PRIMARY RESULTS ON THE CHARACTERISATION OF "TERROIR" IN THE CERTIFIED DENOMINATION OF ORIGIN RIOJA (SPAIN)

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SUMMARY

The integration of variables concerning the climate, lithology, morphology of the relief and the soils in the Denomination of Origin (D.O.) Ca Rioja permits for the configuration of a model from which the demarcation of viticultural regions are obtained after validation.

By means of statistical analysis (automatic classification, AFD, ACP...), redundant climatic variables are eliminated, which permits for the construction of a model with only two variables (ET0 and the Index of Costantinescu) that can explain 88% of the variation. From this analysis, a map with six viticultural climate zones was formed (Fig. 1). The lithology is valued by means of Iithological groupings, whose mapping shows nineteen subzones where land is dedicated to viticulture (Fig.4). The variables concerning the morphology of the relief and the soils were appraised by means of the Soil Series concept (Fig. 7). Treatment of this information with a Geographic Information System (GIS) provides results on the quantification of the contents and the possibility of statistical analysis. The result is a model with cartographic properties, whose units are evaluated from a viticultural point of view by a parametric system, applied the principal taxonomic unit and adapted to particular ecological conditions in the vineyard. Five classes were the result (Figure 10). Validation of the results by comparison with cartographic units described previously was realised through variables related to the distribution or land area and overall vineyard productivity or varietal productivity (Table 4).

RESUMEN

La integraciòn de variables referentes al clima, la litologia y la morfologia del relieve y el suelo en la D.O. Ca Rioja permite la configuraciòn de un modelo a trave's de cuya validaciòn se obtiene la delimitaciòn de zonas viticolas. A través del anàlisis estadistico (Clasificaciòn Automàtica, AFD, ACP,...) se eliminan las variables del clima que aportan informacion redundante, lo que permite la constituciòn de un modelo que con dos ùnicas variables (ET0 e Indice de Costantinescu) explica el 88 % de la varianza y partir de el que se configura una cartografia en seis zonas climàticas viticolas (Fig.1).

La litologia es valorada a través de agrupaciones litològicas cuya cartografia da lugar a diecinueve subzonas con vocacion viticola diferenciada (Fig 4). Las variables referentes a la morfologia del relieve y el suelo son valoradas a través del concepto de Serie de Suelos (Fig 7). El tratamiento de la informaciòn por un Sistema de Informaciòn Geogràfica (GIS) da como resultado la cuantificaciòn de los contenidos y la posibilidad de su tratamiento estadistico. El resultado es un modelo con resultado cartogràfico cuyas unidades son evaluadas desde el punto de vista viticola por un sistema paramétrico aplicado a la unidad taxonomica principal y adaptado a las condiciones ecològicas particulares de la vina que da como resultado cinco clases (Fig 10). La validacion de los resultados mediante su comparaciòn con las unidades cartogràficas anteriormente deflnidas se realiza a través de variables relacionadas con la distribucion superficial y el rendimiento en conjunto y por variedades. (Tabla 4).

1. INTRODUCTION

The demarcation and characterisation of viticulture zones in Spain is burdened with certain difficulties not only from the peculiar characteristics of the terrain, but from the size, distribution and the fraction of land dedicated to viticulture in the Denomination of Origins as well.

"Terroir", viticultural aptitude, and zoning are the three concepts on which the results presented here are grounded. The *"Terroir"* conditions the peculiarities of the wines and its mapping and geographic characterisation represents an important advance in the search for wine quality and style, above all due to its value in the synthesis and simplification of the study of the environmental factors. The term *viticultural aptitude* is used to integrate information on climate, soils, topography and cultural practices with the vegetative, reproductive and qualitative expression of the vineyard. The term *zoning* may be associated with subdivision (classification, in reality) of a territory based upon the eco-pedological and topographical characteristics (Fregoni, 1992).

In this study the results of a Viticulture Zoning of the Certified Denomination of Origin[1] are included. These results were obtained on a scale of 1:50,000 by geographical and analytical identification.of homogeneous units in which *viticultural aptitute* is expressed as a function of climate, the litho-morphology and the soil. The objective was to characterise the environmental units and. their influence on the distribution and productivity of various grapevine varieties.

The methodology was based upon an analysis of the area which included the integration of variables regarding climate, vegetation, topography, lithology, morphology of the land relief and soils, and vineyard distribution and productivity. The actual methods have been described previously in Gòmez *et al.* (1993) and Sotés *et al.* (1996). The final result was a map, whose cartographic units (SMU) synthesise the relation between Lithological Unity, Geoform, and Soil Series. The treatment of the information generated from the layers treated by the Geographical Information System (GIS) gives. as a result the quantification of the contents and the possibility for statistical analysis.

2. CLIMATE

In the study of the climate, the entirety of the quantifiable variables on temperature and pre-

[1] El trabajo ha sido confinanciado por el Instituto Nacional de Denorninaciones de Origen (INDO) y el Consejo Regulador de la D.O. Calificada Rioja

Table 3. Classes defined by principal Soil Taxonomy Unit (STU).

