

# Improvement of sparkling wines production by a zoning approach in Franciacorta (Lombardy, Italy)

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## INTRODUCTION

Franciacorta is a viticultural area which extends in the hills to the South of Iseo lake in Lombardy. It is particularly famous for the production of sparkling wines obtained mostly from *Chardonnay* and *Pinot blanc* and *noir* grapes. The name of this territory is of medieval origin and appeared for the first time in 1277 as "Franzacurta", from the Latin "franchae curtes", i.e. "tax-free" monasteries. It was geographically delimited in 1429, when it was a territory of the Republic of Venezia.

Franciacorta viticultural history, as concern the production of sparkling wines with the Italian version of Champenoise method (*Franciacorta "metodo tradizionale"*), begun in 1960. Nowadays Franciacorta vineyards cover about 1.000 hectares and about 4 million bottles are produced. These wines has obtained recently the D.O.C.G. appellation, the highest level of the Italian classification of wines.

The "zoning" of Franciacorta appellation of origin territory was financially supported by the *Consorzio Tutela Vini Franciacorta*. Different landscape units, homogeneous zones as concern pedological, mesoclimate and land morphology traits (Bogoni *et al.*, 1995), and some widely spread soil types were identified in Franciacorta area in 1992, at the beginning of a zoning work based on the study of "genotype x environment interactions" (Panont *et al.*, 1994). Sensory evaluation of wines and statistical analyses of data are still in progress. Preliminary results are summarised in this paper.

## MATERIALS AND METHODS

**Pedological survey** was carried on in 1992-1993 period. Six main landscape units, i.e. homogeneous environments for soil, land morphology and mesoclimate characteristics were identified and reported on a 1:25.000 map (fig. 1) :

(1) "Morenico recente", of morenic origin, it could be divided in two sub-units, "Morenico" and "Cresta morenica" ; (2) "Ondulazioni esterne" ; (3) "Colluvi and Monte Orfano" ; (4) "Fluvioglaciale", or "Piana esterna" ; (5) "Cordoni e piane di ritiro", or "Piana interna" ; (6) "Colline calcaree".

**Experimental design.** In all "cultivar (*Chardonnay*, *Pinot blanc* and *Pinot noir*) x landscape unit" combinations, experimental plots (replicated groups of ten vines) were chosen in homogeneous vineyards (most of them were trained to Casarsa, an hanging canes trellis system, with about 2500-3000 vines/hectare). *Pinot noir* vineyards were distributed only in 3 landscape units (1, 4 and 5). The total number of vineyards surveyed was 60.

**Nutritional status** of vines (N, P, K, Ca, Mg, B, Cu, Zn, Mn, Fe, S) at veraison and harvest was surveyed with leaf analysis in 1992, 1993 and 1994 (Bogoni *et al.*, 1995).

**Grape maturation** was studied by weekly samples of 200 berries from veraison to vintage in the 1992-1994 period. At harvest, vineyard productivity (vine yield, clusters number/vine, bud fruitfulness, cluster

weight) and must composition traits (soluble sugars, titratable acidity as g/l of tartaric acid, pH, malic and tartaric acids) were measured. From vineyards representative of landscape unit variation, 60 kilograms of grapes were used to prepare wines according to a standardised scheme.

**Wines.** Wines were bottled 6 months after vintage. Chemical analysis of wines were performed according to European Union official methods, to assess their suitability for sensory tests.

**Sensory analyses.** Sensory analyses were performed partially by a trained panel of 15 judges in our Institute. At first, wines were evaluated in discriminant tests (triangular and preference tests, according to Sauvageot, 1980) to estimate the existence of significant differences among wines from different units. In 1992, at bottling and 4 months later, Chardonnay, Pinot b. and Pinot n. wines were tasted to identify descriptive terms according to a standard reference list (Noble *et al.*, 1987). In a third session, upon discussion of the wines, a consensus was reached on a final set of 12 aroma, 10 flavour by mouth terms and 2 colour attributes, reported in a sensory card as a structured scales (Sauvageot, 1980).

**Data analysis.** All statistical analyses were performed using Statistical Analysis System (SAS). Sensory data were previously standardised by taster (mean=0, std=1) and mean ratings of the 22 aroma and taste attributes were analysed by principal component analysis (PCA).

