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DIGESTIBILITY ESTIMATES BASED ON A GRASS GROWTH MODEL ARE DISTRIBUTED VIA INTERNET TO FINNISH FARMERS

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Abstract

Optimising the harvesting time of grass in primary growth is difficult under Finnish climatic conditions, because the digestibility of grass decreases on average by 0.5 percentage units daily. We constructed a model based on cumulative temperature and geographical location which estimates the digestibility of grass. This model is used to produce estimates utilising real time weather information. The estimates are presented as a map, which is revised daily. Farmers have free access to the maps via Internet.

Keywords: Advisory service, cumulative temperature, D-value, forecast, grass, growth stage, Internet, model

Introduction

Under the climatic conditions of Finland, the primary growth of grass after winter is very intensive. Dry matter (DM) yield increases rapidly, but simultaneously the concentration of digestible organic matter in DM (D-value) of grasses decrease. The daily D-value decline in grasses such as timothy and meadow fescue has on average been 0.5 percentage units, but the

range is large (0.1 to 1 unit per day). Cutting the grass very early means unnecessary sacrifices in harvested DM while a late harvest decreases the nutritional value of the forage. Cows consuming grass silage *ad libitum* decreased their daily milk production by 0.5 kg per each percentage unit decline in silage D-value (Rinne et al. 1999a). In silage-based dairy cow diets, a D-value around 69-70 % is generally recommended in Finland.

The development of D-value may not be linear in terms of time, because grass growth is greatly influenced by weather conditions. Several approaches have been taken to model the changes of quality in the growing crop (Fick et al. 1994). Cumulative temperature (CT) has proven to be an accurate predictor of grass D-value under Finnish conditions (Rinne et al. 1999b, 2000). This paper describes the development of a grass growth model based on field data collected during four years. An Advisory Service is based on the model utilising real time weather data. The estimates are distributed via Internet to assists the farmers in choosing the optimal harvesting date of grass in primary growth.

Material and methods

Mixed timothy (*Phleum pratense*) and meadow fescue (*Festuca pratensis*) leys were sampled from experimental plots of Agricultural Research Centre and from practical dairy farms by Valio Ltd. The leys were scattered around Finland and at least 3 data points per each ley were obtained at no more than one week intervals around the actual harvesting time. The data set comprised of all together 62 data sets over 4 years (1996-1999) and totalled 258 individual observations. The D-value of the samples was determined with a cellulase based *in vitro* incubation (Friedel 1990). CT was obtained from the Finnish Meteorological Institute. CT was accumulated since the onset of the growing season, which starts when the mean daily temperature is over 5 °C for five consecutive days. CT was calculated as Σ(mean daily temperature - 5) °C. For the

geographical coordinates X and Y (km), the values of the municipality centre were used. A regression equation for D-value was calculated using SAS MIXED procedure using CT, X and Y as fixed factors while the year and each ley within the year were random factors. The following regression equation was produced:

D-value (%) = 86.3 - 0.052 CT - 0.0059 X - 0.0018 Y (R^2 = 0.95 and root MSE = 0.99)

Finnish Meteorological Institute provides information of CT real time during the growing season. Map images presenting regional D-values are produced based on the previous equation and CT using GIS software to cover whole Finland. CT is estimated by interpolation using ARC VIEW SPLINE procedure for a 5 × 5 km grid from data gathered from the network of meteorological observatories scattered around Finland. The same accuracy is used to produce the map images. Numerical values for each municipality centre are also provided. D-values are presented in the map at 1 %-unit intervals ranging from 75 to 65 % (Figure 1). The estimate of D-value is revised daily. Also forecasts of D-value after 5 days are presented based on three options: the CT development follows a mean rate based on 30 year records, or represents 12.5 % lower or higher percentile of the rate of CT accumulation.

Internet provides a media to distribute the information real time to the farmers. The home page of the Advisory Service (named "Artturi") was placed in the "Agronet" portal which is a non-commercial portal within the agricultural sector in Finland. The Service is freely available at the web site "http://www.agronet.fi/artturi" starting in June 2000. The language of the site is Finnish.

Results and discussion

According to the equation, D-value decreases by 0.05 % units per each increment of 1 °C of CT. In June, the average mean daily temperature in Southern Finland is 15 °C meaning that CT increases by 10 °C daily. Consequently, D-value declines 0.52 percentage unit daily, which

corresponds well to earlier observations in Finland (Rinne et al. 1999a, 2000). The coefficients for X and Y mean that at the same CT, the D-value decreases by 0.59 percentage unit per 100 km shift to east and by 0.18 per 100 km shift to north. A theoretical basis for these effects can be found in the systematic changes of the climate. The onset of growing season is postponed northbound, but the intensity of growth increases at least partly due to longer day light periods. The effect of Y can be interpreted as the effect of shifting from coastal climate in the west towards more continental climate in the east, where for example the snow cover is deeper and melts later in the spring than in the west.

