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SUSTAINOLIVE

Methods for monitoring and evaluating adaptation of STSs

Deliverable D 2.4

WP2. Synopsis of olive grove farming models, including conceptual approaches, methods and STSs identification

Novel approaches to promote the SUSTAInability of OLIVE cultivation in the Mediterranean

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v7	12-05-2021	Draft	José Liétor	Design of conceptual framework for methods and statistics in SUSTAINOLIVE
v8	18-05-2021	Draft	José Liétor	Preliminary Spanish version of D2.4 report
v9	23-05-2021	Draft	José Muñoz-Rojas	Translation into English is made, text and expression edited and adapted, and some contents are completed
v10	26-05-2021	Final	José Liétor	Comments of Gema Parra are incorporated and the final format adapted

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Executive Summary

This document contains the deliverable 2.4 of SUSTAINOLIVE. In the document, the procedures on data management and the key statistical methods and protocols recommended for all tasks in SUSTAINOLIVE are indicated, with exemplary demonstrations.

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F. **C sequestration and C footprint:** Carbon footprint, Carbon sequestration.

G. **Assessment of resilience to climate change.**

H. **Social agrarian metabolism**, social life cycle and life cycle sustainability assessments.

2- Conceptual working framework

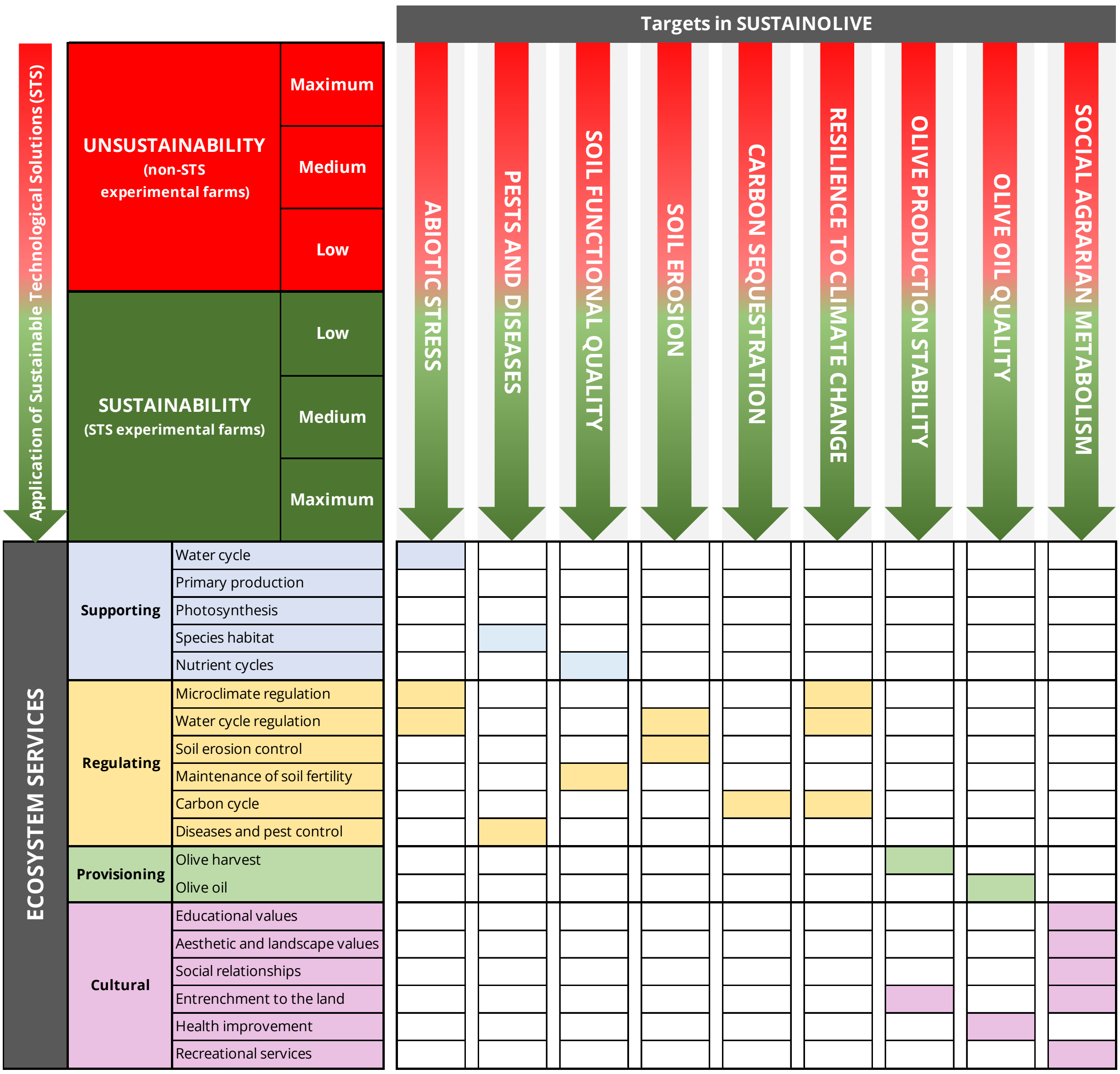

Figure 1. Expected behavior for the diverse sets of parameters analysed in SUSTAINOLIVE along the gradient between STS and non-STS olive groves. In the table, the main ecosystem services linked to each of these parameters are indicated.

A key objective of SUSTAINOLIVE is to establish comparisons between experimental olive plots applying environmentally sustainable practices (hereby named as STS) and others operating under conventional standards lacking such sustainable practices (hereby named as non-STS).

From a purely theoretical perspective, it may be expected that the diverse parameters determining the quality and quantity of ecosystem services delivered by an olive grove follow a shifting gradient along the continuum between STS and non-STS olive groves (Figure 1).

Our work is based on the hypothesis that as the olive groves move from an unsustainable state towards a sustainable climax, a clear improvement in their ecosystemic functionality, and thus also in their gradual economic sustainability will take place gradually. Sustainable states of olive groves are characterized by a lack of herbaceous undercover, naked soils with low fertility rates and subject to soil erosion, low biodiversity, especially regarding the populations of pest natural enemies, high dependence on nutritional supplies and phyto-health products (among others). In contrast, their sustainable climax is defined by the presence of herbaceous undercover and fertile soils rich in organic matter of endogenous and exogenous origin, high biodiversity and related resilience against pests and diseases, closed-up nutrient cycles and high levels of efficiency according to the principles of circular economy.

