# Permanent grasslands and PARMIGIANO REGGIANO

Calerno, Reggio Emilia,

October 23rd 2015

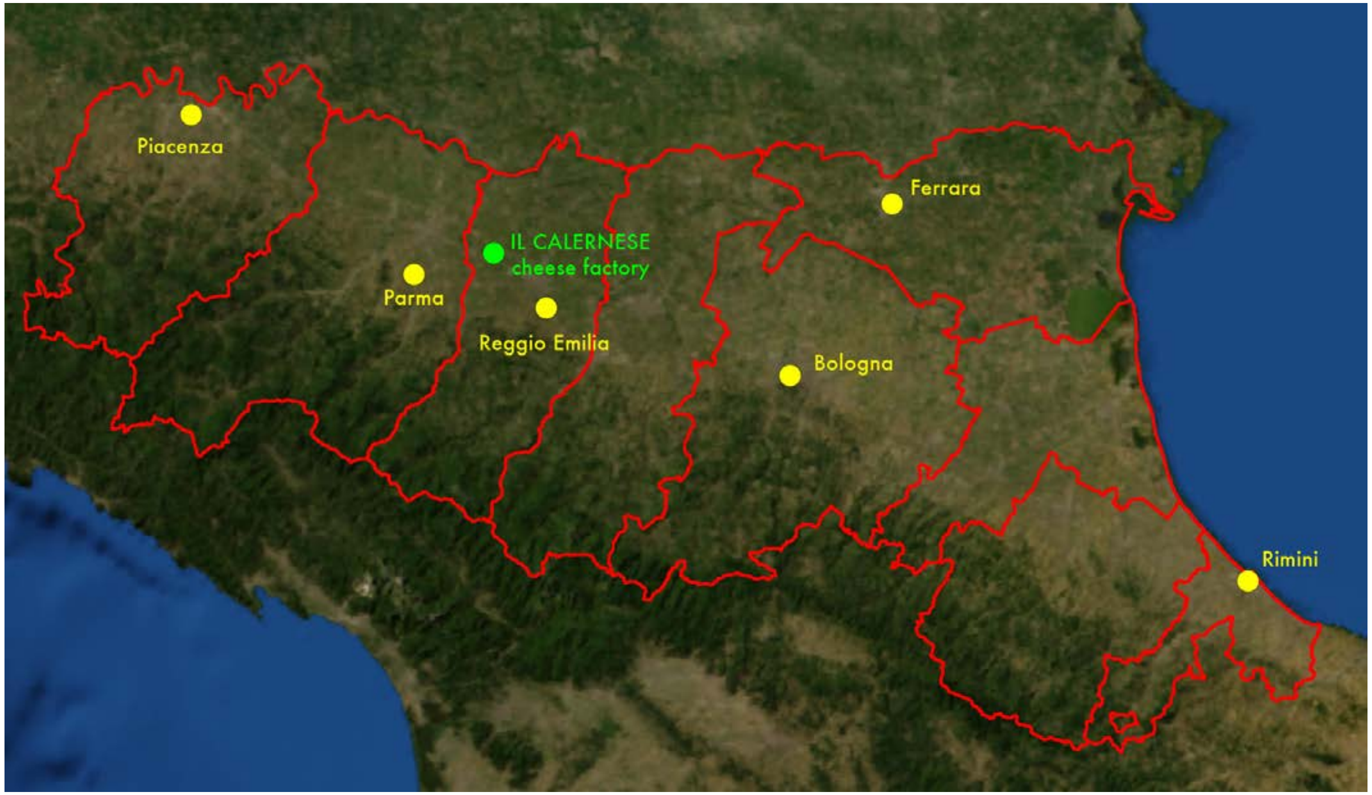


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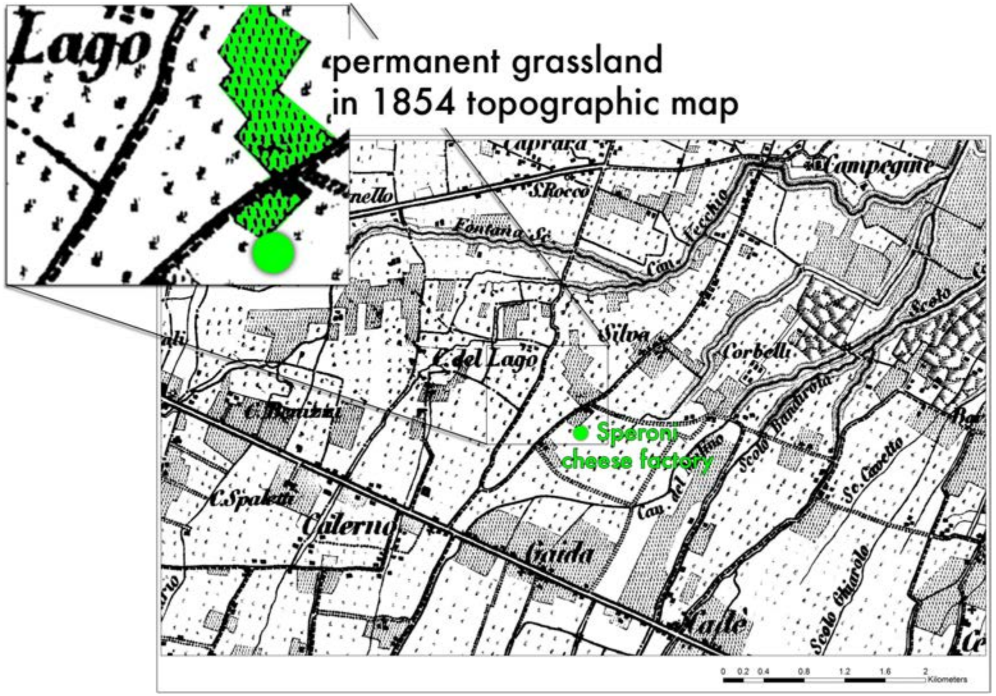
Figure 1.




Permanent grasslands have always been an important element for the economy and landscape of Emilia-Romagna. They cover 16.440 ha of the Po Plain and are mainly located in Parma and Reggio Emilia provinces where small dairy farms, connected with Parmesan cheese production, are located. These meadows are unploughed over 30 years, are irrigated and are managed exclusively through mowing and fertilizing . They are characterized by a high biodiversity They are the most ancient nutritional resource for dairy cows providing milk for Parmigiano-Reggiano cheese. The specific production area of this cheese spreads over the Provinces of Parma, Reggio Emilia, Modena, part of the Bologna Province and the territory of Oltrepò Mantovano.

Permanent grasslands owe their name to the fact that once they are sown they are never rotated with other crops and are maintained through mowing, irrigation and fertilization. Even if the quantity of forage from permanent grasslands is important for the production of the Parmigiano-Reggiano cheese, their extension tends to decrease because of the competition with other crops. The relevance of a product like Parmigiano cheese influenced since year 1000 the economy, the landscape and the society of this land. Since the Trappist monks developed their production system to obtain this unique long-lasting cheese, the small dairy farms and their plots became the landmark of Emilia territory. Nowadays the production system is still based on small farms as centuries ago, with a Consortium connecting dozens of co-operative dairies with ageing facilities to obtain a cheese without preservatives and additives, thanks to silage feeding prohibition

The first references about the permanent grassland used for the Parmigiano Reggiano production dating from the XII century. Some of the present one has been reported from the XVIII century. Probably these grassland are the more southern permanent pastures in plain environment of Europe.