C	STU		PROD kg/ha	SUPERFICIE DE VARIEDADES DE VID (ha)							SUPERF. CLASES DE REGIONES VITÍCOLAS (ha)					
	STU	DESCRIP. (USDA,1994)		V1	V2	V3	V8	V9	V11	TOTAL	C1	C2	C3	C4	C5	TOTAL
1	R01	Xerochrept calcixeróllico	2411	3527.0	6555.1	55.3	14.1	1591.6	29.4	11772.5	26880.1	13659.3	19842.6	2132.7	1177.5	63692.2
2	R02	Xerochrept calcixeróllico	3192	63.8	543.5	18.3	2.7	55.2	0.0	683.5	1064.3	365.5	44.8	381.2	22.2	1878.0
3	R03	Xerochrept calcixeróllico	2338	2259.5	3151.7	22.5	4.9	626.7	7.3	6072.6	3576.1	15437.4	3916.0	2868.4	3884.3	29682.2
4	R04	Xerochrept calcixeróllico	3282	281.3	543.8	0.4	7.4	104.7	0.2	937.8	0.0	2426.1	2493.0	210.6	331.4	5.461.1
5	R05	Xerochrept petrocálcico	519	5.4	13.5	0.0	0.0	37.5	0.0	56.4	0.0	0.0	287.3	0.0	11.0	298.3
6	R09	Haploxeralf cálcico	1600	11.1	55.3	0.0	0.0	7.7	0.5	74.6	321.8	860.7	68.0	0.0	6.7	1257.2
7	R14	Palexeralf petrocálcico	1180	163.6	313.7	0.7	0.0	60.9	0.0	538.9	0.0	1624.1	2839.3	8.0	324.9	4796.3
8	R15	Xerochrept calcixeróllico	3441	911.7	10629.2	77.9	57.7	1744.2	8.1	13427.8	23928.8	9145.9	384.1	430.4	6084.9	39974.1
9	R18	Haploxeralf cálcico	2388	25.5	31.0	0.0	0.0	0.7	0.0	57.2	23.4	160.0	545.1	21.8	21.1	771.4
10	R19	Xerochrept calcixeróllico	2704	2505.1	3010.6	5.8	21.0	1700.3	14.5	7257.3	9922.8	14001.9	3963.0	3608.2	3824.4	35320.3
11	R20	Xerorthent típico	2702	248.9	266.3	2.5	1.1	231.8	0.1	750.7	5.6	941.4	2292.0	1131.5	748.5	5119.0
12	R21	Xerochrept calcixeróllico	1262	3.6	38.9	0.0	0.0	18.0	0.0	60.5	0.0	0.0	0.0	3642.3	480.0	4122.3
13	R23	Xerochrept calcixeróllico	1688	10.1	77.9	0.1	0.0	17.9	0.0	106.0	0.0	0.0	83.5	2427.9	219.3	2730.7
14	R24	Xerochrept calcixeróllico	2699	670.5	477.0	12.1	2.5	230.7	0.6	1393.4	0.0	0.0	7538.1	2752.5	657.5	10948.1
15	XnLFN	Xerorthent lítico /Litol.N	898	38.2	35.1	4.5	0.0	2.5	0.0	80.3	0.0	0.0	46.6	1817.7	1593.4	3457.7
16	XnTL	Xerorthent típico/Litl. L	15.3	531.6	384.8	43.3	0.1	75.5	0.3	1035.6	0.0	2529.6	2973.4	2661.5	2874.1	11038.6
17	XpCFW	X. calcixeróllico/Litol FW	27.9	480.6	2037.9	30.1	7.7	307.0	0.9	2864.2	2072.6	3477.9	3406.4	3115.8	2007.5	14080.2
18	XpTF	Xerochrept típico/Litol. F	10.5	20.5	59.2	1.9	0.1	12.9	0.6	95.2	0.0	0.0	0.0	1675.2	523.8	2199.0
19	PaTÑ	Palexeralf típico/Litol. Ñ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.7	0.0	0.0	133.8	159.5
20	AM	Areas Misceláneas	-	425.8	1754.1	18.6	20.6	355.0	13.6	2588.8	0.0	0.0	0.0	0.0	105057.8	105057.8
TOTALES			-	12183.8	29978.6	294.0	139.9	7180.8	76.1	49853.2	67795.5	64655.5	50723.2	28885.7	129984.1	342044.0

Table 1. Classes defined by Reference Evapotranspiration (ETo) y the Index of Constantinescu (IC)

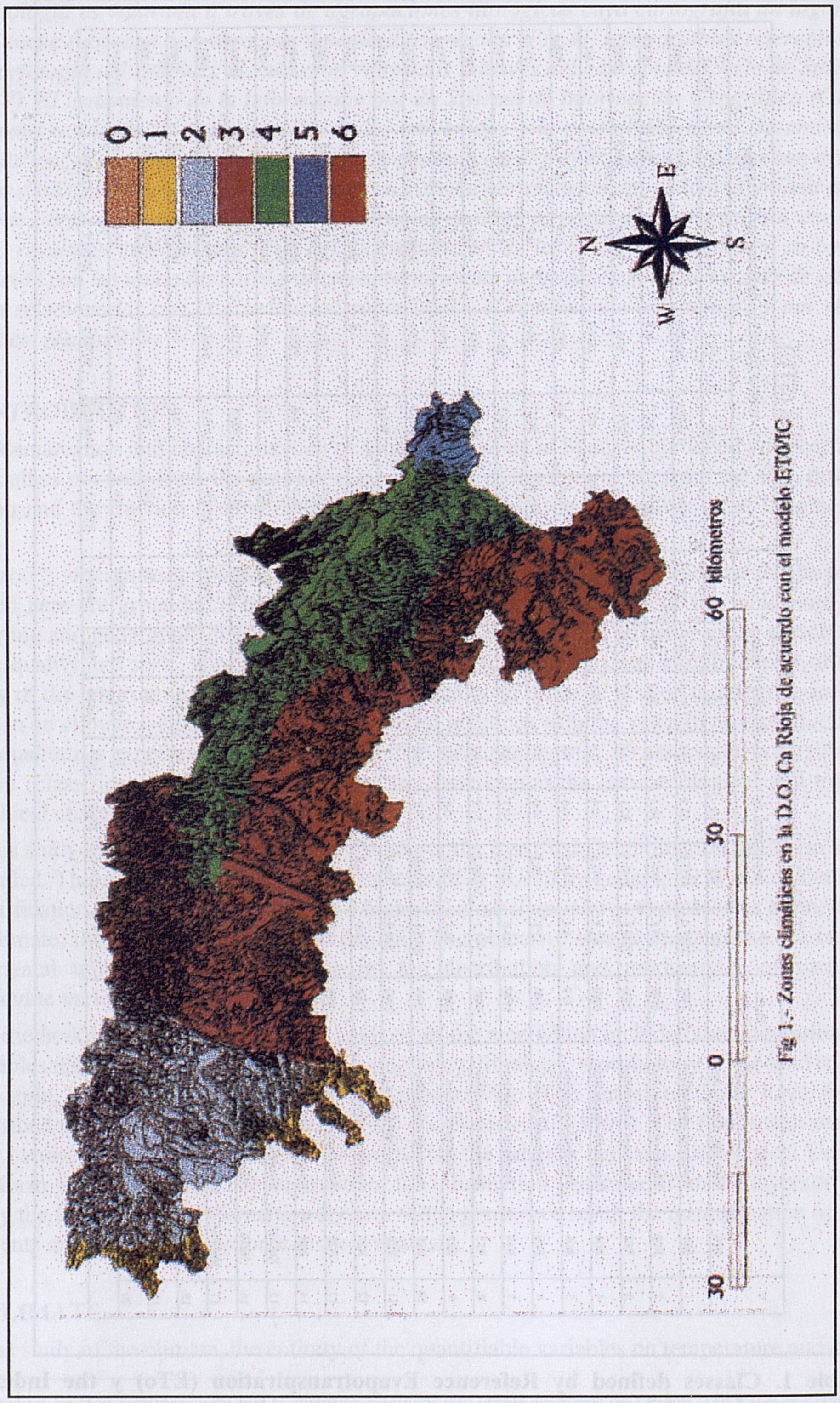

Fig. 1 - Zonas climàticas en la D.O. Ca Rioja de acuerdo con el modelo ET0/IC

cipitation from the meteorological stations in the region were analysed.

The statistical analysis (Automatic Classification, Principal Component Aaalysis, Discriminate Factorial Analysis...) allowed us to eliminate the variables which provided redundant information as well as to construct a model which included the greatest amount of information in the least number of variables. To be more precise, the characterisation of the macroclimate is adequately.described (88% of the variability) by the crop evapotranspiration (ETV) (Riou *et al*., 1994, in Becker *et al*, 1994) and the index of Constantinescu (IC).