## RESULTS

**Vine performances in the different units.** In general, the effects of the six presumed "terroirs" (landscape units) on leaf nutritional status of *Chardonnay*, *Pinot blanc* and *Pinot noir* vines at veraison and harvest in the 1992-1994 period were extremely low, in particular on leaf N (tab.1).

**Table 1.** Landscape unit effect on nutritional status at veraison and harvest. Means of the three cultivars in the 1992-1994 period. Values within columns and period with the same letter are not significantly different (P=0.05).

Landscape Unit	P	K	Ca	Mg	Fe	Mn	B
	%	%	%	%	µg/g	µg/g	µg/g
<b>Veraison</b>							
<i>Morenico recente</i>	0.17 b	1.00 ab	3.49 b	0.39 b	165 c	144 bc	27 b
<i>Ondulazioni esterne</i>	0.17 b	1.20 a	3.53 b	0.38 bc	169 c	197 bc	27 b
<i>Colluvi</i>	0.52 a	1.07 ab	4.65 a	0.58 a	331 a	289 a	37 a
<i>Fluvioglaciale</i>	0.19 b	1.10 ab	3.40 b	0.34 c	206 bc	191 bc	32 ab
<i>Cord. e piane di ritiro</i>	0.15 b	0.75 b	3.63 b	0.36 bc	240 abc	116 c	33 ab
<i>Colline calcaree</i>	0.17 b	1.13 ab	3.02 b	0.45 b	207 bc	222 ab	33 ab
<b>Harvest</b>							
<i>Morenico recente</i>	0.20 a	1.05 ab	3.67 ab	0.40 abc	178 b	129 ed	22 ab
<i>Ondulazioni esterne</i>	0.16 a	1.10 a	3.58 b	0.38 bc	194 b	235 ab	21 b
<i>Colluvi</i>	0.20 a	1.06 ab	4.18 a	0.51 a	220 ab	163 cd	26 ab
<i>Fluvioglaciale</i>	0.21 a	1.08 a	3.60 b	0.33 c	183 b	196 bc	26 ab
<i>Cord. e piane di ritiro</i>	0.15 a	0.69 b	4.25 a	0.37 bc	182 b	102 e	27 a
<i>Colline calcaree</i>	0.17 a	0.88 ab	3.36 b	0.47 ab	175 b	243 a	27 a

Grape maturation processes showed large variation in the different units, especially as concern sugar accumulation, titratable acidity and must pH (not reported data). Differences among units were consistent all along the first part of maturation, later they were not significantly different. In particular "Colline calcaree" and "Piana esterna" showed a delay in the beginning of the maturation process. A peculiar ripening evolution was observed in "Colline and Monte Orfano" unit, where the highest precocity was found. In "Morenico" and "Piana esterna" sugar accumulation during ripening, after a quick increase at veraison, stopped up to the end of August.

Environmental conditions of the different landscape units did not affect significantly yield and cluster weight (tabl. 2, 3, 4). "Monte Orfano" *terroirs* promoted, while "Piana esterna" and "Piana interna" *terroirs* delayed maturation of Chardonnay and Pinot b. grapes in the the 1992-1994 period (tabl. 2, 3). Chardonnay and Pinot b. must composition at harvest obtained in "Morenico", "Ondulazioni esterne" and "Colline calcaree" units, were, in general, very similar.

**Table 2.** Effects of the six pedoclimatic environments (landscape units) on Chardonnay yield and must composition traits in the 1992-1994 period in Franciacorta. Values within rows with the same letter are not significantly different ( $P=0.05$ , Duncan's test).

