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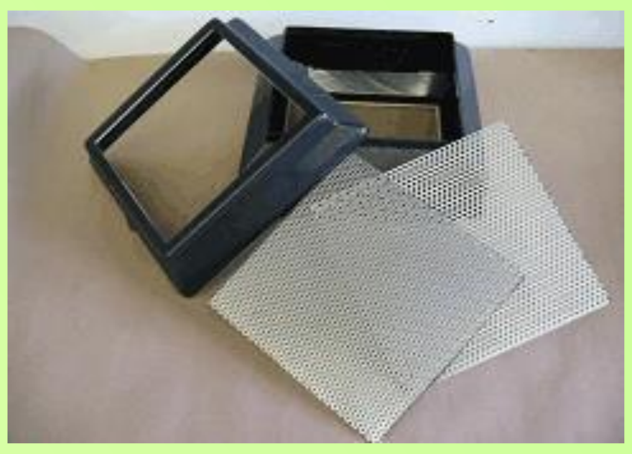
An application of Z-Box method in dairy cow feeding to estimate the relationships among peNDF, other feed variables and productive data



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Physically effective NDF (peNDF)
Physically effective NDF is a chemical-physical parameter which is defined specifically as the fraction of fiber that stimulates chewing and contributes to the floating mat of large particles in the rumen (Mertens, 1997). The consequence of this process is the increase of acetic acid which is the direct precursory of milk lipids

peNDF = pef X NDF

- **physical effectiveness factor (pef)** varies from 0 when feed NDF stimulates no chewing to 1.0 when feed NDF promotes maximum chewing
- pef is related to particle size and particle size reduction because it is related to chewing activity
- peNDF affects ruminal stratification and pH

Pef is directly measured on forage or total mixed rations (TMR) by means of several methods. We chose the **Z-Box method** (Miner Institute e Zen-Noh, 2005) thanks to its easy use and applicability to as-is feed and TMR, and we are trying to obtain an estimating equation which may predict milk fat content and/or other productive data from peNDF and other variables measured on TMR

METHODS

Samples of TMR collected from several farms are sieved and undergo proximate analysis, NDF, ADF, ADL and starch.
Milk yield and milk fat are collected on farm; qualitative data such as type and cut-length of forage, season, geographical origin and altitude (plain/hill/mountain) are also taken into account, to estimate their possible effect.

How pef is calculated
From a representative sample of TMR (about 600g), 3 subsamples (about 50 g each) are placed into the Z-Box (3,18 mm mesh) and the initial weight is recorded. Samples are vertically shaked vigorously (20-25 cm up/down with 2 full shakes per second) for 50 shakes. Finally, pef is calculated as the percentage of retained material (>3,18) on total.

As a first step, in order to investigate the complex relationships existing among the set of variables, Principal Component Analysis (PCA) is used as a data exploration tool. A first PCA model on the whole dataset, including samples both with and without silages (Fig. 1) has been calculated, in order to highlight the main sources of variability. Successively, more detailed studies will involve the calculation of multivariate models on the two datasets (with and without presence of silage in TMR) separately, since the results of this preliminary analysis show a clear separation of the two groups. This could be of particular interest, because so far the available peNDF data and the related requirement recommendations for dairy cow rations have been published almost only for total mixed rations with silages. We are collecting peNDF data for silage-free TMRs also, because this is a common practice in the Parmigiano-Reggiano cheese area. For each PCA model, the overall correlations among all the considered variables and their relative importance are investigated by means of the loadings plots, posing particular attention to the correlations with peNDF and with milk fat.