The geographic definition.of the climatic zones in the D.O. Ca Rioja was able to be done by contrasting this cartographic information with the validation variables by means of a map generated with surface elements (area) as a unit of information and plotted by interpolation with topographical correction and with the use of the intervals defined in the analysis (Table 1., Figure 1).

It is necessary to make some clarifications. Not all of the units are adequately represented with the existing meteorological station, and therefore the result should be taken into account. The Rioja Baja 15 represented fundamentally by classes 1 and 2, which are very different climatically. The Rioja Alta and the fringe of the least energetic relief in the Rioja Baja are defined by class 3, and more gradually towards the Rioja Baja by class 4, and.finally, in areas with scarce water resources, by class 5. Class 6 represents the Southern Sierra, with a very low thermic regime and elevated water resources.

Similarly, the climate is only limiting near the high altitude zones in the north and south, although we consider that the climate leaves an impression of quality in one zone or another. From the results on the general distribution of viticulture areas, the following observations can be made: a marginal situation exists in zones 1, 5, and 6; a favourable situation exists in zones 2, 3, and 4(Figure 2).

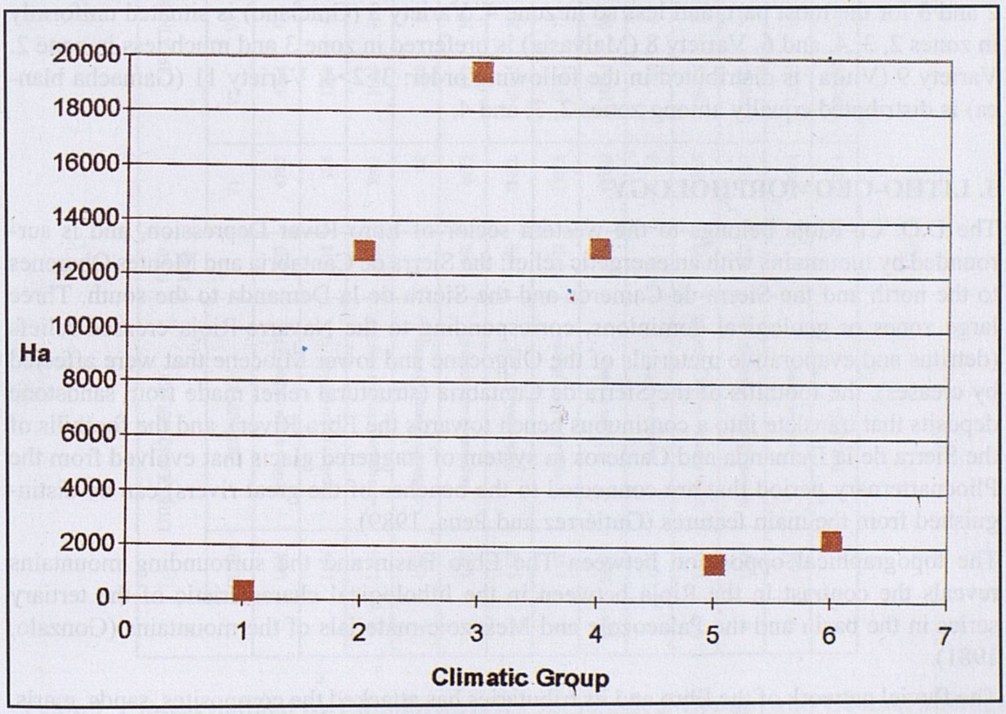

Fig. 2 - Relationship between climatic subzones and vineyard surface area

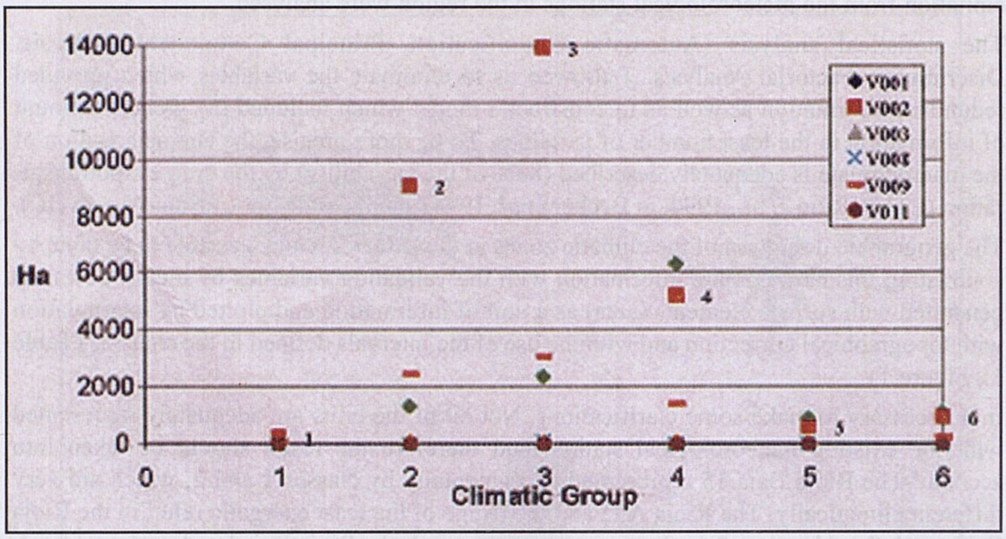

Fig. 3 - Relationship between climatic subzones and vineyard surface area by variety: Garnacha (V001), Tempranillo (V002), Graciano (V003), Malvasia (V008), Macabeu, Viura (V009) y Garnacha blanca (V011)

The zones can be divided into three classes according to vineyard productivity: 1.> 2000 kg/ha (zones 2 and 3), 2.<2000 kg/ha (zone 4), 3. close to 1000 kg/ha (zones 1, 5, and 6).

Similarly, the distribution by varieties shows that variety 1 (Garnacha) is preferentially situated in zone 4, and less so in zones 2, 3, and 6. Variety 2 (Tempranillo) is situated in zones 2 and 3 for the most part, and less so in zone 4. Variety 3 (Graciano) is situated uniformly in zones 2, 3, 4, and 6. Variety 8 (Malvasia) is preferred in zone 3 and much less in zone 2. Variety 9 (Viura) is distributed in the following order: 3>2>4. Variety 11 (Gamacha blanca) is distributed equally among zones 2, 3, and 4.

3. LITHO-GEOMORPHOLOGY

The D.O. Ca Rioja belongs to the western sector of Ebro River Depression, and is surrounded by mountains with an energetic relief: the Sierra de Cantabria and Montes Obarenes to the north and the Sierra de Cameros and the Sierra de la Demanda to the south. Three large zones or geological dominions, corresponding to the Navarre-Rioja creased reliefs (detritus and evaporative materials of the Oligocene and lower Miocene that were affected by creases), the foothills of the Sierra de Cantabria (structural relief made from sandstone deposits that translate into a continuous bench towards the Ebro River), and the foothills of the Sierra de la Demanda and Cameros (a system of staggered glacis that evolved from the Pliocuarternary period that are connected to the benches of the great rivers) can be distinguished from the main features (Gutiérrez and Pena, 1989).