Landscape unit	Vine yield (kg/vine)	Cluster weight (g)	Soluble sugars ( $^{\circ}$ Brix)	Titrat. acidity (g/l)	pH	Malic acid (g/l)	Tartaric acid (g/l)
Morenico recente	5.21 c	164 ab	17.2 b	7.52 abc	3.13 b	3.41 ab	4.97 ab
Ondulazioni esterne	5.60 bc	159 ab	17.3 b	7.15 c	3.25 a	3.28 bc	4.94 ab
Colluvi	6.80 bc	158 ab	18.2 a	6.63 d	3.27 a	2.96 c	4.50 c
Fluvioglaciale	7.86 a	163 ab	16.1 c	7.88 ab	3.12 bc	3.78 a	4.69 bc
Cord. e piane di ritiro	6.76 ab	192 a	15.8 c	8.05 a	3.04 c	3.57 ab	5.35 a
Colline calcaree	5.09 c	146 b	17.2 b	7.43 bc	3.10 bc	3.30 bc	5.19 a
Mean	5.86	162	17.1	7.40	3.16	3.38	4.93

**Table 3.** Effects of five different pedoclimatic environments (landscape units) on Pinot b. yield and must composition traits in the 1992-1994 period in Franciacorta. Values within rows with the same letter are not significantly different ( $P=0.05$ , Duncan's test).

Landscape unit	Vine yield (kg/vine)	Cluster weight (g)	Soluble sugars ( $^{\circ}$ Brix)	Titrat. acidity (g/l)	pH	Malic acid (g/l)	Tartaric acid (g/l)
Morenico recente	4.05 c	151 b	17.5 a	6.64 ab	3.28 a	3.01 a	4.85 ab
Ondulazioni esterne	5.42 c	180 ab	17.1 ab	6.48 b	3.05 b	2.97 a	4.75 ab
Colluvi	5.42 c	129 b	17.5 a	5.32 c	3.37 a	2.56 b	3.71 c
Fluvioglaciale	9.43 a	260 a	16.1 b	7.09 ab	3.14 b	3.18 a	4.63 b
Colline calcaree	7.18 b	204 ab	15.8 b	7.24 a	3.13 b	3.03 a	5.20 a
Mean	5.70	189	16.9	6.58	3.17	2.98	4.75

**Table 4.** Effects of three pedoclimatic environments (landscape units) on Pinot n. yield and must composition traits in the 1992-1994 period in Franciacorta. Values within rows with the same letter are not significantly different ( $P=0.05$ , Duncan's test).

Landscape unit	Vine yield (kg/vine)	Cluster weight (g)	Soluble sugars ( $^{\circ}$ Brix)	Titrat. acidity (g/l)	pH	Malic acid (g/l)	Tartaric acid (g/l)
Morenico recente	3.19 b	142 a	14.8 b	7.69 a	3.01 c	3.33 a	4.60 ab
Fluvioglaciale	3.28 b	103 b	17.9 a	7.85 a	3.14 b	2.95 b	4.77 a
Cord. e piane di ritiro	5.39 a	107 b	17.7 a	5.41 b	3.31 a	2.93 b	4.21 b
Mean	3.54	131	15.8	7.37	3.08	3.21	4.57

Principal component analysis of yield and must composition data, showed a good separation of the six landscape units or environments, along the first two Principal Components (PCs), which accounted, for Chardonnay, for 57 % and 35 % of the variance, respectively (fig. 2). Chardonnay performances were separated along the first PC according to their productivity (yield/vine and cluster weight) and along the second according to must pH, titratable and malic acidity. In the plane formed by the first two Pcs (fig.2), "Morenico" and "Colline calcaree" units were clustered. Furthermore, "Ondulazioni esterne", "Colluvi and Monte Orfano" and "Piana Interna" showed no separation along the second PC.

**Sensory analyses of wines.** The correlation matrix generated from the mean ratings of each wine across the different aroma and flavour by mouth terms was analysed by Principal Component Analysis. The first six "significant" principal components (PC), accounted for 66 % of the variance, respectively. They synthetically represented groups of sensory attributes and were named consequently (PC1/wine body and alcohol ; PC2/salty ; PC3/vegetative, PC4/bitterness, PC5/spicy, PC6/aroma intensity). The six PCs were treated as new variables and

subjected to Analysis of Variance. Results for PC1 and PC6 obtained on Chardonnay vines from 1993 vintage are reported in Figure 3.

“Monte Orfano”, “Ondulazioni” and “Cresta Morenica” Chardonnay wines had the highest alcohol and body, while wines from “Morenico” and “Piana interna” had the lowest. This results may be partially related to must composition recorded in the same units (tabl. 2). “Morenico” and “Piana interna” wines, however, gained the highest values for PC6, as they had the highest aroma intensity.