In the 1854 topographic map (Fig. 1) the dotted grey areas are the permanent grassland (highlighted in green in the upper left box), some of them, like the one in front of the cheese factory are still present. In the 1954 aerial image (Fig. 2), the grassland use is still dominant associated with arable crops, but with a different pattern than before. All the plots where separated by rows of vines sustained from elm, maple and mulberry trees. The “historical” dimensions of the plots are such as to allow a man with an ox to work it in a day.

After few years, because of the mechanization of the agriculture, the plot size increased and almost all the rows of vines disappeared (Fig.3).

This kind of land use is strictly linked to the Parmesan Cheese production, the economic evolution of the food products and their price volatility has strongly conditioned the (economic) sustainability of the permanent grassland. Moreover the agronomic management is not so simple because of high water demand of meadows that pushed towards some alternatives to the traditional furrow irrigation system, such as hose reel (raingun) irrigation which can be consideredmore efficient but also more expensive.

The soils of the permanent grassland express to highest level many soil function, providing a lot of ecosystem functions. They are a big carbon sink, the soil biodiversity is very high, the wildlife biodiversity has a strong ecological impact on the surrounding environment, the buffer and filtering capacity is very high and, last but not least, they are an important cultural heritage of the millennial tradition of the Parmigiano-Reggiano production.

Figure 2. **1954** aerial picture


Figure 3. **1996** aerial picture


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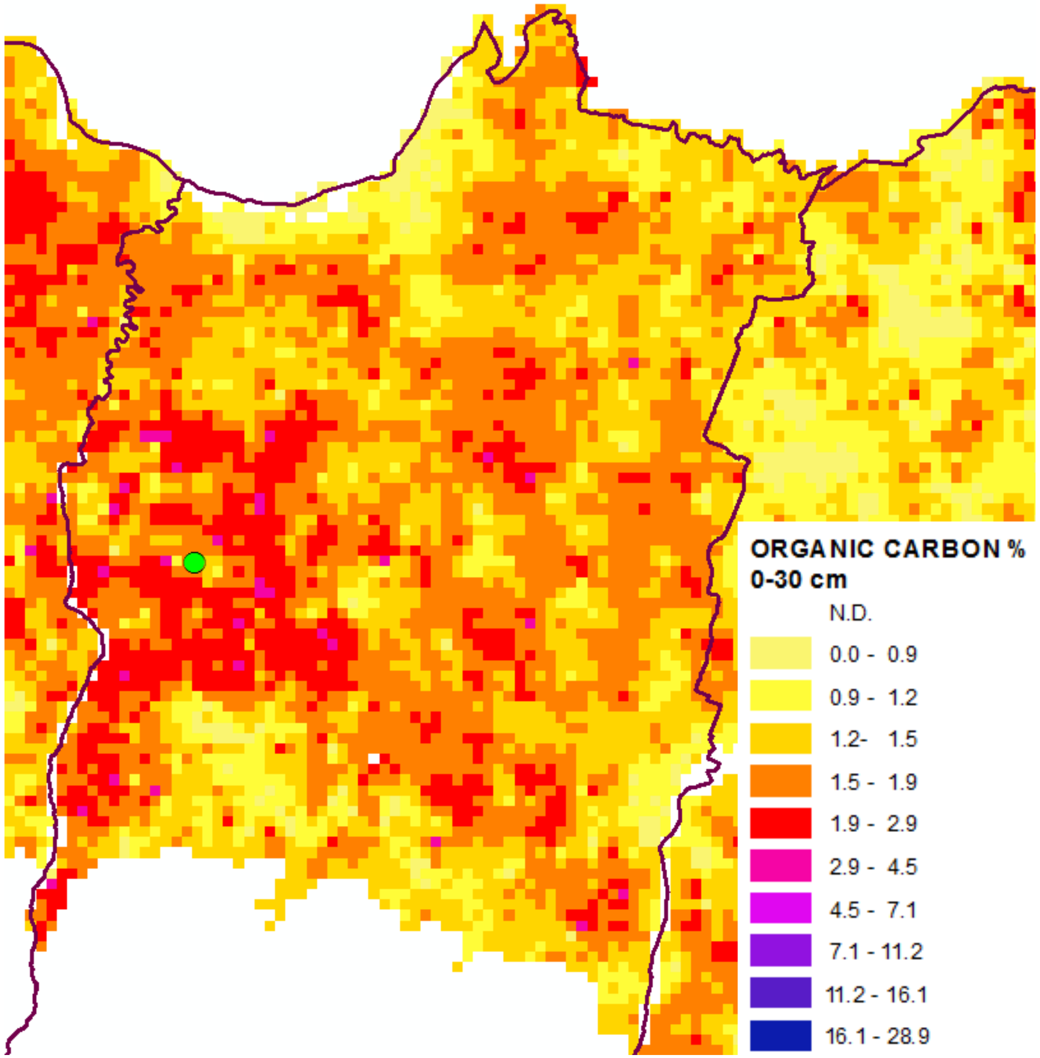
Figure 4. **2000** aerial picture