It is expected that parameters including the resilience against abiotic stress, capacity to tackle pests and diseases, soil functional quality and thus also their capacity to retain and circulate nutrients, resistance against soil erosion, C sequestration capacity, resilience to climate change, stabilization of olive harvesting rates, as well as the diverse indicators of socio-agrarian metabolism, will all bear higher values in STS than in non-STS olive groves.

What still remains to be demonstrated is:

i) Whether our conceptual framework is valid and applicable to all parameters, either ecological and socio-agrarian, and if this is the case,
ii) Which is the magnitude in the differences between STS and non-STS practices.

3- About the need for a statistical protocol

Once the diverse parameters listed in section 1 are measured, SUSTAINOLIVE must address the challenge of designing a specific protocol for the statistical assessment of the data in the different tasks, underpinning a standard theoretical framework to be abided by all partners in the project.

Creating such a protocol will deliver the following benefits:

i) Facilitating data processing by all SUSTAINOLIVE partners.
ii) Avoid incurring in inaccuracies in the selection of statistical methods, mostly amongst partners with lower experience on the subject.
iii) Provide all statistical analyses with uniformity and coherence.
iv) Allow comparisons to be established that are reliable for the results obtained in the different case study countries and regions.

The purpose of this document is not to build a closed-up working plan, but instead providing with a general working framework for the statistical analysis of the results obtained in SUSTAINOLIVE following the recommendation of "type" analyses according to i) the nature of the data, and ii) the targets of their statistical discussion.

Despite of our efforts to anticipate all possible statistical scenarios, and given the abundance and heterogeneity of field experiences and empirical results foreseen for SUSTAINOLIVE, it is possible that along further stages of this project some unforeseen scenarios may appear that will demand slight modifications of this protocol. Such modifications will only be implemented in case that it becomes impossible to adapt any of the statistical procedures set in this protocol. In any case, the selection of any new procedure will be realized in alignment with the recommendations in Zulfigar & Bhaskar (2016).

4- Data treatment

4.1- About the validity of the parameters

Despite of our efforts to compile reliable data that can be processed statistically, at times, it will become necessary to discard certain parameters. For example, if a certain question in the olive farmers´ survey (task 2.1) is not responded by a sufficient number of them, this parameter loses value, as any further statistical analyses to be potentially applied would lack enough mathematical power in order for the results to be considered significant.

