



# Analysis of Culture in Romania over the Last 3 Decades

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## Abstract

Sunflower is one of the most important oil plants grown in the world, about 13% of world oil production is based on this crop, it is also the most important oil plant in Romania. The importance of sunflower cultivation is given by its wide use in human nutrition, but also in animal feed, including industrial and energy uses. In Romania, sunflower was introduced for oil production in the mid-nineteenth century in Moldova, being the main plant producing edible oil, currently Romania occupying a leading place in the European Union, but and in the world to the production of this plant. In 1990, Romania cultivated 394741 ha with sunflower. The areas cultivated with this plant registered significant increases, reaching that in 2019 the surface to triple, reaching 1282697 ha, the figure of 1 million hectares being exceeded for the first time in 2012. The annual production increased from 556242 t in 1990, to 3569150 t in 2019. So, while the area cultivated with sunflower increased 3.2 times, the annual production of sunflower increased 6.4 times. The paper "Analysis of sunflower culture in Romania during the last 3 decades" presents a mathematical analysis, to reveal the trend (trend) of production evolution by using statistical adjustment methods and tests to verify the hypotheses regarding the objective form of evolution on the period considered in the study, as well as the comparative analysis of the correlated data by determining the corresponding advance coefficients. Some significant characteristics are taken into account in terms of geographical area, soil type, weather conditions, treatments performed, crop rotation, etc [1].

**Keywords:** Sunflower production; Mathematical modelling; Statistical adjustment methods

**JEL classification:** Q15, Q19, C18, C22

## Introduction

Sunflower is an oily plant of great economic and food importance. Due to the content of seeds in fatty substances (33-56%) and the special quality of the oil resulting in extraction, the plant is one of the main sources of vegetable fats, used in human nutrition, respectively the most important source of oil for Romania. Occupying the fourth place in the world, after soybeans, oil and rapeseed palm and the first place in Romania, the sunflower is considered a very important plant for the practice of a sustainable agriculture and for ensuring the food security and safety of the population. The high nutritional value of sunflower oil is due to the rich content of unsaturated fatty acids, mainly represented by linoleic acid (44-75%) and oleic acid (14-43%), as well as the low presence of linylene acid (0, 2%), components

that give it stability and long storage capacity, superior to other vegetable oils. The nutritional function of sunflower oil is enhanced by the presence of provitamins of fat-soluble vitamins A, D, E, phosphatides as well as vitamins B, B, K. The oil also contains sterols (approximately 0.04%) and tocopherols (antioxidant fraction of vegetable oil, about 0.07%). The energy capacity (8.8 calories / g oil) and the high degree of assimilation, place the sunflower oil close to the nutritional level of butter [2-5]. Refined sunflower oil is mainly used in food, in the margarine and canning industry. The main use of sunflower is for the oil industry. Sunflower oil is excellent for nutrition, with pleasant fluidity, colour, taste and smell. The product is also used in industry for the production of special varnishes and resins, as well as in painting. The residues resulting from the refining process are used in the manufacture of soaps, in the production of waxes,