Figure 5. **2011** aerial picture

Figure 6. Organic Carbon Map 1:50.000 (tile 500m x 500 m). Province of Reggio Emilia



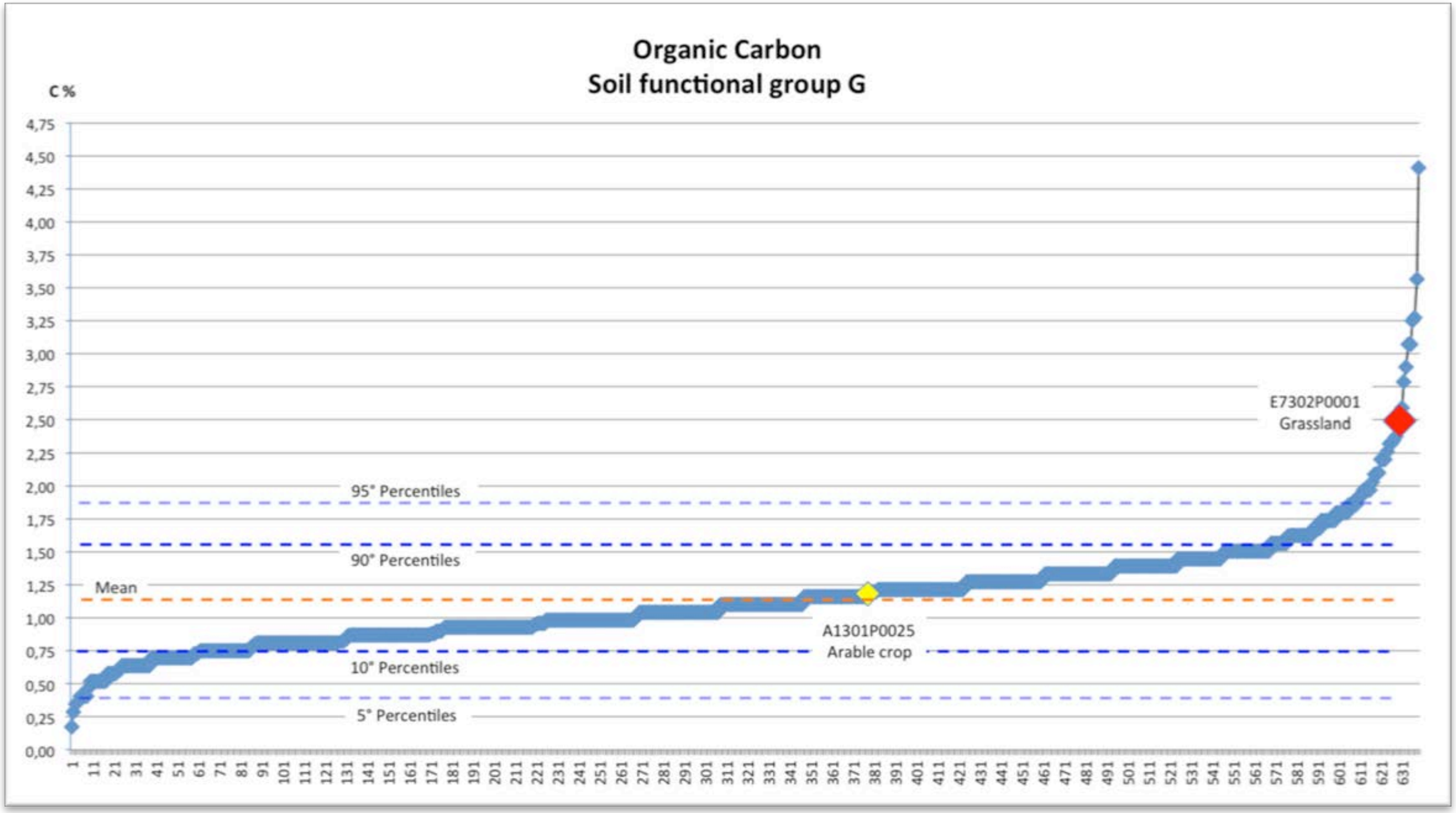

This map is going to be published by the end of 2015 and it represents the **percentage organic carbon content (layer 0-30 cm)** in the Emilia-Romagna plain.

A Scorpan Kriging approach has been used, which combines the trend component of soil properties as derived from the 1:50 000 soil map with geostatistical modeling of the stochastic, locally varying but spatially correlated component. The trend component is described in terms of varying local means, calculated taking into account soil type and dominant land use.

Soil data (**14,240** observations), collected from 1990 to 2014 and made available by the Regional Agricultural Extension Service, by the Soil Survey and by ESDAC (LUCAS data), have been referred to 10 soil functional great groups (A-R), divided in **16 functional subgroups**. Soil functional groups group 231 soil types and they are defined in terms of top-soil textural classes and presence of organic materials (Op horizons); the criteria for the subgroups is oxygen availability.

The observations within each functional subgroup have been further divided in **52** administrative districts characterized by different levels of Soil Organic Carbon (SOC islands) identified by the use of the cluster analysis (MacQueen, 1967). The mean OC values and the standard errors for each combination has been used to calculate the SOC mean value for each polygon (delineation) of the 50k soil map. This value was than subtracted to each data point within the delineation in order to calculate the SOC residuals. Once normalized with a normal score transformation (NS, Goovaerts, 1997), the residuals experimental semivariogram was calculated with a lag of 1500 m and fitted with a double nested spherical model. Sequential Gaussian simulations (*N* = 100) of the normalized residuals were implemented on a 500m regular grid, adopting a multiple grid search strategy. Once back-transformed, the estimated C residuals were added to the locally varying delineation dependent SOC means in order to derive a distribution of 100 values for each grid cell.

Figure 7. Organic Carbon values (sorted from the lower to the higher) of the topsoil of the soil functional group G (soil similar for some Ap horizon caracteristics, e.g. texture from “fine” to “moderately fine”; moderate oxygen availability according to the redoximorphic condition)




The agricultural use of these soils is mainly crop rotation. In the left part of the graphic most of the soils are intensely cultivated, with very low content of organic carbon. In the right part, the highest values are from permanent or semi permanent grassland.
Roughly the upper part of the curve could represent the potential values of OC reachable form this kind of soils in conservative agricultural condition.