Thus; in which cases will we consider any given parameter to be excluded for the statistical analyses?:

i) When it lacks statistical interest.

ii) When the data cannot be processed statistically (generally because the parameter is not of numerical character, and thus it is not possible for it to be classified in categories).

iii) When numerous metrics for this parameter (replications from now on) are unavailable (e.g., when a significant percentage of those surveyed decline or ignore a question; or when something unforeseen during a field experiment impedes sampling a considerable number of empirical blocks).

iv) When numerous replications are unreliable, that is, when it is suspected that the sampling and data gathering method is not adjusted to the standards established in the sampling protocol of SUSTAINOLIVE.

v) When numerous replications happen to be atypical values (“outliers”). In this case, each outlier will be analysed individually to disentangle the reason behind its disparity on respect to the values expected. In the case it is confirmed that measures have been correctly performed, they will be considered as such in the statistical analyses thereafter. In case they are confirmed as invalid, they will be definitely excluded from the statistical analysis.

vi) When two or more of the aforementioned causes concur.

Form now on, for cases iii, iv, v and vi, it will be considered that the minimum percentage of replications needed for a given parameter to be considered valid will be of 50 %.

4.2- About the character of the parameters

Once a given parameter is considered valid, the next step will be to determine if it is qualitative or quantitative.

A **qualitative parameter** is a non-numerical parameter that shows a characteristic or quality (e.g., academic level of the farmer or olive variety predominant in an olive grove). Hereby we consider both purely qualitative parameters and quantitative parameters that are transformed to qualitative. For example, if instead of quantifying the number of cattle heads roaming an olive tree, we restrict ourselves to use a dichotomic code of presence/absence (Yes/No), we are transforming a quantitative parameter into a qualitative one.

Qualitative parameters are of 2 types:

i) Nominal: they cannot be order in categories. For example, if we were surveying farmers on the advantages of applying Sustainable Technological Solutions for their olive groves, each of their responses would be a category in itself, impeding the formation of a hierarchy in which some responses scored higher or lower than others.

In these cases, we will restrict our analysis to some simple groupings, percent calculations and subjective inferences of qualitative nominal parameters. For example, after gathering information on the type of phyto-health products used by a group of surveyed farmers we will obtain a list of active principles that, at most, will allow to estimate the parameters described in table 1.

Table 1. Example of basic treatment of data from a nominal qualitative parameter.

Plant protection product		Product 1	Product 2	Product 3	Product 4	Product 5	Product 6
Farms using the product (N=10)		5	4	6	6	7	5
Descriptive parameters	% farms using the product	50	40	60	60	70	50
	Mode (the most used product)						
	The least used product						

ii) Ordinal: they can be organised in categories. For example, if we assign different degrees of soil erosion levels in the olive groves, these may be ordered ascendingly as: minimum, mean, severe. In such cases, it is extremely important to define with clarity, despite being a qualitative scale, the criteria by which any metric is included into a given category. In this example, if the aspects differentiating the various levels of soil erosion are not well defined, some metrics would end up shifting their category.

At times, it is possible to convert a qualitative nominal parameter into an ordinal one, which improves the foreseeing of statistical descriptors that may be applied.

Returning to the example in table 1, if we were interested in grouping the pesticides applied over a set of experimental olive plots based upon their degree of toxicity, the qualitative nominal parameter "Type of Pesticide" could turn into a quantitative parameter if such products were distributed according to the following classification of toxicity based on parameters LD50 or LC50 for each product: category 4 (highly toxic), category 3 (toxic), category 2 (harmful) and category 1 (low risk), and again a decreasing toxicity punctuation could be assigned (4 points for category 4, and thus successively towards 1 point for category 1).