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phosphatides, lecithin and tocopherols. Phosphatides and lecithin extracted from sunflower oil are used in the food industry, bakery, pastry, in the preparation of chocolate and sausages. This sector has seen an upward trend, mainly due to the constant increase in sunflower production and the constant demand for crude sunflower oil on the foreign market, of 100 thousand tons per year. In the oil industry, the number of companies has increased, currently operating a number of 548 production units, of which 17 units are high capacity and process over 90% of the raw material. The utilization index of the production capacity in 2018 was: 61.5%. In 2017, the refurbishment and investments in the oil industry amounted to 48 billion lei and consisted mainly in refurbishing the operations of extraction, vinification, lecithinization and refining, as well as in the procurement of technologies and installations for the production of emulsifiers with high content of monoglycerides, seedling plants. Cakes resulting from the oil extraction process (approximately 300 kg / t seed), are a valuable source of protein for ruminants, rabbits, pigs and birds [5,6]. Cakes contain crude protein (between 33.7 and 47.8%) and essential amino acids, close to those of soybeans, with the exception of lysine, which is found in smaller amounts [7-10]. The energy value of the cakes is correlated with the degree of peeling of the seeds. The seeds, less rich in oil, are used directly for consumption, whole or peeled, as well as for halva. The stems can be used as a heat source (locally), for the manufacture of soundproofing plates or for obtaining calcium carbonate. The sunflower is also appreciated as a fodder plant, being cultivated mainly for silage. Sunflower is also an excellent honey plant. From one hectare of sunflower can be obtained a quantity of 30 to 130 kg of honey [11-18]. Through the organic residues left after harvest, the sunflower returns to the soil appreciable quantities of mineral elements and organic matter, estimated in the case of a production of 3500 kg / ha, at 65 kg N, 30 kg PO, 300 kg KO and about 7 tons of dry matter, the equivalent of 1200-1500 kg of humus [19-21]. Sunflower can also have medicinal uses. From the ligulate flowers (which contain quercitrin, anticyanin, choline, betaine, xanthophyll, etc.), an alcoholic extract is obtained which is used in the fight against malaria, and the tincture in lung diseases. From achenes, given the content in phytin, lecithin, cholesterol, products were prepared indicated in the prophylaxis of dysentery, typhoid fever and for the healing of suppurative wounds. The oil is used (in folk medicine) to macerate plants used to treat wounds and burns. Sunflower is not a very demanding plant, the expenses with this crop are too high for us: nitrogen and phosphorus fertilization is moderate, the requirements are high compared to potassium, but we have abundant refunds here, the costs for seed are comparable to those of corn. Also, sunflower adapts better than corn, on lands with medium quality soils and better withstands water stress. At the same time, the calendar of agricultural works such as land

preparation, sowing, chemical weed control, harvesting can be done without hindering the works intended for other agricultural crops. There are also a number of inconveniences of the flower - sun that impose very serious restrictions on rotation, excluding monoculture and return to the same land earlier than 6 years, susceptibility to disease, difficulties in placement after many plants with common pests and diseases, high consumption of water and nutrients from the soil, which requires fertilization of post-market crops by applying high doses of fertilizers. In 2019, Romania ranked first in the EU both in terms of sunflower production and cultivated area. The spectacular increase in sunflower cultivation in recent years is due to the possibility for growers to establish the structure of crops according to the market, the involvement of oil factories in cultivation and subsidization, greater stability of sunflower production, due to greater tolerance of its drought.

### **Mathematical Analysis, To Identify the Trend of the Evolution of Sunflower Production**

The analysis and calculations were performed for the sunflower crop, but can also be extended to the main vegetable crops: grain cereals, grain legumes, oil plants, beets, medicinal and aromatic plants, tobacco, fodder, etc.

#### **Study period - 30 years between 1990-2020**

Primary data were considered regarding the cultivated land areas (hectares) and the realized production (tons).

### **General Conclusions**

A primary statistical analysis on the sequence of the period 1990-2021, reveals a good direct correlation, worth 0.73 for the considered dynamic series: cultivated area and production, which leads to the conclusion of the possibility of a comparative study and, respectively, to appropriate mathematical models. The statistical analysis of the dynamic series is based on a system of indicators, which characterizes both the quantitative relationships within the series and the entire time period to which the data refer. Thus, the statistical analysis performed in this study is performed by calculating descriptive statistical indicators.

### **Research Method**

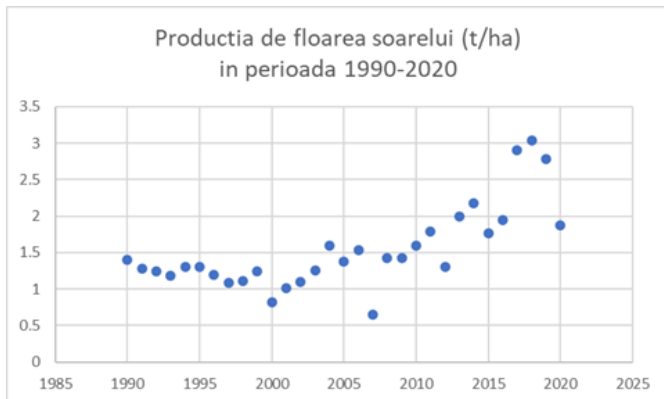
As a general method, the research uses the statistical apparatus applied dynamic data series consisting of annual production per ha (t / ha) over the last three decades and its statistical analysis using the method of indicators and statistical indices. Although the homogeneity of the dynamic series is difficult to ensure, for the homogeneity analysis a single calculation and evaluation procedure was used, ensuring the delimitation on qualitatively different stages in the evolution of the phenomenon of indicators

