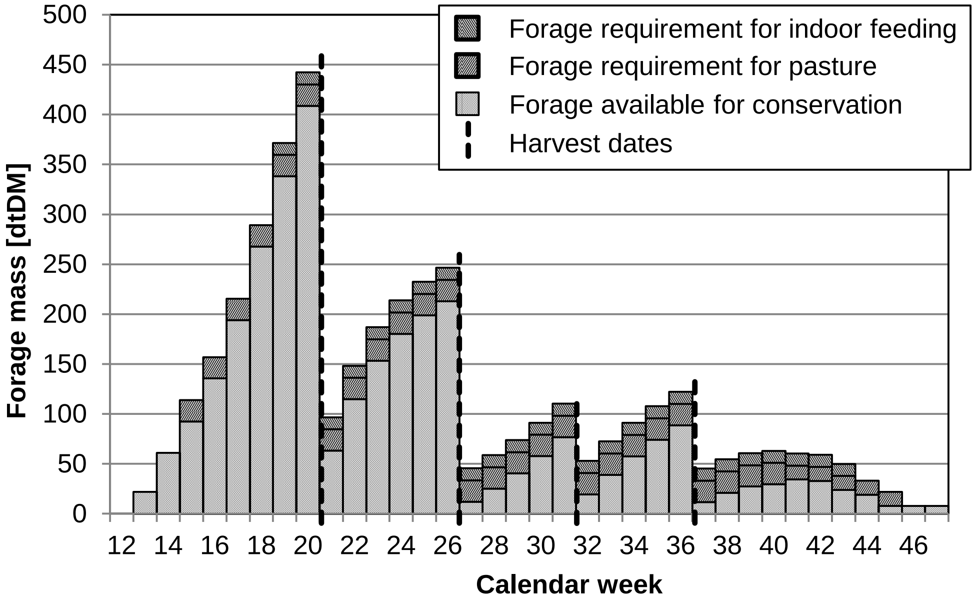

Figure 4: Cumulated forage mass available for conservation at 4 separate dates

The model developed by Agroscope calculates the forage mass and crop area for each conservation cut, and makes these available for calculating the working-time requirements. Performing the calculation on a weekly basis not only takes the different rates of forage growth over the course of the year into account, but also allows the working-time requirement for the harvesting jobs to be allocated to the appropriate work period, thereby enabling peak workloads to be identified in a more differentiated manner.

The ‘forage growth’ characteristic in the model is determined by altitude alone. Solar radiation, water availability, botanical composition and fertiliser-application management are additional parameters that substantially influence this characteristic. For calculations relating to the individual farms, it would be desirable to have access to a broader underlying data source. This would allow taking further parameters into consideration.

4. CONCLUSIONS

To date, the distribution of forage mass to be conserved over the course of the year has been calculated in the ART Work Budget by means of constant percentages. The fresh-grass requirement during the vegetation period were estimated, and likewise taken into account as a constant in the calculation. The user of the ART Work Budget can adjust the number of conservation cuts and the dates on which they are carried out, as well as the parameters influencing the fresh-forage requirement.

The model developed by Agroscope allows the accurate calculatuation of forage masses to be conserved as well as the crop areas, by integrating accurate user inputs.

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