Table 2. Example of transformation of a qualitative nominal parameter into an ordinal one (based on data from table 1)

Plant protection product		Very toxic		Toxic	Harmful	Low risk		TOTAL SCORE
		Product 1	Product 2	Product 3	Product 4	Product 5	Product 6	
Scores according to toxicity		4	4	3	2	1	1	-
Products used by farms (Y = yes, N = no)	Farm 1	Y	N	Y	Y	N	N	9
	Farm 2	N	N	N	Y	Y	Y	4
	Farm 3	N	N	Y	Y	Y	N	6
	Farm 4	Y	Y	N	N	Y	Y	10
	Farm 5	N	Y	Y	N	N	Y	8
	Farm 6	N	N	N	Y	Y	N	3
	Farm 7	Y	Y	Y	N	N	N	11
	Farm 8	Y	N	Y	Y	Y	Y	11
	Farm 9	N	N	N	N	Y	N	1
	Farm 10	Y	Y	Y	Y	Y	Y	15

Following the transformation in table 2, we now count with a figure (column "Total Score") that allows us to widen the possible statistical descriptors and analyses. In any case, we shall never lose sight of the fact that these data arise from a subjective transformation of the original data, and thus, that any conclusions to be inferred from the statistical analyses will need to be considered with a certain level of prudence.

A **quantitative parameter** is defined as a parameter admitting a numerical code, at least in the form of an interval (for example, tree density or olive oil production). Hereby we shall consider both pure quantitative parameters as well as qualitative parameters that are transformed into qualitative ones. For example, if we assign to the diverse models existing for olive cultivation and management (conventional, integrated and organic) an increasing numerical code (1, 2 and 3, respectively) representing an increasing level of sustainability, we will have transformed a qualitative parameter onto a quantitative one.

Since statistical analyses on quantitative parameters are much more powerful, at times it is convenient to realize these transformations, as long as the parameter at cause allows for an ordering based on a gradient of relevance (despite being qualitative). In the case of parameters that do not allow for such a gradient to be established (e.g., a type of soil or of dominant pest) then it becomes senseless to apply such a transformation.

Quantitative parameters can be discrete (they can only adopt certain numerical values; for example, number of visits by the technician of the cooperative) or continuous (they can adopt any numerical value; for example, the concentration of a certain nutrient in the soil solution). As long as it is possible, work in SUSTAINOLIVE will be based on continuous quantitative parameters, instead of discrete ones.

Table 3 shows the diverse statistical descriptive metrics applicable to quantitative parameters (and also to qualitative ones that have been transformed into quantitative).

Table 3. Basic descriptive statistical metrics applicable to quantitative parameters (and also to qualitative ones that have been transformed into quantitative).

Position	Central	Mean
		Median
		Mode
	Not central	Maximum
		Minimum
		Percentiles
Dispersion		Standard deviation
		Variance
		Interquartile range
Distribution shape		Coefficient of asymmetry
		Coefficient of kurtosis

4.3- About the principles of normality and homoscedasticity of variance for quantitative parameters

Not all quantitative parameters can be treated according to the same statistical criteria. Parametric statistics always base their calculations on the assumption that the distribution of the parameter to be studied is known. More specifically, it is mandatory that the data for any parameter subjected to parametric analysis conform to a normal distribution (Figure 2). This is so because it has been proved that many phenomena tend to behave as a normal one when we repeat them a very large number of times (Jose Francisco Lopez, 2019).

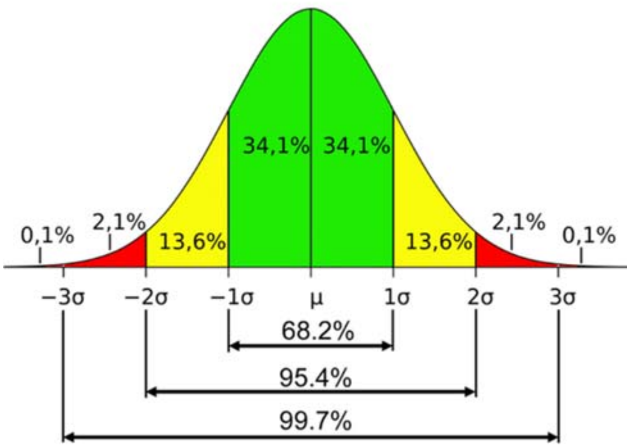

Figure 2. Percentage of observations that would lie within 1, 2, or 3 standard deviations from any mean in a distribution that is normally distributed (taken from PH717 Module 6- Random Error Boston University School of Public Health (link HERE)

It is expected that many of the quantitative parameters analysed in SUSTAINOLIVE do not have a normal distribution (Figure 3).

All the quantitative parameters considered in SUSTAINOLIVE (both pure and also those to be obtained following the transformation of other qualitative ones) will be subjected to statistical tests to determine if their distribution is normal with a confidence level (p) of 99% and, therefore, a level of significance (α) of 0.01. Three possible normality tests are suggested: Kolmogorov Smirnov, Lilliefor and Shapiro-Wilk, of which the most powerful and, therefore, the one recommended in SUSTAINOLIVE is the last one (Ghasemi & Zahediasl, 2012).