studied in dynamics, keeping the same length of time intervals and maintaining the periodicity. The series is formed. The length of the considered series and the collection of the studied data meet the condition of large numbers, being in a sufficient number of data for the horizon of statistical analysis that correctly substantiates the performed calculations. These characteristics give continuity to the data in terms of time variables and, on the other hand, give the possibility to model the dynamic series with an analytical function. Of time this is the main reason why the establishment of the unit of time to which the chronological series analysis refers is made in relation to the declared purpose of the research, of the content and of the possibilities of quantification of each indicator.

### Result (Table 1,2) (Figure 1)

The third part of the study highlights

- average indicators calculated from absolute values 0.7938 t and 0.02, respectively from relative values: the average annual index obtained in the amount of 100.98% and the average growth rate, resulting in the value of 0.98%
- The average dynamic (growth) index resulting in 1.01
- The resulting chronological average of 1.51 t / ha.



**Figure 1:** Authors calculations, according to the National Institute of Statistics, TEMPO-on-line basis.

**Table 1:** The first part of the study calculates the crop production per hectare and the corresponding graphical representation.

Year	Area cultivated (ha)	Annual production (t)	Annual production (t/ha)
1990	394741	556242	1.4
1991	476848	611956	1.28
1992	615050	773986	1.25
1993	588367	695833	1.18
1994	582192	763697	1.31
1995	714490	932932	1.3
1996	916784	1095596	1.19

1997	780746	858060	1.09
1998	962150	1073316	1.11
1999	1043011	1300929	1.24
2000	876807	720871	0.82
2001	800282	823549	1.02
2002	906219	1002813	1.1
2003	1188037	1506398	1.26
2004	976960	1557813	1.59
2005	970950	1340940	1.38
2006	991363	1526232	1.53
2007	835923	546922	0.65
2008	813891	1169936	1.43
2009	766080	1098047	1.43
2010	790814	1262926	1.59
2011	994984	1789326	1.79
2012	1067045	1398203	1.31
2013	1074583	2142087	1.99
2014	1001020	2189309	2.18
2015	1011527	1785771	1.76
2016	1039823	2032340	1.95
2017	998415	2912743	2.91
2018	1006994	3062690	3.04
2019	1282697	3569150	2.78
2020	1170372	2204312	1.88

### Interpretation of values of dynamics indicators

The results of the calculations reveal a very stationary almost easily favourable evolution of the sunflower production characterized by the following combination of indicators: supraunitary dynamics index, dynamics rhythm and absolute positive change.

### Conclusions

For the considered dynamic series, it is recommended to use the average indicators as a way of presentation for the evolution of the corresponding qualitative characteristics.

- The values of the average indicators resulting from the analysis reveal a slightly increasing evolution that requires the taking of special measures for a short, medium or longer period of time to increase the production qualitatively and quantitatively.
- The results obtained from the analysis reflect a weakly favourable situation in the evolution of sunflower production during the research period reflected in the following combination of indicators: super unit dynamics index, dynamics rhythm and positive absolute change, but almost insignificant in value.

- The evolution of sunflower production in the researched period can be grouped into 3 sub periods, quantitatively characterized as follows:
- The first decade, 1990-2000, except for the years 1994, 1998 and 1999, saw a slight decrease in production
- The second decade, 2001-2011, except for the years 2005 and 2007 reveals a slight increase in annual production
- The last decade, 2012-2020 shows a relative instability, alternating as evolution.
- The last 2 years, respectively 2019 and 2020 show a slight decrease in sunflower production.