The D-value estimate of the current Service is only based on the general CT accumulation and geographical location. Soil type, grass species (especially if forage legumes are included), ley management, differences in microclimate and many other factors are likely to cause significant modifications in grass development. At present, we do not have sufficient data to modify the model based on these factors. We continue to collect data on grass development to be able to cover certain specific situations. The models including specific site factors could potentially be utilised in the Service by two-way information transfer. Farmers could send information relevant to their grassland management to the Service, and this information could be used in producing individualized results. In the future, farmers may for example measure CT themselves to control the microclimate of their fields. In addition, the onset of growing season could possibly be determined by measuring soil temperatures on individual field basis.

In conclusion, the Advisory Service described in this paper will improve the ability of farmers to produce forage fitting optimally to the feeding strategy chosen on their farms. Internet provides a powerful tool to distribute the information to farmers as approximately half of Finnish dairy farmers have access to Internet through their PC's. Time lag and cost are greatly reduced in the new Service compared to earlier systems based on chemical analyses of field samples and

publishing results in a newspaper. The possible errors in sampling and analysing are also avoided. However, there still remains several important aspects to be studied in the future. Refining the model based on information from individual fields through two-way information transfer via Internet is within reach. A great challenge lies in extending the Service to cover the regrowth(s) of grass, which would allow the farmers to optimize their harvesting systems across the whole growing period and concerning both quality and quantity of grass. This requires more experimental data on grass growth under different harvesting strategies.

Finally, we wish to emphasize that the actual decision of harvest remains a responsibility of the farmer. The decision should be made based on regular observations of the leys and relies ultimately on the professional skills of the farmer.

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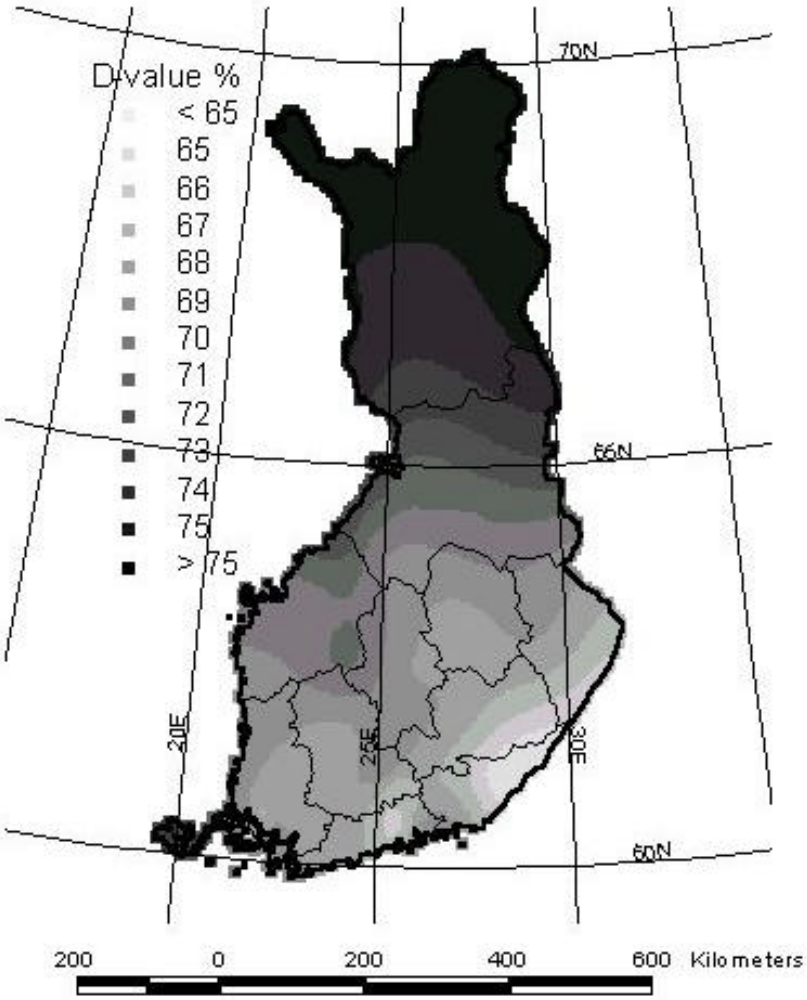

Figure 1 - D-value of timothy in Finland on 16 June 1999 estimated with the model described in the text.