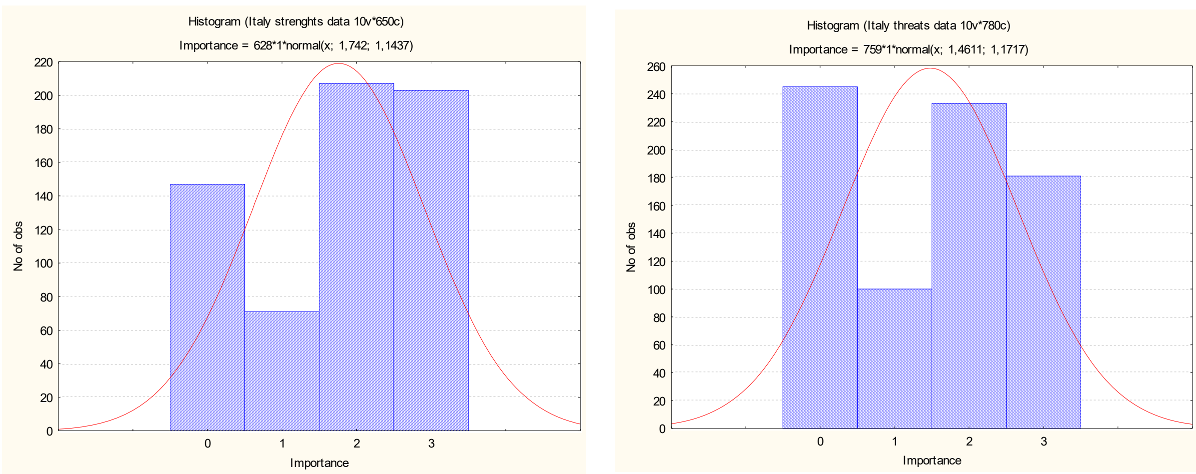

Figure 3. Example of two parameters measured in SUSTAINOLIVE that do not follow a normal distribution. Left: Relevance assigned by Italian olive growers to strengths detected in the sector. Right: Relevance assigned by Italian olive growers to threats detected in the sector. Note that these are a priori qualitative parameters that have been converted into quantitative parameters by creating a classification by categories of relevance (1 point for weakly relevant strengths / threats; 2 points for those of intermediate relevance; 3 points for those of great relevance). In both cases, the Shapiro-Wilk test yielded P values <0.01, that is, the data, as shown in the bar graphs, do not fit a normal curve (in red).

Occasionally it is possible to solve the problem of the lack of normality, by carrying out a mathematical transformation of the data of the parameter at stake:

i) When there are negative asymmetric frequency distributions (high frequencies towards the right side of the distribution), it is convenient to apply the transformation $y = x^2$. This transformation compresses the scale for smaller values and expands it for larger values.

ii) For positive asymmetric distributions (high frequencies placed towards the left side of the distribution) the transformations $\sqrt{x}$, ln(x) and 1/x are used, which compress the higher values and expand the smaller ones. The effect of these transformations is in increasing order: less $\sqrt{x}$ effect, more ln (x) and even more 1/x. Considering that many of the SUSTAINOLIVE parameters, especially those related to farmer surveys, will contain many zeros, it is expected that there will be many cases in which the transformation ln(x) or 1/x become priority options to normalize their distribution (Feng et al., 2014).

In the case of comparing two different parameters, in addition to the normality principle, it will be necessary to verify that the variances of such parameters are homogeneous (homoscedasticity principle of the variances). The statistical test recommended for this is the Levene test with a significance level of 5% ($\alpha = 0.05$) (Nordstokke & Zumbo, 2010).

When a variable complies with the normality principle, it may be subjected to the corresponding parametric statistical analyses. In the case of comparing two parameters, the "homoscedasticity of variances" principle must also be complied with. When this is not the case, non-parametric analysis will be applied.

It will not be necessary to test the homogeneity of variances once it has been shown that any of the compared parameters does not adjust its distribution to a normal curve, since in that case, it must inevitably be subjected to non-parametric analysis.