The topographical opposition between The Ebro Basin and the surrounding mountains reveals the contrast in the Rioja between in the lithological characteristic of the tertiary series in the basin and the Palaeozoic and Mesozoic materials of the mountains (Gonzalo, 1981).

The fluvial network of the Ebro and its tributaries has attacked the composites, sands, marls, and tertiary gypsum. This process has shaped a relief of progressively deeper forms towards

Table 2. Classes defined by Lithologies (GL: Lithological Group) and Geomorphology (FIA)

C	LITHOGEOMORFOLOGY		YIELD kg/ha	AREA IN GRAPE VARIETIES (ha							AREA FOR EACH VITICULTURE CLASS REGION (ha)					
	GL/FIA	DESCRIPTIÓN		V1	V2	V3	V8	V9	V11	TOTAL	C1	C2	C3	C4	C5	TOTAL
1	L0/Y	Arcillas y margas yesíferas (C,Y)	2673	670.5	476.8	12.1	2.5	230.7	0.6	1393.2	0	0	7538.1	2794.5	682.9	11015.5
2	L1/V	Arcillas y margas con yesos (V)	1518	14.6	128.0	0.1	0.0	34.5	0.0	177.2	0	0	83.5	6644.9	768.7	7497.1
3	L2/N	Calizas y calizas dolomíticas duras (K,N)	1142	204.3	114.4	33.8	0.0	4.6	0.0	357.1	0	0	1732.6	2641.0	3642.8	8016.4
4	L3/L	Conglomerados silíceos (U) y arenas (L)	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	9.4	45.9	55.3
5	L4/Z	Conglomerados carbonatados (Z)	2946	167.3	85.1	10.1	0.0	10.6	0.2	273.3	0	42.8	1621.9	516.5	1053.0	3234.2
6	L5/T	Glacis y abanicos (T,G)	2300	2813.0	4011.5	21.7	12.4	907.1	7.8	7773.5	3576.2	21124.8	8941.1	3077.1	4640.0	41359.2
7	L6/F	Terrazas del río Ebro y afluentes	1939	2303.6	6719.5	77.6	12.4	1194.7	36.2	10344.0	26344.5	9181.5	18630.6	4764.2	1974.0	60894.8
8-14	L6+L?	F+ Laderas de enlace	2355	1755.9	3582.0	26.1	13.1	996.6	1.6	6375.3	3999.8	11532.1	6981.8	4377.7	1929.3	28820.7
15	L7/R	Rañizos y rañas (T7)	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	25.8	0	0	133.8	159.6
16-17	L8/X	Arenas, areniscas y arcillas arenosas (X)	2708	2552.7	3042.4	5.2	20.6	1728.1	14.0	9363.0	9946.2	14162.0	4882.7	3630.0	3984.0	36604.9
18	L9/W	Areniscas, limolitas y arcillas rojas (W)	3437	900.7	10478.0	76.6	58.1	1686.5	7.9	13207.8	23928.8	8586.5	310.9	430.4	6071.9	39328.5
19	AM	Areas Misceláneas	-	801.2	1340.9	30.7	20.8	387.4	7.8	2588.8	0	0	0	0	105057.8	105057.8
TOTALES				12183.8	29978.6	294.0	139.9	7180.8	76.1	49853.2	67795.5	64655.5	50723.2	28885.7	129984.1	342044.0

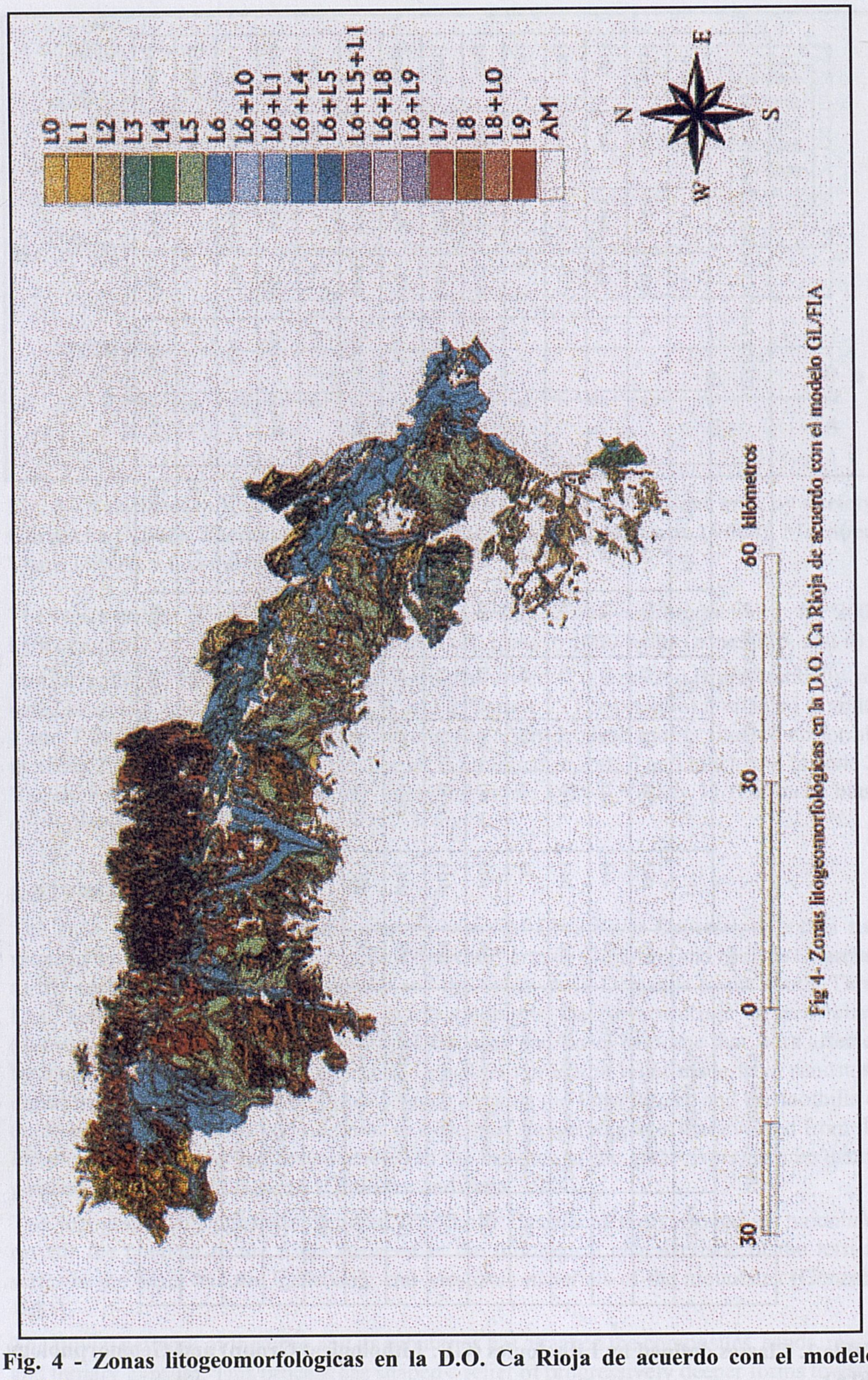

Fig. 4 - Zonas litogeomorfològicas en la D.O. Ca Rioja de acuerdo con el modelo GL/FIA

the river, with a difference in level that at times reaches as much as 1000 m between the valley floor (300-450 m altitude) and the tertiary series peaks (Serradero: 1491 m, Cabimonteros: 1388 m). The weak resistance of these materials to the erosion is evident in light of the fact that they are transformed, in the shape of.staggered levels, into successive sequences of fits (encajamiento) in the network. The erosion in the Cuarternary period is reflected in the dilated surfaces of glacis that occupy the major part of the Riojan basin and shapes its geomorphology.