## MOST FREQUENT SOIL TYPES IN THIS AREA UNDER DIFFERENT LAND COVERAGES


Profile #: E7302P0001
Provice: Reggio Emilia
Location: Azienda Rota
Describers: Marina Guermandi
Date: 24/04/1997
Land use: Grassland
WRB: Someric Kastanozems (WRB, 2014)
Soil Type: RNVw (Slightly calcareous RONCOLE VERDI)

Ap1 0 - 20 cm; dry; silty clay; 2.5Y3/2; strong medium angular blocky, strong coarse angular blocky; common very fine roots; connected cracks (5mm wide); strongly effervescent; clear lower boundary

Ap2 20 - 55 cm; dry; silty clay; 2.5Y3/2; moderate coarse angular blocky, moderate very coarse angular blocky; few hard fine carbonate nodules; connected cracks (3mm wide); strongly effervescent; abrupt lower boundary

Bw 55 - 80 cm; humid; silty clay; 2.5Y5/3; moderate very coarse angular blocky; fine common mottles 2.5Y5/6; few hard medium carbonate nodules, few hard fine Fe-Mn nodules; slightly effervescent; clear lower boundary

Bk1 80 - 100 cm; humid; silty clay loam; 2.5Y5/2; moderate coarse angular blocky; fine common mottles 2.5Y5/4; few hard fine carbonate nodules; violently effervescent; clear lower boundary

Bk2 100 - 130 cm; humid; silty clay loam; 2.5Y5/2; weak coarse angular blocky; fine common mottles 2.5Y5/6; common soft coarse carbonate masses; violently effervescent; clear lower boundary

Bk3 130 - 150 cm; wet; silt loam; 2.5Y5/2; common hard coarse carbonate nodules, common soft coarse carbonate masses; violently effervescent; unknown lower boundary.

| | Up. Lim. | Low. inf. | Sand % | Silt % | Clay % | Text. | pH $H_2O$ | $CaCO_3$ % | OM % | N mg/kg | CEC meq/100 g |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 20 | 11.00 | 44.00 | 45.00 | SIC | 7.4 | 7 | 4.30 | 3 | 31.16 |
| 2 | 20 | 55 | 9.00 | 46.00 | 45.00 | SIC | 7.3 | 8 | 4.40 | 3.1 | 29.86 |
| 3 | 55 | 80 | 11.00 | 41.00 | 48.00 | SIC | 7.8 | 3 | 1.30 | 1 | 31.71 |
| 4 | 80 | 100 | 8.00 | 54.00 | 38.00 | SICL | 8 | 23 | 1.50 | 0.9 | 18.97 |
| 5 | 100 | 130 | 7.00 | 58.00 | 35.00 | SICL | 8 | 30 | 0.90 | 0.5 | 19.92 |
| 6 | 130 | 150 | 10.00 | 65.00 | 25.00 | SIL | 8 | 35 | 1.10 | 0.7 | 13.79 |

Profile #: A1301P0025
Provice: Reggio Emilia
Location: Calerno
Describers: Giuseppe Benciolini, Samuele Albonetti
Date: 08/07/1998
Land use: Arable cropland (cereals)
WRB: Haplic Calcisols (WRB, 2014)
Soil Type: RNV1 (Silty clay loam RONCOLE VERDI)

Ap 0-60 cm; dry; silty clay loam; 10YR 4/3; moderate medium subangular blocky; noneffervescent; neutral; linear clear lower boundary

Bw 60-90 cm; dry; silty clay; 10YR 4/4; strong medium subangular blocky; common fine Fe-Mn nodules; few slickensides, non effervescent; slightly alkaline; linear abrupt lower boundary

Bk 90-140 cm; silty clay loam; 2.5Y 5/4; moderate medium subangular blocky; many soft medium carbonate masses; common medium Fe-Mn nodules; violently effervescent; moderately alkaline; unknown lower boundary

| | Up. Lim. | Low. inf. | Sand % | Silt % | Clay % | Text. | pH $H_2O$ | $CaCO_3$ % | OM % |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 60 | 14.87 | 46.83 | 38.30 | SICL | 6.42 | 0 | 2.04 |
| 2 | 60 | 90 | 10.74 | 47.26 | 42.00 | SIC | 7.69 | 0 | 1.03 |
| 3 | 90 | 140 | 25.02 | 50.18 | 24.80 | SIL | 8.12 | 34 | 0.87 |