5. Statistical protocol

5.1- Non-parametric analyses

These will be applied in the following cases (Table 4):

i) Ordinal qualitative parameters (pure or arising from the transformation of nominal qualitative ones).

ii) Quantitative parameters that do not show a normal distribution, despite having mathematically transformed the data.

iii) Pairs of quantitative parameters that do not show a normal distribution or that, having a normal distribution, do not show homogeneous variances.

The nonparametric first choice tests in SUSTAINOLIVE are (Sheskin, 2003):

i) To detect differences between independent samples:

i.i) Comparison of means in two samples Kolmogorov-Smirnov test for 2 samples

i.ii) Comparison of means in more than two samples: Kruskal Wallis rank test

ii) To detect differences between dependent samples (including dichotomous ones): Cochran's Q test

iii) To detect correlations between parameters:

iii.i) Non-categorical parameters: Spearman's R^2 correlation coefficient

iii.ii) Categorical parameters:
Pearson's Chi square (for comparisons between 2 parameters)
Kendall's Coefficient of Agreement (for comparisons between more than 2 parameters)

The level of significance (α) will be considered as 0.01 in all cases.

5.2- Parametric analyses

They will be applied in the following cases (Table 4):

i) Quantitative parameters that show a normal distribution (both originally and when arising from a mathematical transformation).

ii) Pairs of quantitative parameters showing a normal distribution and homogeneous variances.

Table 4. Simplified scheme of the statistical protocol recommended in SUSTAINOLIVE. To facilitate decision-making by the project partners, a template has been designed in Excel format that allows identifying, step by step, the appropriate statistical routes described in this table (Appendix 1)

Type of variable	**Statistical conditions**		**Type of analysis**	**Differences among independent samples**		**Differences among dependent samples** (including dichotomous)	**Correlations among variables**	
	Normality	**Homo-cedasticity** (only for pairs of variables)		Comparing means in 2 samples	Comparing means in more than 2 samples		Non categorical variables	Categorical variables
Qualitative ordinal			**NON PARAMETRIC**	KOLMOGOROV SMIRNOV for 2 samples	KRUSKAL WALLIS RANKS	COCHRAN Q TEST	R^2 SPEARMAN CORRELATION COEFFICIENT	CHI CUADRADO (2 variables) KENDALL CONCORDANCE (> 2 variables)
Quantitative	Not normal	Not homogeneous						
		Homogeneous						
	Normal	Not homogeneous						
		Homogeneous	**PARAMETRIC**	t STUDENT TEST	ONE-WAY ANOVA	REPEATED MEASURES ANOVA	PEARSON CORRELATION COEFFICIENT	

The first-choice parametric tests in SUSTAINOLIVE are (Sheskin, 2003):

i) To detect differences between independent samples:

i.i) Comparison of means in two samples: Student's t test i.ii) Comparison of means in more than two samples: One-way analysis of variance

ii) To detect differences between dependent samples (including dichotomous ones): Analysis of variance of repeated measures

iii) To detect correlations between parameters: Pearson's correlation coefficient

The level of significance (α) will be considered as equal to 0.01 in all cases.

5.3- Post Hoc analysis

Once the relevant statistical analyses have been carried out, for those that show significant differences between the mean values obtained, corresponding ex-post comparisons will need to be made (Post Hoc comparisons).

Since there is a remarkable variety of Post Hoc tests and not all of them are available in the computer applications for statistical calculations, each SUSTAINOLIVE partner will need to select the test they consider most appropriate. However, it is recommended that in order to perform multiple ex-post comparisons after applying the Kruskal Wallis non-parametric analyses, the mean range test is applied (Pohlert, 2016). For parametric tests that use analysis of variance (ANOVA), the Fisher´s LSD test (Least Significant Difference) will be prioritized (Meier, 2006).

The existence of significant ex-post differences will be tested considering a significance level (α) of 0.05.

5.4- Multivariate analysis

Occasionally, SUSTAINOLIVE partners will need to combine various parameters to analyze how the experimental plots or the countries and regions participating in the project are distributed in the statistical space determined by their range of variability, thus permitting to identify management gradients. Management gradients based on sustainability will be of special interest for SUSTAINOLIVE purposes.

Two types of multivariate analysis will be carried out. Both have the same conceptual and statistical basis, differing mainly in the way in which the final order of experimental subjects is shown to the user.

i) Principal Component Analysis (PCA)

In this case, the experimental subjects are shown within a two-dimensional space determined by the two axes that absorb the greatest amount of the variance of the parameters considered for the analysis.