## CONCLUSIONS

Grape maturation process, vine performances at harvest and sensory analysis of wines allowed a classification of the different pedoclimatic environments within Franciacorta territory. The adopted zoning methodology was suitable to identify zones for the production of high quality sparkling wines. Wines obtained in some landscape units resulted characterised, in the three years period, by peculiar sensory attributes, which could explain the different sensory ratings of commercial sparkling wines produced in the same sites. These units could be therefore regarded as *terroirs* within Franciacorta area.

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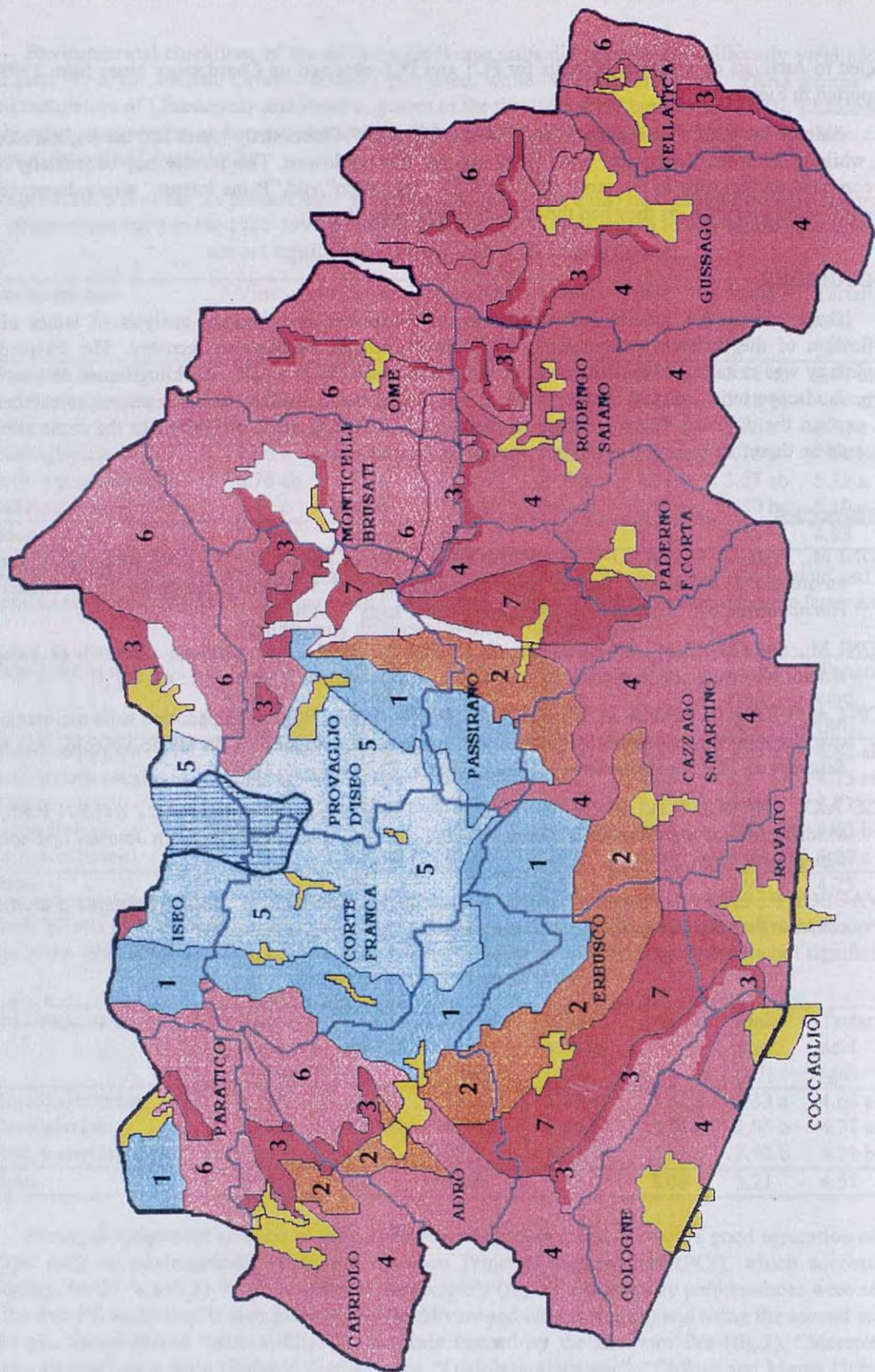
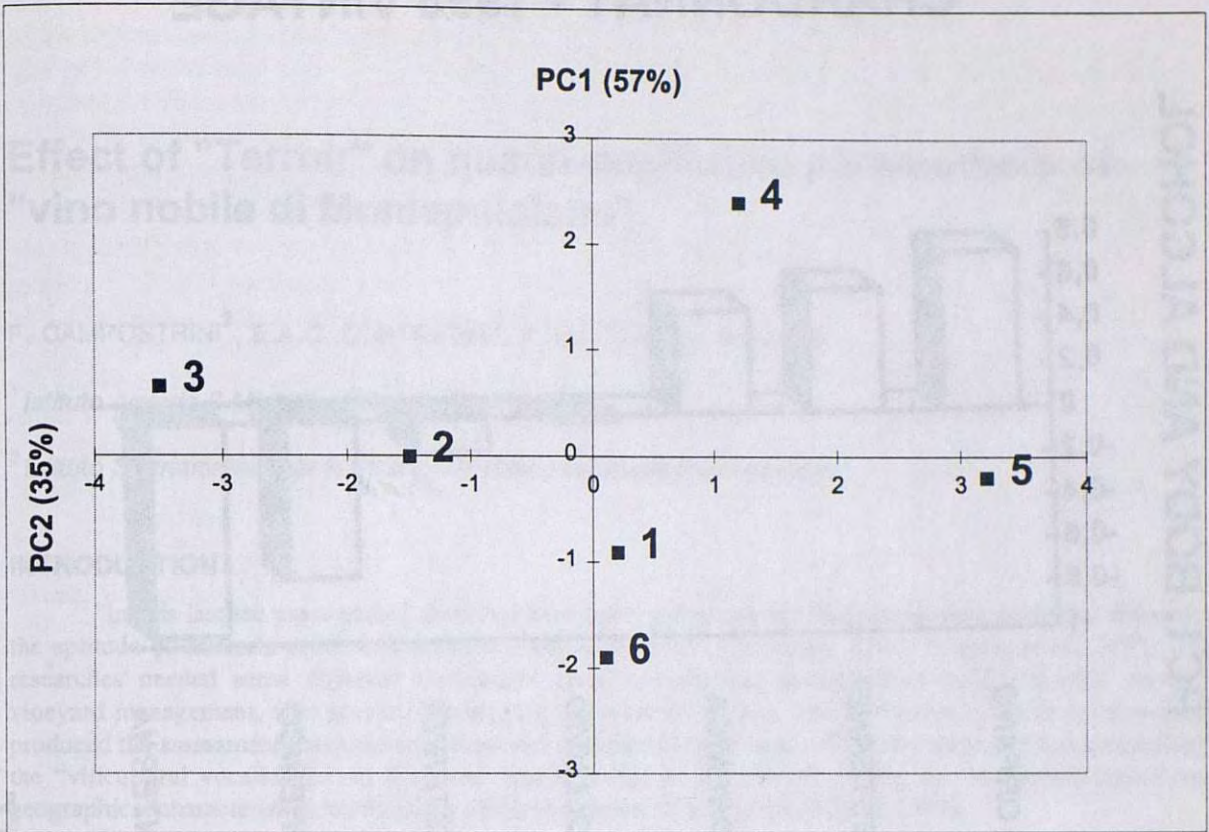


Figure 1. Landscape units distribution within Franciacorta D.O.C.G. territory (1 :25000).

(1) "*Morenico recente*" (which could be divided in two sub-units, "*Morenico*" and "*Cresta morenica*", i.e. the upper parts of hills), (2) "*Ondulazioni esterne*", (3) "*Colluvi and Monte Orfano*", (4) "*Fluvioglaciale orientale e occidentale*", or "*Piana esterna*", (5) "*Cordoni e piane di ritiro*", or "*Piana interna*", (6) "*Colline calcaree*"; (7) "*Morenico antico*".