In Table 2, the different lithologies have been grouped, which have also been used in the correlation with soils. The results of the general distribution of vineyards in litho-geomorphological groupings allows us to make the following groups (Figure 5): marginal situation in the zones LO, .L1, L2, .L3, L4, and L7; favourab1e situation. in the zones L6 (F), L5 (T), and L8 (X); optimum situation in zone L9 (W).

In function of vineyard productivity, the low productivity of lithologies L1, L2 and, above all, L3 and L7 stands out. The lithologies L6 (F) and, above all, L8 (X) and L9 (W) show high vineyard productivity, and the rest of the lithologies have intermediate lithologies. Likewise, by varieties: V1 is found in zones T > F > X; V2 is found in zone W, less so in zone F and even less in zone T << X; V3 is found.in zones F and W and less so in zone N; V8 is found in zone W and less so in F and T; V9 is found in zones X and V and to less extent in F and T; V11 is found in zone F and much less in zones T and W (Figure 6).

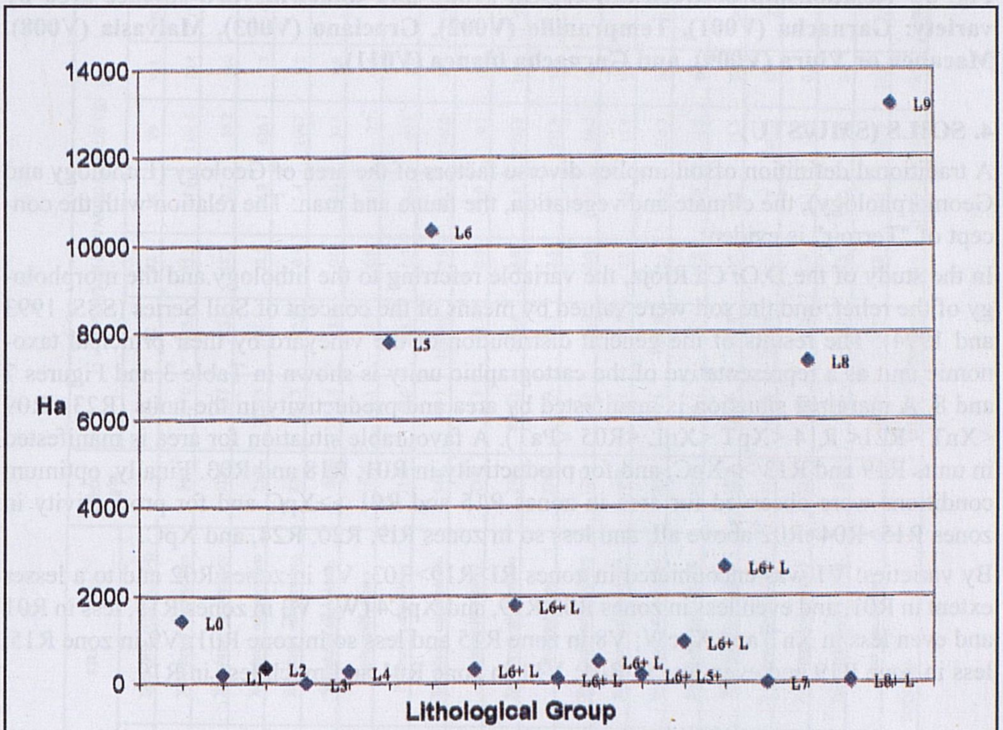

Fig. 5 - Relationship between lithological group and total vineyard surface area

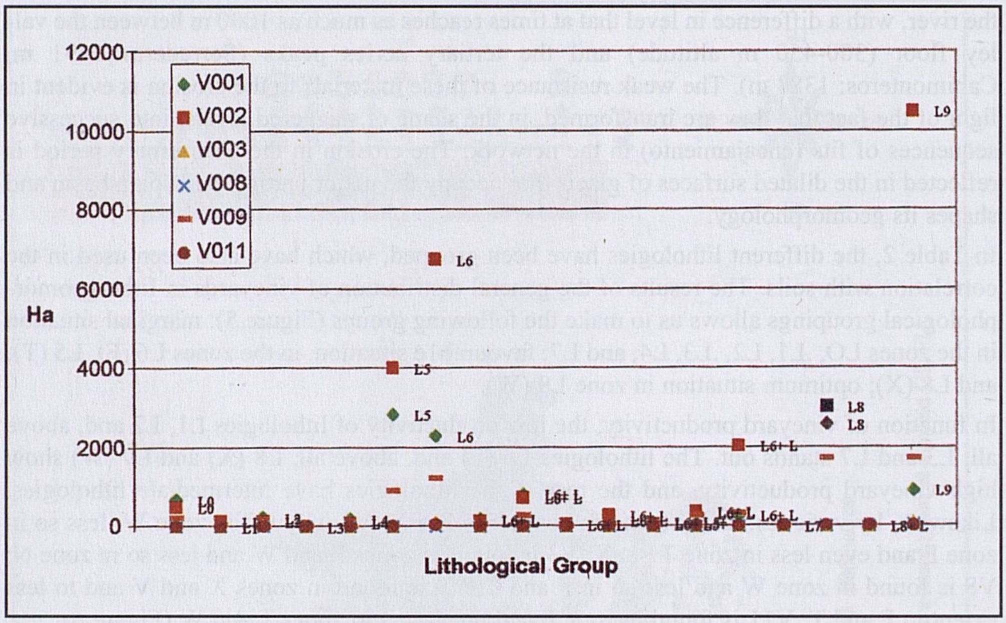

Fig. 6 - Relationship between lithological group and total vineyard surface area by variety: Garnacha (V001), Tempranillo (V002), Graciano (V003), Malvasia (V008), Macabeu or Viura (V009), and Garnacha blanca (V011).

4. SOILS (SMU/STU)

A traditional definition ofsoil implies diverse factors of the area of Geology (Lithology and Geomorphology), the climate and vegetation, the fauna and man. The relation with the concept of "Terroir" is evident.