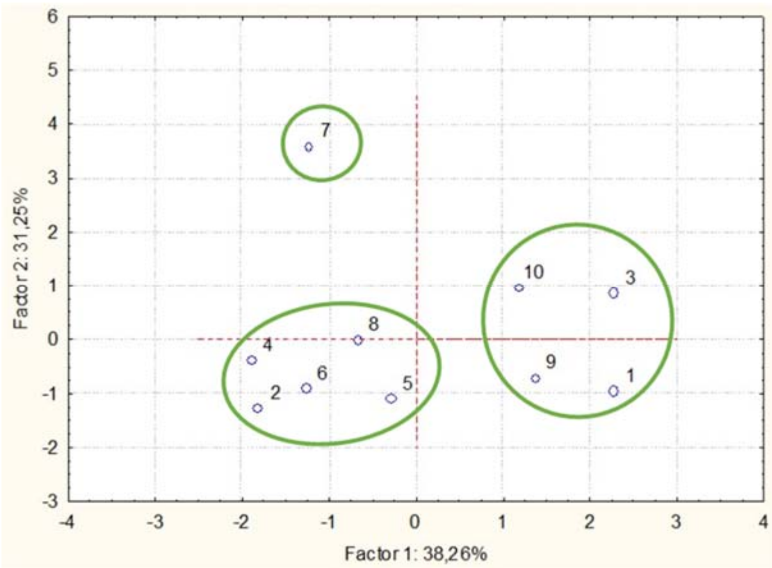

Figure 4. Distribution of experimental olive grove plots along the two main components that absorb the highest proportion of the variance (38.26 and 31.25% respectively) from the combination of 7 study parameters. Three groups of plots are clearly differentiated (surrounded in green) in the space delimited by these main components.

ii) Cladogram (cluster analysis)

In this case, the grouping/ordering of the experimental subjects follows the branching scheme classically used in phylogenetic studies.

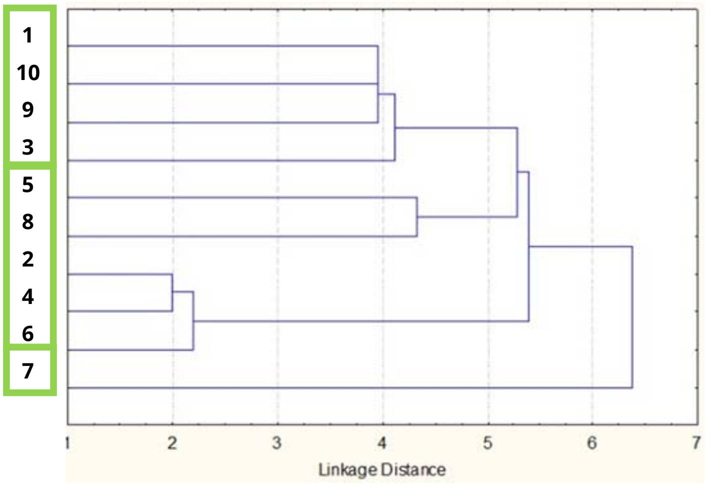

Figure 5. Arrangement of the experimental olive grove plots in Figure 4 in cladogram format. Note how, once again, the plots can be classified into 3 groups, although on this occasion, the cladogram suggests the possibility of dividing the central group into two well-differentiated subgroups (plots 5 and 8 on one side and plots 2, 4 and 6 for another).

6. Pilot for the application of the statistical tests for one specific SUSTAINOLIVE task

In this section we will show how to apply the SUSTAINOLIVE statistical protocol recommendations for Task 2.2 of Work Package 2: Identification of the strengths, weaknesses, opportunities and threats (SWOT) of alternative olive grove cropping practices and OML industries.

To implement this task, key experts from all the countries participating in SUSTAINOLIVE were surveyed about the strengths, weaknesses, opportunities and threats of the sector (SWOT analysis). In total, 44 survey responses were obtained, with 244 items each (50 for strengths, 76 for weaknesses, 58 for opportunities and 60 for threats). The questions were grouped by blocks /

categories (farm characteristics, sustainability challenges, markets demand, etc.). There was also discrimination between types of experts (producers, public administrations, etc.) responding to the survey. Experts surveyed responded on their degree of conformity with each of the items through a qualitative code of relevance consisting of 4 categories depending on whether they were in total disagreement (category 1), or there was a low agreement (category 2), intermediate (category 3) or high (category 4).

