COMPARATIVE ASSESSMENT OF THE AVERAGE YIELD OF FRUIT IN THE MEMBER STATES OF THE EUROPEAN UNION FOR THE PERIOD FROM 1961 TO 2014

Nelly Keranova
Agricultural University-Plovdiv, Faculty of Economics,
4000, Plovdiv, Bulgaria

Abstract

The objective of this work is to group and assess the Member States of the European Union according to the average yield of citrus, pome and stone fruits for the period 1961-2014. The EU countries are grouped through hierarchical cluster analysis based on the average yield of the respective fruit. The purpose is achieved also through a single-factor analysis of variance (ANOVA) by the Duncan criterion. By this analysis a comparative assessment of the EU member states is made.

It was found that the country with the highest average yield of citrus fruits is Italy (140112,63 hg /ha), followed by Spain (106111,58 hg/ha) and the lowest – Cyprus (8715,46 hg/ha). The country with the highest average yield of fresh fruit is Ireland (101670,7 hg/ha), second, but with a significant difference is Romania (75700 hg/ha), and the country with the lowest yield is Latvia (12938,78 hg/ha). Italy (109746,17 hg/ha) and Bulgaria (92132,59 hg / ha) have the highest average yields of stone fruits and the country with the lowest yield is Spain (6821,8 hg/ha).

Keywords: *hierarchical cluster analysis, fruit*

Introduction

Vegetable production, viticulture and fruit growing are traditional sub-branches of plant growing in Bulgaria, which is predetermined by the favorable natural conditions in the country and the productive experience of the population accumulated over the centuries. Each of these sub-sectors is characterized by specific features, both in terms of the requirements towards soil and climatic conditions and in terms of the biological peculiarities in the development of the individual crops.

Fruit growing is important for feeding the Bulgarian population, as fruit is an integral part of the menu in the country. This is due to the rich content of sugar, fructose, pectin, aromatic and tanning substances.

The favorable climatic conditions are also a prerequisite for growing a variety of fruit in the country with the relatively high summer temperatures and the long-lasting sunshine.

Patraset. et al. [5] analysed interrelationships between the parameters and the different fruits and vegetables (blueberries, cherry tomato, cranberries, red grapes, green pepper, raspberry, red pepper and strawberry, broccoli, carrot, butterhead lettuce, red onion, yellow onion) were investigated by principal component analysis and hierarchical cluster analysis.

The study in [4] aimed to segment respondents into clusters based on F&V (fruit and vegetable) -related perceptions, and to describe these clusters with respect to F&V consumption and sex. Of the two identified clusters, the positive cluster was older and consumed more vegetables (both sexes) and fruit (women only), whereas men in the indifferent cluster consumed more juice. Indifferent cluster reported more F&V consumption preventing factors, such as storage and preparation difficulties and low satisfaction with F&V selection and price.

The classification which is made according to the morphological features of fruits is more widespread in Bulgaria. According to it fruits are divided into:

- Pome fruit types - apples, pears, quinces, etc. The edible part of the fruit can be stored for a long time.

- Stone fruit types–plums, wild plums, cherries, sour cherries, apricots, peaches. The edible part of the fruit cannot be stored for a long time.
- Strawberry fruit types– strawberries, raspberries, blackberries, blackcurrant, etc.
- Nut fruit types – walnuts, almonds, hazelnuts, chestnuts.

Citrus fruits – lemons, oranges, mandarins, etc.

This work analyzes data on the average yields of citrus, pome and stone fruits in the EU countries from 1961 to 2014. The aim is to group the EU countries according to the average yields of the respective fruits as well as to make a comparative assessment based on the relevant criterion.

Materials and Methods

The current work makes grouping and comparative assessment of the EU countries according to the average yield of citrus, pome and stone fruits for the period 1961 to 2014. For this purpose a hierarchical cluster analysis is applied by the method of intergroup connection, and the measure of similarity is the quadratic Euclidean distance [7]. In this method, the distance between two clusters A and B is defined as the average value of nA.nB of number of distances between nA points from A and nB points from B by the formula:

$$D(A,B) = \frac{1}{n_A n_B} \sum_{i=1}^{n_A} \sum_{j=1}^{n_B} d(x_i, x_j),$$

where the sum changes for all pointsx_i и x_j from A and B, and

$d(x_i, x_j) = \sum_{m=1}^{p} (x_{im} - x_{jm})^2$, $i, j = \overline{1,n}$

is the quadratic Euclidean distance between two vectors $x_i(x_{i1}, x_{i2}, ..., x_{ip})$ and $x_j(x_{j1}, x_{j2}, ..., x_{jp})$.