In yellow : towns and villages sites.



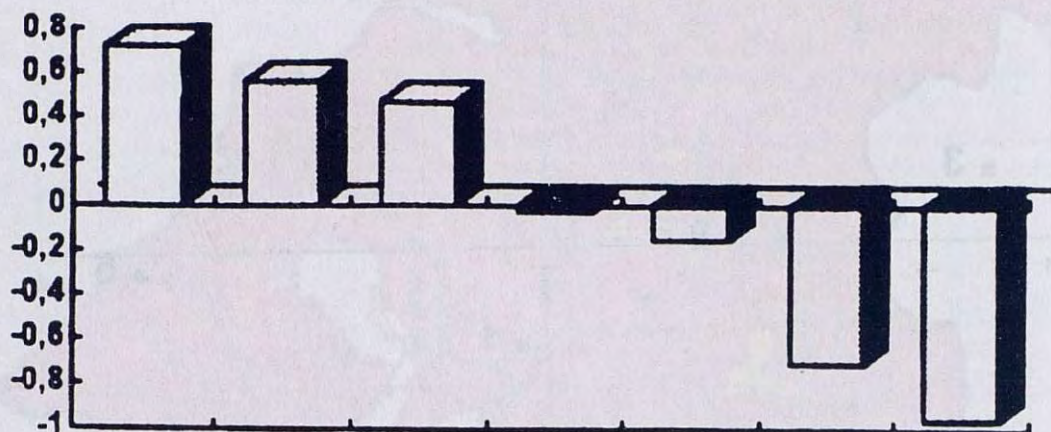
**Figure 2.** Principal component analysis of yield and must composition traits of Chardonnay in the 1992-1994 period in Franciacorta vineyards (PC1 : horizontal axis ; PC2 : vertical axis).

Chardonnay plots performances were separated along the first PC ( PC1, 57% of the variance) according to their productivity (yield/vine and cluster weight) and along the second PC (PC2, 35% of the variance) according to must pH, titratable and malic acidity.

Legend : (1) "*Morenico recente*", (2) "*Ondulazioni esterne*", (3) "*Colluvi and Monte Orfano*", (4) "*Piana esterna*", (5) "*Piana interna*", (6) "*Colline calcaree*".

# CHARDONNAY - 1993 VINTAGE

PC1: BODY AND ALCOHOL



UNIT

PC6: AROMA INTENSITY

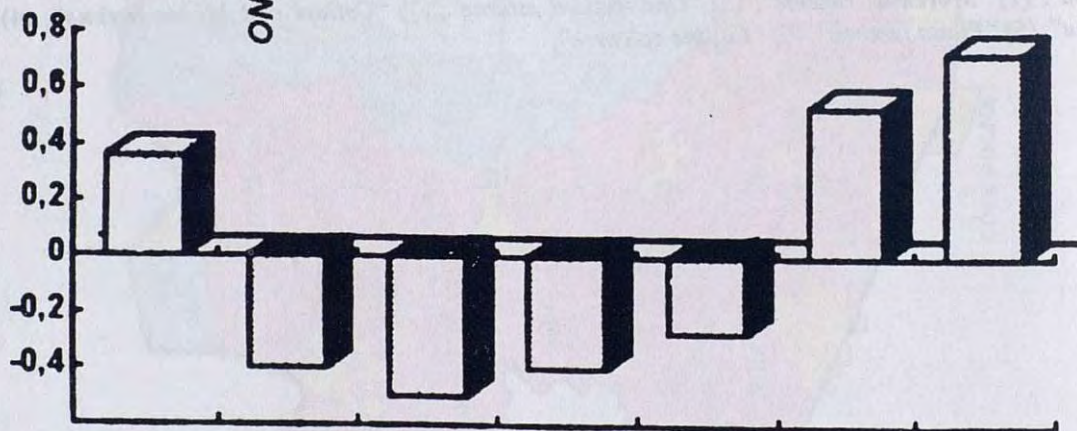


Figure 3. Values of the first (PC1) and sixth (PC6) principal components of the sensory data for Chardonnay wines (1994) obtained from the different landscape units.