To apply the statistical protocol recommended in this document, these would be the steps to follow:

i) Transforming parameters into a quantitative scale.

Since the experts determine the relevance of the parameters (strengths, weaknesses, opportunities and threats) based on a qualitative scale (little, intermediate and high relevance), the first step consists of transforming the qualitative parameters into quantitative ones: If the respondents consider a given parameter has no relevance, we will assign it 0. For the 3 relevance ranges (low, medium, high), we will assign 1, 2 and 3 respectively.

ii) Deciding which are the priority parameters within each country.

The mean relevance for each variable will be calculated and then a ranking from lowest to highest means will be obtained.

To discriminate which strengths, weaknesses, opportunities or threats obtain the highest statistically significant relevance values, the 80th percentile will be calculated for the sequence of mean relevance for each of the parameters. The parameters whose mean relevance were equal to or greater than the 80th percentile value will be selected as those having priority in SUSTAINOLIVE.

iii) Deciding how to make comparison among question blocks (topics).

It is interesting to determine if there are significant differences between blocks of questions (e.g. farmer characteristics versus olive oil production versus markets demands, etc.).

- For each country, the relevance values for strengths, weaknesses, opportunities and threats will be compared considering the response of each expert as a replicate. In case the relevance values fit a normal distribution, a one-way ANOVA will be applied to find significant differences. If the values do not fit a normal distribution, a non-parametric Kruskal Wallis test will be applied.

- In the case of finding significant differences among blocks of questions (*p*-value 0,01), multiple comparison tests of mean ranks after non-parametric analysis or post hoc Fisher LSD test after parametric analysis will be performed respectively. Blocks of questions will be considered as independent parameters (factors).

- *p*-value 0.05 will be the significance level applied for the post hoc multiple comparisons.

iv) Deciding how to make comparison among experts´ categories.

It is interesting to determine if there are significant differences between responses of experts´ categories.

- For each country, the relevance values for strengths, weaknesses, opportunities and threats will be compared by grouping the responses of the same expert category (producers, universities, public administrations, lobbies and specialists in farming sustainability). Due to data never fit a normal distribution, non-parametric Kruskal Wallis tests will be applied.

- In the case of finding significant differences among blocks of questions (*p*-value 0,01), multiple comparison tests of mean ranks after non-parametric analysis will be performed. Experts categories will be considered as independent parameters (factors).

- *p*-value 0.05 will be the significance level applied for the post hoc multiple comparisons.

- For comparisons among the same experts in different countries, a multiple correlation matrix based on Kendall concordance for categorical parameters will be performed (*p*-value<0,01 was the significance level applied).

v) Deciding how to make comparisons among countries.

Now we will try to infer whether a variable is perceived or not as strength, weakness, opportunity or threat in any given country or region compared to the rest.

For each SWOT item, the relevance means will be compared among countries considering the response of each expert in each country as a replicate. Due to whichever variable combined for all countries do not fit a normal distribution, non-parametric Kruskal Wallis tests will be applied. Due to significant differences will not most likely be detected in the vast majority of the cases, only tables with means and standard deviations for each of the survey questions will be obtained.

7- Literature consulted

Feng, C., H. Wang, N. Lu, T. Chen, H. He, Y. Lu & X. Tu. Log-transformation and its implications for data analysis. Shanghai Arch Psychiatry, 26(2):105-9, Abr 2014

Ghasemi, A. & Zahediasl, S. Normality Tests for Statistical Analysis: A Guide for Non-Statisticians. International Journal of Endocrinology and Metabolism 10(2):486-489, Dec 2012

Lopez, Jose Francisco. Estadistica parametrica. Economipedia.com. Mar 2019

Meier, U. A note on the power of Fisher's least significant difference procedure. Pharmaceutical Statistics 5(4):253-63, Oct 2006

Nordstokke, D.W. & Zumbo B.D. A new nonparametric Levene Test for Equal Variances. Psicologica, 31, 401-430, 2010

Pohlert, T. The Pairwise Multiple Comparison of Mean Ranks Package (PMCMR). Published 2016 • Mathematics.

Sheskin, D.J. Handbook of Parametric and Nonparametric Statistical Procedures. Third Edition. 1193 pp. Aug 2003

Zulfigar, A. & Bhaskar, B.. Basic statistical tools in research and data analysis. 663. Indian Journal of Anaesthesia, Vol. 60, Issue 9, Sep 2016