**Table 2:** The second part of the study calculates the absolute, relative and average indicators, both with a fixed and a mobile base.

Year	Absolute indicators			Relative indicators (%)			
	Level	Absolute changes		Dynamic indices		Growth rate	
	Annual production (t/ha)	with fixed base	with mobile base	with fixed base	with mobile base	with fixed base	with mobile base
1990	1.4	0	-	1.0000	-	0	-
1991	1.28	-0.12	-0.12	0.9143	0.91	-0.0857	-0.0857
1992	1.25	-0.15	-0.03	0.8929	0.98	-0.1071	-0.0234
1993	1.18	-0.22	-0.07	0.8429	0.94	-0.1571	-0.0560
1994	1.31	-0.09	0.13	0.9357	1.11	-0.0643	0.1102
1995	1.3	-0.1	-0.01	0.9286	0.99	-0.0714	-0.0076
1996	1.19	-0.21	-0.11	0.8500	0.92	-0.1500	-0.0846
1997	1.09	-0.31	-0.1	0.7786	0.92	-0.2214	-0.0840
1998	1.11	-0.29	0.02	0.7929	1.02	-0.2071	0.0183
1999	1.24	-0.16	0.13	0.8857	1.12	-0.1143	0.1171
2000	0.82	-0.58	-0.42	0.5857	0.66	-0.4143	-0.3387
2001	1.02	-0.38	0.2	0.7286	1.24	-0.2714	0.2439
2002	1.1	-0.3	0.08	0.7857	1.08	-0.2143	0.0784
2003	1.26	-0.14	0.16	0.9000	1.15	-0.1000	0.1455
2004	1.59	0.19	0.33	1.1357	1.26	0.1357	0.2619
2005	1.38	-0.02	-0.21	0.9857	0.87	-0.0143	-0.1321
2006	1.53	0.13	0.15	1.0929	1.11	0.0929	0.1087
2007	0.65	-0.75	-0.88	0.4643	0.42	-0.5357	-0.5752
2008	1.43	0.03	0.78	1.0214	2.20	0.0214	1.2000
2009	1.43	0.03	0	1.0214	1.00	0.0214	0.0000
2010	1.59	0.19	0.16	1.1357	1.11	0.1357	0.1119
2011	1.79	0.39	0.2	1.2786	1.13	0.2786	0.1258
2012	1.31	-0.09	-0.48	0.9357	0.73	-0.0643	-0.2682
2013	1.99	0.59	0.68	1.4214	1.52	0.4214	0.5191
2014	2.18	0.78	0.19	1.5571	1.10	0.5571	0.0955

2015	1.76	0.36	-0.42	1.2571	0.81	0.2571	-0.1927
2016	1.95	0.55	0.19	1.3929	1.11	0.3929	0.1080
2017	2.91	1.51	0.96	2.0786	1.49	1.0786	0.4923
2018	3.04	1.64	0.13	2.1714	1.04	1.1714	0.0447
2019	2.78	1.38	-0.26	1.9857	0.91	0.9857	-0.0855
2020	1.88	0.48	-0.9	1.3429	0.68	0.3429	-0.3237
Source: Authors calculations, according to the National Institute of Statistics, TEMPO-on-line basis							

### Project development proposals through

- Extending the study to the main agricultural crops.
- Carrying out the analysis to highlight particularities arranged by geographical areas.
- Construction of a mathematical model to reveal the trend (trend) of production evolution by using statistical adjustment methods and tests to verify the hypotheses regarding the objective form of evolution during the period considered in the study.
- Linear and quadratic mathematical models can be used to generate the trend function through a one-factor model and to determine the estimators and errors so that the optimal model can be chosen.
- Extending the analysis of the properties of the dynamic series from the point of view of the characterization of the characteristics under the aspect:
  - Variability,
  - Homogeneity,
  - Comparability
- Comparative analysis of correlated data by determining the corresponding advance coefficients.
- Consideration of significant characteristics in terms of geographical area, soil type, weather conditions, and treatments performed, crop rotation, etc.

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