In the study of the D.O. Ca.Rioja, the variable referring to the lithology.and the morphology of the relief, and the soil were valued by means of the concept of Soil Series (SSS, 1993 and 1994). The results of the general distribution of the vineyard by their principal taxonomic unit as a representative of the cartographic unity is shown in Table 3 and Figures 7 and 8. A marginal situation is manifested by area and productivity in the units (R23 <R09 <XnT <R21< R14 <XpT <XnL <R05 <PaT). A favourable situation for area is manifested in units R19 and R13 >>XpC, and for productivity in R01, R18 and R03. Finally, optimum conditions were observed for area in zones R15 and R01 >>XpC and for productivity in zones R15>R04>R02 above all, and less so in zones Rl9, R20, R24, and XpC.

By varieties: V1 was encountered in zones RI>R19>R03; V2 in zones R02 and to a lesser extent in R01, and even less in zones R03,R19, and.XpC4 (W); V3 in zones R15, less in R01 and even less in XnT and XpcW; V8 in zone R15 and less so in zone R01; V9 in zone R15, less in zone R19 and even less in R01; V11 in zone R01 and much less in R19.

5. ZONING MODEL AND DISCUSSION OF VALIDATION RESULTS

In the study of the D.O. Ca Rioja the selection of true variable of influence, their characterisation, treatment, and, especially, the form of integration was established.

A parametric system with a kind of tradition in viticulture was used for the evaluation (Budan and Popa, 1978; Astruc *et al.*, 1980; Merieux *et al.*, 1981; Morlat and Salette, 1977;

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6	R09	Haploxeralf cálcico	1600	11.1	55.3	0.0	0.0	7.7	0.5	74.6	321.8	860.7	68.0	0.0	6.7	1257.2
7	R14	Palexeralf petrocálcico	1180	163.6	313.7	0.7	0.0	60.9	0.0	538.9	0.0	1624.1	2839.3	8.0	324.9	4796.3
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9	R18	Haploxeralf cálcico	2388	25.5	31.0	0.0	0.0	0.7	0.0	57.2	23.4	160.0	545.1	21.8	21.1	771.4
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11	R20	Xerorthent típico	2702	248.9	266.3	2.5	1.1	231.8	0.1	750.7	5.6	941.4	2292.0	1131.5	748.5	5119.0
12	R21	Xerochrept calcixeróllico	1262	3.6	38.9	0.0	0.0	18.0	0.0	60.5	0.0	0.0	0.0	3642.3	480.0	4122.3
13	R23	Xerochrept calcixeróllico	1688	10.1	77.9	0.1	0.0	17.9	0.0	106.0	0.0	0.0	83.5	2427.9	219.3	2730.7
14	R24	Xerochrept calcixeróllico	2699	670.5	477.0	12.1	2.5	230.7	0.6	1393.4	0.0	0.0	7538.1	2752.5	657.5	10948.1
15	XnLFN	Xerorthent lítico /Litol.N	898	38.2	35.1	4.5	0.0	2.5	0.0	80.3	0.0	0.0	46.6	1817.7	1593.4	3457.7
16	XnTL	Xerorthent típico/Litl. L	15.3	531.6	384.8	43.3	0.1	75.5	0.3	1035.6	0.0	2529.6	2973.4	2661.5	2874.1	11038.6
17	XpCFW	X. calcixeróllico/Litol FW	27.9	480.6	2037.9	30.1	7.7	307.0	0.9	2864.2	2072.6	3477.9	3406.4	3115.8	2007.5	14080.2
18	XpTF	Xerochrept típico/Litol. F	10.5	20.5	59.2	1.9	0.1	12.9	0.6	95.2	0.0	0.0	0.0	1675.2	523.8	2199.0
19	PaTÑ	Palexeralf típico/Litol. Ñ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.7	0.0	0.0	133.8	159.5
20	AM	Areas Misceláneas	-	425.8	1754.1	18.6	20.6	355.0	13.6	2588.8	0.0	0.0	0.0	0.0	105057.8	105057.8
TOTALES			-	12183.8	29978.6	294.0	139.9	7180.8	76.1	49853.2	67795.5	64655.5	50723.2	28885.7	129984.1	342044.0