Given are the dendrograms that graphically present the resulting clusters. The single-factor analysis of variance is a method by which the statistical link between one dependent and one independent variable can be examined. It allows for a comparative assessment of a certain number of objects according to an indicator. In this work, we have applied it to evaluate and analyze the EU countries according to the indication "average yield of the respective fruits" from 1961 to 2014. Another reason for combining the cluster analysis with the analysis of variance is the fact that in the cluster analysis no tests for statistical significance are made.

The research is based on data extracted from the FAOSTAT relational database. Microsoft Access provides the possibility to export tables from the corresponding database directly into the medium of MS Excel or SPSS which were used for statistical processing [2], [6]. The data processing was performed through the statistical programme IBM Statistics SPSS 23 [1,3,8].

Results and Discussion

The hierarchical cluster analysis in this work is conducted in three directions: grouping of the EU countries according to the average yield of citrus fruits, pome fruits and stone fruits. The results of this method are presented on the dendrograms on Figures 1-3.

According to their average citrus yields, the EU countries are grouped into three clusters. Italy, which has the highest yield of citrus fruits, forms a single cluster (Figure 1).Cyprus, Greece and Malta form a common cluster because of a proven similarity in the yields of these fruits,

which have average values compared to the other countries, and the smallest yield is in Spain, statistically different from the others. Therefore, it forms a single cluster.

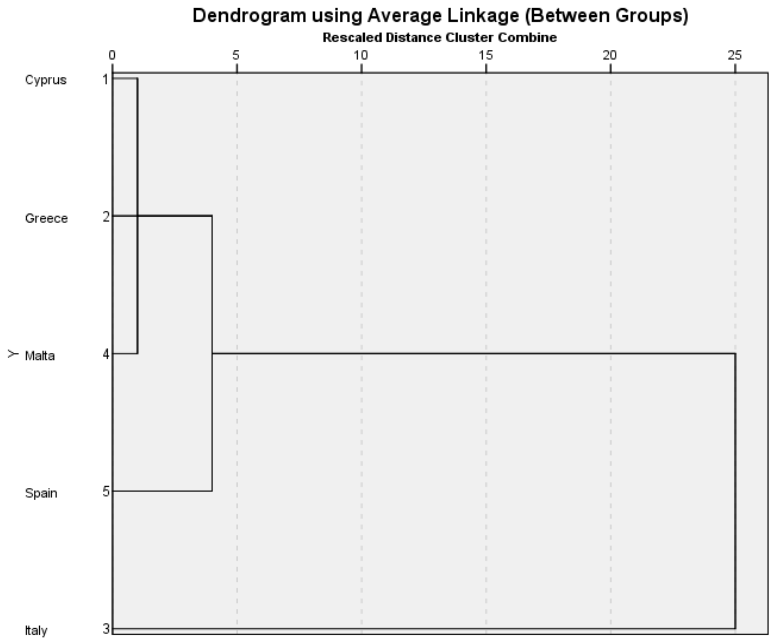

Figure 1. A dendrogram presenting graphically the clustering of EU countries according to the average yields of citrus fruits from 1961 to 2014

According to the degree of similarity in the average yield of pome fruits, the EU countries are grouped into six clusters. Ireland, which has the highest yield, statistically different from that of the other countries, forms a single cluster. The largest cluster includes Poland, Slovakia, Italy, Malta, Cyprus, the Czech Republic, Spain and Romania, to which Hungary can join. These are the countries with the next largest yield after Ireland but with proven similarity according to the given criterion. Greece, Portugal and Bulgaria are grouped in a separate cluster, and France and Latvia form two single clusters, but they can be grouped with the last one on the next level. These are the countries with the lowest average yields of pome fruits for the period under review (Figure 2).