PRELIMINARY RESULTS

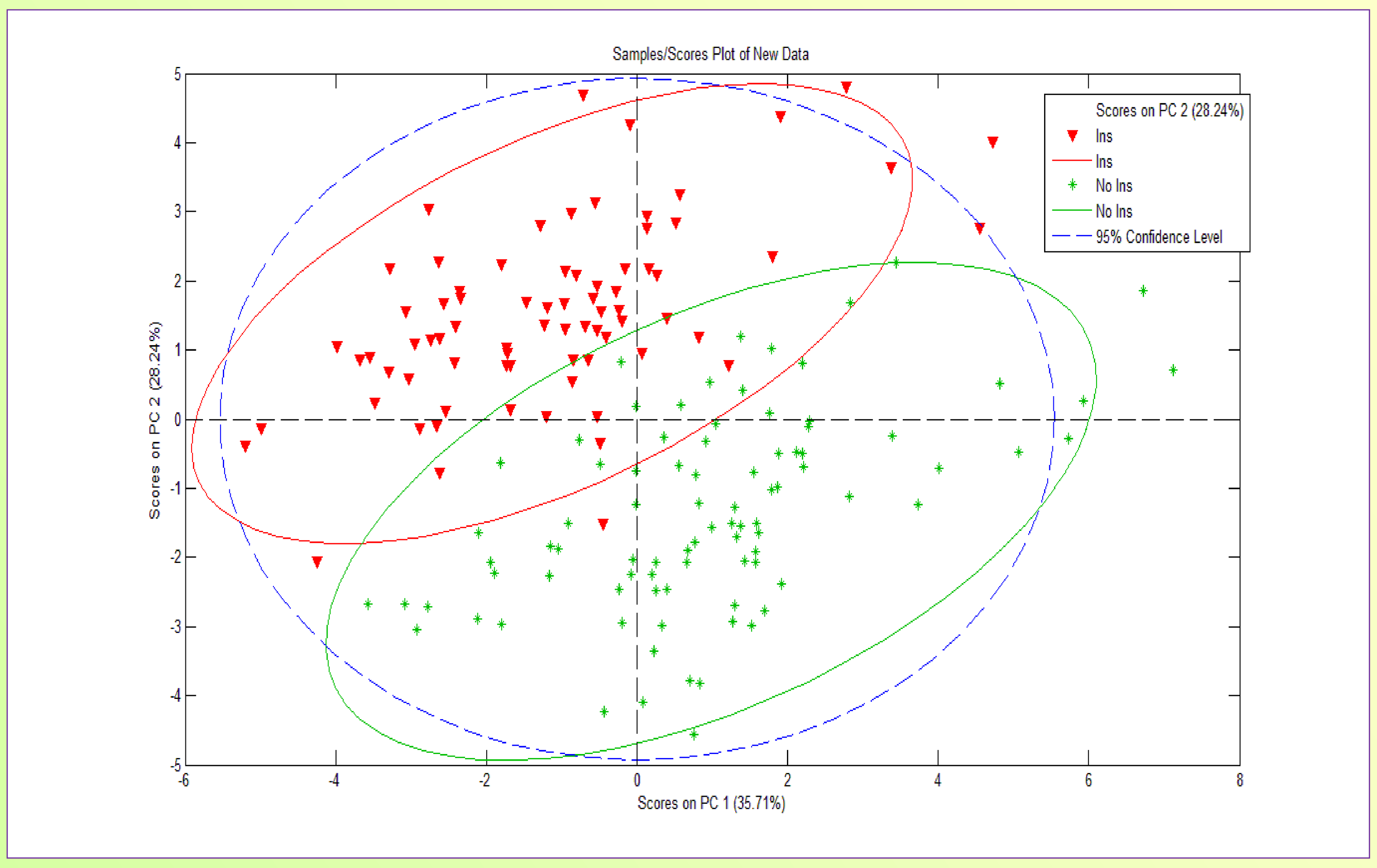

Fig. 1: TMR score plot

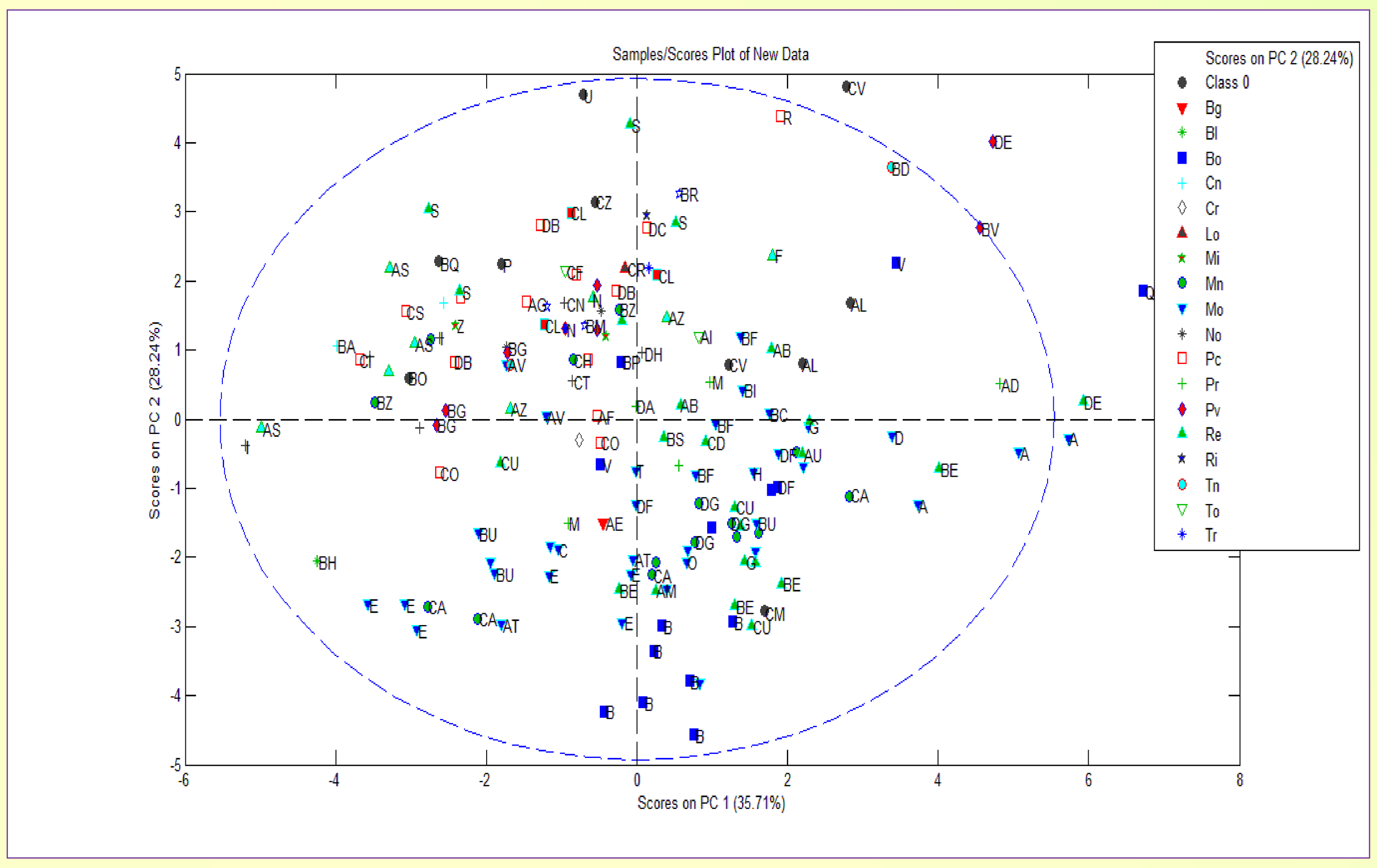

Fig. 3: Geographic score plot

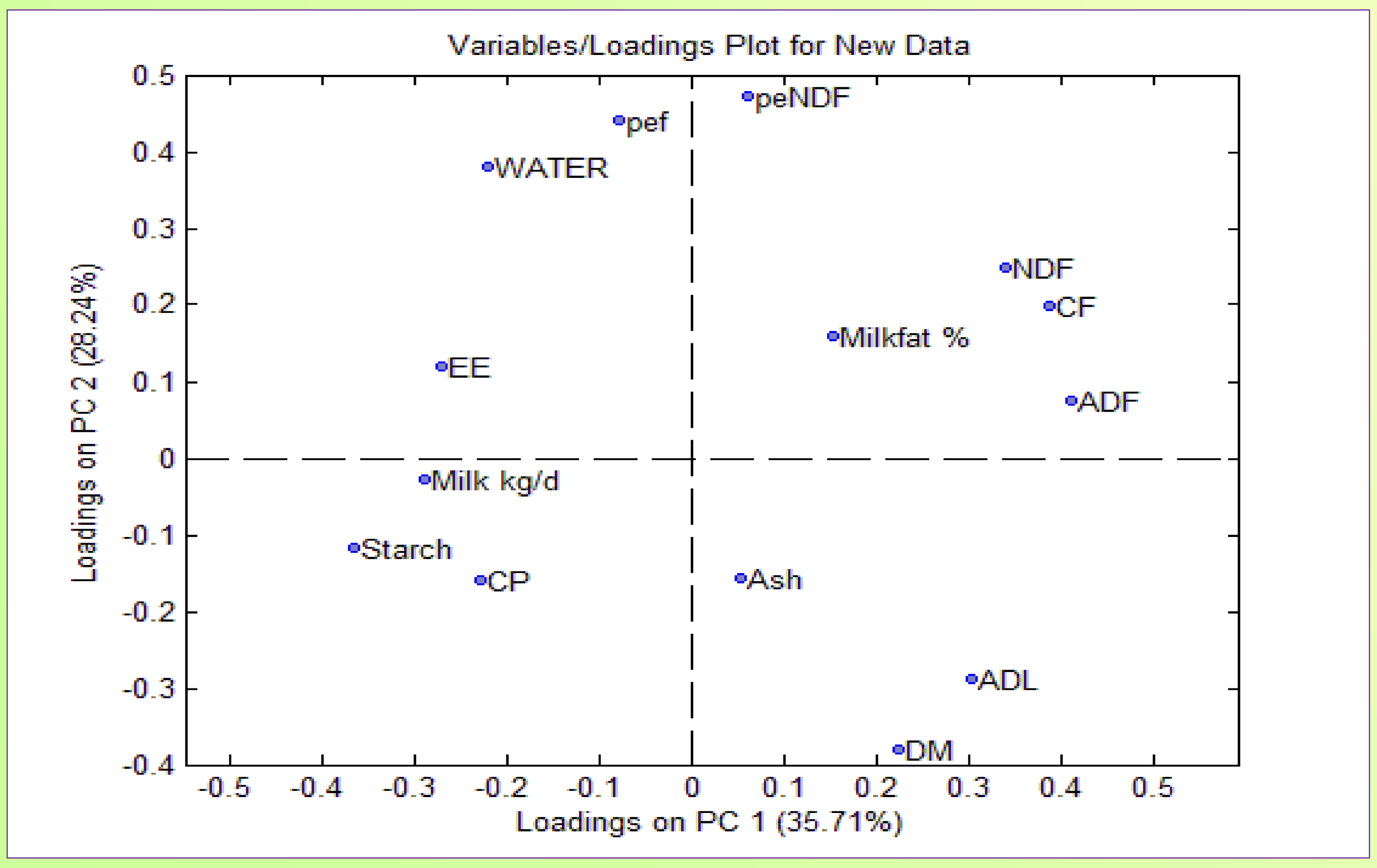

Fig. 2: Loadings plot

PCA was applied to the autoscaled data matrix. The first two principal components, PC1 and PC2, explain about 64% of the whole data variability. The PC1 vs. PC2 score plot reported in **Figure 1** shows the existence of two well distinct groups, according to the type of TMR used: with (red triangles) or without silages (green crosses). TMR with silages lie mainly on the upper left part of the score plot, whilst TMR without silages lie mainly on the lower right side. The corresponding PC1 vs. PC2 loading plot reported in **Figure 2** shows the influence of the 14 variables under study on data variability. PC1 is mainly influenced with positive sign by fibrous parameters of diet (NDF, ADF, CF), and consequently by milk fat, whilst energy-linked parameters (starch and crude protein), as well as milk yield, have influence on PC1 with negative sign. This relationship among variables was expected. PC2 is mainly influenced with negative sign by TMR dry matter, lignin and partially ash, and with positive sign by water content, pef and peNDF, since the samples with higher water content have a higher level of aggregation and consequently lose a lower amount of material during sieving. The correlation between dry matter and lignin, evidenced by the contiguous position of these two variables, is due to forage maturity. Ash are higher in TMR with high dry matter (hay, without silages) since contamination with ground frequently occurs during hay harvesting. The parameters which mainly affect the variability of the two categories of samples are lignin and dry matter (which are higher in TMR with hay and without silages) and pef and water content (in TMR with silages). Finally, **Figure 3** shows the PC1 vs. PC2 scores plot where, at variance with Figure 1, samples are represented with different symbols depending on their geographic origin. The figure shows the presence of partially overlapped sub-clusters, suggesting an effect of geographic origin on TMR composition. A deeper analysis allowed to attribute the presence of these sub-clusters mainly to the farm which provided the samples (indicated with different labels), rather than to the geographic area.