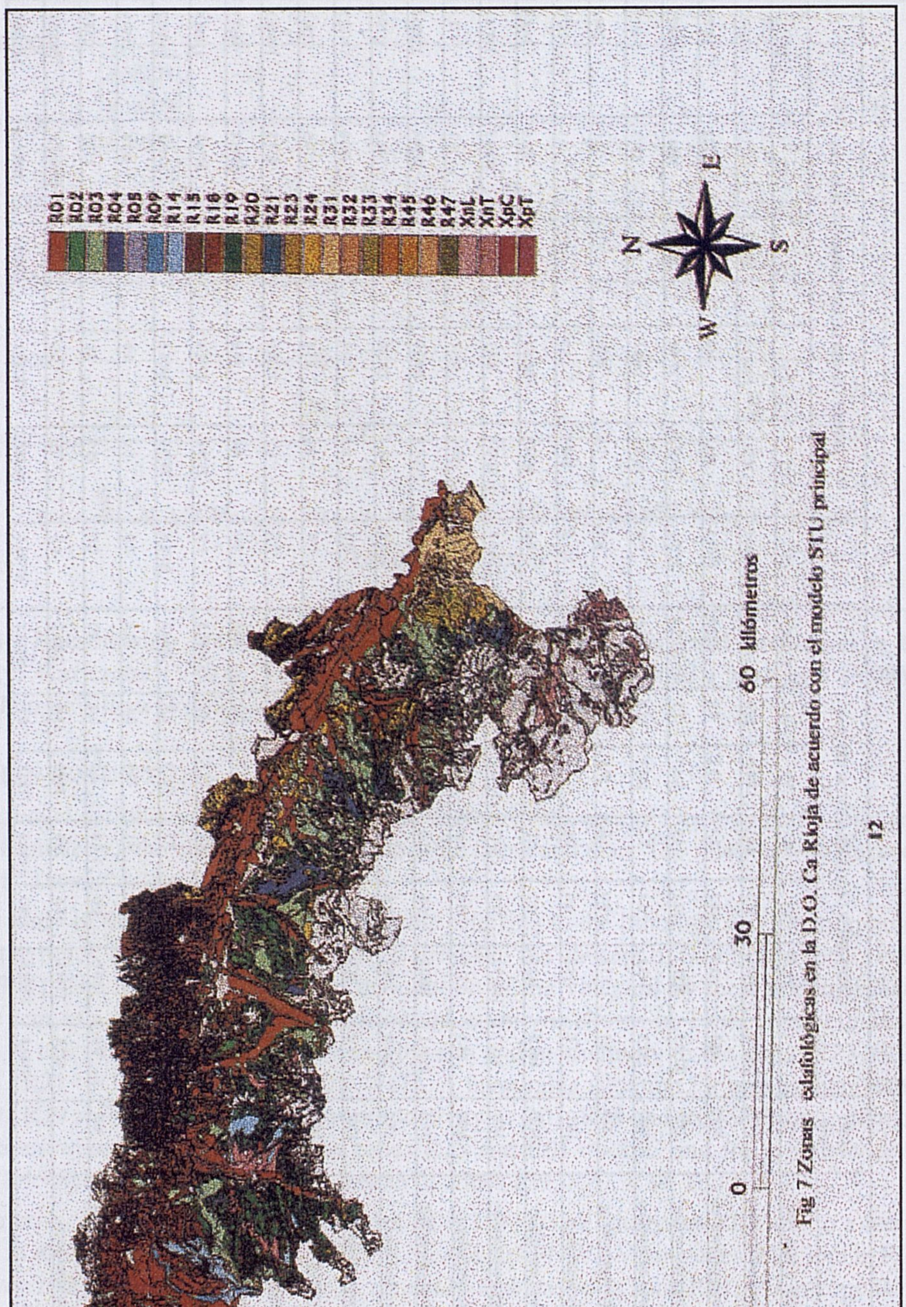

Fig. 7 - Zonas edafológicas en la D.O. Ca Rioja de acuerdo con el modelo STU principal

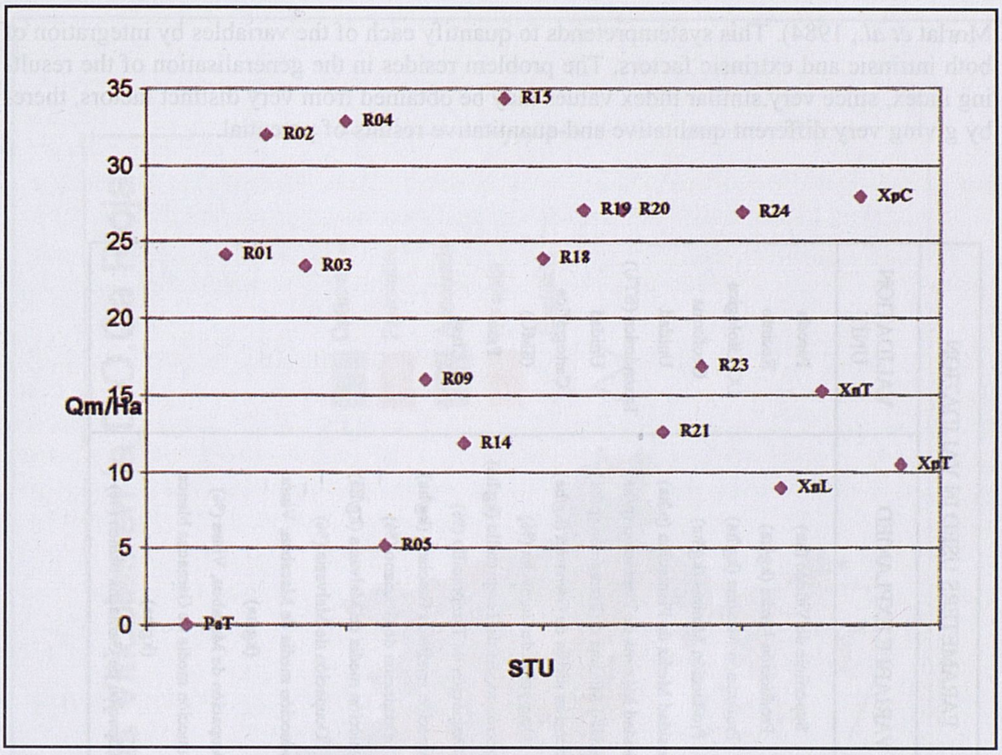

Fig. 8 - Relationship between Principal Soil Taxonomy Units and average vineyard productivity

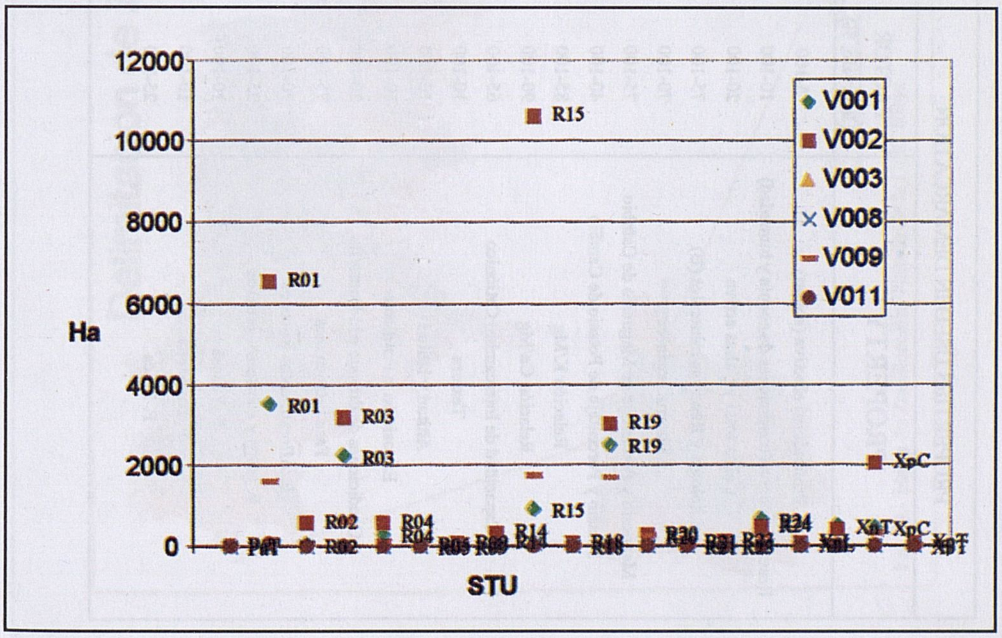

Fig. 9 - Relationship between Principal Soil Taxonomy Units and total vineyard surface area and by varieties: Garnacha (V001), Tempranillo (V002), Graciano (V003), Malvasia (008), Macabeu, Viura (V009) y Garnacha blanca (V011)

Morlat *et al.*, 1984). This systempretends to quantify each of the variables by integration of both intrinsic and extrinsic factors. The problem resides in the generalisation of the resulting index, since very.similar index values may be obtained from very distinct factors, thereby giving very different qualitative and quantitative results of potential.