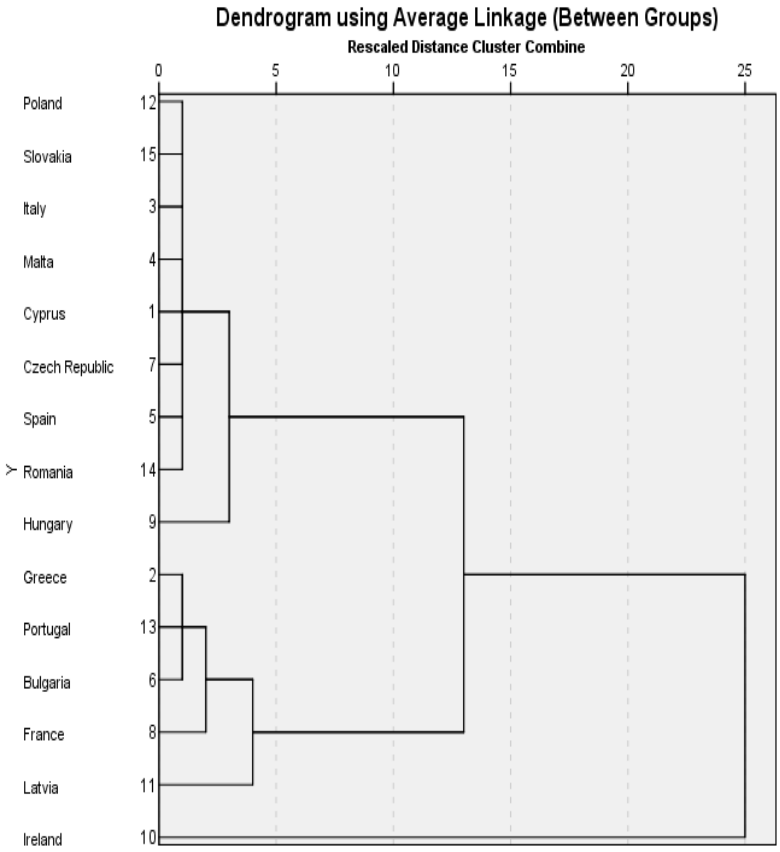

Figure 2. A dendrogram presenting graphically the clustering of EU countries according to the average yields of pome fruits from 1961 to 2014

Following the hierarchical cluster analysis, the EU countries were grouped into five clusters according to the average yields of stone fruits from 1961 to 2014. Italy forms a single cluster as it has the highest yield statistically different from the yields in the rest of the countries. Bulgaria and Germany are second, with similarity in the average yield and therefore form a separate cluster. Spain and Lithuania have the lowest yields and also form a cluster due to their similarity according to this indicator (Figure 3).