PROPERTIES USED IN DEMARCATION		PARAMETERS USED IN VALIDATION	
PROPERTY	FACTOR (Intervalo, %)	VARIABLE EXPLANIED	VALIDATION UNIT
Profundidad efectiva (solum)	5-100	Superficie de Viñedo (ha)	Parcela
Reserva de agua (condiciones de sequía y humedad)	10-100	Producción Media (kg/ha)	Recinto
Caliza total y Caliza activa	20-100	Producción Máxima (kg/ha)	UC Litológica
Litología y Reservas minerales (B)	75-100	Producción Mínima (kg/ha)	Geoforma
Materia orgánica	70-100	Densidad Media de Plantación (p/ha)	Unidad
Magnesio y Porcentaje de Magnesio de Cambio	75-100	Densidad Máxima de Plantación (p/ha)	Taxonómica (STU)
Potasio y Porcentaje de Potasio de Cambio	40-100	Densidad Mínima de Plantación (p/ha)	Unidad
Relación K/Mg	85-100	Producción media de Garnacha (kg/ha)	Cartográfica
Relación Ca/Mg	90-100	Ocupación de Garnacha (%)	(SMU)
Capacidad de Intercambio Catiónico	65-100	Producción media de Tempranillo (kg/ha)	Fase
Textura	10-100	Ocupación de Tempranillo (%)	Clase
Altitud y latitud	10-100	Producción media de Graciano (kg/ha)	
Exposición y Pendiente	10-100	Ocupación de Graciano (%)	
Condiciones de drenaje e hidromorfía	20-100	Producción media de Malvasia (kg/ha)	
Fase Petrocálcica	75-100	Ocupación de Malvasia (%)	
F. Afloramientos Rocosos	70-100	Producción media de Macabeu, Viura	
F. grava y elementos gruesos	95-100	(kg/ha)	
F. Yesosa	10-100	Ocupación de Macabeu, Viura (%)	
F. Disectada	10-100	Producción media de Garnacha blanca	
F. Lítica	25-100	(kg/ha)	
		Ocupación de Garnacha blanca (%)	

Table 4. Elements Employed for Demarcation and Validation

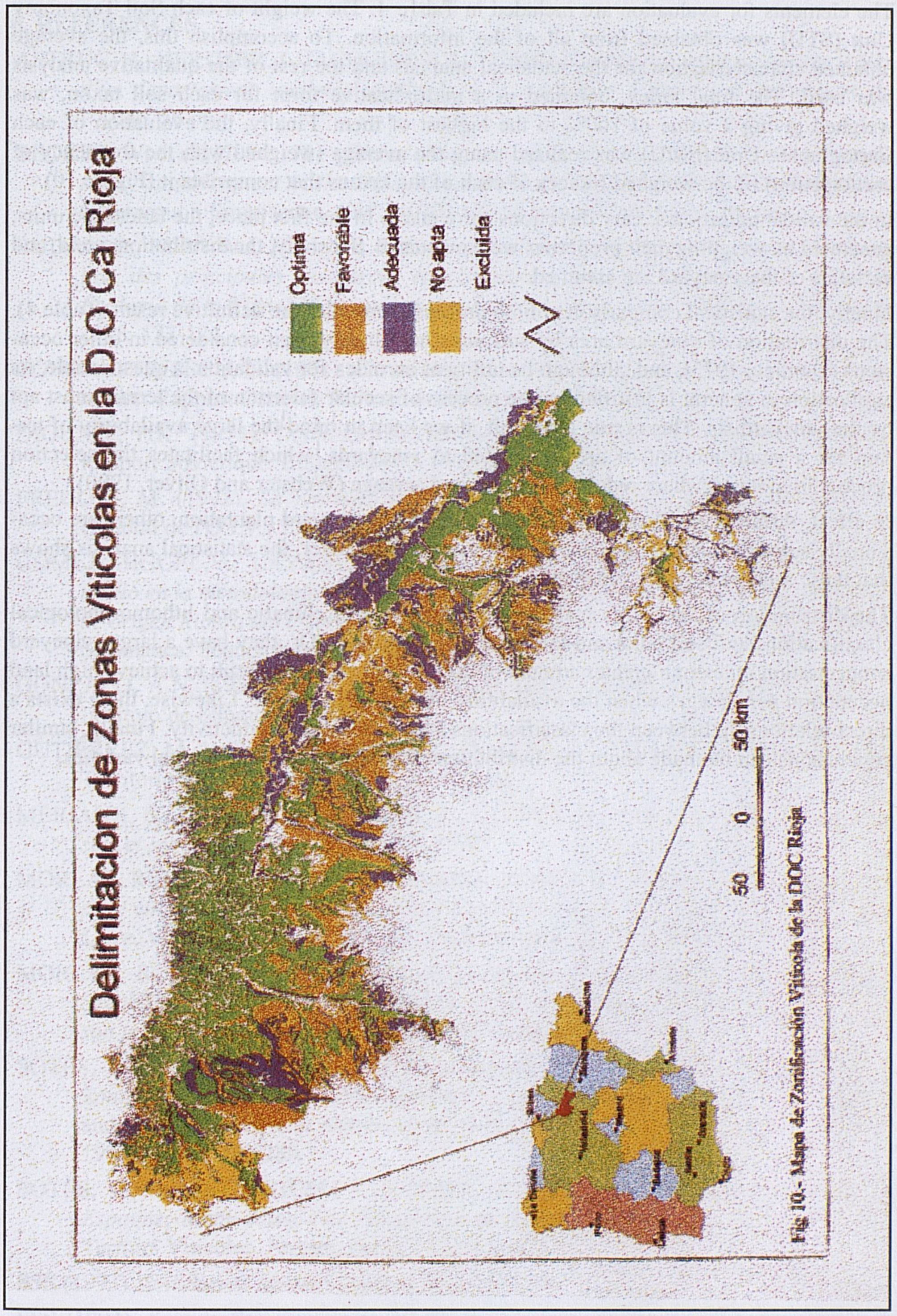

Fig. 10 - Mapa de Zonificación Viticola de la DOC Rioja

The elements for evaluation are included in Tab1e 4. The weight of each Soil Taxonomy Unit (STU) was obtained from all of the information. To accomplish this, the average obtained characterisation for the statistical analysis and the rest of the qualitative analysis was used. The final index, obtained in a multiplicative form for each soil taxon, was weighed giving a value of 100% to the highest of them. Finally, the evaluation of each Cartographic Unit (SMU) was realised using the average (weighed with the frequency of participation) of the weighed Indices of each of the taxons that comprises it (Figure 10).

In the validation process, vary directions were taken. In the first place, the landscape units, generated by weighing their properties were evaluated. Secondly, the distribution, yield, and varieties of the vineyard are assumed.

Finally, the statistical comparison.of both processes provides the definitive result (Table 4). The distribution of vineyard area by soil units has already been considered in other occasions (Dioujev, 1973), and, although its utility as an index for validation is questionable, its application in general is justified by the process of secular selection of the terrain most apt by the vineyardists. This is true above all, if we keep in mind the large availabitity of terrain for a small amount of area dedicated to vineyards, which facilitates the selection process in moment where reduction in vineyard acreage (Webster and Oliver, 1990).

In effect, different Soil Series are clearly selected for vineyard plantation, others are occasionally selected, while others are clearly rejected. Moreover, the statistical analysis shows that these relationships are independent of available area.

The distribution of vineyards maintains a harmony with climatic and lithomorphological classifications and soil units and the best-classified zones. Or, they have a larger vineyard concentration index or a greater amount of hectares, since it is difficult to achieve high land occupation percentages when the availability of land is very large. Likewise, there exists a direct relationship between the classifications and the average productivity. Finally, similar conclusions can be made about the distribution of land area for the principal varieties.

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