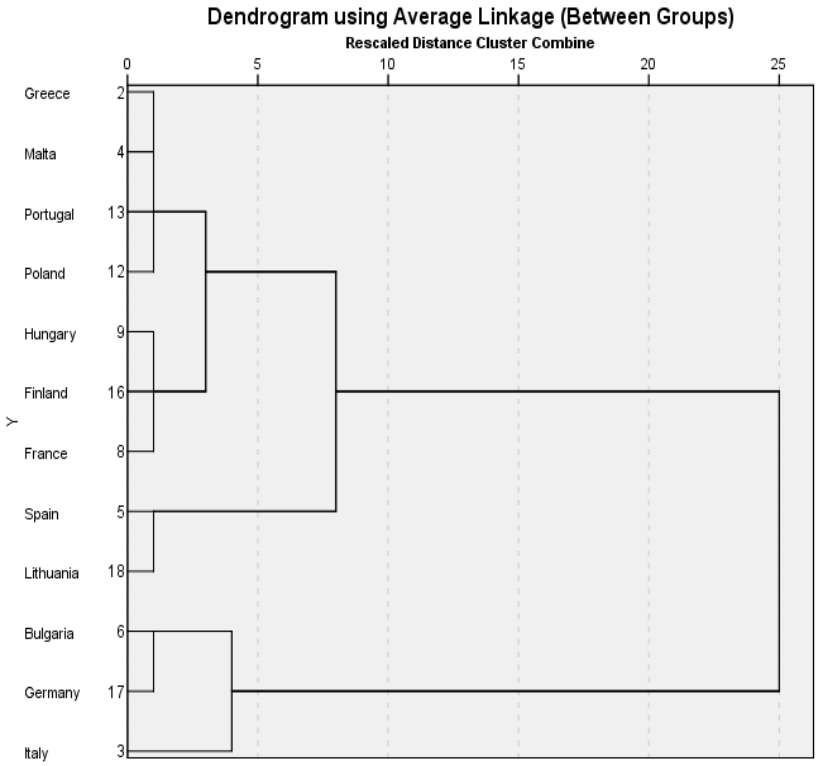

Figure 3. A dendrogram presenting graphically the clustering of EU countries according to the average yields of stone fruits from 1961 to 2014

According to the results from Levene's homogeneity test, we can assert that the experimental data are of equal dispersion and they can be compared according to the chosen criterion. Moreover, the overall statistical evaluation shows a level of significance less than the error $\alpha = 0{,}05$, which is enough to assume that the surveyed EU countries have statistical differences and that the common model is statistically significant.

A comparative assessment of the EU member states was made according to the average yields of citrus, pome and stone fruits by means of a single-factor analysis of variance. The results are shown in Tables 1-3. The tables also include the standard deviations in the yields of each county. It is known that the magnitude of these deviations indicates the degree of sustainability of the respective yields over time. Italy has the largest yield of citrus fruits, but it is not stable over time. The most sustainable are the yields of citrus fruits in Cyprus. The Czech Republic and France have yields of pome fruits, whose values are not the highest but are stable, which is not in significant for their future analysis. France is the country with relatively high yields of stone fruits and at the same time they are sustainable over time.

Table 1. Comparative assessment of the EU countries according to the average yield of citrus fruits

Country	Average yield of citrus fruit	Standard deviation
Cypress	87115,46 [b]	7559,059
Greece	88458,31 [b]	87681,56
Italy	140112,63 [a]	41780,36
Malta	93957,97 [b]	17117,79
Spain	106111,58 [b]	54106,55

Table 2. Comparative assessment of the EU countries according to the average yield of pome fruits

Country	Average yield of pome fruits	Standard deviation
Bulgaria	31004,87 [ef]	18279,71
Cypress	67167,15 [bc]	21767,88
Czech republic	65470,92 [bc]	6036,052
Greece	38688,03 [e]	8576,116
France	24704 [fg]	1509,885
Hungary	50722,36 [d]	34423,29
Ireland	101670,7 [a]	24092
Italy	61844,46 [cd]	29632,83
Latvia	12938,78 [g]	7682,628
Malta	60549,23 [cd]	6704,217
Poland	63130,8 [bcd]	24640,74
Portugal	35376,13 [ef]	4322,874
Romania	75700 [b]	20995,05
Slovakia	63993,72 [bcd]	22535,21
Spain	71469,22 [bc]	15967,51

Table 3. Comparative assessment of the EU countries according to the average yield of stone fruits

Country	Average yield of pome fruits	Standard deviation
Bulgaria	92132,59 [b]	26371,65
Greece	30074,13 [de]	8793,651
France	61503,33 [c]	1115,943
Hungary	52522,43 [c]	4701,093
Italy	109746,17 [a]	33722,91
Malta	31923,5 [de]	11602,07
Poland	34791,73 [de]	8918,863
Portugal	27842,09 [e]	2889,928
Spain	6821,8 [f]	3367,288
Finland	47052,71 [cd]	51834,12
Germany	80422,25 [b]	46068,21
Lithuania	9566,45 [f]	5927,459

Bulgaria takes one of the last places in the European Union based on the indicator "average yield of pome fruits" for the period 1961-2014, and at the same time has unstable quantities over time. In terms of the average yield of stone fruits, however, our country takes one of the top places in the EU, although the yields are relatively unstable. Only Italy is ahead of us, and the yields there are also unstable.

Despite the favorable climatic conditions in Bulgaria, there are imports of different fruits from Greece, Macedonia, Italy. It is necessary to improve the investment climate in order to increase the production of fruit, to improve the material and technical base, to introduce new technological capacities, to reduce production costs, etc.

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